Housing, Health, and Annuities

Article *in* Journal of Risk & Insurance · March 2009

DOI: 10.2139/ssrn.1084594 · Source: RePEc

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January 16, 2008

Abstract

Annuities, long-term care insurance (LTCI), and reverse mortgages appear to offer important consumption smoothing benefits to the elderly, yet private markets for these products are small. A prominent idea is to combine LTCI and annuities to alleviate both supply (selection) and demand (liquidity) problems in these markets. This paper shows that if consumers typically liquidate home equity only in the event of illness, then LTCI and annuities become substitutes and less attractive. The reason is that the marginal utility of wealth drops when an otherwise illiquid home is sold, an event correlated with the timing of benefits from both annuities and LTCI. Simulations confirm that without home equity loans, both LTCI and constant real annuities may be welfare destructive, particularly in combination.

1 Introduction

Among the most significant difficulties in financial planning for the elderly are these: length of life, health status, and medical expenditures are stochastic; a large fraction of wealth is typically tied up in a home; and moving out of the home generates psychic and financial costs. These considerations are related: poor health is associated with old age, exit from the home, and rapid mortality.

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Home equity products, long-term care insurance (LTCI), and annuities hold the promise of consumption smoothing benefits for the elderly by addressing these issues separately. Home equity loans, reverse mortgages, and sale-leasebacks allow homeowners to consume housing wealth without moving out of the home. LTCI spreads large medical expenses across states of the world. Annuities transfer wealth from those who die young to those who live a long time. Relatively weak demand for these products among the elderly has spawned a large literature evaluating the strength of different explanations.

Bequest motives, adverse selection, moral hazard, and partial public provision of LTCI and annuities through Medicaid and Social Security may well dampen demand for private actuarial products. However, these factors do not easily explain away the smallness of private markets. Several papers have shown that with empirical pricing and plausible bequest strength, annuities remain attractive.[1] Finkelstein and McGarry (2003) and Davidoff and Welke (2006) argue that selection may be favorable, rather than adverse, in the markets for LTCI and reverse mortgages. Brown and Finkelstein (2007) show that women face much better pricing for LTCI than men, but do not have much stronger demand, calling into question supply side problems as the dominant market failure.

Given the correlations among illness, mortality, and exit from the home, it is not surprising that a growing literature considers the interactions among demands for these actuarial products. Pauly (1990) shows that demand for LTCI may be weakened by the absence of a market for annuities because life after long-term care is typically short and there is public insurance against extremely high expenditures. In this case, LTCI serves primarily to transfer wealth from relatively young and healthy states to the public provider and to estates after death. The absence of annuities implies that the marginal utility of wealth after death may be much lower than during life, and LTCI exacerbates this problem. By the same logic, demand for annuities should be increased by the presence of LTCI.

Annuities and LTCI may exhibit demand complementarity not only through the tradeoff

[1] See Brown (2007) for a summary.

between consumption while alive and the size of the estate passed on after death, but also through a liquidity channel. Turra and Mitchell (2004), Sinclair and Smetters (2004), and Ameriks et al. (2007a) show that absence of LTCI may weaken demand for illiquid annuities. The intuition for this result is that tying up wealth in an illiquid asset exposes households to very low consumption in the event of expenditure shocks. In this way, annuities may be attractive only in the presence of LTCI, and annuities will make LTCI coverage more important.

Not only are there demand side complementarities between annuities and LTCI, but as Spillman et al. (2001) observe, the risks of long-term care medical need and long life are likely negatively correlated, creating a selection-based supply side complementarity. Combining these considerations, a rising consensus is that bundling LTCI with illiquid annuities may broaden the appeal of both.

This paper shows that if home equity is illiquid, bundling LTCI with annuities may instead reduce demand for both products. Suppose housing wealth is large relative to other wealth and is liquidated only in the event of ill health. This is a relevant scenario because home equity is the largest form of wealth among the elderly, the large majority of older homeowners have little or no mortgage debt, and exit from home ownership is rare except in ill health.[2] In this case, retirees' marginal utility of wealth while relatively young, healthy, and still at home may be large relative to the expected marginal utility of wealth when older and possibly in ill health with home equity liquidated through sale.

The payouts of annuities and LTCI are correlated because the need for long-term care rises with age, whereas annuities fundamentally transfer wealth from the present and after death to the future while alive. This correlation provides a basis for these two actuarial products to be substitutes, rather than complements. The substitution becomes more important if the timing of home equity withdrawals is also correlated. More succinctly, substitution arises because annuities pay when consumers are old and likely sick, LTCI pays when consumers

[2]See, e.g. Venti and Wise (2000) and Walker (2004).

are sick and likely old, and home equity is only likely to be liquidated when consumers are old or sick. Some empirical evidence for the view that home equity crowds out insurance against future ill health is provided in Davidoff (2007): homeowners exposed to high price appreciation in the recent housing boom were more likely to drop LTCI coverage and less likely to add coverage.

