To Leave or Not to Leave: The Distribution of Bequest Motives

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May 19, 2004

Abstract

In this paper, we examine the effect of observed and unobserved heterogeneity in the desire to die with positive net worth. Using a structural life-cycle model nested in a switching regression with unknown sample separation, we find that roughly 70 percent of the elderly single population has a bequest motive that may or may not be active depending on the level of resources at a given age. Both the presence and the magnitude of the bequest motive are statistically and economically significant. All else being equal, households with an operative bequest motive spend between $4,000 and $9,000 a year less on consumption expenditures on average. We conclude that, among the elderly single households in our sample, approximately half of bequeathed wealth will be due to a bequest motive.

JEL Classification: D11, D12, D91, E21

Keywords: Bequest, bequest motive, heterogeneous preferences, wealth, saving

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* The opinions expressed are those of the authors and do not necessarily reflect the views of the Board of Governors of the Federal Reserve System or its staff members.

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I. Introduction

As of 2003, the cohort of those aged 50 or more had amassed a level of wealth never held before by a single generation. The disposition of this wealth over the next 50 years will have large consequences for the generations to follow. Will there be a massive surge in consumption in the decades to come? Or, will the next generation be the recipients of this golden egg? In this paper, we explore the possibility that, after accounting for lifetime resources, heterogeneity in the desire to leave bequests can explain much of the substantial variation in saving behavior observed among the elderly. In doing so, we estimate both the magnitude of the desire to leave a bequest and the proportion of the elderly population that has this desire.

In two papers, Michael Hurd examines the importance of bequests by noting that the difference between the change in wealth for households with and without a bequest motive provides a measure of the strength of the bequest motive (Hurd, 1987 and 1989). Hurd assumes that only people with children save for bequests. Contrary to the predictions of a strong bequest motive, Hurd (1987) finds that people with children decummulate their wealth *faster* than people without children. This finding holds even after controlling for initial income and wealth differences. Hurd (1989) estimates the parameters of a life-cycle model augmented with an egoistic bequest motive and finds the bequest motive to be statistically significant but economically trivial.

The approach in Hurd (1989) is compelling because it controls for the complex relationship between mortality risk, annuity income and liquidity constraints—a crucial requirement for examining bequest motives since U.S. law prohibits the use of social security benefits as collateral. We adopt this approach as well. However, it is not clear that simply having children implies a desire to die with bequeathable wealth. Nor is it clear that households without children lack such a desire. Large-scale heterogeneity in saving behavior owes to a combination of differences in preferences and outcomes (Venti and Wise, 1998; Dynan, Skinner, and Zeldes, 2002). In a sample of TIAA-CREF pension holders, Juster and Laitner (1996) find heterogeneity in preferences for bequests despite homogeneity in earnings, occupation, and education. This heterogeneity exists across households with and without children suggesting a potential problem with the identification strategy used in Hurd (1987, 1989).

Little is known regarding why individuals desire to leave a bequest, if they do at all. Empirical tests of the importance of bequest motives in the literature rely on the assumption of an operative bequest motive, either by selecting a group that definitely has the motive as in Hurd (1987, 1989) or by positing that either everyone has the motive or that nobody does, as in Altonji, Hayashi and Kotlikoff (1997). Nonetheless, if a bequest motive is strong for a certain segment of the population, it will be evident in the relative consumption of this group after conditioning on the structural relationship between mortality risk, wealth, annuity income and the possibility of future liquidity constraints. In this paper we examine consumption expenditures of the elderly in which both the presence of a bequest motive as well as the magnitude of how such a motive enters the decision making process is not assumed but is instead estimated. The estimation of our model is done in the framework of a switching regression where sample separation is unknown. In this context, whereas Hurd (1989) assumes perfect sample separation information regarding who has a bequest motive (households with children), we allow all households to have a bequest motive and let observed spending behavior determine the extent to which bequests are of economic importance.

Using panel data that provide detailed information on the financial resources of a sample of elderly households, we estimate a bequest motive that is substantially larger than found in Hurd (1989). Although we find the existence of children to be a borderline significant indicator of having a bequest motive, the hypothesis that it is a deterministic predictor is soundly rejected. We view this result as being consistent with Hurd's finding that households with children do not behave according to a bequest motive anymore than do households without children. However, rather than interpreting this as evidence against a bequest motive, we show that a significant portion of elderly households with and without children behave according to a statistically significant and economically meaningful bequest motive.

Our results suggest that roughly 70 percent of the elderly population has a bequest motive. By comparing the projected wealth profiles with and without a bequest motive, we conclude that 53 percent of the wealth measured in the sample of elderly single households is a result of a bequest motive. Although we also report results that are consistent with both an altruistic and strategic bequest motive, none of the evidence is significant. This is in line with the literature which suggests the desire to die with positive net worth is largely for egoistic reasons.[1]

The more flexible estimation strategy utilized in this paper comes at the cost of not being able to distinguish between a bequest motive and the desire to hold wealth for other reasons unrelated to utility from consumption, such as health expenses (Palumbo, 1998; Dynan, Skinner and Zeldes, 2002) or status (Carroll, 2000). However, we are able to qualitatively address these potential alternatives by comparing the results from the model to self-reported probabilities of leaving a bequest after conditioning on self-reported expected medical expenses. We find that among households with similar permanent income, wealth, and expected medical expenses, those

[1] For example, see Kuehlwein (1993), Wilhelm (1996), Laitner & Juster (1996), and Altonji, Hayashi and Kotlikoff (1997).

who consume in a way that is more consistent with a bequest motive also reported having a higher likelihood of leaving a bequest.

II. Related Literature

The extent to which bequests, and intergenerational transfers in general, are an important economic phenomenon has been debated extensively for the past two decades. Kotlikoff and Summers (1981) argue that as much as 46% of household wealth is accounted for by bequests while Modigliani (1988) argues that a much smaller 17% is more accurate.[2] The methodology used to obtain these numbers is affected by assumptions regarding how flows of bequests are converted into stocks of inherited wealth. Alternative estimates of the importance of bequests have used micro data which ascertain either the amount of wealth that has been inherited or the amount of savings planned for bequests. Most of these studies have found inherited wealth to be in the range of 15% to 31% of total household wealth (Menchick and David, 1983; Modigliani, 1988; Hurd and Mundaca, 1989; Gale and Scholz, 1994; Juster and Laitner, 1996). However, it is not clear that individuals accurately answer how much of their wealth was given to them opposed to being from the fruit of their own labor. Nor is it clear if returns to past inheritances are included in self-reported bequests. More importantly, measuring the amount of inheritances received does not distinguish between intended versus accidental bequests. On the other hand, simply asking individuals about expected future bequests is biased by past unexpected wealth changes and could say very little about saving behavior.

Analyses of bequests using micro data have focused on wealth at different stages during the life-cycle. This approach yielded an early critique of the life-cycle hypothesis of Modigliani and Brumberg (1954). The standard life cycle model predicts that wealth should begin to decline at some age and continue to do so until death. Although initial estimates using cross section data suggest household wealth increases with age (Menchik and David, 1983), later studies have shown a decline (Hurd, 1990).[3] Moreover, studies examining panel data report a declining

[2] These numbers are based on converting flows of bequests to a stock of inherited wealth. An alternative method is also used which is based on estimating life-cycle saving and then comparing the result to total wealth. With this method, Kotlikoff and Summers (1981) find total intergenerational transfers to be on the order of 81% while Modigliani (1988) finds 20%. The differences between the two estimates come from differences of opinion regarding 1) the timing of bequest transfers 2) educational expenses and 3) capital gains on received inheritances. Davies and Shorrocks (2001) surveyed the literature that was spawned by this debate and proposed a rough estimate of 34-45 percent for the contribution of inheritance to aggregate wealth.

[3] Possible reasons for the increasing age-wealth relationship in the cross section are 1) wealthy people live longer, 2) cohort differences require one to account for differences in tastes (as well as permanent income which would imply a more *positively* sloped wealth trajectory), 3) Hurd (1990) suggests that earlier studies had too much aggregation of age groups and that, the cross section wealth-age profile showed a decline when examining more disaggregated age groups.

trajectory (e.g. Diamond and Hausman, 1984; Hurd, 1987). Nevertheless, Hurd (1987) proves that a declining wealth trajectory need not preclude the possibility of a binding bequest motive. The addition of a bequest motive to the standard life cycle model simply flattens the wealth trajectory. Whether or not the trajectory switches from declining to increasing depends on the parameters of the model.

