

Catastrophes and the Demand for Life Insurance

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Abstract The occurrence of a catastrophe may lead to an increase in risk perception, risk mitigation, and insurance purchasing behavior. While evidence for such a phenomenon has been documented for property insurance, such a relationship between catastrophes and the demand for life insurance has not been explored. The current study assesses the relation between natural disasters and the demand for life insurance in the United States from 1994 through 2004. The empirical results provide evidence of a significant and positive relation 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

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In August 2005, Hurricane Katrina struck the U.S. Gulf Coast, resulting in an estimated 1800 deaths and \$81 billion in total property damage in Alabama, Florida, Georgia, Louisiana, Mississippi, and Tennessee (Knabb, Rhome, and Brown 2005). Prior literature contends that natural disasters such as Hurricane Katrina 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 products (e.g., Browne and Hoyt 2000). While the question of how, “people perceive and respond to these disasters is of fundamental interest” (Viscusi and Zeckhauser 2006), research has thus far not focused on the potential impact that such catastrophes could have on the demand for life insurance.

This paper examines the demand for life insurance following catastrophes in the United States and makes three primary contributions. First, our results suggest that the demand for life insurance increases in states affected by catastrophes. This result persists both in the year of the event and in the year following the event. Second, we find that states that neighbor catastrophe-affected states also experience an increase in the demand for life insurance, even when not directly impacted by the event. Finally, we test for catastrophe-specific effects and we show that the demand for life insurance in states affected by catastrophes (and neighboring states) increased significantly following hurricanes and tornadoes both in the years the events occurred and in the year following the catastrophic event.

The remainder of this paper is organized as follows. We first 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 examine the

relationship between specific types of catastrophes and life insurance demand by refining our catastrophe variables. Last, we present and discuss our results and provide conclusions.

1 The Response to Catastrophic Events and the Demand for Insurance

1.1 Catastrophic Events and Property Insurance

When catastrophes, particularly natural disasters, strike in the United States, property losses are often large while loss of life is relatively minimal.¹ The potential losses associated with such catastrophes can often be reduced through a combination of loss mitigation and the purchase of insurance.² Although individuals may choose to insure these losses through the use of homeowners insurance, earthquake insurance, and/or flood insurance, often the amount purchased is not sufficient to ensure total indemnification in the event of an insurable loss. In the case of Hurricane Katrina, property losses totaled over \$81 billion, yet only \$43.6 billion of the property damage was insured (Insurance Information Institute 2008).

A number of explanations have been provided as to why individuals do not take action to mitigate losses or purchase seemingly necessary insurance products when they are at risk. Kunreuther (1976) evaluated the reasons why individuals in hazard-prone areas purchased insurance against those hazards. The author argued that the decision-making process with respect to insurance purchasing occurs in four distinct stages. First, individuals must perceive the risk as an event which 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

¹ 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, Klindorfer and Kunreuther (1999) note that individuals will typically be leery of adopting these mitigation measures unless the measures are extremely cost effective.

to make an insurance-purchasing decision. Fourth, the individuals must determine whether or not insurance is an attractive purchase. This implies that if one 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.

Slovic, Fischhoff, Lichtenstein, Corrigan, and Combs (1977) investigate the reasons why individuals choose not to protect themselves against low-probability risks. Using a number of experimental approaches, the authors present a threshold explanation to describe why individuals may not purchase insurance. The authors argue that there is some probability threshold that must be crossed before one purchases insurance. 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.

Kunreuther (1984) further explores the failure to purchase disaster insurance. First, he argues that individuals may rely on past experiences to determine if a risk is serious enough to warrant the purchase of insurance. Second, 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. 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 Sullivan, Mustart, and Galehouse 1977; Palm, Hodgson, Blanchard, and Lyons 1990).

Ganderton, Brookshire, McKee, Stewart and Thurston (2000) use an experimental approach to explain insurance buying behaviors. In particular, the authors use a set of experiments to explain the decision to purchase insurance for low-frequency, high-severity events. The authors 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).

Kunreuther and Pauly (2004) provide a theoretical model to explain why individuals may not insure against low-probability events. The authors 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). When the probability is assumed to be inconsequentially low, the consumer may not feel that the costs associated with researching and ultimately obtaining insurance are worth the benefits attributed to the actual insurance product. Thus, while individuals may want to maximize expected utility, the costs associated with obtaining information may be so great that they do not purchase the insurance.

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 necessary insurance prior to a large-loss event.³ Literature indicates, however, that some individuals are moved to purchase property insurance after the occurrence of a catastrophic event. Sullivan, Mustart, and Galehouse (1977) studied 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 respondents had purchased earthquake insurance for their residence.⁴ In 1976 the authors re-surveyed the area and found 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

³ For a thorough examination of these potential cognitive biases, see Meyer, 2005.

