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Essays on Adverse Selection and Moral Hazard in Insurance Market

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ESSAYS ON ADVERSE SELECTION AND MORAL HAZARD IN INSURANCE MARKET

BY

JIAN WEN

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ACCEPTANCE

This dissertation was prepared under the direction of the candidate's Dissertation Committee. It has been approved and accepted by all members of that committee, and it has been accepted in partial fulfillment of the requirements for the degree of Doctor in Philosophy in Business Administration in the Robinson College of Business of Georgia State University.

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ABSTRACT

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By

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Major Department: Department of Risk Management and Insurance

Essay One examines the asymmetric information problem between primary insurers and reinsurers in the reinsurance industry and contributes uniquely to the separation of adverse selection from moral hazard, if both are present. A two-period principal-agent model is set up to identify the signals of adverse selection and moral hazard generated by the actions of the primary insurer and to provide a basis for corresponding hypotheses for empirical testing. Using data from the National Association of Insurance Commissioners (NAIC) and A.M. Best Company, the empirical tests show that the problem of adverse selection exists in the reinsurance market between the affiliated insurers and non-affiliated reinsurers, and even between closely related affiliated insurers and reinsurers. There is no evidence indicating the presence of moral hazard in the reinsurance market.

To address the issue of soaring property insurance premiums and coverage availability in states that are subject to hurricane risks, state and federal governments have not only regulated the private insurance market but have also intervened directly into markets by establishing government-funded insurance programs. With coexisting public and private insurance

mechanisms and price regulation, the risk of cross subsidization and a subsequent moral hazard problem may arise. By using data from the Florida Citizens Insurance Corporation, the Florida Hurricane Catastrophe Fund, the Flood Insurance and the private homeowner insurance market in Florida from 1998 to 2007, the second essay examines the moral hazard problems arising from government regulation and involvement in the private insurance sector. In sum, the provision of national flood insurance is found to be positively related to the population growth in the state of Florida, which shows that state immigrants can take advantage of the lower cost of flood insurance when relocating in higher-risk areas. Further, we find that national flood insurance and the catastrophe fund complement the development of the private insurance sector, while the residual market hinders the development of private property insurance market.

Essay One

Distinguishing Different Effects of Asymmetric Information: Evidence from Property and Liability Reinsurance Market

Abstract

This essay examines the asymmetric information problem between primary insurers and reinsurers in the reinsurance industry and contributes uniquely to the separation of adverse selection from moral hazard, if both are present. A two-period principal-agent model is set up to identify the signals of adverse selection and moral hazard generated by the actions of the primary insurer and to provide a basis for corresponding hypotheses for empirical testing. Using data from the National Association of Insurance Commissioners (NAIC) and A.M. Best Company, the empirical tests show that the problem of adverse selection exists in the reinsurance market between the affiliated insurers and non-affiliated reinsurers, and even between closely related affiliated insurers and reinsurers. There is no evidence indicating the presence of moral hazard in the reinsurance market.

1. Introduction

Since the middle of the last century, the study of the problem of asymmetric information has become important in the field of economics and insurance (Akerlof, 1970; Arrow 1965; Rothschild & Stiglitz, 1976). Much progress has been made from both a theoretical and an empirical perspective. Before economists took the question of information transparency into consideration, they commonly assumed the presence of complete information. The concept of complete information implies that all the information is transparent and equally known to both parties. Conversely, the concept of asymmetric information implies that the information known to one party may be unknown or only partially known or available to another. Of the two concepts, the latter, asymmetric information, comes closest to describing or reflecting the real economic world. Predictably, assuming the presence of asymmetric information could lead to outcomes that would differ significantly from those resulting from an assumption of complete information.

Insurance pricing is a good example of this. The insurer sets the premium based on actuarial data on the previous loss experience within a normal population. In the long run, the company will break even, if the risk is at the "average" level as presumed. Unfortunately, people who, in fact, represent a higher-than-average risk level, may be able to purchase insurance coverage against their more frequent or more severe future losses at a favorable price that was originally based on the lower, average, risk. This disconnect may occur because insurers lack sufficient information on the percentage of the pool with higher risk and the exact risk levels represented, even though the insured is fully aware of the risk level. Therefore, this asymmetric information situation may lead to higher losses for the insurer.

The existence of asymmetric information normally entails two complementary problems: adverse selection and moral hazard. The term adverse selection refers to circumstances which permit an insured with higher risk to buy insurance at a premium calculated to service the average risk level. The term moral hazard refers to the tendency of insurers to exercise less precaution than they should, establishing inadequate incentives to control the risks represented by those to whom they provide coverage. Adverse selection and moral hazard both contribute to the potential for higher losses than the insurer may have expected.

When asymmetric information is known to exist, the optimal risk-sharing scheme and pricing may well need to deviate from those that would be instituted if complete information were available (Rothschild & Stiglitz, 1976). In the presence of serious asymmetric information, the insurer may experience a much higher loss than expected; and in the worst case, the insurance market itself may totally fail (Akerlof, 1970). Therefore, the detection of possible asymmetric information, including the discovery of previously unknown risk, has the potential to benefit both the insurer and the insured.

For example, health and life insurance underwriting requires physical examination and applies deductibles, coinsurance and pricing tied to different risk levels of the insured. Common sense would conclude that such procedures would have the effect of uncovering possible risks, factoring these risks into the coverage, and thereby reducing the danger of asymmetric information. While the theoretical analysis of asymmetric information in the insurance market was introduced almost half a century ago, empirical testing did not appear until the 1980s. Now, from the examination of life, health, annuity and automobile insurance markets, we can see evidence that, compared to other insurance markets, life insurance has less of a problem of asymmetric information due to strict requirement of physical examination to determine the risk status of the insured.

As the insurance for the insurance companies, the reinsurance industry further distributes the risks pooled by the primary insurers. It is not unusual for reinsurance companies to be run nationally or internationally, which buffers the adverse effect of huge losses to the whole insurance market and ultimately lowers the premium paid by individuals. With the catastrophic events in the past decades, the property and liability reinsurance market have exhibited an increasing ability to absorb big losses and stabilize the whole insurance market in the U.S. (Cummins, 2007). Therefore the property and liability reinsurance market is not only a critical part of the insurance market, but also an indispensable factor in stabilizing the economy. However, asymmetric information existing between primary insurers and the reinsurers may still pose a serious threat to the reinsurance market.

The effect of asymmetric information on the reinsurance market can be analyzed from the perspectives of adverse selection and moral hazard. For reinsurance, adverse selection would be evidenced by high-risk firms getting similar or even better terms for their reinsurance purchase than low-risk firms. In contrast, moral hazard exists when the primary insurance companies loosen their underwriting criteria, leading ultimately to higher losses than expected. Both adverse selection and moral hazard would make the actual loss higher than those estimated by the reinsurance company, with negative consequences for the insurance market.

This examination of asymmetric information sheds light on challenges in the reinsurance business. Better knowledge of asymmetric information between the primary insurer and the reinsurer can help improve risk allocation and pricing in the reinsurance market. For the primary insurance company, managing risk through purchasing reinsurance is a much more complex matter—due to factors such as risk diversification, progressive tax and financial needs—than risk management at the level of individual policy holders.

This essay examines the asymmetric information problems between the reinsurance and primary companies in the property and liability reinsurance market in the U.S. Recently, Jean-Baptiste and Santomero (2000) addressed the asymmetric information problems which affect the efficiency of risk allocation between the primary insurance companies and their reinsurers. They showed that long-term contracts between the two will improve the allocation of risk by including and factoring in new risk information over time. They predicted that the use of long-term reinsurance contracts will increase the demand for reinsurance, increase primary insurer's profits and lower the probability of bankruptcy.

Empirically, Doherty and Smetters (2005) and Garven and Grace (2007) provided the evidence of asymmetric information in the reinsurance market. Doherty and Smettters (2005) tested the potential moral hazard problem between the reinsurer and the primary company. They found that loss-sensitive pricing was mainly used to control moral hazard between the non-affiliated reinsurers and insurers, while monitoring was widely used to control moral hazard between the affiliated reinsurers and insurers where the monitoring cost was relatively lower. Garven and Grace (2007) explored the adverse selection problem based on the theoretical predictions by Jean-Baptiste and Santomero (2000). Their findings are consistent with and supportive of the theoretical predictions. Nevertheless, each of these two works only focuses on one side of the asymmetric information issue while ignoring the existence and the effects of the other one.

For example, Doherty and Smetters (2005) assumed moral hazard as the only effect of the asymmetric information; Garven and Grace (2007) only attributed the effects of the asymmetric information to adverse selection.

Further, an interesting research question arises: do adverse selection and moral hazard exist at the same time to be part of the asymmetric information problem? The answer to this question is the contribution of this essay, which distinguishes adverse selection from moral hazard, as they exist between the primary insurer and the reinsurer. The reason for separating these two factors of the asymmetric information is that they lead to higher losses through different mechanisms. Accordingly different contract features are required to correct them. Meanwhile, affiliated and non-affiliated reinsurers are discussed separately, as the affiliated reinsurers belong to one financial group and non-affiliated reinsurers are independent companies with respect to the primary insurer. Due to the varying relationship between reisnurers and insurers, asymmetric information is expected to present different patterns.

The essay proceeds as follows: in the second section, related literature is reviewed. Then, the two-period principal-agent model is set up in the third section. In the fourth section, based on the hypothesis derived from the theoretical model, an empirical test is conducted on the panel data for the affiliated and non-affiliated property and liability reinsurance market from 1992 to 2006.

2. Literature Review

A series of seminal papers (Akerlof, 1970; Borch 1962; Holmstrom, 1979; Raviv, 1979; Rothschild & Stiglitz, 1976) built up the theoretical foundation of asymmetric information studies in economics. Akerlof (1970) suggested that market equilibrium may not exist, due to the existence of asymmetric information between the participants, in contrast to the equilibrium that would be expected if complete information were available (Mossin, 1968). Furthermore, Rothschild and Stiglitz (1976) analyzed the competitive market in which imperfect information, specifically adverse selection, was considered. They found out that low-risk individuals were negatively affected by the presence of high-risk individuals, while high-risk individuals benefited from the presence of low-risk individuals. They also found that single price equilibrium does not exist and that the structure and existence of a possible equilibrium depend upon particular assumptions. Holmstrom (1979), on the other hand, investigated the imperfect information problem in a principal-agent model with the consideration of moral hazard. He concluded that the optimal contract is second-best due to the agent's unobserved action, but additional information, like monitoring or managerial accounting, will improve the efficiency of the contract.

Therefore, the detection of asymmetric information and the corresponding contract designed to address this issue are critical to improving efficiency in the insurance market. In this case, the principal-agent model provides a framework for how to alleviate the agency problem, and, consequently, decreases the occurrence of asymmetric information. Lambert (1983) characterized the optimal long-term contract, designed to control the moral hazard of the agent, as one in which the agent's compensation depends on not only the current period but also the previous period. In addition, Laffont and Tirole (1987) derived the optimal dynamic incentive mechanism under the possible monitoring of the agent, and they showed the existence of the possible continuation equilibrium.

The empirical tests of asymmetric information on insurance markets validate and supplement the theoretical predictions. The empirical hypothesis against the existence of asymmetric information is stated as the positive relation between the risk levels of those who purchase insurance coverage and the actual risk type revealed after losses occur (see Puelz & Snow, 1994). However, mixed results are reported in different business lines of insurance: the insignificance of positive relation of insurance quantity purchase and mortality risk of individuals in life insurance market suggested that information can be treated as complete under the current test (Cawley & Philipson, 1997). For the annuity market, Finkelstein and Poterba (2004) found a systemic relationship between the *ex post* mortality and the timing of annuity payments, consistent with the presence of adverse selection. Puelz and Snow (1994) and Chiaporri and Salanie (2000) reported mixed results regarding the presence of asymmetric information in the automobile insurance market. The prevalent explanation attributes this mixed evidence to the application of long-term contract and risk classification in different insurance business lines. Because insurance premiums are contracted over multiple terms, and factors such as experience rating or risk selection are used to determine the real risk type, the effects of asymmetric information can be moderated over time. For instance, the absence of asymmetric information in life insurance can be attributed as the adoption of medical examination as part of underwriting to reveal the true health status of the insurance applicants.

Reinsurance is also subject to the asymmetric information problem between the insurers and the reinsurers. In comparison to the individual insured, the incentive for the insurer to purchase reinsurance is more complicated. The decision to reinsure involves issues such as risk management, increasing capability or the pursuit of tax benefits. Based on its own firm characteristics, the insurer has its own degree of demand for reinsurance. As Mayer and Smith (1990) pointed out, the ownership structure, firm size, geographic concentration and business lines concentration have significant effects on the demand for reinsurance.

Meanwhile, the complicated risk structure of the insurers may reflect in multiple dimensions in underwriting, operating and financing management. As a result, it's costly for the reinsurer to collect complete information which would reveal the true risk of the insurer before the transaction is done. Consequently, adverse selection occurs when a high-risk firm conceals information and receives better terms from the reinsurers than they would have otherwise received. Therefore, long-term contracts and the practice of retrospective rating, which adjusts premiums based on the loss incurred during the previous policy period, are widely applied in the reinsurance industry to solve the asymmetric information problem. Jean-Baptiste and Santomero (2000) showed that the new information included in pricing of both future and past reinsurance coverage for long-term reinsurance contracts can enhance the effectiveness of risk allocation between the primary insurance companies and reinsurance companies. They stated three hypotheses: 1) Other things being equal, long-term reinsurance contracting relationships will be associated with higher levels of reinsurance coverage; 2) Other things being equal, long-term reinsurance contracting relationships will be associated with higher insurer profits; 3) Other things being equal, long-term reinsurance contracting relationships will be associated with lower levels of bankruptcy.

Garven and Grace (2007) did empirical tests of the above hypothesis to see if there is any adverse selection in the reinsurance market and, further, if the asymmetric information problem is solved over time. With panel data consisting of U.S property-liability insurance firms, which reported to the National Association of Insurance Commissioners (NAIC) during the period 1995 to 2000 and A.M. Best financial ratings for insurance companies, they found evidence supporting the theoretical predictions by Jean-Baptiste and Santomero. These findings imply that longer reinsurance relationships lead to more reinsurance coverage, higher profitability, and lower bankruptcy risk.

Doherty and Smetters (2005) tested moral hazard in the reinsurance market with a multi-period principal-agent model of the reinsurance transaction. They derived predictions on premium design, monitoring, loss control and insurer risk retention. They found that a loss-sensitive premium is used to control moral hazard when insurer and reinsurer are not affiliates, while monitoring is emphasized when the insurer and reinsurers are affiliates.

The problem of asymmetric information in reinsurance markets has been investigated in other countries besides the United States. Adam and Diocon (2006) tested the asymmetric information problem in the UK property-liability reinsurance market. Two relationships are mainly tested in their paper. One is the relationship between gross losses and the amount of reinsurance purchased by a primary insurance company; the other relationship examined is between the reinsurance premiums paid and the gross losses and reinsured claims recovered by the primary insurer. The latter is a demonstration of claim-contingent pricing which characterizes the reinsurance transaction. The Hausman endogeneity test under the Heckman two-stage model can separate adverse selection from moral hazard; they found that information asymmetry does exist in the reinsurance market between the affiliated insurers and reinsurers. Specifically, adverse selection exists in the automobile and third party insurance markets, and moral hazard appears in the miscellaneous and pecuniary insurance markets. In contrast, for the non-affiliated insurance companies, the claim-contingent pricing reduces the problem of asymmetric information.

3. Theoretical Model

Based on the model proposed by Doherty and Smetters (2005), a two-year principal-agent model is set up to capture the asymmetric information between the insurers and the reinsurers in the reinsurance market.

Doherty and Smetters (2005) develop a two-period principal-agent model from which to derive predictions on premium design, monitoring, loss control and insurer risk retention to identify moral hazard in reinsurance transactions. The agent, or primary insurer, pays a premium P_t in period of t to the reinsurer for a reinsurance contract which is subject to a deductible (or "risk retention") of S_t. Under this contract, the indemnity to the primary insurer in period t is $\max[0, L_t - S_t]$, where L_t is incurred direct loss in period t. Action a is taken by the primary insurer when underwriting business, handling claims and controlling risks. The action is not observed by the principal, the reinsurer, whereas it is assumed that action a generates a signal m that is imperfectly correlated with a, but still conveys valuation information to the principal. Consequently, the incurred loss and signal depend on action by the primary insurer who writes insurance business to the insured customer directly. On the other hand, the principal, the reinsurer, receives premium P_t in period t and indemnifies the primary insurer with $\max[0, L_t - S_t]$ if the incurred loss exhausts the "stop loss." To reduce the moral hazard problem which may occur on the side of the primary insurer, the reinsurer pays a cost of c to monitor the primary insurer. The reinsurer picks premiums for year 1 and year 2 to maximize total profit subject to the primary insurer's incentive constraint and participation constraint. The optimal premium structure is then derived from the first-order conditions, and then the model predicts the relations between the reinsurance premium and direct loss control, retrospective rating, experienced rating and monitoring. Specifically, the reinsurance premium P_t is predicted to be "negatively related to the inverse of total direct losses by the primary insurer in period $t-1$, negatively related to the inverse of the amount of reinsured losses in period t, negatively related to the inverse of the amount of total direct losses by the primary insurer in period $t-1$, increasing in the signal of m "(Doherty & Smetters ,2005, p 384).

