MARKET EVIDENCE OF Misperceived Prices and Mistaken Mortality Risks *

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Abstract

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We compare predictions from two models: one with sophisticated, rational consumers, and one with consumers who are misguided about their life expectancy, and use heuristic rules to construct price estimates. Our data are most consistent with the predictions made by the second model, even though transaction prices in these markets are actuarially fair.

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Abstract

We construct and implement a test of rational consumer behavior in a high-stakes financial market. We apply our test to secondary life-insurance markets, where consumers with a life-threatening illness sell their life insurance policies to firms in return for an up-front payment. This secondary life insurance market has been largely ignored by economists, despite its insight into economic behavior.

We compare predictions from two models: one with sophisticated, rational consumers, and one with consumers who are misguided about their life expectancy, and use heuristic rules to construct price estimates. Our data are most consistent with the predictions made by the second model, even though transaction prices in these markets are actuarially fair.
1 Introduction

Making insurance and savings decisions is difficult. Traditional economic models of insurance decisions assume, at a minimum, that consumers can: (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. Our test relies on new data from secondary life insurance markets, where 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 a competitively priced secondary market. 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 an 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

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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 These markets are also worth studying in their own right, since the market is expanding rapidly and “accelerated death benefits” are now included in most life insurance policies.

3 In Bhattacharya, Goldman, and Sood (2003), 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.
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 the psychology and the emerging behavioral economics literatures that are most relevant to our research. Barberis and Thaler (2002), Mullainathan and Thaler (2000), Camerer (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, Skinner, and Weinberg, 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, Slovic, Fischhoff, Layman, and Combs (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, light smokers’ subjective assessment of their probability of surviving to age 75 is marginally lower than the actuarial prediction.

Hurd, McFadden, and Merrill (1999) report a very similar pattern among older populations using data from the AHEAD. For example, 85-89 year-old female respon-
dents’ subjective probability of surviving to age 100 years is 0.30, while the life table value is merely 0.07. By contrast, presumably 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. These data are also consistent with the hypothesis that consumers perceive their mortality risks to be the same as the average mortality risks for their group, but do not know whether their own risks lie above or below the average. For example, heavy smokers perceive their mortality risks to be the same as those of the “average smoker,” and therefore underestimate their own mortality risks. Similarly, HIV+ consumers might perceive their mortality risks to be the same as the average mortality risks for HIV+ persons and therefore those with advanced disease (AIDS) are likely to underestimate their mortality risks. In this paper we use data on secondary life insurance transactions by HIV+ positive consumers to test whether these consumers make systematic mistakes in assessing 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 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. In fact, show that many of the anamolies observed in security markets such as high volatility of prices relative to fundamentals, short term momentum and market overreaction are consistent with two well known psychological biases: investor overconfidence about the precision of private information; and biased self-attribution, which causes asymmetric shifts in investor confidence as a function of their investment outcomes.

Bernheim, Skinner, and Weinberg (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 Model of Sophisticated Consumers

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.4

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 a 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

4The 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).
ance 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 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 $\pi$, 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.

$$B_D = (L_1 + P(\pi) \cdot F - C_1) \cdot (1 + r) + NL + \bar{F} - F$$  \hspace{1cm} (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:

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

We assume that the market for used life insurance is competitive (see note 3 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 $\pi$. 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:

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

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.

\[ EU = U(C_1) + \pi \beta V(B_D) + (1 - \pi) \beta U(C_2) + (1 - \pi) \beta V(B_S) \]  

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 con-
ditions.

