Preference Heterogeneity and Insurance Markets

David M. Cutler, Harvard University and NBER

Amy Finkelstein, MIT and NBER

Kathleen McGarry, UCLA and NBER

January 2006

Abstract

Standard theories of insurance, dating from Rothschild and Stiglitz (1976), stress the role of adverse selection in explaining the decision to purchase insurance. In these models, higher risk people buy full or near-full insurance, while lower risk people buy less complete coverage, if they buy at all. While this prediction appears to hold in some real world insurance markets, including health insurance, in many others, such as life insurance, it is the lower risk individuals who have more insurance coverage. We consider a simple extension to the standard model in which individuals vary in their risk tolerance as well as risk type, with those with lower tolerance for risk becoming endogenously lower risk through investment in risk reducing activities. Depending on whether this behavioral effect dominates the standard asymmetric information effect, we may see higher or lower risk individuals purchasing insurance in equilibrium. We provide an empirical example from the U.S. life insurance industry in which patterns of insurance coverage are consistent with the preference heterogeneity model. Specifically, we show that individuals who engage in risky behavior are both systematically higher risk (higher mortality) and less likely to purchase insurance. We discuss the implications of preference heterogeneity for the existence, nature and empirical detection of inefficiencies in insurance markets.

We are grateful to the National Institutes on Aging for research support.

1. Introduction

The textbook approach to insurance markets emphasizes the role of adverse selection in determining who purchases insurance. In the classic adverse selection models of Akerlof (1970) and Rothschild and Stiglitz (1976), the high risk buy more insurance than the low risk, who may be out of the market entirely. This basic prediction of asymmetric information models has been shown to be robust to a variety of extensions to the standard framework (Chiappori and Salanie 2000, Chiappori et al. forthcoming). And evidence that is consistent with it has been found in several insurance markets, particularly health insurance and annuities.

In practice, however, in many insurance markets it is the lower risk who buy more insurance, or at least the insured have the same risk profile as the general population. This phenomenon appears in both large insurance markets such as life insurance and automobile insurance, and in extremely thin markets such as long-term care insurance or reverse mortgage insurance. This discrepancy between theory and reality is even more striking given that – even in the absence of adverse selection – moral hazard would tend to make the insured higher risk than the uninsured.

The pronounced differences across insurance markets in the sign of the relationship between risk type and insurance coverage motivates the analysis in this paper. We offer a simple extension to the standard insurance model in which individuals vary in their risk tolerance as well as their risk type, and individuals with lower tolerance for risk invest more in risk-reducing activities, thereby endogenously lowering their risk type. In this setting, more risk averse individuals engage in more risk reducing behavior; more risk averse individuals may therefore both be lower risk and have higher values of insurance than less risk averse individuals. The resulting equilibrium relationship between insurance coverage and risk depends on the relative strength of this behavioral effect in comparison to the standard adverse selection and moral hazard effects.

Evidence from the various insurance markets discussed above suggests that the behavioral offset is often at least as large as standard adverse selection. Both Cohen and Einav (2005) in their study of the automobile insurance market and Finkelstein and McGarry (forthcoming) in their work on long-term care insurance argue that preference heterogeneity is quantitatively more important than heterogeneity over unpriced risk in explaining equilibrium insurance holdings.

We provide empirical evidence on the pattern of life insurance holdings in the United States that are consistent with the preference heterogeneity model. Life insurance is one of the largest private insurance markets in the world. It is also a market that in which the risk pattern of ownership has puzzled economists. The market does not exhibit higher ownership rates among higher risk individuals, as standard adverse selection or moral hazard models would predict (Cawley and Philipson, 1999). Nor does variability in financial exposure explain ownership patterns (Bernheim et al. 2003a 2003b). Our empirical results suggest that heterogeneity in risk tolerance can provide a sensible explanation for the observed patterns of coverage. Specifically, we find that individuals who engage in more risky behavior are both higher mortality risk and less likely to purchase insurance.

The remainder of the paper proceeds as follows. Section two briefly summarizes the empirical literature on the relationship between risk type and insurance coverage in six different individual insurance markets. Section three sketches a stylized model that illustrates how preference heterogeneity can affect insurance market equilibria. The model is a simplified version of more formal analysis by de Meza and Webb 2001, Jullien et al., 2002, and Chiappori et al., forthcoming. Section four presents empirical evidence from the U.S. life insurance market that is consistent with the model. In Section five we explore some of the implications of incorporating preference heterogeneity for the efficiency of insurance market equilibria as well as for detecting asymmetric information. There is a brief concluding section.

2. Risk Type and Insurance Purchase in Different Insurance Markets

A large (and growing) empirical literature has investigated the relationship between risk type and insurance coverage in many different insurance markets. This section briefly summarizes that literature. Overall, the evidence suggests a surprising amount of agreement on the relation between risk type and insurance purchase among papers looking within the same market (even across different countries).

However, clear differences emerge *across* insurance markets concerning the relative risk type of those with more insurance compared to those with less insurance. These disparities motivate the subsequent analysis in the paper.

Most of this literature is motivated by testing the predictions of standard models of asymmetric information. Cawley and Philipson (1999) and Chiappori and Salanie (2000) point out that a prediction of many models of asymmetric information is that, conditional on information that is known about and priced by the insurance company, individuals who are higher risk along unobserved dimensions will buy more insurance. Such a relationship could occur because of either adverse selection or moral hazard. With adverse selection, individuals who have private information that they are higher risk than the insurance company expects self-select into more comprehensive insurance contracts; with moral hazard the causality is reversed and individuals who buy more insurance face a lower marginal cost of accidents ex-post and therefore engage in more risky behavior.

Conditioning on the characteristics used in pricing insurance is crucial for examining the predictions of these asymmetric information models, as the predictions are about how people behave *conditional* on the menu of contracts they face. However, for the preference heterogeneity model that we develop below, the unconditional relationship between insurance and risk occurrence is also of considerable – and arguably greater – interest. The goal of our analysis is not to test for the presence or absence of private information about risk type per se, but rather to consider how preference heterogeneity mediates the insurance – risk type relationship through its impacts on risky behavior and on insurance valuation; in this model risk type itself is at least partially endogenous and a function of risk preferences, so it is less obvious that characteristics related to risk type should be controlled for. We therefore present evidence for the conditional and unconditional relationship between insurance coverage and risk occurrence in the existing literature, where available. Interestingly, the conditional and unconditional relationships are almost always of the same sign.

We consider the relationship between risk type and insurance coverage in six different insurance markets for individuals: acute health care insurance, annuities, life insurance, automobile insurance, long-term health care insurance, and reverse mortgages.[1] In all cases, there is evidence from the US market, and often from other developed countries including Canada, France, Israel, Japan and the United Kingdom.

