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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 three-fourths of the elderly single population has a bequest motive that may or may not have an appreciable effect on spending depending on the level of resources. Both the presence and the magnitude of the bequest motive are statistically and economically significant. On average, households with a bequest motive spend about 25 percent less on consumption expenditures. We conclude that, among the elderly single households in our sample, about four-fifths of their net wealth will be bequeathed and approximately half of this is due to a bequest motive.

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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 because 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 and thus suggests 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). An alternative approach is based on noting that, 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 its impact on spending 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 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.

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 status (Carroll, 2000) or uncertain health expenses (Palumbo, 1999; Dynan, Skinner and Zeldes, 2002 and 2004). However, it is unlikely for several reasons that the precautionary saving motive related to uncertain medical costs is having a large influence on the estimated presence and magnitude of the bequest motive. First, the empirical strategy compares the consumption profiles of households, conditioning on wealth and income. Consequently, if households with similar resources face the same risk of medical costs, the precautionary saving motive should affect these households similarly and not affect the relative consumption profiles. Second, we show that households with private health insurance are no less likely to consume in a manner consistent with a bequest motive. Third, we show that households with higher self-reported expected future out-of-pocket medical costs are no more likely to consume in a manner consistent with a bequest motive than households with lower expected costs. Finally, we compare the results from the model to self-reported probabilities of leaving a bequest after conditioning on self-reported expected future out-of-pocket medical costs. We find that among households with similar permanent income, wealth, and expected medical expenses, those who consume in a way that is more consistent with a bequest motive also reported having a higher likelihood of leaving a bequest. We conclude that, although the precautionary motive may be an important component of saving behavior among the elderly, it does little to influence the bequest motive results in this paper.

Our results suggest that roughly 75 percent of the elderly population has a bequest motive. Households with a bequest motive spend about 25 percent less on personal outlays on average. Of the 78 percent of net wealth that is estimated to be bequeathed by single households aged 70 and older, 53 percent is accounted for by 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]

II. Related Literature

The importance of bequests and other intergenerational transfers in the macroeconomy 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

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

[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.

expected future bequests is biased by past unexpected wealth changes and could say very little about saving behavior.

Studies 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 that 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 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

[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), and 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.

virtually certain to leave a bequest do not appear to pursue tax avoidance strategies such as intervivos giving (McGarry, 1999; Poterba, 2001). All this evidence 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 detailed questions about their economic resources.[4] This includes detailed self-reported information regarding all sources of regularly occurring income: social security income, supplemental security income, veteran's benefits, defined benefit retirement pension income, annuities, welfare, and food stamps.[5] 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.[6] Non-regularly occurring income, such as financial

[4] A more comprehensive description of the wealth, income and saving data in the AHEAD survey is provided in the appendix.

[5] Respondents were lastly asked about any "other" sources of regularly occurring income. This could include such sources as annuity payments from reverse mortgages.

[6] Each income source is assumed to last for as long as the respondent claims it 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 in the 1998 OASDI Trustees Report.

assistance from friends and family are added to earnings in the relevant survey period but assumed to not continue into the future.[7]

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 non-collateralized debt (such as credit card debt or debts owing to medical treatment). The sum of these components (less debt) is defined as measured net wealth. Measured wealth can also be thought of as bequeathable wealth.[8]

Measured net wealth is missing two components. First, defined contribution pensions are excluded because these data were not available to us. However, our focus on individuals born prior to 1923—a cohort with very little exposure to defined contribution pension plans—largely mitigates any potential bias in measured wealth. Moreover, because we focus on individuals older than 70 years, it is likely that most of the few defined contribution pensions that did exist were either liquidated and placed into one of the financial accounts noted above, or converted to an annuity, which is included in measured income. Second, measured wealth excludes the value of life insurance policies. Because roughly 40 percent of the sample has a life insurance policy, the effect of life insurance on our results is considered in more detail below.

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.[9] However, the $40,323 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

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[7] Roughly one-fourth of the sample either received (or gave) transfers from (or to) friends and family. The average annual net transfer out of the household is about $600. The assumption that these transfers do not continue in the future has little impact on our results.

[8] Although it is not obvious that housing wealth should be included in measured bequeathable wealth, we argue below that this is more appropriate than excluding it. However, we also report results that exclude housing wealth. Equity in the main home and other real estate excludes the value of reverse mortgages. Any income generated from reverse mortgages is included in measured income.

[9] For comparison, data from the Panel Study of Income Dynamics indicate that, among unmarried individuals older than age 70 that are alive in 1994 and 1999, mean wealth was $161,037 in 1994 and $196,714 in 1999. An alternative source of data is the Federal Reserve's Survey of Consumer Finance (SCF). Restricting the SCF to unmarried households aged 72 and older in 1995, mean wealth was $182,536 in 1995, $179,869 in 1998 and $244,874 in 2001.

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 stability in subsequent waves of the survey. Because 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.[10]

Table 1 shows that mean net wealth fell only slightly between 1995 and 1998, and fell again between 1998 and 2000. However, this cannot be interpreted as evidence against the standard life-cycle model since it neglects the influence of asset returns. Indeed, unexpected differential rates of return to wealth could bias any cross-household comparison of wealth changes. In the presence of unexpected returns to wealth, the standard life-cycle model is hypothesis about saving and spending behavior and not necessarily about ex-post movements in wealth. 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.[11] In turn, the level of saving can be used to define capital gains (the difference between the change in measured wealth and measured saving) and consumption (the difference between measured total income and measured saving)—see the appendix for a more detailed derivation of saving and consumption in the AHEAD. 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.[12] As implied by the standard life-cycle hypothesis, average saving is negative in both periods. However, although capital losses contribute to the *decline* in wealth in the first period, capital gains offset about one-half of the decline in saving in the latter period. Consumption

[10] Rohwedder, Haider, and Hurd (2004) conclude that a combination of question sequence and wording in the 1993 wave of the AHEAD survey led to a severe under-reporting of ownership rates of stocks, CDs, bonds, and checking and saving accounts. In a personal conversation, Bob Willis, director and co-principal investigator of the HRS/AHEAD survey, agreed with the Rohwedder et al conclusion and noted that the flawed methodology was revised considerably in later waves of the survey. Consequently, Willis suggests the wealth data from the 1993 AHEAD not be used to make cross-year comparisons.

[11] Juster et al (2004) show that the same survey instrument used to measure active saving in the Panel Study of Income Dynamics from 1984 to 1994 aligns well with movements in the personal saving rate from the National Income Accounts.

[12] 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.

expenditures are relatively smooth across the two periods, both in terms of the mean—about $21,000—and the median—about $12,500.

Given the uniqueness of the net transaction data that allow total consumption to be measured, we assess the data's reliability by comparing it to a more established survey measure of household 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. These estimates are roughly in line with the estimates from the AHEAD survey.

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.[13] 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.