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

\[ U'(C_2) = V'(B_S) \]  

\[ V'(B_D) = V'(B_S) \]

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 mar-
ket discount factor. Similarly, equation (7) shows that once the uncertainty about
death is resolved, consumers choose consumption so that the marginal utility of con-
sumption 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 secured 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 \textit{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 \textit{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. Our results show that an increase in mortality risk increases the magnitude of life insurance sales.

\[ \frac{dF}{d\pi} > 0 \]  

(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 the 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.

\[
\frac{dF}{dNL} > 0 \quad (10)
\]

\[
\frac{dF}{dL_1} > 0 \quad (11)
\]

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.

\[
\frac{dF}{dL_2} < 0 \quad (12)
\]

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 Prices

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. Overoptimism on the part 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. For example, if consumers perceive their mortality risks to be the average mortality risks for HIV+ persons, then those with advanced disease (higher than average mortality) would underestimate their mortality risks, and those who are in the early stages of HIV infection would overestimate their mortality risks.

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.\footnote{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.} 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 in this model healthy consumers underestimate their life expectancy, they will perceive actuarially fair discount to face value as being less than actuarially fair. Assuming that the market interest rate for borrowing is the same for everyone, relatively healthy consumers will thus perceive terms of trade to be less lucrative in the viatical settlements market than in the credit market. Similarly, relatively unhealthy consumers will perceive terms of trade to be more lucrative in the viatical settlements 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, $(L, NL + \bar{F})$. $B$ 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. 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 $F$, 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 $F$ 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

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6For $H_1$ 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.
reduce their supply of life insurance. If the income effect is weak, consumers continue
to sell all of \( F \), but reduce borrowing. Hence, for H3 consumers as well, increasing
liquid assets will never increase the supply of life insurance.

5 Comparing Model Predictions

Both the economic model and the misperceived price model make several sharp pre-
dictions 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 in-
creased consumption at the cost of reduced bequests. In contrast, in the misperceived
price model the negative correlation between health status and the decision to viat-
icate 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 misper-
ceived 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). 

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, Goldman, and Sood, 2003). 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.\(^7\) Viators are more likely than never-viators to be male, white, college-educated and older. They

\(^7\) 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.
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, viatarios 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 Probability of Viatricating

HCSUS respondents report whether they sold their life insurance by the first or second
follow-up interview. Because we do not observe quantity sold, our focus is necessarily
on the decision to sell at all. Given these responses, we estimate a logit model of the
decision to viaticate. Since we do not observe the exact date of viatication we include
years at risk as an additional covariate\textsuperscript{8}. Years at risk are measured starting from the
year of diagnosis with HIV, or the vatical settlement inception date–1988–whichever
is earlier to the date of viatication or last interview. All other covariates including
health status and asset ownership are measured at time of the baseline interview.

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

\textsuperscript{8}We also test the sensitivity of the results by estimating a discrete-time hazard model of the
decision to vaticalate that more formally accounts for the time at risk and allows for time varying
covariates. The results from the hazard model are similar to those reported in this paper and are
reported in Appendix B.
and increasing risk of opportunistic infections (Fauci, Braunwald, Isselbacher, Wilson, Martin, Kasper, Hauser, and Longo, 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.

We use the predicted mortality estimates to compute the average mortality risks for HIV+ persons and divide our sample into respondents with above average mortality risks and respondents with low mortality risk. Based upon this division we create two linearly dependent dummy variables, Unhealthy and Healthy, which are our main health status indicators. Thus, if HIV+ consumers perceive their mortality risks to be the same as the average mortality risks for HIV+ persons, then Unhealthy respondents will underestimate mortality risks and Healthy will overestimate mortality risks. Assuming that viatical companies observe both CD4 levels and stage of disease (the mortality predictors in our model) and make actuarially fair price offers based on this information then Unhealthy respondents will perceive terms of trade
to be more lucrative in the viatical settlements market and Healthy respondents will perceive terms of trade to be more lucrative in the credit market.

We experiment with different definitions for Unhealthy and Healthy in other specifications to test the robustness of our results. In particular, we test our results with two alternate definitions—the first specification relaxes assumptions about the firms information set (based on which they make price offers) and the second specification relaxes assumptions about consumers perceived mortality risks.