These six markets vary on a number of dimensions. Some, such as life, acute health care and auto insurance are extremely thick, with most or all of the relevant population having at least some private insurance coverage. Others, such as annuities, long-term health care insurance and reverse mortgages cover only a tiny proportion of the at-risk population. In some markets, such as acute health care insurance, there is evidence of quantitatively important moral hazard (see Cutler and Zeckhauser for a review of the literature), while in others such as long-term health care the evidence suggests no substantively important moral hazard effects (Grabowski and Gruber, 2005).[2] Finally, these markets vary considerably in the amount of direct government regulation and/or public provision of insurance. On one extreme, the life insurance market is almost entirely free from government intervention; on the other, automobile and health insurance markets are both highly regulated and feature substantial direct government provision (or mandated purchase). We comment on these factors as appropriate.

Table 1 presents our summary of the evidence from the literature on the relative risk type of those who buy more insurance in these six different insurance markets. The first product we consider is acute care health insurance. This insurance decision is only relevant for people in the US, as acute care insurance is universal in all other developed countries. In the population as a whole, selection is unclear. The insured are older than the uninsured, but they self-report their health status as being better (Cardon and Hendel, 2001). Controlling for factors that can be priced (age, gender, and location of residence), Cardon and Hendel show that there is neither favorable nor adverse selection. Within an employment setting, prices are generally not allowed to vary with individual characteristics. In that environment, adverse selection is rampant. Those with higher expected spending – whether based on observables or

[1] There are also many insurance markets for business, but these have not, to our knowledge, been the subject of similar empirical analyses.
[2] Finkelstein and Poterba (2004) argue that moral hazard effects in annuity markets are also likely to be quantitatively small, although no direct empirical evidence exists.

unobservables – are more likely to buy insurance than those with lower expected spending (see Cutler and Zeckhauser, 2000, for a review). They also buy more generous spending when they do buy.

The second product we consider is annuities, contracts which provide a life-contingent steam of payments in exchange for a lump sum up-front payment. Annuities insure against living beyond one's resources, and thus are more valuable for people with greater variance of age of death. Evidence from annuity markets in several different countries – including the U.S., the U.K., and Japan – is consistent with this prediction. Higher longevity, and thus higher risk, individuals are more likely to own an annuity, and to own larger annuities, than lower longevity, and thus lower risk, people.

While acute care health insurance and annuities present evidence consistent with the standard adverse selection explanation, the evidence from the other four insurance markets suggests that those with more insurance are more likely to be lower risk than those with less insurance, or for risk type to be independent of insurance coverage. Consider life insurance first.[3] Since the primary reason to have life insurance is to insure one's heirs against the possibility of economic loss in the event of early death, the high risk population for life insurance is the population with high expected mortality. But evidence from several countries – including again the U.S., the U.K., and Japan – suggests that lower risk (i.e. lower mortality) individuals are no less likely than higher mortality individuals to own life insurance, and they may even be more likely to be insured.

The life insurance and annuities markets are related. Those with a longer expected lifespan should value annuities more and life insurance less. In practice, people with longer expected survival are more likely to own both types of insurance – we argue because they are more risk averse as a whole.

In automobile insurance, most of the evidence suggests that there is no correlation between insurance coverage and the frequency of automobile accidents. Similarly, in the U.S. long-term care insurance market – which primarily covers expenditures for nursing home care among the elderly – the evidence

[3] Throughout the paper, we refer implicitly to term life insurance, since whole life insurance has a savings component as well.

again suggests that those with long-term care insurance are about the same risk as those without long-term care insurance.

The final market we examine is reverse mortgages. Reverse mortgages provide an individual with a stream of payments as long as the individual remains in their house. A high risk individual is therefore one that has a low chance of dying or of moving houses. In the (very small) U.S. market for reverse mortgages, the evidence in Davidoff and Welke (2005) suggests advantageous selection: people who will stay in their house for a long time, and thus would do well with a reverse mortgage, take out such mortgages less frequently than those who will be in their house less long.

As a whole, there is thus no clear pattern in adverse selection. In some markets, selection is adverse, and strongly so. In other markets, selection is largely favorable. And in a few markets, there does not appear to be either adverse or favorable selection. The fundamental question is how to explain these differing outcomes. The next section presents a theory for this, focusing on variation in risk tolerance as well as risk type.

3. Incorporating preference heterogeneity into the theory of insurance

In this section we develop a simple model that incorporates heterogeneity in risk tolerance in addition to risk type. The basic features of the model are similar to that in Rothschild and Stiglitz (1976). Individuals face a risk of loss, m, with probability p_i. We think of m as the cost of medical care in the event of an illness, or of fixing the car if the individual has an accident. For expositional purposes, we simplify the analysis by assuming there is an (exogenously determined) choice of whether to buy an insurance policy that reimburses m in the amount of a loss.[4] We bypass moral hazard in this analysis by

[4] Deriving the structure of contracts available endogenously – as is done in the standard asymmetric information models such as Rothschild and Stiglitz (1976) – is substantially more complicated with heterogeneity in risk aversion as well as risk type, as the single crossing property no longer holds. Several recent papers have solved formally for the equilibrium when there are with multiple dimensions of heterogeneity (Smart 2000, Wambach 2000) and in several cases when there are potentially endogenous risk type as well (de Meza and Webb 2001, Jullien et al. 2002).

assuming *m* is constant. The (equilibrium) price of insurance is determined endogenously by the risk type of insured individuals, coupled with a zero-profit, competitive insurance market.

There is a fixed load $(F \geq 0)$ on insurance, which may be thought of as the processing cost of insurance. The presence of a load is important, since, as we will see, without it we could never observe a situation in which low risk individuals purchased a policy while high risk individuals did not (under either symmetric or asymmetric information). Empirically, non-trivial loads are a realistic feature of most insurance markets. For example, estimates suggest that loads in the group health insurance market range from 5 percent for large firms to 30 percent or more for small firms (Newhouse 2002). Loads on annuities purchased by 65 year olds are in the range of 12 to 15 percent in both the US and the UK (Brown, Mitchell and Poterba 2002, Finkelstein and Poterba 2002). Average loads for a 65 year old for long-term care insurance in the U.S. are about 18 percent, but can be as high as 50 to 75 percent for some groups (Cutler 1996, Brown and Finkelstein 2004).

3.1 Equilibrium with symmetric information

We consider first the benchmark model with symmetric information, and thus person-specific actuarial pricing on the margin. If individual *i* chooses not to buy insurance, his expected utility is given by

(1) $EU_{Ni} = (1 - p_i)U_i(y) + p_iU_i(y - m)$

where y is his income and U_i is his sub-utility function. Note that we allow individuals to differ potentially not only in their risk type (p_i) but also in their preferences (U_i). We will parameterize this shortly as differences in risk aversion. If the individual instead buys the insurance policy, his expected utility is given by

(2) $EU_{Ii} = U_i(y - \pi_i)$

where π_i is the individual-specific actuarially fair premium with break-even load; $\pi_i = p_im + F$.

