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CATASTROPHES AND THE DEMAND FOR LIFE INSURANCE

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ABSTRACT

Prior research suggests that the occurrence of a catastrophe may lead to increases in risk perception, risk mitigation, and insurance purchasing behavior. Given the extensive damage that often is inflicted by natural disasters, such a phenomenon is intuitive for property risks. Similarly, we posit that the occurrence of catastrophes also may be associated with an increased demand for coverage against mortality risk. Based on U.S. state-level data for the period 1994 through 2004, we provide evidence of a significant relationship between catastrophes and life insurance demand, both for states directly affected by the event and for neighboring states.

Keywords Catastrophes, Natural Hazards, Insurance Demand, Life Insurance
JEL Classification C23, D80, G22, Q54

INTRODUCTION

In August 2005, Hurricane Katrina struck the U.S. Gulf Coast, resulting in an estimated 1,800 deaths and $81 billion in total property damage in several U.S. states (Knabb, Rhome, and Brown, 2005). Prior literature contends that natural disasters such as hurricanes, floods, and tornadoes may cause individuals to adjust their decision-making processes and reassess risks that could result in property damage, leading to an increased demand for an assortment of property-related insurance contracts (e.g., Browne and Hoyt, 2000).

While the question of how individuals respond to natural disasters has been of theoretical and empirical interest, research has thus far not focused on the potential impact that such catastrophes could have on the demand for insurance against mortality risk. We suggest that the cognitive process that occurs following individuals' exposure to catastrophes as it relates to property insurance buying behavior also may play a similar role in relation to their decision to insure against mortality risk. To explore this possibility, we examine the demand for life insurance following catastrophes in the United States based on state-level data for the period 1994 through 2004. We provide empirical evidence of significantly higher life insurance demand in states affected by catastrophes relative to non-affected states. The finding persists both in the year of and in the year following the catastrophe, and the effect generally holds for neighboring states that were not directly affected by the catastrophes.

In the paper that follows, we first briefly review the literature regarding catastrophes and the demand for insurance. Next, we describe the data and empirical methods. We then model the demand for life insurance and present the results. In the final section, we summarize and conclude the paper.

CATASTROPHIC EVENTS AND THE DEMAND FOR INSURANCE

When catastrophes, particularly natural disasters, strike in the United States, property losses often are large while loss of life is relatively minimal.[1] The potential losses associated with such catastrophes often can be reduced through a combination of loss mitigation and the purchase of insurance.[2] Although individuals may choose to insure these risks through the use of homeowners insurance, earthquake insurance, and/or flood insurance, often the amount purchased is not sufficient to ensure indemnification in the event of an insurable loss. In the case of Hurricane Katrina, property losses totaled over $81 billion, yet only $44 billion of the property damage was insured (Insurance Information Institute, 2008).

A number of explanations have been provided as to why individuals fail to purchase seemingly necessary insurance products or do not take action to mitigate losses when they are at risk. Kunreuther (1976) argues that the decision-making process with respect to insurance purchasing occurs in four distinct stages, and that if a person fails to recognize that a potential problem exists or assumes a probability of occurrence so low that the event seems improbable, the steps necessary to reduce potential losses will not be taken.[3] Other researchers concur that if the probability of loss is low (such as for some catastrophic losses), individuals may drive their self-assessed probability of loss to zero (even though the actual probability is higher), ignore the potential loss, and not purchase insurance (see Slovic, Fischhoff, Lichtenstein, Corrigan, and Combs, 1977).

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[1] Property losses resulting from natural disasters have increased steadily over time. The large property losses associated with catastrophes are in part attributable to increased building along the U.S. coast, an increase in property values, and a lack of risk awareness or unrealistic personal assessments of risk (Kron, 2006).

[2] Although mitigation efforts may be useful in reducing the expected loss incurred from a catastrophic event, Kleindorfer and Kunreuther (1999) note that individuals typically are leery of adopting these mitigation measures unless the measures are extremely cost effective.

[3] According to Kunreuther (1976), individuals must first perceive the risk as an event that may potentially result in a loss. Second, individuals must realize that insurance is a viable coping mechanism. Once individuals realize that insurance is available to manage the loss associated with potential risks, they can then (third) begin collecting and interpreting insurance-related information (terms of insurance) in order to make an insurance-purchasing decision. Fourth, the individuals must determine whether or not insurance is an attractive purchase.

Kunreuther (1984) further explores the failure to purchase disaster insurance. He suggests that individuals may rely on past experiences to determine if a risk is serious enough to warrant the purchase of insurance, and that individuals will be more likely to purchase insurance when they know someone else who has purchased coverage or when they have had conversations with others regarding insurance purchases.[4] Ganderton, Brookshire, McKee, Stewart and Thurston (2000) conduct a set of experiments and find that individuals are more likely to purchase insurance for low-probability events when the cost of insurance is low, the expected loss is high, and the individual is less wealthy (i.e., they are less likely to be financially secure enough to self insure or retain the loss).[5] Kunreuther and Pauly (2004) provide a theoretical model to explain why individuals may not insure against low-probability events.[6]

As a result of various decision-making behaviors and cognitive biases, individuals may not take actions necessary to reduce potential losses and may not purchase insurance prior to a large-loss event.[7] However, research suggests that some individuals are moved to purchase property insurance after the occurrence of a catastrophic event. Sullivan, Mustart, and Galehouse (1977) study the awareness and attitudes of individuals living near the San Andreas fault in California. Among a variety of issues explored by the authors was whether or not those surveyed had purchased earthquake insurance. The authors found that in 1970, only 5 percent of

[4] Kunreuther also argues that individuals may not be aware of the existence of useful insurance products, or may perceive the cost of the insurance as too high (see also Sullivan, Mustart, and Galehouse, 1977; and Palm, Hodgson, Blanchard, and Lyons, 1990).

[5] An additional explanation for the purchase of insurance is provided by Schlesinger and Doherty (1985), who argue that individuals will purchase insurance coverage when markets are incomplete and losses and wealth are inversely related. Conversely, the authors argue that individuals will purchase less insurance (or no insurance) coverage when markets are incomplete and losses and wealth are positively related.