The model above only focuses on the moral hazard of the asymmetric information problem. To capture the possible adverse selection problem, one more signal s, which signifies the operation quality of the primary insurer, is incorporated into the model above in this essay. Basically, the signal s is expected to reveal the real risk type of the primary insurer to the reinsurer. Hence, a measure of the loss volatility of the primary insurer, or a measure indicating their overall financial capability, can provide the information relative to the risk type of the insurer. Compared to signal s, another signal m in the model conveys the effort exerted by the primary insurer to the reinsurer, and signal m is imperfectly correlated to efforts under the reinsurance coverage.

Another new contract feature considered in this model is the coverage cap, A, of the reinsurance contract. This is defined in the "excess of loss" reinsurance, whereby the primary insurer covers the amount of each claim up to the retention level and the reinsurer repays the loss beyond the retention level to the coverage cap to the insurer. The difference between retention level and the coverage cap is the actual reinsurance coverage purchased by the primary insurer.

3.1 The Primary Insurer's Problem

Assume the primary insurer is strictly risk-averse, and its utility function is $U(w)$, where $U^{'}(w) > 0, U^{''}(w) < 0$, w is the surplus at the beginning of the contract. The arguments for this risk-averse assumption are the contexts of the progressive tax, the underinvestment problem, high bankruptcy costs and asymmetric information in the reinsurance market. These market frictions make the insurers risk-averse even if the company is widely held by public shareholders. At the beginning of one period, the primary insurer pays premium P to purchase one excess-of-loss reinsurance policy with the retention level of D, and coverage cap of A. Assume the incurred loss over this period is L. The amount of recovered loss payment received from the reinsurer depends on the amount of the incurred losses. If the incurred loss is less than the retention level, $L \leq D$ the reinsurer does not pay anything to the primary insurer. If the incurred loss falls between the retention level and coverage cap, $D \leq L \leq A$ the reinsurer pays the amount of $L - D$ to the primary insurer. If the actual loss is beyond the coverage cap, $A \leq L$ the obligation of the reinsurer is the amount of $A - D$.

During the contract period, the primary insurer exerts an effort of e to underwrite business from the insured, control loss and assess the claims. We argue that this effort is able to generate signals to the reinsurer about real operational quality and incentives of the primary insurer in the sense that the performance of the primary insurer nevertheless reflects the effort it takes. We denote signal s as the indication of the operation quality, which is the real risk type, of the primary insurer. We then denote signal m as the indication of the incentive of the primary insurer. As a result, the conditional joint probability density function of actual loss and signals are represented as $f(s, m, L|e)$.

A two-year framework is considered. In the first year, the reinsurance premium is a function of actual loss, retention level, coverage cap and signals of the primary insurer's effort: $P(\bullet) = P(L_1, D_1, A_1, s_1, m_1)$. For the second-year pricing, the actual loss of the first year is also taken into account, as are the second year losses, the retention level, the coverage cap and the signals in the second-year period: $P(\bullet) = P(L_1, L_2, D_2, A_2, s_2, m_2)$.

For the simplicity of computation, a zero risk-free rate is assumed in this reinsurance model. Define an insurer's end-of-period wealth, π as a random variable. Then the insurer's wealth as end of the first year is π_1 , and the wealth as end of the second year is π_2 . For $i = 1,2$

$$\pi_i = \begin{cases} W_i - P_i - L_i & \text{if } L_i \le D_i \\ W_i - P_i - D_i & \text{if } D_i < L_i \le A_i \\ W_i - P_i - L_i + A_i - D_i & \text{if } A_i < L_i \end{cases} \qquad (1)$$

The expected utility of the insurer for two years are $E(U_1(\pi_1))$ and $E(U_2(\pi_2))$, respectively. So the total expected utility of the primary insurer from taking the reinsurance transaction is $E(U) = E(U_1(\pi_1)) + E(U_2(\pi_2))$. The calculation of expected utility by integration refers to the appendix. Because incurred losses depend on effort e as $f(s, m, L|e)$, the primary insurer picks efforts e_1 and e_2 to maximize its expected utility in two years.

3.2 The Reinsurer's Problem

The reinsurer incurs a monitoring cost of c_1 and c_2 to analyze true risk type of the insurer by observing the information delivered in the two periods, respectively. The reinsurer makes the profit out of the premium income after deduction of loss repayments and monitoring costs[1]. Define the reinsurer's profit I_i , $i = 1,2$ as a random variable. Then the reinsurer's profit in the first year is I_1 and its profit in the second year is I_2. The profit I_i is defined as follows.

$$I_i = \begin{cases} P_i & \text{if } L_i \le D_i \\ P_i - L_i + D_i & \text{if } D_i < L_i \le A_i \\ P_i - A_i + D_i & \text{if } A_i < L_i \end{cases} \qquad (2)$$

[1]Reinsurers will monitor the primary, among which long-term contracts are usually applied. The application of monitoring encourages the primary insurers to take appropriate measures to control their risks, therefore reduces the potential losses of reisnurers. Also see Doherty (1997).

The reinsurer chooses the premium P_1 and P_2 in two years to maximize the total profit $I = E(I_1) + E(I_2)$. The calculation of total profit by integration refers to the appendix.

The optimization problem is to maximize the total profit of the principal, which is the reinsurer in this case, subject to the participation constraint and incentive constraint by the agent, the primary insurer. To solve this optimal problem, the optimal values of $\{P_1, P_2; e_1, e_2\}$ are obtained. The optimization problem is stated as follows.

$$\max_{P_1, P_2, e_1, e_2} I$$

Subject to

$$E(U) \geq \overline{U} \tag{3}$$

$$\partial E(U)/\partial e_1 = 0 \tag{4}$$

$$\partial E(U)/\partial e_2 = 0 \tag{5}$$

Equation (3) is the participation constraint of the primary insurer, where $\overline{U}$ the reservation is the expected utility of the primary insurer that it would have without reinsurance. Equation (4) and (5) are first-order conditions with respect to the efforts in the two periods. The incentive constraints ensure that the primary insurers make efforts to maximize their expected utility.

To simplify the joint probability density function of actual loss $f(s, m, L|e)$, signal s and m are assumed to be independent of actual loss L as suggested by Holmstrom (1979). Further, signals s and m are assumed to be independent from each other, in that signal s is used to address adverse selection, while signal m is adopted to capture moral hazard problem, respectively. Therefore, the joint probability density function of actual loss is written as $f(s, m, L|e) = k(s|e)g(m|e)h(L|e)$.

Let $\lambda, \gamma_1, \gamma_2$ denote the Lagrangian multipliers for constraints (3)-(5), the first-order conditions are reduced as follows:

$$\frac{1}{U^{'}(W_1 - P_1 - L_1)} = \lambda + \gamma_1\left(\frac{k^{'}(s_1|e_1)}{k(s_1|e_1)} + \frac{g^{'}(m_1|e_1)}{g(m_1|e_1)} + \frac{h^{'}(L_1|e_1)}{h(L_1|e_1)}\right) \quad if\ L_1 \leq D_1 \tag{6}$$

$$\frac{1}{U^{'}(W_1 - P_1 - D_1)} = \lambda + \gamma_1\left(\frac{k^{'}(s_1|e_1)}{k(s_1|e_1)} + \frac{g^{'}(m_1|e_1)}{g(m_1|e_1)} + \frac{h^{'}(L_1|e_1)}{h(L_1|e_1)}\right) \quad if\ D_1 < L_1 \leq A_1 \tag{7}$$

$$\frac{1}{U^{'}(W_1 - P_1 - L_1 + A_1 - D_1)} = \lambda + \gamma_1\left(\frac{k^{'}(s_1|e_1)}{k(s_1|e_1)} + \frac{g^{'}(m_1|e_1)}{g(m_1|e_1)} + \frac{h^{'}(L_1|e_1)}{h(L_1|e_1)}\right) \quad if\ A_1 < L_1 \tag{8}$$

$$\begin{aligned}\frac{1}{U^{'}(W_2 - P_2 - L_2)} &= \lambda + \gamma_1\left(\frac{k^{'}(s_1|e_1)}{k(s_1|e_1)} + \frac{g^{'}(m_1|e_1)}{g(m_1|e_1)} + \frac{h^{'}(L_1|e_1)}{h(L_1|e_1)}\right) \\ &\quad + \gamma_2(L_1)\left(\left(\frac{k^{'}(s_2|e_2)}{k(s_1|e_1)k(s_2|e_2)} + \frac{g^{'}(m_2|e_2)}{g(m_1|e_1)g(m_2|e_2)} + \frac{h^{'}(L_2|e_2)}{h(L_1|e_1)h(L_2|e_2)}\right)\right. \\ &\quad if\ L_2 \leq D_2\end{aligned} \tag{9}$$

$$\begin{aligned}\frac{1}{U^{'}(W_2 - P_2 - D_2)} &= \lambda + \gamma_1\left(\frac{k^{'}(s_1|e_1)}{k(s_1|e_1)} + \frac{g^{'}(m_1|e_1)}{g(m_1|e_1)} + \frac{h^{'}(L_1|e_1)}{h(L_1|e_1)}\right) \\ &\quad + \gamma_2(L_1)\left(\left(\frac{k^{'}(s_2|e_2)}{k(s_1|e_1)k(s_2|e_2)} + \frac{g^{'}(m_2|e_2)}{g(m_1|e_1)g(m_2|e_2)} + \frac{h^{'}(L_2|e_2)}{h(L_1|e_1)h(L_2|e_2)}\right)\right. \\ &\quad if\ D_2 < L_2 \leq A_2\end{aligned} \tag{10}$$

$$\begin{aligned}\frac{1}{U^{'}(W_2 - P_2 - L_2 + A_2 - D_2)} &= \lambda + \gamma_1\left(\frac{k^{'}(s_1|e_1)}{k(s_1|e_1)} + \frac{g^{'}(m_1|e_1)}{g(m_1|e_1)} + \frac{h^{'}(L_1|e_1)}{h(L_1|e_1)}\right) \\ &\quad + \gamma_2(L_1)\left(\left(\frac{k^{'}(s_2|e_2)}{k(s_1|e_1)k(s_2|e_2)} + \frac{g^{'}(m_2|e_2)}{g(m_1|e_1)g(m_2|e_2)} + \frac{h^{'}(L_2|e_2)}{h(L_1|e_1)h(L_2|e_2)}\right)\right. \\ &\quad if\ A_2 < L_2\end{aligned} \tag{11}$$

where $k^{'}(s|e)$, $g^{'}(m|e)$, and $h^{'}(L|e)$ are the derivative functions of $k(s|e)$, $g(m|e)$, and $h(L|e)$ with respect to the effort e.

To make Lagrangian multipliers $\lambda, \gamma_1, \gamma_2$ be positive, we make the following assumptions on the likelihood ratio by Lambert (1983): (1) $h^{'}(L_1|e_1)/h(L_1|e_1)$ is decreasing in L_1; (2) $h^{'}(L_2|e_2)/[h(L_1|e_1)*h(L_2|e_2)]$ is decreasing in L_2.

Equations (6)-(11) define the risk-sharing structure between the primary insurer and the reinsurer in the two-period framework. The model predictions are similar to the ones derived by Doherty and Smetters (2005). For example, both models show that the reinsurance premium is not only related to the concurrent direct loss by the primary insurer but also to the direct incurred loss in the last period. However, our model uniquely incorporates the signals to reveal the possible adverse selection and moral hazard problem to the reinsurer over time and generate separate testable predictions for empirical studies. This model allows us to distinguish adverse selection from moral hazard, if any, in the reinsurance market[2]. Furthermore, the model takes into consideration the coverage cap in the excess-of-loss reinsurance policy, a factor which Doherty and Smetters (2005) does not address. The coverage cap and retention level together set the actual reinsurance coverage purchased by the primary insurer. The model predictions and derived hypothesis are discussed as follows.

3.3 Model Predictions

Concurrent direct loss: With the increase of the concurrent loss, $h^{'}(L_1|e_1)/h(L_1|e_1)$ decreases based on the model assumption. According to the utility function of the insurer in the first period, $\frac{\partial U_1}{\partial P_1} = -U^{'}$, $\frac{\partial U_1}{\partial L_1} = -U^{'}$ so $\frac{\partial U^{'}}{\partial L_1} \Big/ \frac{\partial U^{'}}{\partial P_1} > 0$. The model shows that the reinsurance premium is positively related to the concurrent direct loss.

[2] The independence of signals of adverse selection and moral hazard is assumed, and the distinctive separation of two effects is obtained. However, they can be correlated which is discussed later. In this case, the two effects can still be distinguished, but with different impacts on the reinsurance demand.

Signal for adverse selection: The model shows that the reinsurance premium increases with the observation of signal s. Over time, signal s is expected to reveal the true type of the primary insurer, such as its operational quality, to the reinsurer, in order to mitigate a possible adverse selection problem.

Signal for moral hazard: The model suggests that reinsurance premiums increase with the observation of signal m. Signal m is expected to detect the effort incentive driven by the primary insurer with the reinsurance coverage.

With the predictions derived from the model, we are now able to do the empirical test.

4. The Empirical Analysis

This section presents an empirical analysis based on the theoretical model above, along with the corresponding results. First, the empirical hypotheses are derived from the theoretical model and the estimated equations are constructed. Secondly, the data set used for the empirical analysis and the construction of testable variables are introduced. After considering the related econometric issues, the test results for affiliated, non-affiliated property and liability insurers and insurers are discussed and compared.

4.1 Hypotheses

From the theoretical model in section three, we derived the empirical hypothesis regarding reinsurance purchase and the signals of adverse selection and moral hazard.

The variable corresponding to adverse selection is expected to reveal the true risk type of the primary insurer in terms of its overall operation quality and financial strength. A.M. Best ratings on primary insurers, are widely used to rank and compare levels of financial strength among insurance companies. These rankings appear as letter ratings A++, A+, A-, B+, etc., and the company with A++ has highest level of financial strength. Because A.M. Best considers the financial capability, loss experience, operational and managerial risks into rating insurance companies, the financial rating can be a good indicator of the true risk type of the companies. The logic follows that higher rating of the insurer associates with lower risk. In the context of adverse selection in reinsurance market, an insurer with lower ratings is predicted to demand more reinsurance because of their insufficient financial capability or poor loss experience. Therefore, the hypothesis with respect to the adverse selection in the asymmetric information problem is stated as follows.

- **Hypothesis 1**: Other things being equal, a lower A.M. Best financial rating on primary insurers is associated with higher reinsurance purchase.

The signal of moral hazard is defined as the percentage of recovered losses in the last period. The logic behind this definition follows that the recovered losses from the reinsurer in the last period has an impact on the insurer's incentive to purchase reinsurance next period. The more the insurer recovers form the reinsurance company, the higher incentive to purchase reinsurance. Meanwhile, the insurer may not exert more effort to control its risk than it would have otherwise. The hypothesis with respect to moral hazard is stated as follows:

- **Hypothesis 2**: Other things being equal, a higher percentage of recovered losses in the previous period will be associated with higher reinsurance purchase.

To simplify calculation, we assume that adverse selection and moral hazard exist independent of each other. However, we have also found that in most cases they can be correlated. It is reasonable to expect that a primary insurer, who conceals unfavorable risk information and buys reinsurance under these false pretenses, may pose serious moral hazard to the reinsurer. In cases where these two factors do correlate, any estimates made under the assumption of independence will be biased. In case of a positive correlation, the estimates for the effects of adverse selection and moral hazard would be higher than they should have been otherwise, while the estimates would be lower than they should have been otherwise in the case of negative correlation.