⁴ Some reasons provided for not purchasing earthquake insurance included that it was too expensive, not necessary, or that respondents were not aware that it was available.

increase may be a result of respondents experiencing the effects of the San Fernando earthquake in 1971.

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 earthquakes that occurred in the early 1980s appeared to be associated with earthquake insurance purchases in three of the four counties surveyed.

Shelor, Cross, and Anderson (1992) examined the impact of the 1989 Loma Prieta earthquake on insurer stock values. The authors found that stock prices increased following the earthquake for two samples of insurers (one containing property-liability insurers based on primary SIC codes, and one with both primary and secondary property-liability and life-health SIC codes), 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. However, the authors do not explicitly discuss the potential influence that the presence of the life insurers had on the results, nor do the authors suggest that the demand for life insurance might increase as well.

Browne and Hoyt (2000) assess the factors that drive the demand for flood insurance. Evaluating the period from 1983 to 1993, the authors find that in addition to income and price, 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 residing in states that had not experienced such large losses. Zaleskiewicz, Piskorz, and Borkowska (2002) also investigate the effects that the occurrence of a flood can have on insurance

purchasing behavior. The authors evaluate a sample of 66 property owners who were affected by a 1997 flood in Poland and find that those 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.

Although the empirical literature focusing on the relationship between insurance demand and catastrophic events concentrates on property insurance, there is some anecdotal evidence 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”. Coupled with the theoretical and empirical literature reviewed above, this anecdotal evidence encourages an empirical investigation into the relationship between the occurrence of catastrophes and life insurance demand.

1.2 Demand for Life Insurance

Although research indicates that the occurrence of a catastrophe may lead to an increase in risk perception, risk mitigation, and insurance purchasing behavior in general, the literature has not examined the impact that such an event may have on the demand for life insurance. Figure 1 shows the average number of life insurance policies issued for states that did and did not experience a catastrophic event 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. Figure 2 shows the average number of life insurance policies issued for states that did and did not experience a catastrophic event in the prior year. Similar to the findings in Browne and Hoyt’s (2000) analysis of flood insurance purchases, Figure 1 and Figure 2 indicate that

states affected by a large catastrophic event not only experience an increase in the demand for life insurance in the year of the event, but also in the year following the event.

[Insert Figure 1]

[Insert Figure 2]

The increase in the demand for property insurance following a catastrophe is intuitively congruent, as individuals observe the actual damage caused to either their own possessions or the property of others, which may then lead to a change in attitude regarding risk. 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”. However, 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. when compared to those that occur on an international scale. 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. Such mental and cognitive adjustments could be responsible for changes in the demand for products which could 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 from future harm. We argue that while such protection efforts may 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.

While catastrophe-induced insurance purchases may in some cases be associated with irrational behavior, the occurrence of a disaster has been shown to increase the awareness of insurance as a need (Browne and Hoyt 2000). Thus, the existence of distress following a catastrophic event could increase the (rational or irrational) demand for life insurance. Those who do not have life insurance (or who do not carry a “sufficient” amount) may reassess their needs after witnessing the destruction caused by a catastrophic event. Furthermore, individuals may feel inclined to proactively protect themselves as a result of this greater risk awareness.

Zietz (2003) provides a survey of the various factors that have been identified by prior research as determinants of life insurance demand.⁵ In general, most 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, we argue that catastrophes may be an event of significant enough import in an individual’s life to induce a change in the demand for life insurance.

2 Data and Empirical Method

Major catastrophes are defined here as those events affecting the United States and resulting in large insured property losses. Because we are primarily interested in determining whether or not the occurrence of a catastrophe is related to life insurance purchasing behaviors, 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. We examine state-specific data for all states and all insurers (aggregated) for the period from 1994 through 2004 (a total of 550 observations). Life insurer-specific data is obtained from the National Association of Insurance Commissioners (NAIC) database while additional

⁵ Among the factors identified 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).

state-specific data is from the U.S. Census and U.S. Census Statistical Abstracts. Catastrophe-related death and injury data is collected from the National Oceanic and Atmospheric Administration (NOAA). Catastrophes are identified via Swiss Re Sigma Reports (Born and Viscusi 2006).⁶ Our sample of catastrophes consists of a total of 18 events (Table 1). The identified catastrophes are then used to determine if a relationship exists between large catastrophes and life insurance demand.

