



Bequest motives and the annuity puzzle

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ABSTRACT

Few retirees annuitize any wealth, a fact that has so far defied explanation within the standard framework of forward-looking, expected utility-maximizing agents. Bequest motives seem a natural explanation. Yet the prevailing view is that people with plausible bequest motives should annuitize *part* of their wealth, and thus that bequest motives cannot explain why most people do not annuitize *any* wealth. I show, however, that people with plausible bequest motives are likely to be better off not annuitizing any wealth at available rates. The evidence suggests that bequest motives play a central role in limiting the demand for annuities.

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1. Introduction

People face significant lifespan risk in old age. While roughly one-fifth of 65-year-olds in the U.S. will die before they turn 75, another fifth will live to age 90 and beyond. Life annuities, which convert a stock of wealth into a lifelong flow of income, can insure people against this risk and would therefore appear to be a valuable part of retirees' portfolios. In most countries, however, voluntary annuitization is almost non-existent.² The lack of annuitization is especially surprising given the large welfare gains from annuities in life cycle models. Calibrated models suggest that typical 65-year-olds would be willing to pay one-fourth of their wealth for access to actuarially fair annuities, which exceeds the 10 to 15 percent loads (the excess of premiums over expected benefits) of available annuities (Mitchell et al., 1999). The "annuity puzzle" literature has identified several extensions of the simple life cycle model that reduce annuity gains (see Brown, 2007 for a review). But trying to understand the near absence of voluntary annuitization within the framework of forward-looking, expected utility-maximizing agents has proven so difficult as to prompt a search for explanations outside of the rational model (e.g., Brown et al., 2008).³

In this paper, I investigate to what extent bequest motives—valuing the prospect of leaving wealth to family, friends, or other good causes—can explain why annuity markets are so small. In particular, I use a numerical life cycle model to

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¹ I am grateful to the National Institute on Aging for financial support (training grant 5T32AG00243).

² See James and Song (2001) for information about Australia, Canada, Chile, Israel, Singapore, Switzerland, the U.K., and the U.S. Among people at least 65 years old in the U.S., private annuities comprise just one percent of total wealth (Johnson et al., 2004). Variable annuities, which are the most popular type of annuity in most countries, are primarily a tax-deferred saving vehicle rather than longevity insurance. Less than one percent of variable annuity contracts in the U.S. were converted to life annuities in 2003 (Beatrice and Drinkwater, 2004).

³ Perhaps the most successful way yet found to reduce the demand for annuities in life cycle models is to include equity markets but rule out equity-linked annuities (e.g., Michaelides et al., 2007; Yogo, 2009). Forcing people to choose between the equity premium and annuities' "mortality premium" reduces the value of annuities, but it does not explain why equity-linked variable annuities are similarly unpopular. See Horneff et al. (2009).

answer two main questions. How strong must bequest motives be to eliminate purchases of available (actuarially unfair) annuities? And how many people would buy available annuities if everyone had one of several bequest motives estimated in the saving literature? I find that moderate bequest motives, much weaker than those required to eliminate purchases of actuarially fair annuities, can eliminate purchases of available annuities. Even in a model in which the only reason to prefer non-annuity wealth to annuity income is that non-annuity wealth is bequeathable, altruists who wish to leave bequests gain little from actuarially fair annuities and are in many cases better off not annuitizing any wealth at available rates. Moreover, in simulations of annuity decisions by single retirees in the U.S., five out of the six estimates of bequest motives from the saving literature significantly reduce the predicted demand for annuities.

The idea that bequest motives reduce optimal annuitization dates back at least to Yaari's (1965) seminal article and has considerable intuitive appeal: the single unavoidable cost of purchasing annuities is the foregone opportunity to bequeath that wealth. Despite this, the prevailing view in the literature is that while bequest motives may explain why people do not annuitize *all* of their wealth, they cannot explain why most people do not annuitize *any* wealth.⁴ The supposed desirability of partial annuitization is based on a result derived in a perfect markets setting, in which case people should annuitize all but what they wish to bequeath (Davidoff et al., 2005). The applicability of this prediction to actual annuitization decisions depends on annuity prices being close enough to actuarially fair, which means roughly that annuity loads are small relative to the gain from fair annuities. I find, however, that annuity loads are not small relative to what people who wish to leave bequests gain from fair annuities. Although plausible bequest motives would not eliminate purchases of *actuarially fair* annuities, they can eliminate purchases of *available* annuities. Bequest motives therefore complement adverse selection and other factors that cause annuities to be actuarially unfair in reducing annuity purchases.

Plausible bequest motives significantly reduce the utility cost of uninsured lifespan risk. Without annuities, even people without bequest motives leave large bequests on average in an effort to smooth their consumption over time (Kotlikoff and Spivak, 1981). Annuities allow people to trade these incidental bequests for greater consumption. This trade is a large free lunch for people without bequest motives, which explains the robust annuity gains in selfish life cycle models. Bequest motives, even those that have little effect on saving, can significantly reduce the gains from this trade. People with bequest motives can support themselves by drawing on their bequests if they live longer than expected. In so doing, they effectively purchase an annuity from their heirs (Becker, 1991). Of course, failing to annuitize future consumption means that bequests depend on realized lifespan. But unless people are very risk averse over bequests—much more than most altruists should be and more than is implied by the wealth elasticity of bequests—bequest insurance is not worth buying at even slightly actuarially unfair rates.

Most estimates of the demand for and value of annuities are based on models without bequest motives. The exceptions typically include several factors that reduce annuity demand in addition to bequest motives (e.g., Michaelides et al., 2007; Ameriks et al., 2009), which makes it difficult to determine how bequest motives affect the value of insuring lifespan risk. Moreover, many of the frequently-modeled disadvantages of annuities, such as a lack of inflation protection, a lack of exposure to the stock market, or illiquidity (combined with uninsured spending risks), could be, and in many cases have been, remedied. Two papers that focus specifically on how bequest motives affect the demand for annuities are Friedman and Warshawsky (1990) and Vidal-Melia and Lejarraga-Garcia (2006). Both show that strong enough bequest motives can eliminate purchases of annuities with high enough loads. But both papers use bequest motives whose strength is difficult to interpret and whose homothetic form is inappropriate for altruists and inconsistent with some patterns in the data, such as the fact that richer people leave a larger fraction of their wealth as bequests (Auten and Joulfaian, 1996; Hurd and Smith, 2002).⁵ In this paper, I estimate the effects of a variety of bequest motives on the value of annuities and on the different components of this value, and I calculate the demand for realistically-priced annuities based on several estimates of bequest motives from the saving literature.

2. Theory

This section uses a simple model to explain the prevailing view that bequest motives should reduce but not eliminate annuitization and to explain why bequest motives may in fact eliminate annuitization.

2.1. Lifespan risk and annuities

Consider the wealth allocation decision of an individual who lives two periods with probability p and lives one period otherwise. In the first period, the individual chooses how much of his wealth, w , to consume, save, and annuitize, $c_1 + s + \pi = w$. Non-contingent saving, $s \geq 0$, earns a gross rate of return R regardless of whether the individual lives. Annuities, $\pi \geq 0$, earn a larger gross return than non-contingent saving if the individual lives, $R_a > R$, but return nothing if the

⁴ An exception is Abel (2003), who cites the lack of annuitization as suggestive evidence of widespread bequest motives but does not investigate this quantitatively.

⁵ Friedman and Warshawsky (1990) also restrict attention to single-year annuities rather than the much more common annuities that last for life. Single-year annuities only become attractive late in life when mortality hazard rates rise above annuity loads. With the 2003 U.S. Social Security Administration male life table, the mortality hazard rate does not reach ten percent (a typical load in the U.S. private annuity market) until age 84. In addition, annuity loads have fallen significantly since 1983, the end of Friedman and Warshawsky's (1990) sample period (Mitchell et al., 1999).

individual dies. In old age, the individual receives income, y , in addition to his accumulated non-contingent saving and annuities. Bequests if the individual dies young and wealth in old age are

$$b_1 = Rs = R(w - c_1) - R\pi, \quad (1)$$

$$x_2 = Rs + R_a\pi + y = R(w - c_1) + (R_a - R)\pi + y. \quad (2)$$

In old age, the individual splits his wealth between consumption and an immediate bequest, $c_2 + b_2 = x_2$. Bequests must be non-negative, $b_1, b_2 \geq 0$.

Without annuities, the individual's choice of how much to bequeath should he die young and his choice of how much to consume and bequeath in old age are inseparable. Each unit of non-contingent saving buys R units of short-lifespan bequests and R units of wealth in old age. In saving for old age, short-lifespan bequests arise incidentally. In saving for short-lifespan bequests, wealth in old age arises incidentally. Annuities relax the constraint linking short-lifespan bequests and wealth in old age by allowing the individual to trade one for the other. Annuitizing an additional unit of saving reduces short-lifespan bequests by R and increases wealth in old age by $(R_a - R)$. By paying benefits only if the annuitant lives, annuities convert "incidental" bequests into wealth in old age.

Suppose the individual maximizes expected utility,

$$EU = u(c_1) + \beta[pV(x_2) + (1 - p)v(b_1)],$$

where

$$V(x) = \max_{c \in [0, x]} \{u(c) + v(x - c)\}$$

is utility in old age as a function of wealth in old age, x . Utility from consumption and bequests, $u(\cdot)$ and $v(\cdot)$, are strictly increasing and strictly concave, and the marginal utility of consumption approaches infinity as consumption approaches zero. The optimal allocation in old age satisfies the first-order condition $u'(c_2^*) \geq v'(b_2^*)$, which holds with equality if $b_2^* > 0$.

Net expected marginal utility of annuitizing an additional unit of saving is

$$\frac{\partial EU(c_1, \pi)}{\partial \pi} = \beta[p(R_a - R)V'(x_2) - (1 - p)Rv'(b_1)],$$

where I used (1) and (2), the budget constraints for short-lifespan bequests and wealth in old age. This equation can be rewritten

$$\frac{\partial EU(c_1, \pi)}{\partial \pi} = \beta R[(1 - p - \lambda)V'(x_2) - (1 - p)v'(b_1)], \quad (3)$$

where $R_a = (1 - \lambda)\frac{R}{p}$ and $\lambda \geq 0$ is the *load*, the percentage by which premiums exceed expected discounted benefits. Actuarially fair annuities have $\lambda = 0$.

