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ABSTRACT

This paper develops a market-based test of whether consumers make systematic mistakes in assessing their own mortality risks, and whether they are able to make "correct" price comparisons between insurance and credit markets. This test relies on data from secondary life insurance markets, wherein consumers sell their life insurance policies to firms in return for an up front payment. We find evidence consistent with the hypotheses that: (1) unhealthy consumers are systematically too optimistic about their mortality risks and (2) consumers focus on nominal price information in deciding to sell life insurance, rather than on the real discounted expected price.

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1 Introduction

Making insurance and savings decisions is difficult. Traditional economic models of insurance decisions assume, at a minimum, that consumers can solve two problems: (1) accurately assess the risks they face; and (2) interpret the information conveyed by market prices. But are these assumptions reasonable, especially in markets where consumers face unfamiliar risks?

In this paper, we develop a market-based test of whether consumers make systematic mistakes in assessing their own mortality risks, and whether they are able to make "correct" price comparisons between insurance and credit markets.[1] Our test relies on new data from secondary life insurance markets, wherein consumers bequeath their life insurance policies to firms in return for an up-front payment. These markets are good candidates for such a test because they require consumers to assess risks regarding their own mortality accurately, as well as decode complicated price signals in an unfamiliar environment.

To set up this test, we develop an economic model of the consumer decision to sell life insurance in the secondary market in the context of competitive pricing.[2] This model of a sophisticated consumer produces two sharp predictions. First, the model predicts a positive correlation between mortality risk and the decision to sell life insurance. The reasoning is that a sudden increase in mortality risk increases the consumers' wealth by increasing the market value of the consumers' life insurance policy. In response to this increase in wealth, the consumers desire to increase both consumption and bequests. Thus consumers sell some or all of their life insurance policy and use some of the proceeds for current consumption and invest the remainder for future consumption or bequests. Second, the model predicts a positive correlation between asset holdings and the decision to sell life insurance.

Next, we contrast these predictions with the predictions from a model with two mutually consistent interpretations motivated by the psychology and behavioral economics literature: that unhealthy consumers are systematically too optimistic about their mortality risks and that consumers focus on nominal price information in deciding to sell insurance, rather than on the real discounted expected price. This model also predicts a positive correlation between mortality and life insurance sales. However, in contrast to the economic model this model predicts that (1) among healthier patients those with significant non-liquid assets should be *less* likely to sell life insurance and that (2) among sicker patients those with significant non-liquid assets should be *more* likely to sell life insurance. We test predictions from these models against data on life insurance sales by HIV+ consumers.

2 Literature Review

There are extensive literatures on both consumer perception of mortality risk and distortions in consumer decision-making under uncertainty. In this section we briefly summarize findings from both the psychology and the emerging behavioral economics literature that are most relevant to our research. Barberis and Thaler [2002], Mullainathan and Thaler [2000], Kagel and Roth [1995], Rabin [1998], and Kahneman and Tversky [2000] provide deeper and more extensive reviews.

In the past, the behavioral economics literature has typically relied on two types of non-market evidence: small-scale psychological experiments and consumer self-reports of risk perceptions. Recently, market based tests of the predictions of behavioral economics have emerged in two different settings: in financial markets [see Barberis and Thaler, 2002] and in the analysis of consumer savings behavior [see Bernheim et al., 1997].

2.1 Consumer perception of mortality risks

Extensive evidence from the psychology literature shows that people make systematic mistakes in assessing their mortality risks. In particular, Lichtenstein et al. [1978] and several other studies have shown that people underestimate mortality risks from likely causes of death and overestimate mortality risks from unlikely causes of death. In related research, studies have found that people overestimate highly publicized risks. For example, Moore and Zhu [2000] hypothesize that given the recent flood of information on the alleged hazards of passive smoking in government publications and the media, people are likely to overestimate the health risk of passive smoking. They find evidence consistent with a model whereby individuals systematically overestimate the effects of passive smoking on their health and where the short-term effects of passive smoking on health care costs are negligible.

In addition to the evidence from psychology literature, recent studies using data on subjective survival expectations from the Health Retirement Study (HRS) and the Asset and Health Dynamics Among the Oldest Old (AHEAD) find that people tend to be optimistic about their longevity, with of optimism greatest for people with the shortest life expectancies. Schoenbaum

[1997], using data from the HRS, shows that current heavy smokers tend to be overly optimistic about their probability of surviving to age 75; that is, heavy smokers' subjective assessment of their own survival probabilities are higher than those obtained from actuarial models. By contrast, never smokers' subjective assessment of their probability of surviving to age 75 is marginally lower than the actuarial prediction.

Hurd et al. [1999] report a very similar pattern among older populations using data from the AHEAD. For example, 85-89 year-old female respondents' subjective probability of surviving to age 100 years is 0.30, while the life table value is merely 0.07. By contrast, preumably healthier 70-74 year-old female respondents are more pessimistic about their survival chances than is warranted—their subjective probability of surviving to age 85 years is 0.51, while the life table value is 0.58.

The data from these studies show that peoples' perceptions of their own mortality risks are systematically biased. In particular, people with relatively low life expectancy tend to *underestimate* their mortality risks and people with relatively high life expectancy tend to marginally *overestimate* their mortality risks.

2.2 Limits to consumer problem solving ability

While much of the literature on consumer perceptions of mortality risks has focused on consumer self-reports rather than market behavior, there is also a growing body of evidence from markets which suggests that consumers have limited information processing ability, and hence use simple heuristics to economize on this scarce resource. Numerous studies have documented how these simple heuristics sometimes lead consumers to make systematic mistakes. For example, Odean [1998] finds that customers at a large brokerage firm were less likely to realize capital losses than capital gains despite tax incentives that encourage loss realization. Odean shows that this loss aversion is consistent with prospect theory [Kahneman and Tversky, 1979] and theories of mental accounting [Thaler, 1985]. Similarly, Benartzi and Thaler [2001] find that individuals making asset allocation decisions in defined contribution plans use a naïve "1/n strategy": they divide contributions evenly across the funds offered in the plans. Consistent with this naïve notion of diversification they find that the proportion invested in stocks depends strongly on the proportion of stock funds in the plan.

Bernheim et al. [1997] analyze household data on wealth and savings, arguing that the data are consistent with "rule of thumb" and "mental accounting" theories of wealth accumulation. They find little support for the traditional life cycle model of savings and wealth accumulation. Laibson [1997] also analyzes household savings behavior and argues that people not only find it difficult to make optimal savings decisions but often find it difficult to stick their decisions. In particular, consumers' short run discount rates are much higher than their long run discount rates, implying that preferences are time inconsistent. This discount structure leads consumers to save little today even though savings are optimal from a life cycle perspective. Liabson argues that consumers often invest in illiquid assets or other commitment devices to overcome this tendency for over-consumption.

Finally, many standard textbooks on life insurance markets claim that price comparisons in life insurance are sufficiently complex to be well beyond the analytic capabilities of "ordinary" consumers [Maclean, 1962; Magee, 1958]. Research on life insurance markets reach similar conclusions. For example, Belth [1966] argues that the inability of consumers to make price comparisons in life insurance markets explains the persistence of substantial variation in prices of similar life insurance products.

3 An Economic Model of the Decision to Sell Life Insurance.

A secondary life insurance transaction (also called a viatical settlement) is the sale of a life insurance policy to a third party for immediate cash payment at a discount to face value; it involves the sale of a used life insurance policy. When a consumer sells his used policy, the buyer becomes the sole beneficiary of the policy and she collects the face value of the policy when he dies.[3] There is a good reason why this market attracts only consumers who have suffered adverse health events. Life insurance premiums are set at the time of purchase based upon the mortality profile of the consumer *at the time of purchase*. When the consumer suffers an adverse health event (worse than average for his age), suddenly he is more likely to collect his life insurance earlier than originally thought at the time of purchase. Indeed, his premiums would be much higher were he to buy the policy after the event. In effect, the adverse health event creates equity in the consumer's used life insurance policy. It is this equity, which is a real asset for the consumer, that is sold on the viatical settlements market.

With this reasoning in mind, we start our analysis of viatical settlement markets by considering the plight of the chronically ill consumer who purchased life insurance prior to the development of illness. Consumers considering whether to sell life insurance are often too frail to work—due to life-threatening illness—and may need funds to finance consumption, including medical treatment. Though their liquid assets may be insufficient to support their consumption, these consumers have the option to sell or borrow against their non-liquid assets, such as a house or life insurance, thereby reducing bequests.

3.1 A Model of Consumption and Bequests under Mortal Uncertainty

Consider a consumer whose initial wealth includes a house with a market value of NL dollars (net of any outstanding loans against the house) and a life insurance policy with face value $\bar{F}$ dollars. In our simple model, there are two periods: consumers survive the first period with certainty, die at the beginning of the second period with probability π, and if they survive, die with certainty at the end of the second period. Figure 1 is the timeline of events in this two-period model.

At the beginning of the first period the consumer earns income L_1, sells an amount F of his life insurance policy at the actuarially fair price, $P(\pi)$, consumes an amount C_1 and borrows or lends his remaining liquid assets. At the end of the first period the uncertainty about the length of the consumer's life is resolved—he knows then whether he will survive to the second period. If the consumer dies he leaves assets B_D as bequests in the beginning of period two, consisting of the net value of the consumer's house, proceeds of his remaining life insurance policy, and the portfolio of his bonds and interest payments.

$$B_D = (L_1 + P(\pi) * F - C_1) * (1 + r) + NL + \bar{F} - F \quad (1)$$

The first term in the parenthesis reflects the consumer's net lending or borrowing.