The argument that annuities are less beneficial for home owners and those facing medical expenditure risk presumes that annuities cannot be made liquid or with payment streams that are highly front-loaded. Annuities certainly can be designed to be front-loaded (e.g. nominally constant annuities in high inflation economies). However, consumers who want front-loaded consumption are unlikely to gain as much from annuitization as those who can tolerate a smoother stream of payments. This is because the gain from annuitization comes from transferring money from after death to during life.[3] These transfers are largest late in life, when the consumer is less likely to be alive. One might design a liquid annuity to overcome the problem of stochastic cash needs, but if consumers learn about mortality, the number of annuitants dying with assets to share among survivors will be smaller than when annuities are illiquid, so some of the benefit of annuitization is lost.[4]

The next section of this paper presents a simple consumption and savings model that takes a similar model without home equity in Davidoff et al. (2005) as a starting point. Consistent with the discussion above, we find that there are reasons for LTCI and annuities to be both utility substitutes and complements, and that the illiquidity of home equity tends to reverse the signs of both of these offsetting effects.

Section 3 provides calibrated examples of a single 62 year old male's consumption and savings problem. The numerical examples verify the results of the simple analytical model and show surprisingly large effects of home equity on the complementarity between LTCI and a constant real annuity. For one set of parameters, when home equity is fully liquid, the presence of LTCI increases the value of the right to annuitize 50% of non-housing wealth

[3]See Bernheim (1987b) and Davidoff et al. (2005).
[4]See Direer (2007).

by the equivalent of approximately 100% of non-housing wealth. When home equity is liquidated only on sale, and sale is triggered only by mild or severe illness, the presence of LTCI moves the effect of annuitization from a benefit equal to increasing non-housing wealth by 11% to a cost of 12% of non housing wealth. Likewise, the presence of a large annuity increases the welfare effect of full LTCI coverage by a very large margin when home equity is liquid. When home equity is illiquid, the presence of a large annuity moves the effect of full LTCI coverage from a small loss of 5% of non-housing wealth to a large loss of 28%.

In the analysis that follows, the modeled consumer is given exogenous endowments of LTCI, annuity, and home equity liquidity. There appear to be very large benefits to making home equity liquid, but I do not ask why there is a small market for home equity lending among the elderly, or why this market appears to be growing. I also do not ask what the optimal demand or design is for a product that combines home equity lending, LTCI, and an annuity. Optimal demand for a combined product would depend on the product's design, which will depend on consumption smoothing, selection, and moral hazard considerations. This paper focuses only on consumption smoothing, leaving complicated questions of multi-dimensional selection and moral hazard to a few remarks in the conclusion and to future research. I abstract away from the structure of existing government insurance programs (Medicaid and Social Security most importantly) to focus on underlying demand. I do consider exogenous endowments of annuities and LTCI and the welfare effects of these endowments, but I do not explicitly consider optimal design of a public or mixed public and private system. Consideration of Medicaid's friendly treatment of home equity relative to other forms of wealth would presumably reinforce the results presented here.

2 A two period problem

To analyze the joint demand for LTCI and annuities, and the role of home equity in determining demand, this section lays out a stylized retiree's consumption and insurance problem.

Simulations in the next section allow a somewhat more realistic sequence of events, at the cost of specifying the problem's parameters.

A consumer currently living in a home with cash value h faces uncertainty about the length of her life and the need for costly medical care. She derives utility from the consumption of housing and another good in each of two future periods. In the first future period, she will be alive for sure, but may be either sick or healthy. In the second future period, she will be dead, sick, or healthy. There is no possibility of survival past the second period. As long as she is healthy, she has a sufficiently strong preference for remaining in her home that she does not sell the home. However, if she becomes ill in either period, there is no cost to moving , and the parameters are such that she chooses to sell the home.

Before any consumption takes place, the consumer must allocate wealth w between liquid savings and an illiquid annuity. Liquid savings may be spent in the first period or carried over to the second period, but the annuity can only be consumed in the second period. We will explore the effect of exogenous LTCI coverage on annuity demand, but the same analysis would apply to the effect of an exogenous allocation of wealth between the annuity and liquid savings on demand for LTCI.