We define the (monetized) value of insurance (V_{Ii}) as the difference between certainty equivalent income (C_{Ii}) with insurance and certainty equivalent income without insurance (C_{Ni}). Trivially, C_{Ii} is given by $y - \pi_i$. C_{Ni} is defined implicitly by $U_i(C_{Ni}) = EU_{Ni}$. We assume a constant absolute risk aversion (CARA) utility function, with a coefficient of absolute risk aversion $\varphi_i > 0$. This gives us

(3) $C_{Ni} = y - p_i m - 0.5\varphi_i \sigma_i^2$

where σ_i^2 is the variance of income without insurance.[5] The (monetized) value of insurance (V_{Ii}) is therefore

(4) $V_{Ii} = C_{Ii} - C_{Ni} = 0.5\varphi_i \sigma_i^2 - F$

Equation (4) has a transparent interpretation. The value of insurance relative to no insurance is increasing in the individual's risk aversion (φ_i), and in the variance of his income without insurance (σ_i^2). The value of insurance is decreasing in the fixed load (F) the individual must pay for the insurance. Equation (4) yields the following purchase decision:

(5) Buy if and only if $0.5\varphi_i \sigma_i^2 - F > 0$

This makes clear the importance of a load. Without a load, as long as everyone is somewhat risk averse ($\varphi > 0$), everyone will buy insurance.

Without preference heterogeneity, (i.e. $\varphi_i = \varphi$ is the same for all individuals) equation (5) indicates that the decision to purchase insurance is increasing in the variance of income without insurance (σ_i^2): people facing greater risks will be more likely to buy insurance. In our simple model in which the size of the loss *m* is the same for all risk types, this variance is equal to $p_i(1 - p_i)m^2$. As long as the probability of loss is not too high (specifically, as long as $p_i < 0.5$), the variance of income without insurance is increasing in risk type (p_i), and therefore the higher risk will buy insurance more than the lower risk; of course if

[5] Equation (3) is an approximation under other utility functions.

$p_i > 0.5$ then the variance of income without insurance is decreasing in mean risk type, and the lower risk will be insurance more than the higher risk. In general, for the insurance markets discussed in section two, it is likely to be a reasonable assumption that the mean and variance of uninsured income are positively related; we discuss this in more detail in the next subsection. This suggests that a symmetric information model with homogenous preferences will lead to a positive correlation between risk type and insurance coverage.

3.2 Incorporating Preference Heterogeneity

Equation (5) shows clearly that heterogeneity in preferences will affect the equilibrium. People that are more risk averse will be more likely to buy insurance, holding the distribution of losses constant. One could imagine a situation where both preferences and risks were heterogeneous, and each was determined exogenously (as might be the case with certain genetic diseases). In this case, risk type and risk preferences might well be uncorrelated and therefore the positive correlation between risk type and insurance purchase would be unchanged.

However, it is likely to be the case that there is in fact a feedback from risk preferences into risk type, through behaviors that individuals undertake. Suppose that people can take an action *a* that reduces their probability of a suffering a loss. i.e., $p_i = p(a_i)$, where $p' < 0$. In the life insurance or acute health care context, for example, *a* might be quitting smoking or losing weight. In the case of automobile insurance, *a* includes reducing driving speed and paying more attention to the road. The cost of this action is $c(a)$, where $c(0) = 0$, $c' > 0$ and $c'' > 0$. The increasing marginal cost of risk reducing behavior seems a natural assumption.

There are two benefits of undertaking such an action. The first is that it lowers insurance premiums. The financial benefit to undertaking behavior da is $(p' m)\, da$, while the cost is $c'\, da$. People will thus invest in prevention until $p' m = c'$. If the benefits were entirely monetary, the equilibrium investment will be the same for everyone, assuming that the costs of behavioral change are the same.

But there are likely to be non-monetary benefits as well. There is reduced quality of life associated with poor health or a crippling car accident, or the emotional trauma on one's family from an early death. These non-monetary costs associated with risk occurrence are unlikely to be completely – or perhaps even partially insurable. Health insurance will pay for medical expenses – and potentially even for home help aides to perform tasks that the individual in his diminished capacity can no longer perform; but it will not cover the utility loss associated with not being able to enjoy athletic activities or extended travel. Presumably, the lack of availability of insurance coverage for non-monetary costs associated with risk occurrence stems from the difficulty of verifying these costs and the resultant concerns of extreme moral hazard if the payoff in event of the accident substantially exceeds the monetary costs of the accident.

The inability to insure all costs associated with an accident creates incentives to engage in risk reducing behavior in addition to buying insurance. In turn, the increasing marginal cost of risk reducing behavior suggests that individuals have an incentive to buy insurance in addition to any risk reduction undertaken. In practice, consistent with these assumptions, it is common in the data to see individuals engaging in both preventive health activities and insurance purchases.[6]

Of course, it is not the case that more risk averse individuals have a greater incentive to invest more in activities that reduce the average probability of a loss; average probabilities are incorporated into prices (Dionne and Eeckhoudt 1985, Jullien et al., 1999). Rather, risk averse people wish to reduce the variance of risk. However, if the mean and variance of uninsured loss are positively correlated – and insurance cannot completely insure all the non-monetary costs associated with an accident – more risk averse individuals will want to invest in activities that reduce the mean chance of accident, since this will also reduce the variance. A necessary assumption for the preference heterogeneity model we develop to lead to a negative correlation between risk type and insurance purchase is therefore that the mean and variance of

[6] Of course, the stylized insurance model we have sketched incorporates only a monetary cost of the accident *m*, which insurance fully covers. An uninsurable component of the accident could easily be incorporated into the above model by specifying that the insurance benefit is strictly less than the accident cost *m* .Doing so would complicate the algebra without having any substantive effect on the analysis.

uninsured loss are positively correlated, so that more risk averse individuals have an incentive to invest in more risk reducing behavior.

For a loss of a constant dollar amount, where the probability of the loss varies across individuals, the variance of losses is given by $p_i(1-p_i)m^2$ This variance of loss falls with mean loss p_i provided $p_i < 0.5$. The assumption that $p_i < 0.5$ is likely to be a reasonable one for all of the insurance markets discussed in section two. Think of the risk of dying in a given year or even 10-year interval for life insurance; if one thinks of wanting to insure income prospects until age 55, for example, according to US life tables, the probability that a 25 year old dies before 55 is about 19 percent for lifelong smokers, compared to 12 percent in the population as a whole. Similarly, the risk of a 65 year old ever entering a nursing home for long-term care insurance (about one-third, Kemper and Murtaugh, 1991), of having a car accident in a given year for auto insurance, or of having health expenditures above some minimal amount (only 20 percent of people have medical spending above $3,200 in a year according to Conwell and Cohen, 2005) are all below 50 percent. Alternatively, we could model differences in risk type by assuming all individuals have the same probability *p* of an accident but that higher risk individuals have a higher loss *m* in the event of this accident. In this case, too, the variance of income without insurance is increasing in risk type.