If the consumer survives, then at the beginning of the second period, he earns income L_2 and consumes an amount C_2. Since all uncertainty is resolved by the beginning of the second period, we assume that the consumer bequeaths B_S to his heirs and to the buyer of his life insurance policy *at the* *beginning* of the second period rather than when he dies at the end of the second period. An heir who prefers to receive the bequest at the end of the second period can simply buy a bond of one-year maturity with his bequests. Under these conditions, second period bequests will include savings from the first period, life insurance that has not been cashed out, non-liquid assets, and unspent earnings from the second period:

$$B_S = (L_1 + P(\pi) * F - C_1) * (1 + r) + (NL + \bar{F} - F) * \left(\frac{1}{1 + r}\right) + L_2 - C_2 \quad (2)$$

We assume that the market for used life insurance is competitive (see footnote 2 for a justification of this assumption). Thus, $P(\pi)$ is the perfectly competitive market price a viatical settlement company is willing to pay per unit face value of a policyholder with mortality risk π. Let r be the market rate of interest at which the firms can borrow funds. Assuming that the consumer continues to pay the premium on the policy even after the sale of the policy, the present value of the expected profit from the purchase of the policy is:

$$\text{profits} = \left(\left[\frac{\pi}{1 + r} + \frac{1 - \pi}{(1 + r)^2}\right] - P(\pi)\right) F \quad (3)$$

The first terms in equation (3) represents the present value of the expected revenue the buyer would receive after the death of the policyholder, while the last term represents the cost to the firm of purchasing the policy. Therefore the zero-profit condition under perfect competition implies:

$$P(\pi) = \left[\frac{\pi}{1 + r} + \frac{1 - \pi}{(1 + r)^2}\right] \quad (4)$$

The above condition can be viewed as the demand for life insurance given the mortality risk of the consumer and the cost of funds for the firm. In equilibrium, the prices are actuarially fair and the firms are willing to buy all life insurance policies supplied by consumers. The consumer's problem is to choose the optimal value of consumption and the financing of the consumption through sale of life insurance or credit to maximize expected utility from consumption and bequests.

$$EU = U(C_1) + \pi\beta V(B_D) + (1 - \pi)\beta U(C_2) + (1 - \pi)\beta V(B_S) \quad (5)$$

Substituting equations (1), (2), and (4) for B_D, B_S, and $P(\pi)$ respectively, and then differentiating (5) with respect to C_1, C_2, F yields the following first order conditions.

$$\frac{U'(C_1)}{[(\pi)V'(B_D) + (1-\pi)V'(B_S)]} = \beta(1+r) \tag{6}$$

$$U'(C_2) = V'(B_S) \tag{7}$$

$$V'(B_D) = V'(B_S) \tag{8}$$

Equation (6) shows that consumers choose consumption in the first period so that the ratio of the marginal utility of consumption to the expected marginal utility of bequests equals the ratio of the consumer's intertemporal discount factor to the market discount factor. Similarly, equation (7) shows that once the uncertainty about death is resolved, consumers choose consumption so that the marginal utility of consumption in the second period equals the marginal utility of bequests in the second period.

Equation (8) shows that selling life insurance helps consumer reduce the "riskiness" of their bequest portfolio. As in other insurance markets, risk averse consumers sell life insurance to equalize the marginal utility of bequests whether the consumer dies at the end of the first period or survives to the second period. Borrowing does not affect the "riskiness" of the bequest portfolio since the repayment of loans taken in prior periods is not contingent on the mortality of the consumer. On the other hand, selling life insurance enables consumers to increase resources when alive at the cost of reducing near term bequests. In other words, the *ex post* cost of obtaining funds from a viatical settlement (relative to borrowing) will depend on the timing of the consumer's death—if consumers die at the end of the second period then a viatical settlement will have lower costs than borrowing but if consumers die at the end of the first period then viatical settlement will be more expensive than borrowing. Of course, the expected *ex ante* cost of financing an extra dollar of consumption through borrowing and selling life insurance will be the same.

3.2 The Effect of Mortality Risk on the Size of the Settlement

Appendix A solves the consumer's maximization problem and derives the key comparative statics. The results show that an increase in mortality risk increases the magnitude of life insurance sales.

$$\frac{dF}{d\pi} > 0 \tag{9}$$

The intuition for this result is as follows. An increase in mortality risk increases the consumer's wealth by increasing equity in the consumer's life insurance policy. In response to this increase in wealth, the consumer will demand both increased consumption and bequests, which are both assumed to be normal goods. Thus the consumer will sell some or all of the life insurance policy and use some of the proceeds for current consumption and invest remaining proceeds for future consumption or bequests.

3.3 The Effect of Assets on the Size of the Settlement

The comparative static results show that an increase in the value of the consumer's house, or an increase in current income, raises the magnitude of life insurance sales.

$$\frac{dF}{dNL} > 0 \tag{10}$$

$$\frac{dF}{dL_1} > 0 \tag{11}$$

The intuition for these results is as follows. Trivially, an increase in the value of the consumer's house or an increase in the current income increases the consumer's wealth. This increase in wealth would mechanically increase the size of near-term bequests, B_D, were the consumer to die at the end of the first period. To maximize utility under these changed circumstances and equate the marginal utility of bequests and consumption, the consumer will want to liquidate some of his life insurance holdings, effectively moving funds between from the early death state of the world (which is overly funded because of the nature of the increased wealth) to the current time period. Therefore, the consumer will increase life insurance sales and use some of his wealth to increase consumption and late term bequests, at the expense of the originally increased near term bequests.

In contrast, if the consumer experiences an increase in future income then in equilibrium, he would reduce the magnitude of life insurance sales.

$$\frac{dF}{dL_2} < 0 \tag{12}$$

The intuition for this result is that an increase in future income increases future bequests but leaves near term bequests unchanged. Consumers reduce life insurance sales and increase borrowing to simultaneously increase current consumption and bequests and reduce late-term bequests, again equilibrating marginal utility across the states of the world and across time periods in accordance with the first order conditions (6)-(8).

4 A Model of Misperceived Price and the Decision to Sell Insurance

This section presents an alternative model of the decision to sell life insurance in which consumers have misperceptions about the real price (opportunity cost) of selling insurance. The key assumption in this model is that relatively unhealthy consumers perceive a higher return from selling life insurance relative to borrowing than actually exists, and that the opposite is true for relatively healthy consumers. This assumption can be motivated in at least two ways, both consistent with the spirit of the papers cited in our literature review.

The first motivation is that relatively unhealthy consumers overestimate their life expectancy while relatively healthy consumers slightly underestimate their life expectancy. This "optimism bias" of relatively unhealthy consumers leads them to view actuarially fair viatical settlement offers more favorably than they would appear to someone correctly perceiving mortality risk.

The second motivation is that consumers with limited analytic capabilities use a simple rule of thumb to calculate the present value of expected costs (in terms of forgone bequests) of a viatical settlement. In particular, consumers incorrectly mistake the discount to face value (nominal price) on the viatical settlement for the true cost of a viatical settlement—which is the net present value of foregone bequests. Since in competitive markets the discount to face value rises with life expectancy this view also leads consumers to view actuarially fair viatical settlement offers more favorably if they expect to live a long life. For example, if viatical settlement firms face a cost of borrowing of 15% per annum, then under a constant mortality hazard assumption the actuarially fair price of a life insurance policy held by a consumer with life expectancy of 6 months is 95% (or 5% discount on face value) of the face value and for a consumer with a life expectancy of 2 years is 79% (or 21% discount on face value). We argue that consumers fixate on the discount to face value rather than the true cost (15% per annum) of the viatical settlement. Thus, consumers with life expectancy of 6 months prefer selling life insurance to borrowing at an interest rate of 15% per annum, and the opposite holds for consumers with life expectancy of 2 years. Even though prices are actuarially fair, unhealthy consumers prefer selling life insurance and healthy consumers prefer borrowing.

As in the economic model of the previous section, consumers hold three distinct assets: a life insurance policy, other non-liquid assets such as housing, and liquid assets such as income. They can finance consumption in three ways. They can consume liquid assets directly, borrow against other non-liquid assets at a given interest rate r, or sell part or all of their life insurance policy at a price p per dollar of coverage. Each action has costs in terms of foregone bequests. Liquid assets cannot be bequeathed once spent, loans must be repaid, and heirs cannot collect on life insurance that has been sold.

Unlike in the economic model, consumers in this model solve a static optimization problem of distributing wealth between consumption and bequests to maximize utility.[4] In particular, such consumers do not discount bequests, while firms, which live forever and are risk neutral, discount future income at the market rate of interest. This simple model generates sharp predictions that we can test with the available data; adding some dynamic elements to the model would complicate it without altering the main predictions that we test in the empirical portion of the paper.

4.1 The Effect of Mortality Risk on the Size of the Settlement

As our example in the introduction to this section shows, the discount to face value of life insurance offered by viatical settlement firms depends on life expectancy. Even for life insurance policies with the same face value, firms will charge lower discounts to consumers closer the end of life since firms are more likely to collect earlier. Since consumers in this section incorrectly perceive the discount to face value as the true price of the viatical settlement, they trade off the discount to face value against the annual interest rate for borrowing. Assuming that the market interest rate for borrowing is the same for everyone, relatively unhealthy consumers will perceive terms of trade to be more lucrative in the viatical settlements market than in the credit market.