Indirect evidence concerning the existence of a bequest motive is mixed but largely supportive. Individuals act to decrease their tax liability through intergenerational transfers (Bernheim et al. 2001; Page, 2003; Bernheim et al. 2004; Joulfaian 2004) and offset public transfers by purchasing life insurance and selling annuities (Bernheim, 1991). Furthermore, the presence of a bequest motive aids in explaining the amount of total wealth in the U.S. as well as its distribution (Kotlikoff and Summers, 1981; Gale and Scholz, 1994; Bernheim et al., 2001).

Despite the potential presence of a bequest motive, there is little evidence that individuals leave bequests for altruistic reasons. Linking parents' and childrens' income tax returns to parents' estate tax records, Wilhelm (1996) finds evidence inconsistent with the compensatory bequest implications of an altruistic bequest model. Although Laitner and Juster (1996) note that roughly one-half of TIAA-CREF annuitants conform to the altruistic model, they show little evidence of altruism toward one's children in the full sample. Estimating the first-order conditions of a model of altruism that is robust to uncertainty and liquidity constraints, Altonji, Hayashi and Kotlikoff (1997) find that parents do not offset inter-vivos transfers given an increase in their children's permanent income. They conclude that this is a strong rejection of intergenerational altruism. Laitner and Ohlsson (2001) find only weak evidence for parental altruism in the U.S. and Sweden. The very rich who are subject to estate taxation, and who are virtually certain to leave a bequest do not appear to pursue tax avoidance strategies such as intervivos giving (McGarry, 1999; Poterba, 2001). This suggests motives other than the maximization of a dynastic utility function.

III. The Data

We use panel data from the Asset and Health Dynamics Among the Oldest Old (AHEAD) survey, a survey of households born in 1923 or earlier. At the time of the initial wave in 1993, these households had at least one age eligible respondent of age 69 or older. Households that maintained at least one living member were interviewed again in 1995, 1998 and 2000. Since the purpose of the AHEAD is to examine the relationship between age-related health changes in the elderly and the economic resources available to these households, it is ideally suited for the examining the effects of a bequest motive on behavior.

The initial 1993 wave of the AHEAD consists of 6,046 households of which 4,362 had at least one living member that was interviewed in the subsequent three waves. In order to make the data consistent with the theoretical model described below, the sample is restricted to single households that claim to be retired and not working. With these restrictions, there are 1,575 households present in all four waves. All analyses use compensatory household weights which control for unequal selection probabilities as well as geographic and race group differences in response rates.

Respondents were asked extensively about their economic resources. This includes detailed information regarding all sources of regularly occurring income: social security income, supplemental security income, welfare, food stamps, veteran's benefits, retirement pensions, and annuities. In each wave of the survey, respondents noted the amount of each type of income received, how long the income is expected to last, and whether the income source is adjusted for increases in the cost of living. We use this information to construct a profile of total income for each survey and then combine them to create a single profile that utilizes the most current information: income from 1995 to 1998 is based on the 1995 survey, income from 1998 to 2000 is based on the 1998 survey, and income from 2000 forward is based on the 2000 survey.[4] Non-regularly occurring income, such as financial assistance from friends and family as well as cash-out withdrawals of retirement accounts are added to earnings in the relevant survey period but assumed to not continue into the future.[5]

Household respondents also provided detailed balance sheet information. The specific components of net worth include equity in a main home, other real estate (including a second home), vehicles, owned business, investment retirement accounts, corporate equities and mutual funds, transaction bank accounts, CD's and saving bonds, corporate and government bonds, assets in a trust, other assets (such as art, jewelry and collectibles), and other noncollateralized debt (such as credit card debt or debts owing to medical treatment).

Table 1 shows the sample means of total net wealth and its components from each survey year. In general, the level of wealth is consistent with alternative surveys of household wealth.[6]

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[4] Income sources are assumed to last for as long as the respondent claims they will last. If the income source is adjusted for cost-of-living increases, the level of income is held constant in real terms. Otherwise, future income values are discounted by the CPI-U as forecasted by Social Security Administration.

[5] Only a small fraction of households receive transfers from friends and family. The assumption that these transfers do not continue in the future has little impact on our results. Any potential bias is toward finding no bequest motive.

[6] The Panel Study of Income Dynamics suggests that, among unmarried individuals older than age 70 that are alive in both the 1994 and 1999 survey, mean wealth is $161,037 in 1994 and $196,714 in 1999. An alternative source of data is the Federal Reserve's Survey of Consumer Finance. Restricting the SCF to

However, the $40,404 increase in total net wealth between 1993 and 1995 is puzzling. As indicated in the table, most of the change owes to a large increase in the value of stocks and mutual funds. Although an increase of this magnitude would be consistent with large and varying capital gains, the rate of return to equities from 1993 to 1995 was substantially smaller than in the subsequent periods. In particular, the Standard & Poor's index of common stock rose at an annual rate of 7 percent in real terms between 1993 and 1995 but rose 23 percent (annual rate) from 1995 to 1998 and then another 11 percent (annual rate) from 1998 to 2000. Table 1 also reports the share of total net worth for each subcomponent. The doubling of the share of wealth in stocks and mutual funds from 1993 to 1995 is again suspicious, particularly given its relative constancy in all subsequent years. We contend that the initial wave of interviews lacked the degree of respondent rapport present in the later surveys. Since such a large *increase* in wealth has the potential to bias the results toward finding evidence of a strong bequest motive, the 1993 wave is not used in the estimation of the model.

Table 1 shows that mean net wealth fell between 1995 and 1998 but increased over the subsequent two years. However, this cannot be interpreted as evidence against the standard life-cycle model since it neglects the influence of asset returns. Indeed, differential rates of return to wealth could bias any cross-household comparison of wealth changes. To address this issue, the AHEAD provides information allowing capital gains to be netted out of the change in wealth. Along with balance sheet information, respondents were asked about the net transactions in each component of wealth. The sum of these transactions provides a measure of household saving. In turn, the level of saving can be used to define capital gains (the difference between the change in wealth and saving) and consumption (the difference between total income and saving). We estimate the theoretical model using this measure of consumption.

Table 2 reports the mean and median of total income, saving, capital gains and consumption from 1995 to 1998 and 1998 to 2000. Before computing the sample statistics, the values are annualized by using the individual specific number of months between survey dates.[7] As implied by the standard life-cycle hypothesis, average saving is negative in both periods. However, although capital losses contribute further to the decline in wealth in the first period, capital gains are sufficient to more than offset the decline in saving in the latter period. Consumption expenditures are relatively smooth across the two periods, both in terms of the mean—about $20,000—and the median—about $13,000. These estimates are roughly in line

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unmarried households age 72 and older in 1995, mean wealth was $182,536 in 1995, $179,869 in 1998 and $244,874 in 2001.

[7] The average number of years between the 1995 and 1998 wave is 2.86 and the average number of years between the 1998 and 2000 wave is 2.11.

with alternative surveys of consumption. The 1997 Consumer Expenditure Survey (CEX) suggests that, on average, non-married, non-working individuals older than age 70 spent about $16,300 on consumption. The median of expenditures in the CEX is $13,456.

The results in table 2 are insufficient to adequately assess the strength of the bequest motive. Household saving in the AHEAD is negative as indicated by the life-cycle model without a bequest motive, but household wealth does not appear to decline much over the five year span of the AHEAD. In order to properly condition upon varying mortality risk, income profiles, and liquidity constraints, more structure is needed. The next section provides this structure.

Estimates of mortality hazard rates are based on the life-tables from the National Institute of Health. Although these tables are arrayed by birth-cohort, age and gender, a substantial literature has noted that mortality is also related to wealth and race (Smith, 1999; Deaton, 2003). We incorporate these indicators of mortality risk by combining the life-tables with a model of mortality that conditions on age, birth-cohort, permanent income and race. Permanent income is used in place of wealth for two reasons. First, it more adequately reflects the part of lifetime resources that have the potential to influence long-term health outcomes. Second, since lifetime income is likely to be more exogenous than wealth, it raises fewer concerns when used as a regressor in a model that estimates the bequest motive. Social security income is used as a proxy for permanent income. The appendix provides a detailed description of the mortality model and how it is used to modify the life-tables.