[6] Kunreuther and Pauly argue that individuals are faced with explicit or implicit costs when making insurance purchasing decisions. When individuals believe that the probability of a catastrophic event occurring is relatively low, they may behave in a manner consistent with the probability of occurrence equaling zero, similar to the threshold explanation presented by Slovic et al. (1977). In addition to the aforementioned reasons provided for the failure of individuals to mitigate against certain high loss risks, some researchers have posited that federal assistance following a disaster may reduce one's mitigation efforts. The concern is that by providing citizens with aid following a major disaster, individuals will anticipate future governmental assistance and will thus discount the value of taking precautions prior to the occurrence of a catastrophe. While this idea has been presented previously, it has not been supported by the prior literature (Kunreuther, Ginsberg, Miller, Sagi, Slovic, Borkan, and Katz, 1978).

[7] For a thorough examination of these potential cognitive biases, see Meyer (2005).

respondents had purchased earthquake insurance for their residence.[8] In 1976 the authors re-surveyed the area and find that earthquake insurance purchases had increased from 5 percent to 22 percent. While the authors do not specifically provide a reason for this increase, Lindell and Perry (2000) argue that the increase may be a result of respondents experiencing the effects of the San Fernando earthquake in 1971.[9]

Shelor, Cross, and Anderson (1992) examine the impact of the 1989 Loma Prieta earthquake on insurer stock prices. The authors find that stock prices increased following the earthquake for two samples of insurers, particularly for the two days following the earthquake's occurrence. The authors conclude that the positive market response was due to investor expectations of increased demand for property-liability insurance in the affected areas.

Browne and Hoyt (2000) assess the factors related to the demand for flood insurance. The authors note that the occurrence of a disaster has been shown to increase the awareness of insurance as a need. Evaluating the period from 1983 through 1993, the authors find that flood insurance purchasing behaviors are associated with the level of flood losses in a given state during the prior year. The authors provide evidence that residents of states that incurred larger flood-related losses in the previous year had a tendency to purchase a greater number of flood insurance policies with greater levels of coverage than those individuals residing in states that had not experienced such large losses.[10]

While property damage is a real possibility in the event of a catastrophe, deaths and injuries resulting from catastrophic events are relatively minimal in the U.S., especially when

[8] Some reasons provided for not purchasing earthquake insurance included that it was too expensive, not necessary, or that respondents were not aware of its availability.

[9] Similarly, Palm, Hodgson, Blanchard, and Lyons (1990) performed a survey-based study and evaluated the relationship between the occurrence of an earthquake and the insurance purchasing behavior of residents in four counties located in California. They suggest that earthquakes occurring in the early 1980s appeared to be associated with earthquake insurance purchases in three of the four counties surveyed.

[10] In addition to Browne and Hoyt (2000), Zaleskiewicz, Piskorz, and Borkowska (2002) evaluate a sample of 66 property owners who were affected by a 1997 flood in Poland and find that individuals who reported a greater level of fear when considering floods were more likely to purchase flood insurance after the flood than those that did not report high levels of flood-based fear.

compared to those that occur on an international scale.[11] As noted by Bourque, Siegel, Kano, and Wood (2006), the number of deaths attributable to natural disasters in the U.S. has declined over the previous 30 years. Although the number of deaths has declined over time, a level of psychological distress is associated with the occurrence of a natural disaster. Ganderton et al. (2000) state, "The losses in natural disasters can often be so severe and large that they dominate people's assessment of the risk they face". Such cognitive adjustments could be responsible for changes in the demand for products that aim to secure the property, health, and financial assets of individuals. Weinstein (1989) suggests that feelings of worry increase following the personal experience of a traumatic event, which may then lead individuals to attempt to protect themselves in various ways from future harm. While such protection efforts have come in the form of property insurance purchases and increased mitigation efforts, protection-based decisions also may come in the form of an increase in life insurance demand. Those individuals who do not have life insurance (or who do not carry a "sufficient" amount) may be more likely to reassess their needs after witnessing the destruction caused by a catastrophic event. Furthermore, individuals may feel more inclined to proactively protect themselves against mortality risk as a result of greater risk awareness.

Some anecdotal evidence exists regarding the impact that catastrophes may have on the demand for life insurance. In particular, between 1918 and 1919, the U.S. faced an influenza pandemic that resulted in the death of hundreds of thousands of Americans. Weisbart (2006) notes, "In 1919, stories on the experience of major life insurers routinely reported record sales in 1918, driven in part by people who came to have a fresh appreciation of the value of owning life insurance". Although natural catastrophes that affect the United States do not generally result in

[11] For example, Hurricane Katrina is considered one of the most destructive natural disasters to impact the United States and it resulted in approximately 1,800 deaths. The Boxing Day tsunami that occurred in the Indian Ocean in December 2004 resulted in over 280,000 deaths in countries such as Indonesia and Thailand while the 2005 earthquake in Kashmir, Pakistan resulted in over 87,000 deaths (Castleden, 2007).

the number of deaths attributed to the influenza pandemic in the early twentieth century, it is possible that major catastrophes may be related to an increased demand for life insurance.

Zietz (2003) provides a survey of the various factors that have been identified by prior research as determinants of life insurance demand.[12] In general, many of the previously examined factors are associated with significant life changes, whether the change is the birth of a child, a new job, or simply a change in age. In the same vein, catastrophes may be events with enough significance so as to be related to an increased demand for life insurance.

Figure 1 shows the average number of life insurance policies issued for states that did and did not experience a major catastrophic event (defined below) in a given year. The figure illustrates that those states affected by a large catastrophic event experienced a greater demand for life insurance than those states that were not impacted by such an event in eight out of nine years of the sample period. Similarly, Figure 2 shows the same phenomenon for states that experienced a catastrophic event in the prior year. Together, Figures 1 and 2 suggest that states affected by a large catastrophic event experience higher demand for life insurance relative to non-affected states, not only in the year of the event, but also in the year following the event. We next model the demand for life insurance with specific consideration given to the potential role of catastrophes.

[Insert Figure 1]

[Insert Figure 2]

[12] Among the factors identified by prior literature as having some influence on the demand for life insurance are age, education, employment, income, population, life expectancy, marital status, number of children, and a variety of psychographic traits (Zietz, 2003).