[13] An individual's current health condition is largely a function of a lifetime of health related choices, e.g. what to eat and drink, whether to smoke cigarettes, and how much to exercise. Many of the decisions are related to education, which is in turn related to permanent income. Moreover permanent income is related to access to preventative health care earlier in life. For these reasons, a proxy for permanent income is a better indicator of health status than wealth, which is confounded by saving behavior and idiosyncratic risk. Indeed, households that are less risk averse may have more wealth but worse health, all else being equal.

Following the life cycle model of Yaari (1965), a household at age *s* is assumed to solve the following intertemporal allocation problem:

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

where w_t and c_t are the household's wealth and consumption at age *t*.[14] 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 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*,

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

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

[14] We do 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.

life, at which point the bequest motive would be influential.[15] 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

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

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:

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

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.

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

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 is correlated with various observable characteristics and depends on an idiosyncratic component that is unobserved by the econometrician. These characteristics, including the unobservable component, are fixed in time and so households do not switch regimes—the regime is a time-invariant characteristic of individual preferences. 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 representative of the whole population, the probabilities correspond to the actual distribution of the presence of a bequest motive in the population.

A. The likelihood function

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 elasticity of intertemporal substitution and r is the rate of return which is set to 2.6 percent.[16] The function $g(.)$ also depends on the marginal utility of leaving a bequest, α. The econometric model is as follows:

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

where, z_i is a vector of bequest motive indicators, assumed to be pre-determined and constant after 1995, 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.

[16] 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.

We assume that the unobserved idiosyncratic component in the switching equation, η_i, is normally distributed and reflects the econometrician's uncertainty regarding the presence of a bequest motive.[17] The error term in regime *k* is assumed to be "transitory measured consumption" and reflects the mis-measurement of true consumption. We model this error as $\varepsilon_{ki\tau} = u_\tau + e_{ki\tau}$, where u_τ is assumed constant across all households but allowed to vary over time, and $e_{ki\tau}$ is mean zero and normally distributed but serially correlated, $corr(e_{ki\tau+1}, e_{ki\tau}) = \rho$. We assume that the uncertainty regarding the presence of a bequest motive is unrelated to transitory measured 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. That is, the value of wealth in 1998 is not used as an initial condition for computing optimal consumption between 1998 and 2000 because it may be correlated with ε_{ki1}.

Given the distributional assumptions, (5) can be estimated by maximum likelihood. Transitory measured 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 *pdf* 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 *cdf* of a standard normal distribution. We assume the standard deviation of transitory measured consumption is constant across regimes. Given the complex survey design of the AHEAD, we maximize the likelihood function using household level population weights.[18]

B. Identification

The structural specification used to estimate the empirical model has several advantages over a reduced form specification. Foremost, the structural specification 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

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[17] The assumption of normality in the switching equation is not very restrictive because most of the bequest motive indicators are dummy variables.

[18] The quasi-maximum likelihood estimator using household survey weights yields consistent and asymptotically normal estimates (Sakata, 2002).

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.[19]

The life-cycle model provides the structure to generate the conditional means of the respective regimes, and to estimate the behavioral parameters of the model. More specifically, consider the Euler equation (2) for a household of age s whose wealth constraint eventually binds at some age K where $K \le T$. This excludes only those very high-wealth households consuming at their satiation level, as indicated by (3). Consequently, for most households, iterating the Euler equation forward from any age $t \ge s$ to age K yields:

$$a_t c_t^{-\gamma} = \alpha \sum_{i=t+1}^{K} \beta^{i-t} \left(1+r\right)^{i-t} m_i + a_K c_K^{-\gamma} \beta^{K-t} \left(1+r\right)^{K-t} \quad (7)$$

where c_K is consumption in the last period when wealth constraint is not binding. Thus, consumption at any age can be expressed in terms of the single unknown c_K. Substituting (7) into the intertemporal budget constraint and combining the result with the terminal conditional $W_K = 0$ yields the solution for $c_K = h(w_s, \{y_t, a_t, m_t\}_{t=s}^{K}, s)$, which can then be used to derive c_t from equation (7). This solution is then matched to the data.

There are three sources of independent variation across households that determine the optimal consumption path: Mortality rate profiles, income profiles, and the level of initial wealth. Mortality rates vary exogenously with age, birth cohort, gender, permanent income (reflecting inherent ability), and race. Income and initial wealth vary exogenously with inherent ability, ex-post returns to lifetime saving, and the presence of a bequest motive. Together, income and initial wealth determine the level of consumption but, because of borrowing constraints, variation in their relative magnitudes has implications for both the level and the slope of the consumption profile. When combined with measured consumption, this variation is used to identify the behavioral parameters β, γ, and α.

First, note that c_K interacts with β but not α. Consequently, because the level of resources available to the households affects the level of current spending through its effect on c_K, the effect of variation in wealth and income on the contemporaneous marginal utility of consumption is scaled by β and not α. Second, even in the limiting case with no variation in c_K (very high-wealth households consuming at their satiation level), variation in mortality risk

[19] 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.

alone can separately identify β and α, as indicated by the first term (7). Specifically, an increase in α increases the impact of mortality risk at any age, while an increase in β strengthens the impact of mortality rates in the near or far future depending on whether $\beta(1+r)$ is greater than or less than one. Therefore, variation in the shape of the entire mortality rate profile—rather than the immediate mortality risk—aids in separately identifying these two parameters. This variation would be hard to incorporate in a reduced form specification but is naturally used by the structural approach. Finally, the inverse of the elasticity of intertemporal substitution γ is identified from the functional form, as indicated in (7) , as well as from the slope of the measured consumption profile—variation that is provided by having two periods of measured consumption. Although β, γ, and α all affect the slope of the consumption profile, as noted above, the identification of β and α does not rest on variation in the slope of the consumption profile across households. As a result, variation in the intertemporal pattern of measured consumption can be used to separately identify γ.[20]

The separate identification of the strength and the presence of the bequest motive is based on the assumption that measured consumption is a mixture of two normal distributions after conditioning on the structural form of the life-cycle model. As far as the population average of consumption is concerned, holding other parameters constant, there is no clear distinction between the two: Higher consumption could reflect either a weaker bequest motive or a smaller probability of having a bequest motive. However, the two parameters can be identified by the cross-sectional variation in measured consumption. Consumption increases with wealth but the rate of this increase varies depending on the presence of the bequest motive. Intuitively, if consumption relative to wealth and income differs depending on the presence of a bequest motive, all else being equal, then the unconditional distribution of the error term would be bimodal. Maximization of the likelihood function pins down the strength of the bequest motive and its probability by fitting the mixture of the two conditional normal distributions to the regime residuals. Although the particular distributional assumption is relevant, it is less important so

[20] The model has one more feature that is helpful for identification. From (7), the marginal utility of contemporaneous consumption depends on the number of years $K-t$. If the wealth constraint were never binding, this would simply reflect age and therefore age variation would further help in separately identifying β and α. When the wealth constraint binds, the age at which wealth is exhausted, K, becomes an endogenous variable that responds among other things to wealth and the relative importance of future income in the present value of resources. Therefore, the interaction of these two dimensions of the data with the parameters β and α provide an extra source of identification.

long as the underlying consumption distribution is bimodal.[21] The distance between the means of the two distributions—centered on the respective conditional consumption functions for the two regimes—provides an estimate of the *magnitude* of the bequest motive, while the relative density at the two means provides an estimate of the *presence* of the bequest motive.