IV. Theoretical Model

Taking income $\{y_t\}_{t=s}^{T}$ as given, single elderly households that are permanently out of the labor force optimally allocate their bequeathable wealth (w_s) over their remaining life cycle. Following the life cycle model of Yaari (1965), a household at age *s* is assumed to solve the following intertemporal allocation problem:

$$V\left(w_s\right) = \underset{c_s, c_{s+1}, \ldots, c_T}{Max} \sum_{t=s}^{T-s} \beta^{t-s} \left(a_t u\left(c_t\right) + m_t b\left(w_t\right)\right)$$
$$\textit{subject to } w_{t+1} = \left(1+r\right) w_t + y_t - c_t$$
$$w_s \textit{ given},$$

where w_t and c_t are the household's wealth and consumption at age *t*.[8] The probability of being alive at age *t* is given by a_t and the probability of dying at age *t* is given m_t with the convention

[8] We choose to not model the taxation of estates. Over the time period examined in this paper, estate taxes applied to estates larger than $600,000. Only a few individuals in our sample have wealth in this range.

that death occurs at the beginning of the period. Households die with certainty by age T. Future utility is discounted by the factor of time preference β. Households place value on consuming while alive and leaving some wealth upon death. The period utility function is isoelastic, $u(c) = (1-\gamma)^{-1} c^{1-\gamma}$.

Utility from leaving a bequest is assumed to be linear in wealth, $b(w_t) = \alpha w_t$, where α is a constant. This specification is preferred for two reasons. First, much of the empirical evidence cited above favors this simple egoistic motive over a more complex motive of altruism. Second, the specification introduces an intuitive notion of bequests as a luxury good: as wealth increases, the marginal utility from bequests increases relative to the marginal utility of consumption. As noted by Cooper (1979), "Persons in the wealth category we are now discussing have more current income that they can expend. Beyond a certain point, the real value of greater wealth is power, control, and security." At the same time, less wealthy individuals still enjoy the possibility of leaving a bequest in the case of a premature death.

Constraints on the ability to borrow against future income are an important aspect of the allocation problem facing the elderly. In particular, U.S. law forbids using social security income as collateral. We explicitly model this constraint in the dynamic budget equation. At any age N,

$$w_{s+N} = \left(1+r\right)^{N} w_s + \sum_{t=s}^{s+N} (1+r)^{t-s} \left(y_t - c_t\right) \geq 0 \qquad N = 1,\ldots,T-s. \tag{1}$$

Given isoelastic utility, it is straightforward to show that the optimal consumption profile satisfies the following Euler equation

$$\left(c_{t+1}/c_t\right)^{-\gamma} \geq \left(\beta\left(a_{t+1}/a_t\right)\right)^{-1}\left(1+r\right) - \left(m_{t+1}/a_{t+1}\right)\alpha c_t^{-\gamma}. \tag{2}$$

Without mortality risk, the standard relationship between the rate of return on wealth and the degree of impatience defines the slope of the consumption profile until the penultimate period of life, at which point the bequest motive would be influential.[9] In contrast, mortality risk not only affects the rate of time preference but, when combined with a linear bequest motive, generates an inverse relationship between the growth rate of consumption and the level of consumption. In general, any examination of the bequest motive based on the growth rate of consumption must also account for mortality risk.

There are three possible qualitative solutions to the life-cycle model depending on whether or not the liquidity constraint binds at the end of life (Hurd, 1989). The Euler equation determines the shape of the consumption profile, and its location is pinned down by the restriction that the optimal wealth trajectory yields positive or zero wealth at age T. In the first case, the wealth constraint is not binding at age *T*. If a household reaches age *T* with positive net worth, the optimal consumption path is given by

$$c_t^{-\gamma} = \alpha \sum_{j=t+1}^{T} \left(m_j / a_{j-1} \right) \left(\beta \left(1+r \right) \right)^{j-t} . \quad (3)$$

This path does not depend on income or wealth. It is the "satiation" path of consumption that gives an upper bound for consumption at any given age. A household follows this path if it is able to finance it; that is, if following this path keeps wealth positive at all ages. If wealth reaches zero at age *T*, then consumption is low enough so that the marginal utility from consumption exceeds the guaranteed marginal utility from bequests. In the second case, wealth reaches zero at age *T*. The slope of consumption is determined by the Euler equation and the level is determined so that wealth is exhausted by age *T*. In the third case, wealth reaches zero at some age $N < T$. Until age *N*, the slope of consumption is determined by the Euler equation and the level is determined by condition (1), which implies that the present discount sum of dissaving between age *t* and *N* is equal to initial wealth. For age $t > N$, consumption follows the path of income if they satisfy the following condition:

$$a_t y_t^{-\gamma} \geq \beta \left(1+r \right) \left(a_{t+1} y_{t+1}^{-\gamma} + m_{t+1} \alpha \right) . \quad (4)$$

When income is constant (for example, if all income comes from a real annuity), this exhausts all possible solutions. However, if income varies with age, the constraint may be binding a number of times and the solution consists of multiple segments in which consumption follows the Euler equation, but separated by periods when the wealth constraint is active and consumption follows the path of income. Throughout the rest of the paper, we assume that households follow the solutions outlined here. In the next section we outline the empirical model.

V. Empirical Model

In this section, an empirical model is developed that is used to obtain an estimate of both the presence and strength of a bequest motive. We assume that the theoretical model describes the behavior of a household in one of two regimes: households with a bequest motive ($\alpha > 0$), and households without a bequest motive ($\alpha = 0$). The regime in which a household resides depends on various observable characteristics and an unobservable idiosyncratic component. These characteristics, including the unobservable component, are fixed in time and so households do not switch regimes. Put differently, a researcher who analyzes a sample drawn from the population is not able to ascertain with full confidence the regime an individual is in but is able to arrive at a probability that the individual is in a particular regime. To the extent that the sample is

[9] Without mortality risk, the probability of death is zero until the last period of life.

representative of the whole population, the probabilities correspond to the actual distribution of the presence of a bequest motive in the population.

Define the function $g(x_i;\theta,\alpha,\tau)$ as the solution to the life-cycle model where $x_i=[w_{si},\{y_t,a_t,m_t\}_{t=s_i}^{T}]$. The function $g(.)$ takes the characteristics of a given household along with a given set of parameters, solves for the optimal consumption profile between 1995 and the year the household turns 119 years old, and returns the optimal value of consumption from 1995 to 1998 for $\tau=1$ and from 1998 to 2000 for $\tau=2$. The function $g(.)$ depends on initial wealth in 1995, the lifetime path of income, survival and mortality probabilities , and the parameters of the model, $\theta=[\beta,\gamma,r]$, where β is the factor of time discounting, γ is the inverse of the intertemporal rate of substitution and r is the rate of return which is set to 2.6 percent.[10] The function $g(.)$ also depends on the marginal utility of leaving a bequest, α. The econometric model is as follows:

$$\begin{cases} c_{i\tau}=g\left(x_i;\theta,\alpha,\tau\right)+\varepsilon_{1i\tau} & \textit{if } I_i>0 \text{ (}\textit{bequest motive, regime } 1\text{)}, \\ c_{i\tau}=g\left(x_i;\theta,0,\tau\right)+\varepsilon_{2i\tau} & \textit{if } I_i\le 0 \text{ (}\textit{no bequest motive, regime } 2\text{)}, \\ I_i=\lambda' z_i+\eta_i & \text{(}\textit{switching equation}\text{)}, \end{cases} \tag{5}$$

where, z_i is a vector of bequest motive indicators and λ is a vector of the corresponding coefficients. The switching equation determines the presence of the bequest motive while the magnitude of α determines its strength.

We assume that the unobserved idiosyncratic component in the presence of a bequest motive, η_i, is normally distributed. The error term in regime *k*, $\varepsilon_{ki\tau}=u_\tau+e_{ki\tau}$, reflects transitory consumption where u_τ is a constant aggregate shock that occurs to all households at time *t* and the error term $e_{ki\tau}$ is normally distributed and independent beyond one period.[11] The correlation between $e_{ki\tau}$ and $e_{ki\tau+1}$ is given by ρ. We assume that the unobservable determinants of having a bequest motive are unrelated to transitory consumption, $E[\eta_i\varepsilon_{ki\tau}]=0$. So as to minimize the potential dependence of x_i on $\varepsilon_{ki\tau}$ and η_i, the optimal consumption profile generated by $g(\cdot)$ is based on wealth as of 1995, w_{si}. The value of wealth in 1998 is not used as an initial condition for computing optimal consumption between 1998 and 2000 because it is correlated with ε_{ki1}.