After the annuitization decision, the consumer learns whether she is healthy or sick in the first period. If she is ill (i.e. in long-term care), she sells the home, incurs a medical expense x, and allocates all remaining wealth between rental housing (if any is needed during or after care) and other consumption, giving rise to indirect utility v_1, and then dies before the start of period two. If the consumer is healthy in the first period, she lives to the second period after enjoying utility u_1 over first period expenditures. u_t and v_t are concave functions of expenditures. Home rental prices are constant so v_t implicitly takes this price as an argument. If alive in period two, the consumer learns again whether she is in good or ill health, and again remains in the home if and only if healthy.

The consumer is exogenously endowed with, and forced to hold, a quantity m of a home equity loan and quantities i_1 and i_2 of medical insurance ("LTCI") covering care expenses

in the first and second periods, respectively. The consumer chooses how to allocate savings between a liquid asset and an illiquid annuity, described below. The interest rate in the economy is zero and the actuarial products are fairly priced, so the consumer must repay m out of the sales proceeds if and when she moves. The probabilities of ill health are q_1 and q_2, so insurance subtracts $i_1 \frac{q_1}{1-q_1}$ and $i_2 \frac{q_2}{1-q_2}$ in the event of good health in periods one and two. Commonly available LTCI contracts involve a guaranteed premium and coverage through time, so the separation between i_1 and i_2 is not representative of real contracts.[5] The distinction here is to emphasize the different effects of LTCI payments received relatively early or late in life.

Because the interest rate is zero, an annuity paying a in the second period costs $a\left[1-q_1\right]$ in either state in the first period. By contrast, liquid savings paying b in the second period cost b only if healthy in the first period (liquid savings carried from the ill state in period one to either state in period two are logically impossible). As a matter of interpretation, from a period zero perspective, the entire quantity $w-a$ represents liquid savings. A decrease in the quantity b need not imply an increase in annuitization because there is the alternative of greater period one consumption.

Conditional on a home equity loan (equivalent here to a reverse mortgage) m and first and second period health insurance i_1 and i_2, the consumer's problem is:

$$\begin{aligned}\max_{a,b} U = {} & q_1 v_1\left(w-a\left[1-q_1\right]-x+i_1+h\right) \\ & +\left[1-q_1\right] u_1\left(w-a\left[1-q_1\right]-\frac{i_1 q_1}{1-q_1}-b+m\right) \\ & +\left[1-q_1\right]\left[q_2 v_2\left(a+b-x+i_2+h-m\right)+\left[1-q_2\right] u_2\left(a+b-\frac{i_2 q_2}{1-q_2}\right)\right].\end{aligned} \tag{1}$$

Assuming both must be held in weakly positive quantities, the first order conditions for

[5] Although LTCI purchase can be deferred and contracts can be canceled despite increasingly favorable pricing over time, with the premium and coverage fixed but the probability of care rising.

annuities and liquid savings carried to the second period are:

$$\frac{\partial U}{\partial a} = [1-q_1]\left[-q_1 v_1' - [1-q_1]\,u_1' + q_2 v_2' + [1-q_2]\,u_2'\right] \leq 0. \tag{2}$$

$$\frac{\partial U}{\partial b} = [1-q_1]\left[-u_1' + q_2 v_2' + [1-q_2]\,u_2'\right] \leq 0. \tag{3}$$

We thus have:

Result 1. *If, at an optimum, marginal utility is greater when healthy (ill) in the first period, then all non-housing saving carried over to the second period is annuitized (liquid).*

When insurance and home equity lending markets are incomplete, there may be a marginal utility imbalance across first period states. If home equity is large and illiquid, marginal utility is likely to be greater when healthy, and savings carried to the second period are likely to be annuitized rather than held in liquid form. By contrast, if medical expenditures are large and uninsured, liquid savings are likelier to be held. First period health insurance thus makes annuitization relatively attractive, and this is the intuition shared by Turra and Mitchell (2004), Sinclair and Smetters (2004), and Ameriks et al. (2007a).

The effect of first period LTCI coverage on the decision of how to carry savings over to the second period will be softened if illiquid housing funds medical expenses. Indeed, if housing wealth is large relative to medical expenses, all savings will be annuitized for any non-negative i_1. In that case, LTCI will simply compound the first period marginal utility imbalance, so that the consumer would not optimally choose $i_1 > 0$. Under commonly modeled preferences, this imbalance will lead to less, rather than more annuitization, because the demand for savings will fall. Mortgage debt m should therefore make annuitization of second period savings less attractive if first period marginal utility is highest when ill, but should make annuitization more attractive if marginal utility is highest when healthy. We thus see that for purposes of deciding whether to save to the second period though annuities, LTCI and reverse mortages have a more positive effect in combination than in isolation.