DATA, EMPIRICAL MODEL, AND METHODOLOGY

Major catastrophes are defined here as those events affecting the United States and resulting in large insured property losses. Because we primarily are interested in determining whether or not the occurrence of a catastrophe is related to life insurance purchasing behavior, we focus only on natural disasters that cause significant property damage (i.e., greater than $1 billion) and are identified by Swiss Reinsurance (SwissRe) Company as costly events.[13] Table 1 identifies the 18 catastrophes that we include in the analysis to determine if a relationship exists between catastrophes and the insuring of mortality risk. For several reasons discussed below, the set of catastrophes included in the sample is based on the size of insured property damage, as opposed to the number of deaths or injuries. First, very few catastrophes occur within the U.S. that cause a significant number of deaths. Second, a large catastrophe that results in many deaths and injuries presumably should be associated with a large amount of property damage. Finally, because a change in demand may be due to a change in the perception of risk, property damage resulting from a catastrophe may be sufficient to induce an increase in the demand for life insurance. While the identification of catastrophes is based on the dollar amount of property damage rather than deaths or injuries, we control for death and injuries attributed to catastrophes in our models.

[Insert Table 1]

[13] Catastrophes are identified via Swiss Re Sigma Reports (similar to Born and Viscusi, 2006). Each year Swiss Re publishes a Sigma Report that explores the impact of catastrophes, both in the U.S. and internationally. Included in each publication is a list of the 40 most costly catastrophes since 1970. Using available Swiss Re reports, catastrophes were selected for inclusion in this study if at any point during the sample period a catastrophe from the period was included on this list. It should be noted that this list changes each year as catastrophes are added and removed. We include a catastrophe once it is included on the list and keep it in the sample even if it is subsequently removed in another year. As such, smaller catastrophes occurred that are not included in this study. However, since we are interested in determining whether or not a relationship between catastrophes and life insurance demand exists, we focus on the largest catastrophes for purposes of this particular study.

We examine U.S. data for all states and all (aggregated) insurers for the period from 1994 through 2004 (for a total of 550 state-year observations). Life insurer-specific data are obtained from the National Association of Insurance Commissioners (NAIC), while additional state-specific data are from the U.S. Census and U.S. Census Statistical Abstracts. Catastrophe-related death and injury data are collected from the National Oceanic and Atmospheric Administration (NOAA), and data related to state-by-state declared disasters are from the Federal Emergency Management Agency (FEMA).

Our hypothesis is that states experiencing large catastrophic events will exhibit a greater demand for life insurance. To assess the relationship between catastrophes and the demand for life insurance, we estimate various fixed-effects regression models. The dependent variable for each of the models is the ratio of new individual life insurance policies issued (*IssuedNum*) in a given state for a given year to the state's yearly population.[14] Independent variables include catastrophe-based factors and economic/demographic control variables. Variable definitions are described below in Table 2.

[Insert Table 2]

Catastrophe-specific independent variables include: a binary variable indicating the occurrence of a major catastrophe (equal to one if yes, and zero otherwise) in a given state for a given year (*CAT*); a binary variable indicating the occurrence of a major catastrophe (equal to one if yes, and zero otherwise) in the prior year in a given state for a given year (*PriorCAT*); an interaction variable equal to one if the state experienced a catastrophe in the current and prior year (*CATInteract*); a binary variable equal to one if a state not directly affected by a catastrophic event borders a state that was directly affected by the event (*Contiguous*); a binary

[14] We examine the number of individual life insurance policies in a given state, as opposed to the total (including group) number of policies, since we anticipate that life insurance demand on an individual policy basis is more sensitive to catastrophes.

variable equal to one if a state not directly affected by a catastrophic event in the prior year borders a state that was directly affected by the event in the prior year (*PriorContiguous*); a variable (*Disasters*) that captures the number of declared disasters for each state;[15] the number of deaths attributed to a catastrophe (*CATDeath*); the number of deaths attributed to a catastrophe in the prior year (*PriorCATDeath*); the number of injuries attributed to a catastrophe (*CATInjury*); and the number of injuries attributed to a catastrophe in the prior year (*PriorCATInjury*).

Control variables (economic and demographic) are included based on findings from prior literature that imply a relationship between the control variable and life insurance demand, and for which state-level aggregate data are available. Control variables utilized in the regression models include: the total number of life insurers writing policies within a given state (*Insurers*); median household income in a given state (*MedianInc*);[16] the percent of homeownership in a given state (*Homeown*); and the percent of the state population between the ages of 25 and 64 in a given state (*Age*).[17]

An important consideration in estimating the model is the potential impact of firm effects and time effects.[18] To address the potential bias, we employ a fixed-effects approach, as described in Petersen (2009).[19] The model is represented in equation (1) as:

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[15] The variable is based on data (see http://www.fema.gov/news/disaster_totals_annual.fema) for the number of disasters that were declared (according to FEMA) for each state since 1953. For each individual state, we employ a single (constant) value. Variations of this variable could be used (such as a longer or shorter time period to calculate the number of disasters for each state, or an annually updated measure for each year of the sample period). A discussion of the variable's importance in the model follows.

[16] Median income data are based on two-year moving averages.

[17] We also considered per capita health expenditures and education as additional regressors. However, these factors were highly correlated with the other variables.

[18] If the residuals of the estimates between the states are correlated in a given year or if the residuals of the estimates for a given state are correlated over time, the standard errors will be biased downward, favoring a finding of statistical significance.