[10] The real interest rate is set to the 1995 to 2000 average rate of return on a three month treasury bill less the percent change in the CPI.
[11] Transitory consumption reflects both behavioral deviations from the model as well as measurement error in the data.

Identification of the bequest motive in the empirical model comes from the assumption that the data is a mixture of two normal distributions conditioned on the structural form of the life-cycle model. This has several advantages over a reduced form specification. Foremost, the structural identification does not require assumptions regarding which households have a bequest motive. Second, the structural specification conditions on the whole path of annuities and mortality rates. A parsimonious reduced form specification could not adequately capture the effects of liquidity constraints and mortality risk, and so would be misspecified. Third, by using a fully specified structural model we are able to estimate behavioral parameters instead of reduced form coefficients that are difficult to interpret in terms of behavioral parameters.[12]

Idiosyncratic transitory consumption in regime *k* is given as $e_{ki\tau} = c_{i\tau} - g(x_i;\theta,\alpha_k,\tau) - u_\tau$, where $\alpha_k = \alpha$ in for $k = 1$ and $\alpha_k = 0$ for $k = 2$. Since sample separation is unknown, each observation contributes a weighted average of two probabilities to the likelihood function:

$$l\left(x_i, z_i;\theta,\alpha,\lambda,\sigma\right) = \Phi\left(\lambda' z_i\right)\phi\left(e_{1i1}, e_{1i2};\sigma\right) + \left(1-\Phi\left(\lambda' z_i\right)\right)\phi\left(e_{2i1}, e_{2i2};\sigma\right), \qquad (6)$$

where $\phi(.)$ is the *p.d.f.* of a two-dimensional normal distribution with the second moments given by σ, a vector of the standard deviations in periods 1 and 2 (σ_1, σ_2) and the intertemporal correlation (ρ), and $\Phi(.)$ is the *c.d.f.* of a standard normal distribution. We assume the standard deviation of transitory consumption is constant across regimes. Given the complex survey design of the AHEAD, we maximize the likelihood function using household level population weights.[13]

Household wealth is measured with considerable error and the same is certainly true for saving, which is used to define consumption. The data include two periods of consumption for each household, the first period measures consumption between 1995 and 1998 and the second period measures consumption between 1998 and 2000. Large swings in consumption resulting from measurement error bias the parameter estimates. So as to reduce the impact of influential outliers, the sample distribution of changes in consumption over the two periods is trimmed. In addition to reducing the effect of measurement error, trimming the data also eliminates valid observations. The result is a truncated sample that implies a truncated error distribution endogenous to the model parameters. A modified likelihood function that accounts for the potential of sample selection bias is used to estimate the model.[14]

[12] An alternative interpretation of our approach is as a simulation exercise that relies on data-driven rather than arbitrarily selected parameter values. We show that allowing for heterogeneity in the presence of a bequest motive yields results that fit the empirical patterns in consumption remarkably well.
[13] Sakata (2002) shows that the quasi-maximum likelihood estimator using household survey weights yields consistent and asymptotically normal estimates.
[14] A formal presentation of the modified likelihood function is provided in the appendix.

The truncated sample restricts the change in annual consumption to be between -$70,000 and less than $70,000. This trim drops 440 observations. The top trim drops 245 observations while the bottom trim drops approximately 195 observations.[15] We also delete observations with negative wealth in 1995, 1998 or 2000 (48 observations), and for whom we do not have information about income (5 observations). Our final sample includes 1,082 observations. The model is estimated using the numerical algorithm described in the appendix. Variances of the parameter estimates are computed as the outer product of the contributions to the first derivatives of the log likelihood function with respect to the parameters.[16]

VI. Results

Various specifications of the switching equation are used in estimating the empirical model. The maximum likelihood estimates are reported in tables 3 and 4. The estimates correspond to consumption at a two year frequency. As a matter of presentation, the estimated bequest motive parameter is reported as $\alpha^{-1/\gamma}$. This transformation provides an intuitive dollar-value interpretation. For households that do not exhaust their wealth by the end of life, (3) implies that consumption at age *T* is $\alpha^{-1/\gamma}$. That is, $\alpha^{-1/\gamma}$ is the level of consumption that makes one indifferent between consuming and leaving a bequest in the last period of life. When consumption is less than this amount at age *T*, the marginal utility of consumption exceeds the marginal utility of leaving a bequest, and consumption is more attractive. In general, a large value of $\alpha^{-1/\gamma}$ implies a weak bequest motive.[17]

The first column of table 3 tests the validity of assuming with certainty that only households with children have a bequest motive. This is the assumption made in Hurd (1989), and it implies that 82 percent of the sample has a bequest motive. We estimate the model by imposing that households with children have a bequest motive and that the switching equation error is zero with a zero variance.[18] Although the estimate of the time discount factor is implausible and the elasticity of substitution is close to zero, the bequest motive is in line with the result in Hurd (1989). The level of consumption over two years that makes households indifferent between consuming and leaving a bequest in the last period of life is $239,323 and is

[15] Our estimates are robust to more restrictive trims (-$50,000 to $50,000) as well as to less restrictive trims (-$90,000 to $90,000).
[16] If the model is properly specified, this is equivalent to the information matrix in terms of expected values.
[17] Standard errors are corrected for this transformation using the delta method.
[18] In terms of (6), $\Phi(\lambda' z_i)$ equals one for households with children, and it equals zero for households without children.

highly significant.[19] This level of consumption is well above that of most households suggesting that bequests are largely due to uncertain mortality.

Comparing the predicted consumption profiles with and without a bequest motive reveals the implied strength in the desire to leave a bequest. The average of predicted two-year consumption over the sample period for households without children (no bequest motive) is roughly $28,499. Predicted two-year consumption for households with children (bequest motive) is $28,465. The difference is trivial and suggests that the bequest motive is essentially inactive, conditional on the identifying assumption that only those households with children have a bequest motive. This is the same conclusion found in Hurd (1989).

The second column in table 3 reports the estimated parameters of the model under imperfect sample separation information. Only a constant is considered in the switching equation. The behavioral parameters are within the range of values typically reported in the literature and are significant at standard levels of significance. Abstracting from mortality risk, future utility is discounted at a rate of 0.95 over two years (approximately 0.975 annually), and the estimated elasticity of intertemporal substitution is 0.39. Transitory consumption has a standard deviation of roughly $25,000 and is somewhat persistent with an intertemporal correlation of 0.26.

The level of consumption over two years that makes households indifferent between consuming and leaving a bequest is $53,726, significantly lower than implied by the assumption that only households with children have a bequest motive. The estimate is highly significant. The constant in the switching equation suggests that the probability a household has a bequest motive is 71 percent. This does not correspond to the probability of leaving a bequest because households can die with positive net worth due to uncertain mortality. Indeed, the parameters of the model indicate that only 12 percent of the sample are consuming at the satiation level of consumption given by (3). Households below the satiation level of consumption may or may not leave a bequest depending on their length of life. Nonetheless, the bequest motive clearly affects the consumption of those households for whom the motive is present. If all households had a bequest motive, the average predicted two-year consumption over the sample period would be $33,315. In contrast, assuming that households do not have a bequest motive suggests a level of annual consumption equal to $44,697.

Overall, allowing the presence of a bequest motive to vary across all households greatly improves the fit of the model. The specification in the first column of table 3 is a special case of

[19] Using the parameters estimated by nonlinear two-stage least squares in Hurd (1989), the implied level of consumption over two years that makes a household indifferent between consuming and leaving a bequest

the switching regression and can be formally compared to the specification in the second column using the likelihood ratio test. The difference in the log-likelihood between the two specifications is overwhelmingly significant.

Although the presence of children is clearly not a definitive predictor of the presence of a bequest motive, it is still be a useful indicator. The results in the third column of table 3 control for the presence of children in the switching equation. The estimated effect of having at least one child is significant at the 10 percent level, and it implies that households with children have a 75 percent probability of having a bequest motive, and that those without children have a 57 percent probability. [20] Neither the behavioral parameters nor the properties of transitory consumption are significantly altered from the specification in which no bequest motive indicators are included in the switching equation.