4.2 Estimated Equations

Following the hypothesis above, the estimated equation is stated as:

$$REINS_{i,t} = \alpha_{10} + \beta_{11} RAT_{i,t} + \beta_{12} LV_{i,t} + \beta_{13} \frac{L^R_{i,t-1}}{L^D_{i,t-1}} + \beta_{14} \frac{P^R_{i,t-1}}{L^R_{i,t-1}} + \beta_{15} LR^D_{i,t} + \sum_{j=1}^{K_1} \gamma_j X_{i,j,t} + u_{i,t} \quad (12)$$

Where

$REINS_{i,t}$ = Reinsurance purchase for the primary insurer i in year t;

$RAT_{i,t}$ = A. M. Best's rating for the primary insurer i in year t;

$LV_{i,t}$ = Loss volatility of the primary insurer i in year t;

$\frac{L^R_{i,t-1}}{L^D_{i,t-1}}$ = Percentage of recovered loss out of the total direct loss for primary insurer i in year $t-1$;

$\frac{P^R_{i,t-1}}{L^R_{i,t-1}}$ =Proxy for the reinsurance price in which $P^R_{i,t-1}$ is the ceded reinsurance premium and $L^R_{i,t-1}$ is the recovered loss for the primary insurer i in year $t-1$;

$LR^D_{i,t}$ =Loss ratio defined as $\frac{L^D_{i,t}}{DPW^D_{i,t}}$ in which $L^D_{i,t}$ is the direct loss and $DPW^D_{i,t}$ is direct written premium for the primary insurer i in year t;

$X_{i,j,t}$ = The jth control variable for the primary insurer i in year t. A set of control variables include log of total assets, liquidity, leverage, return on equity, dummy variable for a stock company, product Herfindahl index, geographic Herfindahl index, percent of business lines with long tail liabilities[3], reinsurance sustainability index, effective tax rate, percentage of homeowner written premium in coastal states[4], and measure of internal reinsurance;

$u_{i,t}$ = error term in equation (12) for the primary insurer i in year t.

Equation (12) is the estimation of adverse selection with the incorporation of the effect of moral hazard. The independent variable $RAT_{i,t}$ represents the financial strength of the primary insurer, whereby the higher rating indicates stronger financial ability[5]. Intuitively, the more vulnerable primary insurer with lower A.M. Best rating is more likely to purchase reinsurance to protect against future possible adverse events. As a result, the estimated coefficient sign of $RAT_{i,t}$ is expected to be negative with the presence of adverse selection after controlling for additional moral hazard. Another variable for controlling adverse selection is $LV_{i,t}$ which captures the loss volatility of the primary insurer. It is calculated as the difference of the losses incurred over the two years divided by the direct premiums written. Compared to A. M. Best ratings, this variable mainly reveals the loss experience of the company and its risk type in insurance operation. Higher loss volatility means this company is more risky compared to the overall property and liability market. Therefore, the estimated coefficient of $LV_{i,t}$ is expected to be positive in the presence of adverse selection.

[3] We follow the definition of long tail lines by Phillips, Cummins and Allen (1998) and Garven and Grace (2007) and adopt the same definition as well. Long tail lines include Farmowners Multiple Peril, Homeowners Multiple Peril, Commercial Multiple Peril, Ocean Marine, Medical Malpractice, International, Reinsurance, Workers' Compensation, Other Liability, Products Liability, Aircraft, Boiler and Machinery and Automobile Liability.

[4] The inclusion of percentage of written premiums in the coastal areas reflects the significant impact of hurricane risks on the homeowner insurance market. Further, reinsurance plays an indispensable role in the property insurance market in the coastal states.

[5] The construction of variable $RAT_{i,t}$ is explained in detail later in this section.

The percentage of recovered losses from the last period reflects the impact of moral hazard on the reinsurance demand. The estimated coefficient of $\frac{L_{i,t-1}^{R}}{L_{i,t-1}^{D}}$ is expected to be positive with the presence of moral hazard.

4.3 Econometric Issues

Fixed Effect versus Random Effect: The individual effect can be controlled using fixed effect or random effect approaches. A fixed effect model assumes that the individual effect is correlated with the independent variables in the model, while a random effect model assumes that there is no correlation between the individual effect and the independent variables. Hausman (1978) proposes a test to check a more efficient model against a less efficient, but consistent, model. Under the null hypothesis, both fixed effect and random effect estimates are consistent, but a random effect estimate is more efficient; whereas, under the alternative hypothesis, the fixed effect estimate is consistent, but the random effect estimate is not consistent. In this paper the Hausman test shows that fixed effect model is appropriate for affiliated, non-affiliated and all companies together.

Endogenous Variable: With the presence of moral hazard, the reinsurance coverage may make insurer take less precaution controlling risks, which leads to higher incurred losses. Hence the right-hand side explanatory variable of $LR_{i,t}$ is endogenous. It is correlated with the error term of the equation (12). To correct the endogeneity, the first stage estimation equation (13) is used:

$$LR_{i,t}^{D} = \alpha_{20} + \beta_{21} REINS_{i,t-1} + \beta_{22} REINS_{i,t-2} + \beta_{23} LR_{i,t-1}^{D} + \beta_{24} \ln(DPW)_{i,t} + \varepsilon_{i,t} \qquad (13)$$

$REINS_{i,t-1}$ =One lag of reinsurance purchase for the primary insurer i in year $t-1$;

$\varepsilon_{i,t}$ =error term in equation (13) for the primary insurer i in year t.

From Wooldridge (2002), the OLS estimators will be biased if the endogenous variables are included in the estimated model. To conduct an endogeneity test, a set of suitable instrument variables (IV hereafter) is needed for this potential endogenous variable. The regression-based approach introduced by Wooldridge (2002) is applied. An appropriate IV needs to be correlated to the endogenous variable and uncorrelated with the error term in the model. Intuitively, the direct loss is positively related to the direct written premium by the primary insurers, and the direct written premium can serve as an IV *per se*. Therefore, log of direct written premium is used as one IV for loss incurred. In addition, one and two lags of reinsurance purchase are included in the model as one instrumental variable. This inclusion can be used to test its effect on the concurrent losses incurred which may arise due to moral hazard with the reinsurance coverage.

The reduced form of direct incurred loss is estimated by using all the independent variables in the estimation (12) and four IVs as the independent variables. After the residual of this estimate is obtained, the dependent variable, the reinsurance purchase in the equation (12), is regressed on all the independent variables and the obtained residual, as well. The insignificant robust t-statistic of estimated coefficient for the error term indicates that the direct incurred loss is not an endogenous variable in the estimation and the corresponding results are unbiased. The corresponding p-value is 0.00 which implies that the variable of concurrent loss incurred is endogenous in the estimation equations, and the OLS estimators are biased. We need to apply IVs to fix the endogeneity issue.

In addition, equation (13) partly reflects the potential of moral hazard on the part of the primary insurer. With the presence of moral hazard, the higher level of reinsurance purchase in the previous period will be associated with the higher level of concurrent direct loss for a primary insurer if other firm characteristics are controlled. Hence, the estimated coefficient of lag of reinsurance purchase is expected to be positive if moral hazard does exist in the reinsurance market.

Heteroskedasticity: If the error terms do not have constant variance with each observation, the heteroskedasticity problem arises. In this case, the OLS estimators are unbiased and consistent but inefficient because the assumption of the constant variance for error terms is violated. In the presence of hetoroskedasticity, the variance of the coefficients obtained from OLS tends to be underestimated, so the OLS standard error is not valid for constructing confidence intervals and t statistics. To solve this problem, Weighted Least Square (WLS) estimators or robust standard errors are usually adopted to improve efficiency.

In the estimation, the White test is employed to detect the possible heteroskedasticity problem. The White test statistics is 2261.24 and corresponding p-value is 0.00. This result rejects the null hypothesis that the residuals in the model are homoskedasticity. Therefore, the heteroskedasticity issue occurs when estimating the model, and the estimators are unbiased and consistent but inefficient. In addition, the normal standard errors are invalid to construct the confidence intervals and the t-statistics. Therefore, the robust standard errors are used instead to improve the estimator efficiency in the presence of heteroskedasticity.

Individual Effect versus Pooled OLS: The error term $u_{i,t}$ in equation (12) can be decomposed as $u_{i,t} = a_i + \nu_{i,t}$, where a_i is called individual effect, $\nu_{i,t}$ is idiosyncratic error and $u_{i,t}$ is composite error. The individual effect is usually unobservable. If the unobserved individual effect is correlated with other independent variables in the model, the pooled OLS estimators are biased and inconsistent. If the individual effect is a random variable and is uncorrelated with other independent variables, the pooled OLS estimator is unbiased and consistent but inefficient.

As a result, the presence of the individual effect to choose the appropriate estimation method needs to be tested. Breusch and Pagan (1979) derive the Lagrange Multiplier (LM) test to detect the presence of individual effect. Based on the residuals from the equation (12), the LM test statistics is 5217.6, which reject the null hypothesis of the absence of individual effect. In the presence of individual effect, the pooled OLS estimation is not appropriate for our model.

Overidentifying Test: To test the model identification, Anderson Canon and Cragg-Donald tests are undertaken by using STATA code of "xtivreg2". The small p-value of these tests shows the model proposed is identified.

4.4 Data Description and Variables Construction

A panel data set representing the property and liability reinsurance market in the United States from 1992 to 2006 is constructed to test the hypotheses. The data includes the reinsurance premium, direct loss, financial strength ratings and other firm characteristics of the primary insurers. The data are collected from NAIC annual statements and A.M. Best Company for the corresponding years. Each insurance company is required to report its underwriting business, claims, profitability, reserves and other required operational and financial information to the state commissioner every year, so the NAIC annual statements comprise an extensive and reliable resource for the study of the insurance and reinsurance market in the United States. A.M. Best Company is a private rating agency and, accordingly, the A.M. Best rating is an independent opinion on the company's overall financial strength. The ratings are evaluated quantitatively and qualitatively based on the company's balance sheet, operating performance and other business information. In the context of insurance industry, a company which is assigned a higher rating is believed by investors to have enough financial resources and expertise to deal with the risks it is facing, including underwriting risk, operational risk and default risk. Therefore, the ratings can be indicators of risk status of primary insurers. A.M. Best ratings are an indicator of financial strength of companies, and the higher the rating, the stronger financial ability of the company[6].

Insurance companies can be categorized as affiliated and non-affiliated, which apply quite different risk management strategies due to their financial structures. For example, affiliated insurers can diversify their risks through the use of both external and internal reinsurance within the group. Non-affiliated insurers only buy reinsurance from other outside reinsurers.

The data on affiliated, non-affiliated insurers are collected separately. Table 3 and Table 5 list the descriptive statistics for the affiliated, non-affiliated and all property and liability insurers from 1990 to 2006, respectively.

Construction of Dependent Variable

Previous studies apply different definitions for the reinsurance variable. For example, Mayers and Smith (1990), Garven and Lanmm-Tenant (2003) and Cole and McCullough (2006) use the following construction to measure the reinsurance purchase:

$$\mathrm{Re}\,insurance = \frac{Internal \;\&\; External\;\; ceded\; reinsurance}{Direct\; premium\, written + (\mathrm{int}\, ernal + external\;\; assumed\; reinsurance)}$$

where "internal ceded reinsurance" refers to the intercompany pooling or non-pool reinsurance within affiliations. Garven and Grace (2007) use another ratio to define the reinsurance purchase:

$$\mathrm{Re}\,insurance = \frac{External\;\; ceded\; reinsurance - external\, assumed\; reinsurance}{Direct\; premium\, written + (\mathrm{int}\, ernal + external\;\; assumed\; reinsurance)}$$

They tested adverse selection in the reinsurance market with the emphasis on unaffiliated insurance companies. The numerator of the ratio is the net ceded reinsurance by the primary

[6] For more details on A.M. Best rating, see http://www.ambest.com/ratings/guide.asp

insurer. Therefore, this creates a continuous variable ranging from -1 to +1. A negative reinsurance purchase means that this primary insurer actually acts as a “reinsurer” in the market.

Even though Garven and Grace (2007) specifically tested adverse selection for the non-affiliates in the reinsurance market and obtained supporting evidence in line with the theoretical predictions, we are still interested in how the results will change if we consider the affiliation issue. To test the simultaneous effects of adverse selection and moral hazard in the reinsurance market, empirical studies for affiliation and non-affiliates are performed, respectively.

For affiliates, the reinsurance purchase is defined as:

$$REINS = \frac{Internal\ ceded\ reinsurance\,\mathrm{Pr}\,emium}{Direct\ premium\ written + total\ assumed\ reinsurance}$$

For non-affiliates, the reinsurance purchase is defined as:

$$REINS = \frac{External\ ceded\ reinsurance\,\mathrm{Pr}\,emium}{Direct\ premium\ written + total\ assumed\ reinsurance}$$

Construction of Independent Variables and Control Variables

A.M. Best Rating: The variable of $RAT_{i,j}$ is constructed from the A.M. Best financial strength ratings as discussed before. Table 1 lists A.M. Best rating scales and associated descriptions. Mayer and Smith (1990) transfer the letter scales to numerical scales from 0 to 6, while Doherty and Phillips (2002) convert the various A.M. Best financial strength ratings to numerical scores ranging from 0 to 4. If the firm is rated A++ or A+, it is assigned a score of 4, 3 if the firm is rated A, 2 if it is rated A-, 1 if it is rated B++ or B+, and 0 if it is rated B and lower.

Because this essay attempts to examine the effect of adverse selection on the reinsurance purchase by different primary insurers with different risk levels, it is more appropriate to break these ratings into detailed subgroups to describe the risk type of primary insurers. Consequently the same approach by Mayer and Smith (1990) is adopted in this essay. Accordingly, seven subgroups are created from the letter scales. If the firm is rated A++ or A+, it is assigned 6; 5 if the firm is rated A or A-; 4 if it is rated B++ or B+; 3 if it is rated B or B-; 2 if it is rated C++ or C+; 1 if it is rated C or C-, and 0 if it is rated D and lower. Table 2 tabulates the transformed numerical scales and the associated letter scales.

Loss Volatility: Two measures of loss volatility are applied: 1) Loss volatility can be defined as the difference between the current losses incurred and the previous year's losses incurred, divided by the current written premiums, an approach proposed by Lei and Schmit (2008); 2) To allow for volatility over a long time period, the second measure of loss volatility is calculated as the difference between concurrent losses incurred and the average losses incurred over the last three years, divided by the current direct written premiums. The effects of both loss volatility measures on the demand for reinsurance are tested and compared. The higher loss volatility indicates a more risky operation of the insurance company. Together with the A.M. Best financial ratings, loss volatility is used to reveal the insurer's true risk type, further confirming the presence of adverse selection.

Percentage of Recovered Losses in the Prior Period: As the signal of moral hazard, this variable is constructed as the percentage of recovered loss from the reinsurance out of the total losses incurred from the last year.

Loss Ratio: The variable is calculated as $\left(\frac{L_{i,t}^{D}}{DPW_{i,t}^{D}}\right)$. The reinsurance purchase is related to the direct gross loss, $L_{i,t}^{D}$ by the primary insurer. The sign of the coefficient of loss ratio is expected to be positive, which means that a greater direct gross loss will induce increased reinsurance purchase.

Reinsurance Price in Prior Period: This variable is computed as reinsurance premium divided by the recovered loss. The higher the reinsurance premium, the lower the amount of reinsurance demanded.

Reinsurance Purchase in the Prior Period: This variable is represented as $REINS_{i,t-1}$. In practice, the reinsurance usually involves a long-term contract to allow for the collection of new information over time to monitor the primary insurance companies. In the presence of moral hazard, the increased purchase of reinsurance in the previous period may reduce the managerial incentives of the primary insurance company to control risks, and increase the direct incurred loss in the next year.

Size: The Log of the firm's total assets is included to control the size factor of a company. Firms with big size are assumed to be more financially capable and expected to demand less external reinsurance accordingly.

Organization Type: To control for the effect of the organization type on the demand for reinsurance, a dummy variable for a stock company is included. If the insurer is a stock company, the dummy is equal to 1; otherwise it is equal to 0. Different organization types affect the risk diversification of the companies. For example, a public traded firm is able to spread its operating risks across its numerous stockholders, while a mutual company has only limited resources to deal with its risks. It follows that reinsurance is in higher demand for mutual companies than for stock companies when diversifying risks efficiently.

Liquidity: Liquidity of a primary insurance company measures its capacity to settle claims in a timely manner. Lower liquidity implies more demand for reinsurance is needed to relieve tight financial constraints.

Leverage: Leverage describes how much debt is included in the total assets. A higher leverage ratio means a higher dependence on the debt out of the total assets. A firm with higher leverage is expected to demand more reinsurance since it need the external resources to boost its underwriting capabilities.

Return on Equity: The return on the equity measures how much return a primary insurance company earns on its equity. A negative relation between the return on equity and reinsurance demand is expected because a profitable firm is able to handle their risks more easily without much reinsurance coverage.