To see the complementarity between LTCI and mortgage debt on the margin of the

quantity of savings to annuitize, suppose that the first period medical expenditure shock is sufficiently insured, or that housing wealth is large and illiquid, so that second period consumption is financed wholly by annuities. Now only the first order condition (2) holds with equality. In this case, the effect of the level of first period insurance on the level of annuitized savings is signed by:

$$\frac{\partial^2 U}{\partial a \partial i_1} = [1 - q_1]\, q_1 \left[u_1'' - v_1''\right]. \tag{4}$$

The effect of the level of second period insurance on the level of annuitized savings is signed by:

$$\frac{\partial^2 U}{\partial a \partial i_2} = [1 - q_1]\, q_2 \left[v_2'' - u_2''\right]. \tag{5}$$

The effect of housing liquidity on the relationship between insurance and annuitization is governed by:

$$\frac{\partial^3 U}{\partial a \partial i_1 \partial m} = u_1''' \tag{6}$$

$$\frac{\partial^3 U}{\partial a \partial i_2 \partial m} = -v_2'''. \tag{7}$$

Under the weak assumption that u_t''' and v_t''' are positive (necessary for non-increasing risk aversion), the effect of first period health insurance on annuity demand is more positive when housing is more liquid. The effect of second period health insurance on annuity demand, by contrast is more negative when housing is liquid.

Ignoring housing, past simulations have essentially found that the effect of insuring medical shocks that occur early in life is stronger than the effect of insuring risks that occur late in life, so that LTCI and annuities are complementary. Equations (6) and (7) show that housing illiquidity may lead to exactly the opposite conclusion, that annuities and LTCI are

substitutes. When housing is liquid and there is no LTCI, the fact that marginal utility is higher when sick than healthy creates a precautionary demand for liquid assets in the first period that undermines annuity demand. LTCI covering the early retirement period ameliorates this problem, and hence the complementarity with annuities. Alternatively, annuities take resources away from the state of illness early in retirement, and thereby augment demand for LTCI. With illiquid housing, first period marginal utility may be larger when healthy than when ill, generating an opposite precautionary need for liquidity early in life that both LTCI paying later in life and illiquid annuities exacerbate.

The net impact of all of these considerations on demand for annuities and LTCI is not obvious. Given that all three of mortality uncertainty, health expenditure risk, and housing wealth are important factors in financial planning, it is plausible that all of these considerations may be important, whatever their direction. To obtain some idea of how home equity affects joint demand for LTCI and annuities in different insurance environments, the next section describes the setup and results of some numerical examples.

3 A numerical example

This section evaluates the welfare consequences of annuitizing non-housing wealth and committing to an LTCI contract for a hypothetical retired 62 year old male homeowner, with and without a reverse mortgage. To simplify already complex lifecycle considerations, I assume there is no bequest motive. To focus on the interactions of demand for the different products, I assume that each is fairly priced, although one might interpret the floor on the utility function described below as implying a government subsidy to LTCI payments for insolvent consumers.

Exactly as in Ameriks et al. (2007b), the consumer can be in any of four health states at each integer age between 62 and 101: healthy, moderately ill, severely ill, or dead. Health status maps one-to-one with medical costs that cannot be changed, but can be partially offset

by insurance. If healthy, there is no medical expenditure. If moderately ill, there are positive and uninsurable out of pocket costs. Expenses are greater but possibly insured if severely ill. I use the transition probabilities of moving across health states described in Ameriks et al. (2007b). The transition probabilities are designed to match both population average mortality and health status transition rates from Robinson (2002). There is no possibility of survival past 101.

The consumer's taste for living at home is perfectly correlated with health status. There is no direct utility cost to moving when moderately or severely ill, but there is a large utility cost to moving while healthy. The home is thus sold only in a state of poverty or ill health. I assume an efficient rental housing market, so there is a re-optimization gain to moving whenever in ill health. I make the more or less ad hoc assumption that moving out of the home involves only a one-time utility cost (and no financial cost) if healthy. An alternative assumption, that would yield different mobility patterns, would be that every period in the home while alive generates positive utility.[6] The difference arises because it is possible that ill health will give way to future good health. The mobility pattern that I assume is broadly consistent with available panel data: exit from owned homes is rare among the elderly, but much less rare when in ill health and increasing in age. Moreover, the implied exit rates from home ownership by age are not far off from empirical estimates.[7]

The consumer has a lifetime utility function given by:

$$\sum_{t=62}^{101}\sum_{s=1}^{3}\left[1+\delta\right]^{62-t} q_{st}\left[\frac{\alpha h_{st}^{1-\gamma}+\left[1-\alpha\right]c_{st}^{1-\gamma}}{1-\gamma}-L(s)\times M_{st}\right]. \tag{8}$$

q_{st} is the probability of being alive and in health state s in period t, evaluated at age 62. $L(s)$ is a large number in good health ($s = 1$) and zero otherwise, and M_{st} indicates

[6]It is not obvious whether the cost of moving should be one-shot or a flow cost. A referee once took exception to flow costs, so I choose one-shot, with a conjecture that the basic results are unaffected by the choice.