Restricting the sample to households with children has little effect on the results, as reported in the final column of table 3. The time discount factor is somewhat stronger but this is offset by a larger elasticity of intertemporal substitution, and the properties of transitory consumption are unchanged. The constant in the switching equation indicates that 78 percent of households with children have a bequest motive, similar to what was found when estimating over the entire sample and including an indicator for having children.

A more detailed examination of the effect of children on the presence of a bequest motive is provided in table 4, which reports the results from alternative specifications of the switching equation.[21] The estimates of the behavioral parameters are essentially unchanged from those reported in table 3 and so are not shown. As indicated in column one, households with two children have the largest and most significant probability of having a bequest motive. However, the effect of children on the presence of a bequest motive is insignificant when grandchildren are included in the specification. The point estimates in the second column of table 4 suggest that, among households without grandchildren, the probability of having a bequest motive varies between 32 percent for those more than two children and 61 percent for those with two children. The presence of grandchildren significantly increases the probability of having a bequest motive by roughly 29 to 36 percentage points, depending on how many children are present.

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in the last period of life is $359,106.

[20] At the 10 percent significance level, the critical value of a chi-squared variable with one degree of freedom is 2.71. The difference in the log-likelihood between the second and third column of table 3 is 1.94. Therefore, the likelihood ratio test fails to reject (at the 10% level) the hypothesis that the coefficient on the child dummy is zero.

[21] The interpretation of these results must be tempered by the fact that the indicators considered in the switching equation may be endogenous.

It is assumed that households with a bequest motive receive utility from having wealth at death primarily for egoistic reasons. However, the financial characteristics of a household's children could influence the presence of a bequest motive insofar as households desire to leave bequests for altruistic reasons. To examine the possibility of an altruistic bequest motive, the model is estimated over households with children, and various financial and demographic characteristics of the children are included in the switching equation. The switching equation also controls for the number of children and the presence of grandchildren. Although this may not conclusively reveal the type of bequest motive because the model is still restricted to a constant bequest motive parameter, it does indicate how the presence of a bequest motive varies across households with children. The results are reported in the final column of table 4.

In general, the point estimates are consistent with an altruistic motive for desiring to leave a bequest. However, none of the characteristics are significant suggesting that the assumption of an egoistic bequest motive is plausible. Among households with the same number of children, those with children who are financially better off have a lower probability of having a bequest motive relative to those with children that are worse off. Having children that are college educated also lowers the probability of having a bequest motive. Insofar as a college education implies more human capital, this could be interpreted as intergenerational altruism. However, it could also indicate a substitution of intervivos transfers in the form of college expenses for bequests. Regardless, the effects are insignificant. In contrast, households with children that own their own home are more likely to have a bequest motive.

An alternative to the egoistic and altruistic bequest motive is the strategic motive, which suggests that bequests are used as compensation for services rendered by the beneficiaries (Bernheim, Shleifer, and Summers, 1985). All else being equal, it is likely that children who live near their parents spend more time attending to the needs of their parents. To examine this, the number of children that live within ten miles of the parent is included in the switching equation. The result, reported in the final column of table 4, is consistent with the strategic bequest motive hypothesis. Relative to the typical household, those with an additional child that lives within ten miles have roughly a ten percentage point higher probability of having a bequest motive. However, as with the other characteristics, the result is insignificant.

As an informal test of reasonableness of our results, the performance of the model is examined by comparing the predicted consumption profile to independent data on expenditures in the Consumer Expenditure Survey (CEX). Restricting the CEX to single, nonworking households that are age 70 and higher, total expenditures are regressed on a full set of single-year age indicators. The sample is restricted to the 1993 to 1997 waves of survey to match the same cohorts in the AHEAD. The fitted expenditure profile is shown in Figure 1 along with two standard error bands. This is compared to predicted consumption from the estimated life-cycle model that includes a constant and an indicator of children in the switching equation (specification *iii* in table 3). Consumption is predicted for each household assuming a bequest motive, $\{\hat{c}_{1it}\}_{t=s_i}^{T}$, and also generated assuming no bequest motive, $\{\hat{c}_{2it}\}_{t=s_i}^{T}$. A weighted average yields each household's unconditional consumption profile where the weights are given by the probability of having a bequest motive, $\{\hat{c}_{it}^{u} \equiv \hat{p}_i\hat{c}_{1it} + (1-\hat{p}_i)\hat{c}_{2it}\}_{t=s_i}^{T}$ with $\hat{p}_i = \Phi(\hat{\lambda}'z_i)$. Averaging $\hat{c}_{it}^{u}$ by age is not comparable to the fitted CEX profile since the CEX is subject to mortality bias. Correcting for survival rates that are conditioned by age, gender, cohort, race and permanent income, the predicted unconditional consumption profile is given by $\{\overline{c}_t^{u} = N^{-1}\sum_{i=1}^{N}\hat{a}_{it}\hat{c}_{it}^{u}\}_{t=72}^{90}$ and shown in Figure 1. The predicted level of consumption is roughly in line with expenditures in the CEX, and the two profiles share the same downward trajectory. However, the predicted consumption profile masks a sizable degree of heterogeneity that depends on the presence of a bequest motive. As indicated in Figure 2, households without a bequest motive consume a fair bit more on average than the unconditional average.[22]

The difference in consumption between households with and without a bequest motive provides the necessary information needed to determine the fraction of wealth attributable to the bequest motive. Using the predicted conditional consumption profiles, along with the budget constraint, a wealth profile is generated for each household assuming a bequest motive is present, $\{\hat{w}_{1it}\}_{t=s_i}^{T}$, and another wealth profile is generated assuming no motive is present, $\{\hat{w}_{2it}\}_{t=s_i}^{T}$. The share of bequeathed wealth attributed to the desire to leave a bequest is then computed as

$$\sum_{t=70}^{119}\sum_{i=1}^{N}\hat{m}_{it}\hat{p}_i(\hat{w}_{1it} - \hat{w}_{2it}) \Big/ \sum_{t=70}^{119}\sum_{i=1}^{N} m_{it}(\hat{p}_i\hat{w}_{1it} - (1-\hat{p}_i)\hat{w}_{2it}) .$$

Although uncertain mortality still plays a large role, much of bequeathed wealth is due to the desire to leave a bequest. The difference between wealth at death conditional on having and not having a bequest motive suggests that the bequest motive accounts for 53 percent of all bequeathed wealth among single households aged 70 and older.

Because no identifying assumption was made regarding which households have a bequest motive, the results are only suggestive that some households behave in a way that is consistent with a life-cycle model that includes a desire to leave a bequest. An alternative hypothesis is that some households prefer to save wealth for medical expenses (Palumbo, 1998; Dynan, Skinner and Zeldes, 2002), or for status (Carroll, 2000). In order to address these alternatives, we

[22] The conditional profiles in Figure 2 are weighted by the survival probabilities in the cross-section.

examine self-reported probabilities of leaving a bequest and of future medical expenses. Survey respondents were asked what they believed was the probability that they would leave a bequest larger than \$0, \$10,000, and \$100,000. In addition, respondents were asked what the probability was that they would expend all of their existing wealth on future medical expenses in the coming five years.

The self-reported probabilities are compared to the predicted probability of leaving a bequest. For each household, the predicted probability of leaving a bequest conditional on having or not having a bequest motive is created by first creating an indicator variable that reflects whether wealth is larger than the intended bequest (\$0, \$10,000, or \$100,000) at each age. The probability of leaving a bequest of a given size conditional on the bequest motive regime is the weighted average of the indicator variable over the lifetime of the household where the weights reflect the probability of dying at a given age. The unconditional probability of leaving a bequest is then obtained by weighing the two conditional probabilities by the probability of having the bequest motive.

In addition to the predicted probability of leaving a bequest, we created an indictor variable that provides a binary estimate of whether a household has a bequest motive. The variable is based on the individual households likelihood function and equals one if $\phi\left(\hat{e}_{1i1},\hat{e}_{1i2};\hat{\sigma}\right)>\phi\left(\hat{e}_{2i1},\hat{e}_{2i2};\hat{\sigma}\right)$, and equals zero otherwise. About half (46.4 percent) of the households in the sample have a likelihood that is greater when imposing the estimated bequest motive with certainty. For a given level of wealth and income and a known path of survival probabilities, these are households that consume in a way that is more consistent with a bequest motive than without one.