While selecting catastrophes on the basis of victims (either deaths or injuries) may seem appropriate when evaluating the demand for life insurance, for a number of reasons we focus instead on events based on the size of insured property damage. First, very few catastrophes occur within the U.S. that result in 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 either a rational or irrational change in the perception of risk, the property damage resulting from the catastrophe may be sufficient to induce an increase in the demand for life insurance.

[Insert Table 1]

Two separate yearly fixed effects regression models are estimated to assess the relationship between catastrophes and the demand for life insurance. The first model uses the number of individual life insurance policies issued (*IssuedNum*) in a given state for a given year as the dependent variable, while the second model uses the face value of individual life

⁶ 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 exist 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.

insurance policies (*FaceAmt*).⁷ Each dependent variable is scaled by the population within the appropriate state. Independent variables incorporated in each regression include catastrophe-based variables and economic/demographic control variables. Variable definitions are below in Table 2.

[Insert Table 2]

Catastrophe-specific independent variables include: a binary variable indicating the occurrence of a major catastrophe in a given state for a given year (*CAT*); a binary variable indicating the occurrence of a major catastrophe in the prior year in a given state for a given year (*PriorCAT*); an interaction variable between the *CAT* and *PriorCAT* variables (*CATInteract*); a binary variable indicating whether a state not directly affected by a catastrophic event borders a state that was directly affected by the event (*Contiguous*); a binary variable indicating whether 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*); 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 selected based on findings from prior literature that imply a relationship between the control variable and life insurance demand. Control variables utilized in the regression models include: the percent of homeownership in a given state (*Homeown*); median income in a given state (*MedianInc*); the

⁷ Individual life insurance policies are used rather than the total number of policies in a given state as we anticipate that an increase in demand will occur on an individual policy basis rather than on a group policy basis.

percent of the state population between the ages of 25 and 64 in a given state (*Age*); and the total number of life insurers writing policies within a given state (*Insurers*).⁸

An important consideration in estimating the model is the potential impact of firm effects and time effects. 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. To address this potential bias, we employ a fixed-effects approach, as described in Petersen (2009).⁹ The basic model is represented as:

$$\begin{aligned}
\log(\text{DEMAND}_{i,t}) = & \alpha + \beta_1 \text{CAT}_{i,t} + \beta_2 \text{PriorCAT}_{i,t} + \beta_3 \text{CATInteract}_{i,t} \\
& + \beta_4 \text{Contiguous}_{i,t} + \beta_5 \text{PriorContiguous}_{i,t} + \beta_6 \log(\text{CATDeath})_{i,t} \\
& + \beta_7 \log(\text{PriorCATDeath})_{i,t} + \beta_8 \log(\text{CATInjury})_{i,t} + \beta_9 \log(\text{PriorCATInjury})_{i,t} \quad (1) \\
& + \beta_{10} \log(\text{Age})_{i,t} + \beta_{11} \log(\text{MedianInc})_{i,t} + \beta_{12} \log(\text{Homeown}) \\
& + \beta_{13} \log(\text{Insurers})_{i,t} + \varepsilon_{i,t}
\end{aligned}$$

The primary variables of interest are the *CAT*, *PriorCAT* and *Contiguous* variables.¹⁰ The *CAT* binary variable allows us to determine whether or not a change in the demand for life insurance occurs in a given state for a given year when a catastrophe occurs. The *PriorCAT* binary variable allows us to determine whether or not a catastrophe that occurred in the prior year in a given state results in a change in the demand for life insurance in the following year. We include the *PriorCat* variable since there may be a lag between the occurrence of the

⁸ We considered the inclusion of per capita health expenditures and education as additional regressors. However, the regressors were highly correlated with the other regressors used in the model.

⁹ The model employed consists of yearly fixed-effects with standard errors clustered by state, as described in 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 estimated a model in which standard errors are clustered by both state and year. The results are consistent between the two methods.

¹⁰ 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 a 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 to concerns over excessive VIFs.

catastrophe and the issuance of a new life insurance policy. We anticipate that one, if not both, of the *CAT* and *PriorCAT* variables will be significant and positive.

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.¹¹ As previously stated, individuals may rely on past experiences to determine if a hazard is serious enough to warrant the purchase of insurance. 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.¹² We do not impose any expectations regarding the direction of the control variable coefficients. Summary statistics are in Table 3, and a comparison 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 greater number of life insurance policies issued than those states that did

¹¹ 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 is done 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.

¹² It should be noted that two phenomena mitigate 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 to have an effect on. Second, the states that appear multiple times are more likely to experience a ‘numbing’ effect in relation to their potential response to catastrophe risk and the need for life insurance.

not experience a catastrophe in six of the nine years in which a catastrophe occurred. Although this evidence supports the hypothesis that life insurance demand is positively related to the occurrence of a catastrophe, Table 4 also indicates that there is not a significant difference in the amount of life insurance in force between states that are and are not directly impacted by a catastrophe.