[19] The model employed consists of yearly fixed-effects with standard errors clustered by state (see Petersen, 2009). We also considered a two-way fixed-effects model using year and state fixed effects. However, since our data do not contain multiple observations within a single year (i.e., even if more than one catastrophe strikes a given state in a given year, no state is represented multiple times within a given year), a two-way fixed effects regression would not be appropriate as it would eliminate any cross-sectional variation. As per Petersen (2009), we also estimate a model in which standard errors are clustered by both state and year. The results obtained from the two-way cluster models are consistent with those presented in this paper and thus are not reported.

$$\begin{aligned}\log(DEMAND_{i,t}) &= \alpha + \beta_1 CAT_{i,t} + \beta_2 PriorCAT_{i,t} + \beta_3 CATInteract_{i,t}\\ &+ \beta_4 Contiguous_{i,t} + \beta_5 PriorContiguous_{i,t} + \beta_6 Disasters_i + \beta_7 \log(CATDeath)_{i,t}\\ &+ \beta_8 \log(PriorCATDeath)_{i,t} + \beta_9 \log(CATInjury)_{i,t} + \beta_{10} \log(PriorCATInjury)_{i,t}\\ &+ \beta_{11} \log(Insurers)_{i,t} + \beta_{12} \log(MedianInc)_{i,t} + \beta_{13} \log(Homeown)_{i,t}\\ &+ \beta_{14} \log(Age)_{i,t} + \varepsilon_{i,t}\end{aligned} \quad (1)$$

The primary variables of interest are the *CAT*, *PriorCAT*, and *Contiguous* variables.[20,21] The *CAT* (*PriorCAT*) binary variable allows us to determine whether a significant difference exists between demand for life insurance among states that did or did not experience a catastrophe in a given (prior) year. We include the *PriorCat* variable since there may be a lag between the occurrence of the catastrophe and the issuance of a new life insurance policy. The *CATInteract* variable is included in the regression models to account for any additional change in life insurance demand given consecutive years of catastrophe-exposure. We anticipate that at least one, if not all, of the *CAT* variables will be significant and positive.[22]

The *Contiguous* variable is included in order to determine if those states that are geographically close to a catastrophic event but not directly impacted by the event also experience an increase in life insurance demand.[23] As previously stated, individuals may rely on past experiences to determine if a hazard is serious enough to warrant the purchase of insurance.

[20] The variance inflation factors (VIFs) were checked for each of the independent variables employed in the models. None of the independent variables had a VIF greater than 4. Kennedy (1998) notes that a VIF greater than 10 may be cause for concern. Correlations between independent variables are located in the Appendix. Alternative versions of the models were estimated in which the *CAT* and *PriorCAT* variables were replaced by variables denoting the number of catastrophes impacting a given state in a given year or prior year. The results obtained from those regressions were similar to those presented here and thus are not reported. These additional variables are not included within our full model due excessive VIFs.

[21] The term “log” denotes the use of the natural logarithm throughout this paper.

[22] It should be noted that two phenomena potentially militate against finding a significant catastrophe effect. First, several states reappear in Table 1 over time, rendering an ever-shrinking pool of people for the catastrophes on which to have an effect. Second, it is possible that the states appearing multiple times may be more likely to experience a numbing effect in relation to their potential response to catastrophe risk and the need for life insurance (see Meyer, 2005).

[23] The *Contiguous* and *PriorContiguous* variables do not result in double-counting if the state has already been affected by a catastrophe. For example, if a hurricane strikes Florida but does not impact Georgia, Georgia is considered a contiguous state. However, if a hurricane strikes Florida and misses Georgia, but Georgia then experiences state-wide flooding in the same year, it will not be considered a contiguous state. This coding approach is followed in order to preserve the underlying purpose of the variable, which is to determine if non-impacted states experience an increase in the demand for life insurance when in close proximity to affected states.

Assuming an indirect experience may be sufficient enough to promote a change in the assessment of risk, we anticipate that one, if not both, of the *Contiguous* and *PriorContiguous* variables will be significant and positive. The *Disasters* variable is included in the models to assess whether states that historically have experienced more catastrophic events exhibit greater demand for life insurance, even prior to the actual occurrence of a catastrophe in a given year.

The number of deaths and injuries attributed to catastrophes in each state (*CATDeath*, *CATInjury*, *PriorCATDeath* and *PriorCATInjury*) are included in each of the regression models to account for the potential differential effects of catastrophe-related death and injury on the decision to insure mortality risk. Prior empirical research that examines the demand for property insurance following a catastrophe generally accounts for the size of insurable losses. While such a proxy does provide some indication of the overall destructiveness of the event, the number of deaths and injuries associated with a catastrophic event may also be related to the population's general insurance-purchasing response. We expect the coefficients of these variables, if they are significant, to be positive.[24]

In addition to the catastrophe-related variables, we also include state-specific factors that may influence life insurance demand. As noted previously, control variables included in the regression models are identified via prior life insurance demand literature. The *Insurers* variable proxies for the overall availability of life insurance in each state. We anticipate that an increasing number of insurers in a given state represents a greater level of life insurance availability and thus expect a positive relation between the number of insurers writing life insurance in a state and life insurance demand.

We also control for the potential effect of a given state's median income (*MedianInc*) and the level of homeownership (*Homeown*). Prior literature suggests that generally there is a positive relation between the demand for life insurance and both median income and

[24] The relatively small number of deaths and injuries that occur in the United States resulting from natural disasters suggests that the relation between these two variables (death and injury) and the demand for life insurance may be insignificant.

homeownership (Zietz, 2003). Income may have a positive relation with life insurance demand given the desire to protect the potentially higher level of income given premature death. However, Ganderton et al. (2000) suggest that individuals who are less wealthy (and likely have lower income) may be more likely to purchase insurance for low probability events. Related to homeownership, Ganolfi and Miners (1996) discuss that the expected sign on a homeownership variable could also be positive or negative. Homeownership may lead to an increased demand for life insurance if individuals hope to cover the cost of the mortgage in the event of death and if the home is not considered a liquid asset. Conversely, homeownership could result in a reduced demand for life insurance if individuals view the home as a liquid asset that could be used as a substitute for life insurance.

To control for the impact that population age may have on the demand for life insurance, we include the *Age* variable. Age may impact the demand for life insurance due to life-cycle factors or as a result of increased levels of dependency during certain portions of one's life. Lin and Grace (2007) find that the relation between age and life insurance demand changes over time and varies based on the level of household financial vulnerability. In particular, the authors find a positive relation between life insurance demand and financial vulnerability and that older individuals have a tendency to use less life insurance to protect against a given level of financial vulnerability than do younger individuals. Browne and Kim (1993), in their international examination of determinants of life insurance demand, find a positive and significant relation between the demand for life insurance and the dependency ratio.[25] Li, Moshirian, Nguyen and Wee (2007) also present evidence of a positive relation between the demand for life insurance and the dependency ratio in their analysis of life insurance demand within OECD countries. Similar to prior literature, we anticipate a positive relation between the demand for life insurance and the proportion of the population between the ages of 25 and 64.