We verify the strength of the association between the predictions from our model and the subjective probability of leaving a bequest by estimating a probit probability model with the subjective probability as the dependent variable, expressed as a number between zero and one. The results are reported in table 5. The probability of leaving a bequest is clearly correlated with the level of wealth and income. Moreover, households that believe they are likely to expend their wealth on future medical expenses also report having a small probability of leaving a bequest. Although the effect is significant, the magnitude is somewhat small. Evaluating the probability at the mean, a ten percentage point increase in the self-reported probability of large future medical expenses reduces the self-reported probability of leaving a bequest by about two percentage points, regardless of the self-reported size of the bequest.

The self-reported and predicted probabilities of leaving a bequest are significantly related, as indicated in table 5. Among households with the same level of wealth and income, as well as the same probability of large future medical expenses, a ten percentage point increase in the predicted probability of leaving a bequest suggests a six percentage point increase in the self-reported probability of leaving a bequest.[23] This relationship is similar for bequests larger than $0, $10,000 and $100,000. The predicted probability is a function of individual wealth, annuities, age and mortality but not consumption. Therefore, these specifications only highlight that the nonlinear structural predictions perform much better in explaining subjective probabilities than the reduced form linear specification in wealth and income.

The generated bequest motive indicator has a similar significant relationship. This is of interest because the bequest motive indicator reflects the fit of the two regimes for a particular individual, and is a function of the individual specific consumption-to-wealth relationship. Households whose individual likelihood is greater when imposing the estimated bequest motive with certainty have a 15.8, 12.7 and 5.7 percentage point larger self-reported probability of leaving a bequest larger than zero, $10,000, and $100,000, respectively. The significant relationship between the model predictions and the self-reported probabilities, all else being equal, is suggestive of an active bequests motive.

The distributions of self-reported and predicted probabilities of leaving a bequest larger than $10,000 are reported in table 6. Overall, the distribution of the predicted probabilities is well aligned with the distribution of the self-reported probabilities. A third of the sample reported a probability greater than 80 percent. This is almost identical to the percent predicted by the model. However, whereas about one half of the sample reported a probability less than 20 percent, the model predicts that only about a quarter of the sample has a probability in that range.[24] The last two columns of table 6 report the distribution of the self-reported probability of leaving a bequest greater than $10,000, separating the sample by the generated bequest motive indicator described above. Among households who consume in a way that is more consistent with a bequest motive, about a third report a probability that is less than 20 percent, while 40.7 percent report a probability that is greater than 80 percent. In contrast, about two-thirds of households who consume in a way that is more consistent with not having a bequest motive self-report a bequest probability that is less than 20 percent.[25]

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[23] The marginal relationship is evaluated at the mean.

[24] Note that 28 percent of the sample has positive net wealth and yet claims to have a zero probability of dying with positive net worth. This cannot be matched by our model because there is a non-zero probability of immediate death which implies that the probability of leaving a bequest is non-zero.

[25] The differences in expected medical expenses between households with and without a predicted bequest motive are minor and have little effect on the distribution of self-reported bequest probabilities.

VII. Conclusions

Assumptions regarding the desire to leave bequests are a crucial element to policy prescriptions related to the distribution of wealth, taxation, government debt and charitable contributions, to name a few. Our perception of wealth inequality relies heavily on whether a significant portion of household wealth is attributable to bequests as opposed to life-cycle saving. If bequests are merely a result of an uncertain length of life, estate taxes may have no direct distortionary effect on saving. The neutrality of government spending rests on a belief that all later generations are equally cared for by the current generation in terms of discounted utility. Moreover, social security reform requires knowledge of the saving response to changes in payments. Under an operative bequest motive, an increase in payments may simply be saved. In general, the nature of why households save relates to the effects of many policy instruments. Without taking seriously the full range of saving behavior, government actions can have diluted or even the opposite desired effects.

In this paper, we estimate that about 70 percent of a representative sample of elderly single households has a desire to leave an estate with positive net worth. The magnitude of this desire is both statistically and economically significant. All else being equal, households with an operative bequest motive spend between $4,000 and $9,000 a year less on consumption expenditures. This implies that about half of the wealth measured within the sample will be bequeathed as a consequence of a bequest motive. As in Hurd (1989), we show that elderly households with children do not consume in a way that is any more consistent with a bequest motive than do households without children. However, we argue that this is not evidence against the importance of the bequest motive. The assumption of children as a definitive indicator of a bequest motive is rejected. Although the probability that a household with children has a bequest motive is 75 percent, the probability for households without children is 57 percent. In general, the life-cycle model with an egoistic bequest motive fits the data better when the presence of a bequest motive is allowed to vary across all households, as opposed to restricting it to households with children.

We find evidence that is consistent with both the altruistic and strategic bequest motives. Among households with children, those with children who are better off financially and are college educated have a lower probability of having a bequest motive. Consistent with the strategic bequest motive, we show that households with children that live within ten miles are also more likely to have a bequest motive. However, none of the evidence is statistically significant and we conclude that the egoistic bequest motive is the most plausible.

In terms of out-of-sample fit, the predicted probability of leaving a bequest aligns well with self-reported probabilities. Moreover, we show that the estimated bequest motive is not simply reflecting the desire to accumulate wealth for future medical expenses. Slightly more than two-fifths of households that consume in a way that is consistent with a bequest motive reported a probability of leaving a bequest that was greater than 80 percent. In contrast, only about a quarter of households that consume in way consistent with no bequest motive reported a probability of leaving a bequest greater than 80 percent.

Future research is needed to better understand the effect of heterogeneous preferences toward leaving bequests. Most previous studies rest on the assumption that all households have a bequest motive and proceed to measure empirically the economic significance of the motive and its impact on various dimensions of household behavior. Some studies assume that only households with children have a bequest motive and use the relative behavior between households with and without children as an indicator of the strength of the bequest motive. In this paper, we have shown that both of these prevailing assumptions are suspect. Better indicators of the desire to die with positive net worth would greatly improve our understanding of household wealth determination.

Appendix

A.1 Mortality Rates

Vital statistics from the National Institute of Health (NIH) are used which provide the number of individuals alive out of 100,000 for each age from 0 to 119 separately by birth-year cohort and gender. Note that for future values, these are NIH projections. These values are assumed to reflect the true age-mortality profile but neglect the effect of income, marital status, and race differences. It is further assumed that the true hazard function of mortality is given as

$$\text{Prob}\left(\text{Die at age t}\right) = \exp\left(\omega' X_{it} + f\left(t\right)\right)$$

where $f\left(t\right)$ reflects the true age-mortality profile from the Vital Statistics. The first term is the effect of a quadratic in log permanent income relative to the median and race on the hazard function. Social security earnings are used for permanent income and truncated at the 10th and 90th percentile. These effects are estimated using those individuals who died in the AHEAD between waves I and III, approximating the age effect by age dummy variables. Since the exact time of death is unknown (it is only known if an individual is dead by wave II or dead by wave III), estimating the hazard model cannot be done using standard procedures. Instead the likelihood function needs to be modified. To see this, consider the following,

$$\begin{aligned}\text{Prob}\left(\text{Alive in wave k and dead by wave k}+1\right) &= \int_{k-1}^{2(k-1)} \mu\left(u\right) du = D\left(u\right)\Big|_{k-1}^{2(k-1)} = -S\left(u\right)\Big|_{k-1}^{2(k-1)} \\ &= S\left(k-1\right) - S\left(2(k-1)\right)\end{aligned}$$

$\mu\left(u\right)$ is the instantaneous probability of dying *u* years after wave I (the hazard function), $D\left(u\right)$ is the probability of dying *u* years after wave I, and $S\left(u\right)$ is the probability of living *u* years after wave I. Assuming an exponential hazard function, $\mu\left(u\right) = \exp(\omega' X + \delta A)$, where $\delta A \approx f\left(t\right)$ and A is the age in wave I, the survival function is given as

$$S\left(t\right) = \exp\left(-\int_0^t \mu\left(u\right) du\right) = \exp\left(-t \exp\left(\omega' X + \delta A\right)\right).$$

The exact number of years following wave I in which an individual dies, *t*, is censored both at a maximum of 6 (the last wave in 1998) as well as censored to be equal to 2, 4, or 6. The likelihood function is given by

$$L\left(\omega, \delta\right) = \prod_{i=1}^{N} d_i \left[S_i\left(2(k-1)\right) - S_i\left(k-1\right)\right] + \left(1-d_i\right) S_i\left(6\right)$$

where d_i is one if the individual is dead by wave 4 (1998) and zero otherwise, and k_i is the earliest wave in which an individual is known to be dead. Maximizing $L\left(\omega, \delta\right)$ separately by gender yields the estimate $\hat{\omega}$.