In the first alternate specification, we assume that firms only observe the stage of disease (AIDS vs. No AIDS) and not CD4 levels. Therefore, consumers with low CD4 levels conditional on stage of disease will no longer get actuarially fair offers as in this model firms cannot observe CD4 levels and thus will overestimate mortality risks for these respondents. Consumers still perceive their mortality risks to be the same as the average mortality risks for HIV+ persons. Thus in this specification those with AIDS will be classified as Unhealthy and these respondents will perceive terms of trade to be more lucrative in the viatical settlements market. On the other hand, respondents with asymptomatic or symptomatic stage of disease will be classified as Healthy and these respondents will perceive terms of trade to be more lucrative in the credit market.

In the second alternate specification, we assume that consumers perceive their mortality risks to be the same as the mortality risks for the “average” HIV+ person with their stage of disease. As in the original specification, firms observe both stage and CD4 levels. In this specification, conditional on stage of disease those with low CD4 levels will perceive terms of trade to be more attractive in the viatical settlements market. Therefore in this specification those with CD4 levels less than or equal to 200 are classified as Unhealthy and those with CD4 levels above 200 are classified as Unhealthy. In contrast to previous models, this model also includes stage of disease as an additional covariate (as consumers use stage of disease to estimate their own
We use house ownership as the measure of non-liquid assets. We designate the indicators for house ownership and non-ownership as \textit{House} and \textit{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: \(1(\text{Income} < $500\text{per month})\), \(1($501 \leq \text{Income} < $2,000)\), and \(1(\text{Income} \geq $2,000)\).

### 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 (\textit{Unhealthy}) and house ownership (\textit{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 \textit{less} likely to viicate to finance consumption, while Prediction 3[E] implies that high income consumers will be \textit{more} likely to viicate.
6.5 Results

Table 4 reports the mean marginal effects for four different specifications of the empirical model. We average the marginal effects 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. Standard errors are computed by the Delta method.

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 probability of vicaticating. Healthy consumers without houses are more likely to viaticate than healthy house owners. In contrast, unhealthy consumers without houses are less likely to viaticate than unhealthy consumers who own a house. The results clearly demonstrate an ordering of the probability of vicatication that is consistent with the misperceived price model. In particular, 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, education and bequest motive variables to Model 1. Whites have significantly higher probability of viaticating than do Blacks, Hispanics, and respondents of other races. Older respondents are significantly more likely to viaticate. There are no statistically significant differences between high school dropouts, high school graduates and college educated respondents in the probability of viaticating, 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 this model 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. In Model 3, respondents with AIDS are classified as Unhealthy and those with less advanced disease (Asymptomatic and Symptomatic) are classified as Healthy. Except for the change in definition of health status, the specification of Models 2 and 3 are identical. As with Models 1 and 2, the estimates from Model 3 are also consistent with the misperceived price model. We find that among the healthy, those with houses are significantly less likely to viaticate than those without, which is consistent with Predictions 2[M], of the misperceived price model.

In Model 4, we assume that respondents perceive their mortality risks to the same as those of the “average” person with their stage of disease. However, viatical firms make price offers based on information about both stage of disease and CD4 levels. Thus in this model we add stage of disease as an additional covariate and those with CD4 levels below 200 are classified as Unhealthy, while those with CD4 levels above 200 are classified as Healthy. The estimates from this model are also consistent with the ordering of the probability of viaticating implied by the misperceived price model. Among unhealthy consumers, those with houses are more likely to viate. Among healthy consumers, those with houses are less likely to viaticate, although in this case the difference in the probability of viation 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 out-
comes 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; it is unobservably sick patients rather than healthier patients who are driven out of the market.

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. Of course, even these efforts may not completely eliminate asymmetric information—patients may still have private information about their health status.