[25] The dependency ratio used in Browne and Kim (1993) is given as the ratio of dependents (the portion of the population under the age of 15 or over the age of 64) to the working-age portion of the population (those between the ages of 15 to 64).

Summary statistics and expected signs for the coefficients are in Table 3, and a comparison of the means of the dependent and independent variables over the sample period appears in Table 4.

[Insert Table 3]

[Insert Table 4]

Table 4 provides some initial evidence that those states affected by a catastrophe tend to have a higher number of life insurance policies issued in a given year than do those states that are not directly affected by a catastrophic event. More specifically, states that experience a catastrophe have a significantly greater number of life insurance policies issued than those states that did not experience a catastrophe in six of the nine years in which a catastrophe occurred. We next present the results of the regression analyses.

EMPIRICAL RESULTS AND DISCUSSION

The findings from various forms of the regression model in equation (1) are presented in Table 5.[26] Results across all forms of the model indicate that the demand for life insurance is significantly higher in states that experienced a major catastrophe (relative to those states that did not experience a catastrophe) in a given year (*CAT*), and/or in the prior year (*PriorCAT*).[27]

[26] Due to concerns regarding any bias that may occur as a result of the events of September 11, 2001, we re-estimated the model after removing the 2001 New York observation. Results for models that included and excluded the 2001 New York observation are quantitatively similar. These similar results also hold true for the inclusion and exclusion of the 2002 New York observation.

[27] These results persist for models estimated with only *CAT* and *PriorCAT*, as well as for various additional forms of the model not shown here. In terms of the economic significance of the results, the coefficients on *CAT* and *PriorCAT* suggest that the marginal effect of a major catastrophe on a state's demand for new life insurance policies is approximately 21 percent to 26 percent (see Halvorsen and Palmquist, 1980).

Results for several forms of the model also suggest that catastrophic events are related to significantly higher demand for life insurance in neighboring states that are not directly affected by the catastrophe. Results from all models indicate that *Disasters* is not statistically significant, suggesting that the demand for life insurance is not systematically higher in those states that have experienced a greater number of declared disasters over time.

All of the coefficients on the control variables are statistically significant. We find that several variables are positively related to life insurance demand; namely, the number of life insurers (*Insurers*) writing business in a state, the percent of homeowners in a state (*Homeown*), and the percent of the state's population that is between the ages of 25-64 (*Age*), consistent with expectations from prior literature. Results also indicate that a state's median income (*MedianInc*) is negatively related to the demand for life insurance. Because we examine the number of new policies issued, as opposed to the amount of life insurance purchased, such a result would appear consistent with discussion and results from Ganderton et al. (2000) discussed above.

The evidence suggests that neither the number of deaths nor the number of injuries attributable to catastrophic events are related to life insurance demand, indicating that physical harm and loss of life are not necessarily drivers for increased life insurance demand (or indicating that their effects are outweighed by the other factors).

[Insert Table 5]

The results from our analyses provide evidence that life insurance purchasing behavior is related to recent state-specific catastrophe activity. The results indicate that states affected by catastrophes, as well as states that neighbor catastrophe-affected states, exhibit a demand for life insurance that is significantly greater than the demand in other states. Research by Tversky and

Kahneman (1974) examines a variety of biases and heuristics that affect judgment including an "availability" heuristic and a corresponding "retrievability" bias. The authors argue that individuals may assess the probability of an event based on "…the ease with which instances or occurrences can be brought to mind". Although availability may be useful in determining probability, this heuristic may be biased by "retrievability", whereby an event that is easily retrieved appears more likely than an event that is less easily retrieved, regardless of the actual probabilities of the two events. It is possible that the ease of event recall increases following catastrophes, which then leads to reassessment of the potential for loss and increased life insurance purchasing behavior.

The findings also may relate to an adjustment in risk perception following an event characterized by a great deal of uncertainty. Sunstein and Zeckhauser (2008) argue that individuals have a tendency to overreact to low-probability high-severity events, leading them to "…exaggerate the benefits of preventive, risk reducing, or ameliorative measures", particularly when faced by vivid and salient events. The occurrence of a catastrophe may lead individuals to overreact to the event as a result of what they witness both in person and through various forms of media, and this overreaction may lead to increased insurance purchasing behavior. The findings also are consistent with the tendency for some individuals to underinsure (e.g., Bernheim, Forni, Gokhale, and Kotlikoff, 1999). Following a catastrophic event, underinsured individuals may be motivated to purchase new or additional life insurance so as to reduce the gap between their needs and their coverage.

Another possible explanation for the higher demand for life insurance in states affected by major catastrophes relates to the issue of regret. Braun and Muermann (2004) argue that individuals may choose to purchase insurance not because they necessarily believe they need it, but rather because they would regret not having the insurance if an event occurred in which the insurance was needed. From this perspective, the catastrophic event induces some regret-based concern regarding the ownership of life insurance that prompts an individual to make the purchase. Results indicate that life insurance marketing efforts may be geared toward those affected by the destruction caused by a catastrophe.[28]

The results suggesting that the demand for life insurance increases in the year following a catastrophe may relate to a given catastrophe occurring late in the year or because individuals do not have the means to purchase life insurance directly following the event.[29] In the case of consumers not having the financial capability to purchase the insurance immediately following the catastrophe, this explanation would appear reasonable given the potential for prospective insureds to incur large property losses following a catastrophe.

SUMMARY AND CONCLUSIONS

With the potential to inflict billions of dollars in property damage and large losses of life, catastrophes can adversely affect individuals, businesses, states, and entire national economies. Large property losses caused by catastrophes have led prior literature to focus on the relationship between catastrophes and property insurance demand. We evaluate the relationship between catastrophic events and the demand for life insurance, and make two primary contributions to the prior literature. First, we provide evidence that the demand for life insurance in states directly affected by major catastrophes is significantly higher than life insurance demand in non-affected states, both in the year of the event and in the year following the event. Second, we provide evidence indicating that states bordering catastrophe-affected states also experience significantly greater demand for life insurance. Overall, while prior research has shown that catastrophes have spillover effects related to the demand for property

[28] This explanation seems rooted in the age-old adage that, "Insurance is sold, not bought". The findings also may be indicative of what Weisbart described as "…a fresh appreciation of the value of owning life insurance," as exhibited in the early 1900s.