More formally, let a_i reflect consumer i's risk of death, and let $H_1 = \{i|a_i < \bar{a}\}$, $H_2 = \{i|a_i = \bar{a}\}$, and $H_3 = \{i|a_i > \bar{a}\}$ for some cutoff level $\bar{a}$ so that H_1 consists of healthier consumers than H_3. We choose a cutoff value $\bar{a}$ such that for consumers in H_2, the perceived costs of financing current consumption through the credit and viatical settlement markets are equal. H_1 consumers perceive lower prices in the credit market, while H_3 consumers perceive the viatical settlements market to be more lucrative. Figure 2 shows the budget constraint for H_3 consumers. The vertical axis represents current consumption, the horizontal axis represents bequests, and W represents the initial endowment, $\left(L, NL + \bar{F}\right)$. B represents the net present value of the endowment—$L + p\bar{F} + \frac{NL}{1+r}$, where p is the actuarially fair unit price of life insurance sales.

Selling all of $\bar{F}$ moves consumers from W to A, where consumers have only non-liquid assets left to fund bequests. To increase current consumption past A, consumers must turn to the credit market, where they borrow at interest rate r, represented by the line segment AB. At point B, consumers leave no bequests, consuming everything in the current period. The kink in the budget constraint is caused by consumer's misperception about the relative prices of borrowing and selling life insurance. A consumer who correctly observed that the real prices of the two activities are the same would have a straight line connecting points W and B for a budget constraint since the policy is discounted by firms at the market rate of interest, the same rate at which consumers can borrow.

Another strategy that consumers could pursue would be to borrow first and then sell their life insurance after their credit is exhausted. WCB is the perceived budget constraint for this strategy, where C represents the exhaustion of non-liquid asset collateral and B represents the sale of $\bar{F}$ as well. Since H_3 (the unhealthiest) consumers perceive that the terms of trade favor the viatical settlements market; the slope of WA is greater (in absolute value) than the slope of WC. Therefore, consumers will viaticate first and then borrow only if $p\bar{F}$ is insufficient to finance current consumption. Similarly H_1 (the healthiest) consumers will perceive that the terms of trade favor credit markets and choose to borrow first. Therefore this model also predicts a negative correlation between health status and the decision to viaticate.

4.2 Effect of Assets on the Size of the Settlement

Changes in non-liquid assets lead to a parallel shift in the consumer's budget line and do not affect the perceived terms of trade in the two markets. Increasing non-liquid assets raises both the value of the endowment and maximum possible bequests, since consumers either leave additional non-liquid assets as bequests or use them for borrowing.

For healthy H_1 consumers, these additional assets will induce them to substitute borrowing for life insurance sales, since the former is on more favorable terms. Figure 3 shows this effect. H_1 consumers initially borrow fully against their non-liquid assets and also sell life insurance at E. For the utility curves as drawn, increasing *NL* shifts the budget line from WAB to W'A'B'. At E', consumers have completely substituted borrowing for viaticating.[5] For other preferences, this complete substitution may not happen, but as long as consumption and bequests are normal goods, increased assets will decrease life insurance sales for H_1 consumers.

For sicker H_3 consumers, the additional non-liquid assets can induce more life insurance sales. Figure 4 demonstrates the effect of an increase in *NL* for H_3 consumers. For these consumers, terms of trade favor the viatical settlements market. If consumption is a normal good, an increase in *NL* leads these consumers to sell a larger part of $\bar{F}$, as they can use the additional non-liquid assets to finance bequests. At G' on the new budget constraint, consumers sell the same amount of life insurance as at their initial optimum, E. Thus, the new equilibrium will lie on C'G', where consumers sell a larger part of $\bar{F}$ than at E.

Increasing liquid assets leads to a parallel shift in the consumer's budget constraint. Consumers use additional liquid assets to either finance increased consumption or to increase bequests by substituting for viatication or borrowing. If bequests are a normal good, increasing liquid assets will cause consumers to decrease their supply of life insurance, decrease their borrowing, or both. For H_1 consumers who do not initially sell life insurance, increasing liquid assets will reduce borrowing but have no effect on life insurance supply. For H_3 consumers who sell all of their life insurance and also borrow, the effects of increasing L depend upon the strength of the income effect. If the income effect is strong, consumers eliminate borrowing and reduce their supply of life insurance. If the income effect is weak, consumers continue to sell all of $\bar{F}$, but reduce borrowing. Hence, for H_3 consumers as well, increasing liquid assets will never increase the supply of life insurance.

5 Comparing Predictions from the Economic and Misperceived Price Model

Both the economic model and the misperceived price model make several sharp predictions regarding the behavior of consumers in the viatical settlement and credit markets.

Prediction 1: *Health status is negatively correlated with the decision to viaticate.*

Although this prediction is consistent with both the economic model and the misperceived price model the mechanism through which mortality risks affect life insurance sales is very different across the two models. In the economic model an increase in mortality risk increases the value of the consumers' life insurance policy. This "wealth-effect" induces consumers to increase life insurance sales to finance increased consumption at the cost of reduced bequests. In contrast, in the misperceived price model the negative correlation between health status and the decision to viaticate arises from a "price-effect." Unhealthy consumers perceive that the terms of trade are more favorable in the viatical settlements market as the discount to face value of their life insurance increases with life expectancy.

Prediction 2[E]: *For all consumers, the decision to viaticate is positively correlated with non-liquid assets.*

This prediction is consistent with the economic model only and follows directly from the comparative static result shown in equation (10). In contrast, the misperceived price model makes the following prediction:

Prediction 2[M]: *For the healthiest consumers, the decision to viaticate is negatively correlated with non-liquid assets. For the sickest, the decision to viaticate is positively correlated with non-liquid assets.*

This follows from Figures 4 and 3 and is a rather stringent test of the misperceived price model. It requires that the impact of non-liquid assets on the decision to viaticate in our empirical specification have different signs depending on the underlying health status of the consumer.

Prediction 3[E]: *For all consumers, increase in liquid assets or current* *income will increase the incentive to participate in the viatical settlements market.*

This prediction is consistent with the economic model only. Thus, it would constitute evidence in favor of the economic model if we observe that people with higher incomes are more likely to viaticate than are patients with lower incomes. In contrast, the misperceived price model makes the following predictions.

Prediction 3[M]: *For all consumers, increase in liquid assets will either reduce or leave unchanged the incentive to participate in the viatical settlements market.*

Thus, a measured zero or negative correlation between the decision to viaticate (or borrowing) and amount of liquid assets, all else remaining the same, would be consistent with the predictions of the misperceived price model.

6 Empirical Tests of the Models

To test the predictions of these models, we use data from the HIV Costs and Services Utilization Study (HCSUS), a nationally representative survey of HIV-infected adults receiving care in the United States. This dataset is appropriate because it contains extensive information on a sample of terminally ill patients who constitute a large share of the viatical settlements market [National Viatical Association, 1999]. Bozzette et al. [1998] describe the design of the data set, including sampling, in detail. Though HCSUS does not contain information about transaction prices and quantities in the viatical settlements market, we do not need them to conduct the tests we describe in Section 5.

6.1 Data

HCSUS is a panel study that followed a cohort of HIV+ patients over three interview waves. The dataset has information on the respondents' demographics, income and assets, health status, life insurance, and participation in the viatical settlements market.

Questions about life insurance holdings and sales were asked in the first follow-up (FU1) survey in 1997 and the second follow-up (FU2) survey in 1998. Of the 2,466 respondents in FU1, 1,353 (54.7%) reported life insurance holdings. These 1,353 respondents are our analytic sample as they are the only patients at risk to viaticate. We exclude 344 respondents with missing values for at least one of the key variables—diagnosis date, health status, liquid assets, or non-liquid assets. These exclude respondents were similar to the sample with complete data when compared by their observed covariates. We also exclude 123 respondents who resided in states with minimum price regulation of viatical settlements as these regulations distort the viatical settlements market by restricting settlements by relatively healthy consumers [see Bhattacharya et al., 2002]. In our remaining analytic sample of 886 respondents, 146 (16%) respondents had sold their life insurance by the FU1 or FU2 interview dates.

Table 1 compares summary statistics from the baseline interview of respondents who sold their life insurance at some point in time with those who never did.[6] Viators are more likely than never-viators to be male, white, college-educated and older. They are also richer and are more likely to own a house. They are also less likely to be married or have any children alive. Finally, viators are typically in poorer health than never-viators, with lower CD4 T-cell levels at the baseline survey and more progressive HIV disease.

6.2 The Hazard of Viaticating

HCSUS respondents report whether they sold their life insurance by the first or second follow-up interview. Given these responses, we estimate an empirical model of the decision to viaticate that allows for time-varying covariates. Because we do not observe quantity sold, our focus is necessarily on the decision to sell at all.