If private information is a concern then we would expect that those who sold were less likely to die in the period after the sale. To check this we estimate a probit model with 2-year mortality as the dependant variable and the decision to sell life insurance and our clinical indicators—CD4 levels and stage of disease—as the explanatory variables. This test is similar in spirit to the test that Cawley and Philipson (1999) use to look for the presence of adverse selection in life insurance markets. In this model, the coefficient on whether a person sold his life insurance was insignificant and had the wrong sign (positive), which suggests that adverse selection is not an important concern in this market.\(^9\)

\(^9\)Results from this model are available upon request from the authors.
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 by more forthright disclosure of mortality risks, or if
buyers in these markets were 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.\textsuperscript{10} 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 repaid 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.

\textsuperscript{10}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.
APPENDIX

A Comparative statics for the economic model

The first order conditions from expected utility maximization are:

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

\[ U'(C_2) = V'(B_S) \]  \hspace{1cm} (A-2)

\[ V'(B_D) = V'(B_S) \]  \hspace{1cm} (A-3)

Rearranging terms and simplifying yields:

\[ U'(C_1) = \beta (1 + r) V'(B_D) \]  \hspace{1cm} (A-4)

\[ U'(C_2) = V'(B_D) \]  \hspace{1cm} (A-5)

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

A.1 Comparative statics with respect to \( \pi \)

Totally differentiating (A-4), (A-5) and (A-6) and setting changes in all exogenous parameters except mortality risks equal to zero implies:
\[\left[U''(C_1) + (1 + r)^2 \beta V''(B_D)\right] dC_1 + \left[r (1 - \pi) \beta V''(B_D)\right] dF = (A-7)\]

\[\left[r F \beta V''(B_D)\right] d\pi\]

\[\left[(1 + r) V''(B_D)\right] dC_1 + \left[\left(\frac{r}{1 + r}\right) U''(C_2) + \left(\frac{r}{1 + r}\right) (1 - \pi) V''(B_D)\right] dF = (A-8)\]

\[\left[\left(\frac{r}{1 + r}\right) F V''(B_D)\right] d\pi\]

Let \(D\) be defined as follows:

\[D = \left[U''(C_1) U''(C_2) \left(\frac{r}{1 + r}\right)\right] + \left[U''(C_1) V''(B_D) (1 - \pi) \left(\frac{r}{1 + r}\right)\right] + \left[V''(B_D) U''(C_2) \beta r (1 + r)\right]\]

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

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

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

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

\[
\left[ U''(C_1) + (1 + r)^2 \beta V''(B_D) \right] dC_1 + r (1 - \pi) \beta V''(B_D) dF = \left[ (1 + r) \beta V''(B_D) \right] dNL
\]  

\[
\left[ (1 + r) V''(B_D) \right] dC_1 + \left[ \left( \frac{r}{1 + r} \right) U''(C_2) + \left( \frac{r}{1 + r} \right) (1 - \pi) V''(B_D) \right] dF = \left[ \left( \frac{r}{1 + r} \right) U''(C_2) + V''(B_D) \right] dNL
\]

Let \( A \) be defined as follows:

\[
A = U''(C_1) \left( V''(B_D) + U''(C_2) \left( \frac{r}{1 + r} \right) \right) + V''(B_D) U''(C_2) \beta r (1 + r)
\]

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

\[
\frac{dF}{dNL} = \frac{A}{D} > 0 \quad (A-13)
\]

\[
\frac{dC_1}{dNL} = \frac{V''(B_D) U''(C_2) \beta \left( \frac{r}{1 + r} \right) (1 + \pi r)}{D} > 0 \quad (A-14)
\]
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:

\[
\left[ U''(C_1) + (1 + r)^2 \beta V''(B_D) \right] dC_1 + \\
\left[ r (1 - \pi) \beta V''(B_D) \right] dF = \\
\left[ (1 + r)^2 \beta V''(B_D) \right] dL_1
\]  

\[
\left[ (1 + r) V''(B_D) \right] dC_1 + \\
\left[ \left( \frac{r}{1 + r} \right) U''(C_2) + \left( \frac{r}{1 + r} \right) (1 - \pi) V''(B_D) \right] dF = \\
\left[ (1 + r) V''(B_D) \right] dL_1
\]