3 Empirical Results

The results of the regression model based on equation (1) for both the *IssuedNum* and *FaceAmt* dependent variables are presented in Table 5.^{13,14} Focusing first on the *IssuedNum* dependent variable, the results indicate that the *CAT*, *PriorCAT*, and *Contiguous* variables all are statistically significant and positive. The control variables that are statistically significant include the number of insurers writing policies in a given state, the percent of the state between the ages of 25 and 64, median income, and the level of homeownership in a given state. Results indicate that the occurrence of a catastrophe in a given year, or in the prior year, is related to a significant increase in the demand for life insurance. Additionally, results suggest that catastrophic events are significantly related to increases in the demand for life insurance in neighboring states that are not directly affected by the catastrophe. However, evidence does not suggest that the number of deaths or the number of injuries attributable to the event are related to demand, nor does a relationship appear to exist between the occurrence of a catastrophe in the prior year and life insurance demand in a non-impacted neighboring state.

¹³ Due to concerns regarding the bias which 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 nearly identical. This result also holds true for the inclusion and exclusion of the 2002 New York observation.

¹⁴ As a result of the relatively high correlations among the death and injury variables, the models are also estimated after omitting these variables. The results are quantitatively similar to those presented.

[Insert Table 5]

The regression results using the *FaceAmt* dependent variable are similar to those obtained using the *IssuedNum* dependent variable. The *CAT* and *PriorCAT* variables once again are statistically significant and positive, as are the *Contiguous* and the *PriorContiguous* dummy variables. These results imply that the amount of life insurance purchased increases significantly both in the year of a catastrophe and in the year following a catastrophe. Results also suggest that neighboring states which are not directly affected by the catastrophe experience a significant increase in the amount of life insurance purchased compared to non-neighboring states.

Based on the two alternative dependant variables employed above, results suggest that the occurrence of a catastrophe is related to an increased demand for life insurance and that the increased demand persists even in the year following the event. Results also indicate that neighboring states exhibit a significant increase in the demand for life insurance even when not directly affected by the event. It should also be noted that none of the death or injury variables entered the regressions significantly, 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).¹⁵

The results in the previous analysis imply that the occurrence of a catastrophe in the form of a natural disaster is related to an increase in the demand for life insurance. To gain further insight, we examine the impact that specific catastrophes may have on the demand for life insurance by creating new binary variables that indicate the type of catastrophe in a given state for a given year. Because our sample contains only one flood and one earthquake event, we create an “Other” category that encompasses the flood and earthquake, as well as four

¹⁵ A number of the states within our sample never experienced a catastrophe over the sample period. As a result, we also estimated the models after excluding these states. The results are quantitatively similar to those reported.

other events that are not identified as hurricanes or tornadoes.¹⁶ The summary of these events is shown in Table 6.

[Insert Table 6]

Similar to our *CAT* variables, we include prior year variables to determine if there is a residual effect on the demand for life insurance in the year after a natural disaster occurs. We estimate the same yearly fixed-effects regression model used in the previous section, but we remove the *CAT*, *PriorCAT* and *CATInteract* variables and replace them with the event-specific variables.¹⁷

The results using the event-specific independent variables are located in Table 7.¹⁸ Based on the *IssuedNum* dependent variable, and similar to the regressions in the previous section, the *Contiguous* variable is statistically significant. With respect to the event-specific variables, the *Hurricane*, *Tornado*, and *Other* variables are all statistically significant and positive, indicating that the occurrence of any of these events is related to a significant increase in the demand for life insurance. The prior-year variables for *Hurricane*, *Tornado*, and *Other* are also positive and statistically significant, suggesting that an increase in life insurance demand continues into the next year following a catastrophe.

¹⁶ The following events are included in the *Other* category: Northridge Earthquake (01/17/1994), Wind, Hail, and Flooding (05/05/1995), Cold Spell with Ice and Snow (01/05/1998), Hail, Floods, and Tornadoes (04/06/2001), Tropical Storm Allison (06/05/2001), and Thunderstorms and Hail (04/04/2003). The Hail, Floods, and Tornadoes (04/06/2001) event was classified as an *Other* event due to concerns regarding proper interpretation of the results given that the event included both floods and tornadoes. The models are also estimated when classifying this event as a *Tornado* event rather than as an *Other* event and results are quantitatively similar to those presented.

¹⁷ The omitted group for the dummy variables consists of states that did not experience a catastrophe in a given year.