There are three kinds of respondents—those who have viaticated by FU1, those who viaticated between FU1 and FU2, and those who never viaticate in the observation window. Each has a different contribution to the likelihood function. Let $\lambda(t)$ be the probability of viaticating at time t given that the respondent has not viaticated in the preceding $t-1$ years. Time is measured starting from the year of diagnosis with HIV, or the viatical settlements market inception date—1988—whichever is earlier. The probability that a respondent never viaticated is $\prod_{t=1}^{T}(1-\lambda(t))$, where T is years between the start and end of the observation window. Similarly, the probability that a respondent viaticated by FU1 is $1-\prod_{t=1}^{T_1}(1-\lambda(t))$, where T_1 is years between the start and the FU1 interview date. The probability that a respondent did not viaticate between the start date and FU1 but did viaticate by FU2 is $\prod_{t=1}^{T_1}(1-\lambda(t))-\prod_{t=1}^{T_2}(1-\lambda(t))$, where T_2 is years between the start and the FU2 interview date. Combining these three types of respondents gives the likelihood function:

$$
\begin{aligned}
L = \quad & \prod_{i=1}^{N} D_{1i}\left[\prod_{t=1}^{T_1}(1-\lambda_i(t))-\prod_{t=1}^{T_2}(1-\lambda_i(t))\right]+ \\
& D_{2i}\left[1-\prod_{t=1}^{T_1}(1-\lambda_i(t))\right]+ \\
& D_{3i}\left[\prod_{t=1}^{T}(1-\lambda_i(t))\right]
\end{aligned} \tag{13}
$$

where, i subscripts over the N respondents; D_{1i} is a binary variable that indicates if respondent i viaticated between FU1 and FU2; D_{2i} indicates if respondent i viaticated by FU1; and D_{3i} indicates that respondent i never viaticated.

We model the hazard of viaticating as,

$$\lambda_i(t)=\frac{1}{1+\exp(\lambda_t^0+X_{it}\beta)}, \tag{14}$$

where, X_{it} is a vector of covariates measured at time t,β is the vector of regression coefficients, and $\frac{1}{1+\exp(\lambda_t^0)}$ is the baseline logit hazard rate. We maximize the likelihood function (13) with respect to the parameters $\lambda_t^0$and β.

HCSUS respondents were interviewed at three discrete times. One major consequence of this sampling strategy is that we do not observe X_{it} at each point in time t, so we have no measures of patient health status or changes in assets between surveys. We use a step function approximation to impute values of X_{it}. For example, suppose a respondent is sampled at time points t_1, t_2, and t_3, and reports values for X_t of x_1, x_2, and x_3 at each of these time points respectively. We assign

$$X_t = \begin{cases} x_1 & \text{for } t \leq t_1 \\ x_2 & \text{for } t_1 < t \leq t_2 \\ x_3 & \text{for } t_2 < t \leq t_3 \end{cases}$$

6.3 Measuring Health, Income, and Assets

We include demographics, health status, income, and a full set of interactions between non-liquid assets and health status as covariates in our survival analysis. We also include marital status, living alone, and whether the respondent has at least one living child as proxies for the strength of the bequest motive. When HCSUS was conducted, the two most important health status measures for HIV patients were CD4+ T-lymphocyte cell count and the Center for Disease Control (CDC) definition of clinical stage. CD4+ T-cell count measures the function of a patient's immune system; depletion correlates strongly with worsening HIV disease and increasing risk of opportunistic infections [Fauci et al., 1998]. While healthy patients have CD4 cell counts above 500 cells per ml., declines into lower clinically recognized ranges correlate with worsening disease. These ranges are: between 200 and 500 cells per ml., between 50 and 200 cells per ml., and below 50 cells per ml. There are three categories in the CDC definition of clinical stage: asymptomatic, symptomatic, and AIDS [Centers for Disease Control and Prevention, 1993]. Patients have AIDS if they manifest conditions such as Kaposi's Sarcoma, Toxoplasmosis, or the other life-threatening conditions on the CDC list. Symptomatic HIV+ patients manifest signs of to their infection, but not one of the CDC's listed conditions.

Ideally, we would like to classify HCSUS respondents into groups H_1 and H_3 that are based upon their subjective mortality risks, but these data are not available. Instead, we construct a one-dimensional indicator of mortality risk by regressing one-year mortality after the baseline survey on the two clinical health measures. This probit regression is shown in Table 2. Not surprisingly, respondents with lower CD4 T-cell levels or with more advanced disease are more likely to die. Using these results, we predict one-year mortality rates for each respondent at each time point when we have new CD4 T-cell levels and clinical stage indicators. Finally, we use a cutoff value of 0.04 for predicted mortality to divide our sample into respondents with high mortality risks (25% of respondents at baseline) and respondents with low mortality risk (75% of respondents at baseline). Based upon this division we create two linearly dependent dummy variables, *Unhealthy* and *Healthy*, which are our main health status indicators. Because we do not know the true cutoff value we try different cut-off values for the health status indicator in other specifications to test the robustness of our results.

We use house ownership as the measure of non-liquid assets as it was asked in all three surveys. Respondents who owned a house at baseline reported having higher non-liquid assets as compared to respondents who did not own a house at baseline ($66,740 vs. $25,832).[7] We designate the indicators for house ownership and non-ownership as *House* and *NoHouse*, respectively. We use income, which was asked in each interview, as a measure of liquid assets. Because many HCSUS respondents only report their income within ranges, we enter income in our models as a series of indicator variables: $1(Income < \$500 per month)$, $1(\$501 \leq Income < \$2,000)$, and $1(Income \geq \$2,000)$.

6.4 Summary of Hypothesis

Table 3 maps the predictions from the economic and misperceived price models into testable hypotheses. To evaluate them, we include in the model interactions between health status (*Unhealthy*) and house ownership (*House*). The first prediction implies that the hazard of viaticating should be higher for the unhealthy, regardless of home ownership.

Prediction 2[M] implies that home ownership should have an opposite effect on the healthy than it has on the unhealthy. For the unhealthy, home ownership should increase the probability of viaticating; for the healthy, it should reduce it. We consider this a strong test of the misperceived price model, since the effect of assets should reverse sign based on the classification of health from the one-year mortality regression. In contrast, Prediction 2[E] implies that the hazard of viaticating should be higher for homeowners, regardless of health status.

Prediction 3[M] implies that high income consumers with will be *less* likely to viaticate to finance consumption, while Prediction 3[E] implies that high income consumers will be *more* likely to viaticate.

6.5 Results

Table 4 reports the average hazard ratios at $t = 1$ and baseline hazard rates for four different specifications of the empirical model. We average the hazard ratios for each covariate across all individuals in the sample as they depend not only on the regression coefficient associated with the covariate but also on the values of the other covariates. Appendix B specifies our methodology for computing the hazard ratios and their confidence intervals.

The second column (Model 1) in Table 4 reports the results for the simplest empirical model needed to test the hypotheses presented in Table 3. Healthy consumers with houses have the lowest viatication hazards. Healthy consumers without houses are 1.6 times more likely to viaticate at $t = 1$ year than healthy house owners, unhealthy consumers without houses are 2.2 times more likely, while unhealthy consumers who own a house are 3.9 times more likely. Figure 5 plots the predicted survivor functions—that is, cumulative probability of *not* viaticating—implied by the results in Model 1 for each house ownership and health group from $t = 1$ year to $t = 9$ Years [8] It clearly demonstrates an ordering of viatication hazards that are consistent with the misperceived price model. In particular, among healthy consumers homeowners are significantly less likely to viaticate. In contrast, among unhealthy consumers homeowners are significantly more likely to viaticate. These results are consistent with prediction 2[M] of the misperceived price model,rather than prediction 2[E] of the economic model. The results are also consistent with prediction 1 from both the economic and misperceived price model. Regardless of home ownership, unhealthy consumers are significantly more likely to viaticate. Income has no statistically significant effect on viatication probabilities, which is also weak evidence favoring Prediction 3[M] of the misperceived price model.

Model 2 in Table 4 adds demographic, bequest motive, and education variables to Model 1. Whites have significantly higher hazards of viaticating than do Blacks, Hispanics, and respondents of other races. Older respondents are significantly more likely to viaticate. Respondents with no children alive are more likely to viaticate, though the effect is statistically significant at the 90% confidence level. There are no statistically significant differences between high school dropouts, high school graduates and college educated respondents in viatication hazards, though the point estimates indicate college graduates and those with some college education are more likely to viaticate.

As was the case with Model 1, the results of these models are also consistent with misperceived price model. In particular, we find that among healthy consumers those with houses are significantly less likely to viaticate than those without, which is consistent with prediction 2[M] of the misperceived price model, but inconsistent with prediction 2[E] of the economic model.

In Models 3 and 4, we check the robustness of our results to a change in the definition of health status. Instead of a cutoff value of 0.04 for predicted mortality, we use a value of 0.012 to divide our sample differently into unhealthy (50% of respondents at baseline) and healthy respondents (50% of respondents at baseline). Except for the change in definition of health status, the specification of Models 3 and 4 are identical to Models 1 and 2. As with Models 1 and 2, the estimates from Models 3 and 4 are also consistent with the misperceived price model. We find that among the healthy, those with houses are less likely to viaticate than those without, which is consistent with Predictions 2[M], although in this case the difference in the viatication hazards is not statistically significant.

7 Alternate Theories

The evidence presented here is consistent with the misperceived price model rather than the economic model. Here, we consider four alternate explanations that could, under certain conditions, give rise to similar findings.

One important factor that we did not explicitly model is means-tested programs such as Medicaid. In most states, proceeds from viatical settlements are counted as assets for the purposes of means-testing, but life insurance polices themselves are excluded. Clearly, this might reduce incentives to viaticate for individuals who would otherwise be eligible for these programs. However, the bias here goes the wrong way. Such program rules make the unhealthy *less* likely to sell insurance—and contrary to what the data show—since they tend to be more indigent and thus more likely to be eligible for Medicaid or other public programs.