Of course, at the end of the day, the reasonableness of an assumption rests on its empirical relevance. Consistent with the assumption that more risk averse individuals invest more in risk reducing behavior, Barsky et al. (1997) present evidence that more risk averse individuals (as measured by stated preferences over hypothetical income gambles) are less likely to engage in risk behaviors such as smoking, drinking or holding risky employment. We provide similar evidence below. This evidence supports a key assumption of the model, and indirectly supports the assumption that mean and variance are positively correlated.

When we allow for differences in risk aversion (φ_i) across individuals, the level of risk aversion has two countervailing effects on the value of insurance, and hence on the purchase decision. We summarize this by differentiating the equation for the value of insurance (4) with respect to risk aversion:

$$(6)\quad \frac{\partial V_{Ii}}{\partial \varphi_i} = 0.5(\underbrace{\sigma_i^2}_{\text{risk aversion effect }(+)} + \underbrace{\varphi_i \frac{\partial \sigma_i^2}{\partial \varphi_i}}_{\text{risk taking effect }(-)})$$

For any given risk probability, more risk averse people value insurance coverage more. We refer to this as the "risk aversion effect"; it suggests that all else equal more risk averse people should be more likely to own insurance. The other effect we refer to as the "risk taking effect": more risk averse people invest more in risk reduction, and this reduces the variance of possible outcomes which in turn reduces the value of insurance. The risk taking effect therefore suggests that more risk averse people will be lower risk, and therefore value insurance less.

The net effect of risk aversion on insurance demand is therefore theoretically ambiguous. Whether the direct effect of risk aversion or the risk taking effect of risk aversion dominates depends on several parameters, which may well vary across different insurance markets. The magnitude of the direct effect (more risk averse individuals are more likely to buy insurance) is larger for larger risks (i.e. larger σ^2). The magnitude of the risk taking effect (that more risk averse individuals invest in risk reducing behavior which lowers the value of insurance) is increasing in the extent to which risk averse individuals are able to reduce their risk type (which of course depends on the production technology available). Most importantly, equation (6) makes clear how heterogeneous risk aversion combined with endogenous risk type may produce a force that pushes toward greater insurance ownership among lower risk individuals.

Scattered evidence exists for the prediction of this model that individuals who engage in less risky behavior may value insurance more. Finkelstein and McGarry (forthcoming) find that individuals who receive more preventive health care and individuals who are more likely to wear seat belts are more likely to have long-term care insurance. Hemenway (1990) finds that individuals who wear their seat belt while driving are more likely to purchase rental car insurance when they rent a car. In Section four we provide a more systematic analysis of the relationship between risky behavior on the one hand, and insurance coverage, risk occurrence, and risk preferences on the other, in the context of the U.S. life insurance market.

3.3 Equilibrium with asymmetric information

Extending the model to allow for private information about risk type leads to one key difference: the equilibrium (zero profit) price of insurance is no longer the own-type actuarially fair price $p_i m + F$ but rather $\hat{p}m + F$ where $\hat{p}$ is the zero-profit (break even) price given the equilibrium set of individuals purchasing a particular insurance policy.[7] Under this alternative pricing regime, the value of insurance is given by

$$(4)' \quad W_{Ii} = C_{Ii} - C_{Ni} = 0.5\varphi_i\sigma_i^2 + (p_i - \hat{p})m - F$$

which yields the new purchase decision

$$(5)' \quad \text{Buy if and only if} \quad 0.5\varphi_i\sigma_i^2 + (p_i - \hat{p})m - F > 0$$

A comparison of the buy decision under symmetric information (equation 5) with that under asymmetric information (equation $5'$) indicates that all of the previous comparative static effects continue to hold. In addition, there is also now a new (additively separable) effect $(p_i - \hat{p})m$ encouraging high risk people to buy insurance We refer to this new term as the "effective subsidy". Equation $(5)'$ indicates that the effective subsidy is increasing in risk type (p_i). This additional effect encouraging purchase among the high risk underscores the importance of allowing for preference heterogeneity in explaining the many real world examples in which risk type and insurance coverage are negatively correlated.

Beyond preference heterogeneity, there are two other possible mechanisms to get the lower risk more likely to buy insurance: if the lower risk are also higher variance (in our case, this means p > 0.5); or if

---

[7] In models with multiple insurance policies, such as the two policy model of Rothschild and Stiglitz (1976), the higher risk buy more insurance because of screening / rationing rather than a subsidy per se. The end result is still a factor propelling higher risk individuals to have more insurance, even though the mechanism is different from the one outlined here.

the effective load is higher for higher risk individuals. As we noted above, the first is unlikely to be the case in the insurance markets discussed in section 2. Little is known about how administrative loads vary with expected losses, but we doubt that loads are increasing with risk since many administrative costs – marketing, screening, and the like – are fixed costs, which do not vary with expected loss.

Indeed, most of the effects that come readily to mind would also work in the other direction. For example, richer people may value risk reduction more than poorer people – if the value of life is higher for the rich than the poor. But richer people are also in less need of insurance. Hence, variation in income would, theoretically, enforce a positive relationship between riskiness and insurance purchase.

It is also worth emphasizing that the preceding analysis has abstracted away from any potential moral hazard effects of insurance on risk occurrence. Allowing for moral hazard would introduce another force pushing in the direction of those with more insurance looking higher risk (*ex post*). The fact that we do not observe this relationship in so many insurance markets suggests that the offsetting force of variation in risk preference is quantitatively important enough to counteract any impact of moral hazard as well.

4. Risky behavior, insurance purchases and risk occurrence: Evidence from the U.S. life insurance market

In this section we provide empirical evidence on the relationships among risky behavior, risk preferences, risk type, and insurance coverage in the U.S. term life insurance market. We chose this market for several reasons. It is an extremely important market – indeed, it is one of the largest private insurance markets in the world.[8] Relatedly, the evidence that those who buy insurance are lower or the same risk as those who do not (e.g. Cawley and Philipson 1999, McCarthy and Mitchell 2003) makes it a sensible setting to test the predictions of the preference heterogeneity model. Moreover, there is a well-documented puzzle concerning the determinants of demand in this market, as neither standard adverse selection stories nor financial vulnerabilities stories appear to do well in explaining ownership patterns

[8] At the end of 2004, Americans paid $17.5 trillion in life insurance premiums (American Council on Life Insurers, 2004).

(Cawley and Philipson 1999, McCarthy and Mitchell 2003, Bernheim et al, 2003a 2003b). Finally, the life insurance market is somewhat unusual among insurance markets in the United States in that there is little restriction on the price schedule that can be charged, other than that it is actuarially based. In a heavily regulated market, such as the U.S. automobile insurance market, or non-group health insurance market, it is more difficult to infer which aspects of the equilibrium are inherent to the market itself and which stem from regulatory constraints.