Product Herfindahl index: This variable is used to capture the product diversity of an insurance company. Product Herfindahl index is defined as $\sum_{l=1}^{n}(\frac{DPW_l}{TDPW})^2$, where DPW_l denotes the direct premiums written from business line l and $TDPW$ is the total direct premiums written for an insurance company. The smaller the index, the more diversified the business lines of the company. An index of 1 means this company has no diversification in its products, with all its business in one line.

Geographic Herfindahl index: This variable captures the geographic diversification of an insurance company's operations. The Geographic Herfindahl index is defined as $\sum_{s=1}^{50}(\frac{DPW_s}{TDPW})^2$, where DPW_s is the direct premiums written in state s and $TDPW$ is the total direct premiums written for an insurance company. The smaller the index, the more geographically diversified the company. An index of 1 means this company has no diversification in its business locations, concentrating all its business on one state.

Percentage of long tail business lines: From the previous literature (for example, Garven & Grace, 2007), we learn that the existence of long tail business lines increases a primary insurer's demand for reinisurance. In this essay, this variable is included as one of the control variables used to predict the reinsurance demand.

Percentage of direct written premiums in coastal areas: The catastrophic risk exposures and insurance coverage in the coastal areas pose severe challenges to the operation of insurers. Reinsurance is highly demanded for the insurers who underwrite such hurricane risks in the coastal states to combat the tremendous losses. Therefore the percentages of direct written premiums in coastal states, such as Florida, Texas, Alabama, Louisiana, North Carolina, South Carolina and Mississippi, are included to be explanatory variables in the model.

Measure of Internal Reinsurance: The variable of "Internal" is defined as $Internal = \frac{\text{int}\,ernal\ ceded\ reinsurance - \text{int}\,ernal\ assumed\ reinsurance}{external\ ceded\ reinsurance - external\ assumed\ reinsurance}$ as in Garven and Grace (2007). This ratio is the percentage of the net internal ceded reinsurance out of the net external ceded reinsurance. It is expected that the higher the ratio, the less the demand for external reinsurance. Internal reinsurance is not available to non-affiliated insurers, as discussed earlier.

Contract Sustainability: The contract sustainability, which depicts how frequently insurers change reinsurers, reflects an important feature of a long-term reinsurance contract. Garven and Grace (2007) showed that this variable is positively associated with the external reinsurance purchase. The variable is defined as the percentage of premiums ceded over a three-year period to external reinsurers which are present in all three years. In the analysis, fifteen three-year windows are considered: 1990-1992, 1991-1993, 1992-1994, etc. Hence value of sustainability of 1992 is based on 1990-1992 windows.

Effective Tax Rate: To control the effect of tax on the reinsurance demand, the variable of effective tax rate is constructed as $1-\frac{NI_{i,t}}{BTNI_{i,t}}$, where NI is after-tax net income and $BTNI$ is before-tax net income.

4.5 Estimation Results

Primary insurers in the reinsurance market are categorized into affiliated and non-affiliated companies. Because of their different managerial structures, affiliated and non-affiliated insurers tend to use reinsurance as a risk management tool at different ways. For affiliated insurers, in addition to any reinsurance they may purchase from other non-affiliated insurers, they can cede part of their risk to the other companies in the group with which they are affiliated. In this scenario, reinsurers from the same group possess or have access to more information about the ceding companies, and thus have more control over the risk management process. Consequently, we would expect the nature of the information problem between affiliated insurers and reinsurers to be different from that between non-affiliated insurers and reinsurers.

Empirical analysis is undertaken at two levels. First, the demands for total reinsurance for affiliated and non-affiliated insurers are tested respectively, in which two measures of loss volatility are used alternatively to test the robustness of the model. Second, the reinsurance purchases for affiliates are analyzed individually to see if there is any different information problem. Further, depending on how much reinsurance is bought from affiliated reinsurers, the data are divided into three subgroups and reinsurance demand of affiliated insurers is examined in detail.

4.5.1 Empirical Results for Affiliated Property and Liability Insurers

Adverse Selection

First, the total reinsurance demand for affiliated insurers is analyzed. Hypothesis 1 suggests a negative relationship between A.M. Best ratings and the external reinsurance purchase. The regression results with two definitions of loss volatility are summarized in Table 6 and Table 7, respectively. The fixed effect model results show that the A.M. Best ratings have a significant and negative effect on the purchase of external reinsurance at 1% significance level as reported in Table 6A and 7A. This negative association with the reinsurance purchase is robust to the different loss volatility measures. In this case, the A.M. Best rating serves as an ordinal index. The magnitude of this coefficient is -0.013, which only implies the higher the rating, the lower the external reinsurance purchase all else being equal, since A. M. Best rating is an ordinal index. The results show that neither of the coefficients of loss volatility measures is statistically significant. The negative coefficient of the A.M. Best rating supports Hypothesis 1 which states that there is adverse selection in the reinsurance transaction. The coefficients for the loss ratio in two cases are significantly positive, implying that the insurers with higher loss ratio purchase more total reinsurance. However, the findings suggest that adverse selection exists in reinsurance transactions initiated by affiliated insurers, which runs counter to the common expectation or speculation. Affiliated insurers are expected to suffer fewer information problems because they have the opportunity to buy reinsurance within the same group. The reasoning would be that, with more information available, adverse selection could disappear between the affiliated insurers and reinsurers. So, to understand this more accurately, I decompose the total reinsurance purchases into purchases from affiliated reinsurers and purchases from non-affiliated reinsurers, and then performed a detailed analysis.

Table 8 lists the regression results of reinsurance demand of the affiliated insurers from affiliated, non-affiliated and all reinsurers. The column under the title of “affiliated reinsurers” includes the effects of all the independent variables on the reinsurance purchased from affiliated reinsurers. The column in the middle shows the effects on reinsurance purchases from outside non-affiliated reinsurers and the effects on the total reinsurance demand are listed in the last column. The loss volatility definition two is used in this scenario. The results show that A.M Best ratings are not statistically significant in explaining reinsurance purchases between the affiliated insurers and reinsurers. On the contrary, for non-affiliated insurers and reinsurers, A.M. Best ratings are shown to be significantly and negatively related to the reinsurance demand of -0.034. The findings suggest that the insurers with lower A.M. Best ratings would like to seek more reinsurance from the reinsurers outside of their group. Loss volatility, another indicator for adverse selection, presents opposite effects for affiliated and non-affiliated reinsurers. When the insurers and reinsurers are affiliated in one group, the estimated coefficient of the loss volatility is -0.038, implying that 1 percent increase of loss volatility is associated with 3.8 percent decrease of reinsurance demand from its own financial group. When considering reinsurance from outside of the group, the coefficient of loss volatility is estimated to be 0.031, which suggests that 1 percent increase of loss volatility is associated with 3.1 percent increase of reinsurance demand from the affiliated reinsurers. Therefore, the evidences above suggest that adverse selection problem exists between affiliated insurers and non-affiliated reinsurers as expected, and is not found between affiliated insurers and reinsurers within a financial group.

Some affiliated insurers choose to transfer most of their risks to their affiliated companies within their group, but other affiliated insurers may cede most premiums to non-affiliated reinsurers. Consequently, an information problem may be present in different ways for those affiliated insurers. According to the percentage of ceded premiums paid to affiliated reinsurers, three subgroups are created. Table 9A summaries the regression results for affiliated insurers with more than 75 percent ceded premiums paid to affiliated reinsures; Table 9B lists the results with more than 50 percent ceded premiums paid to affiliated reinsurers; Table 9C summarizes the results with less than 20 percent ceded premiums paid to affiliated reinsurers. For the affiliated insurers which transfer most of their risks to their affiliated members, an adverse selection problem is presented with the significantly negative coefficient of A.M. Best ratings and the positive coefficient of loss volatility (see Table 9A). For the affiliated insurers which mostly buy reinsurance from non-affiliated companies, there is no evidence showing the existence of adverse selection (see Table 9C). This comparison indicates that information asymmetry is still a problem even within a single group, especially when affiliated insurers cede most of their premiums to their affiliated reinsurers.

In summary, there is supporting evidence of the presence of adverse selection between affiliated insurers and non-affiliated reinsurers. Nevertheless, when affiliated insurers purchase most of their reinsurance from their affiliated reinsurers, there is still an adverse selection problem.

Moral Hazard

Recall Hypothesis 2 states that the percent of recovered losses in the previous year is positively associated with the reinsurance purchase with the presence of moral hazard. From Table 6A we can see that the estimated coefficient of the percent of recovered losses in the previous period is significantly positive. The coefficient of 0.091 implies that 1 percent increase of percent of recovered losses from the last period is associated with around 0.1 percent increase in reinsurance demand. With the changed measure of loss volatility, the percentage of recovered losses in the prior period is no longer statistically significant as shown in Table 7A. In the first stage estimation, the estimated coefficient for the one and two lag of reinsurance purchase are significantly positive to the loss ratio, which means the higher the reinsurance purchase of previous years the higher the loss ratio in the current period. When affiliated insurers cede premiums to non-affiliated reinsurers, the estimated coefficients of the percent of recovered loss in the last year is 0.414, which is statistically significant at 1 percent level, as shown in Table 8. Overall, it is not clear if there is a moral hazard problem for affiliated insurers based on these mixed results. Table 9A, 9B, and 9C list regression results for affiliated insurers in three subgroups. The estimated coefficients of lag of recovered losses are not significantly positive in these cases, which does not support the hypothesis of the existence of moral hazard for affiliated insurers.

In summary, there is no consistent supporting evidence of the existence of moral hazard for affiliated insurers. One possible explanation could be that affiliated insurers still manage their risks effectively and diligently even after transferring part of their risks to affiliated reinsurers, because they have consistent interest within a financial group.

Estimation of Other Control Variables

Reinsurance-specific factors, sustainability index, the reinsurance price in the last period and internal reinsurance percentage, have different effects on the demand for reinsurance. As predicted, the percentage of internal reinsurance is negatively and significantly correlated to the demand for external reinsurance. Affiliated insurers will demand less external reinsurance once they take part in an internal insurance risk management pool or other similar arrangements. Surprisingly, the estimated coefficient for reinsurance price is significantly positive. One possible explanation could be that the affiliated insurer retains the “good” risks for its own group, and purposely cedes the “bad” risks to external reinsurers with less consideration of price. However, the reinsurance sustainability index has no significant effect on the demand for reinsurance, which also can be attributed to the dependence on the internal reinsurance arrangements among the group.

Other firm-specific factors also have effects on the demand for the affiliated insurers. The estimated coefficients of loss ratio and leverage are significantly positive as expected. Higher loss and higher leverage encourage the insurer to buy more reinsurance to diversify risks and stabilize business performance. As expected, log of total assets and the geographic Herfindahl index are negatively related to the demand for reinsurance. Stronger financial capability and geographical diversification increase the insurers' own ability to control risks, reducing the demand for external reinsurance coverage. Interestingly, the estimated coefficients of the percentage of homeowner written premiums in Alabama, Louisiana, North Carolina, South Carolina and Mississippi are significantly negative, while the estimated coefficients for states of Florida and Texas are insignificant.

4.5.2 Empirical Results for Non-Affiliated Property and Liability Insurers

The regression results for non-affiliated insurers are presented in the middle column in Table 6A and 7A. Recall that Hypothesis 1 states that the lower A.M. Best ratings are associated with higher reinsurance demand with the presence of adverse selection. The loss volatility is expected to be positively related to the reinsurance purchase to diversify insurers' risks. From Table 6A, we can see that the estimated coefficient for the A.M. Best rating is significantly positive, which implies that the insurers with higher ratings purchase more reinsurance. The estimated coefficient of loss volatility is significantly negative. This evidence shows that more stable non-affiliated insurers with better ratings are associated with the higher demand for reinsurance, which rejects the null hypothesis of existence of adverse selection for non-affiliated insurers.

In terms of moral hazard, the mixed results are presented in Table 6A and 7A when two loss volatility measures are used alternatively. The estimated coefficient of the percentage of the recovered losses out of the total losses incurred is not statistically significant in Table 6A, while it is significantly positive of 0.003 when second loss volatility definition is applied in Table 7A. Taking the relation of loss ratio and the reinsurance purchase in the last period in the first stage examination, the relationship is not significantly positive. Overall, no consistent supporting evidence is found on the existence of adverse selection or moral hazard for the non-affiliated insurers in the property and liability reinsurance market.

The regression results also show that reinsurance sustainability index, loss ratio, leverage, liquidity and percentage of homeowner-written premiums in Florida are positively related to the purchase of reinsurance. As tested in Garven and Grace (2007), the long-term reinsurance relationship is related to the higher purchase of reinsurance, and the positive coefficient estimation of sustainability index is consistent with their findings. As expected, the non-affiliated insurer with higher leverage purchases more reinsurance. Besides, the product Herfindahl index and geographic Herfindahl index are negatively related to the reinsurance demand, which is consistent with the results by Garven and Grace (2007). Once insurers have diversified their risks in product lines and geographic distributions, the need for reinsurance is decreased. Since homeowner insurance in the Florida market faces huge catastrophic hurricane risks, insurers in this market demand more reinsurance. The estimated coefficient of the percentage of homeowner-written premiums in Florida in the regression equation is significantly positive, which indicates that the underwriting of homeowner insurance in Florida increases the demand for reinsurance for the non-affiliated insurers. This result is opposite to the findings for the affiliated insurers in the coastal states, which indicates the business line of homeowner insurance is insignificant or is significantly negative to the reinsurance purchase. From this comparison we could infer that affiliated and non-affiliated insurers apply reinsurance in different ways to diversify catastrophic hurricane risks. The non-affiliated insurers present a strong demand for external reinsurance for their homeowner insurance business in the high risk areas, while the affiliated insurers may rely on other financial capabilities within a group rather than the external reinsurance in this case.

4.5.3 Regression Results for All Property and Liability Insurers

To test the asymmetric information for the whole reinsurance market, the regression is run on the panel data including all the affiliated and non-affiliated property and liability insurers from 1992 to 2006. There is no supporting evidence on the presence of adverse selection or moral hazard problem in the reinsurance market.

From Table 6A we can see that the estimated coefficient of A.M. Best rating is not statistically significant, while the loss volatility is shown to be statistically significant and negatively related to reinsurance purchase. With the second loss volatility measure, this variable presents a significantly positive relationship to the external reinsurance demand which is shown in Table 7A. These mixed findings fail to support the null hypothesis 1 of the existence of adverse selection in the reinsurance market.

In terms of moral hazard, the estimated coefficients for the lag of recovered losses ratio is not statistically significant in Table 6A and 7A. In the first stage regression, the estimated coefficients of reinsurance purchases in the last period are 0.095 in Table 6A, which is statistically significant and positive. This may suggest moral hazard problem arises because the purchase of reinsurance in the last period looses the primary insurers' incentives to control risks, leading to a higher loss ratio in the current period. However, this finding is not robust to the changes of loss volatility measure, and this estimated coefficient turns out to be insignificant in Table 7A. From these mixed evidence we may infer that the moral hazard problem does not prevail in the reinsurance market.

Among the control variables included, loss ratio and leverage are positively related to the demand for the reinsurance as expected. Product Herfindahl index, geographic Herfindahl index and percentage of homeowner written premium in Alabama, Louisiana, North Carolina, South Carolina and Mississippi are negatively related to reinsurance demand, if all insurers are considered. The regression results for all the insurers in the reinsurance market are more similar to the results for the affiliated insurers, where the affiliated insurers account for 40 percent of all insurers.

5. Conclusion

As an effective risk management tool, reinsurance meets the corporate demand for insurance by diversifying risks, obtaining expertise from the reinsurer, increasing capacity and lowering taxes. Thus the reinsurance market is an important and supplementary part of the primary insurance market. However, the asymmetric information problem may exist between the reinsurer and the primary insurer, and such a problem may damage the insurance market.