A related alternative explanation concerns the tax treatment of viatical settlements. The 1996 Health Insurance Portability and Accountability Act, which came into effect in January 1997, exempts proceeds derived from a viatical settlement from federal taxes as long as the seller is certified by a physician to have a life expectancy of 24 months or less or to be chronically ill. Several large states, such as California and New York, have also passed similar provisions exempting viatical settlement transactions from state taxes [Sutherland and Drivanos, 1999]. Although these laws might lead to a negative correlation between health and the hazard of selling insurance after 1997, the vast majority of our data refer to the period before the HIPAA implementation. Most respondents in our study reported that they sold their life insurance before the first quarter of 1997 – thus there is only a 2-3 month overlap in the time when these laws were effective and the period of life insurance sales in the HCSUS sample.

As in any insurance market, asymmetric information (patients know more than firms about their mortality risks) could be an important determinant of market outcomes in the viatical settlements market. As Akerlof [1970], Wilson [1977], and Rothschild and Stiglitz [1976] demonstrate, asymmetric information might lead to adverse selection in insurance markets; that is, high-risk individuals are more likely to participate and low risks are driven out of the market. Since, consumers are sellers in this market, adverse selection in these markets leads to the opposite of the typical "lemons" problems—patients with unobserved mortality risks rather than the healthier patients are driven out of the market. However, the institutional details of this industry argue against the importance of adverse selection in these markets. In particular, there are good reasons to believe that viatical settlement companies have accurate information on patient's mortality risks. Unlike other insurance markets, viatical settlement firms often use the services of independent physicians and actuaries to determine the life expectancy of the seller National Viatical Association [1999]. Furthermore, companies scrutinize patient medical records before making an offer to buy, and they have access to the mortality experience of a large pool of patients.[9]

Finally, it is worth considering the role of transaction costs. Transaction costs in credit markets might be systematically different for healthy and unhealthy consumers; in particular, unhealthy consumers might face a higher cost of borrowing against their house as compared with healthy consumers. For example, lenders might charge higher prices to unhealthy consumers if they expect to incur significant costs in collecting loan repayments from the estates of unhealthy consumers and but do not expect such costs for healthy consumers (as they might be more likely to repay their loans before they die). In this case, it would be likely that unhealthy consumers would prefer the viatical settlement market, while healthy consumers would prefer the credit market to finance their consumption needs. However, this explanation is based on two assertions that are unlikely to be true. First, this explanation assumes that lenders know the health status or life expectancy of borrowers. This is unlikely since credit applications do not usually require borrowers to disclose their health status. Second, this explanation assumes that transaction costs in the viatical settlement market do not systematically depend on the life expectancy of the sellers. However, it seems likely that unhealthy consumers, who have little time left alive, might view the sometimes lengthy process of searching and negotiating with viatical firms in this relatively new market as particularly onerous, relative to healthier consumers. Therefore, it seems unlikely that our results are driven by differences in transaction costs in credit markets for healthy and unhealthy consumers, although we cannot rule out this explanation.

8 Discussion and Conclusions

Our empirical findings are that, among healthier chronically ill consumers, homeowners are less likely to sell their life insurance than are non-home owners. In contrast, among unhealthy consumers, homeowners are more likely to sell their life insurance policies. These empirical findings cannot be reconciled with a straightforward economic model of savings, consumption, and bequests. Instead, these findings are consistent with two possible and mutually consistent interpretations motivated by the psychology and behavioral economics literature: (1) relatively unhealthy consumers overestimate their life expectancy and this "optimism bias" leads them to view actuarially fair viatical settlement offers more favorably than they would appear to someone correctly perceiving mortality risk, and (2) consumers mistakenly believe that the discount to face value on the viatical settlement is a good approximation to the true price of the viatical settlement. Since in a competitive market the discount to face value rises with life expectancy, this mistaken view leads long-life-expectancy consumers to view actuarially fair viatical settlement offers less favorably than do their unhealthier peers.

This conclusion raises the following question: can such consumer mistakes persist in the long run? The standard argument against persistence of consumer mistakes is that they lead to mispriced or imperfect markets that in turn create arbitrage opportunities. However, Barberis and Thaler [2002], in their review of the literature on consumer mistakes in financial markets, argue persuasively that while the statement "prices are right" implies "no free lunch," the converse does not necessarily hold. They argue that mispricing does not always lead to arbitrage opportunities, as strategies designed to take advantage of mispricing—especially in financial markets—can be costly or risky. Our results add a new dimension to this debate; we find that "prices are right" does not imply "no mistakes." Our results show that despite consumer mistakes, there is no real mispricing in this market—the only mistakes are in consumer perceptions not in market prices. Thus, since prices are actuarially fair (firms make zero profits), such mistakes are likely to persist.

The above discussion leads naturally to the policy implication that consumer mistakes might be reduced if buyers in these markets are required to "decode" prices for sellers in a way that is more easily understandable. Such regulations have recently been implemented in other mortality contingent claims markets such as the reverse mortgage market. Reverse mortgage markets allow consumers to take loans against equity in their homes. However, unlike normal loans, reverse mortgages limit the loan repayment to the value of the house and require no repayment for as long as the borrower is alive. Thus, just like viatical settlement markets, the loan amount available from a reverse mortgage will depend on the life expectancy of the borrower. Also like viatical settlement markets, the *ex post* cost of obtaining funds from a reverse mortgage will depend on the timing of the borrower's death—if consumers live well past their life expectancy then a reverse mortgage will have low costs but if consumers die sooner than expected then a reverse mortgage will be expensive. Recognizing that consumers typically find it difficult to compare the costs of a reverse mortgage with other credit instruments, the Home Owner Equity Protection Act [HOEPA, 1994] subjects all reverse mortgages to a Truth-in-Lending disclosure. This provision requires lenders to project and disclose the total annual average cost of these loans if they were repayed after two years, at the borrower's life expectancy and 40% beyond the borrower's life expectancy. Our findings suggest that similar regulations might be beneficial for consumers in secondary life insurance markets.

APPENDIX

A Comparative statics for the economic model

The first order conditions from expected utility maximization are:

$$U'(C_1) = \beta(1+r)\left[(\pi)V'(B_D) + (1-\pi)V'(B_S)\right] \tag{A-1}$$

$$U'(C_2) = V'(B_S) \tag{A-2}$$

$$V'(B_D) = V'(B_S) \tag{A-3}$$

Rearranging terms and simplifying yields:

$$U'(C_1) = \beta(1+r)V'(B_D) \tag{A-4}$$

$$U'(C_2) = V'(B_D) \tag{A-5}$$

$$C_2 = L_2 - \left(\bar{F} - F\right)\left(\frac{r}{1+r}\right) \text{ as } \left[V'(B_D) = V'(B_S) \Rightarrow B_D = B_S\right] \tag{A-6}$$

A.1 Comparative statics with respect to π

Totally differentiating (A-4), (A-5) and (A-6) and setting changes in all exogenous parameters except mortality risks equal to zero implies:

$$\begin{aligned}\left[U''(C_1) + (1+r)^2\beta V''(B_D)\right]dC_1 + \left[r(1-\pi)\beta V''(B_D)\right]dF = \\ \left[rF\beta V''(B_D)\right]d\pi\end{aligned} \tag{A-7}$$

$$\begin{aligned}\left[(1+r)V''(B_D)\right]dC_1 + \\ \left[\left(\frac{r}{1+r}\right)U''(C_2) + \left(\frac{r}{1+r}\right)(1-\pi)V''(B_D)\right]dF = \\ \left[\left(\frac{r}{1+r}\right)FV''(B_D)\right]d\pi\end{aligned} \tag{A-8}$$

Let D be defined as follows:

$$\begin{aligned} D = \quad & U''(C_1)\,U''(C_2)\left(\tfrac{r}{1+r}\right) + \\ & U''(C_1)\,V''(B_D)\,(1-\pi)\left(\tfrac{r}{1+r}\right) + \\ & V''(B_D)\,U''(C_2)\,\beta r\,(1+r) \end{aligned}$$

Under standard assumptions about the utility functions, D is positive.

Solving (A-7) and (A-8) with respect to the endogenous variables yields:

$$\frac{dF}{d\pi} = \frac{U''(C_1)\,V''(B_D)\,F\left(\frac{r}{1+r}\right)}{D} > 0 \tag{A-9}$$

$$\frac{dC_1}{d\pi} = \frac{U''(C_2)\,V''(B_D)\,F\beta\left(\frac{r^2}{1+r}\right)}{D} > 0 \tag{A-10}$$

A.2 Comparative statics with respect to NL

Totally differentiating (A-4), (A-5) and (A-6) and setting changes in all exogenous parameters except NL equal to zero implies:

$$\begin{aligned} & \left[U''(C_1) + (1+r)^2\,\beta V''(B_D)\right] dC_1 + \\ & [r\,(1-\pi)\,\beta V''(B_D)]\,dF = \\ & [(1+r)\,\beta V''(B_D)]\,dNL \end{aligned} \tag{A-11}$$

$$\begin{aligned} & [(1+r)\,V''(B_D)]\,dC_1 + \\ & \left[\left(\frac{r}{1+r}\right)U''(C_2) + \left(\frac{r}{1+r}\right)(1-\pi)\,V''(B_D)\right] dF = \\ & \left[\left(\frac{r}{1+r}\right)U''(C_2) + V''(B_D)\right] dNL \end{aligned} \tag{A-12}$$

Let A be defined as follows:

$$\begin{aligned} A = U''(C_1)\left(V''(B_D) + U''(C_2)\left(\frac{r}{1+r}\right)\right) + \\ V''(B_D)\,U''(C_2)\,\beta r\,(1+r) \end{aligned}$$