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

\[
\frac{dF}{dL_1} = \frac{U''(C_1) V''(B_D) (1 + r)}{D} > 0
\]  

\[
\frac{dC_1}{dL_1} = \frac{U''(C_2) V''(B_D) \beta r (1 + r)}{D} > 0
\]

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:
\[ \left[ U''(C_1) + (1 + r)^2 \beta V''(B_D) \right] dC_1 + 
\]
\[ r (1 - \pi) \beta V''(B_D) dF = 
\]
\[ [0] dL_2 \]

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

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

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

\[ \frac{dC_1}{dL_2} = \frac{U''(C_2) V''(B_D) \beta r (1 - \pi)}{D} > 0 \]  \hspace{1cm} (A-24)
B A Discrete-Time Model of the Hazard of Vicaticating

HCSUS respondents report whether they sold their life insurance by the first or second follow-up interview. Given these responses, we estimate an discrete time hazard 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. This model serves as a check of the probit results that we present in section 6.5.

B.1 Empirical Model

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 viicate between the start date and FU1 but did viicate 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:

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

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 viatating as,

\[ \lambda_i (t) = \frac{1}{1 + \exp(\lambda_0^t + X_{it} \beta)} \]  \( \text{(B-2)} \)

where, \( X_{it} \) is a vector of covariates measured at time \( t \), \( \beta \) is the vector of regression coefficients, and \( \frac{1}{1 + \exp(\lambda_0^t)} \) is the baseline logit hazard rate. We maximize the likelihood function (B-1) with respect to the parameters \( \lambda_0^t \) and \( \beta \).

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

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

**B.2 Results**

Table 5 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. We use monte-carlo simulations to compute standard errors. The regression specifications are identical to those reported in Table 4.

The results are similar to those reported in Table 4 and clearly demonstrate 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.
References


Table 1: Weighted Descriptive Statistics at Baseline

<table>
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<tr>
<th>Variables</th>
<th>Never sold life insurance (N=740)</th>
<th>Ever sold life insurance (N=146)</th>
<th>Entire sample (N = 886)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>CD4 T-cell levels:</strong></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>&lt; 50 cells per ml</td>
<td>9.36%</td>
<td>12.08%</td>
<td>9.83%</td>
</tr>
<tr>
<td>50 – 200 cells per ml</td>
<td>21.68%</td>
<td>40.00%</td>
<td>24.84%</td>
</tr>
<tr>
<td>201 – 500 cells per ml</td>
<td>43.32%</td>
<td>31.40%</td>
<td>41.26%</td>
</tr>
<tr>
<td>&gt; 500 cells per ml</td>
<td>25.64%</td>
<td>16.52%</td>
<td>24.07%</td>
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<tr>
<td><strong>Disease Stage:</strong></td>
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</tr>
<tr>
<td>Asymptomatic</td>
<td>10.93%</td>
<td>11.85%</td>
<td>11.09%</td>
</tr>
<tr>
<td>Symptomatic</td>
<td>54.37%</td>
<td>38.61%</td>
<td>51.64%</td>
</tr>
<tr>
<td>AIDS</td>
<td>34.70%</td>
<td>49.54%</td>
<td>37.26%</td>
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<tr>
<td><strong>Income and Assets:</strong></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>House ownership</td>
<td>29.38%</td>
<td>33.57%</td>
<td>30.11%</td>
</tr>
<tr>
<td>Monthly Income</td>
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<tr>
<td>&lt; $500</td>
<td>15.81%</td>
<td>13.57%</td>
<td>15.42%</td>
</tr>
<tr>
<td>$501 - $2000</td>
<td>39.85%</td>
<td>38.73%</td>
<td>39.66%</td>
</tr>
<tr>
<td>&gt; $2000</td>
<td>44.34%</td>
<td>47.70%</td>
<td>44.92%</td>
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<tr>
<td><strong>Bequest Motives:</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Any Children Alive</td>
<td>37.82%</td>
<td>29.18%</td>
<td>36.32%</td>
</tr>
<tr>
<td>Married</td>
<td>16.01%</td>
<td>12.30%</td>
<td>15.37%</td>
</tr>
<tr>
<td>Separated, Divorced, Widowed</td>
<td>25.55%</td>
<td>28.06%</td>
<td>25.98%</td>
</tr>
<tr>
<td>Never Married</td>
<td>58.44%</td>
<td>59.64%</td>
<td>58.64%</td>
</tr>
<tr>
<td><strong>Demographics:</strong></td>
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<td></td>
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</tr>
<tr>
<td>Age</td>
<td>34.88 years</td>
<td>38.01 years</td>
<td>35.42 years</td>
</tr>
<tr>
<td>Male</td>
<td>84.19%</td>
<td>89.35%</td>
<td>85.08%</td>
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<tr>
<td>Black</td>
<td>25.41%</td>
<td>17.32%</td>
<td>24.01%</td>
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<tr>
<td>Hispanic</td>
<td>13.61%</td>
<td>4.18%</td>
<td>11.98%</td>
</tr>
<tr>
<td>White</td>
<td>56.68%</td>
<td>75.97%</td>
<td>60.01%</td>
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<tr>
<td>Other race</td>
<td>4.30%</td>
<td>2.53%</td>
<td>3.99%</td>
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<tr>
<td>Have college degree</td>
<td>24.52%</td>
<td>36.38%</td>
<td>26.57%</td>
</tr>
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</table>
Table 2: One-Year Mortality Probit Regression