Based on an extended theoretical model, this paper empirically tests the asymmetric information problem in the property and liability insurance market by separating adverse selection from moral hazard. Using the panel data from NAIC and A.M. Best Company, adverse selection is shown to exist between affiliated insurers and non-affiliated reinsurers. When affiliated insurers mostly use reinsurance within their groups, adverse selection problems arise among those group members. For non-affiliated insurers, there is no supporting evidence found on the existence of asymmetric information including adverse selection or moral hazard. Overall, the results provide supporting evidence of the presence of adverse selection and mixed evidence of moral hazard in the reinsurance market. While the findings are consistent with the results of Garven and Grace (2007), a detailed investigation is needed. It is interesting that the adverse selection does exist between affiliated insurers and non-affiliated reinsurers, even in an affiliated financial group which is contrary to the initial expectations. However, there is no adverse selection issue among non-affiliated insurers and reinsurers. These phenomena may be explained by the long-term reinsurance contracts between the non-affiliated insurers and outsider reinsures which reveal the risk type of insurers over time. For affiliated insurers and reinsurers within a financial group, the lack of such risk detection for ceding companies nevertheless lead to this asymmetric information problem. On the other side, moral hazard problem is not found in the reinsurance market no matter in the affiliated or non-affiliated insurers, which may suggest that reinsurers control the moral hazard problem by monitoring or loss-sensitive premiums. The results imply that more attention should be paid to the asymmetric information between affiliated insurers and reinsurers within a financial group.

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Table 1
A. M. Best Financial Strength Rating Categories

Category	Associated Description
Secure	A++, A+ (Superior); A, A- (Excellent); B++, B+ (Good)
Vulnerable	B, B- (Fair); C++, C+ (Marginal); C, C- (Weak), D (Poor); E (Under Regulatory Supervision); F (In Liquidation); S (Rating Suspended)

Data sources: http://www.ambest.com/ratings/guide.asp

Table 2
Constructed Numerical Scales and Associated Letter Scales

Letter Scale	Numerical Scales
A++, A+ (Superior)	6
A, A- (Excellent)	5
B++, B+ (Good)	4
B, B- (Fair)	3
C++, C+ (Marginal)	2
C, C- (Weak)	1
D (Poor)	0
E (Under Regulatory Supervision)	0
F (In Liquidation)	0
S (Rating Suspended)	0

See Mayer and Smith (1990)

Table 3. Descriptive Statistics for the Affiliated Property and Liability Insurers

Variables	Number of Observations	Mean	Standard Deviation	Minimum	Maximum
Reinsurance Purchase	4,077	0.209	0.209	0.000	1.000
A.M.Best Ratings	4,077	5.027	1.238	0.000	6.000
Loss Volatility Definition One[1]	4,077	-0.006	0.330	-1.998	0.997
Loss Volatility Definition Two[2]	2,535	0.162	1.672	-69.360	3.145
Lag of Ratio of Recovered Losses	3,197	2.676	17.611	0.000	870.864
Reinsurance Sustainability Index	4,077	0.098	0.217	0.000	1.000
Loss Ratio	4,077	0.566	0.374	0.017	6.637
Lag of Reinsurance Price	3,197	0.798	1.381	0.002	26.585
Internal Reinsurance Percentage	4,077	2.248	11.347	-48.507	135.345
Log of Total Assets	4,077	18.179	4.186	6.666	24.930
Stock Indicator	4,077	0.893	0.310	0.000	1.000
Return on Equity	4,077	8.394	14.388	-49.500	98.800
Leverage	4,077	4.517	2.942	0.000	34.100
Liquidity	4,077	1.592	1.591	0.035	9.999
Effective Tax Rate	4,024	0.209	0.254	0.000	1.000
Product Herfindahl Index	3,306	0.405	0.252	0.082	1.000
Georgraphic Herfindahl Index	4,077	0.183	0.192	0.030	1.000
Percentage of Homeowner Written Premium in Florida	4,077	0.408	2.401	0.000	79.660
Percentage of Homeowner Written Premium in Texas	4,077	0.233	2.838	0.000	100.000
Percentage of Homeowner Written Premium in AL, LA, MC, NC and MS	4,077	0.465	2.235	0.000	61.186
Percentage of Long Tail Business Lines	4,077	0.603	0.352	0.000	1.000

1. Loss Volatility Definition One = $(L_t^D - L_{t-1}^D)/(DPW_t)$

2. Loss Volatility Definition Two = $(L_t^D - (L_{t-1}^D + L_{t-2}^D + L_{t-3}^D)/3)/(DPW_t)$

Table 4. Descriptive Statistics for the Non-Affiliated Property and Liability Insurers

Variables	Number of Observations	Mean	Standard Deviation	Minimum	Maximum
Reinsurance Purchase	5,064	0.286	0.211	0.000	1.000
A.M.Best Ratings	5,064	3.752	1.803	0.000	6.000
Loss Volatility Definition One	5,064	0.023	0.215	-1.887	0.989
Loss Volatility Definition Two	2,971	0.032	0.295	-8.232	1.489
Lag of Ratio of Recovered Losses	4,009	1.755	12.110	0.001	550.955
Reinsurance Sustainability Index	5,064	0.103	0.200	0.000	0.999
Loss Ratio	5,064	0.493	0.276	0.015	7.518
Lag of Reinsurance Price	4,009	1.330	1.842	0.006	29.078
Internal Reinsurance Percentage	N/A	N/A	N/A	N/A	N/A
Log of Total Assets	5,063	15.596	3.840	5.413	22.051
Stock Indicator	5,064	0.448	0.497	0.000	1.000
Return on Equity	5,064	6.494	13.822	-49.300	93.900
Leverage	5,064	4.015	3.013	0.000	49.500
Liquidity	5,064	1.812	1.351	0.000	9.999
Effective Tax Rate	4,912	0.164	0.229	0.000	1.000
Product Herfindahl Index	4,890	0.549	0.288	0.117	1.000
Georgraphic Herfindahl Index	5,064	0.713	0.342	0.035	1.000
Percentage of Homeowner Written Premium in Florida	5,064	0.039	0.694	0.000	28.772
Percentage of Homeowner Written Premium in Texas	5,064	0.027	0.464	0.000	11.431
Percentage of Homeowner Written Premium in AL, LA, MC, NC and MS	5,064	0.044	0.593	0.000	11.006
Percentage of Long Tail Business Lines	5,064	0.634	0.346	0.000	1.000

1. Loss Volatility Definition One = $(L_t^D - L_{t-1}^D)/(DPW_t)$

2. Loss Volatility Definition Two = $(L_t^D - (L_{t-1}^D + L_{t-2}^D + L_{t-3}^D)/3)/(DPW_t)$

Table 5. Descriptive Statistics for the Property and Liability Insurers

Variables	Number of Observations	Mean	Standard Deviation	Minimum	Maximum
Reinsurance Purchase	9,141	0.252	0.213	0.000	1.000
A.M.Best Ratings	9,141	4.321	1.699	0.000	6.000
Loss Volatility Definition One	7,804	0.014	0.380	-24.957	3.202
Loss Volatility Definition Two	5,506	0.092	1.157	-69.360	3.145
Lag of Ratio of Recovered Losses	7,804	2.600	20.633	0.000	975.168
Reinsurance Sustainability Index	9,141	0.101	0.208	0.000	1.000
Loss Ratio	9,141	0.526	0.325	0.015	7.518
Lag of Reinsurance Price	7,804	1.116	1.764	0.002	29.078
Internal Reinsurance Percentage	9,141	1.076	7.761	-48.507	135.345
Log of Total Assets	9,140	16.748	4.199	5.413	24.930
Stock Indicator	9,141	0.646	0.478	0.000	1.000
Return on Equity	9,141	7.342	14.108	-49.500	98.800
Leverage	9,141	4.239	2.992	0.000	49.500
Liquidity	9,141	1.714	1.467	0.000	9.999
Effective Tax Rate	8,936	0.185	0.242	0.000	1.000
Product Herfindahl Index	8,196	0.491	0.283	0.082	1.000
Georgraphic Herfindahl Index	9,141	0.477	0.388	0.030	1.000
Percentage of Homeowner Written Premium in Florida	9,141	0.204	1.695	0.000	79.660
Percentage of Homeowner Written Premium in Texas	9,141	0.119	1.929	0.000	100.000
Percentage of Homeowner Written Premium in AL, LA, MC, NC and MS	9,141	0.232	1.570	0.000	61.186
Affiliation indicator	9,141	0.446	0.497	0.000	1.000
Percentage of Long Tail Business Lines	9,141	0.620	0.349	0.000	1.000

1. Loss Volatility Definition One = $(L_t^D - L_{t-1}^D)/(DPW_t)$

2. Loss Volatility Definition Two = $(L_t^D - (L_{t-1}^D + L_{t-2}^D + L_{t-3}^D)/3)/(DPW_t)$

Table 6A. Estimated Coefficients on Reinsurance Purchase for the Property and Liability Insurers

Second Stage Regression	**Dependent Variable: Reinsurance Purchase**		
Variables	**Affiliation**	**Non-Affiliation**	**All P/L Insurers**
A.M.Best Ratings	**-0.013 (0.005)*****	**0.009 (0.003)*****	0.004 (0.003)
Loss Volatility Definition One	-0.013 (0.014)	**-0.045 (0.016)*****	**-0.031 (0.009)*****
Lag of Ratio of Recovered Losses	**0.091 (0.016)*****	0.0009 (0.0005)	0.0001 (0.002)
Reinsurance Sustainability Index	-0.014 (0.011)	**0.016 (0.010)***	0.003 (0.007)
Loss Ratio	**0.091 (0.016)*****	**0.173 (0.030)*****	**0.151 (0.016)*****
Lag of Reinsurance Price	**0.013 (0.003)*****	0.001 (0.001)	**0.004 (0.001)*****
Internal Reinsurance Percentage	**-0.001 (0.003)*****		**-0.002 (0.0003)*****
Log of Total Assets	**-0.072 (0.025)****	**-0.274 (0.230)*****	**-0.121 (0.018)*****
Stock Indicator	0.002 (0.030)	-0.011 (0.016)	-0.014 (0.014)
Return on Equity	**0.001 (0.0002)****	0.0002 (0.0002)	**0.0003 (0.0001)****
Leverage	**0.011 (0.001)*****	**0.009 (0.001)*****	**0.009 (0.001)*****
Liquidity	-0.003 (0.003)	**0.017 (0.004)*****	0.003 (0.002)
Effective Tax Rate	-0.015 (0.010)	-0.006 (0.010)	-0.011 (0.007)
Product Herfindahl Index	0.003 (0.028)	**-0.130 (0.032)*****	**-0.066 (0.021)*****
Georgraphic Herfindahl Index	**-0.073 (0.034)*****	**-0.047 (0.018)****	**-0.074 (0.014)*****
Percentage of Homeowner Written Premium in Florida	0.001 (0.001)	**0.010 (0.006)***	0.001 (0.002)
Percentage of Homeowner Written Premium in Texas	-0.006 (0.004)	-0.013 (0.012)	-0.005 (0.004)
Percentage of Homeowner Written Premium in AL, LA, NC, SC and MS	**-0.019 (0.003)*****	0.008 (0.027)	**-0.014 (0.003)*****
Percentage of Long Tail Business Lines	0.006 (0.016)	0.001 (0.013)	0.004 (0.010)
Affiliation indicator			-0.013 (0.025)
Square of Log of Total Assets	**0.001 (0.0004)*****	**0.006 (0.0006)*****	**0.002 (0.0004)*****

Continued

First Stage Regression	**Endogeneous Variable: Loss Ratio**		
One Lag of Reinsurance Purchase	**0.205**	-0.035	**0.095**
	(0.066)*	(0.026)	**(0.031)***
Two Lag of Reinsurance Purchase	**0.135**	**-0.047**	0.030
	(0.063)	**(0.025)***	(0.030)
One Lag of Loss Ratio	**0.823**	**0.381**	**0.555**
	(0.032)*	**(0.014)***	**(0.016)***
One Lag of Log Direct Premium Written	**0.083**	**0.163**	**0.091**
	(0.016)	**(0.010)***	**(0.009)***
F-stat	F(409,1790)	F(540,2652)	F(964,4864)
	=1.75	=4.39	=16.42
Observations	2,236	3,226	5,524
R-squared	0.154	0.101	0.126

1. Fixed effect model on panel data is used for affiliated, non-affiliated and all property and liability insurers based on Hausman test.

2. Regression results of year dummies are not reported in this table.

3. The regreesion results of other instrumental variables included in the first stage regression are not shown in this table.

4. Regression results are shown as coefficient and standard deviation. The figures on the top are the estimated coefficients and the figures in the parenthesis are standard deviations.

5. * , ** and *** denote significance at 10%, 5% and 1% level respectively.

Marginal Effects (Measured at the Means)

Variables	**Affiliation**	**Non-Affiliation**	**All P/L Insurers**
Log of Total Assets	**-0.072**	**-0.274**	**-0.121**
	(0.025)*	**(0.030)***	**(0.018)***

Table 6B. Comparison of Expected Coefficients Signs and Regression Results

Variables	Expe. Sign	Affi. Sign	Non-affi. Sign	All P/L Sign
Signal of Adverse Selection				
A.M.Best Ratings	-	-	+	
Loss Volatility Definition One	+		-	-
Signal of Moral Hazard				
Lag of Recovered Losses Ratio	+	+		
Reinsurance-specific Factors				
Reinsurance Sustainability Index	+		+	
Lag of Reinsurance Price	-	+		+
Internal Reinsurance Percentage	-	-		-
Firm-specific Factors				
Loss Ratio	+	+	+	+
Log of Total Assets[1]	-	-	-	-
Stock Indicator	-			
Return on Equity	-	+		+
Leverage	+	+	+	+
Liquidity	-		+	
Effective Tax Rate	+			
Product Herfindahl Index	-		-	-
Georgraphic Herfindahl Index	-	-	-	-
Percentage of Homeowner Written Premium in Florida	+		+	
Percentage of Homeowner Written Premium in Texas	+			
Percentage of Homeowner Written Premium in AL, LA, NC, SC and MS	+	-		-
Percentage of Long Tail Business Lines	+			
Instrumental Variables for Loss Ratio				
One Lag of Reinsurance Purchase	+	+		+
Two Lag of Reinsurance Purchase	+	+	-	
One Lag of Loss Ratio	+	+	+	+
One Lag of Log Direct Premium Written	+	+	+	+

1. This is the marginal effect measured at the mean.

Table 7A. Estimated Coefficients on Reinsurance Purchase for the Property and Liability Insurers

Second Stage Regression	**Dependent Variable: Reinsurance Purchase**		
Variables	**Affiliation**	**Non-Affiliation**	**All P/L Insurers**
A.M.Best Ratings	**-0.037 (0.010)*****	**0.008 (0.004)****	-0.002 (0.003)
Loss Volatility Definition Two	0.005 (0.022)	**0.038 (0.021)***	**0.032 (0.010)*****
Lag of Ratio of Recovered Losses	-0.0001 (0.0003)	**0.003 (0.001)*****	0.0001 (0.0001)
Reinsurance Sustainability Index	-0.031 (0.021)	**0.017 (0.010)***	0.0005 (0.008)
Loss Ratio	**0.123 (0.037)*****	0.015 (0.038)	**0.045 (0.018)****
Lag of Reinsurance Price	-0.003 (0.002)	0.0005 (0.001)	0.002 (0.001)
Internal Reinsurance Percentage	**0.002 (0.001)*****		**-0.001 (0.0004)*****
Log of Total Assets	**-0.199 (0.057)*****	**-0.328 (0.034)*****	**-0.188 (0.021)*****
Stock Indicator	0.035 (0.058)	-0.023 (0.017)	-0.010 (0.015)
Return on Equity	**0.001 (0.0004)*****	**0.0005 (0.0002)****	**0.0004 (0.0002)*****
Leverage	**0.006 (0.003)****	**0.007 (0.001)*****	**0.007 (0.001)*****
Liquidity	**0.055 (0.009)*****	**0.016 (0.005)*****	**0.012 (0.003)*****
Effective Tax Rate	**-0.031 (0.017)***	-0.016 (0.010)	**-0.017 (0.007)****
Product Herfindahl Index	**-0.136 (0.054)****	**-0.113 (0.036)*****	**-0.040 (0.023)***
Georgraphic Herfindahl Index	**-0.204 (0.067)*****	**-0.037 (0.019)****	**-0.062 (0.014)*****
Percentage of Homeowner Written Premium in Florida	-0.0001 (0.004)	0.006 (0.072)	-0.0005 (0.002)
Percentage of Homeowner Written Premium in Texas	0.008 (0.007)	-0.018 (0.011)	-0.002 (0.004)
Percentage of Homeowner Written Premium in AL, LA, NC, SC and MS	**-0.002 (0.009)*****	0.033 (0.052)	**-0.003 (0.005)*****
Percentage of Long Tail Business Lines	-0.067 (0.034)**	-0.004 (0.013)	0.004 (0.010)
Affiliation indicator			-0.023 (0.021)
Square of Log of Total Assets	**0.004 (0.001)*****	**0.007 (0.0007)*****	**0.004 (0.0004)*****

Continued

First Stage Regression	Endogeneous Variable: Loss Ratio		
One Lag of Reinsurance Purchase	0.113 (0.103)	**-0.053** **(0.029)***	0.068 (0.072)
Two Lag of Reinsurance Purchase	0.141 (0.125)	-0.007 (0.028)	-0.017 (0.071)
One Lag of Loss Ratio	**0.231** **(0.031)*****	**0.382** **(0.018)*****	**0.267** **(0.018)*****
One Lag of Log Direct Premium Written	-0.067 (0.045)	**0.022** **(0.012)***	0.032 (0.021)
F-stat	F(351,1363) =1.78	F(474,2120) =5.24	F(808,3537) =2.19
Observations	1,749	2,627	4,381
R-squared	0.121	0.104	0.149

1. Fixed effect model on panel data is used for affiliated, non-affiliated and all property and liability insurers based on Hausman test.