Solving (A-11) and (A-12) with respect to the endogenous variables yields:

$$\frac{dF}{dNL} = \frac{A}{D} > 0 \tag{A-13}$$

$$\frac{dC_1}{dNL} = \frac{V''(B_D)\,U''(C_2)\,\beta\left(\frac{r}{1+r}\right)(1+\pi r)}{D} > 0 \tag{A-14}$$

A.3 Comparative statics with respect to L_1

Totally differentiating (A-4), (A-5) and (A-6) and setting changes in all exogenous parameters except L_1 equal to zero implies:

$$\begin{aligned} &\left[U''(C_1) + (1+r)^2\beta V''(B_D)\right] dC_1 + \\ &[r(1-\pi)\beta V''(B_D)]\, dF = \\ &\left[(1+r)^2\beta V''(B_D)\right] dL_1 \end{aligned} \tag{A-15}$$

$$[(1+r)\,V''(B_D)]\,dC_1 + \tag{A-16}$$

$$\left[\left(\frac{r}{1+r}\right)U''(C_2) + \left(\frac{r}{1+r}\right)(1-\pi)\,V''(B_D)\right] dF = \tag{A-17}$$

$$[(1+r)\,V''(B_D)]\,dL_1 \tag{A-18}$$

Solving (A-15) and (A-16) with respect to the endogenous variables yields:

$$\frac{dF}{dL_1} = \frac{U''(C_1)\,V''(B_D)\,(1+r)}{D} > 0 \tag{A-19}$$

$$\frac{dC_1}{dL_1} = \frac{U''(C_2)\,V''(B_D)\,\beta r(1+r)}{D} > 0 \tag{A-20}$$

A.4 Comparative statics with respect to L_2

Totally differentiating (A-4), (A-5) and (A-6) and setting changes in all exogenous parameters except L_2 equal to zero implies:

$$\left[U''(C_1) + (1+r)^2 \beta V''(B_D)\right] dC_1 + \tag{A-21}$$
$$[r(1-\pi)\beta V''(B_D)] \, dF =$$
$$[0] \, dL_2$$

$$[(1+r) V''(B_D)] \, dC_1 + \tag{A-22}$$
$$\left[\left(\frac{r}{1+r}\right) U''(C_2) + \left(\frac{r}{1+r}\right)(1-\pi) V''(B_D)\right] dF =$$
$$[-U''(C_2)] \, dL_2$$

Solving (A-21) and (A-22) with respect to the endogenous variables yields:

$$\frac{dF}{dL_2} = -\frac{U''(C_1) U''(C_2) + (1+r)^2 \beta V''(B_D) U''(C_2)}{D} < 0 \tag{A-23}$$

$$\frac{dC_1}{dL_2} = \frac{U''(C_2) V''(B_D) \beta r (1-\pi)}{D} > 0 \tag{A-24}$$

B Monte Carlo computation of hazard ratios

We use Monte Carlo simulations to calculate the hazard ratios and confidence intervals reported in Table 4. Let $\mu_{est} = \begin{pmatrix} \beta_{est} \\ \lambda^0_{est} \end{pmatrix}$ be the maximum likelihood estimates of $\beta = (\beta_1, \beta_2, ...\beta_k)$ (where k is the number of covariates) and $\lambda^0 = (\lambda^0_1, \lambda^0_2, \ldots \lambda^0_9)$ from equation (17), and let $\sum_{est}$ be the estimated variance covariance matrix of μ, which is asymptotically distributed multivariate normal.

In each iteration of the Monte Carlo simulation, we draw a random vector of regression coefficients, $\mu^{(i)} = \left(\beta^{(i)}, \lambda^{0(i)}\right)$ from $N\left(\mu_{est}, \Sigma_{est}\right)$, where i indexes over the iterations. Using this randomly drawn $\mu^{(i)}$ we calculate an average hazard ratio for each dichotomous covariate:

$$\text{hazard ratio}_{i,k} = \frac{1}{N}\sum_{j=1}^{N} \frac{\lambda_j\left(1|X_k = 1, X_{k+1} = 0, ...X_{k+m} = 0, \mu = \mu^{(i)}\right)}{\lambda_j\left(1|X_k = 0, X_{k+1} = 0, ...X_{k+m} = 0, \mu = \mu^{(i)}\right)} \tag{B-1}$$

where, j subscripts over the N respondents in the data set, and $(X_k, ...X_{k+m})$ is a mutually exclusive set of dichotomous covariates.

For continuously measured covariates we calculate the average hazard ratio using:

$$\text{hazard ratio}_{i,k} = \frac{1}{N}\sum_{j=1}^{N} \frac{\lambda_j\left(1|X_k = X_k + \theta, \mu = \mu^{(i)}\right)}{\lambda_j\left(1|X_k = X_k, \mu = \mu^{(i)}\right)} \tag{B-2}$$

where, θ is an arbitrary offset. For the hazard ratio corresponding to age, we set $\theta = 5$ years.

We repeat 100,000 iterations. Finally, we calculate the mean and confidence intervals of (B-1)-(B-2) over all the iterations, which we report in Table 4.

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Notes

[1] In particular, our test distinguishes sophisticated consumers from ordinary ones; it does not pinpoint whether mistakes by ordinary consumers, if they occur, are due to misperceived mortality risk or misassessed price signals.

[2] In Bhattacharya et al. [2002], we develop evidence that secondary life insurance markets are competitively priced. In particular, we find that calculations of the expected net present value of viatical settlements for people with different life expectancies match (suitably transformed) transaction prices in that market.

[3] The secondary life insurance industry emerged in the 1980s in response to the advent of AIDS, which at that time was almost always fatal. The industry has grown rapidly, with $500 million in policies sold by 1995 and $1 billion in policies by 1998 [National Viatical Association, 1999]. The discovery of effective medication for HIV infection appears not to have deterred growth. Companies are expanding their business and some have started marketing viatical settlements to the elderly and patients with other terminal illnesses [American Council of Life Insurance, 1999].

[4] We also abstract away from consumers who are not 'cash-constrained'—that is, those who save liquid assets to finance future consumption or bequests—because such individuals would never be interested in viaticating.

[5] For H_1 consumers with an initial optimum in the lower part of the budget constraint, an increase in NL will have no effect on the supply of life insurance.

[6] Including the 344 respondents who had at least one missing value has no appreciable effect on the summary statistics that we report in Table 1.

[7] This relationship between non-liquid assets and house ownership persist even after controlling for health status. For both healthy and unhealthy consumers house ownership is associated with significantly higher non-liquid assets.

[8]The graph is plotted for patients in the reference income category—$1(Income < \$500)$.

[9] Of course, even these efforts may not completely eliminate asymmetric information—patients may still have private information about their health status and the efforts they will undertake to avoid poor health.

References

Akerlof, G. A. (1970). The market for 'lemons': Quality uncertainty and the market mechanism. *Quarterly Journal of Economics*, 84(3):488–500.

American Council of Life Insurance (1999). Accelerated death benefits popularity doubles, new acli-limra survey shows. LIMRA International News Release, Washington, D.C.

Barberis, N. and Thaler, R. (2002). A survey of behavioral finance. Working Paper 9222, National Bureau of Economic Research.

Belth, J. M. (1966). Price competition in life insurance. *The Journal of Risk and Insurance*, 33(3):365–379.

Benartzi, S. and Thaler, R. (2001). Naïve diversification strategies in defined contribution saving plans. *American Economic Review*, 91(1):79–98.

Bernheim, B. D., Skinner, J., and Weinberg, S. (1997). What accounts for the variation in retirement wealth among u.s. households? Working Paper 6627, National Bureau of Economic Research.

Bhattacharya, J., Goldman, D. P., and Sood, N. (2002). Price regulation in secondary insurance markets. Mimeo, RAND.

Bozzette, S. A., Berry, S. H., Duan, N., Frankel, M., Leibowitz, A. A., Lefkowitz, D., Emmons, C., Senterfitt, J., Berk, M., and Morton, S. C. (1998). The care of hiv-infected adults in the united states. hiv cost and services utilization study consortium. *New England Journal of Medicine*, 339(26):1897–904.

Centers for Disease Control and Prevention (1993). 1993 revised classification system for hiv infection and expanded surveillance case definition for aids among adolescents and adults. *JAMA*, 269(6):729–30.

Fauci, A. S., Braunwald, E., Isselbacher, K. J., Wilson, J. D., Martin, J. B., Kasper, D. L., Hauser, S. L., and Longo, D. L., editors (1998). *Harrison's Principles of Internal Medicine*. McGraw-Hill Inc., New York, NY, 14 edition.

HOEPA (1994). The Home Owner Equity Protection Act of 1994. 15 U.S.C. §1639.

Hurd, M., McFadden, D., and Merrill, A. (1999). Predictors of mortality among the elderly. Working Paper 7440, National Bureau of Economic Research.

Kagel, J. and Roth, A., editors (1995). *Handbook of Experimental Economics*. Princeton University Press, Princeton, NJ.

Kahneman, D. and Tversky, A. (1979). Prospect theory: An analysis of decision under risk. *Econometrica*, 47:263–91.

Kahneman, D. and Tversky, A. (2000). *Choices, Values, and Frames*. Cambridge University Press, Cambridge, UK.

Laibson, D. (1997). Golden eggs and hyperbolic discounting. *Quarterly Journal of Economics*, 112(2):443–477.

Lichtenstein, S., Slovic, P., Fischhoff, B., Layman, M., and Combs, B. (1978). Judged frequency of lethal events. *Journal of Experimental Psychology: Human Learning and Memory*, 4(6):551–578.