[7]In model used here, approximately half of deaths occur before having liquidated home equity. Sheiner and Weil (1992) estimate that 42% of estates include a home. Walker (2004) finds that among the only predictors of selling among elderly single homeowners in the AHEAD survey are poor health and long stays at nursing homes.

that a move out of the original home occurs in state s, period t. This utility function exhibits constant relative risk aversion and an income elasticity of housing demand of one, with both risk aversion and substitution between housing and the other good governed by γ. These features may not match reality particularly closely, but are subject to debate (see, e.g. Davis and Ortalo-Magné (2007)), so this computationally convenient and commonly modeled functional form is a natural choice.

Consumption and savings are linked as follows:

$$c_{st} = \begin{cases} w_{st} - \frac{w_{\hat{s}t+1}}{1+r} + a - x_s + M_{st}\left[h[1+g]^{t-62} - m\right] - z_{st} & \text{If } w_{st} > 0. \\ f(\mu) & \text{otherwise.} \end{cases} \tag{9}$$

w_{st} is wealth carried into state s at time t from some state $\hat{s}$ in period $t-1$. $w_{\hat{s}t+1}$ is savings carried out of state s and period t. a is constant annuity income, x_s is net medical expense in state s, which by the structure of the problem is constant across time. h is initial housing wealth and g is the real appreciation rate of housing. z, detailed below, represents housing expenditures. m is a forward, not reverse, mortgage with interest only due each period until death or a move out of the home, at which point m is also due. I consider two values for m: the value of the home at age 62 and zero. In the case where there is no home price appreciation, the mortgage is equivalent to a sale leaseback.

Medical expense x_s includes insurance and out of pocket medical expenses. The cost of moderately ill health (state 2) is always borne by the consumer. A fraction i of severe health costs (state 3, long term care) are covered by insurance. In exchange for the insurance coverage, in every period and every state while alive, the consumer makes a constant payment such that the expected value of this annuity to an insurer equals the age 62 expected total costs covered. Because medical expenditures are not optional, an additive disutility to poor health would not affect the analysis at all. Similarly, the fact that dying young makes lifetime utility greater for $\gamma > 1$ does not affect the analysis. If the LTCI payment were rising over time, there would be a somewhat greater complementarity between LTCI and

annuity demand.

The consumer's utility function is independent of medical condition, but the marginal utility of expenditures is greatest when the there are large uninsured expenses. This might match an ability to pay for better care or better surroundings in the event of long-term care. A natural conjecture is that if the marginal utility of consumption were multiplicatively lower in long-term care, the results presented here would be strengthened.

For a homeowner, housing cost z_{st} is equal to the initial home value h times a cost of maintenance, taxes, insurance and any mortgage debt. At the time of sale, the principal amount is owed, so the cash infusion at sale is $h[1-g]^{t-62} - m$. Normalizing the price per unit of housing to one, a consumer who has transitioned out of homeownership to renting pays the housing quantity h_{st} times the interest rate plus maintenance, taxes, and insurance minus the appreciation rate g. Actuarially fair pricing of the mortgage (at the riskless rate) is simplified by the assumptions that home prices are deterministic and non-decreasing and that there is no choice of maintenance.

If wealth is non-positive, the consumer is allowed a very modest level of expenditures such that utility μ per period is attained regardless of health status. This backstop can thus be thought of as akin to Medicaid in that for most parameters, bankruptcy only occurs after repeated spells of severely ill health. There is no minimal annuity provided by social security in the simulation, so there is some upward bias in the estimated welfare gains to annuitization relative to that would accrue to retirees in developed countries with otherwise facing otherwise similar parameters. The ratio of the disutility from moving to the disutility from living at the minimum consumption level importantly affects the problem, so I present results with different ratios.

3.1 Optimization procedure

I solve the consumer's problem backward. After age 101, the consumer is dead. At age 101, the consumer's terminal utility over wealth if no longer at home is determined by

finding the utility-maximizing after-medical expense allocation of starting wealth and annuity income between housing and non-housing consumption.[8] If the consumer is at home at the start of this final period, he chooses between moving or not, with the choice trivial if in ill health. In the event of a move, housing sale proceeds are calculated as described above, and consumption is allocated between rental housing and all other goods. If still in the original home, housing consumption is fixed at the initial level and all wealth after medical and mortgage expenses plus any annuity income. The state of death generates zero utility.