¹⁸ Half of the hurricanes in our sample occurred in 2004. In order to ensure that these observations are not overly influential on the results, the regressions are estimated without the 2004 observations. Our results are quantitatively similar to those obtained from the model including the 2004 observations. We also estimated separate regressions in which we removed single years to ensure that no single year influences the overall results. The results from these additional regressions indicate that no single year unduly influences the variables of interest. This procedure is also performed for the analyses in the prior section and results are quantitatively similar.

[Insert Table 7]

Event-specific regression results based on the *FaceAmt* dependent variable indicate that the *Contiguous* variable is once again significant, as is the *PriorContiguous* variable. Consistent with the results of the previous model, the *Hurricane*, *Tornado*, and *Other* variables are all significant and positive. Additionally, states impacted by hurricanes and tornadoes (as well as those events contained in the *Other* variable) tend to experience a significant increase in the demand for life insurance in the year following the event.

The results from the event-specific regressions imply that (1) the demand for life insurance increases both in the year of the event and in the year following the event for states affected by hurricanes and tornadoes, and (2) the demand for life insurance in neighboring states that are not directly affected by the catastrophe increases significantly in the year the catastrophe occurs. These results are similar to the results obtained in the prior analysis.

4 Discussion

The results from our state-level analyses provide evidence that life insurance purchasing behavior is related to the occurrence of catastrophes. The results first imply that states affected by catastrophes experience an increase in life insurance demand that is significantly greater than the demand experienced in other states. Several reasons discussed below may help to explain this increased demand. Such a finding may be the result of 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. This overreaction may then induce an individual to purchase insurance, even if the probability of loss associated with the risk suggests that the purchase is unwarranted. The findings are also 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 additional life insurance so as to reduce the gap between their needs and their coverage.

Another possible explanation for the increased demand for insurance 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 also may indicate that, from a marketing perspective, life insurers may gear their marketing efforts towards those affected by the destruction caused by a catastrophe. This explanation seems rooted in the age-old adage that “Insurance is sold, not bought”. The results may also be indicative of what Weisbart described as “...a fresh appreciation of the value of owning life insurance,” as exhibited in the early 1900s.

The results also suggest that the demand for life insurance increases in the year following a catastrophe. Such a result may occur for several reasons, including either because a given catastrophe occurs late in the year or because the individual does not have the means to purchase life insurance directly following the event. 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. In the case of the consumer not having the financial capability to purchase the insurance immediately following the catastrophe, this explanation would appear reasonable given that the individual experiences large property losses following a catastrophe and the individual may not have the means to purchase life insurance until the property losses have been covered.

In addition to those states directly affected by the catastrophe, neighboring states also appear to experience an increased demand for life insurance. While several explanations likely relate to this result, some insight may be gained from Tversky and Kahneman (1974). The authors discuss 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. Thus, while those individuals in neighboring states are not directly affected by the catastrophic event, ease of event recall increases which may then lead to a reassessment of the potential for loss and the purchase of life insurance.

Based on the event-specific regressions, results suggest that both hurricanes and tornadoes result in an increase in life insurance demand in the year of the event and in the year following the event. These events are of particular interest because they represent the largest amount of property damage (hurricanes) and the largest number of deaths and injuries (tornadoes) within our sample. The results are particularly interesting because of the differing characteristics of these events, in terms of preparatory time before the event (tornadoes appear with little or no warning while attention may be given to hurricanes days

before landfall), the number of occurrences (tornadoes occur with much greater frequency than do hurricanes), and the potential for damage (the NOAA states that hurricanes often result in greater damage than tornadoes). Although many characteristics differentiate these events, they each have seemingly similar relationships to life insurance purchasing decisions.

5 Conclusions

With the potential to impose billions of dollars in property damage and large losses of life, catastrophes are not only costly to society but also have the ability to adversely affect individuals, businesses, states, countries, 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 life insurance demand, and make three primary contributions to the prior literature. First, we explore the relationship between life insurance demand and catastrophic events and find that the demand for life insurance in states directly affected by a catastrophe significantly increases both in the year of the event and in the year following the event. Second, we examine how a catastrophe in one state may influence demand for life insurance in neighboring states that are not directly impacted by the event. Results indicate that states bordering catastrophe-affected states also experience a significantly greater increase in the demand for life insurance. Finally, we investigate the effect that particular types of events may have on the demand for life insurance. Results suggest that tornadoes and hurricanes are related to an increased demand for life insurance, both in the year of the event and in the year following the event. Overall, our results indicate that when viewing the potential implications of catastrophes on insurance demand, it is important to consider life insurance as well as property insurance.