Maclean, J. B. (1962). *Life Insurance*. McGraw-Hill Inc., New York, NY, 9 edition. pp. 349-51.

Magee, J. H. (1958). *Life Insurance*. Richard D. Irwin, Inc., Homewood, IL, 3 edition. p. 683.

Moore, M. J. and Zhu, C. W. (2000). Passive smoking and health care: Health perceptions myth vs. health care reality. *Journal of Risk and Uncertainty*, 21(2/3):283–310.

Mullainathan, S. and Thaler, R. H. (2000). Behavioral economics. Working Paper 7948, National Bureau of Economic Research.

National Viatical Association (1999). Nva information booklet. NVA: Washington, DC.

Odean, T. (1998). Are investors reluctant to realize their losses? *Journal of Finance*, 53:1775–1798.

Rabin, M. (1998). Psychology and economics. *Journal of Economic Literature*, 36:11–46.

Rothschild, M. and Stiglitz, J. E. (1976). Equilibrium in competitive insurance markets: An essay on the economics of imperfect information. *Quarterly Journal of Economics*, 90(4):630–49.

Schoenbaum, M. (1997). Do smokers understand the mortality effects of smoking? evidence from the health and retirement survey. *American Journal of Public Health*, 87(5):755–9.

Sutherland, W. and Drivanos, P. (1999). Viatical settlements: Life insurance as a liquid asset for the seriously ill. *Journal of Financial Planning*, 12(5).

Thaler, R. (1985). Mental accounting and consumer choice. *Marketing Science*, 4(3):199–214.

Wilson, C. (1977). A model of insurance markets with incomplete information. *Journal of Economic Theory*, 16:167–207.

Table 1: Weighted Descriptive Statistics at Baseline

Variables	Never sold life insurance (N=740)	Ever sold life insurance (N=146)	Entire sample (N = 886)
CD4 T-cell levels:			
< 50 cells per ml	9.36%	12.08%	9.83%
50 – 200 cells per ml	21.68%	40.00%	24.84%
201 – 500 cells per ml	43.32%	31.40%	41.26%
> 500 cells per ml	25.64%	16.52%	24.07%
Disease Stage:			
Asymptomatic	10.93%	11.85%	11.09%
Symptomatic	54.37%	38.61%	51.64%
AIDS	34.70%	49.54%	37.26%
Income and Assets:			
House ownership	29.38%	33.57%	30.11%
Monthly Income			
< $500	15.81%	13.57%	15.42%
$501 - $2000	39.85%	38.73%	39.66%
> $2000	44.34%	47.70%	44.92%
Bequest Motives:			
Any Children Alive	37.82%	29.18%	36.32%
Married	16.01%	12.30%	15.37%
Separated, Divorced, Widowed	25.55%	28.06%	25.98%
Never Married	58.44%	59.64%	58.64%
Demographics:			
Age	34.88 years	38.01 years	35.42 years
Male	84.19%	89.35%	85.08%
Black	25.41%	17.32%	24.01%
Hispanic	13.61%	4.18%	11.98%
White	56.68%	75.97%	60.01%
Other race	4.30%	2.53%	3.99%
Have college degree	24.52%	36.38%	26.57%

Table 2: One-Year Mortality Probit Regression

Variable	Coefficient	Standard Error
CD4 T-cell < 50	1.40	0.39
CD4 T-cell 51-200	0.50	0.39
CD4 T-cell 201-500	0.32	0.38
CD4 T-cell 500+*	-	
Asymptomatic	-0.51	0.47
Symptomatic	-0.41	0.22
AIDS*	-	
Intercept	-2.25	0.38

*Reference categories

Table 3: Hypotheses

Prediction	**Test**[†]
Misperceived price Model Prediction 1: Negative correlation between health status and the decision to viaticate.	$\lambda(t\mid \text{Unhealthy, House}) > \lambda(t\mid \text{Healthy, House})$ $\lambda(t\mid \text{Unhealthy, No House}) > \lambda(t\mid \text{Healthy, No House})$
Prediction 2a: Among healthy consumers, negative correlation between the decision to viaticate and the amount of nonliquid assets	$\lambda(t\mid \text{Healthy, House}) < \lambda(t\mid \text{Healthy, No House})$
Prediction 2b: Among unhealthy consumers, a positive correlation between the decision to viaticate and the amount of nonliquid assets	$\lambda(t\mid \text{Unhealthy, House}) > \lambda(t\mid \text{Unhealthy, No House})$
Prediction 3: Zero or negative correlation between liquid assets and the decision to viaticate	$\lambda(t\mid \text{Income \$2,000+}) \leq \lambda(t\mid \text{Income \$500 to \$2,000})$ $\leq \lambda(t\mid \text{Income below \$500})$
Economic Model Prediction 1: Negative correlation between health status and the decision to viaticate.	$\lambda(t\mid \text{Unhealthy, House}) > \lambda(t\mid \text{Healthy, House})$ $\lambda(t\mid \text{Unhealthy, No House}) > \lambda(t\mid \text{Healthy, No House})$
Prediction 2a: Among healthy consumers, positive correlation between the decision to viaticate and the amount of nonliquid assets	$\lambda(t\mid \text{Healthy, House}) > \lambda(t\mid \text{Healthy, No House})$
Prediction 2b: Among unhealthy consumers, a positive correlation between the decision to viaticate and the amount of nonliquid assets	$\lambda(t\mid \text{Unhealthy, House}) > \lambda(t\mid \text{Unhealthy, No House})$
Prediction 3: Positive correlation between liquid assets and the decision to viaticate	$\lambda(t\mid \text{Income \$2,000+}) > \lambda(t\mid \text{Income \$500 to \$2,000})$ $> \lambda(t\mid \text{Income below \$500})$

[†] $\lambda(t)$ is the hazard of viaticating at time t.

Table 4: Empirical models of viatication hazards

Variables	**Model 1** Haz. Ratio (Conf Int.)	**Model 2** Haz. Ratio (Conf Int.)	**Model 3** Haz. Ratio (Conf Int.)	**Model 4** Haz. Ratio (Conf Int.)
Income				
Income < $500	1.00	1.00	1.00	1.00
	(Ref Cat)	(Ref Cat)	(Ref Cat)	(Ref Cat)
Income $500 –2000	1.08	0.90	1.05	0.88
	(0.69 – 1.64)	(0.55 – 1.43)	(0.69 – 1.56)	(0.54 – 1.38)
Income > $2000	1.42	1.02	1.35	0.98
	(0.91 – 2.14)	(0.60 – 1.64)	(0.88 – 2.00)	(0.58 – 1.55)
House ownership and Health Status				
Healthy*House	1.00	1.00	1.00	1.00
	(Ref Cat)	(Ref Cat)	(Ref Cat)	(Ref Cat)
Unhealthy*House	3.90	4.35	2.71	2.93
	(2.37 – 6.24)	(2.50 – 7.13)	(1.62 – 4.39)	(1.64 – 4.90)
Unhealthy *NoHouse	2.16	2.46	2.25	2.60
	(1.31 – 3.41)	(1.39 – 4.03)	(1.35 – 3.60)	(1.45 – 4.35)
Healthy*NoHouse	1.55	1.83	1.31	1.56
	(1.00 – 2.36)	(1.11 – 2.84)	(0.77 – 2.12)	(0.87 – 2.61)
Bequest Motives				
Never Married	-	1.00	-	1.00
		(Ref Cat)		(Ref Cat)
Married	-	1.12	-	1.07
		(0.63 – 1.83)		(0.62 – 1.70)
Separated, Widowed, Divorced	-	1.02	-	1.09
		(0.71 – 1.42)		(0.76 – 1.50)
At Least One Child Alive	-	0.73	-	0.73
		(0.47 – 1.08)		(0.48 – 1.07)
Living Alone	-	1.02	-	1.01
		(0.75 – 1.37)		(0.75 – 1.34)
Demographics				
White	-	1.00	-	1.00
		(Ref Cat)		(Ref Cat)
Black#	-	0.67	-	0.73
		(0.44 – 0.98)		(0.48 – 1.04)
Hispanic#	-	0.32	-	0.33
		(0.13 – 0.62)		(0.13 – 0.66)
Other Race#	-	0.55	-	0.60
		(0.20 – 1.17)		(0.21 – 1.25)
Age	-	1.21	-	1.21
		(1.10 – 1.34)		(1.10 – 1.33)
Male	-	1.03	-	1.08
		(0.61 – 1.70)		(0.65 – 1.77)
Education				
Less Than High School	-	1.00	-	1.00
		(Ref Cat)		(Ref Cat)
High School°	-	0.65	-	0.66
		(0.33 – 1.20)		(0.34 – 1.21)
Some College°	-	1.54	-	1.64
		(0.84 – 2.66)		(0.91 – 2.80)
College °	-	1.24	-	1.30
		(0.61 – 2.31)		(0.64 – 2.41)