At age 100, for each health state, the consumer chooses a savings level and thus implicitly age 100 expenditures, pursuant to equation (9). The choice of savings maximizes the sum of age 100 utility plus discounted age 101 indirect utility as a function of health and wealth, with each potential health state at age 101 weighted by the formulaic transition probabilities specific to each age 100 health state. This tradeoff of utility at time t and probability-weighted indirect utility over wealth by state at time $t+1$ is repeated back for all health states and ages back to age 62, at which age the consumer is in good health and in the initial owned home.

To determine the welfare effects of liquid home equity, a real annuity and LTCI under different parameter combinations, I solve the consumer's problem under nine discrete combinations of levels of these actuarial products (to conserve space, I report only four of these scenarios in most cases). The consumer has an endowment of \$100,000 in liquid wealth before annuitization. One of \$50,00, \$10,000 or zero of that \$100,000 is spent on an actuarially fair constant real annuity. The annuity pays out the amount a each period while alive per dollar invested, where:

$$a = \frac{1}{\sum_{t=62}^{101} q_t (1+r)^{62-t}}, \tag{10}$$

q_t is the probability of survival to age t conditional on being alive and healthy at age 62, and r is a riskless interest rate. The probabilities q are taken from the Ameriks et al. (2007b)

[8] Savings choices are in thousands of dollars, but the allocation between housing and non-housing consumption if out of the home is continuous, as there is a closed form solution to the allocation problem.

calibration of health transitions.

The consumer is endowed with either zero, 50% or full LTCI coverage. An LTCI policy commits the consumer to pay a constant sum every period while alive (including if institutionalized) in exchange for payment of all long-term care expenses. The constant payment is set equal to $k \sum_{t=62}^{101} q_{3t}/a$, where q_{3t} is the probability that the consumer will be in the severely ill health state at age t conditional on being healthy at age 62. k denotes the annual cost of LTCI times the fraction of expenses covered. This product is better than actuarially fair to the consumer in the sense that benefits are available in the event of bankruptcy, but there is no net payment to the insurer; however, medical expenses are covered in the event of bankruptcy for the non-insured, too.

For each set of parameters, I estimate the welfare effects of nine or four combinations of LTCI and annuity as follows. First, I calculate utility for a wide range of wealth levels with no LTCI and no annuity. For the remaining combinations of annuity and LTCI j, I calculate the utility level u_j achieved from a starting point of the initial wealth level. I then look up the initial wealth w_j required to attain utility u_j in the baseline case with no annuity and no LTCI. The welfare effect of a given combination of annuity and LTCI for each set of parameters is thus the difference (essentially a compensating or equivalent variation) between w_j and the initial wealth endowment assumed in the cases j. A positive (negative) value w_j implies that annuity and insurance combination j is better (worse) than no annuity and no LTCI. I do not calculate the optimal combination of annuity and LTCI holdings.

The consumer may not annuitize, purchase LTCI, or take on mortgage debt at any time after age 62. In the context of this model, there would be a considerable gain to annuitizing or purchasing LTCI after moving if a fair annuity or LTCI were available. However, after moving, most frequently due to poor health, the consumer has health information that is likely to be private and may face adverse selection.

3.2 Parameterization

Table 1 lists parameter choices for the consumer's savings, consumption, and mobility problem. As in Ameriks et al. (2007b), medical expenditures are zero in the healthy state, $10,000 in the moderately ill state and $50,000 in the long-term care state. Given that these figures apply to a group that is mostly covered by Medicare, one might interpret the $10,000 as net of any non-LTCI insurance proceeds. I assume that these costs are constant in real terms over time, sidestepping the question of whether rising costs reflect medical inflation rates or improvements in quality.

The liquidity of home equity depends on the disutility from moving and the availability of mortgage debt. In the simulations reported in the first panel of Table 2, 99 units of utility are subtracted for a move out of the home in good health, but a 100% loan to value mortgage is given to the consumer. In the second, fourth, and fifth panels, the disutility of moving remains at 99, but there is no mortgage available. In the third panel, there is no mortgage available, but the disutility from moving is much weaker, at 9 units of utility.

We will see below that the ratio of housing to non-housing wealth factors critically into the welfare evaluation of annuitization. In the baseline case, the ratio of housing wealth to liquid non-housing wealth is two to one, with the housing endowment set at $200,000. This ratio is somewhat higher than the median among consumers over 62 in the seventh wave of the HRS/AHEAD survey, but is just below the median ratio among those households with less than average stated probabilities of leaving a large bequest and among unmarried respondents. The level of wealth is set higher than population averages to avoid frequent bankruptcy and thus heavier reliance on the assumed minimum utility level. In the fourth panel, liquid wealth is set equal to housing wealth.