2.2. Rejection of bequest motives

If actuarially fair annuities are available ($\lambda = 0$), the expected marginal utility of annuitizing savings is proportional to $(V'(x_2) - v'(b_1))$. The individual annuitizes his savings up until the marginal utility of short-lifespan bequests equals the marginal utility of wealth in old age or until he annuitizes all of his savings, whichever comes first: $V'(x_2^*) \geq v'(b_1^*)$, which holds with equality if $b_1^* > 0$.⁶ The individual annuitizes what he wishes to consume above endowed income and bequeaths the rest, $c^* = R_a\pi^* + y$ and $b_1^* = b_2^* = R(w - c_1^* - \pi^*)$. Thus, *with fair annuities, people set aside what they wish to bequeath and annuitize all future consumption* (Davidoff et al., 2005).⁷ At the optimum, bequests are insured against lifespan risk and consumption and bequests are equally valuable at the margin if the individual leaves a bequest.

This result is the basis for the view that bequest motives do not explain why so few people annuitize any wealth. With fair annuities, the only people who should not annuitize any wealth are those whose pre-existing income covers their desired future consumption or, what is equivalent in this model, those who wish to leave all of their non-annuity wealth as a bequest. It appears, however, that many people who do not annuitize any wealth do not wish to leave all of their non-annuity wealth as a bequest. Most retirees expect to and do leave bequests worth less than their stock of wealth at

⁶ I assume throughout that the individual wishes to consume more than his endowed income in old age. This means that, without annuities, the marginal utility of wealth in old age exceeds the marginal utility of short-lifespan bequests: $V'(x_2) = u'(c_2) \geq v'(b_2) > v'(b_1)$. The last inequality follows because long-lifespan bequests are smaller than short-lifespan bequests when consumption exceeds income in old age, $c_2 > y \Rightarrow b_2 = R(w - c_1) - (c_2 - y) < R(w - c_1) = b_1$. People who wish to consume more than their endowed income in old age would annuitize some wealth at actuarially fair rates. They therefore would not buy actuarially fair life insurance, which is equivalent to selling actuarially fair annuities ($\pi^* < 0$). That most people are not over-annuitized by public and employer pensions is consistent with Brown (2001a), who finds that life insurance ownership in old age appears to be driven more by tax incentives and past decisions than by a desire to increase bequests at the expense of consumption.

⁷ As Davidoff et al. (2005) note, this result is implicit in Yaari (1965).

retirement (Hurd and Smith, 2002), and many more people report saving for retirement than report saving to leave bequests (Dynan et al., 2002).

With actuarially unfair annuities ($\lambda > 0$), people who wish to leave bequests no longer fully annuitize planned future consumption: $V'(x_2^*) > v'(b_1^*)$, which implies $b_2^* < b_1^*$ and $c_2^* > R_a\pi^* + y$ if $b_1^* > 0$ (Davidoff et al., 2005). Large enough loads can eliminate annuity purchases even by people who wish to consume more than their endowed income in old age. For large enough λ , annuitizing wealth may reduce expected utility,

$$\frac{\partial EU(c_1^*, \pi = 0)}{\partial \pi} = \beta R[(1 - p - \lambda)V'(R(w - c_1^*)) - (1 - p)v'(R(w - c_1^*))] < 0,$$

even among people who would benefit from fair annuities, $V'(R(w - c_1^*)) > v'(R(w - c_1^*))$. Yet one would expect purchases of annuities whose prices are close to actuarially fair to approximate purchases of fair annuities. Empirically, annuity prices appear reasonably close to actuarially fair: annuity loads (which average 10 to 15 percent in the U.S. market; Mitchell et al., 1999) are a smaller percentage of premiums than loads in several insurance markets with widespread participation and are smaller than the welfare gains from actuarially fair annuities in simulation models. But annuity purchases appear to be much smaller than one would expect with actuarially fair annuities.

There are at least two explanations for the discrepancy between observed behavior and the prediction of the actuarially fair annuities model. One explanation is that the lack of annuitization is due to something missing from the simple model. This interpretation has prompted investigations of several possibilities. An alternative explanation, which I test in this paper, is that the loads on available annuities are not small enough for the perfect markets model to provide reliable predictions of annuitization. Although annuity loads are small relative to what people without bequest motives gain from actuarially fair annuities, they may be large relative to what people with bequest motives gain from fair annuities.

2.3. Bequest motives and the value of annuities

For people who wish to consume more than their pre-existing income, annuitizing future consumption increases consumption at the expense of bequests, smooths consumption, and insures bequests. Consider how bequest motives affect the gain from each component in turn.

The gain from increasing consumption at the expense of bequests. Annuitizing savings (given c_1) reduces short-lifespan bequests and increases wealth in old age, some of which is spent on consumption. For people without bequest motives, increasing consumption at the expense of bequests is a free lunch that significantly increases welfare in calibrated models. The benefits are so large because, without annuities, people who wish to smooth their consumption over time leave large bequests whether they value bequests or not. Kotlikoff and Spivak (1981) estimate that 55-year-olds without bequest motives consume only about three-fourths of their wealth on average.⁸ Fully annuitizing their wealth using an annuity with a ten percent load would allow them to consume 90 percent of their wealth on average, 15 percent more than they consume without annuities. Of course, this increase in consumption comes at the expense of bequests. By fully annuitizing, people leave no bequest instead of leaving bequests worth one-fourth of their wealth on average. Whereas someone without a bequest motive would be willing to pay roughly 17 percent of his wealth for the opportunity to trade bequests for consumption at this rate, someone who valued bequests at 50 cents on the dollar would be willing to pay roughly 4.5 percent of his wealth, about one-fourth as much.⁹

The gain from smoothing consumption. By eliminating the risk of leaving larger bequests than one wishes to leave, annuities also have a consumption-smoothing benefit. Without annuities, the first-order condition for consumption in the first period is

$$u'(c_1^*) = \beta R[(1 - p)v'(b_1^*) + pV'(x_2^*)].$$

Wealth in old age is more valuable at the margin than short-lifespan bequests, $V'(x_2^*) \geq v'(b_2^*) > v'(b_1^*)$, because in old age the individual consumes some of what he would have left as a bequest had he died young. In deciding how much to consume in the first period, the individual trades off the cost of consuming “too” aggressively ($u'(c_1) < \beta Ru'(c_2)$) against the cost of leaving “excess” bequests ($u'(c_1) > v'(b_1)$). With log utility and the discount rate equal to the interest rate, people without bequest motives choose $c_2^* = \max\{pc_1^*, y\}$. Given that the typical 65-year-old has about a fifty percent chance of surviving to age 85 (Bell and Miller, 2005), he or she optimally consumes just half as much at 85 as at 65. Bequest motives increase the return to saving and thereby encourage people to choose consumption paths that are closer to the optimal consumption path with perfect annuity markets. By consuming some of their “intended” bequests in long-lifespan states, people with bequest motives partially insure their consumption against lifespan risk.

The gain from insuring bequests. Whereas people who wish to leave small bequests use annuities mostly to increase consumption at the expense of bequests, people who wish to leave larger bequests use annuities mostly to insure their bequests.

⁸ Specifically, a 55-year-old man with no annuitized wealth and constant relative risk aversion preferences with coefficient of risk aversion $\sigma = 0.75$ consumes about three-fourths of his wealth on average. An otherwise identical individual with a stronger preference for smooth consumption, $\sigma = 1.75$, consumes only about two-thirds of his wealth on average.

⁹ Someone without a bequest motive would be willing to pay wtp , where $0.90(w - wtp) = 0.75w$. This implies $wtp \approx 0.17w$. Someone who values bequests at 50 cents on the dollar would be willing to pay $0.17 - 0.50 \times 0.25 = 0.045$.

Although people who are risk averse over bequests would benefit from insuring their bequests at actuarially fair rates, bequest insurance may not be sufficiently valuable to justify paying available annuity loads for it. Most altruists and their beneficiaries, for example, should not be very risk averse over bequests because bequests are usually small relative to beneficiaries' total wealth.

In deciding how much wealth to annuitize at actuarially unfair rates, people trade off the benefits of a better distribution of wealth between consumption and bequests, a better distribution of consumption over time, and less risky bequests against the cost of reducing total consumption and bequests by the annuity loads. The next section tests whether the smaller gains from annuities that people with bequest motives would enjoy are large enough to warrant paying available loads.

3. Simulations

This section describes the results from three exercises. First, I test how bequest motives affect the value of annuities. Second, I decompose the gain from annuities into its component parts and examine how bequest motives affect each component. For both of these exercises, I use the standard model from the annuity literature. Finally, I simulate the demand for annuities among single retirees in the U.S. using several estimates of bequest motives from the saving literature and compare these simulated ownership rates to the empirical ownership rate. For this exercise, I use both the standard model and a more realistic model with medical spending risk.

3.1. Baseline model and parameterization

This section presents the baseline model I use to estimate the effect of bequest motives on the demand for and welfare gain from annuities. I adopt the standard model and parameterization from the annuity puzzle literature, which includes lifespan risk, one risk-free asset, and a single-premium immediate annuity (e.g., Mitchell et al., 1999). Using this simple model has three main advantages. First, it is transparent. The effect of bequest motives on the value of annuities is clearest in a model without other factors that affect the value of annuities. Second, it is conservative. A model in which the only disadvantage of annuitized wealth is that it is not bequeathable tends to overstate the value of annuities and thus overstate the strength of bequest motives necessary to eliminate annuity purchases.¹⁰ Finally, the simple model highlights the fundamental tradeoff involved in buying annuities. The essential, defining feature of a life annuity is that annuitized wealth is not bequeathable. Many of the other potential disadvantages of annuities considered in the literature, such as a lack of stock market exposure, have been addressed by the introduction of new products.