A number of opportunities for future research are apparent in the area of life insurance demand and catastrophes. First, prior literature offers evidence that the stock prices of property-casualty insurers experience abnormal returns following the occurrence of a catastrophe. Does a similar market response occur for life insurer stock prices following a natural disaster? Second, future research also may consider the effect that catastrophes have on life insurance demand in markets outside of the United States. As noted previously, the majority of natural disasters that occur in the U.S. do not result in a substantial loss of life. However, outside of the U.S., natural disasters can and do result in large losses of life, and thus we might observe an even greater increase in the demand for life insurance in other countries following non-U.S. catastrophes.¹⁹

¹⁹ For example, 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).

Appendix Correlation Matrix

	CAT	PriorCAT	CAInteract	Contiguous	PriorContiguous	Log(CATDeath)	Log(CATInjury)	Log(PriorCATDeath)	Log(PriorCATInjury)	Log(Insurers)	Log(Age)	Log(MedianInc)	Log(Homeown)
CAT	1.000												
PriorCAT	0.021	1.000											
CAInteract	0.454	0.436	1.000										
Contiguous	-0.217	-0.033	-0.109	1.000									
PriorContiguous	0.169	-0.227	-0.109	0.037	1.000								
Log(CATDeath)	0.508	0.011	0.232	-0.100	0.055	1.000							
Log(CATInjury)	0.574	-0.001	0.235	-0.117	0.155	0.723	1.000						
Log(PriorCATDeath)	-0.050	0.531	0.125	-0.080	-0.116	-0.027	-0.046	1.000					
Log(PriorCATInjury)	0.026	0.574	0.275	-0.040	-0.040	0.043	0.038	0.708	1.000				
Log(Insurers)	-0.051	-0.010	-0.117	-0.037	-0.060	0.062	0.031	0.082	0.013	1.000			
Log(Age)	0.101	0.090	0.062	0.069	0.058	0.045	0.037	0.060	0.053	-0.407	1.000		
Log(MedianInc)	-0.091	-0.125	-0.067	0.028	0.013	-0.042	-0.025	-0.072	-0.043	-0.368	0.422	1.000	
Log(Homeown)	0.142	0.085	0.068	0.117	0.112	0.023	0.077	-0.011	0.062	-0.147	-0.091	-0.190	1.000

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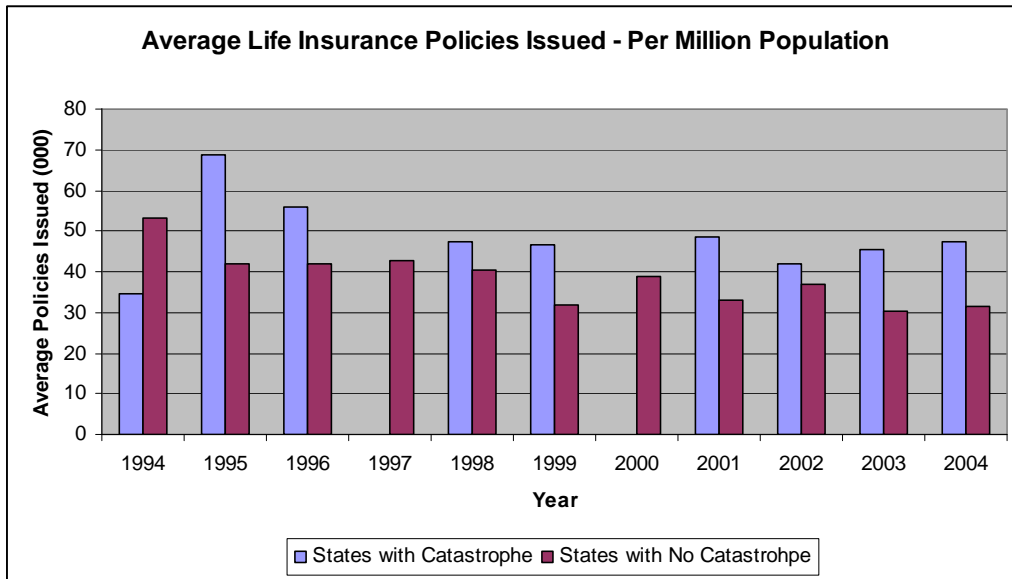
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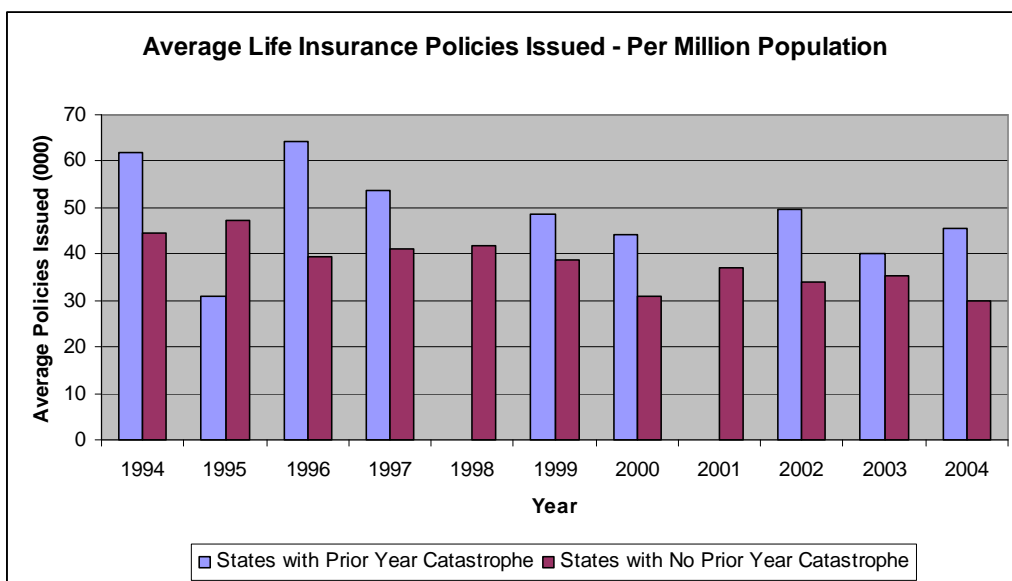
Figures