We use the 1992 Health and Retirement Study (HRS) for our analysis. This is the first wave of a biannual panel survey designed to be representative of individuals aged 51 to 61 in 1992 and their spouses; in some of the analysis we use the panel dimension to track the subsequent mortality experience of these individuals through 2002. We exclude 0.01 percent of individuals because they are below 40 or above 80 in 1992. The average age in our sample is 56; over 95 percent of individuals are between 50 and 65.

About 50 percent of the sample owns term life insurance.[9] About 50 percent of these insured individuals hold insurance that was purchased through a current or former employer; another 40 percent hold individual (non-group) policies and the remaining 10 percent hold both.

We examine whether risky behavior and insurance coverage are negatively related as the preference heterogeneity model suggests may be the case. We have three measures of risky behavior: (1) whether the individual currently smokes, (2) whether the individual has a drinking problem (defined as three or more drinks per day), and (3) the mortality rate per 100,000 employees in the individual's industry-occupation cell, from Viscusi (2003).[10] On average, 27 percent of people smoke, 5 percent have a drinking problem, and the average mortality risk by industry-occupation cell is 4 fatalities per 100,000 employees.

---

[9] Another 21 percent owned whole life insurance without any term policy. As noted above, we focus specifically on *term* life insurance which is a pure insurance vehicle, rather than *whole* life insurance which combines an insurance vehicle with a savings instrument.

[10] The data used for the Viscusi (2003) study come from the U.S. Bureau of Labor Statistics Census of Fatal Occupational Injuries. Viscusi emphasizes the importance of using industry and occupation cells as there is substantial variation in risk within either industry or occupational aggregates.

We also construct two measures of active steps individuals can take to reduce mortality risk: (1) the fraction of gender-appropriate preventive health activity undertaken,[11] and (2) whether the individual reports always wearing a seat belt.[12] On average in our sample, individuals undertake 60 percent of the gender-appropriate preventive health activities, and 80 percent report always wearing a seat belt. The measures of preventive health activity and seat belt use were unfortunately first collected in 1996. Our analysis of the preventive health behaviors and seat belt use therefore suffers from potential sample selection bias; to observe this behavior the individual must survive until 1996.

Consistent with the predictions of the preference heterogeneity model, we find that individuals who engage in more risky behavior are less likely to have insurance; they are also higher risk. Table 2, Panel A presents the relationship between insurance coverage and risky behavior for the five different measures of risky behavior just discussed. For each risky behavior, we report both the bivariate, unconditional relationships, and the relationship including controls for a plausibly exogenous set of demographic variables that are intended to proxy for the individual's financial vulnerability, or potential need for life insurance. These controls consist of a full set of single-year age indicators, as well as indicators for gender, marital status, employment, and spousal employment; we also control for the number of children and the number of children who still live at home.[13]

The evidence in remarkably consistent with the preference heterogeneity model. Individuals who engage in risky (risk reducing) behavior are systematically less likely (more likely) to own term life insurance; this relationship is statistically significant in all 10 specifications.

The standard adverse selection story suggests that those who have private information that they are higher risk should purchase *more* insurance; thus if smoking or drinking problems are not priced we

[11] These activities are: whether the individual had a flu shot; had a blood test for cholesterol; checked her breasts for lumps monthly; had a mammogram or breast x-ray; had a Pap smear; had a prostate screen.

[12] The Center for Disease Control reports that "More than half of the people involved in fatal crashes were not wearing seat belts." (National Center for Injury Prevention and Control, 2001 p. 74).

[13] As discussed earlier, the extensive literature testing for asymmetric information about risk type in insurance markets takes great care to condition on the risk classification done by the insurance company. Our purpose is not to test for asymmetric information about risk type in this market. We therefore do not condition on this risk classification which includes, among other things, extremely detailed information on health status and health behaviors; the preference heterogeneity model we developed suggests that such variables may well be affected by risky behavior.

should see a positive relationship between these behaviors and insurance coverage, rather than the negative one observed. In fact, however, some of these are priced (including smoking) but others are not (such as seat belt use). We observe the negative relationship between risky behavior and insurance purchases for both unpriced and priced risky behaviors. For the priced behaviors, adverse selection presumably doesn't operate, and the results can be interpreted purely from the symmetric information preference heterogeneity story. For the unpriced behaviors, adverse selection may operate, but apparently its effect is not strong enough to overcome the effects stemming from preference heterogeneity.

The preference heterogeneity story suggests two offsetting effects for the value of insurance for those who engage in risky behavior (and are therefore higher risk). (Panel B presents some suggestive evidence that is consistent with those who engage in risky behavior being higher risk; we measure risk occurrence by whether the individual has died by 2002. First, individuals who engage in risky behavior and are therefore higher risk will value insurance more because the variance of uninsured income is higher (under the assumption of a positive relationship between the mean and variance of uninsured income). Second, they will value insurance less because they are presumably less risk averse to be willing to engage in such risky behavior. The fact that we see a consistent *negative* relationship between risky behavior and insurance coverage suggests that the second effect – which operates via risk aversion – dominates, at least in the term life insurance market in the United States.

Consistent with this, we provide some suggestive evidence on a negative relationship between risk aversion and risky behavior. As a proxy for risk aversion, we use the respondents' answers to questions concerning their willingness to engage in various hypothetical income gambles.[14] Based on the answers, we form four ordinal categorical variables of increasing risk aversion and examine their relationship with risky behavior. About 65 percent of the sample falls in the most risk averse category; the remainder are roughly evenly split across the other three risk aversion categories.

[14] The survey questions as respondents if they would be willing to trade a good job with a steady income equal to their current family income for a new job with a "50-50 chance it will double your (family) income and a 50-50 chance that it will cut your (family) income by a third." A second question increases or decreases the possible gain / loss in income depending on the response to the initial question. These responses can be used to group people into four risk-tolerance categories.

Table 4 reports our results concerning the relationship between various risky behaviors and these ordinal measures of risk aversion. Overall, the evidence suggests that those who are in the least risk averse category are statistically significantly more likely to engage in various risky behaviors (or less likely to engage in various risk reducing behaviors) than those in the most risk averse category.[15] We also find that those who are less risk averse are less likely to have term life insurance.

Finally, the preference heterogeneity model offers a potential explanation for a negative (or at least non-positive) relationship between risk occurrence and insurance coverage. It also suggests that, conditional on the risky behaviors undertaken, the relationship between risk occurrence and insurance coverage should be *less* negative than the unconditional one. Table 3 presents evidence that supports this prediction. Column 1 shows the unconditional relationship between whether the individual has term life insurance in 1992 and subsequent risk occurrence (whether the individual dies by 2002); consistent with prior work summarized in Table 1, we find a negative relationship. Column 2 further shows that, consistent with the predictions of the preference heterogeneity model, controlling for risky behaviors attenuates the negative relationship; indeed, the point estimate suggests that the negative relationship declines by over 50 percent. Columns 3 and 4 show the same pattern holds when the analysis includes controls for the basic demographic measures of need discussed previously.[16]

5. Implications

Our empirical results show that preference heterogeneity may play an important role in understanding who purchases insurance. In this section, we briefly explore some of the welfare implications of models where preference heterogeneity is important in the equilibrium. The implications of such models are far more complex than the standard uni-dimensional model of private information suggests.