The model is a life cycle model of retirement, from age 65 until death. At age 65 the individual makes a once-and-for-all choice about how much wealth to annuitize.¹¹ Then the individual chooses a consumption path (and therefore a sequence of potential bequests) to maximize expected utility,

$$EU = \sum_{t=65}^T \beta^{t-65} S_t u(c_t) + \sum_{t=66}^{T+1} p_t v\left(\frac{b_t}{(1+r)^{t-65}}\right),$$

subject to the constraint that bequests must be non-negative,

$$b_t = (1+r)^{t-65} (N - \Pi) - \sum_{s=1}^{t-65} (1+r)^s [c_{t-s} - (y_{pre} + y_{ann})] \geq 0, \quad \forall t \in \{66, 67, \dots, T+1\}.$$

Together with mortality risk, this constraint precludes borrowing. N is the individual's initial (age 65) non-annuity wealth, and $\Pi \in [0, N]$ is the portion of that wealth that the individual uses to purchase a single-premium immediate annuity. T is the maximum achievable age, S_t is the probability of living to at least age t , and $p_t = S_t - S_{t-1}$ is the probability of dying between age $t-1$ and age t . Assets earn a certain, real after-tax return, r . The individual discounts future utility from consumption, $u(c)$, with the discount factor β .

Pre-existing income from public and private pensions (e.g., Social Security and defined benefit employer pensions) is constant in real terms and equal to y_{pre} . At age 65, the individual may augment his pre-existing income by using some of his initial non-annuity wealth, N , to purchase a single-premium immediate annuity. In exchange for a single premium paid

¹⁰ The model also excludes taxes. Excluding estate and gift taxes is without much loss for understanding the choices of most people in the U.S., as few people have enough wealth to be subject to the estate tax. In 2008, for example, only estates worth more than \$2 million were taxed. While the size of estates that are exempt from taxes has varied, estate taxes have typically been levied on between one and two percent of all estates (Chamberlain et al., 2006). The tax treatment of capital gains, however, likely has a bigger effect on tradeoffs involving bequests. Currently in the U.S., the cost basis of inherited assets is "stepped up" to market value at the time of the decedent's death; capital gains realized during the decedent's life on assets eventually left as a bequest are not taxed. In this way, bequests tend to be taxed more lightly than consumption.

¹¹ Robustness checks show that there is little incentive in the model to delay annuity purchases. Among retirees with comparable levels of pre-existing income and non-annuity wealth, simulated annuity ownership rates among individuals in their late 60s are similar to those among individuals in their late 70s.

at age 65, Π , the annuity provides the individual with a constant real income stream beginning immediately and lasting until death. The premium for an annuity paying a constant real income stream of y_{ann} for life is

$$\Pi(y_{ann}, \lambda) = \sum_{t=65}^T \frac{S_t y_{ann}}{(1+r)^{t-65}} / (1-\lambda),$$

where λ is the load. Actuarially fair annuities have zero loads, $\lambda = 0$, and expected discounted income equals the premium. Annuities with a ten percent load ($\lambda = 0.1$) pay on average 90 cents of income per dollar of premiums.

The discounting of future bequests is unusual. The expected utility (from the perspective of the 65-year-old decision maker) of the prospect of leaving a bequest of b_t if the individual dies immediately before age t is $p_t v(\frac{b_t}{(1+r)^{t-65}})$. The individual cares about the present value of bequests rather than the real bequest. Compared to the more commonly-used preferences over real bequests, preferences over the present value of bequests tend to have a smaller effect on the value of annuities and are thus a more conservative choice in terms of explaining the low demand for annuities.¹² The longer one lives, the cheaper (in present value terms) it is to leave a given real bequest. Individuals with preferences over real bequests therefore face less lifespan risk, measured by the extent to which the costs of achieving a given standard of living increase in lifespan, and thus tend to gain less from annuities. Results based on preferences over real bequests are very similar.

Parameterization of the model. I adopt parameter values that are widely-used in the annuity literature (see, for example, Mitchell et al., 1999). The discount rate and the interest rate are three percent per year, $\beta = \frac{1}{1+r} = \frac{1}{1.03}$. Mortality probabilities come from the 2003 U.S. Social Security Administration male life table, adjusted so that the maximum possible age is 110 years, $T = 110$. Setting a maximum age allows me to solve the model via backward induction. Utility from consumption is constant elasticity, $u(c) = \frac{c^{1-\sigma}}{1-\sigma}$, with a coefficient of relative risk aversion, σ , of two.

Utility from bequests is

$$v(b) = a \left(\sum_{i=1}^{\infty} \beta^{i-1} \right) \frac{\left(y_h + \frac{b}{\sum_{i=1}^{\infty} (1+r)^{-(i-1)}} \right)^{1-\sigma}}{1-\sigma}.$$

This utility function arises naturally under altruism. In particular, it is the utility function of the head of a dynasty of altruistically-linked individuals. It also approximates the preferences of altruists with multiple heirs or a long-lived heir. Under this interpretation, a is the degree of altruism and y_h is the heir's permanent income. I assume that y_h is equal to the individual's pre-existing annuity income, y_{pre} , and I report results for a range of degrees of altruism, a . The assumption that $y_h = y_{pre}$ ensures that the problem is scalable in total wealth, the sum of initial non-annuity wealth and the actuarial value of the pre-existing annuity income stream, $W = N + \sum_{t=65}^T \frac{S_t y_{pre}}{(1+r)^{t-65}}$. The gains from annuities as a function of the strength of bequest motives are therefore invariant to the overall level of wealth, given the fraction of wealth already annuitized.

This bequest motive is a particular parameterization of a functional form that is widely-used in the saving literature (see, for example, De Nardi, 2004; Ameriks et al., 2009; De Nardi et al., 2010). The degree of altruism, $a \geq 0$, determines the strength of the bequest motive, and the heir's income, $y_h \geq 0$, determines the threshold wealth level below which an altruist with access to actuarially fair annuities leaves no bequest. Richer people divide their wealth above the threshold between consumption and bequests in a fixed proportion. The larger is y_h , the higher is the threshold, and so the greater the extent to which bequests are luxury goods. When $y_h > 0$, the marginal utility of bequests is decreasing in the size of the bequest, which implies that bequests are luxury goods and that people are risk averse over bequests. Empirically, bequests are luxury goods: the rich leave a larger fraction of their wealth to their heirs than the poor.¹³ In Appendix A.1, I test the robustness of the results to a wide range of alternative parameterizations of the bequest motive spanning the range of bequest motives used in numerical life cycle models, from linear bequest motives (e.g., Hurd, 1989; Kopczuk and Lupton, 2007) to constant relative risk aversion bequest motives (e.g., Friedman and Warshawsky, 1990).

I present results for individuals with half of their wealth already annuitized by public and employer pensions. This is roughly the average share among U.S. households headed by 65-year-olds in the eighth and ninth deciles of the wealth distribution (Dushi and Webb, 2004). Poorer households have higher shares of their wealth already annuitized and, as a result, gain less from additional annuitization.

Table 1 summarizes the parameters of the model.

¹² I am grateful to the editor for suggesting this way of discounting future bequests.

¹³ The wealth elasticity of both realized and anticipated bequests have both been estimated to be about 1.3 (Auten and Joulfaian, 1996; Hurd and Smith, 2002). Among single Americans who were at least 70 years old in 1993 and died before 1995, the 30th percentile of the bequest distribution was just \$2 thousand, the median was \$42 thousand, and the mean was \$82 thousand (Hurd and Smith, 2002).

Table 1
Parameters of the model.

Parameter values
Preferences
$EU = \sum_{t=65}^T \beta^{t-65} S_t u(c_t) + \sum_{t=66}^{T+1} p_t v\left(\frac{b_t}{(1+r)^{t-65}}\right)$
$u(c) = \frac{c^{1-\sigma}}{1-\sigma}, \sigma = 2$
$v(b) = a\left(\sum_{i=1}^{\infty} \beta^{i-1}\right) \frac{\left(y_h + \frac{b}{\sum_{i=1}^{\infty} (1+r)^{-(i-1)}}\right)^{1-\sigma}}{1-\sigma}, y_h = y_{ref}, \text{ Vary } a \text{ to vary strength of bequest motive}$
$\beta = \frac{1}{1.03}$
Budget set
$W \equiv 1, \text{ Normalization (the problem is scalable)}$
$N = \frac{W}{2}, \text{ One-half of total wealth is already annuitized}$
$y_{ref} = \frac{W-N}{\sum_{t=65}^T (1+r)^{-(t-65)} S_t}$
$r = 0.03$
Risk
$\{(p_t, S_t)\}_{t=65}^{111}$ from 2003 U.S. Social Security Administration male life table, adjusted so $S_{111} = 0$

Note. Aside from the bequest motive, all parameter values are standard in the annuity literature.

3.2. Results

3.2.1. Should people who wish to leave bequests buy available annuities?

In this section, I measure the welfare gain from annuities as a function of the strength of the bequest motive. The gain from annuities is the fraction of the individual's non-annuity wealth that he would be willing to pay for access to the annuities, $\frac{WTP}{N}$.¹⁴ I present results in terms of two different measures of the strength of bequest motives. One is the degree of altruism, a . The other is the demand for bequests as a fraction of initial non-annuity wealth when actuarially fair annuities are available, $\frac{b^*}{N}$. The demand for bequests is the fraction of the individual's initial non-annuity wealth that he would bequeath had he access to actuarially fair annuities, $\frac{b^*}{N} \in [0, 1]$; he would annuitize the remainder, $\frac{\Pi^*}{N} = (1 - \frac{b^*}{N})$. Given that preferences are defined over the present value of bequests, the demand for bequests, b^* , is the optimal present value of bequests. The corresponding real bequests are $b_t^* = R^{t-65} b^*$. The bequest motive at the $\frac{b^*}{N} = 0$ position is the strongest bequest motive consistent with leaving no bequest, which for non-homothetic bequest motives, such as the altruistic one I use, is not the same as having no bequest motive.¹⁵ The main advantages of measuring the strength of the bequest motive in terms of the demand for bequests are that it is easy to interpret and that it can be meaningfully compared across different parameterizations of the bequest motive.