Fig. 1 Comparison of Policies Issued in States With and Without Catastrophes



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

Fig. 2 Comparison 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.

Tables

Table 1 Included Catastrophes

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
FaceAmt	Amount of individual life insurance in force 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 <i>CAT</i> and <i>PriorCAT</i>
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
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
Age	Percent of the population between the ages of 25 and 64 for a given state in a given year
MedianInc	Median income for a given state in a given year
Homeown	Percent of homeowners in the population for a given state in a given year

Table 3 Summary Statistics

Variable	Mean	Std. Dev.	Min	Max
IssuedNum*	229219	223670	13662	1080584
FaceAmt (\$Billions)*	184	218	10.3	1820
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
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
Age	0.519	0.020	0.437	0.554
MedianInc	46846.3	7120.5	31723.0	64545.5
Homeown	68.7	5.4	50.2	80.3
Insurers	687.5	78.4	522.0	990.0

*Note: The summary statistics for *IssuedNum* and *FaceAmt* 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 (0.326)	26.64 (0.003)	13.93 (0.028)	7.141 (0.325)	14.73 (0.000)	15.70 (0.000)	5.081 (0.110)	15.12 (0.000)	15.86 (0.000)
FaceAmt (Millions)	-2.340 (0.602)	-1.360 (0.397)	0.118 (0.950)	0.735 (0.694)	4.360 (0.008)	-0.836 (0.699)	3.960 (0.274)	-1.06 (0.671)	2.380 (0.386)
Contiguous	-0.061 (0.804)	-0.195 (0.003)	-0.186 (0.003)	-0.35 (0.000)	-0.333 (0.010)	-0.351 (0.000)	-0.460 (0.000)	-0.483 (0.000)	-0.235 (0.003)
PriorContiguous	-0.143 (0.691)	-0.073 (0.083)	-0.020 (0.896)	0 (NA)	0.217 (0.098)	0 (NA)	0.376 (0.007)	0.235 (0.087)	0.14 (0.315)
CATDeath	3 (0.000)	3.889 (0.146)	3.714 (0.087)	0.4 (0.034)	3.667 (0.044)	2.154 (0.2401)	0.923 (0.007)	2.476 (0.047)	1.875 (0.317)
CATInjury	138 (0.000)	23.33 (0.301)	2.143 (0.160)	8.4 (0.150)	39.4 (0.103)	2.231 (0.043)	21 (0.041)	30.1 (0.012)	50.13 (0.329)
PriorCATDeath	-2.102 (0.794)	-0.805 (0.323)	-0.482 (0.435)	0 (NA)	0.05 (0.533)	0 (NA)	-0.5489 (0.389)	-0.085 (0.655)	0.401 (0.721)
PriorCATInjury	-11.143 (0.858)	-3.366 (0.323)	-4.651 (0.495)	0 (NA)	-3.783 (0.191)	0 (NA)	0.879 (0.329)	1.013 (0.840)	-2.779 (0.797)
Age	0.009 (0.692)	-0.003 (0.715)	0.013 (0.119)	0.003 (0.688)	0.015 (0.000)	-0.006 (0.344)	0.007 (0.234)	-0.007 (0.167)	0.005 (0.312)
MedianInc	3987 (0.555)	-6700 (0.000)	111.4 (0.968)	-2134.8 (0.389)	-884.93 (0.670)	-5043.6 (0.0330)	-355.63 (0.881)	-6377.8 (0.000)	-2479.2 (0.247)
Homeown	-10.518 (0.039)	1.379 (0.326)	3.725 (0.101)	1.395 (0.477)	0.608 (0.704)	1.204 (0.489)	2.182 (0.188)	0.569 (0.696)	2.087 (0.160)
Insurers	18.04 (0.796)	67.3 (0.005)	-1.718 (0.906)	-24.9 (0.189)	11.07 (0.416)	46.86 (0.000)	18.99 (0.208)	40.27 (0.000)	12.28 (0.337)