B. Measurement error

Although measurement error is incorporated into the empirical model as discussed above, there remains a potential for extreme outliers to bias the results. In general, we consider two sources of measurement error: regular inaccuracies in the reporting of the value of assets conditional on owning the asset, and the misreporting of the ownership of an asset that leads to the omission of the assets value completely. Although active saving is directly measured independently from the reported asset values for categories of assets that are heavily influenced by capital gains (such as corporate equities, real estate, and personal businesses), active saving is simply measured as the change in the value of the asset between survey years for the remaining categories (checking accounts, for example). Consequently, the misreporting of the ownership of a particular asset in one survey year but not another may give rise to extreme outliers.

The data include two periods of consumption for each household. Large swings in consumption resulting from extreme measurement error could bias the parameter estimates. So as to reduce the impact of these influential outliers, the sample distribution of *changes* in consumption over the two periods is trimmed. We assume the measurement error remaining in the sample is adequately captured by the error structure in (5). However, trimming the data could also eliminate valid observations. This implies a truncated error distribution, which is endogenous to the model parameters. A modified likelihood function that accounts for the potential of sample selection bias is used to estimate the model.[22]

The truncated sample restricts the change in annual consumption to be between -$70,000 and less than $70,000. Our final sample includes 1,126 observations.[23] The model is estimated using the numerical algorithm described in the appendix. Variances of the parameter estimates

[21] Indeed, within the data, for households with high levels of wealth, there are a significant number of households with high levels of consumption and a significant number with low levels of consumption. This is consistent with a bequest motive that is 1) present for only a segment of the population and 2) a luxury good.

[22] A formal presentation of the modified likelihood function is provided in the appendix.

[23] Our estimates are robust to more restrictive trims (-$50,000 to $50,000) as well as to less restrictive trims (-$120,000 to $120,000). These results are available upon request. In addition to the trim, the sample also excludes 40 households with negative net wealth. Setting the wealth of these households to zero and including them in the sample has no effect on the results.

are computed as the outer product of the contributions to the first derivatives of the log likelihood function with respect to the parameters.[24]

VI. Results

Various specifications of the switching equation are used in estimating the empirical model. The results are reported in Tables 3, 4 and 5. The estimates correspond to consumption at a two year frequency. For expositional purposes, 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.[25]

A. Model estimates

The first column of Table 3 reports the results from 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.[26] Although the estimate of the time discount factor is implausible, the implication of the magnitude of the bequest motive is the same as in Hurd (1989).[27] The level of consumption over two years that makes households indifferent between consuming and leaving a bequest in the last period of life is $246,318. This level of consumption is well above what most households could afford suggesting that bequests are largely due to uncertain mortality.

Comparing the predicted consumption profiles with and without a bequest motive reveals the implied strength of the desire to leave a bequest. As indicated in the penultimate row of Table 3, predicted consumption over the sample period for households with children (bequest motive) is

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[24] If the model is properly specified, this is equivalent to the information matrix in terms of expected values.

[25] Standard errors are computed directly for this transformed parameter.

[26] In terms of (6), $\Phi(\lambda' z_i)$ equals one for households with children, and it equals zero for households without children.

[27] These results were obtained by restricting the discount factor to be no larger than 2 and the standard errors of the remaining parameters were obtained as if the discount factor was set to be equal to 2. There was no interior solution for the discount rate even if we relaxed this restriction to allow for discount factors as large as 8, although the impact of this relaxation on the likelihood was relatively minor.

only 0.2 percent less than the predicted consumption for households without children (no bequest motive). The difference is trivial implying that, conditional on the identifying assumption that only those households with children have a bequest motive, the bequest motive is essentially inactive. 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 fairly tightly estimated. Abstracting from mortality risk, future utility is discounted at a rate of 0.91 over two years, and the estimated elasticity of intertemporal substitution is 0.29. Transitory measured consumption has a standard deviation of roughly $23,000 and is somewhat persistent with an intertemporal correlation of 0.25. 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 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 a useful indicator. The results in the third column of Table 3 control for the presence of children in the switching equation. 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. The level of consumption over two years that makes households indifferent between consuming and leaving a bequest in the last period of life is significant and equal to $47,687, considerably lower than the level implied by the assumption that only households with children have a bequest motive.

The estimated effect of having at least one child on the presence of a bequest motive is significant at a 10 percent level, and it implies that households with children have a 79 percent probability of having a bequest motive, while those without children have a 63 percent probability. These do not correspond to the probabilities 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 14 percent of the sample are consuming at the satiation level of consumption as given by (3). Households below the satiation level of consumption may or may not leave a bequest depending on their length of life. As indicated in Figure 1, roughly 10 percent of the sample is predicted to have zero net wealth by age 80. Naturally, the fraction of households affected by the wealth constraint grows with age but it also varies with the presence of the bequest motive. Individuals who have a bequest motive are significantly less likely to face a binding constraint at any age, although the incidence of a binding wealth constraint is also growing with age reflecting that the bequest motive is infra-marginal for most of the population: while it provides utility on the margin, the consumers are planning to run out of wealth if they live long enough. Conditional on no bequest motive, the fraction of the sample with a binding wealth constraint rises to almost 30 percent by age 90. The presence of a bequest motive reduces the fraction of households with a binding wealth constraint by almost 10 percentage points.

Whether the wealth constraint binds depends largely on the level of initial wealth. Consequently, the effect of the bequest motive on spending is largest for wealthy households. The effect of the bequest motive on spending can be seen in Figure 2, which shows the sample mean of the average propensity to consume out of cash-on-hand by age, defined as the sum of wealth and current income. The age profiles are conditional on either having (the dashed line) or not having (the solid line) a bequest motive, and are stratified by initial net wealth: less than $25,000, $25,000 to $100,000, and greater than $100,000.[28]

The average propensity to consume is lowest for households in the high-wealth group regardless of whether a bequest motive is present. For a 75 year-old household with no bequest motive, the average propensity to consume out of cash-on-hand is 0.32 in the high-wealth group, and 0.86 in the low-wealth group. The presence of a bequest motive increases the average propensity to consume considerably for households in the high-wealth group and has essentially no effect on households in the low-wealth group. This differential impact based on wealth clearly characterizes bequests as a luxury good. Despite the presence of a bequest motive, the marginal utility of consumption for households in the low-wealth group significantly exceeds that of leaving a bequest. This is in contrast to households in the high-wealth group where the presence of a bequest motive damps considerably spending relative to cash-on-hand. On average, if all households had a bequest motive, predicted consumption would be 74 percent of what it would be if no households had a bequest motive, as indicated in the penultimate row of third column of Table 3.