Fig. 1 shows how bequest motives affect the welfare gain from actuarially fair annuities and from annuities with ten percent loads. In panel (a), the strength of bequest motives is measured as the fraction of the individual's non-annuity wealth that he would bequeath had he access to actuarially fair annuities, b^*/N . In panel (b), the strength of bequest motives is measured as the strength of altruism, a . People without bequest motives are willing to pay 25.3 percent of their non-annuity wealth for access to actuarially fair annuities and 17.1 percent of their wealth for access to annuities with a ten percent load. People who wish to leave bequests, on the other hand, gain less—often much less—from annuities. Panel (a) shows, for example, that someone who would bequeath one-fifth of his wealth had he access to fair annuities would be willing to pay 3.7 percent of his non-annuity wealth for access to fair annuities and would not annuitize any wealth if annuities had a ten percent load. Panel (b) shows that even modest degrees of altruism significantly reduce the value of annuities. Altruists with $a \geq \frac{1}{3}$, for example, would be willing to pay less than 5 percent of their non-annuity wealth for access to actuarially fair annuities and would not annuitize any wealth if annuities had a ten percent load. These results show that the key factor driving the large, robust gains from annuities typically estimated in the literature is the assumption that people place zero value on the prospect of leaving wealth to their heirs. For people who wish to leave bequests, non-annuity wealth and actuarially equivalent income streams are fairly close substitutes.

The results also reject the prevailing view that people who wish to leave bequests should partially annuitize their wealth. Even people who would annuitize most of their wealth had they access to actuarially fair annuities may be better off not annuitizing any wealth in the U.S. private annuity market, where loads average 10 to 15 percent of premiums (Brown, 2007). For the preferences and wealth levels represented in the figure, even people who would annuitize four-fifths of their non-annuity wealth had they access to actuarially fair annuities would not annuitize any wealth with ten percent loads. Although optimal purchases of actuarially fair annuities provide a fairly good approximation for the demand for realistically-priced annuities for people without bequest motives, the same is not true for people with bequest motives. With bequest motives,

¹⁴ An individual with initial non-annuity wealth $(N - WTP)$ and with access to annuity markets is equally well off as an otherwise identical individual with initial non-annuity wealth N and without access to annuities. Willingness to pay for access to annuities is always non-negative since the individual can always choose not to annuitize any wealth.

¹⁵ With fair annuities, the individual fully annuitizes if and only if $u'(c_{full}) \geq v'(0)$, where c_{full} is what the individual consumes if he fully annuitizes. The bequest motive at the $\frac{b^*}{N} = 0$ position is the one such that $u'(c_{full}) = v'(0)$.

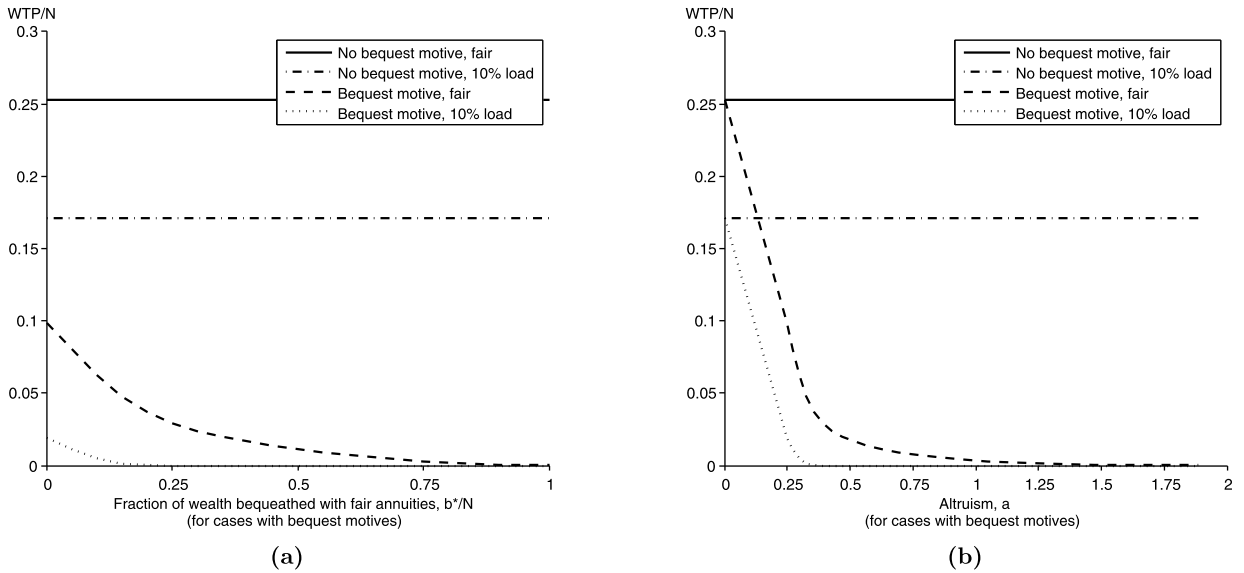


Fig. 1. Welfare gains from annuities as a function of the strength of the bequest motive. The gain from annuities is measured as the fraction of the individual's non-annuity wealth that he would be willing to pay for access to the annuities. In panel (a), the strength of the bequest motive is measured as the fraction of the individual's non-annuity wealth that he would bequeath had he access to actuarially fair annuities, b^*/N . In panel (b), the strength of the bequest motive is measured as the degree of altruism, a . One-half of wealth is already annuitized, which is roughly the average share among 65-year-olds in the eighth and ninth deciles of the wealth distribution.

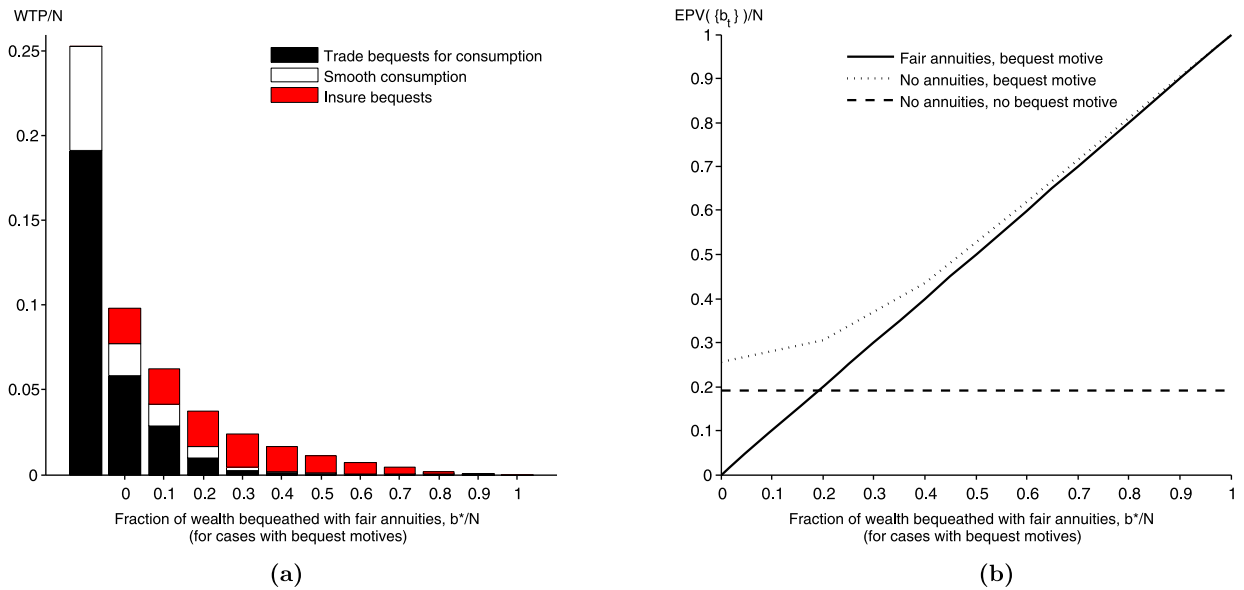


Fig. 2. Panel (a): Components of the gain from actuarially fair annuities for individuals without bequest motives (first bar) and for individuals with bequest motives of various strengths. Panel (b): Expected discounted bequests as a fraction of initial non-annuity wealth. One-half of wealth is already annuitized.

the predictions of perfect-markets models may significantly overstate the demand for realistically-priced annuities because bequest motives significantly increase the sensitivity of annuity purchases to loads. Bequest motives much weaker than those required to eliminate purchases of fair annuities can eliminate purchases of annuities with realistic loads.

3.2.2. Why do bequest motives reduce annuity gains so much?

To understand why bequest motives can have such a large effect on the value of annuities, decompose the gains from annuities into three parts: from trading bequests for consumption, from smoothing consumption, and from insuring bequests. Panel (a) of Fig. 2 shows the size of each of these gains for people who have no bequest motive (the first bar) and for

people who have altruistic bequest motives of various strengths.¹⁶ By far the largest component of the gain from annuities for people with low demand for bequests is the gain from trading bequests for consumption, which accounts for over three-fourths of the gain from annuities for people without bequest motives. In addition to gaining less from trading bequests for consumption, people with bequest motives also gain less from annuities' consumption smoothing role because, without annuities, bequests partially insure consumption. Finally, panel (a) shows that bequest insurance is not very valuable with this bequest motive. As Appendix A.1 shows, this conclusion holds even for altruists who are more risk averse over bequests than most altruists are likely to be. It appears that only in rare cases would altruists (and their heirs) be sufficiently risk averse over bequests to justify using currently available annuities to insure their bequests.

Panel (b) of Fig. 2 shows expected discounted bequests by people with and without annuities as a function of bequest motives. In accordance with the results in panel (a), panel (b) shows that much of what annuities do for people who wish to leave little or nothing to their heirs is allow them to convert incidental bequests into greater consumption. Without annuities, people who die young leave large bequests whether they value them or not. In the simulation, even people without bequest motives leave bequests worth 19.1 percent of their wealth on average (hence the 19.1 percent gain from trading bequests for consumption in panel (a)). Even people who would bequeath twenty percent of their wealth had they access to actuarially fair annuities ($b^e/N = 0.2$) leave bequests worth about ten percent more of their non-annuity wealth on average (30.5 percent) if they do not buy annuities than if they buy actuarially fair annuities. The value that people place on the bequests that arise incidentally from financing future consumption with non-annuity wealth is the primary determinant of the gain from annuities. These results suggest that people who do not wish to trade most of their (expected) bequests for greater consumption are unlikely to benefit from buying available annuities.