[15] Using additional assumptions (e.g. they assume that the utility function exhibits constant relative risk aversion) and data, Barsky et al. (1997) construct measures of average risk tolerance for the four categories and find even more pronounced relationships between risk aversion and risky behaviors than what we report using the ordinal measures.

[16] The theory also suggests that the negative relationship between risky behavior and insurance should attenuate (i.e. become less negative) when risk aversion is controlled for; we find no compelling evidence for this, which may reflect the lack of power in our risk aversion proxies.

Consider again the model in section three. To keep things simple, suppose that there are two possible levels of risk aversion (high [H] or low[L]) and two possible risk types (again, high or low). Risk type is inversely related to risk aversion, but not perfectly so; for example, genetics influences the risk of a health event separate from risk aversion.

As in the Rothschild-Stiglitz model, an equilibrium with symmetric information is always *ex post* efficient (that is, efficient given risk types), provided there are no externalities to the insurance decision and the market is competitive.

The more interesting case is where information about risk type is asymmetric. The optimality condition is for people to purchase insurance if $0.5\varphi_i\sigma_j^2 - F > 0$, where i indexes risk aversion types and j indexes levels of risk. In equilibrium, however, if there is asymmetric information people will purchase insurance if $0.5\varphi_i\sigma_i^2 + (p_i - \hat{p})m - F > 0$, where $\hat{p}$ is the average risk of insurance purchasers. One clear result from the Rothschild-Stiglitz model carries over directly: it is possible that low risks should optimally buy insurance, but will not do so in equilibrium.[17]

With heterogeneity in risk aversion, however, there might be *over-insurance* as well as underinsurance, a result not present in the Rothschild-Stiglitz framework. Suppose that risk aversion among the highly risk averse is sufficiently great that all high risk aversion people choose to buy insurance, even those who are not very likely to suffer a loss. Because highly risk averse people invest more in their own health, it is likely that this group will be on average relatively healthy (i.e. low risk), and premiums could therefore be low. Now consider the group that is high risk but not very risk averse. Suppose they are close to indifferent between being insured and not. It is possible that that efficient outcome for this group is not to purchase insurance $(0.5\varphi_L\sigma_H^2 - F < 0)$, but they choose to buy

[17] For low risks, $p_L < \hat{p}$, and insurance premiums are actuarially unfair. In our model, the low risk might choose to be uninsured rather than buy insurance at a high price. The analogy in the Rothschild-Stiglitz model is that the low risks are in a less generous insurance plan than is optimal for them, to discourage the high risks from joining the plan.

anyways because the price is subsidized by the presence of low risk / very risk averse people $(0.5\varphi_L\sigma_H^2 - F > (\hat{p} - p_H)m)$. In this case, there is overinsurance in equilibrium.[18]

Finally, it is also possible for the equilibrium to produce an efficient insurance allocation, even with private information about risk type. This would be the case, for example, if all of the low risk individuals are also low risk aversion individuals, and it is not efficient for low risk aversion individuals to buy (i.e. condition (5) is not satisfied for them regardless of risk type). In this case, only the high risk aversion / high risk individuals would buy insurance in equilibrium, and this equilibrium would be first best socially efficient.

As these examples make clear, the nature of the reduced form relationship between risk type and propensity to buy insurance is not informative about the presence or absence of private information about risk type or market inefficiency. This is unfortunate because the standard, and widely used, test for private information about risk type in the literature has been to reject the null hypothesis of symmetric information if there is a positive correlation between insurance coverage and risk occurrence (e.g. Chiappori and Salanie 2000). The above examples make clear that this test may erroneously fail to reject the null of symmetric information in markets with multiple forms of unobserved heterogeneity and loads on policies.[19] This result suggests the importance of using more nuanced tests for asymmetric information – such as those recently developed by Chiappori et al. (forthcoming) or Finkelstein and Poterba (2006) – for accurately testing for the presence of private information about risk type.

Moreover, to understand the equilibrium and make welfare assessments, it is critical to observe not only the reduced form allocations of insurance coverage across risk types, but also the underlying risk aversion of individuals of different risk types. This suggests that the method developed by Cohen and Einav (2005) for recovering the joint distribution of risk type and risk aversion from insurance market data will be critical for making efficiency conclusions about specific insurance markets.

---

[18] This example is similar in spirit to the results in de Meza and Webb (2001).
[19] This point has been previously made theoretically by Chiappori et al., (forthcoming) and empirically by Finkelstein and McGarry (forthcoming).

6. Conclusion

Insurance markets differ substantially in whether higher risk individuals or lower risk individuals are more likely to be covered. In health insurance, for example, risk is positively related to coverage, as standard adverse selection and moral hazard models would predict. The opposite is true about life insurance.

This paper suggests that incorporating preference heterogeneity into models of insurance market equilibrium may be very important for understanding these differential patterns. When risk type is endogenous to attitudes towards risk, risk type and insurance purchase may be positively correlated, negatively correlated, or uncorrelated even if standard adverse selection and moral hazard effects also operate. Preference heterogeneity may therefore be an important component of the varying equilibria that have been observed.

We present empirical evidence from the U.S. life insurance market consistent with the hypothesized mechanism by which preference heterogeneity can generate a negative relationship between insurance coverage and risk occurrence. Specifically, we find that individuals who are less risk averse engage in more risky behaviors, have lower mortality (i.e. are lower risk) and are more likely to purchase insurance. Moreover, controlling for risky behavior attenuates the negative relationship between insurance coverage and risk occurrence in the data.

An important and interesting direction for further work is to systematically explore whether the strength of the various mechanisms discussed here can explain the differential patterns across various insurance markets in the sign of the risk – insurance coverage relationship. We began this paper with evidence of marked and persistent differences across insurance markets in the direction of selection. Annuities and acute health care insurance appear adversely selected while life insurance, long-term care insurance, auto insurance and reverse mortgages appear to be advantageously selected or un-selected. The evidence we presented from the life insurance market suggests that the preference heterogeneity model may well help explain why this market is not adversely selected. Whether it can also explain the patterns in other markets is an open and interesting question for further research.

References

Akerlof, George. 1970. "The market for 'lemons': quality uncertainty and the market mechanism." *Quarterly Journal of Economics* 488-500.

Barsky, Robert, Thomas Juster, Miles Kimball and Matthew Shapiro. 1997. "Preference parameters and behavioral heterogeneity: An experimental approach in the health and retirement study." *Quarterly Journal of Economics* 112(2): 537-579.