2. Regression results of year dummies are not reported in this table.

3. The regreesion results of other instrumental variables included in the first stage regression are not shown in this table.
4. Regression results are shown as coefficient and standard deviation. The figures on the top are the estimated coefficients and the figures in the parenthesis are standard deviations.
5. * , ** and *** denote significance at 10%, 5% and 1% level respectively.

Marginal Effects (Measured at the Means)

Variables	Affiliation	Non-Affiliation	All P/L Insurers
Log of Total Assets	**-0.199** **(0.057)*****	**-0.328** **(0.034)*****	**-0.121** **(0.018)*****

Table 7B. Comparison of Expected Coefficients Signs and Regression Results

Variables	Expe. Sign	Affi. Sign	Non-affi. Sign	All P/L Sign
Signal of Adverse Selection				
A.M.Best Ratings	-	-	+	
Loss Volatility Definition Two	+	+	-	+
Signal of Moral Hazard				
Lag of Recovered Losses Ratio	+		+	
Reinsurance-specific Factors				
Reinsurance Sustainability Index	+		+	
Lag of Reinsurance Price	-	+		
Internal Reinsurance Percentage	-	-		-
Firm-specific Factors				
Loss Ratio	+	+		+
Log of Total Assets[1]	+/-	-	-	-
Stock Indicator	-			
Return on Equity	-	+	+	+
Leverage	+	+	+	+
Liquidity	-	+	+	+
Effective Tax Rate	+			-
Product Herfindahl Index	-		-	-
Georgraphic Herfindahl Index	-	-	-	-
Percentage of Homeowner Written Premium in Florida	+			
Percentage of Homeowner Written Premium in Texas	+			
Percentage of Homeowner Written Premium in AL, LA, NC, SC and MS	+	-		-
Percentage of Long Tail Business Lines	+			
Instrumental Variables for Loss Ratio				
One Lag of Reinsurance Purchase	+	+	-	
Two Lag of Reinsurance Purchase	+			
One Lag of Loss Ratio	+	+	+	+
One Lag of Log Direct Premium Written	+		+	

1. This is the marginal effect measured at the mean.

Table 8. Estimated Coefficients on Reinsurance Purchase for the Affiliated Property and Liability Insurers

Second Stage Regression	Dependent Variable: Reinsurance Purchase		
Variables	**Affiliated Reinsurers**	**Non-Affiliated**	**All Reinsurers**
A.M.Best Ratings	-0.013 (0.011)	**-0.034** **(0.007)*****	**-0.037** **(0.010)*****
Loss Volatility	**-0.038** **(0.022)***	**0.031** **(0.016)****	0.005 (0.022)
Lag of Ratio of Recovered Losses	**-0.003** **(0.001)****	-0.001 (0.001)	-0.0001 (0.0003)
Reinsurance Sustainability Index		-0.013 (0.015)	-0.031 (0.021)
Loss Ratio	0.026 (0.037)	**0.133** **(0.026)*****	**0.123** **(0.037)*****
Lag of Reinsurance Price	-0.0001 (0.0004)	**0.011** **(0.004)****	-0.003 (0.002)
Internal Reinsurance Percentage		**-0.001** **(0.001)*****	**0.002** **(0.001)*****
Log of Total Assets	**-0.256** **(0.062)*****	**-0.082** **(0.040)****	**-0.199** **(0.057)*****
Stock Indicator	0.030 (0.060)	0.056 (0.041)	0.035 (0.058)
Return on Equity	**0.001** **(0.0004)*****	**0.001** **(0.0002)*****	**0.001** **(0.0004)*****
Leverage	-0.005 (0.003)***	**0.008** **(0.002)*****	**0.006** **(0.003)****
Liquidity	**0.040** **(0.009)*****	**0.018** **(0.007)*****	**0.055** **(0.009)*****
Effective Tax Rate	-0.022 (0.017)	-0.013 (0.012)	**-0.031** **(0.017)***
Product Herfindahl Index	**-0.162** **(0.058)*****	0.017 (0.039)	**-0.136** **(0.054)****
Georgraphic Herfindahl Index	-0.063 (0.075)	**-0.114** **(0.078)****	**-0.204** **(0.067)*****
Percentage of Homeowner Written Premium in Florida	0.0001 (0.004)	0.001 (0.002)	-0.0001 (0.004)
Percentage of Homeowner Written Premium in Texas	0.010 (0.007)	-0.001 (0.005)	0.008 (0.007)
Percentage of Homeowner Written Premium in AL, LA, NC, SC and MS	0.005 (0.011)	-0.006 (0.007)	**-0.002** **(0.009)*****
Percentage of Long Tail Business Lines	**-0.071** **(0.034)****	0.038 (0.024)	-0.067 (0.034)**
Square of Log of Total Assets	**0.004** **(0.001)*****	**0.002** **(0.0007)****	**0.004** **(0.001)*****

Continued

First Stage Regression	**Endogeneous Variable: Loss Ratio**		
One Lag of Reinsurance Purchase	0.010 (0.151)	**0.414** **(0.192)****	0.113 (0.103)
Two Lag of Reinsurance Purchase	0.234 (0.167)	-0.190 (0.192)	0.141 (0.125)
One Lag of Loss Ratio	**0.216** **(0.035)*****	**0.233** **(0.030)*****	**0.231** **(0.031)*****
One Lag of Log Direct Premium Written	-0.084 (0.056)	-0.61 (0.045)	-0.067 (0.045)
F-stat	F(311,1090) =1.64	F(351,1363) =1.79	F(351,1363) =1.78
Observations	1,434	1,749	1,749
R-squared	0.168	0.105	0.121

1. Fixed effect model is used for the affiliated insurers cede to affiliated, non-affiliated and all reinsurers based on Hausman test.

2. Regression results of year dummies are not reported in this table.

3. The regreesion results of other instrumental variables included in the first stage regression are not shown in this table.

4. Regression results are shown as coefficient and standard deviation. The figures on the top are the estimated coefficients and the figures in the parenthesis are standard deviations.

5. * , ** and *** denote significance at 10%, 5% and 1% level respectively.

Marginal Effects (Measured at the Means)

Variables	**Affiliated Reinsurers**	**Non-Affiliated**	**All Reinsurers**
Log of Total Assets	**-0.256** **(0.060)*****	**-0.082** **(0.040)****	**-0.199** **(0.057)*****

Table 9A. Estimated Coefficients on Reinsurance Purchase for the Affiliated Property and Liability Insurers with More than 75% Ceded Premium Paid to Affiliated Reinsurers

Second Stage Regression	**Dependent Variable: Reinsurance Purchase**		
Variables	**Affiliated Reinsurers**	**Non-Affiliated Reinsurers**	**All Reinsurers**
A.M.Best Ratings	**-0.057** **(0.018)*** **	**-0.012** **(0.004)*** **	**-0.054** **(0.019)*** **
Loss Volatility	**0.102** **(0.056)* **	**0.022** **(0.012)* **	**0.138** **(0.058)** **
Lag of Ratio of Recovered Losses	**-0.025** **(0.002)*** **	0.001 (0.001)	**-0.021** **(0.002)**
Reinsurance Sustainability Index		0.006 (0.007)	0.048 (0.033)
Loss Ratio	**0.087** **(0.040)** **	**0.015** **(0.008)* **	**0.099** **(0.042)** **
Lag of Reinsurance Price	-0.001 (0.002)	**0.005** **(0.003)* **	0.001 (0.002)
Internal Reinsurance Percentage		**-0.001** **(0.0001)*** **	**0.002** **(0.001)*** **
Log of Total Assets	**-0.181** **(0.097)* **	-0.003 (0.021)	-0.084 (0.100)
Stock Indicator	-0.013 (0.089)	0.006 (0.020)	0.046 (0.093)
Return on Equity	0.0005 (0.0008)	0.0001 (0.0001)	0.001 (0.001)
Leverage	-0.004 (0.006)	**0.007** **(0.001)*** **	0.004 (0.006)
Liquidity	**0.050** **(0.012)*** **	**0.007** **(0.003)*** **	**0.060** **(0.013)*** **
Effective Tax Rate	**-0.071** **(0.026)*** **	-0.001 (0.006)	**-0.060** **(0.027)** **
Product Herfindahl Index	-0.156 (0.107)	**-0.055** **(0.024)** **	-0.106 (0.110)
Georgraphic Herfindahl Index	**0.372** **(0.163)** **	**-0.097** **(0.035)*** **	**0.279** **(0.164)* **
Percentage of Homeowner Written Premium in Florida	-0.016 (0.010)	0.002 (0.002)	-0.001 (0.010)
Percentage of Homeowner Written Premium in Texas	0.017 (0.032)	-0.005 (0.007)	0.009 (0.033)
Percentage of Homeowner Written Premium in AL, LA, NC, SC and MS	0.014 (0.016)	-0.003 (0.004)	**0.028** **(0.017)* **
Percentage of Long Tail Business Lines	**-0.171** **(0.059)*** **	**0.021** **(0.013)* **	**-0.161** **(0.061)*** **
Square of Log of Total Assets	0.003 (0.002)	-0.0001 (0.00004)	0.001 (0.002)

Continued

First Stage Regression	**Endogeneous Variable: Loss Ratio**		
One Lag of Reinsurance Purchase	-0.172 (0.127)	0.575 (0.396)	-0.111 (0.117)
Two Lag of Reinsurance Purchase	0.143 (0.132)	**-1.115** **(0.337)***	0.018 (0.138)
One Lag of Loss Ratio	**-0.507** **(0.056)***	**-0.486** **(0.056)***	**-0.520** **(0.056)***
One Lag of Log Direct Premium Written	**0.178** **(0.069)***	**0.154** **(0.065)**	**0.161** **(0.068)**
F-stat	F(160,318) =6.61	F(218,548) =3.01	F(222,555) =2.93
Observations	502	513	513
R-squared	0.585	0.293	0.549

1. Fixed effect model is used for the affiliated insurers cede to affiliated, non-affiliated and all reinsurers based on Hausman test.

2. Regression results of year dummies are not reported in this table.

3. The regreesion results of other instrumental variables included in the first stage regression are not shown in this table.
4. Regression results are shown as coefficient and standard deviation. The figures on the top are the estimated coefficients and the figures in the parenthesis are standard deviations.
5. * , ** and *** denote significance at 10%, 5% and 1% level respectively.

Marginal Effects (Measured at the Means)

Variables	**Affiliation**	**Non-Affiliation**	**All P/L Insurers**
Log of Total Assets	**-0.181** **(0.097)***	-0.003 (0.021)	-0.084 (0.100)

Table 9B. Estimated Coefficients on Reinsurance Purchase for the Affiliated Property and Liability Insurers with More than 50% Ceded Premium Paid to Affiliated Reinsurers

Second Stage Regression	**Dependent Variable: Reinsurance Purchase**		
Variables	**Affiliated Reinsurers**	**Non-Affiliated Reinsurers**	**All Reinsurers**
A.M.Best Ratings	**-0.024 (0.013)***	**-0.018 (0.005)*****	**-0.035 (0.014)****
Loss Volatility	0.012 (0.050)	-0.017 (0.019)	0.014 (0.051)
Lag of Ratio of Recovered Losses	**-0.017 (0.001)*****	**0.003 (0.001)****	**-0.012 (0.001)*****
Reinsurance Sustainability Index		-0.002 (0.009)	**-0.054 (0.025)****
Loss Ratio	0.014 (0.035)	0.010 (0.013)	0.018 (0.035)
Lag of Reinsurance Price	-0.0003 (0.001)	0.006 (0.004)	-0.002 (0.002)
Internal Reinsurance Percentage		**-0.001 (0.0002)*****	**0.002 (0.001)*****
Log of Total Assets	**-0.321 (0.071)*****	-0.014 (0.027)	-0.216 (0.072)
Stock Indicator	-0.003 (0.063)	0.003 (0.024)	0.041 (0.064)
Return on Equity	0.0005 (0.0006)	0.0003 (0.0002)	0.0003 (0.0006)
Leverage	-0.002 (0.004)	**0.009 (0.002)*****	**0.008 (0.004)****
Liquidity	**0.045 (0.009)*****	**0.009 (0.004)****	**0.055 (0.010)*****
Effective Tax Rate	**-0.043 (0.020)****	-0.012 (0.008)	**-0.047 (0.021)****
Product Herfindahl Index	-0.023 (0.080)	**-0.072 (0.029)****	-0.013 (0.079)
Georgraphic Herfindahl Index	-0.146 (0.101)	**-0.109 (0.038)*****	**-0.265 (0.102)*****
Percentage of Homeowner Written Premium in Florida	0.002 (0.004)	**0.005 (0.002)*****	**0.011 (0.004)*****
Percentage of Homeowner Written Premium in Texas	0.011 (0.009)	-0.005 (0.004)	0.002 (0.010)
Percentage of Homeowner Written Premium in AL, LA, NC, SC and MS	0.005 (0.013)	0.003 (0.005)	0.017 (0.013)
Percentage of Long Tail Business Lines	**-0.150 (0.041)*****	0.023 (0.016)	**-0.132 (0.042)*****
Square of Log of Total Assets	0.005 (0.001)	0.0003 (0.0005)	**0.004 (0.001)*****

Continued

First Stage Regression	Endogeneous Variable: Loss Ratio		
One Lag of Reinsurance Purchase	-0.070 (0.182)	0.020 (0.448)	-0.027 (0.167)
Two Lag of Reinsurance Purchase	0.204 (0.194)	-.154 (0.413)	0.203 (0.200)
One Lag of Loss Ratio	**-0.313** **(0.050)*****	**-0.313** **(0.050)*****	**-0.318** **(0.049)*****
One Lag of Log Direct Premium Written	-0.091 (0.084)	**-0.088** **(0.079)****	-0.096 (0.081)
F-stat	F(218,548) =3.01	F(222,555) =2.93	F(222,555) =2.96
Observations	799	812	812
R-squared	0.397	0.218	0.380

1. Fixed effect model is used for the affiliated insurers cede to affiliated, non-affiliated and all reinsurers based on Hausman test.

2. Regression results of year dummies are not reported in this table.

3. The regreesion results of other instrumental variables included in the first stage regression are not shown in this table.
4. Regression results are shown as coefficient and standard deviation. The figures on the top are the estimated coefficients and the figures in the parenthesis are standard deviations.
5. * , ** and *** denote significance at 10%, 5% and 1% level respectively.