Panel (b) of Fig. 2 also shows how an alternative measure of the strength of bequest motives (expected bequests by people without annuities) relates to the primary measure, the amount of wealth people would set aside for bequests had they access to actuarially fair annuities. This alternative measure and two others in Appendix A.3 show that bequest motives that have relatively minor effects on saving can eliminate purchases of available annuities. Bequest motives that increase the expected present value of bequests by people without annuities from 19.1 to 30.5 percent of their non-annuity wealth eliminate purchases of annuities with ten percent loads. The figures in Appendix A.3 show that bequest motives capable of eliminating annuitization may have little effect on the optimal consumption path or on the age at which people exhaust their wealth.

3.2.3. Can bequest motives explain why so few people buy annuities?

Considerable evidence suggests that bequest motives are widespread and have important effects on the economy. Inter-household transfers are common and large (Gale and Scholz, 1994). Compared to optimal behavior in selfish life cycle models, most households accumulate too much wealth before retirement (Scholz et al., 2006) (though see Skinner, 2007 for a contrasting view) and spend their wealth too slowly after retirement (Palumbo, 1999).¹⁷ In fact, except for emergencies, many people appear to *actively save* (spend less than their after-tax income) during retirement (Dynan et al., 2004). De Nardi (2004) shows that bequest motives help make model-predicted saving behavior and wealth distributions more consistent with data from the U.S. and Sweden. Dynan et al. (2004) conclude that one reason the rich save a larger fraction of their permanent income than the poor is their desire to leave bequests. Lockwood (2010) shows that the combination of slow wealth spend down during retirement and the low demand for long-term care insurance are highly inconsistent with a selfish life cycle model and instead match well a model with bequest motives. Ameriks et al. (2009) conclude from consumption choices and responses to a survey designed to separately identify bequest motives and precautionary motives that "strong bequest motives are too prevalent to be ignored".

Yet despite this evidence, the importance of bequest motives remains controversial. To get an idea about the likely effect of bequest motives on the aggregate demand for annuities, in this section I simulate the demand for annuities among single retirees in the U.S. using several bequest motives estimated in the saving literature. In particular, I use bequest motives from De Nardi (2004), Kopczuk and Lupton (2007), Ameriks et al. (2009), De Nardi et al. (2010), and Lockwood (2010), and a bequest motive I estimate based on Hurd and Smith's (2002) estimates of anticipated bequests. These bequest motives represent a wide range of estimates based on a variety of estimation strategies. De Nardi (2004) calibrates a bequest motive based on the distribution of bequests and finds that it is also consistent with saving profiles and the wealth distribution in the U.S. and Sweden. Kopczuk and Lupton (2007) estimate a bequest motive based on wealth changes in panel. Ameriks et

¹⁶ The gain from smoothing consumption is the excess of the expected discounted value of the uninsured consumption path over the expected discounted value of the welfare-equivalent flat consumption path. The gain from bequest insurance is the excess of the expected discounted value of uninsured bequests and the discounted value of the welfare-equivalent certain bequest. The gain from trading bequests for consumption is the residual gain from annuities not accounted for by consumption smoothing or bequest insurance. Kotlikoff and Spivak (1981) decompose annuity gains for people without bequest motives. They call the gain from smoothing consumption "the substitution effect" and the gain from trading bequests for consumption "the income effect".

¹⁷ One manifestation of slow wealth spend-down is that people rarely spend their home equity, especially absent shocks such as a spouse's death or nursing home admission (Venti and Wise, 2004). Davidoff (2009) shows that housing wealth can substitute for annuities and long-term care insurance if people sell their house only if they live a long time or require long-term care. As he notes, this raises the question of why people do not take out reverse mortgages. My results suggest that just as people need not wish to bequeath all of their non-annuity wealth to prefer not to buy available annuities, they need not wish to bequeath all of their home equity to prefer not to take out available (actuarially unfair) reverse mortgages. Only people who wish to consume almost all of their non-annuity wealth (including housing) in typical states of the world are likely to benefit from annuities and reverse mortgages at current prices.

Table 2
Bequest motives used to calculate the aggregate demand for annuities.

Paper	Bequest motive	Parameters
Ameriks et al. (2009)	$v(b) = \frac{\omega}{1-\sigma} (\phi + \frac{b}{\omega})^{1-\sigma}$	$\omega = 16, \phi = 5.05$
De Nardi (2004)	$v(b) = \phi_1 (1 + \frac{b}{\phi_2})^{1-\sigma}$	$\phi_1 = -9.5, \phi_2 = 11.6$
De Nardi et al. (2010)	$v(b) = \theta \frac{(k+b)^{1-\sigma}}{1-\sigma}$	$\theta = 2, 360, k = 273$
Hurd and Smith (2002) ^a	$v(b) = \theta b$	$\theta = 25.5^{-\sigma}$
Kopczuk and Lupton (2007)	$v(b) = \theta b$	$\theta = 23.8^{-\sigma}$
Lockwood (2010)	$v(b) = (\frac{m}{1-m})^\sigma \frac{(\frac{m}{1-m}c_0+b)^{1-\sigma}}{1-\sigma}$	$m = 0.96, c_0 = 18$

Notes. Utility from consumption is constant relative risk aversion, $u(c) = \frac{c^{1-\sigma}}{1-\sigma}$, in all cases. Unlike the previous sections, preferences are defined over real bequests rather than the present value of bequests because all of the estimated bequest motives come from models in which preferences are defined over real bequests.

^a The Hurd and Smith (2002) bequest motive is one I estimate to match Hurd and Smith's estimates of average anticipated bequests.

Table 3
Summary statistics of the sample of 65–69-year-old single retirees used to estimate the demand for annuities.

Variable	Mean
Female	0.73
Age	67.1
Non-annuity wealth	\$271,209
Income	\$19,689
Any annuity	0.043
Life annuity	0.036
Have children	0.90
N	794

Notes. Statistics are raw (unweighted) means. I select retirees by dropping people with more than \$3000 in earnings in the year of the survey. The wealth variable includes all non-annuity wealth. The income variable refers to non-asset income. The “Any annuity” variable includes all private (non-pension) annuities. The “Life annuity” variable counts only those annuities that last for life. I assume that two-thirds of the individuals who own annuities of unknown type (because of missing variable values) own life annuities, which is the share of life annuities in total annuities for 65–69-year-olds whose annuity type can be determined.

al. (2009) estimate a bequest motive based on consumption choices and survey responses. De Nardi et al. (2010) estimate a bequest motive based on wealth change in panel. Lockwood (2010) estimates a bequest motive based on wealth change in panel and long-term care insurance ownership. Finally, using the baseline model in this paper, I estimate a bequest motive based on Hurd and Smith's (2002) estimates of average anticipated bequests.¹⁸ Table 2 shows the functional forms and parameter values of these bequest motives. Lockwood (2010) discusses the relationship between these bequest motives and their implications for behavior in more detail.

I simulate the demand for annuities by 65–69-year-old single retirees in the 2006 wave of the Health and Retirement Study (HRS), a representative sample of people over 50 years old in the U.S. I use the RAND release of all variables other than those necessary to measure ownership of life annuities, for which I require more detailed data than are available in the RAND release. Table 3 shows summary statistics for this sample. The sample is mostly female both because women tend to live longer than men and because women are more likely than men to be retired at these ages. Only about 3.6 percent of the sample owns a life annuity. Roughly one-third of the annuities reported by all 65–69-year-olds (not just single retirees) do not last for life. Incidentally, only about one-fourth of reported annuities stop all payments when the owner dies. Most make payments to the owner's spouse or heirs after the owner's death.

I simulate the demand for annuities using both the simple model from Section 3.1 in which the only disadvantage of annuitized wealth is that it is not bequeathable and a model with medical spending risk. Retirees in the U.S. face significant medical spending risk, mostly due to uninsured long-term care costs. I follow Brown and Finkelstein (2008), who use an actuarial model of long-term care risk developed by Robinson (2002). Details of this model appear in Appendix A.2. I use

¹⁸ Hurd and Smith (2002) estimate that, between 1993 and 1995, average anticipated bequests (based on how likely people say they are to leave bequests of different sizes) by households age 70 and over increased from about \$70 thousand to about \$123 thousand. Average wealth increased from about \$188 thousand to about \$290 thousand over the same period. In my model, the same (linear) bequest motive that matches expected bequests in 1993 given average wealth in 1993 matches expected bequests in 1995 given average wealth in 1995 almost exactly.

Table 4

Simulated and empirical annuity ownership rates among 65–69-year-old single retirees in the Health and Retirement Study.

	Annuity ownership rate			
Bequest motive				
None	69.1%	67.6%	61.0%	54.9%
De Nardi et al. (2010)	60.6%	62.3%	56.4%	44.8%
Hurd and Smith (2002)	24.7%	15.6%	11.7%	4.9%
Kopczuk and Lupton (2007)	21.7%	13.6%	10.6%	4.4%
De Nardi (2004)	19.0%	18.5%	15.4%	4.5%
Lockwood (2010)	16.8%	16.8%	12.6%	3.8%
Ameriks et al. (2009)	0.3%	0.0%	0.0%	0.0%
Average ownership,				
middle four bequest motives ^a	20.5%	16.1%	12.6%	4.4%
Empirical ownership rate	3.6%			
Model				
Medical spending	No	Yes	Yes	Yes
Minimum annuity size	\$0	\$0	\$20,000	\$20,000
Fixed cost	\$0	\$0	\$0	\$2,000

Note. The simulation uses annuities with a ten percent load, typical of the U.S. private market.