Bernheim, Douglas, Lorenzo Forni, Jagadeesh Gokhale, and Laurence Kotlikoff. 2003a. "The Mismatch Between Life Insurance and Financial Vulnerabilities: Evidence from the Health and Retirement Survey," *American Economic Review* 93(1), March: 354-365.

Bernheim, Douglas, Katherine Carman, Jagadeesh Gokhale, and Laurence Kotlikoff. 2003b. "Are Life Insurance Holdings Related to Financial Vulnerabilities?" *Economic Inquiry* 41(4), October: 531-54.

Brown, Jeffrey R. and Amy Finkelstein. 2004. "Supply or Demand: Why is the Market for Long-Term Care Insurance So Small?" NBER Working Paper 10782.

Brown, Jeffrey R., Olivia Mitchell and James Poterba. 2002. "Mortality Risk, Inflation Risk and Annuity Products." In O. Mitchell, Z. Bodie, B. Hammond, and S. Zeldes, Innovations in Retirement Financing, University of Pennsylvania Press: Philadelphia, PA, pp. 175-197.

Cardon, James and Igal Hendel. 2001. "Asymmetric Information in Health Insurance: Evidence from the National Medical Expenditure Survey." *RAND Journal of Economics* 32, 408-427.

Cawley, John and Tomas Philipson. 1999. "An empirical examination of information barriers to trade in insurance." *American Economic Review* Vol 89, no 4 pp.827-846.

Chiappori, Pierre-Andre and Bernard Salanie. 2000. "Testing for Asymmetric Information in Insurance Markets." *Journal of Political Economy*, 108 (1), pp. 56-78.

Chiappori, Pierre-Andre, Bruno Jullien, Bernard Salanie, and Francois Salanie. forthcoming. "Asymmetric Information in Insurance: General Testable Implications." *Rand Journal of Economics.*

Cohen, Alma. 2005. "Asymmetric Information and Learning in the Automobile Insurance Market." *Review of Economics and Statistics* 87: 197-207.

Cohen Alma and Liran Einav. 2005. "Estimating risk preferences from deductible choice." Unpublished mimeo. Stanford University.

Conwell, Leslie and Joel Cohen. 2005. "Characteristics of Persons with High Medical Expenditures in the US Civilian Non-Instiutionalized Population, 2002." Statistical Brief Number 73, Agency for Health Care quality and Research, March 2005.

Cutler, David. 1996. "Why Don't Markets Insure Long-Term Risk?" Unpublished working paper. http://post.economics.harvard.edu/faculty/dcutler/papers/ltc_rev.pdf

Cutler, David and Richard Zeckhauser. 2000. "The Anatomy of Health Insurance" in A. Culyer and J. Newhouse, eds. Handbook of Health Economics, Volume IA, Amsterdam: Elsevier.

Dionne, Georges and Louis Eeckhoudt. "Self-Insurance, Self-Protection, and Increased Risk Aversion." *Economic Letters* 1985, 17, pp. 39-42.

Dionne, Georges, Christian Gourieroux and Charles Vanasse. "Testing for evidence of adverse selection in the automobile insurance market: a comment." *Journal of Political Economy* 2001, 109(2) pp. 444-451.

Davidoff, Thomas and Gerd Welke. 2005. "Selection and moral hazard in the reverse mortgage market." Unpublished mimeo.

de Meza, David and Webb, David C. 2001. "Advantageous selection in insurance markets." *Rand Journal of Economics*, 32 (2), pp. 249-262.

Hurst, Erik. 2003. "Grasshoppers, Ants, and Pre-Retirement Wealth: A Test of Permanent Income Consumers." NBER Working Paper 10098.

Finkelstein, Amy and Kathleen McGarry. forthcoming. "Private information and its effect on market equilibrium: new evidence from long-term care insurance." *American Economic Review*

Finkelstein, Amy and James Poterba. 2002. "Selection Effects in the Market for Individual Annuities: New Evidence from the United Kingdom." *Economic Journal*, 112 (476), pp. 28-50.

Finkelstein, Amy and James Poterba. 2004. "Adverse Selection in Insurance Markets: Policyholder Evidence from the U.K. Annuity Market." *Journal of Political Economy*, 112(1), pp. 193-208.

Finkelstein, Amy and James Poterba. 2006. "Testing for adverse selection with 'unused observables'." Unpublished mimeo.

Grabowski, David and Jonathan Gruber. 2005. "Moral hazard in nursing home use." NBER WP 11723.

Hemenway, David. 1990. "Propitious Selection." *Quarterly Journal of Economics* 105 (4): 1063-1069.

Jullien Bruno, Bernard Salanie and Francois Salanie. 1999. "Should More Risk-Averse Agents Exert More Effort?" *The Geneva Papers on Risk and Insurance Theory*, 24, pp. 19-28.

Jullien, Bruno, Bernard Salanie, and Francois Salanie. 2002. "Screening risk-averse agents under moral hazard." Unpublished mimeo.

Kemper, Peter and Christopher Murtaugh. 1991. Lifetime use of nursing home care." *New England Journal of Medicine* 324: 595-600.

McCarthy, David and Olivia Mitchell. 2003. "International Adverse Selection in Life Insurance and Annuities." NBER Working Paper 9975.

Mitchell, Olivia S., James M. Poterba, Mark Warshawsky, and Jeffrey R. Brown. 1999. "New Evidence on the Money's Worth of Individual Annuities." *American Economic Review*, 89, 1299-1318.

Newhouse, Joseph. 2002. Pricing the Priceless: A Health Care Conundrum. MIT Press: Cambridge, MA.

National Center for Injury Prevention and Control. 2001 "Injury Fact Book 2001-2002," Atlanta, GA: Centers for Disease Control and Prevention,"

Pueltz, Robert and Arthur Snow. 1994. "Evidence on Adverse Selection: Equilibrium Signaling and Cross-Subsidization in the Insurance Market." *Journal of Political Economy*, 102: 236-257.

Rothschild, Michael and Joseph E. Stiglitz. 1976. "Equilibrium in Competitive Insurance Markets: An Essay on the Economics of Imperfect Information," *Quarterly Journal of Economics* 90, 630-649.

Society of Actuaries. 1992. "Report of the long-term-care experience committee: 1985 national nursing home survey utilization data." *Transactions of the Society of Actuaries*, 1988-89-90 Reports. pp.101-164.

Smart, Michael. "Competitive insurance markets with two unobservables." *International Economic Review*, 2000, 41 (1) pp. 153-169.

Smith, V. Kerry, Donald Taylor and Frank Sloan. "Longevity expectations and death: can people predict their own demise?" *American Economic Review* September 2001, 91 (4) pp. 1126-1134.

Viscusi, W. Kip. 2003. "The Value of Life: Estimates with Risks by Occupation and Industry," John M. Olin Center for Law, Economics and Business, Discussion Paper no. 422, May..

Wambach, Achim. "Introducing Heterogeneity in the Rothschild-Stiglitz Model." *Journal of Risk and Insurance* 2000, 67 (4) pp.579-92.