[29] In the case of a late-year event, the life insurance application may not be processed until the following year, even if an individual completes the application in the year of the event. This explanation may be reasonable given the large number of events in our sample that occur in the second half of each year.

insurance, results of this study indicate that catastrophes also have spillover effects for life insurance demand.

Future research may consider the effect that catastrophes have on life insurance demand in markets outside of the United States. As noted earlier, the majority of natural disasters that occur in the U.S. do not result in substantial loss of life. However, outside of the U.S., natural disasters can and do result in large losses of life, and thus the question arises as to whether we might observe a similar relationship between catastrophes and life insurance demand in other countries following non-U.S. catastrophes.

Appendix Correlation Matrix

	CAT	PriorCAT	CATInteract	Contiguous	PriorContiguous	Disasters	Log(CATDeath)	Log(CATInjury)	Log(PriorCATDeath)	Log(PriorCATInjury)	Log(Insurers)	Log(MedianInc)	Log(Homeown)	Log(Age)
CAT	1.000													
PriorCAT	0.022	1.000												
CATInteract	0.455	0.436	1.000											
Contiguous	-0.218	-0.035	-0.110	1.000										
PriorContiguous	0.170	-0.227	-0.109	0.035	1.000									
Disasters	0.207	0.198	0.106	0.010	0.015	1.000								
Log(CATDeath)	0.509	0.012	0.232	-0.101	0.056	0.211	1.000							
Log(CATInjury)	0.575	-0.001	0.236	-0.118	0.156	0.202	0.724	1.000						
Log(PriorCATDeath)	-0.050	0.531	0.125	-0.081	-0.116	0.208	-0.028	-0.047	1.000					
Log(PriorCATInjury)	0.026	0.575	0.276	-0.041	-0.123	0.198	0.044	0.039	0.709	1.000				
Log(Insurers)	-0.050	-0.009	-0.117	-0.041	-0.060	0.310	0.063	0.032	0.083	0.014	1.000			
Log(MedianInc)	-0.091	-0.125	-0.068	0.029	0.013	-0.316	-0.042	-0.025	-0.072	-0.044	-0.388	1.000		
Log(Homeown)	0.144	0.087	0.069	0.105	0.114	-0.115	0.024	0.079	-0.010	0.063	-0.141	-0.189	1.000	
Log(Age)	0.101	0.089	0.082	0.072	0.058	-0.079	0.045	0.037	0.060	0.053	-0.408	0.423	-0.094	1.000

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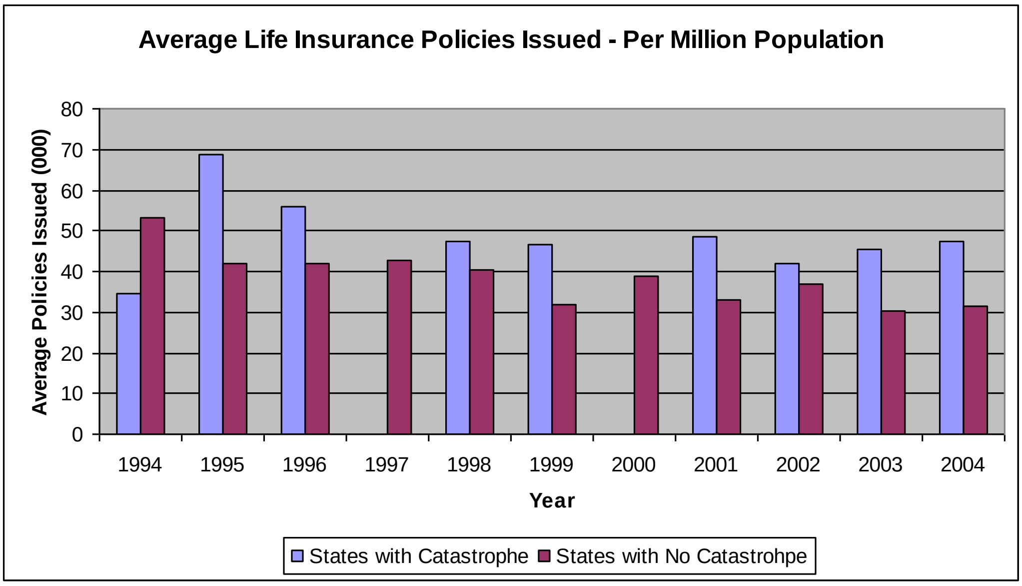
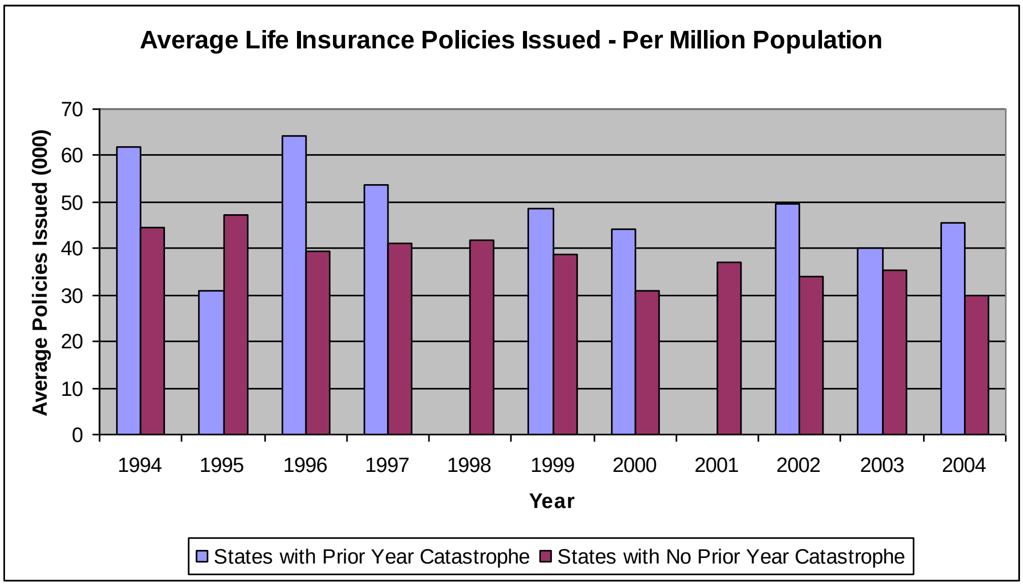
Figure 1
Comparison of Number of Policies Issued in States with and without Catastrophes in a Given Year



Note: Catastrophic events as defined for purposes of this study did not occur in our sample for 1997 or 2000.