^a Simple average of the ownership rates using the Hurd and Smith (2002), Kopczuk and Lupton (2007), De Nardi (2004), and Lockwood (2010) bequest motives.

these life cycle models to simulate the demand for annuities separately for each individual with each bequest motive. The key variables that determine an individual's demand for annuities are his or her initial age, initial non-annuity wealth, and income. The simulation uses annuities with a ten percent load, typical of the U.S. private market. Following Pashchenko (2009), I also consider restrictions on the minimum size of the annuity that may be purchased. Pashchenko (2009) reports that Vanguard and Berkshire-Hathaway, two major annuity sellers, only sell annuities with premiums at least as great as \$20,000 and \$40,000, respectively.

Table 4 shows simulated and empirical annuity ownership rates among the sample of single retirees. Comparison of the first three columns reveals that neither medical spending nor minimum purchase requirements has a large effect on predicted ownership rates and that the effect of the bequest motives is similar in each case. For ease of exposition, then, I focus my discussion on the more realistic case that with medical spending and a \$20,000 minimum purchase requirement, which appears in the third column.

All but one of the bequest motives significantly reduce annuity ownership. Without bequest motives, simulated annuity ownership far exceeds observed levels, 61.0 percent versus 3.6 percent. With all but one of the bequest motives, by contrast, simulated annuity ownership is much closer to observed ownership, ranging from 0 to 15.4 percent. The exception is De Nardi et al.'s (2010) relatively weak bequest motive, the effects of which are mostly limited to the rich.¹⁹ On the other end of the spectrum, Ameriks et al.'s (2009) relatively strong bequest motive eliminates annuity purchases because it is strong even for the relatively poor. Between these two bequest motives lie the other four bequest motives (the "middle four"), under which annuity ownership clusters between 10.6 and 15.4 percent, with an average of 12.6 percent.

Although most of the bequest motives bring the model much closer to the observed ownership rate, predicted ownership rates tend to be higher than the 3.6 percent rate observed in the data. The fourth column presents the results from a model in which individuals must pay a one-time, fixed cost of \$2000 to buy an annuity. One could view this experiment as an effort to bring the model closer to reality by including the costs of buying and owning annuities, such as the one-time costs of learning about annuities and searching for good prices and the recurring costs of preparing tax documentation for owned annuities.²⁰ Alternatively, one could view this experiment as measuring the extent to which the model over-predicts the value of annuities, assuming that the costs of buying and owning annuities are negligible. It answers, "What fraction of people is predicted to be made at least \$2000 better off by the opportunity to buy annuities?" The results show that a one-time cost of \$2000 to buy an annuity reduces average ownership under the middle four bequest motives to 4.4 percent, within one percent of the observed rate.

In light of these results, the low demand for annuities does not seem very surprising, and bequest motives appear to be an important factor limiting annuity purchases. Realistic bequest motives significantly reduce annuity purchases because they disproportionately affect the people who would otherwise benefit most from annuities: those in the upper half of the wealth distribution. Unlike people in the lower half of the wealth distribution, who gain little from annuities even without bequest motives because they are fairly well annuitized by Social Security and employer pensions (Dushi and Webb, 2004), people in the upper half of the wealth distribution are less well annuitized by Social Security and employer pensions. Absent bequest motives, standard models suggest that these people would gain very much from annuities. The evidence suggests,

¹⁹ Lockwood (2010) presents evidence that De Nardi et al.'s (2010) procedure leads to an underestimate of the strength of the bequest motive.

²⁰ Mulligan and Sala-i Martin (2000) estimate median adoption and shopping costs for interest-bearing assets of \$111 per year. They also cite an Internal Revenue Service (IRS) estimate of the time cost of tax preparation activities for interest-bearing assets of 4.4 hours per year.

Table 5

Proxies for bequest motives and ownership of life annuities in the Health and Retirement Study.

Parental status	Parental status		Importance of leaving an inheritance			
	% of sample	Own annuity	Children	No children	Own annuity	
Children	92.4%	4.8%	Very	22.8%	20.4%	4.4%
No children	7.6%	5.6%	Somewhat	44.2%	34.4%	5.0%
Full sample	100%	4.8%	Not at all	28.6%	42.8%	5.1%
			Disagree	4.5%	2.4%	3.3%

Notes. All data are weighted using 1992 household weights. "Disagree" means the respondent and his or her partner disagree about the importance of leaving an inheritance. Annuity ownership rates correspond to annuities that last for life.

however, that these same people tend to have the strongest demand for bequests. Bequest motives naturally complement pre-existing annuities as an explanation of why annuities are unpopular throughout the wealth distribution.

Additional progress toward understanding the effects of bequest motives on annuitization decisions will likely require a better understanding of bequest motives. Two aspects of the results in particular suggest the value of additional research about bequest motives. First, although there appears to be some central tendency among existing estimates of bequest motives, the range of estimates is very wide. Second, although most of the bequest motives come close to matching the overall ownership rate, they do not match the pattern of ownership across the income distribution. The model predicts too much ownership among poorer retirees and too little ownership among richer retirees. In simulations based on the middle four bequest motives, virtually all of the people who buy annuities come from the bottom income quartile, whereas empirically most of the people who buy annuities come from the top income quartile. Simulated ownership is concentrated among the poor because bequest motives in which bequests are luxury goods have little effect on the poor. The model would better match the pattern of ownership across the income distribution if poorer retirees' bequest motives "kicked in" at lower levels of consumption, as would be the case with altruistic bequest motives and intergenerational persistence in economic status.

A comparison of the first two columns indicates that medical spending has comparatively little effect on the demand for annuities. This is in contrast to the findings of some papers, such as Ameriks et al. (2009) and Peijnenburg et al. (2010), that suggest that medical spending risk significantly reduces the demand for annuities. In principle, medical spending could increase or decrease the gain from annuities (Davidoff et al., 2005). It could increase the gain from annuities by effectively undoing some annuitization, or it could reduce the gain from annuities by increasing the demand for liquid (non-annuity) wealth. In practice, the effect of medical spending on the demand for annuities depends largely on the timing of the spending. Peijnenburg et al. (2010) find that medical spending risk reduces the demand for annuities only if large medical costs are likely to arrive early in retirement; medical spending after age 70 has little effect on the demand for annuities among 65-year-olds. Moreover, they show that many of the models of medical spending risk used in the literature have very different implications for the timing of medical spending, which can explain why different papers reach different conclusions about the effect of medical spending risk on annuity decisions.

Both individual-level panel data and actuarial models of long-term care usage indicate that medical spending tends to be modest before age 70 and grow rapidly with age (De Nardi et al., 2010; Robinson, 2002). In this case, medical spending is unlikely to significantly decrease the demand for annuities—it may even increase the demand for annuities (Pang and Warshawsky, 2010). Medical spending risk that rises with age increases the incentive to save wealth into old age. Saving wealth into old age is the type of saving for which annuities, due to their mortality credit, offer the greatest advantage over non-contingent assets.

Another piece of evidence against the hypothesis that medical spending explains the low demand for annuities is that models in which medical spending significantly reduces the demand for annuities tend to predict much greater demand for long-term care insurance than is observed empirically (Ameriks et al., 2009; Lockwood, 2010). Together with my results, these findings suggest that bequest motives are likely to be more important than medical spending in explaining why so few people buy annuities.

4. Discussion of results and conclusion

The simulation results suggest that bequest motives should be a crucial determinant of the annuity purchasing decision. Empirically, however, ownership of life annuities is rare even among people who seem likely to have weak bequest motives. The main variables used as proxies for bequest motives are whether someone has children and the self-reported importance of leaving bequests. Table 5 summarizes these measures and how they relate to ownership of life annuities in the Health and Retirement Study.²¹ Annuity ownership is only slightly greater among households without children than among households

²¹ Respondents are asked, "Some people think it is important to leave an inheritance to their surviving heirs, while others don't. Do you (both) feel it is very important, somewhat important, or not at all important (or do you differ in how important it is)?" The possible answers are that (both) think it is "very important", "somewhat important", or "not at all important", or that the respondent and his or her partner disagree. This question was asked only in 1992, when most of the sample was between 51 and 61 years old. Annuity ownership rates are measured in 2006 and correspond to annuities that last for life. For some households with annuities, missing data prevent me from determining whether their annuities last for life. I assume that just under

with children (5.6 percent versus 4.8 percent), and is only slightly greater among households who say that it is not at all important to leave bequests than among those who say it is very important (5.1 percent versus 4.4 percent). Similarly, Brown (2001b) finds that whether households have children and how important they say it is to leave bequests have little explanatory power for their reported plans about whether to annuitize the balances of their defined contribution (DC) employer retirement plans.

The apparent inconsistency between the simulation results and the empirical results is likely due at least in part to the difficulty of identifying people with especially weak bequest motives.²² Available proxies are ill-suited to this task. Whether someone has children does not identify especially weak bequest motives. Hurd (1987) and Kopczuk and Lupton (2007) find that people with and without children have similar saving behavior in old age. Gale and Scholz's (1994) results imply that households with and without children are similarly likely to report giving at least \$3000 to other households in the preceding two years (15.9 percent vs. 13.1 percent). In the HRS, about 55 percent of people without children say it is somewhat or very important to leave bequests (versus 67 percent of people with children).²³ That many people without children appear to have bequest motives may explain why bequest motives estimated based on the assumption that people without children have no bequest motive are so weak (e.g., Hurd, 1989). Similarly, the reported importance of leaving bequests apparently fails to identify especially weak bequest motives. Laitner and Juster (1996) find that some couples who say that it is not important to leave bequests choose joint life annuities with substantial guarantees, thereby reducing their income in exchange for bequest potential.²⁴

Bequest motives strong enough to eliminate purchases of available annuities are likely more prevalent than the reported importance of leaving bequests suggests. Even bequest motives that have little effect on saving or optimal purchases of actuarially fair annuities can have a large effect on the demand for actuarially unfair annuities. People who would leave small bequests were perfect insurance markets available or whose bequest motives have little effect on their saving—in other words, people who could rightly say that leaving bequests is not important to them—may prefer not to buy available annuities *because of their bequest motive*. People need not have strong bequest motives or even value bequests as such to gain little from annuities; they need only view spending as having an opportunity cost that is not entirely contingent on their being alive.