Restricting the sample to households with children has little effect on the results, as reported in the fourth column of Table 3. The time discount factor is a touch stronger but this is offset by a slightly larger elasticity of intertemporal substitution. The constant in the switching equation indicates that households with children have a 79 percent probability of having a bequest motive, identical to the probability when using the entire sample and including an indicator for having children.

[28] These three wealth groups split the sample roughly into thirds.

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 several alternative specifications of the switching equation. The estimates of the behavioral parameters are very similar to those reported in Table 3 and so are not shown. As indicated in the first column, 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 is roughly 50 percent for those with either one child or more than two children, and is 70 percent for those with two children. The presence of grandchildren increases the probability of having a bequest motive by roughly 25 percentage points. At 91 percent, households with two children and at least one grandchild have the highest probability of having a bequest motive. However, this result is insignificant at conventional levels of significance.

Households with a bequest motive are assumed to 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.[29] 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.[30] These 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 the same or 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

[29] The interpretation of these results must be tempered by the fact that the indicators are not necessarily time-independent. However, because we only use predetermined values as of 1995, the potential for endogeneity is somewhat mitigated.

[30] We considered a Tobit specification that allowed the bequest motive parameter α to vary by certain household characteristics. Because the results were largely insignificant and did not change the main results, we do not report them here. They are available upon request.

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, and that this, in turn, could lead to larger intended bequests. To examine this hypothesis, the number of children that live within ten miles of the parent is included in the switching equation. Of course, this variable is likely endogenous: children of parents willing to pursue such a bequest motive strategy should locate close to their parents. Nevertheless, we would still expect a positive association between location and the presence of a bequest motive if this type of motive is present, even though interpreting the magnitude of the estimate is difficult. The sign of the point estimate, reported in the final column of Table 4, is consistent with the strategic bequest motive hypothesis but small. Relative to the typical household, those with an additional child that lives within ten miles have only roughly a five percentage point higher probability of having a bequest motive. Moreover, the effect is insignificant.

Returning to Table 3, the last two columns examine the influence of housing equity and life insurance, respectively, on the estimated presence and magnitude of the bequest motive. Hurd (1989) excludes housing equity from his baseline estimates, arguing that high transaction costs make it difficult to change the level of housing consumption services, and importantly, that non-housing consumption is completely financed only out of non-housing wealth. While it is likely that housing equity was fairly illiquid for the households in Hurd's sample, which covered 1969 to 1977, financial deregulation and new technologies over the past two decades have reduced transaction costs to allow the creation of new instruments that permit previously illiquid obligations to be securitized and traded. Consequently, the difficulties in extracting housing equity have been reduced considerably. Moreover, it is not clear that non-housing consumption is unaffected by housing equity, regardless of how it is financed. Many households could think of their home as a future bequest and consume a larger share of their non-housing wealth than they would otherwise. Excluding housing equity from total wealth could thus bias the result toward finding no bequest motive. Indeed, Hurd (1989) finds some support for a sizable bequest motive when housing equity is added to total wealth.

Despite this argument, we estimate the model excluding housing equity from total wealth for completeness. The results are reported in the fifth column of Table 3. As in Hurd (1989), the exclusion of housing equity reduces the time discount factor suggesting that households are somewhat less willing to consume their housing equity regardless of whether or not they have a bequest motive. Although less patient, households appear more sensitive to interest rate changes, as the elasticity of intertemporal substitution is larger than in the second column of Table 3. More importantly, the bequest motive parameter is just as significant and is somewhat larger than when housing equity is included in total wealth. The effect of the bequest motive on predicted consumption is unchanged: The bequest motive reduces consumption by roughly 25 percent.[31]

As noted above, measured wealth does not include the value of life insurance. If households consume more out of measured wealth knowing that their heirs will receive a life insurance payout, then the exclusion of the value of a life insurance settlement could in principle bias the results against finding a significant bequest motive. About 16 percent of the sample owns a whole-life insurance policy, and 27 percent own a term-life insurance policy. Given the relative liquidity of whole-life policies, we estimated the model including these policies in measured wealth.[32] The effects are negligible and are not reported. However, as shown in the final column of Table 3, there is some evidence that owning a life insurance policy is associated with the presence of a bequest motive. Owning either a whole- or term-life insurance policy is associated with a 12-percentage point higher probability of having a bequest motive, and is significant at a 10 percent level.

Finally, we considered various alterative model and data specifications to examine the robustness of the results. First, we added the log of initial wealth in the regime equations as a proxy for the error term in the initial wealth. While this variable was itself significant, it had little effect on the estimates of the parameters of interest. Second, we added to initial wealth those resources that were transferred out of the household in the form of financial assistance or gifts. Given that these transfers were relatively minor, adding them back to wealth had little effect on the results. Third, we considered a more robust model of the error-term that allows the standard deviation of transitory measured consumption to vary with the log of net wealth. Although this form of heteroskedasticty was significant, it had little effect on the estimated magnitude of the

[31] The fact that the exclusion of housing equity does not affect the results in this paper but does in Hurd (1989) may reflect the higher quality of wealth data in the AHEAD compared to the Retirement History Survey. The ability to collect wealth data has improved appreciably in the two decades following the collection of the RHS data (Juster and Smith, 1997). In particular, the quality of financial wealth data is far superior. As indicated in Table 1, housing equity is only slightly more than one-third of total wealth. Although mean housing equity was not reported in Hurd (1989), it was likely a larger source of potential bequeathable wealth than in this paper. If this is true, it is not surprising that the inclusion of housing equity in Hurd (1989) had a large and significant effect on the estimated magnitude of the bequest motive.

[32] The value of the policy was added to initial wealth and treated as completely fungible with all other forms of wealth. Wealth in later periods is not used in the empirical model and so no adjustment is required.

bequest motive. Fourth, we considered alternative trims of the data. Allowing for a more restrictive trim—change in spending between -50,000 to 50,000, dropping 100 additional observations—and less restrictive trims—change in spending between -120,000 to 120,000, adding 200 observations—both yielded fairly similar results to those reported in Table 3.[33]

B. Bequest versus precautionary motive

The empirical results above imply that roughly 75 percent of the elderly population consume in a manner consistent with a life-cycle model modified to include the desire to leave a bequest, and that this desire reduces spending by about 25 percent on average. However, because no assumptions were made regarding which households have a bequest motive, the observed patterns of spending relative to wealth may indicate a desire to save for uncertain medical expenses rather than for a bequest. Distinguishing between the bequest and precautionary motive is made difficult by the fact that precautionary savings can also serve the bequest motive (Dynan, Skinner and Zeldes, 2002 and 2004). Estimating a model that accounts for both the bequest motive and the risks associated with future medical expenses is beyond the scope of this paper. Nevertheless, we consider several potential alternative hypotheses suggesting a weaker bequest motive in favor of a stronger precautionary motive and provide evidence against each.