The vital statistics from the NIH are converted to hazard rates, $\nu = \exp\left(f\left(t\right)\right)$. These are then adjusted as follows to yield individual specific hazard rates,

$$\begin{aligned}\text{Prob}\left(\text{Die at age t}\right) &= \exp\left(\omega' X_{it} + f\left(t\right)\right) \\ &= \exp\left(\omega' X_{it}\right) \exp\left(f\left(t\right)\right) \\ &\approx \exp\left(\hat{\omega}' X_{it}\right) \nu.\end{aligned}$$

A.2 Truncated Switching Regression

We modify the likelihood function implied by (6) in order to account for the potential sample selection bias due to trimming the data. Denote the lower and the upper bound of the trimmed sample of changes in consumption as L and H, respectively. Conditional on being in regime $k=1$ or 2 ($\alpha_k=\alpha$ in for $k=1$ and $\alpha_k=0$ for $k=2$), an observation is included in the sample if

$$L<\left(g\left(x_i;\theta,\alpha_k,1\right)+u_2+e_{ki2}\right)-\left(g\left(x_i;\theta,\alpha_k,1\right)+u_1+e_{ki1}\right)<H .$$

The distribution of e_{kit} is a truncated normal with the truncation points given by

$$\tilde{L}\left(x_i,\theta,\alpha_k\right)=L-\left(g\left(x_i;\theta,\alpha_k,1\right)+u_1-g\left(x_i;\theta,\alpha_k,2\right)-u_2\right)$$
$$\tilde{H}\left(x_i,\theta,\alpha_k\right)=H-\left(g\left(x_i;\theta,\alpha_k,1\right)+u_1-g\left(x_i;\theta,\alpha_k,2\right)-u_2\right),$$

with variance equal to $\sigma_1^2+\sigma_2^2-2\sigma_1\sigma_2\rho$. Predicted consumption depends on the value of the bequest motive parameter and so is dependent upon the regime for which it is being predicted. These values modify the *p.d.f.'*s for regimes 1 and 2 in (6) as follows:

$$\frac{\phi\left(e_{ki1},e_{ki2};\sigma\right)}{\Phi\left(\tilde{L}\left(x_i;\theta,\alpha_k\right)\Big/\left(\sigma_1^2+\sigma_2^2-2\sigma_1\sigma_2\rho\right)^{1/2}\right)-\Phi\left(\tilde{H}\left(x_i;\theta,\alpha_k\right)\Big/\left(\sigma_1^2+\sigma_2^2-2\sigma_1\sigma_2\rho\right)^{1/2}\right)},$$

for $k=1$ and 2, respectively. These two *p.d.f.'*s, weighted by the probability of being in the respective regime, are used to define the log-likelihood function for the truncated switching regression model.

A.3 Estimation Procedure

Solving for the optimal path of consumption

Given the parameters, the path of mortality rates and income, and initial wealth, the algorithm proceeds as follows. The satiation path of consumption given by (3) determines the minimum initial level of wealth needed to financing such a policy, w_s^*. If the initial wealth equals or exceeds w_s^*, consumption follows the satiation path provided that optimal consumption in the last period exceeds income y_T (otherwise some constraints are binding). If the initial wealth is less than w_s^* and y_T exceeds the satiation level of consumption at time *T* (the maximum consumption in that period), some constraints must be binding. Otherwise, the level of wealth corresponding to the path of consumption satisfying the Euler equation and ending with y_T is computed. This level is compared to w_s, if it exceeds w_s, some constraints are binding. If not, binary search algorithm over consumption c_T in period *T* belonging to the interval $[y_T,c_T^h]$ is used to find the consumption profile that is exactly financed by w_s. If the corresponding path does not violate non-negativity constraints, this is the optimal solution. Otherwise, some constraints are binding.

Whenever it is determined that the wealth constraints are binding, the first age where the solution to the unconstrained problem yields negative wealth is noted as age k^*. This is done as a by-product of the steps described above. Age k^* is the earliest age where the constraint may be binding: if it were binding earlier, consumption over some initial period would have exceeded the unconstrained one, which may not be optimal. When the constraint binds at *k*, $c_{k+1}\le y_{k+1}$, and it follows from the Euler equation that $a_k c_k^{-\gamma}\ge\beta\left(1+r\right)\left(a_{k+1}y_{k+1}^{-\gamma}+m_{k+1}\alpha\right)$. The terminal condition also guarantees that $c_k\le c_k^h$. These conditions yield an upper bound on c_k, the lower bound is given by $c_k\ge y_k$. The level of wealth corresponding to these two bounds can be found, and when the initial wealth is within the region, binary search algorithm is used to search for the path that is financed by it. If it satisfies the non-negativity constraint before *k*, the constraint may be binding at k. The algorithm then proceeds to test later points in the same manner. If another place where the constraint may bind is found, the levels of utility corresponding to the two solutions are compared and the better one is selected. If not, this is the solution and evaluation of the utility is not performed. Evaluating the utility level requires calculating the whole path of consumption; this is done by calling recursively the same procedure starting at a period after the constraint binds and with initial wealth of zero.

Numerical optimization

Maximization of the log-likelihood function is accomplished by using a two-step maximization procedure: $\max_{\{\beta,\gamma,\alpha\}} \max_{\{\lambda,u,\sigma\}} \sum_i \log(\ell_i)$, where l_i is given by (6) modified according to Appendix A.2, $u = [u_1, u_2]$, and $\sigma = [\sigma_1, \sigma_2, \rho]$. In other words, given behavioral parameters, full maximization is performed over distributional parameters λ, u, and σ. This helps to reduce the number of costly evaluations of the function $g(.)$, which depends only the behavioral parameters and need not be evaluated when maximizing over λ, u, and σ. The estimation was performed using Matlab. The Nelder-Mead (Matlab's *fminsearch*) algorithm is used starting from an initial guess obtained by means of a grid search. The derivatives of the likelihood function are computed by finite differentiation. In addition to the usual convergence criterion, the estimates were tested for convergence using an artificial regression of Davidson and MacKinnon (1993, p. 472).

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Table 1.-Mean Wealth of the Elderly

	1993	1995	1998	2000
Total Net Wealth	141,275	181,617	170,731	173,569
Tangible Wealth	84,833	93,348	87,347	86,630
Net Equity in Home	65,046	67,234	63,134	67,037
Financial Wealth	51,933	84,415	78,790	81,578
Stocks/Mutual Funds	15,450	38,740	37,885	42,447
Share of Total Net Wealth				
Real Assets	0.60	0.51	0.51	0.50
Net Equity in Home	0.46	0.37	0.37	0.39
Financial Wealth	0.37	0.46	0.46	0.47
Stocks/Mutual Funds	0.11	0.21	0.22	0.24

Sample includes all non-married, non-working heads of household present in the 1993, 1995, 1998 and 2000 AHEAD survey (1,575 observations). Dollar values are in 1996 dollars.

Table 2.-Saving and Consumption of the Elderly: Annual Average

	Mean		Median	
	1995 to 1998	*1998 to 2000*	*1995 to 1998*	*1998 to 2000*
Change in Wealth	-4,879	1,690	-1,105	-187
Saving	-4,128	-2,013	-111	-93
Capital Gains	-751	3,703	0	0
Income	18,327	17,660	12,658	11,889
Consumption	22,455	19,673	13,071	12,060

Sample includes all non-married, non-working heads of household present in the 1993, 1995, 1998 and 2000 AHEAD survey (1,575 observations). Values are annualized by individual specific number of years between survey interviews. The average number of years between waves 2 and 3 is 2.86 and between waves 3 and 4 is 2.11. Dollar values are in 1996 dollars.