This paper makes two main contributions. First, it shows that modest bequest motives can eliminate purchases of available annuities. Second, it shows that many of the main estimates of bequest motives in the saving literature significantly reduce the predicted ownership rate of annuities, although not quite to the observed rate of about four percent. The simulation results, together with evidence that bequest motives are widespread, suggest that many people would not annuitize any wealth at available rates even if there were no reason other than bequest motives not to annuitize. That most people are also fairly well annuitized by public and employer pensions (Dushi and Webb, 2004), have family members with whom to share their lifespan risk (Kotlikoff and Spivak, 1981; Brown and Poterba, 2000), and face significant medical spending risk (Sinclair and Smetters, 2004; Turra and Mitchell, 2008; Ameriks et al., 2009) limits the market for annuities still further. In light of these and other factors, and given the large effect of even modest bequest motives on the value of annuities, it seems unsurprising that few people buy available annuities.

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Appendix A

A.1. The gains from annuities with different bequest motives and shares of already-annuitized wealth

In this section, I present results that show how the value of annuities depends on the particular form of the bequest motive and the fraction of wealth that is already annuitized. Otherwise the model is the same as the baseline model pre-

three-fourths of these households own annuities that last for life, which is the share of annuities that last for life among the annuities whose type can be determined.

²² People who do not value bequests are likely to be better off buying available annuities, but the converse is not necessarily true. Although people who wish to leave bequests are unlikely to benefit from annuities with typical loads, they might benefit from annuities with unusually small loads or from annuities with some other advantage, such as favorable tax treatment. Johnson et al. (2004) find evidence that many of the people who annuitize their Individual Retirement Accounts (IRAs) may do so to avoid the ten percent tax penalty on early, non-annuitized withdrawals.

²³ People without children leave bequests mostly to their siblings (39 percent) and other relatives (45 percent) (statistics in this footnote are from Hurd and Smith's (2002) analysis of people in the U.S. who are at least 70 years old). They also give more to friends (10 percent) and charity (6 percent) than people with children. The last surviving members of households with children leave the large majority of their estates to their children (92 percent). The rest goes mostly to other relatives (5 percent) and friends (2 percent). Less than one percent goes to charity. Even households with a surviving spouse give away about 20 percent of their wealth on average (to children if they have them and to charity otherwise) upon the death of the first-dying spouse.

²⁴ If the annuitant dies within the guarantee period, the insurer pays the annuitant's heirs for the remaining guarantee period. As Davidoff et al. (2005) note, guarantees are a strange way to leave bequests because they involve paying insurance loads to buy risky bequest prospects. But it is hard to understand why people without bequest motives would reduce their income to increase their expected bequests.

sented in Section 3.1. In the main text, I showed results for an individual with half of his wealth already annuitized, roughly the average share among U.S. households headed by 65-year-olds in the eighth and ninth deciles of the wealth distribution (Dushi and Webb, 2004). In this appendix, I show results for individuals with one-third, two-thirds, and three-fourths of their wealth already annuitized. These correspond roughly to the shares of annuitized wealth in total wealth among 65-year-olds in the top decile, the fifth decile, and the second and third deciles of the wealth distribution, respectively (Dushi and Webb, 2004).

I also consider the effects of a wide range of bequest motives, all of which are special cases of the following functional form,

$$v(b) = \theta_1 \frac{(\theta_2 + b)^{1-\theta_3}}{1 - \theta_3}.$$

This form incorporates as special cases the vast majority of bequest motives used in life cycle models, including the altruistic bequest motive in the main text. $\theta_1 \geq 0$ determines the strength of the bequest motive. $\theta_2 \geq 0$ and $\theta_3 \geq 0$ determine the wealth elasticity of bequests and risk aversion over bequests. Bequests are luxury goods (as they are empirically) if $\theta_3 < \sigma$ or if $\theta_3 = \sigma$ and $\theta_2 > 0$. I present results for four combinations of θ_2 and θ_3 , including the combination corresponding to the altruistic dynasty presented in the main text.

Linear bequest motives: $v(b) = \theta_1 b$ ($\theta_3 = 0$). With linear (constant marginal utility) bequest motives, preferences over consumption and bequests are quasilinear and bequests are extreme luxury goods. With actuarially fair annuities, people with linear bequest motives leave bequests only if they have more than enough wealth to purchase their desired consumption stream. They leave any wealth in excess of this amount as bequests. People are risk neutral over bequests; they care only about their expected bequest. Linear bequest motives are sometimes used to approximate altruistic bequest motives (e.g., Hurd, 1989), which arise from concern about the welfare of one’s heirs, and are sometimes used to describe “joy-of-giving” bequest motives (e.g., Kopczuk and Lupton, 2007), which arise from enjoying giving for its own sake. Most altruists should have approximately linear bequest motives because bequests are typically small relative to recipients’ total (human and non-human) wealth. Bequest-sized windfalls thus have little effect on recipients’ marginal utility of wealth and thus on the altruist’s marginal utility of bequests. Linear bequest motives are a particularly good approximation for altruists who have multiple heirs, whose heirs have bequest motives, or who give to large organizations. A linear bequest motive matches Hurd and Smith’s (2002) estimates of the increase in anticipated bequests during the 1990s boom in asset markets almost perfectly.

Threshold bequest motives: $v(b) = \theta_1 \frac{(\theta_2 + b)^{1-\sigma}}{1-\sigma}$ ($\theta_2 > 0$, $\theta_3 = \sigma$). Threshold bequest motives are similar to linear bequest motives in that bequests are luxury goods. But they are unlike linear bequest motives in that the marginal utility of bequests decreases in the size of the bequest, which implies that people are risk averse over bequests. θ_2 determines the threshold wealth level below which an individual with access to actuarially fair annuities leaves no bequest. Richer individuals divide their wealth above the threshold between consumption and bequests in a fixed proportion. The larger is θ_2 , the higher is the threshold, and so the greater the extent to which bequests are luxury goods. Among the papers using bequest motives of this form (though in some cases with slightly different parameterizations) are De Nardi (2004), Ameriks et al. (2009), and De Nardi et al. (2010).

An intuitive way to parameterize threshold bequest motives is to imagine an altruist who has a single, selfish heir with a T_h -year planning horizon, $v(b) = a \sum_{i=1}^{T_h} \beta^{i-1} u(c_i^h(b))$. If the heir consumes her income, y_h , plus the annuity value of any bequest received and has the same constant elasticity preferences for consumption as the altruist, then

$$v(b) = a \left(\sum_{i=1}^{T_h} \beta^{i-1} \right) \frac{(y_h + \frac{b}{\sum_{i=1}^{T_h} (1+r)^{-(i-1)}})^{1-\sigma}}{1 - \sigma} \propto \frac{(\sum_{i=1}^{T_h} \frac{y_h}{(1+r)^{i-1}} + b)^{1-\sigma}}{1 - \sigma}.$$

In this case, θ_2 is the discounted value of the heir’s income, $\theta_2 = \sum_{i=1}^{T_h} \frac{y_h}{(1+r)^{i-1}}$. This leaves two parameters to be specified: y_h and T_h . As in the main text, I assume that the heir’s income is equal to the individual’s pre-existing annuity income, $y_h = y_{pre}$. In addition to the infinitely-lived dynasty used in the main text, $T_h = \infty$, I also report results for $T_h = 25$ (“Threshold 25”). The Threshold 25 bequest motive is approximately the bequest motive that someone who was altruistic toward a single, selfish member of the next generation would have.

Homothetic bequest motives: $v(b) = \theta_1 \frac{b^{1-\sigma}}{1-\sigma}$ ($\theta_2 = 0$, $\theta_3 = \sigma$). With this bequest motive, preferences over consumption and bequests are homothetic: people with twice as much wealth consume twice as much and leave bequests that are twice as large. This bequest motive is inconsistent with the evidence that bequests are luxury goods, but it is occasionally used in simulation models. I include it to test the robustness of the results to unusually high risk aversion over bequests.

Table 6 summarizes the parameterizations of the different types of bequest motives.

Fig. 3 shows how different types of bequest motives and different shares of already annuitized wealth affect the welfare gain from annuities. The greater the extent to which bequests are luxury goods—and thus the lower the risk aversion over bequests—the smaller are the gains from annuities. The widely-used, empirically-supported types of bequest motives in which bequests are luxury goods significantly reduce the value of annuities. Even the “Threshold 25” bequest motive, which roughly corresponds to the bequest motive of an altruist who is unusually risk averse over bequests, significantly reduces

Table 6
Parameters of the different types of bequest motives.

Bequest motives parameterization			
General form			
$v(b) = \theta_1 \frac{(\theta_2 + b)^{1-\theta_3}}{1-\theta_3}$			
Parameter values			
	θ_1	θ_2	θ_3
Linear	≥ 0 , targets b^*/N	N/A	0
Dynasty	≥ 0 , targets b^*/N	$\sum_{i=1}^{\infty} \frac{y_{pre}}{(1+r)^{i-1}}$	σ
Threshold 25	≥ 0 , targets b^*/N	$\sum_{i=1}^{25} \frac{y_{pre}}{(1+r)^{i-1}}$	σ
Homothetic	≥ 0 , targets b^*/N	0	σ

Note. All other parameters are the same as in the baseline model presented in the text.