The precautionary motive is a response to uninsurable risk, and thus the saving response to uncertain medical costs is largely mitigated by access to both social and private insurance. Indeed, the effect of asset-based means tested social insurance programs, such as Medicaid, *reduces* the saving of households (Hubbard, Skinner, Zeldes, 1995). All else being equal, this would bias the results toward finding no bequest motive. However, the fact that Medicaid affects the saving behavior of some households more so than others could be influencing the empirical results. A potential alternative hypothesis to the bequest motive is that Medicaid creates two groups of people: Those who do not save in order to maintain eligibility for Medicaid and, in so doing, consume in a manner inconsistent with a bequest motive, and those who are wealthy enough to make self-insuring utility maximizing and, in so doing, consume in a manner consistent with a bequest motive.

We argue the effect of Medicaid on the estimated presence and magnitude of the bequest motive is small for two reasons. First, although some self-insuring occurs, most wealthy households purchase insurance and so have less of a need to save. In the AHEAD sample, roughly 85 percent of households in the top third of the wealth distribution have health insurance beyond Medicare and Medicaid, and 14 percent have long-term health care. Second, and more

[33] Any of these additional results are available upon request.

importantly, the empirical model conditions on initial wealth and so is implicitly comparing the consumption profiles among households with similar wealth. This is clear from Figure 2, which indicates that the identification of the bequest motive is largely based on households with wealth greater than $25,000. The estimates presented in the first column of Table 5 imply that the bequest motive damps spending by roughly the same magnitude (25 percent) when estimating the model on households with wealth greater than $50,000 (roughly the median) as when estimating over the full sample. The estimates of behavioral parameters are also quite close to those based on the full sample.

Still, not all high-wealth households purchase private health insurance beyond Medicare, and even fewer purchase long-term care insurance. Thus, a second alternative hypothesis could be that there are some high-wealth households that self-insure and, in so doing, consume in a manner consistent with a bequest motive, and there are other high-wealth households that prefer to purchase private health insurance and, in so doing, consume in a manner inconsistent with a bequest motive. To test this hypothesis, we include in the switching equation whether or not a household has access to private health insurance and long-term care insurance.[34] As indicated in the second column of Table 5, access to long-term care insurance is insignificant and so is not associated with either having or not having a bequest motive. Although access to private health insurance is significant, it is associated with *having* a bequest motive, contrary to the alternative hypothesis.[35]

Despite access to social or private health insurance, most households face some risk of out-of-pocket medical costs. Consequently, to the extent that this risk differs across households, a third alternative hypothesis is that all households self-insure by saving, but those with a higher risk save more and, in so doing, consume in a manner more consistent with a bequest motive, while those with a lower risk save less and, in so doing, consume in a manner less consistent with a bequest motive. To test this alternative, we include in the switching equation a unique survey instrument in the AHEAD that asks households their expected probability that future medical costs will exhaust their wealth within the next five years. If the precautionary motive is heavily influencing the estimated bequest motive, households with a high probability of large medical costs should save more and consume in a manner that we mistakenly attribute to a bequest

[34] As with including the characteristics of children in the switching equation, only predetermined values as of 1995 are used.
[35] To determine if private health insurance were simply acting as a proxy for initial wealth, we considered a specification that also includes the log of initial wealth in the switching equation. The result was unchanged.

motive. As indicated in the last column of Table 5, a higher probability of large medical costs is indeed associated with having a bequest motive but the effect is not significant.

We conclude that, although the precautionary motive is likely present, the saving patterns observed in the data are largely consistent with a significant bequest motive.[36] In general, precautionary saving models with uncertain medical expenses alone cannot explain these patterns precisely because most of aggregate personal saving is done by high wealth households (Dynan, Skinner and Zeldes, 2004). Palumbo (1999) concludes that the precautionary saving motive for uncertain medical expenses damps spending by roughly 7 percent. Even if one were to argue that the effect of the bequest motive estimated in this paper was mis-identified one-for-one with the precautionary motive, this would still imply the bequest motive damps spending by about 18 percent, more than twice as large as the effect of the precautionary motive.

C. Model predictions

As an alternative check on the validity of the results, we examine self-reported probabilities of leaving a bequest. Survey respondents were asked what they believed was the probability that they would leave a bequest larger than $0, $10,000, and $100,000. 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 create 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 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,

[36] Although we do not show the results, including the indictors for long-term health care, private health insurance and the probability of large medical costs directly in the regime equations (additively) did not affect the estimates of the parameters of interest.

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 self-reported probability of leaving a bequest by estimating a probit probability model with the self-reported probability as the dependent variable, expressed as a number between zero and one. In addition, we also control for the self-reported probability that a household's future medical expenses will exhaust all its wealth. The results are reported in Table 6. The probability of leaving a bequest is clearly correlated with the level of wealth and income. Moreover, consistent with the precautionary saving motive, households that expect large future medical expenses 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.

As indicated in Table 6, the self-reported and predicted probabilities of leaving a bequest are significantly related. 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 five percentage point increase in the self-reported probability of leaving a bequest.[37] 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 self-reported probabilities than the reduced form linear specification in wealth and income.

The generated bequest motive indicator has a similar significant relationship. This is more compelling than the previous results 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 13, 11 and 5 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 a bequest motive and serves as an external validation of the results.

[37] The marginal effect is evaluated at the mean.

The distributions of self-reported and predicted probabilities of leaving a bequest larger than $10,000 are reported in Table 7. Overall, the distribution of the predicted probabilities is well aligned with the distribution of the self-reported probabilities. A fifth of the sample reported a probability greater than 80 percent. This is similar 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.[38] The last two columns of Table 7 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 that reported a probability of leaving a bequest as less than 20 percent, 44 percent consume in a way that is more consistent with a bequest motive while 65 percent consume in a way that is more consistent with not having a bequest motive. Among households that reported a probability of leaving a bequest as more than 80 percent, 29 percent consume in a way that is more consistent with a bequest motive while only 14 percent consume in a way that is more consistent with not having a bequest motive.[39]

We next compare the predicted consumption profile from the estimated model 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 3 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

[38] Note that 26 percent of the sample has positive initial 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 greater than zero.
[39] 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.

given by $\{\bar{c}_t^u = N^{-1}\sum_{i=1}^{N}\hat{a}_{it}\hat{c}_{it}^u\}_{t=72}^{90}$ and shown in Figure 3. 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 4, households without a bequest motive consume a fair bit more on average than the unconditional average.[40]

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. Of the 78 percent of net wealth that is estimated to be bequeathed by single households aged 70 and older, 53 percent is accounted for by a bequest motive.