Marginal Effects (Measured at the Means)

Variables	Affiliation	Non-Affiliation	All P/L Insurers
Log of Total Assets	**-0.321** **(0.071)*****	-0.015 (0.027)	**-0.216** **(0.072)*****

Table 9C. Estimated Coefficients on Reinsurance Purchase for the Affiliated Property and Liability Insurers with Less than 25% Ceded Premium Paid to Affiliated Reinsurers

Second Stage Regression	**Dependent Variable: Reinsurance Purchase**		
Variables	**Affiliated Reinsurers**	**Non-Affiliated Reinsurers**	**All Reinsurers**
A.M.Best Ratings	-0.005 (0.004)	**-0.024** **(0.010)****	**-0.029** **(0.010)*****
Loss Volatility	-0.004 (0.006)	0.011 (0.021)	-0.014 (0.022)
Lag of Ratio of Recovered Losses	**0.004** **(0.002)****	0.0001 (0.0002)	0.0001 (0.00001)
Reinsurance Sustainability Index		-0.013 (0.019)	-0.014 (0.019)
Loss Ratio	0.001 (0.007)	**0.039** **(0.018)****	**0.042** **(0.182)****
Lag of Reinsurance Price	0.0001 (0.0002)	0.002 (0.005)	0.002 (0.005)
Internal Reinsurance Percentage		**0.005** **(0.002)*****	**0.005** **(0.002)*****
Log of Total Assets	**-0.042** **(0.021)****	-0.099 (0.062)	-0.102 (0.064)
Stock Indicator	-0.004 (0.023)	0.070 (0.054)	0.072 (0.056)
Return on Equity	0.00001 (0.0001)	**0.001** **(0.0004)*****	**0.001** **(0.0004)*****
Leverage	**0.004** **(0.001)*****	**0.008** **(0.003)*****	**0.010** **(0.003)*****
Liquidity	0.007 (0.007)	**0.028** **(0.012)****	**0.035** **(0.013)*****
Effective Tax Rate	-0.004 (0.006)	-0.020 (0.017)	**-0.018** **(0.018)****
Product Herfindahl Index	**-0.046** **(0.019)****	0.004 (0.051)	-0.035 (0.052)
Georgraphic Herfindahl Index	-0.040 (0.030)	**-0.136** **(0.058)****	**-0.149** **(0.060)****
Percentage of Homeowner Written Premium in Florida	-0.003 (0.003)	-0.004 (0.005)	-0.006 (0.005)
Percentage of Homeowner Written Premium in Texas	**-0.005** **(0.002)*****	0.003 (0.006)	0.001 (0.006)
Percentage of Homeowner Written Premium in AL, LA, NC, SC and MS	0.005 (0.004)	-0.006 (0.007)	-0.005 (0.007)
Percentage of Long Tail Business Lines	-0.006 (0.009)	0.045 (0.030)	-0.042 (0.030)
Square of Log of Total Assets	**0.001** **(0.0004)***	0.002 (0.001)	0.002 (0.001)

Continued

First Stage Regression	Endogeneous Variable: Loss Ratio		
One Lag of Reinsurance Purchase	-0.135 (0.963)	0.162 (0.237)	0.064 (0.228)
Two Lag of Reinsurance Purchase	0.421 (0.766)	0.025 (0.229)	0.183 (0.191)
One Lag of Loss Ratio	**0.398** **(0.066)*****	**0.466** **(0.043)*****	**0.466** **(0.043)*****
One Lag of Log Direct Premium Written	0.067 (0.118)	-0.002 (0.067)	0.003 (0.067)
F-stat	F(114,284) =0.73	F(165,531) =0.86	F(165,531) =0.87
Observations	431	731	731
R-squared	0.141	0.155	0.154

1. Fixed effect model is used for the affiliated insurers cede to affiliated, non-affiliated and all reinsurers based on Hausman test.

2. Regression results of year dummies are not reported in this table.

3. The regreesion results of other instrumental variables included in the first stage regression are not shown in this table.

4. Regression results are shown as coefficient and standard deviation. The figures on the top are the estimated coefficients and the figures in the parenthesis are standard deviations.

5. * , ** and *** denote significance at 10%, 5% and 1% level respectively.

Marginal Effects (Measured at the Means)

Variables	Affiliation	Non-Affiliation	All P/L Insurers
Log of Total Assets	**-0.042** **(0.021)****	-0.099 (0.062)	-0.102 (0.064)

Appendix

The expected utility of a primary insurer from taking reinsurance transactions in two years is as follows:

$$E(U)=\iint\int_{0}^{D_1}U_1(W_1-P_1-L_1)f(L_1,s_1,m_1|e_1)dL_1ds_1dm_1+\iint\int_{D_1}^{A_1}U_1(W_1-P_1-D_1)f(L_1,s_1,m_1|e_1)dL_1ds_1dm_1$$

$$+\iint\int_{A_1}^{+\infty}U_1(W_1-P_1-L_1+A_1-D_1)f(L_1,s_1,m_1|e_1)dL_1ds_1dm_1-e_1$$

$$+\iiint\left\{\iint\int_{0}^{D_2}U_2(W_2-P_2-L_2)f(L_2,s_2,m_2|e_2(L_1))dL_2ds_2dm_2-e_2(L_1)\right\}f(L_1,s_1,m_1|e_1)dL_1ds_1dm_1$$

$$+\iiint\left\{\iint\int_{D_2}^{A_2}U_2(W_2-P_2-D_2)f(L_2,s_2,m_2|e_2(L_1))dL_2ds_2dm_2-e_2(L_1)\right\}f(L_1,s_1,m_1|e_1)dL_1ds_1dm_1$$

$$+\iiint\left\{\iint\int_{A_2}^{\infty}U_2(W_2-P_2-L_2+A_2-D_2)f(L_2,s_2,m_2|e_2(L_1))dL_2ds_2dm_2-e_2(L_1)\right\}f(L_1,s_1,m_1|e_1)dL_1ds_1dm_1$$

The first part, which integrates from zero to D_1 for the actual loss, is the primary insurer's utility if the primary insurer retains the actual loss to itself; the following integral between D_1 and A_1 is the primary insurer's utility with the recovered loss of L_1-D_1 by the reinsurer; the third part integrated from A_1 to the infinity is the primary insurer's utility with the recovered loss of A_1-D_1 by the reinsurer; the effort e_1 is subtracted from the expected utility for the first year to obtain the net expected utility. The next integral part is the calculation for the expected utility of the primary insurer for the second year.

The total profit for a reinsure in two years is:

$$
\begin{aligned}
I = & \iint \int_{0}^{D_1} P_1 f(L_1, s_1, m_1 | e_1) dL_1 ds_1 dm_1 + \iint \int_{D_1}^{A_1} (P_1 - L_1 + D_1) f(L_1, s_1, m_1 | e_1) dL_1 ds_1 dm_1 \\
& + \iint \int_{A_1}^{+\infty} (P_1 - A_1 + D_1) f(L_1, s_1, m_1 | e_1) dL_1 ds_1 dm_1 - c_1 \\
& + \iiint \iint \int_{0}^{D_2} P_2 f(L_2, s_2, m_2 | e_2(L_1)) f(L_1, s_1, m_1 | e_1) dL_2 dL_1 ds_2 ds_1 dm_2 dm_1 \\
& + \iiint \iint \int_{D_2}^{A_2} (P_2 - L_2 + D_2) f(L_2, s_2, m_2 | e_2(L_1)) f(L_1, s_1, m_1 | e_1) dL_2 dL_1 ds_2 ds_1 dm_2 dm_1 \\
& + \iiint \iint \int_{A_2}^{+\infty} (P_2 - A_2 + D_2) f(L_2, s_2, m_2 | e_2(L_1)) f(L_1, s_1, m_1 | e_1) dL_2 dL_1 ds_2 ds_1 dm_2 dm_1
\end{aligned}
$$

The first part, which integrates from zero to D_1, is the reinsurer's premium income if the reinsurer makes no payment to the insurer. The second integral between D_1 and A_1 is the reinsurer's profit when it pays $L_1 - D_1$ to the primary insurer and its income becomes $P_1 - L_1 + D_1$. The third part integrated from A_1 to the infinity is the reinsurer's profit if the reinsurer pays $A_1 - D_1$ to the primary insurer and the reinsurer's income is $P_1 - A_1 + D_1$. The monitoring cost c_1 is deducted from the expected profit for the first year to obtain the net expected profit. The next integral part is the calculation for the expected profit for the second year.

Essay Two

Moral Hazard under Government Intervention: Evidence from Florida Homeowner Insurance Market

ABSTRACT

To address the issue of soaring property insurance premiums and coverage availability in states that are subject to hurricane risks, state and federal governments have not only regulated the private insurance market but have also intervened directly into markets by establishing government-funded insurance programs. With coexisting public and private insurance mechanisms and price regulation, the risk of cross subsidization and a subsequent moral hazard problem may arise. By using data from the Florida Citizens Insurance Corporation, the Florida Hurricane Catastrophe Fund, the National Flood Insurance and the private homeowner insurance market in Florida from 1998 to 2007, this essay examines the moral hazard problems arising from government regulation and involvement in the private insurance sector in Florida. In sum, the provision of national flood insurance is found to be positively related to the population growth in the state of Florida, which shows that state immigrants can take advantage of the lower cost of flood insurance when relocating in higher-risk areas. Further, we find that national flood insurance and the catastrophe fund complement the development of the private insurance sector, while the residual market hinders the development of private property insurance market.

1. Introduction

Hurricane Andrew and the severe 2004-2005 storm seasons dramatically changed Florida's property insurance market. Private insurers have responded to the changed market environment by restricting the supply of coverage and increasing prices. Under political pressure from voters, both legislators and insurance regulators became concerned about how to provide sustainable and affordable insurance to property owners. Therefore, government intervention has taken different approaches, focusing on price regulation and as well as the use of government-funded insurance programs such as the National Flood Insurance Program (Flood Insurance),[7] the Citizens Property Insurance Corporation (Florida Citizens), and the Florida Hurricane Catastrophe Fund (CAT Fund). This essay answers the question of how well government intervention has worked by examining the effects of public policies on demographic changes and the homeowner insurance market in Florida, which has significant implications for public policy studies and insurance market analysis under catastrophic risks.

The population of Florida has grown rapidly since the 1980s at a rate significantly above the national growth rate, with the immigration accounting for about 85 percent of the increase (Economics and Demographic Research, 2009). In addition to economic prosperity and nice weather, other factors that may contribute to immigration to Florida are examined within the context of insurance. In sharp contrast to the higher insurance premiums charged by private insurers, the relatively lower cost of the residual, or high risk, market (in a risk adjusted sense) and flood insurance may encourage people to relocate to the state and to high risk areas. This essay examines the interactions between government insurance programs and the demographic changes in the last decade.

[7] The NFIP is funded by the federal government. It is not a program supported by the state of Florida. The NFIP predates Florida's increased hurricane incidence. However, it fills in coverage that is not provided by the private market nor by any other state program.

In the Florida homeowner insurance market, the introduction of government insurance programs, such as the Florida Citizens, the Flood Insurance, and the CAT Fund, is meant to fill the coverage gap left by private insurers. However, the government's involvement may induce different types of inefficiencies, such as crowding-out effect and moral hazard. Crowding out is any reduction in private consumption or investment that occurs because of an increase in government spending. In this paper, it means the supplanting of private insurance coverage by the coverage provided by governments. Moral hazard refers to the tendency of insurers to exercise less precaution than is socially optimal by establishing inadequate incentives to control, underwrite or manage the risks of homeowners.

By using data on the Florida Citizens, the CAT Fund, the Flood Insurance and homeowner insurance in Florida from 1998 to 2007, this essay examines the moral hazard problem arising from government regulation and involvement in the private insurance sector. In sum, the provision of national flood insurance is found to be positively related to population growth in the state of Florida, which shows that new residents have taken advantage of the lower cost of flood insurance when relocating in higher-risk areas. In addition, we find that national flood insurance and the catastrophe fund complement the development of the private insurance sector, while the residual market discourages the property insurance market. Moreover, the evidence shows that new entrants to the Florida homeowner insurance market take on excessive exposures, which may be beyond the insurers' capacities to bear risk. Thus, the moral hazard problem exists in which some less liquid and less capable[8] insurers take more insured exposures as a result of subsidies from the state government. Finally, this essay tests how government

[8] Liquidity and capability are the two issues here. Capacity, surplus and reinsurance can be increased by the subsidies received, such as takeout bonuses, grants and the support of the guaranty association, from governments.

intervention and involvement have influenced the provision of insurance in the private market in Florida.

The rest of this paper proceeds as follows. Section 2 summarizes the evolution of homeowner insurance market and government involvement in managing hurricane risks in the past two decades. The economics of government regulation and intervention are analyzed in the subsequent section. Section 4 develops the hypotheses for empirical tests and reports the results, which is followed by a conclusion in Section 5.

2. Evolution of the Florida Homeowner Insurance Market

2.1 After Hurricane Andrew

The frequency and severity of both natural and man-made disasters have increased substantially in recent years (Insurance Information Institute, 2008). Natural catastrophes include events such as earthquakes, hurricanes and floods. Man-made disasters refer to terrorism, explosions and aviation collisions, etc. Figure 1 plots top 12 most costly disasters in the United States history. From this figure we can see ten of the twelve most expensive disasters of all types were caused by hurricanes, and eight of ten most expensive hurricanes in US history have occurred in the past five years. The state of Florida, surrounded by Gulf of Mexico and Atlantic Ocean, has been repeatedly struck by hurricanes in the past three decades. Eight of the ten most costly hurricanes ever to make landfall in U.S. history hit Florida from 1980 to 2006, causing more than $60 billion (in 2007 dollars) insured losses (Insurance Information Institute, 2008). Figure 2 plots Florida's ten costliest hurricanes and total insured losses from 1980 to 2007. Most of hurricanes have occurred in the past fifteen years, with a few in the 1980s. Since there is a difference between the risk of hurricanes and their actual occurrence, the occurrence of more hurricanes in the past fifteen years in Figure 2 is the evidence of increased risk. The upward trend has imposed tremendous challenges to property insurers, along with the rapidly population growth and economic development in the coastal areas in recent years.

2.1.1 Market Structure

Since Hurricane Andrew in 1992, significant changes had taken place in the Florida's property insurance market. Market concentration, barriers to entry and exit and insurers' geographic diversification are several important aspects of insurance market structure. Concentration not only affects market performance and competition, but also signifies insurers' vulnerability to severe losses from catastrophes. Greater concentration implies that some insurers have larger amounts of exposures to catastrophe losses. Concentration ratios at the top firms' market shares, such as top four-firm (CR4), eight-firm (CR8) or twenty-firm (CR20), and Herfindahl-Hirschman Index (HHI) are normally used to measure the concentration level of a market. HHI is the sum of the squared market shares of all firms in the market and can range from 0 to 10,000 (equal to a 100% market share by one insurer). Higher indices reflect greater market concentration, which may enhance efficiency through the economy of scale. Less concentration, on the other hand, could promote competition as well as greater risk diversification.

Table 2 shows the homeowners insurance market concentration in Florida from 1992 to 2007. From the table we can see that CR4 was 59.3 percent and HHI was 1440 as of 1992, indicating that the Florida homeowner insurance market was relatively concentrated in the year Hurricane Andrew occurred. The market concentration had remained stable until middle of the 1990s', and the combined market share for top insurer groups decreased thereafter. The combined market share of top four groups (CR4) fell from 59.3 percent in 1992 to 36 percent in

2007, while CR20 decreased from 85.2 percent to 65.9 percent in 2007. Also, the HHI index fell significantly from 1440 to 612 in 2007. This suggests that there is a greater dispersion of exposures covered by insurers in Florida fifteen years after Hurricane Andrew, which signifies a greater diversification of risks among insurers in Florida homeowner insurance market.

The changes of leading insurers' market shares in Florida in 1992, 2003, 2005 and 2007 are summarized in Table 3. The market share of the largest two insurers, State Farm and Allstate decreased from 50.8 percent in 1992 to 26.1 percent in 2007. While big insurers had retrenched from the Florida homeowner insurance market, the other relatively smaller insurance companies took on more exposures in this market. For example, AIG was ranked 8th in 2007 from rank of 53rd in 1992, with a market share increase from 0.2 percent to 2.5 percent. Southern Farm Bureau also significantly increased its penetration to Florida's homeowner insurance market. The change of market concentration indicates that some smaller or new insurers see opportunities to grow and hopefully prosper in the market, while other big insurers see danger and need to retrench because of their high exposures subject to hurricane risks.

According to the Florida Office of Insurance Regulation (FLOIR), 40 insurers have entered the Florida property insurance market since 2005. Most of the new entrants in the market are small regional or single-state companies. Klein (2009a) demonstrated this by looking at the ratio of an insurer's Florida homeowners premiums to its combined homeowners insurance premiums in all states. In 1992, the mean Florida/Countywide premium ratio was 6.6 percent and the median ratio was 18.4 percent among insurers writing homeowners insurance in Florida. In 2007, the mean ratio had increased to 63.2 percent and the median ratio had increased to 90.3 percent; 42 of the 92 insurer groups in the Florida homeowners insurance market wrote 100 percent of their premiums in Florida. Those regional insurers are subject to catastrophe risk due to the lack of risk diversification. Poe and Tower Hill groups are good examples. Poe was hit hard in 2004 and 2005 storm seasons and became insolvent in 2006. The liquidation generated approximately $988 million in payments by the Florida Insurance Guaranty Association for 46,162 claims for Poe's policyholders (Florida Insurance Association, 2007). Tower Hill was struck by 2004 and 2005 storm seasons as well and was downgraded by A. M. Best Company.