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Standard Error</th>
</tr>
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<tbody>
<tr>
<td>CD4 T-cell &lt; 50</td>
<td>1.40</td>
<td>0.39</td>
</tr>
<tr>
<td>CD4 T-cell 51-200</td>
<td>0.50</td>
<td>0.39</td>
</tr>
<tr>
<td>CD4 T-cell 201-500</td>
<td>0.32</td>
<td>0.38</td>
</tr>
<tr>
<td>CD4 T-cell 500+*</td>
<td>-</td>
<td>-</td>
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<tr>
<td>Asymptomatic</td>
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<td>0.47</td>
</tr>
<tr>
<td>Symptomatic</td>
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</tr>
<tr>
<td>AIDS*</td>
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</tr>
<tr>
<td>Intercept</td>
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*Reference categories
Table 3: Hypotheses

<table>
<thead>
<tr>
<th>Prediction</th>
<th>Test†</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Misperceived price Model</strong></td>
<td></td>
</tr>
</tbody>
</table>
| Prediction 1: Negative correlation between health status and the decision to viaticate. | Pr(Sell | Unhealthy, House) > Pr(Sell | Healthy, House)  
Pr(Sell | Unhealthy, NoHouse) > Pr(Sell | Healthy, NoHouse) |
| Prediction 2a: Among healthy consumers, negative correlation between the decision to viaticate and the amount of non-liquid assets | Pr(Sell | Healthy, House) < Pr(Sell | Healthy, No House)* |
| Prediction 2b: Among unhealthy consumers, a positive correlation between the decision to viaticate and the amount of non-liquid assets | Pr(Sell | Unhealthy, House) > Pr(Sell | Unhealthy, No House) |
| Prediction 3: Zero or negative correlation between liquid assets and the decision to viaticate | Pr(Sell | Income $2000+) ≤ Pr(Sell | Income $500 to $2000)  
≤ Pr(Sell | Income below $500) |
| **Economic Model** | | 
| Prediction 1: Negative correlation between health status and the decision to viaticate. | Pr(Sell | Unhealthy, House) > Pr(Sell | Healthy, House)  
Pr(Sell | Unhealthy, NoHouse) > Pr(Sell | Healthy, NoHouse) |
| Prediction 2a: Among healthy consumers, positive correlation between the decision to viaticate and the amount of non-liquid assets | Pr(Sell | Healthy, House) > Pr(Sell | Healthy, No House)* |
| Prediction 2b: Among unhealthy consumers, a positive correlation between the decision to viaticate and the amount of non-liquid assets | Pr(Sell | Unhealthy, House) > Pr(Sell | Unhealthy, No House) |
| Prediction 3: Positive correlation between liquid assets and the decision to viaticate | Pr(Sell | Income $2000+) > Pr(Sell | Income $500 to $2000)  
> Pr(Sell | Income below $500) |