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 75 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

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

operative bequest motive spend about 25 percent less on personal outlays. This implies that of the almost four-fifths of household wealth we estimate will be bequeathed, about one-half will be due to 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 79 percent, the probability for households without children is 63 percent. In general, the life-cycle model with an egoistic bequest motive fits the data much better when the presence of a bequest motive is allowed to vary across all households, as opposed to restricting it to households with children. Assuming a deterministic bequest motive results in estimates of the time discount factor and elasticity of intertemporal substitution that are highly implausible, while relaxing this assumption yields estimates that are consistent with estimates typically reported in the literature.

We find little 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 a touch 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 one-fourth 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 one-seventh of households that consume in way consistent with no bequest motive reported a probability of leaving a bequest greater than 80 percent.

These results are relevant for the assessment of the efficiency cost and desirability of estate taxation. We find that most of the population has a bequest motive but for a majority, at least some of bequests are of an accidental nature. Only at high wealth levels does the difference between having and not having a bequest become clearly visible. A tax on small bequests is therefore unlikely to be largely distortionary.[41] A tax on large bequests may be distortionary

[41] This is not to say that such a tax is necessarily desirable as a first-best policy would be to address the lack of insurance that gives rise to accidental bequests (Kopczuk, 2003).

because some of the large bequests appear motivated by bequest considerations. At the same time, the existence of some accidental bequests among the wealthy suggests a peculiar policy prescription that resembles the current U.S. estate tax: Imposing taxation while simultaneously allowing for wide-spread and relatively cheap avoidance. Under this kind of policy, the tax could apply to bequests left by people without a bequest motive while cheap avoidance could allow others to escape taxation without a real reduction in wealth and thereby reduce the efficiency cost. Of course, our results say nothing about the potential influence of bequests on the saving behavior of the recipient.

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.

VIII. Appendix

A. Measuring Wealth, Income and Consumption in the AHEAD

Total household net wealth in the AHEAD is comprised of twelve components: main home equity (w_1), real estate equity other than main home equity (w_2), a farm or private business, net of any loans (w_3), automobiles, motor homes, or boats, net of any loans (w_4), investment retirement accounts or Keoghs (w_5), checking and saving accounts, money market funds (w_6), certificates of deposit, government saving bonds, treasury bills (w_7), equities in publicly traded corporations or mutual funds (w_8), municipal, government or foreign bonds, or bond funds (w_9), trust funds (w_{10}), other savings or assets, such as jewelry, money owed by others, a collection for investment purposes, beneficiary rights in a trust or estate (w_{11}), total non-collateralized debt, such as credit card balances, medical debts, and loans from relatives ($-w_{12}$). With $t = 1995$, 1998, and 2000, total net wealth for each household is given as $w_t = \sum_{k=1}^{12} w_{kt}$, with tangible wealth defined as $w_t^{Tangible} = \sum_{k=1}^{4} w_{kt}$ and financial wealth given as $w_t^{Financial} = \sum_{k=5}^{12} w_{kt}$.

In 1998 and 2000, respondents were asked about their "active" saving since the previous survey, defined as the net acquisition of assets. These questions were specific to the components of wealth where capital gains are most relevant. Measured active saving in the main home (s_1), other real estate (s_2), and farm or private business (s_3), depend on ownership status. If there was no change in ownership status between the survey years, active saving is defined as the change in the mortgage or loan principal plus investments and improvements. If there was a change in ownership status, the active saving is simply the change in net equity. Active saving in transportation assets (s_4) is defined as the change in the self-reported value of the assets between survey years after depreciating the asset at a rate of 20 percent per year. Active saving in investment retirement accounts or Keoghs (s_5) and in equities for publicly traded corporations or mutual funds (s_8) are defined as the self-reported acquisition of assets less withdrawals in these accounts. Active saving in all other assets are defined as the change in the self-reported value of the assets between waves, based on the assumption that capital gains in these assets are relatively small. Total saving is given as $s_t = \sum_{k=1}^{12} s_{kt}$. The dynamic budget constraint implies the change in wealth is the sum of capital gains and active saving, $\Delta w_t = G_t + s_t$. Thus, given both the change in wealth and active saving, capital gains in each asset is derived as $G_{kt} = \Delta w_{kt} - s_{kt}$.

Respondents provided detailed information regarding all sources of income over the previous calendar year, or previous month. These include self-reported social security income, supplemental security income, veteran's benefits, defined benefit retirement pensions, annuities, welfare, food stamps, and financial assistance from friends and family. Also, dividend and interest income were provided. Combining these sources of income yields a measure of all resources that flowed into the household in previous calendar year. This is scaled by the number of years between survey waves for each household to generate a measure of total inter-survey-year income that is at the same frequency as measured active saving. The difference between total income and active saving yields measured consumption between survey years. In Table 2, income, consumption, and capital gains values are annualized by the individual specific number of years between survey dates. For the purposes of estimating the empirical model, consumption and income are converted to a two-year frequency.

B. 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,

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

C. 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.

D. 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 $a_k c_k^{-\gamma} \ge \beta(1+r)\left(a_{k+1} y_{k+1}^{-\gamma} + m_{k+1}\alpha\right)$. 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.3, $u = [u_1, u_2]$, 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	181,598	170,731	167,783
Tangible Wealth	87,090	96,358	91,230	85,681
Net Equity in Home	63,807	66,419	61,401	61,560
Financial Wealth	54,186	85,240	79,501	82,102
Stocks/Mutual Funds	15,450	38,740	37,885	42,586
Share of Total Net Wealth				
Real Assets	0.62	0.53	0.53	0.51
Net Equity in Home	0.45	0.37	0.36	0.37
Financial Wealth	0.38	0.47	0.47	0.49
Stocks/Mutual Funds	0.11	0.21	0.22	0.25

Sample includes all non-married, non-working heads of household present in the 1993, 1995, 1998 and 2000 AHEAD survey (1,576 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	-4,870	-1,362	-1,105	-251
Saving	-4,118	-2,678	-111	-101
Capital Gains	-752	1,315	0	0
Income	18,327	17,647	12,658	11,921
Consumption	22,449	20,325	13,071	12,139

Sample includes all non-married, non-working heads of household present in the 1993, 1995, 1998 and 2000 AHEAD survey (1,576 observations). Values are annualized by individual specific number of years between survey interviews. Dollar values are in 1996 dollars.