Table 1: Risk Type of Those with More relative to Less Insurance: Summary of the Evidence

Market	Selection Direction, Unconditional			Selection Direction, Conditional on Option Set		
	Paper	Country studied	Selection Direction	Paper	Country Studied	Selection Direction
Health Insurance	Cardon and Hendel (2001)	US	UNCLEAR*	Cutler and Zeckhauser (2001)**	US	ADVERSE
Annuities	Mitchell et al. (1999)	US	Adverse	Finkelstein and Poterba (2004)	UK	Adverse
	Finkelstein and Poterba (2002)	UK	Adverse	Finkelstein and Poterba (2006)	UK	Adverse
	McCarthy and Mitchell (2003)	US, UK, Japan	Adverse			
	SUMMARY		ADVERSE			ADVERSE
Life Insurance	Cawley and Philipson (1999)	US	Advantageous	Cawley and Philipson (1999)	US	Advantageous or None
	McCarthy and Mitchell (2003)	US, UK, Japan	Advantageous			
	SUMMARY		ADVANTAGEOUS			ADVANTAGEOUS OR NONE
Automobile Insurance				Chiappori and Salanie (2000)	France	None
				Dionne et al. (2001)	Canada	None
				Chiappori et al. (forthcoming)	France	None
				Cohen (2005)	Israel	Adverse
	SUMMARY					NONE
Long-term care insurance	Society of Actuaries (1992)	US	Advantageous	Finkelstein and McGarry (forthcoming)	US	Advantageous or none
	Finkelstein and McGarry (forthcoming)	US	Advantageous			
	SUMMARY		ADVANTAGEOUS			ADVANTAGEOUS OR NONE
Reverse Mortgages	Davidoff and Welke (2005)	US	ADVANTAGEOUS	Davidoff and Welke (2005)		ADVANAGEOUS

Note: Each cited paper uses different data.
* Advantageous on self-reported health, adverse on expenditures.
** Denotes review paper summarizing large literature.

Table 2: The relationship between risky (or risk reducing) behavior and insurance coverage or risk occurrence

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(1)
Panel A: Dependent Variable Is Term Life Insurance Coverage in 1992 (mean = 0.50)										
Coeff	-0.031***	-0.020*	-0.018	-0.057***	-0.002**	-0.004***	0.112***	0.123***	0.063***	0.082***
	(0.010)	(0.011)	(0.020)	(0.021)	(0.0008)	(0.0009)	(0.016)	(0.016)	(0.012)	(0.013)
RHS Variable	Indicator for Smoker (1992)		Indicator for Drinking Problem (1992)		Mortality Risk in Industry-Occupation Cell (1992)		Preventive Health Activity (1996)		Always Wear Seat Belt (1996)	
Addl'l Controls	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes
N	11,917	10,922	11,917	10,922	10,993	10,087	10,129	9,381	10,164	9,412
Panel B: Dependent Variable is Died by 2002 (mean = 0.13)										
Coeff	0.109***	0.087***	0.087***	0.049***	0.004***	0.0006	-0.001	0.0009	-0.049***	-0.039***
	(0.008)	(0.008)	(0.017)	(0.017)	(0.0007)	(0.0007)	(0.010)	(0.010)	(0.008)	(0.008)
RHS Variable	Indicator for Smoker (1992)		Indicator for Drinking Problem (1992)		Mortality Risk in Industry-Occupation Cell (1992)		Preventive Health Activity (1996)		Always Wear Seat Belt (1996)	
Addl'l Controls	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes
N	11,635	10,654	11,635	10,654	10,713	9,837	10,443	9,393	10,484	9.427

Note: Table reports results from OLS regressions. Dependent variable is given in panel headings. First row gives coefficient on right hand side variable listed in the second row. Additional controls consist of indicator variables for age, gender, whether the individual works, whether the individual is married, whether the individual's spouse works, as well as continuous measures of the number of children and the number of children at home; all controls are measured in 1992. Heteroskedasticity-robust standard errors are in parentheses. ***, **, * denotes statistical significance at the 1 percent, 5 percent, and 10 percent levels respectively.

Table 3: The relationship between life insurance coverage in 1992 and survival through 2002

	(1)	(2)	(3)	(4)
Died by 2002	-0.061***	-0.027	-0.031**	-0.012
	(0.014)	(0.019)	(0.015)	(0.020)
Controls for risky behavior	NO	YES	NO	YES
Additional controls	NO	NO	YES	YES
N	11,206	9,088	10,335	8,436

Note: Table reports results from OLS regressions. Dependent variable is whether individual has term life insurance coverage in 1992. Controls for risky behavior consist of indicator variables for whether the individual smokes, whether the individual has a drinking problem, and whether he always wears as seat belt, as well as a continuous measure of the mortality risk of his industry-occupation cell, and the amount of preventive health activity undertaken; all of these are measured in 1992 except for preventive health activity and seat belt wearing which are measured in 1996. Additional controls consist of indicator variables for age, gender, whether the individual works, whether the individual is married, whether the individual's spouse works, as well as continuous measures of the number of children and the number of children at home; all are measured in 1992. Heteroskedasticity-robust standard errors are in parentheses. ***, **, * denotes statistical significance at the 1 percent, 5 percent, and 10 percent levels respectively.

Table 4: The relationship between risk aversion and risky behavior, insurance coverage, and risk occurrence

	Indicator for Smoker (1992)		Indicator for Drinking Problem (1992)		Mortality Risk in Industry-Occupation Cell (1992)		Preventive Health Activity (1996)		Always Wear Seat Belt (1996)		Indicator for Have Term Life Insurance (1992)	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(19)	(11)	(12)
Least risk averse	0.046*** (0.013)		0.025*** (0.007)		0.517*** (0.183)		-0.017* (0.010)		-0.018 (0.013)		-0.052*** (0.015)	
Second least risk averse	-0.005 (0.013)		-0.004 (0.006)		0.098 (0.175)		-0.003 (0.010)		0.002 (0.013)		-0.024 (0.016)	
Third least risk averse	0.008 (0.013)		0.004 (0.007)		-0.284* (0.155)		0.009 (0.010)		0.010 (0.012)		-0.009 (0.015)	
Most risk averse												
Add'l controls	NO	YES	NO	YES	NO	YES	NO	YES	NO	YES	NO	YES
N	11,467		11,467				9,814		9,849		11,076	

Note: Table reports results from OLS regressions. Dependent variable is given in column headings. Risk aversion is an ordinal measure based on willingness to accept various hypothetical gambles; see text and Barsky et al. (1997) for more details. Additional controls consist of indicator variables for age, gender, whether the individual works, whether the individual is married, whether the individual's spouse works, as well as continuous measures of the number of children and the number of children at home; all are measured in 1992. Heteroskedasticity-robust standard errors are in parentheses. ***, **, * denotes statistical significance at the 1 percent, 5 percent, and 10 percent levels respectively.