† Pr(Sell | ) is the probability of selling (viaticating) life insurance.
Table 4: Empirical Models of the Probability of Viaticating

<table>
<thead>
<tr>
<th>Variables</th>
<th>Model (1)</th>
<th>Model (2)</th>
<th>Model (3)</th>
<th>Model (4)</th>
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<tr>
<td><strong>Income</strong></td>
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<td></td>
</tr>
<tr>
<td>Income (500,2000]</td>
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<td>[0.041]</td>
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<td><strong>Health and House Ownership</strong></td>
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<td><strong>Observations</strong></td>
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<td>886</td>
<td>886</td>
<td>886</td>
</tr>
</tbody>
</table>

Coefficients are mean marginal effects. Standard errors in brackets.
* significant at 10%; ** significant at 5%;
Reference Categories are Income < 500; Healthy*House; Never Married; White; Less than high school; Asymptomatic
Table 5: Results of Discrete Time Models of the Hazard of Viaticating

<table>
<thead>
<tr>
<th>Variables</th>
<th>Model 1</th>
<th>Model 2</th>
<th>Model 3</th>
<th>Model 4</th>
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</thead>
<tbody>
<tr>
<td>Income</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Income &lt; $500</td>
<td>1.00 (Ref Cat)</td>
<td>1.00 (Ref Cat)</td>
<td>1.00 (Ref Cat)</td>
<td>1.00 (Ref Cat)</td>
</tr>
<tr>
<td>Income $500 – $2000</td>
<td>1.08 (0.69 – 1.64)</td>
<td>1.00 (Ref Cat)</td>
<td>0.90 (0.55 – 1.43)</td>
<td>0.92 (Ref Cat)</td>
</tr>
<tr>
<td>Income &gt; $2000</td>
<td>1.42 (0.91 – 2.14)</td>
<td>1.02 (0.60 – 1.64)</td>
<td>0.98 (0.57 – 1.58)</td>
<td>0.99 (0.59 – 1.61)</td>
</tr>
<tr>
<td>House ownership and Health Status</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Healthy*House</td>
<td>1.00 (Ref Cat)</td>
<td>1.00 (Ref Cat)</td>
<td>1.00 (Ref Cat)</td>
<td>1.00 (Ref Cat)</td>
</tr>
<tr>
<td>Unhealthy*House</td>
<td>3.90 (2.37 – 6.24)</td>
<td>4.35 (2.50 – 7.13)</td>
<td>3.08 (1.75 – 5.10)</td>
<td>3.17 (1.77 – 5.36)</td>
</tr>
<tr>
<td>Unhealthy*NoHouse</td>
<td>2.16 (1.31 – 3.41)</td>
<td>2.46 (1.39 – 4.03)</td>
<td>2.07 (1.14 – 3.43)</td>
<td>2.61 (1.50 – 4.32)</td>
</tr>
<tr>
<td>Healthy*NoHouse</td>
<td>1.55 (1.00 – 2.36)</td>
<td>1.83 (1.11 – 2.84)</td>
<td>1.91 (1.09 – 3.12)</td>
<td>1.46 (0.86 – 2.34)</td>
</tr>
<tr>
<td>Bequest Motives</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Never Married</td>
<td>-</td>
<td>1.00 (Ref Cat)</td>
<td>1.00 (Ref Cat)</td>
<td>1.00 (Ref Cat)</td>
</tr>
<tr>
<td>Married</td>
<td>-</td>
<td>1.12 (0.63 – 1.83)</td>
<td>1.15 (0.65 – 1.84)</td>
<td>1.09 (0.63 – 1.74)</td>