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.

Table 5 Catastrophes and the Demand for Life Insurance

Variable	Dependent Variable: <i>IssuedNum</i>		Dependent Variable: <i>FaceAmt</i>	
	Coefficient	Std. Errors	Coefficient	Std. Errors
Intercept	-3.871	3.827	12.650***	2.752
CAT	0.260***	0.051	0.136***	0.028
PriorCAT	0.234***	0.049	0.115***	0.024
CATInteract	-0.066	0.049	-0.057	0.034
Contiguous	0.078***	0.028	0.063***	0.018
PriorContiguous	0.045*	0.026	0.063***	0.020
Log(CATDeath)	-0.017	0.031	0.002	0.014
Log(CATInjury)	-0.009	0.017	-0.009	0.010
Log(PriorCATDeath)	-0.012	0.031	0.001	0.017
Log(PriorCATInjury)	0.001	0.019	0.001	0.010
Log(Insurers)	1.420***	0.437	-0.565**	0.217
Log(Age)	1.231**	0.520	-0.945	0.657
Log(MedianInc)	-0.403**	0.194	0.846***	0.169
Log(Homeown)	0.779**	0.362	-0.204	0.182
N	550		550	
R ²	0.570		0.698	
Adjusted R ²	0.560		0.690	

*Significant at the 10 percent level

**Significant at the 5 percent level

*** Significant at the 1 percent level

Table 6 Number of Catastrophes by Year, Type, and Property Damage Amount

No.	\$P.D.	Hurricane	Tornado	Other	Total
1994				1 \$19.6B	1 \$19.6B
1995		1 \$3.4B		1 \$1.3B	2 \$4.7B
1996		1 \$2.4B			1 \$2.4B
1997					
1998		1 \$4.5B	1 \$1.5B	1 \$1.2B	3 \$7.2B
1999		1 \$3.5B	1 \$1.7B		2 \$5.2B
2000					
2001				2 \$6.8	2 \$6.8B
2002			1 \$1.8B		1 \$1.8B
2003			1 \$3.6B	1 \$1.6B	2 \$5.2B
2004		4 \$32.7B			4 \$32.7B
Total		8 \$46.5B	4 \$8.6B	6 \$30.5B	18 \$85.6B

Note: Property damage (P.D.) values are given in billions of U.S. Dollars. Property damage values are obtained from the Insurance Information Institute.

Table 7 Event-Specific Regressions

Variable	<u>Dependent Variable:</u> <i>IssuedNum</i>		<u>Dependent Variable:</u> <i>FaceAmt</i>	
	Coefficient	Std. Errors	Coefficient	Std. Errors
Intercept	-3.636	3.721	12.765***	2.723
Contiguous	0.781**	0.030	0.065***	0.018
PriorContiguous	0.492*	0.025	0.064***	0.020
Log(CATDeath)	-0.032	0.026	0.001	0.013
Log(CATInjury)	-0.002	0.015	-0.011	0.011
Log(PriorCATDeath)	-0.012	0.027	0.008	0.018
Log(PriorCATInjury)	-0.002	0.018	-0.004	0.011
Log(Insurers)	1.435***	0.423	-0.510**	0.212
Log(Age)	1.189**	0.507	-0.839	0.662
Log(MedianInc)	-0.413**	0.194	0.778***	0.171
Log(Homeown)	0.717**	0.349	-0.275	0.185
Hurricane	0.287***	0.051	0.126***	0.023
PriorHurricane	0.268***	0.058	0.119***	0.026
Tornado	0.206***	0.049	0.135***	0.040
PriorTornado	0.199***	0.045	0.106***	0.030
Other	0.147**	0.060	0.073**	0.028
PriorOther	0.157***	0.050	0.063**	0.026
N	550		550	
R ²	0.581		0.700	
Adjusted R ²	0.568		0.691	

*Significant at the 10 percent level

**Significant at the 5 percent level

*** Significant at the 1 percent level