Figure 2
Comparison of Number of Policies Issued in States with and without Catastrophes in the Prior Year



Note: Catastrophic events as defined for purposes of this study did not occur in the prior year for 1998 and 2001.

Table 1
Catastrophes Included in the Sample

Date	Peril	Insured Loss*	States Affected
01/17/1994	Northridge Earthquake	$19.6B	CA
05/05/1995	Wind, Hail, and Flooding	$1.5B	NM, TX
10/01/1995	Hurricane Opal	$3.4B	AL, FL, GA, MS, NC, SC, TN
09/05/1996	Hurricane Fran	$2.4B	MD, NC, OH, PA, SC, VA, WV
01/05/1998	Cold Spell with Ice and Snow	$1.5B	ME, NH, NY, VT
05/15/1998	Wind, Hail, and Tornadoes	$1.7B	IA, MN
09/20/1998	Hurricane Georges	$4.5B	AL, FL, LA, MS
05/03/1999	Series of Tornadoes in Midwest	$1.8B	AL, AR, FL, GA, IL, IN, KS, KY, LA, MO, MS, NC, NE, OH, OK, SC, TN, TX
09/10/1999	Hurricane Floyd	$3.5B	CT, DE, FL, GA, MA, MD, ME, NC, NH, NJ, NY, PA, RI, SC, VA, VT
04/06/2001	Hail, Floods, Tornadoes	$2.6B	AR, KS, MO, MS, OK, TX
06/05/2001	Tropical Storm Allison	$4.2B	FL, GA, LA, MS, NC, NJ, PA, SC, TX
04/27/2002	Spring Storm with Tornadoes	$1.9B	GA, IL, IN, KS, KY, MD, MO, NY, OH, PA, TN, VA, WV
04/04/2003	Thunderstorms and Hail	$1.8B	AL, IL, IN, LA, MI, MO, MS, NY, TN, TX
05/02/2003	Thunderstorms, Tornadoes, Hail	$3.6B	AL, AR, CO, GA, IA, IL, IN, KS, KY, MO, MS, NC, NE, OK, SC, SD, TN
08/11/2004	Hurricane Charley	$8.8B	FL, NC, SC
08/26/2004	Hurricane Frances	$5.6B	FL, GA, NC, NY, SC
09/02/2004	Hurricane Ivan	$14.1B	AL, DE, FL, GA, LA, MD, MS, NC, NJ, NY, OH, PA, TN, VA, WV
09/13/2004	Hurricane Jeanne	$4.2B	DE, FL, GA, MD, NC, NJ, NY, PA, SC, VA

*Note: Insured losses are inflation-adjusted to 2007 U.S. Dollars

Table 2
Variable Definitions

Variable	Definition
IssuedNum	Number of individual life insurance policies issued for a given state in a given year, scaled by the state's population in thousands
CAT	Binary variable denoting the occurrence of a major catastrophe for a given state in a given year
PriorCAT	Binary variable denoting the occurrence of a major catastrophe in the prior year for a given state
CATInteract	Interaction variable between the variables *CAT* and *PriorCAT*, equal to one if and only if a state experienced a major catastrophe in the current and prior year
Contiguous	Binary variable denoting a state that borders a state directly impacted by a catastrophe in a given year
PriorContiguous	Binary variable denoting a state that borders a state directly impacted by a catastrophe in the previous year
Disasters	The number of disasters declared by a given state since 1953
CATDeath	Number of deaths attributed to catastrophes for a given state in a given year
CATInjury	Number of injuries attributed to catastrophes for a given state in a given year
PriorCATDeath	Number of deaths attributed to catastrophes in the prior year for a given state
PriorCATInjury	Number of injuries attributed to catastrophes in the prior year for a given state
Insurers	Total number of life insurers licensed to write life insurance business for a given state in a given year
MedianInc	Median household income for a given state in a given year
Homeown	Percent of homeowners in the population for a given state in a given year
Age	Percent of the population between the ages of 25 and 64 for a given state in a given year

Table 3
Summary Statistics

Variable	Expected Sign	Mean	Standard Deviation	Minimum	Maximum
IssuedNum*	NA	229219	223670	13662	1080584
CAT	+	0.218	0.413	0	1
PriorCAT	+	0.232	0.423	0	1
CATInteract	+	0.054	0.227	0	1
Contiguous	+	0.172	0.378	0	1
PriorContiguous	+	0.171	0.377	0	1
Disasters	+	34.76	16.909	7	83
CATDeath	+	0.600	3.528	0	40
CATInjury	+	6.118	48.338	0	796
PriorCATDeath	+	0.732	4.080	0	53
PriorCATInjury	+	5.652	39.104	0	678
Insurers	+	687.5	78.4	522.0	990.0
MedianInc	+/-	46846.3	7120.5	31723.0	64545.5
Homeown	+/-	68.7	5.4	50.2	80.3
Age	+	0.519	0.020	0.437	0.554

*Note: The summary statistics for *IssuedNum* are based on the unscaled values.