Table 3.-Estimates of the Empirical Model

	i	*ii*	*iii*	*iv*
		Behavioral Parameters		
Time Discount Factor (β)	5.62	0.95	0.95	0.97
	(0.31)	(0.02)	(0.02)	(0.01)
Elasticity of Substitution ($1/\gamma$)	0.017	0.393	0.391	0.544
	(0.001)	(0.028)	(0.030)	(0.027)
Bequest Motive ($\alpha^{-1/\gamma}$)	239,323	53,726	52,935	57,726
	(3,635)	(2,401)	(2,429)	(1,559)
		Transitory Consumption		
Aggregate Shock, period 1 (u_1)	3,590	-7,351	-7,333	-7,793
	(1,293)	(1,257)	(1,263)	(1,406)
Aggregate Shock, period 2 (u_2)	-101	-8,854	-8,800	-8,860
	(1,326)	(1,210)	(1,212)	(1,295)
Standard Deviation, period 1 (σ_1)	26,903	22,723	22,664	22,503
	(373)	(362)	(362)	(395)
Standard Deviation, period 2 (σ_2)	28,481	25,267	25,267	25,162
	(611)	(636)	(637)	(697)
Intertemporal Correlation ($\sigma_{1,2}$)	0.47	0.26	0.26	0.27
	(0.02)	(0.03)	(0.03)	(0.03)
		Switching Equation		
One or more children			0.50	
			(0.27)	
Constant		0.55	0.17	0.78
		(0.12)	(0.23)	(0.14)
		Predicted Sample Averages		
Probability of having a bequest motive	0.822	0.709	0.718	0.783
Consumption: Bequest motive	28,465	33,315	33,265	33,330
Consumption: No Bequest Motive	28,499	44,697	44,802	45,640
Log-Likelihood	-10,053	-9,900	-9,898	-7,845

The results in column *i* assume perfect sample separation information: households with children have a bequest motive. The average probability of having a bequest motive in column *i* is simply the fraction of the sample with children. The results in column *ii* assume no sample separation information, and the results in column *iii* assume imperfect sample separation information. Columns *i* through *iii* are based on 1,082 observations. The results column *iv* restrict the sample to households with children and assume no sample separation information (859 observations). See text for estimation procedure. Standard errors are in parentheses. Dollar values are in 1996 dollars and the model is estimated at a two-year frequency. Predicted consumption values are averaged over the sample period 1995 to 2000.

Table 4.-Alternative Specifications for the Switching Equation

	i	*ii*	*iii*
		Switching Equation	
Number of children			-0.50
			(0.51)
One child	0.36	-0.31	
	(0.37)	(0.51)	
Two children	0.94	0.09	
	(0.36)	(0.55)	
Three or more children	0.34	-0.65	
	(0.30)	(0.56)	
One or more grandchildren		0.99	1.30
		(0.48)	(0.58)
Children Characteristics			
Financially better off than parents			0.06
			(0.21)
Financially same as parents			0.54
			(0.33)
High school degree			0.16
			(0.54)
Some college			-0.60
			(0.47)
College degree			-0.54
			(0.45)
Own a home			0.48
			(0.25)
Live within ten miles of parents			0.34
			(0.30)
Constant	0.18	0.18	0.30
	(0.23)	(0.23)	(0.55)
		Predicted Sample Averages	
Probability of having a bequest motive	0.716	0.720	0.841
Consumption: Bequest motive	33,418	33,430	32,926
Consumption: No Bequest Motive	44,827	44,730	45,754
Log-Likelihood	-9,896	-9,893	-7,824

Only the estimated parameters of the switching equation are shown. The results in column *i* and *ii* are based on the full sample (1,082 observations), and the results in column *iii* restrict the sample to households with children (859 observations). See text for estimation procedure. Standard errors are in parentheses. Dollar values are in 1996 dollars and the model is estimated at a two-year frequency. Predicted consumption values are averaged over the sample period 1995 to 2000.

Table 5.-Self-Reported Probability of Leaving Bequest and Model Predictions

	Self-Reported Probability of Leaving a Bequest Larger than…					
	…$0		*…$10,000*		*…$100,000*	
Constant	-1.56	-0.87	-1.55	-1.07	-1.91	-1.95
	(0.21)	(0.15)	(0.18)	(0.16)	(0.20)	(0.21)
Wealth	0.0121	0.0230	0.0131	0.0386	0.0093	0.0319
	(0.003)	(0.003)	(0.005)	(0.004)	(0.004)	(0.003)
Social Security Income	0.36	0.41	0.51	0.60	0.41	0.57
	(0.15)	(0.14)	(0.16)	(0.15)	(0.19)	(0.18)
Self-Reported Probability of	-0.52	-0.50	-0.61	-0.61	-0.74	-0.62
Large Medical Expenses	(0.15)	(0.15)	(0.16)	(0.15)	(0.22)	(0.21)
Predicted Probability of	1.46		1.71		1.79	
Leaving a Bequest	(0.23)		(0.22)		(0.27)	
Predicted Bequest		0.41		0.32		0.18
Motive Indicator		(0.10)		(0.10)		(0.13)
Log-Likelihood	-442.8	-455.6	-393.4	-420.6	-223.1	-244.7

The sample is restricted to households that self-reported the probability of leaving a bequest and the probability of large future medical expenses (758 observations). Models are estimated by maximum likelihood using a probit specification for a continuous dependent variable between zero and one. Wealth and social security income are in tens of thousands of 1996 dollars, and the probability of large medical expenses is the self-reported probability that medical expenses will deplete all wealth within in the next five years. The predicted probability of leaving a bequest is the predicted probability of dying with wealth larger than $0, $10,000, or $100,000. The predicted bequest indicator is equal to one if the individual observation's contribution to the likelihood function would be greater if a bequest motive were present with certainty, and zero otherwise.

Table 6.-Distribution of Probability of Leaving a Bequest Larger than $10,000

Probability	Self-Reported	Predicted	Self-Reported	
			Bequest motive	No bequest motive
0 to 0.2	46.7	22.6	33.8	59.6
0.2 to 0.4	3.1	9.6	3.8	2.4
0.4 to 0.6	11.6	13.7	15.1	8.1
0.6 to 0.8	5.0	18.7	6.1	4.0
0.8 to 1.0	33.6	35.4	41.2	25.9

The table reports the percent of households whose probability of leaving a bequest larger than $10,000 is within a given quintile. Sample weights are used in all calculations. The predicted unconditional probabilities reflect the weighted average of the probability of leave a bequest with and without a bequest motive, where the weights reflect the probability of have a bequest motive. The last two columns show the self-reported probabilities of leaving a bequest larger than $10,000 separated by the predicted presence of a bequest motive. The sample is separated into those households whose individual contribution to the likelihood would be greater if a bequest motive were present with certainty and those households whose individual contribution would be greater if a bequest motive were absent with certainty.

Figure 1.-Total Expenditures of Non-Married, Non-Working Households by Age
(Thousands of 1996 dollars)

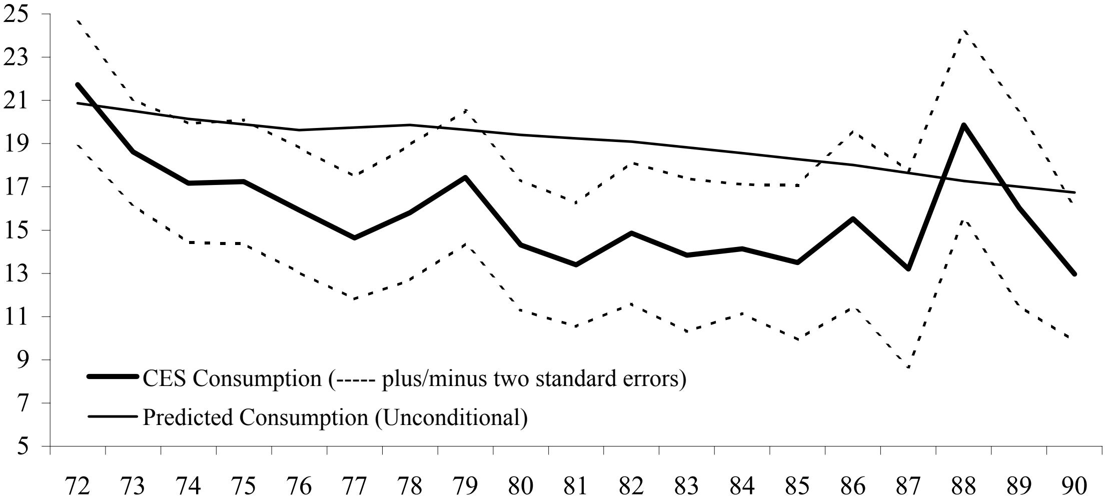

Figure 2.-Predicted Consumption by Age
(Thousands of 1996 dollars)