The risk aversion parameter γ is set at a moderate level of two as a baseline. Discounting is set equal to the (riskless) interest rate of 3%. Home price appreciation is set equal to zero as a baseline but appreciation is also considered.

The transition probabilities are such that one dollar of LTCI coverage costs approximately

Table 1: Parameterization of the Consumer's Problem

Symbol	Meaning	Base Case	Other values
t	age	min 62, max 101	None
x	Medical expenditures		
x_1	Expenditures if healthy	0	None
x_2	Expenditures if moderately ill	10	None
x_3	Expenditures if very ill	50	None
i	Fraction of x_3 insured	0	1
h	Starting home value	200	0
	Non-housing wealth placed in a real annuity	0	10, 50
γ	Risk aversion parameter	2	4
δ	Discount rate	.03	None
r	Interest rate	.03	None
g	Real price appreciation	0	.02
	Other costs of housing (taxes, etc)	.025	None
w	Starting wealth	100	200
L	Disutility of moving	-99	-9
μ	Disutility of consumption if bankrupt	-99	None
α	Utility weight on housing consumption	.25	None

Note: Dollar values in thousands.

five cents per period. One dollar of annuity income per period while alive costs $14.05 up front.

3.3 Numerical Results

The top panel of Table 2 displays the value of purchasing a constant real annuity for $50,000 and/or committing to a LTCI contract that covers 100% of long term care needs. Here, a home equity loan equal to the value of the home is available. Consistent with simulations published elsewhere, there are large gains to both the real annuity and LTCI. Notably, there is a complementarity between the two actuarial products. The gain to purchasing each, measured in dollars required to attain equal utility without either product, is greater in combination with the other product. The right to purchase LTCI is worth $94,000 with no annuity, but worth $154,000 with an annuity (compare the first to the second case, and then the third to the fourth). The right to purchase an annuity is worth $6 without LTCI, but worth $66,000 with full LTCI coverage (compare the third to the first case in the top panel,

and then the fourth to the second).

In the second panel, no mortgage debt is available. In the absence of an annuity, we find a small gain to purchasing LTCI that covers 50% of losses without an annuity, but a small welfare loss to purchasing full LTCI coverage. Welfare is monotonically increasing in annuity purchases from zero to $10,000 to $50,000 in principal amount as long as there is no LTCI. However, in the presence of full LTCI coverage, the annuity becomes welfare destructive. Comparing the ninth and seventh rows to the first and third rows of the second panel of Table 2, we find that adding full LTCI coverage moves the welfare effect of annuitizing $50,000 from the equivalent of being given $11,000 to having $12,000 taken away. Likewise, adding full LTCI coverage becomes more welfare destructive when a large annuity is purchased, moving from a loss of $5,000 with no annuity to a loss of $28,000 with a large annuity (compare the third and ninth rows of the second panel to the first and seventh).

The results of the first two panels confirm that when housing is liquid, LTCI and annuities are complementary in that they are more welfare enhancing in the presence of the other. On the other hand, when moving is costly in utility terms, and no mortgage debt is available, the complementarity between annuities and LTCI is negative. Moreover, both LTCI and annuities are much more welfare improving individually when home equity is liquid.

The third panel of Table 2 shows that when the utility cost of moving is smaller (-9 rather than -99), the gain to annuitization and LTCI increases, and they again become highly complementary. Thus liquidity matters both in terms of mortgage availability and in terms of utility costs of moving.

The fourth panel shows that when liquid wealth is as large as home equity, annuities and LTCI are again complementary. The fifth panel shows that increasing the curvature parameter γ from 2 to 4 has no effect on the magnitude of the results with illiquid housing.

Not surprisingly, in an unreported simulation, increasing the rate of home price appreciation from zero to two percent per year worsens the welfare effects of LTCI and the real annuity as well as their interaction. The effect of appreciation combined with illiquidity of

housing is moderately strong, as the welfare loss to taking both LTCI and the annuity is equivalent to losing 24% of non-housing wealth with no LTCI or annuities, as opposed to the loss of 17% with no appreciation.