Table 3.-Model Estimates

	i	*ii*	*iii*	*iv*	*v*	*vi*
			Behavioral Parameters			
Time Discount Factor (β)	2.00	0.91	0.90	0.93	0.85	0.90
	(n.a.)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)
Elasticity of Substitution ($1/\gamma$)	0.059	0.287	0.284	0.380	0.379	0.283
	(0.005)	(0.026)	(0.027)	(0.051)	(0.036)	(0.027)
Bequest Motive ($\alpha^{-1/\gamma}$)	246,318	48,090	47,687	47,842	43,826	48,132
	(5,159)	(1,973)	(1,968)	(2,983)	(2,058)	(2,026)
			Transitory Measured Consumption			
Constant, period 1 (u_1)	2,373	-6,503	-6,578	-6,973	-1,560	-6,618
	(1,217)	(1,189)	(1,188)	(1,326)	(952)	(1196)
Constant, period 2 (u_2)	-684	-7,328	-7,362	-6,824	-2,141	-7,408
	(1,134)	(1,137)	(1,138)	(1,205)	(929)	(1143)
Standard Deviation, period 1 (σ_1)	26,880	22,903	22,866	22,586	22,803	22,910
	(354)	(342)	(341)	(380)	(322)	(342)
Standard Deviation, period 2 (σ_2)	27,111	24,327	24,336	23,210	24,286	24,349
	(550)	(550)	(548)	(569)	(544)	(554)
Intertemporal Correlation ($\sigma_{1,2}$)	0.43	0.25	0.25	0.24	0.22	0.25
	(0.02)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)
			Switching Equation			
One or more children			0.45			
			(0.26)			
Life insurance policy						0.39
						(0.25)
Constant		0.67	0.34	0.82	0.63	0.54
		(0.12)	(0.22)	(0.14)	(0.13)	(0.15)
			Predicted Sample Averages			
Prob (Having a bequest motive)	0.820	0.748	0.757	0.794	0.735	0.752
Bequest effect on consumption	0.998	0.741	0.741	0.732	0.756	0.743
Log-Likelihood	-10,425.8	-10,279.4	-10,277.8	-8,378.4	-10,258.8	-10,278.0

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 *iv* restrict the sample to households with children and assume no sample separation information . The results in column *v* exclude housing equity from the measure of total net wealth. 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. The bequest effect on consumption is the ratio of predicted consumption over the sample period assuming all households have a bequest motive to predicted consumpiton assuming no households have a bequest motive. Column *iv* is based on 923 observations; all others are based on 1,126 observations.

Table 4.-Alternative Specifications for the Switching Equation

	i	*ii*	*iii*
		Switching Equation	
Number of children			-0.06
			(0.15)
One child	0.16	-0.42	
	(0.35)	(0.51)	
Two children	0.85	0.25	
	(0.36)	(0.52)	
Three or more children	0.38	-0.35	
	(0.30)	(0.54)	
One or more grandchildren		0.74	0.76
		(0.46)	(0.80)
Children Characteristics			
Financially better off than parents			-0.77
			(0.65)
Financially same as parents			-0.84
			(0.72)
High school degree			1.72
			(1.23)
Some college			-0.34
			(0.77)
College degree			-0.18
			(0.65)
Own a home			1.39
			(0.71)
Live within ten miles of parents			0.10
			(0.82)
Constant	0.34	0.34	-0.48
	(0.22)	(0.22)	(1.11)
		Predicted Sample Averages	
Prob (Having a bequest motive)	0.756	0.758	0.798
Bequest effect on consumption	0.743	0.745	0.726
Log-Likelihood	-10,276.1	-10,274.9	-6,555.4

Only the estimated parameters of the switching equation are shown. The results in column *i* and *ii* are based on the full sample (1,126 observations), and the results in column *iii* restrict the sample to households with children (721 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. The bequest effect on consumption is the ratio of predicted consumption over the sample period assuming all households have a bequest motive to predicted consumpiton assuming no households have a bequest motive.

Table 5.-Model Estimates

	i	*ii*	*iii*
		Behavioral Parameters	
Time Discount Factor (β)	0.85	0.90	0.90
	(0.05)	(0.03)	(0.04)
Elasticity of Substitution $(1/\gamma)$	0.297	0.284	0.286
	(0.046)	(0.027)	(0.032)
Bequest Motive $(\alpha^{-1/\gamma})$	57,394	47,787	51,610
	(3,394)	(1,966)	(2,448)
		Transitory Measured Consumption	
Constant, period 1 (u_1)	-14,243	-6,615	-7,600
	(2,343)	(1,186)	(1,532)
Constant, period 2 (u_2)	-16,017	-7,392	-7,959
	(2,185)	(1,139)	(1,455)
Standard Deviation, period 1 (σ_1)	28,819	22,866	24,015
	(812)	(342)	(434)
Standard Deviation, period 2 (σ_2)	30,483	24,366	25,741
	(1,220)	(554)	(707)
Intertemporal Correlation $(\sigma_{1,2})$	0.22	0.25	0.26
	(0.05)	(0.03)	(0.03)
		Switching Equation	
Long-term health care policy		0.23	
		(0.64)	
Private health insurance policy		0.56	
		(0.24)	
Prob (Medical costs exhaust wealth)			0.60
			(0.48)
Constant	0.68	0.28	0.52
	(0.15)	(0.20)	(0.20)
		Predicted Sample Averages	
Prob (Having a bequest motive)	0.751	0.746	0.776
Bequest effect on consumption	0.732	0.741	0.731
Log-Likelihood	-5,391.0	-10,276.3	-7,502.1

The results in column *i* are based on households with wealth greater than $50,000 (569 observations). The results in the second column are based on the full sample (1,126 observations), and the results in the last column are based on households that self-reported the probability there future medical expenses would exhaust all their wealth within five years (814 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. The bequest effect on consumption is the ratio of predicted consumption over the sample period assuming all households have a bequest motive to predicted consumpiton assuming no households have a bequest motive.

Table 6.-Self-Reported Probability of Leaving Bequest and Model Predictions

	Self-Reported Probability of Leaving a Bequest Larger than…					
	…$0		*…$10,000*		*…$100,000*	
Constant	-1.55	-0.95	-1.62	-1.18	-1.96	-1.96
	(0.20)	(0.15)	(0.18)	(0.16)	(0.20)	(0.21)
Wealth	0.0142	0.0259	0.0108	0.0294	0.0108	0.0302
	(0.004)	(0.003)	(0.004)	(0.004)	(0.004)	(0.003)
Social security income	0.42	0.46	0.49	0.56	0.35	0.49
	(0.15)	(0.14)	(0.15)	(0.15)	(0.19)	(0.19)
Prob (Medical costs exhaust wealth)	-0.52	-0.51	-0.61	-0.64	-0.63	-0.60
	(0.14)	(0.14)	(0.15)	(0.15)	(0.22)	(0.21)
Prob (Leave bequest)	1.29		1.44		1.54	
	(0.21)		(0.20)		(0.25)	
Bequest motive indicator		0.34		0.31		0.18
		(0.10)		(0.10)		(0.13)
Log-Likelihood	-455.8	-469.8	-411.3	-434.0	-220.6	-239.3

The sample is restricted to households that self-reported the probability there future medical expenses would exhaust all their wealth within five years (800 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 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 7.-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	53.6	27.2	44.2	65.0
0.2 to 0.4	5.7	8.4	7.1	4.0
0.4 to 0.6	15.3	12.0	17.4	12.9
0.6 to 0.8	4.6	15.6	5.1	3.9
0.8 to 1.0	20.8	36.8	26.2	14.1

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. Sample includes all households used in the estimation and that reported a probability of leaving a bequest (1,027 observations).