</tr>
<tr>
<td>Separated, Widowed, Divorced</td>
<td>-</td>
<td>1.02 (0.71 – 1.42)</td>
<td>1.04 (0.73 – 1.45)</td>
<td>1.07 (0.75 – 1.48)</td>
</tr>
<tr>
<td>Atleast One Child Alive</td>
<td>-</td>
<td>0.73 (0.47 – 1.08)</td>
<td>0.73 (0.47 – 1.08)</td>
<td>0.68 (0.44 – 1.00)</td>
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<tr>
<td>Living Alone</td>
<td>-</td>
<td>1.02 (0.75 – 1.37)</td>
<td>1.01 (0.74 – 1.35)</td>
<td>0.98 (0.72 – 1.32)</td>
</tr>
<tr>
<td>Demographics</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>White</td>
<td>-</td>
<td>1.00 (Ref Cat)</td>
<td>1.00 (Ref Cat)</td>
<td>1.00 (Ref Cat)</td>
</tr>
<tr>
<td>Black#</td>
<td>-</td>
<td>0.67 (0.44 – 0.98)</td>
<td>0.69 (0.45 – 0.99)</td>
<td>0.71 (0.47 – 1.04)</td>
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<tr>
<td>Hispanic#</td>
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<td>0.32 (0.13 – 0.62)</td>
<td>0.32 (0.13 – 0.66)</td>
<td>0.33 (0.12 – 0.67)</td>
</tr>
<tr>
<td>Other Race#</td>
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<td>0.62 (0.21 – 1.31)</td>
<td>0.59 (0.21 – 1.23)</td>
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<tr>
<td>Age</td>
<td>-</td>
<td>1.21 (1.10 – 1.34)</td>
<td>1.22 (1.11 – 1.35)</td>
<td>1.20 (1.09 – 1.33)</td>
</tr>
<tr>
<td>Male</td>
<td>-</td>
<td>1.03 (0.61 – 1.70)</td>
<td>1.08 (0.65 – 1.77)</td>
<td>1.01 (0.60 – 1.64)</td>
</tr>
<tr>
<td>Education</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Less Than High School</td>
<td>-</td>
<td>1.00 (Ref Cat)</td>
<td>1.00 (Ref Cat)</td>
<td>1.00 (Ref Cat)</td>
</tr>
<tr>
<td>High Schoolº</td>
<td>-</td>
<td>0.65 (0.33 – 1.20)</td>
<td>0.64 (0.33 – 1.17)</td>
<td>0.59 (0.29 – 1.08)</td>
</tr>
<tr>
<td>Some Collegeº</td>
<td>-</td>
<td>1.54 (0.84 – 2.66)</td>
<td>1.55 (0.84 – 2.66)</td>
<td>1.65 (0.93 – 2.76)</td>
</tr>
<tr>
<td>College º</td>
<td>-</td>
<td>1.24 (0.61 – 2.31)</td>
<td>1.24 (0.60 – 2.30)</td>
<td>1.23 (0.62 – 2.23)</td>
</tr>
<tr>
<td>Stage of Disease</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Asymptomatic</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1.00 (Ref Cat)</td>
</tr>
<tr>
<td>Symptomatic</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0.59 (Ref Cat)</td>
</tr>
<tr>
<td>AIDS</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0.68 (0.39 – 0.88)</td>
</tr>
</tbody>
</table>

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Figure 1: Timeline for Two-Period Model

Period 1
Sell life insurance $F$, consume $C_1$, and borrow/lend remaining assets

If dead: bequeath $B_D$
If alive: get $L_2$, consume $C_2$, and bequeath remaining assets $B_S$ at the end of Period 2

Nature reveals whether dead or alive

Period 2
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