Table 4
Comparison of Means across the Sample Period

Variable	1994	1995	1996	1998	1999	2001	2002	2003	2004
IssuedNum	-18.657	**26.64**	**13.93**	7.141	**14.73**	**15.70**	5.081	**15.12**	**15.86**
	(0.326)	**(0.003)**	**(0.028)**	(0.325)	**(0.000)**	**(0.000)**	(0.110)	**(0.000)**	**(0.000)**
Contiguous	-0.061	**-0.195**	**-0.186**	**-0.35**	**-0.333**	**-0.351**	**-0.460**	**-0.483**	**-0.235**
	(0.804)	**(0.003)**	**(0.003)**	**(0.000)**	**(0.010)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.003)**
PriorContiguous	-0.143	-0.073	-0.020	0	0.217	0	**0.376**	0.235	0.14
	(0.691)	(0.083)	(0.896)	(NA)	(0.098)	(NA)	**(0.007)**	(0.087)	(0.315)
CATDeath	**33**	3.889	3.714	**0.4**	**3.667**	2.154	**0.923**	**2.476**	1.875
	(0.000)	(0.146)	(0.087)	**(0.034)**	**(0.044)**	(0.240)	**(0.007)**	**(0.047)**	(0.317)
CATInjury	**138**	23.33	2.143	8.4	39.4	2.231	**21**	**30.1**	50.13
	(0.000)	(0.301)	(0.160)	(0.150)	(0.103)	(0.043)	**(0.041)**	**(0.012)**	(0.329)
PriorCATDeath	-2.102	-.805	-0.482	0	0.05	0	-0.5489	-0.085	0.401
	(0.794)	(0.323)	(0.435)	(NA)	(0.533)	(NA)	(0.389)	(0.655)	(0.721)
PriorCATInjury	-11.143	-3.366	-4.651	0	-3.783	0	0.879	1.013	-2.779
	(0.858)	(0.323)	(0.495)	(NA)	(0.191)	(NA)	(0.329)	(0.840)	(0.797)
Insurers	18.04	**67.3**	-1.718	-24.9	11.07	**46.86**	18.99	**40.27**	12.28
	(0.796)	**(0.005)**	(0.906)	(0.189)	(0.416)	**(0.000)**	(0.208)	**(0.000)**	(0.337)
MedianInc	3987	**-6700**	111.4	-2134.8	-884.93	-5043.6	-355.63	**-6377.8**	-2479.2
	(0.555)	**(0.000)**	(0.968)	(0.389)	(0.670)	(0.033)	(0.881)	**(0.000)**	(0.247)
Homeown	**-10.518**	1.379	3.725	1.395	0.608	1.204	2.182	0.569	2.087
	(0.039)	(0.326)	(0.101)	(0.477)	(0.704)	(0.489)	(0.188)	(0.696)	(0.160)
Age	0.009	-0.003	0.013	0.003	**0.015**	-0.006	0.007	-0.007	0.005
	(0.692)	(0.715)	(0.119)	(0.688)	**(0.000)**	(0.344)	(0.234)	(0.167)	(0.312)

The difference between the means of catastrophe and non-catastrophe affected states are provided and is calculated as the mean of catastrophe states minus the mean of non-catastrophe states. P-values are provided in parentheses. The *Disasters* variable is not included in Table 4, given its time invariant nature.

Table 5
Fixed-Effects Regression Results for Catastrophes and the Demand for Life Insurance

	Dependent Variable: *IssuedNum*				
Variable	Model 1	Model 2	Model 3	Model 4	Model 5
Intercept	-9.5116**	-10.7051**	-11.1747**	-10.8852**	-11.3379**
	(4.5742)	(4.9818)	(5.0686)	(5.0227)	(5.1016)
CAT	**0.2584*** **	**0.2648*** **		**0.2432*** **	
	(0.0480)	**(0.0493)**		**(0.0462)**	
PriorCAT	**0.2329*** **		**0.2395*** **		**0.2157*** **
	(0.0450)		**(0.0465)**		**(0.0428)**
CATInteract	-0.0647			**0.0841** **	**0.0829* **
	(0.0480)			**(0.0418)**	**(0.0439)**
Contiguous	**0.0772*** **	**0.0934*** **	0.0059	**0.0933*** **	0.0130
	(0.0275)	**(0.0319)**	(0.0290)	**(0.0317)**	(0.0284)
PriorContiguous	**0.0452* **	-0.0181	**0.0756** **	-0.0077	**0.0769** **
	(0.0260)	(0.0273)	**(0.0305)**	(0.0265)	**(0.0308)**
Disasters	0.0003	0.0007	0.0008	0.0008	0.0008
	(0.0020)	(0.0022)	(0.0023)	(0.0022)	(0.0023)
Log(CATDeath)	-0.0182	-0.0240	0.0145	-0.0247	0.0107
	(0.0306)	(0.0293)	(0.0312)	(0.0296)	(0.0315)
Log(CATInjury)	-0.0100	-0.0106	0.0192	-0.0096	0.0178
	(0.0183)	(0.0185)	(0.0191)	(0.0182)	(0.0194)
Log(PriorCATDeath)	-0.0130	0.0212	-0.0167	0.0240	-0.0102
	(0.0309)	(0.0295)	(0.0306)	(0.0299)	(0.0307)
Log(PriorCATInjury)	0.0012	0.0254	-0.0035	0.0200	-0.0059
	(0.0193)	(0.0177)	(0.0196)	(0.0188)	(0.0199)
Log(Insurers)	**1.3980*** **	**1.4297*** **	**1.4775*** **	**1.4449*** **	**1.4891*** **
	(0.4890)	**(0.5163)**	**(0.5361)**	**(0.5184)**	**(0.5362)**
Log(MedianInc)	**-0.3962* **	**-0.4519* **	**-0.4598* **	**-0.4438* **	**-0.4526* **
	(0.2103)	**(0.2325)**	**(0.2365)**	**(0.2320)**	**(0.2362)**
Log(Homeown)	**0.7932** **	**0.8922** **	**0.8975** **	**0.8975** **	**0.9043** **
	(0.3876)	**(0.4016)**	**(0.4072)**	**(0.4038)**	**(0.4086)**
Log(Age)	**1.2226** **	**1.5252** **	**1.5815** **	**1.5179** **	**1.5766** **
	(0.5397)	**(0.5952)**	**(0.6119)**	**(0.5942)**	**(0.6118)**
Observations	550	550	550	550	550
Adjusted R-squared	0.56	0.52	0.51	0.53	0.52

*, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.
Values in parentheses represent robust standard errors.