Figure 1: Timeline for Two-Period Model

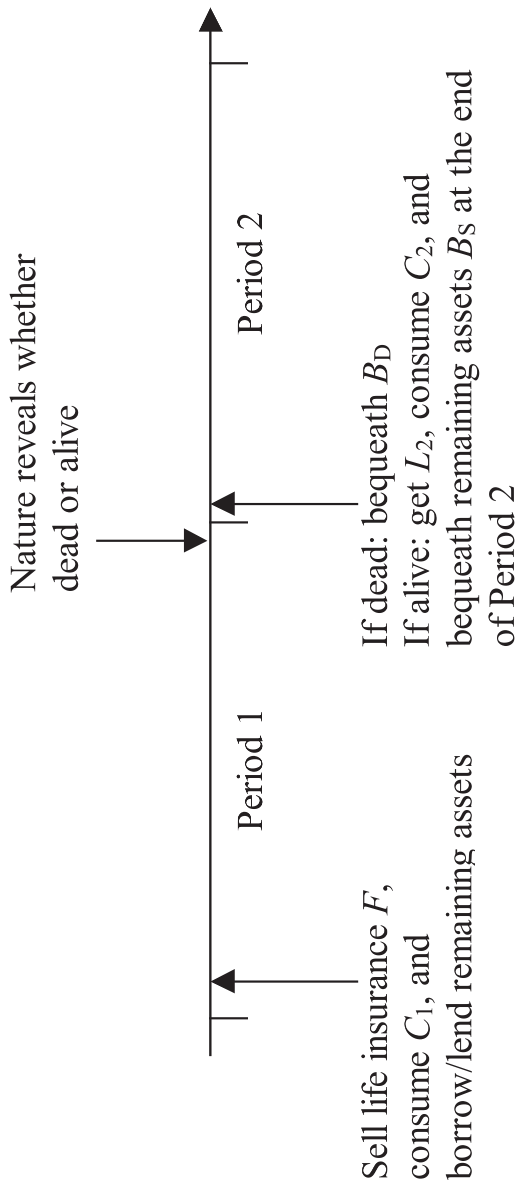

Figure 2: Budget Constraint for H_3 Consumers

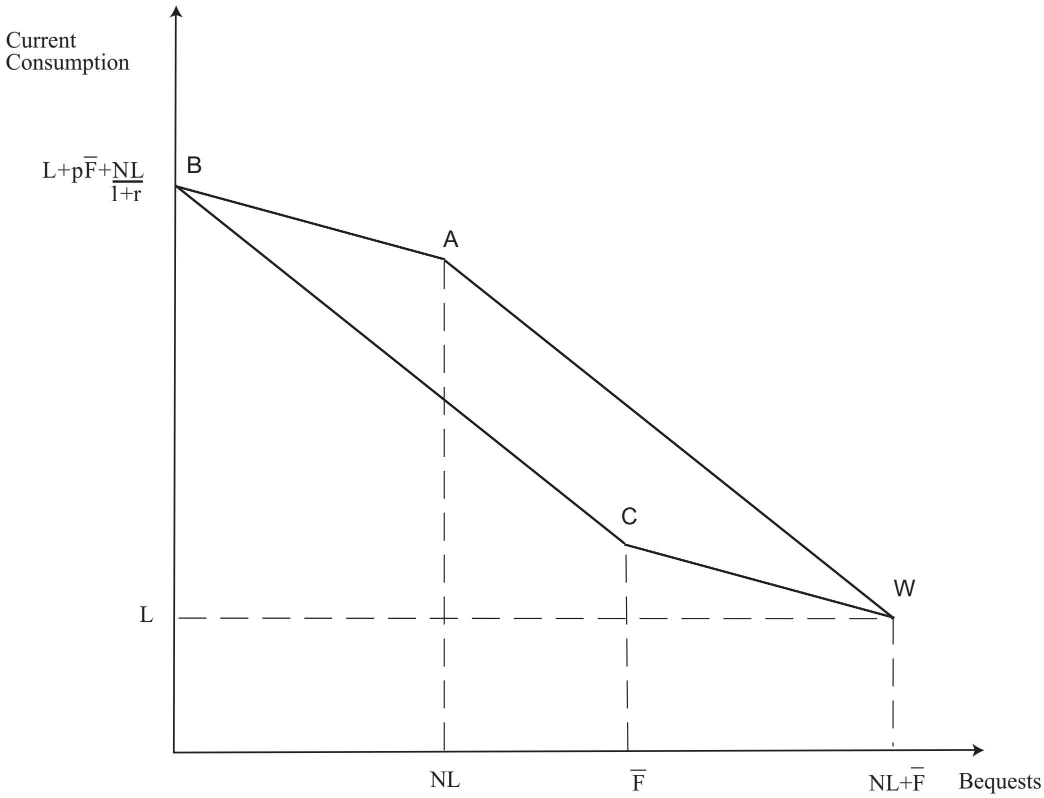

Figure 3: The Effect of Increasing Non-Liquid Assets for H_1 Consumers

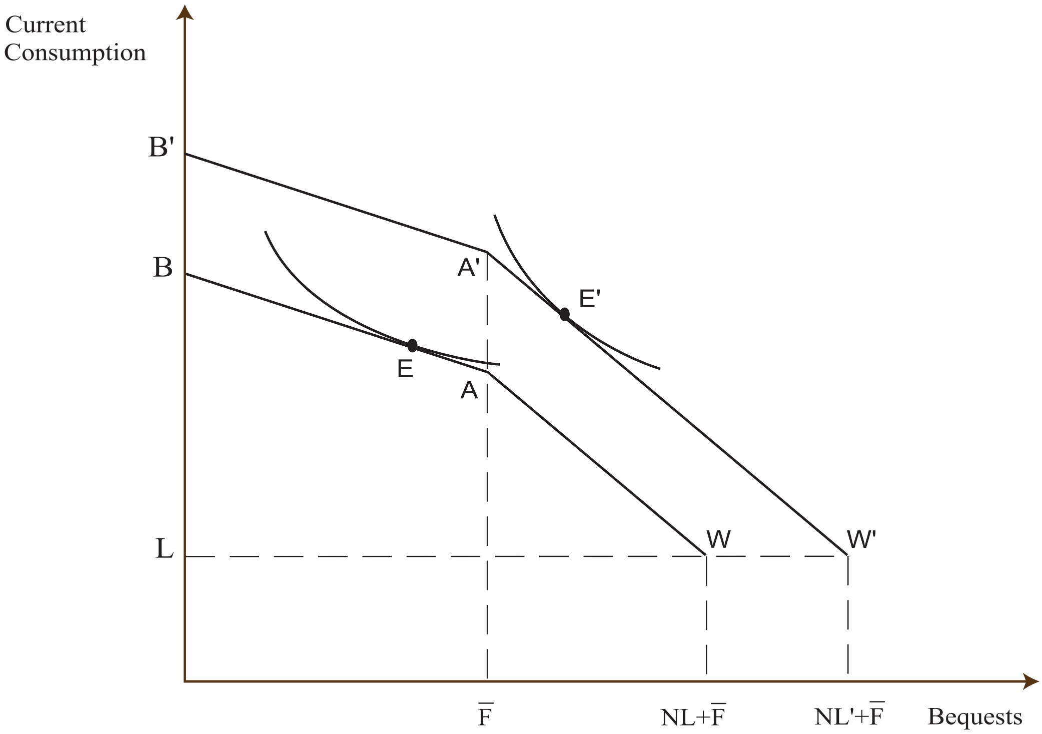

Figure 4: The Effect of Increasing Non-Liquid Assets for H_3 Consumers

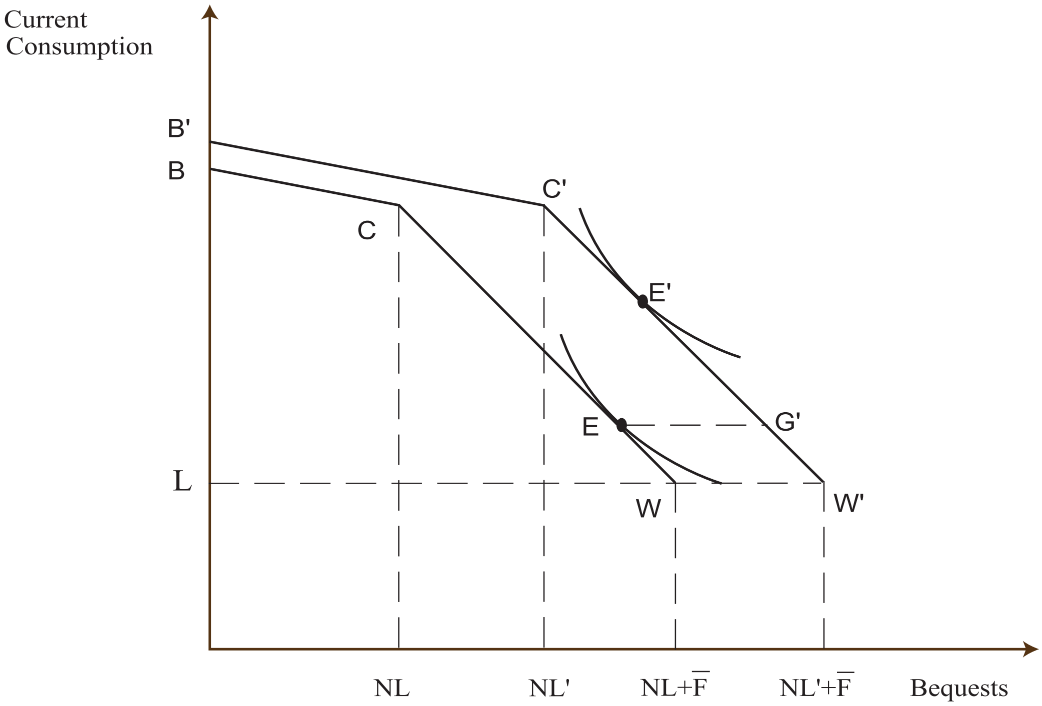

Figure 5: Proportion Not Viaticated by Health Status and House Ownership