4 Conclusion

A large number of US retirees can be characterized as having a large fraction of their wealth tied up in home equity that is likely to be liquidated only later in life and in a state of poor health. For such homeowners, trading liquid wealth for payments that are loaded on states of the world in which the house has likely been sold can be welfare destructive. LTCI pays only in the event of severe illness, and is highly correlated with exit from the home. Much of annuities' value comes from payments very late in life, when the owner is necessarily more likely to have been driven out of the home than in early retirement. Given concave utility, bundling LTCI and annuities makes this problem of the timing of payments worse. Expanding the market for home equity products for the elderly may thus be a critical step towards expanding the market for both annuities and LTCI. We thus have reason to suspect that LTCI might not expand much even if annuities are added and Medicaid coverage of long-term care eliminated, per Pauly (1990).

Simulations demonstrate that for a plausible set of parameters featuring a moderately large ratio of home equity to wealth, the interactive effect of housing liquidity on the relationship between LTCI and annuity demand is remarkably large. It has been difficult for researchers to identify situations under which an immediate, fairly priced constant real annuity is welfare destructive. The combination of illiquid housing and limited medical expenditure risk appears to be such a situation. Very large insurance benefits to LTCI become welfare costs if the home already provides significant implicit insurance, and all the more so if a large fraction of non-housing wealth is committed to a real annuity.

A comprehensive old age security policy that converts home equity into annuities that pay

Table 2: Value of LTCI and a Real Annuity Under Different Parameter Values

Disutility of		Liquid	Price	Risk	Mtg	Annuitized	LTCI	
Bankrupt	Move	Assets	Growth	Aversion	($)	($)	(%)	Value
-99	-99	100	0	2	200	0	0	0
-99	-99	100	0	2	200	0	100	94
-99	-99	100	0	2	200	50	0	6
-99	-99	100	0	2	200	50	100	160
-99	-99	100	0	2	0	0	0	0
-99	-99	100	0	2	0	0	50	4
-99	-99	100	0	2	0	0	100	-5
-99	-99	100	0	2	0	10	0	2
-99	-99	100	0	2	0	10	50	5
-99	-99	100	0	2	0	10	100	-6
-99	-99	100	0	2	0	50	0	11
-99	-99	100	0	2	0	50	50	4
-99	-99	100	0	2	0	50	100	-17
-99	-9	100	0	2	0	0	0	0
-99	-9	100	0	2	0	0	100	128
-99	-9	100	0	2	0	50	0	6
-99	-9	100	0	2	0	50	100	120
-99	-99	200	0	2	0	0	0	0
-99	-99	200	0	2	0	0	100	98
-99	-99	200	0	2	0	50	0	9
-99	-99	200	0	2	0	50	100	145
-99	-99	100	0	4	0	0	0	0
-99	-99	100	0	4	0	0	100	-5
-99	-99	100	0	4	0	50	0	11
-99	-99	100	0	4	0	50	100	-17

Notes: Dollar amounts in thousands. Parameter values as in Table 1 except where noted. Each panel starts with a base case of no LTCI or annuity, and the last column reports how much more or less than the initial endowment of liquid wealth the consumer would accept to remain in the no insurance case rather than be in the case listed.

for consumption and medical insurance seems attractive on consumption smoothing grounds. However, such a product might have less appealing moral hazard and selection characteristics than reverse mortgages alone (which appear to appeal to heavy discounters and the short-lived) or than only annuities and LTCI in combination (which may have offsetting selection effects that allow fair pricing).[9] Reverse mortgage contracting alone is quite complicated given endogenous maintenance and exit from the home as well as stochastic home prices. Profits from a given product offering would be immensely difficult to project in a competitive environment featuring stand-alone actuarial products, different bundles of two products, and different bundles of all three of annuities, LTCI, and reverse mortgages would be immensely challenging to characterize.

The analysis in this paper has assumed that willingness to exit homeownership is perfectly correlated with health status. This is not a terrible approximation, but is not literally true. If long-term illness did not always entail sale of the home, then the negative relationship between LTCI and reverse mortgages presented here would be attenuated.

In terms of public policy, the analysis suggests that simultaneous public provision of medical insurance and compulsory annuitization of retirement savings might be undesirable without a deep market for home equity borrowing. The result of possibly adverse welfare effects of annuitization and LTCI would have been strengthened with a pre-existing mandatory pension or coverage of a minimal standard of long-term care. Alternatively, such social insurance might spur development of a private market for home equity trades. Caution is necessary in applying the results to a public policy setting since public pensions are designed in part to overcome a perceived failure of individuals to save adequately.

Finally, the results in this paper provide further evidence that important financial decisions are shaped by the liquidity of home equity and the timing of home sales. These results augment those of Chetty and Szeidl (2004) and Shore and Sinai (2005), who show that housing considerations shape risk aversion with respect to portfolio choice and housing

[9]See Spillman et al. (2001), Webb (2006), and Davidoff and Welke (2006).

purchases early in life.

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