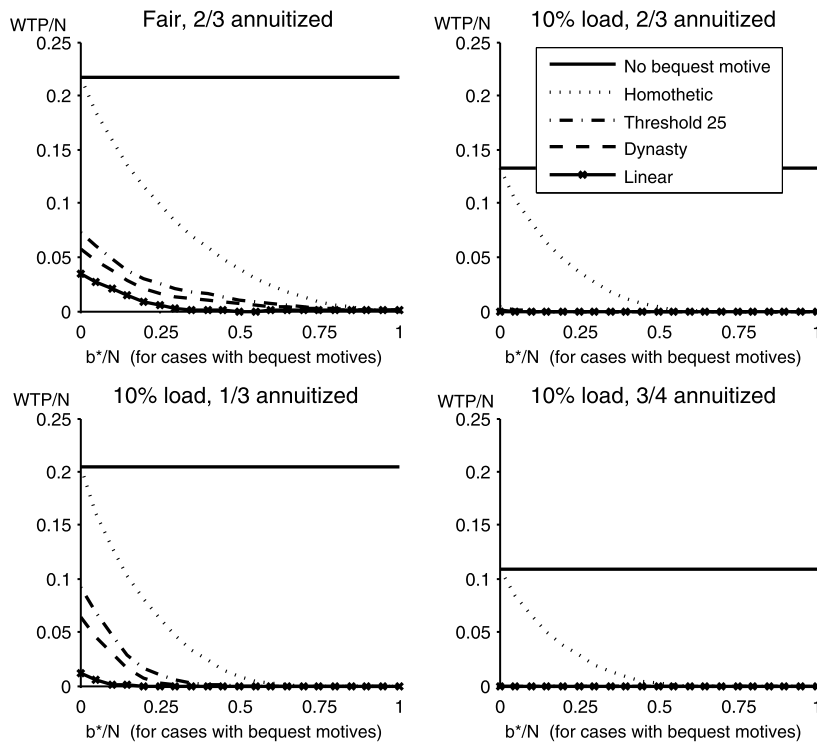


Fig. 3. Welfare gains from annuities as a function of the type and strength of bequest motives. The y-axes measure the gain from annuities as the fraction of the individual's non-annuity wealth that he would be willing to pay for access to the annuities. The x-axes measure the strength of bequest motives as the fraction of the individual's non-annuity wealth that he would bequeath had he access to actuarially fair annuities and the rest to annuities with ten percent loads. The results in the top panels are for individuals with two-thirds of their wealth already annuitized, which is typical of 65-year-olds in the middle of the wealth distribution. The results in the bottom left panel are for individuals with one-third of their wealth already annuitized, which is the average share among 65-year-olds in the top wealth decile. The results in the last panel are for individuals with three-fourths of their wealth already annuitized, which is roughly the average share among 65-year-olds in the second and third deciles of the wealth distribution.

the value of annuities. Based on these results, it seems likely that most altruists who wish to leave bequests would prefer to self-insure rather than buy available annuities to insure their bequests.

Bequest motives in which bequests are not luxury goods have a more modest effect on the value of annuities. But even with homothetic preferences over consumption and bequests, the optimal demand for realistically-priced annuities is often far below the optimal demand for actuarially fair annuities. For example, an individual with homothetic preferences around the middle of the wealth distribution (with two-thirds of wealth already annuitized) who would annuitize two-fifths of his wealth had he access to fair annuities ($\frac{b^*}{N} = 0.6$) would not annuitize any wealth given annuities with ten percent loads.

Comparing the different panels, it is clear that larger shares of already-annuitized wealth reduce the gains from annuities. Individuals with two-thirds or more of their wealth already annuitized, as 65-year-olds in the bottom and middle of the wealth distribution have, would not annuitize any wealth at ten percent loads if they had any of the luxury-type bequest

motives and wished to leave any wealth to their heirs. Preferences in which bequest are luxury goods naturally complement already annuitized wealth in explaining the lack of demand for annuities. The poor may have little demand for bequests but they also have most of their wealth already annuitized. Richer people have less wealth already annuitized but higher demand for bequests. People who wish to leave bequests and are not especially risk averse over bequests are likely to be better off not annuitizing any wealth at available rates.

A.2. The model of medical spending risk

I follow Brown and Finkelstein's (2008) model of medical spending risk except that I use a simpler Medicaid asset testing rule and year-long rather than month-long periods to reduce computation time. The model is based on an actuarial model of transitions across health states developed by James Robinson.²⁵ At any time, the individual is in one of five health states: healthy, requiring home health care, living in an assisted living facility, living in a nursing home, or dead. The (Markov) transition probabilities across these states depend on the individual's current health status and age.

Individuals face exogenous medical spending requirements depending on their health status and age. When the individual is 65 years old, nursing homes cost \$52,195 per year (\$143 per day), assisted living facilities cost \$26,280 per year (\$72 per day), and skilled (registered nurse) and unskilled home health care costs \$37 and \$18 per hour. These are based on the average prices of long-term care services in the U.S. (MetLife Mature Market Institute, 2002a, 2002b). From this base, the price of each type of medical care grows by 1.5 percent per year in real terms, roughly the historical rate of growth of real wages and long-term care prices. Spending on home health care at any age is the product of the hourly wage rates and the Robinson model's age-specific estimates of care usage. Medicare covers 35 percent of home health care spending and none of the costs of nursing homes or assisted living facilities in the model. Based on these prices and usage rates, home health care for a 70-year-old costs about \$5518 per year, and home health care for a 90-year-old costs about \$17,120.

Nursing homes and assisted living facilities have some consumption value, e.g., from room and board. These facilities provide consumption worth \$6180 (\$515 per month), the amount that the Supplemental Security Income (SSI) program paid single elderly people in 2000. Home health care has no consumption value.

Means-tested social insurance programs support people who cannot afford to pay for their medical care or achieve a certain standard of living. People who do not require facility-based care and who cannot afford to consume at least \$6180 in any year receive transfers that enable them to consume exactly this much. People who do require facility-based care but cannot afford to pay for private care stay in Medicaid nursing homes. I report results for the case in which Medicaid nursing homes are perfect substitutes for private ones, i.e., they have the same consumption value of \$6180 per year. Making Medicaid nursing homes less attractive tends to reduce the demand for annuities, but at the same time it increases the demand for long-term care insurance far above observed levels (Lockwood, 2010).

Due to means tests, people who receive social transfers cannot save and thus leave no bequest if they die immediately thereafter. Following Medicaid's means-testing rules, annuity wealth, but not annuity income, is shielded from social insurance asset means-testing; people can maintain ownership of their annuity even if they receive government transfers. This makes annuities more attractive as a store of wealth.

A.3. The strength of bequest motives

My primary measure of the strength of bequest motives is the demand for bequests if actuarially fair annuities were available. Fig. 4 shows the correspondence between this measure and two alternatives. Panel (a) shows how bequest motives affect the optimal consumption path without annuities. The individual begins with \$300 thousand of total wealth, half of which is annuitized, and has Dynasty bequest motives. Stronger bequest motives encourage the individual to postpone consumption—to consume less early on and *more* in later life—because money saved for consumption in old age has the added benefit of increasing bequests should the individual die before consuming it. The consumption paths of individuals who would bequeath one-fourth of their wealth had they access to fair annuities and of individuals without bequest motives are qualitatively similar. In both cases, consumption basically declines at an increasing rate until it equals income, which occurs well before the maximum lifespan.

Panel (b) shows the age at which people without annuities exhaust their wealth (and thereafter leave zero bequests) as a function of how much they would bequeath were fair annuities available. People without bequest motives exhaust their wealth by age 85 and consume their income thereafter. People with stronger bequest motives save more and so take longer to exhaust their wealth, if they ever do: people at the 111 position at the top of the y-axis leave bequests even if they live to the maximum age, 110. Aside from the Homothetic case, bequest motives that would lead people to bequeath twenty percent of their non-annuity wealth had they access to fair annuities ($\frac{b^*}{N} = 0.2$) delay the age at which people exhaust their wealth by seven years relative to people without bequest motives, from 85 to 92 years old.

²⁵ As Brown and Finkelstein (2008) note, this model is widely-used in industry and government. See Robinson (2002) and Brown and Finkelstein (2004) for details. Although Robinson (2002) estimates separate models for men and women, I only use the model for women because it is likely to better approximate the risk facing single individuals. Wives typically outlive their husbands and provide them significant informal care as their health deteriorates. The results are similar using the model for men.

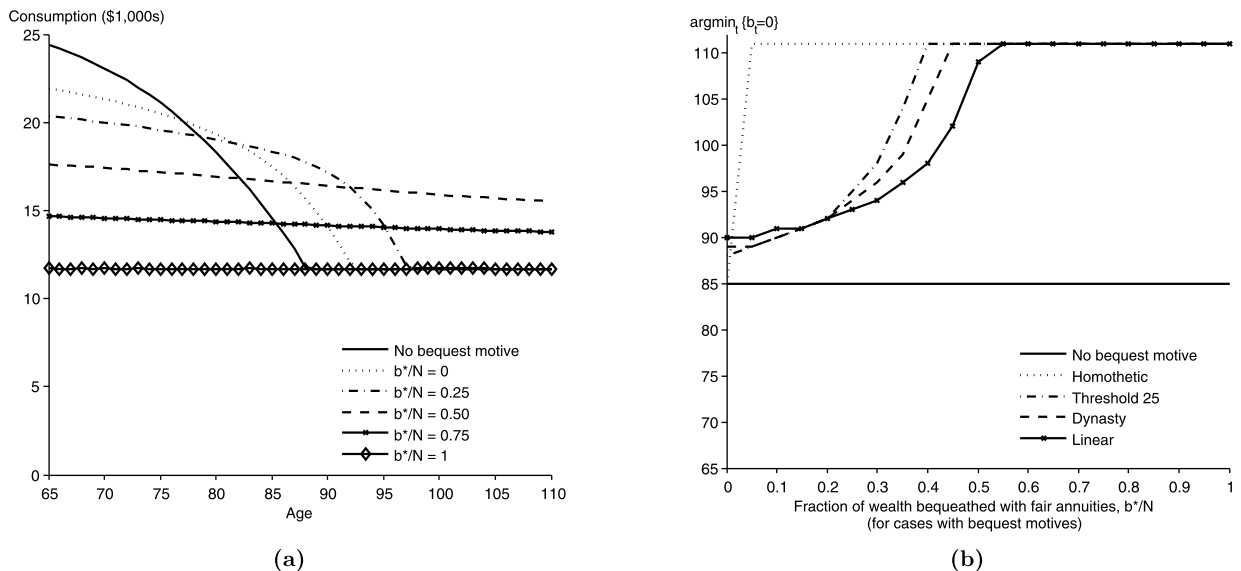


Fig. 4. Panel (a) shows how the consumption path of an individual with \$300,000 of total wealth, half of which is annuitized, depends on the strength of his (Dynasty) bequest motive. Panel (b) shows the minimum age at which an individual with half of his wealth annuitized exhausts his non-annuity wealth as a function of his bequest motive.

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