Figure 1.-Percent of Households with Binding Wealth Constraint

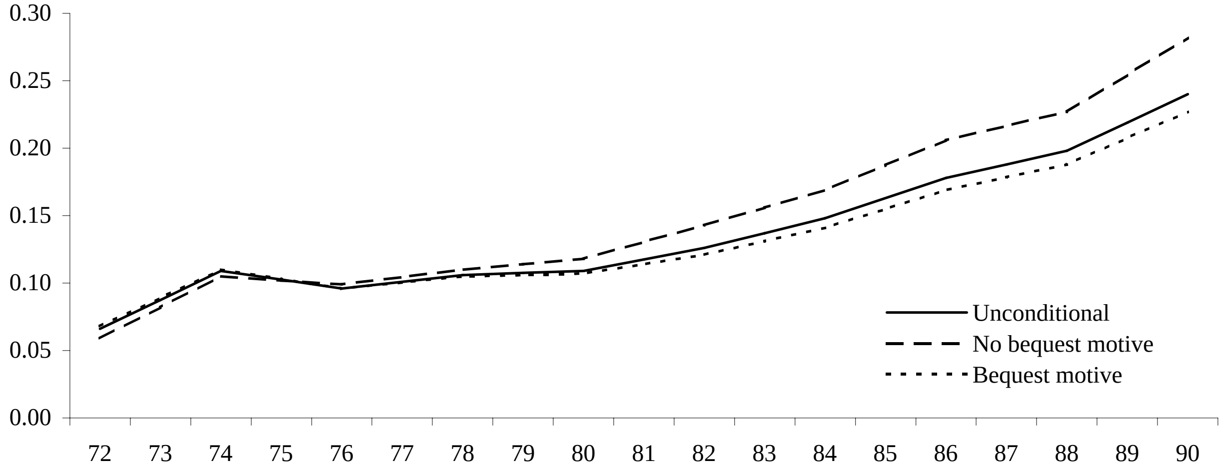

Figure 2.-Average Propensity to Consume out of Cash-On-Hand by Age

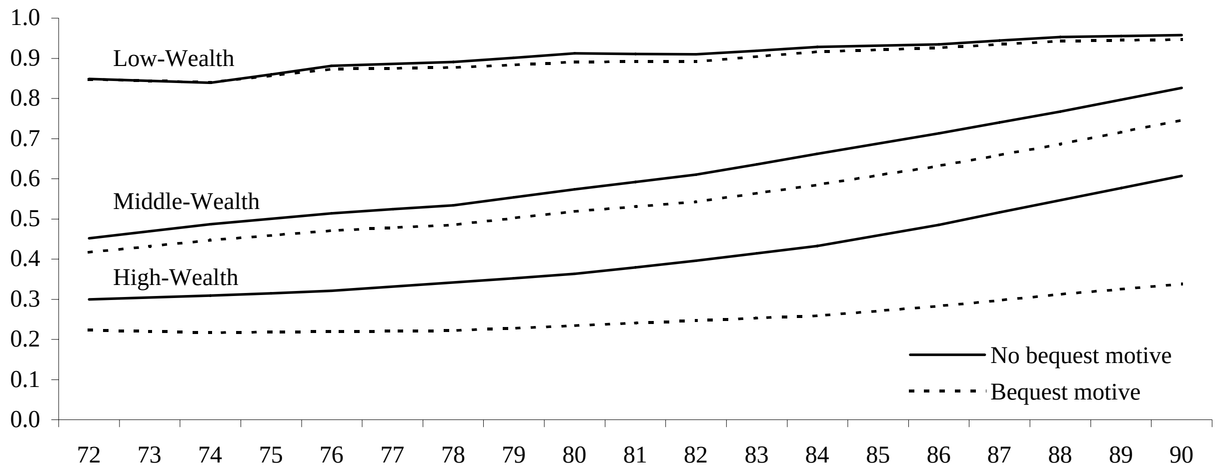

Figure shows the average ratio of predicted annual consumption to cash-on-hand, defined as the sum of net wealth and income. Averages are weighted by the probability of survival to a given age. Households in the low wealth group have initial total net wealth less than or equal to $25,000, households in the middle wealth group have initial total net wealth between $25,000 and $100,000, and households in the high wealth group have initial net wealth greater than $100,000. The solid line is conditional on all households having no bequest motive, and the dashed line is conditional on all households having a bequest motive.

Figure 3.-Total Expenditures of Non-Married, Non-Working Households by Age
(Thousands of 1996 dollars)

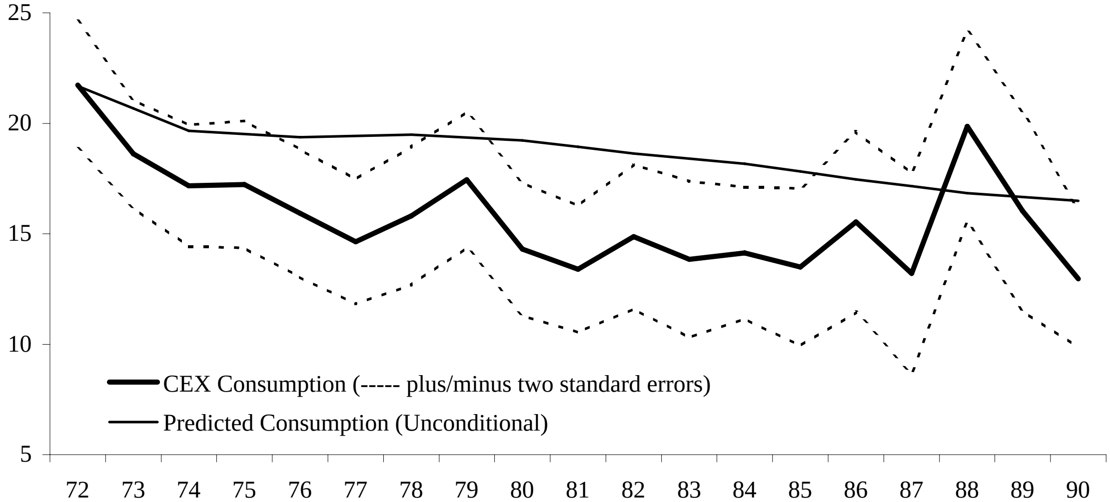

Figure 4.-Predicted Consumption by Age
(Thousands of 1996 dollars)