Homeowners had difficulties in finding insures to provide coverage and paying increased premiums due to the restructuring of insurance market exposed to hurricane risk. Since some insurers retrenched from the market, homeowners needed to find new insurers to underwrite their coverage, and others were forced into the residual market. Also prices increased significantly, especially in the high-risk coastal areas. Meanwhile, many policyholders had to accept higher deductibles (1 percent to 5 percent of their dwelling coverage limit) to be covered in voluntary market coverage and make their premiums more affordable (Insurance Information Institute, 2008)

Prices

Prior to Hurricane Andrew in 1992, insurers paid little attention to the risk posed by hurricanes, so insurance was relatively cheap and readily available. The insurers did not use catastrophe models and did little to control their catastrophe exposures. Hurricane Andrew was a wake-up call to the insurance industry. Using new and relatively crude catastrophe models to estimate their risks, insurers sought to raise their rates and adjust their exposures to reflect the new reality.

Many insurers have filed and implemented substantial price increases to reflect the higher degree of risk and reinsurance cost after Hurricane Andrew (Klein, 2008). In addition, premiums in the coastal areas are as expected to be significantly higher and experienced larger rate increases than interior areas within the state because of the additional risk brought by coastal exposures. To measure the sub-state differences and changes in prices among counties, the average rates per $1000 of coverage by county are calculated. Though this approach still confounds other policy terms with rates, it is less affected by changes in the amount of insurance.

I employed this approach with county-level data available for Florida in 1997, 2000, 2003, 2006 and 2007, and the results of representative counties are plotted in Figure 3 and Figure 4. Monroe, Dade and Franklin represent the high risk areas in Florida, while Leon and Clay are the representative counties in the interior areas within the state. From 1997 to 2000, Monroe experienced the greatest increase from its rate of $18.98 to $28.95, and its rate fell to $15.16 in 2003. One reason for this trend is that Hurricane Andrew in 1992 produced $10.6 billion in underwriting losses, which made the cumulative insurers' profit negative from 1992 to 2003 (NAIC Report on Profitability by Line by State, 2006). Other counties in the coastal areas, such as Dade and Franklin, had relatively small rate increases during this period. Leon and Clay, which are exposed to less catastrophic risks, had lower rates around $2.50 for $1000 coverage which remained stable after Hurricane Andrew occurred. The striking results reflect the high level of risk in coastal areas which includes the Florida Keys, and insurers' reassessment to hurricane risks. Right After the property insurance industry made even until 2003, insurers experienced huge losses again in the 2004-2005 storm seasons. As a result, high price increases were demanded by insurers, especially to the insureds in hurricane-prone zones. For example, homeowners insurance rate per $1000 coverage in Monroe doubled in 2006 to around $35 from 2003. The rate increased a little bit to $37 in 2007. For the other interior counties in the states relative to the coastal areas, the average rate per $1000 had kept stable during the period.

Profitability

Profitability reflects the overall performance of a firm in a market. Indicators of profitability include loss ratios, underwriting profit, profits on insurance transactions (PIT), return on net worth. Each measure has its own advantages and disadvantages, revealing specific financial aspects of a firm. Underwriting gains (losses) after Hurricane Andrew to 2007, as a base to measure profitability, are presented first. The analysis of PIT and return on net worth during this period follows to examine the profitability of Florida homeowner insurance market.

Figure 6 and Figure 7 respectively plot the underwriting gains (losses) and accumulative underwriting gains (losses) of the Florida homeowner insurance market from 1992 to 2007. The graph clearly tells us that the tremendous underwriting losses of \$10.50 billions stroke the insurance industry in Florida, which took nine years to make even until 2003. The underwriting analysis focuses on the insurers' performance on their principle business, providing coverage to inured risks, while ignoring other financial activities, such as investment income.

Taking into account of investment income, profit on insurance transactions (PIT) and return on net worth provide more financial information on the performance of insurance industry. Those two measures are obtained from National Association Insurance Commissioners (NAIC) profitability annual reports. PIT reflects expenses, taxes and investment income, as well as losses, attributable to the underwriting of a particular line of insurance in a state. The return on net worth includes investment income attributable to insurers' surplus, as well as profits on insurance transactions. It also requires the formula-based allocation of surplus by line and state. The high PIT and return on net worth indicate high profitability of a firm. Table 4 lists PIT and return on net worth of Florida insurance industry in the line of homeowner multiple perils from 1985 to 2007. In 1992, the PIT and return on net worth were -657.4 percent and -714.9 percent, respectively. There were still negative profits and return on net worth in 1993 due to the continuing claims payment after Hurricane Andrew. From 1994 to 2003, positive profits were generated with the average of 20 percent of PIT during this period without huge catastrophe losses. This observation suggests that the property insurance industry in Florida is significantly influenced by catastrophe events which may cause billions of insured losses, and profitability is closely linked to the climate changes and associated hurricane strikes.

2.1.2 Regulation and Public Involvement

As we have discussed above, Hurricane Andrew dramatically changed the Florida homeowner insurance market in terms of market structure, availability of insurance coverage and insurance price. Facing big challenges posed by the future potential catastrophic losses, insurers restricted their exposures in high risk areas and filed for rate increases. Hence, the voluntary market shrank -- residents had difficulty obtaining insurance coverage for their properties. Further, state regulators were reluctant to allow prices to rise. This in turn created an availability crisis as insurers reduced their presences in high risk areas. To fix this market failure, and provide the availability of insurance coverage to property owners, state regulation of prices and market exit, and public insurance entry into the private market have become the norm in the Florida property insurance market. Besides rate regulation, which artificially lower the cost of insurance, state facilities also lower insurance cost as well as seek to increase the availability of insurance.

Insurance regulatory functions can be divided into two primary categories: solvency regulation and market conduct regulation. Solvency regulation aims to protect policyholders against the risks that insolvent insurers fail to meet their financial obligations. Market conduct regulation seeks to maintain fair and reasonable prices, products and trade practices. Dealing with the unavailability of coverage and price spikes, legislators and regulators in Florida imposed the binding constraints on the market conduct of insurers, with the result being price suppression (prices below actuarially fair value) and compression (difference between high and low risk areas). With the strict price regulation, the state still saw continued availability problems and thus decided to increases its presence by establishing a state-owned company to provide insurance to the very high risk areas and to set up a fund to provide reinsurance with below-market premiums to primary insurers.

Price Regulation

Price regulation has significant implications for the insurers' ability to charge what they believe to be adequate rates, which in turn, can affect the supply and demand of insurance. Pricing constraints can be divided into two categories: price suppression and price compression. Price suppression refers to a ceiling on the overall rate level that insurers can charge, while price compression reduces the rate differentials across various geographic areas of the state, normally between high and low risk areas. The two kinds of price regulations are closely related. Regulators intend to cap rates in high risk areas, while they keep the relatively stable rates in low risk areas. As a result, price compression may lead to an overall rate level that is inadequate to cover the total cost of risk.

After Hurricane Andrew, regulators resisted large immediate rate increases and only allowed insurers to gradually raise rates over the decade. Figure 8 lists the Insurance Service Office (ISO) advisory loss cost filings in Florida for the period of 1991 to 2000. The ISO is a rate advisory organization which provides advisory prospective loss cost, including incurred losses as well as loss adjustment expenses. Figure 8 presents the indicated rates, filed rates and implemented rates[9] in respective years. Prior to Hurricane Andrew, the ISO filed for a 3.3 percent decrease in 1991 and 2.2 percent decrease in 1992, and regulators approved both rate decreases. In 1995, the ISO filed for a rate increase of 171.1 percent to incorporate catastrophe loss estimates. The regulators only approved 48.7 percent increase. The same trend continued in 1996 that the ISO filed an increase of 77.5 percent and the regulators only allowed a rate increase of 23.2 percent. Until 2000, increased rates were believed to reflect actual losses cost that the ISO filed a rate decrease of 2.8 percent. However, the regulator imposed a 4.7 percent decrease. This suggests that regulators in Florida suppressed rates under the actuarially fair costs. At the same time, price compression prevailed for most of the decade, and rates in high risk areas were more constrained than in low risk areas (Muslin, 1996). Price compression worsened supply-availability problems because insurers were concerned about substantial rate inadequacy (Grace, Klein & Kleindorfer, 2004).

However, the rate suppression conflicts the regulators' attempts to sustain an adequate availability of coverage. Insurers are reluctant to take on risk exposures by employing suppressed rates under actual costs, and they are forced to do so as they are constrained by a moratorium enacted after Hurricane Andrew. The moratorium only allowed insurers to shed exposures through cancellation and non-renewals initiated by insured, unless insurers negotiated with insurance regulators, and it ended on June 1, 2001. After the moratorium expired, the policy termination increased as insurers reduced their risk exposures in high risk areas. Consequently, the residual market has been rapidly growing while voluntary market shrank under regulatory price suppression and compression.

The Residual Market

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[9] The indicated rate is the comparable rate that ISO calculates based on the actuarially fair cost; the filed rate refers to the rate insures file to the regulation authority; the implemented rate pertains the rate that ISO approves and implement.

State-run residual market mechanisms are important components of public policies towards catastrophe risks dealing with the coverage availability problem. The residual market provides insurance coverage to property owners who are unable to buy insurance from the voluntary market. Residual market mechanisms include assigned risk plans, windstorm and beach pools, joint underwriting associations, and reinsurance pools. As a secondary source of coverage, the residual market should charge adequate rates and remain relatively small. When deficits incur, the residual market assesses against all insurers in relation to their voluntary market premiums for relevant lines of insurance, which means that the voluntary market bears more risks than the policies they write. In such case, insurers are discouraged to enter and encouraged to exit the market that leads to a shrinking market. Consequently, these mechanisms provide coverage at the expense of development of the voluntary market.

In November 1993 after Hurricane Andrew, the Florida Residential Property and Casualty Joint Underwriting Association (JUA) was established to provide coverage to homeowners who were unable to obtain coverage from the voluntary market. The plan extended to certain commercial property coverage (apartments and condos) in 1995 (Marlett & Eastman, 1998). Figure 9 presents the policies numbers and exposures of the JUA from 1993 to 2002. From the graph we can see that the JUA had grown rapidly with the peak of 850,000 policies in 1995 and exposures of $78 billions in 1996. An aggressive depopulation had been undertaken to shed the JUA to a shadow of its former itself. As of 2001, it only had 67,230 policies. Since the insurers, who took out of the JUA, only committed to provide coverage for three years, the improvement had reversed after 2000. The policies JUA wrote climbed to 110,700 by the end of 2002 (Insurance Information Institute, 2008). Moreover, these policies concentrated in the coastal areas of the state, like Dade, Broward, Monroe and Palm Beach counties. It suggests that a significant portion of catastrophe risk is insured through the state-sponsored mechanism.

The Florida Windstorm Underwriting Association (FWUA) assumed the wind risk for many homes in coastal areas in Florida. Figure 10 plots the policy numbers and exposures of the FWUA from 1990 to 2000. FWUA continued to grow until 1998. It peaked at more than 500,000 policies and $91.1 billions in exposures at the end of 1998. It declined marginally to 398,222 policies by the end of January 2003, although exposures were even higher at $108.5 billion (Insurance Information Institute, 2008).

Due to Florida's unique exposures to hurricane risk, the Florida legislators created the Florida Citizens to secure the availability of property insurance coverage to Florida residents, by merging the JUA and the FWUA and on May 4th, 2002. The Florida Citizens provides full coverage or wind coverage for residential properties, and has experienced a significant growth in the recent years. Figure 11 plots Florida Citizens exposures from 2002 to 2008. The exposures of Florida Citizens jumped to $408.80 billions in 2006 as many property owners were not able to obtain insurance coverage from voluntary markets after the storm seasons 2004-2005. As of September 30th, 2009, the Florida Citizens had 636,139 personal lines account policies and 419,160 high risk account policies.[10] The total number of the Florida Citizens policies has fallen from its high of 1.4 million in October 2000 to under 1.1 million in September, 2009.

Florida regulators have sought to depopulate the Florida Citizens by encouraging small insurers to take policies out the Florida Citizens. The FLOIR had approved the takeout policies from the Florida Citizens by 17 insurers as of January 10th, 2009. The term "approved" refers to the potential number of policies that may be removed by an insurer based on a consent agreement with the FLOIR. The Florida Citizens reports that 1.3 million policies have been

[10] Information obtained from Florida Citizens' website at http://ww.citizensfla.com

removed since 2003, with 765,219 policies removed since 2005. However, the depopulation scheme is open to questions as the new small insurers are not financially strong with only limited amounts of capital. The insolvencies cost of those companies will ultimately fall back on consumers and taxpayers through the state's guaranty fund.

The Florida Citizens incurred large funding shortfalls of $1.6 billion for 2004 and over $2 billion in 2005. The 2004 deficit resulted in a 6.8 percent surcharge on all homeowners premiums in the state. To cover 2005 shortfall, $715 million was appropriated by the Florida legislature to reduce the Florida Citizens' assessments. The remainder of the deficit will be collected over a 10-year period in "emergency assessment" on premium written statewide that will be passed on as surcharges to policyholders.

Florida Hurricane Catastrophe Fund

The CAT Fund was created by Florida legislature in 1993 after Hurricane Andrew, which is tax-exempt and provides catastrophe reinsurance to participating insurers in the state. The CAT Fund is funded by premiums paid by the participating insurers and investment income, and it can apply emergency assessment if necessary to repay debt. The emergency assessment applies to all business lines except workers' compensation, accident and health, medical malpractice and national flood insurance premiums.

The CAT Fund was faced with a shortfall in resources to reimburse insurers from the 2005 hurricane season, and issued $1.35 billion in revenue bonds in 2006. An emergency assessment of 1 percent for approximately six years on all policies issued or renewed after January 1, 2007 was levied to finance the post-event bonds. Since the CAT Fund's cash balance for paying claims had been exhausted, the CAT Fund took steps in 2006 and 2007 to create liquidity for paying future claims by issuing pre-event liquidity financings of $2.8 billion in July 2006 and $3.5 billion in October 2007 (Florida Hurricane Catastrophe Fund, 2007).

There is a significant debate about the function and economic feasibility for CAT Fund, the state-sponsored mechanism. The proponents contend that the CAT Fund is helpful to fill a supply gap in private reinsurance market at a lower price. On the other hand, the opponents are concerned with “crowding out” private reinsurance and financial shortfall which leads to assessment on all the policyholders across the state. In the latter case, this state CAT Fund may raise the cross subsidization issue, and further moral hazard problem in the insurance market.

National Flood Insurance Program

There are a couple of federal insurance programs to cover risks which private insurers are reluctant or unable to cover, including national flood insurance, crop insurance and terrorism insurance. Due to its vulnerability to hurricane risks, the Florida residents have benefited a lot by participating in the national flood insurance program to cover the flood risk which is excluded from the regular homeowner insurance.

Administered by Federal Emergency Management Agency (FEMA), Flood Insurance provides federally backed flood insurance, which is not provided by private insurers, to homeowners, renters and business by requiring the participating communities to enforce floodplain management ordinances to reduce flood losses. Currently there are around 20,000 communities have joined this program nationwide.

Guaranty Fund

To provide security and honor claim payment to insureds in case of insurers become insolvent, the Florida Guaranty Association (FIGA) was established to process covered claims underwritten by insolvent or liquidated insurers in the state. The FIGA funding comes from four sources: estate distribution, recoveries from CAT Fund, investment income and assessment from member companies. The FIGA is partly funded by assessment on property liability insurance premiums in the state which are limited to 2 percent annually. While no assessment has been levied in some years free of catastrophic losses, full 2 percent of assessments were applied after Hurricane Andrew in 1992 and 2004-2005 tropical storm seasons. For Hurricane Andrew, not only 2 percent of property-casualty insurance premiums were assessed, but additional 2 percent were borrowed to cover its capacity shortfall. It took five years for FIGA to pay off all its debts from Hurricane Andrew. FIGA has been processing the outstanding claims received as a result of five insolvencies in the 2004 and 2005 hurricanes, and claims from catastrophe losses accounted for 60 percent of open claims by end of 2008 (FIGA, 2008).

The funding schemes of guaranty association reveal its financial vulnerability to catastrophe in Florida and the spread-out risks to all insurers and insured and taxpayers. From this mechanism, the insolvent or liquidated insurers transfer their obligations to state-run program, which ultimately adversely affect the benefits of various stakeholders.

2.2 Evolvement of Legislation

Hurricane Andrew devastated the insurance industry in the state, and Florida Department of Insurance found that the existing rules and regulations inadequate to address the extraordinary circumstances. The insurance commissioner and representatives from large insurers worked together closely to find appropriate recovery solutions (Florida Department of Insurance, 1993). A series of emergencies rules were filed to deal with the claims and stabilize the market. The department of insurance issured a total of 27 emergencies rules in 1992 and 30 in 1993, which showed a strong hands-on approach adopted by regulators (Mittler, 1997). For instance, emergency rule 4ER92-11 established procedures for the withdrawal of any insurance company from the state of Florida and it mandated that at least 90 days prior to commencing any steps directed toward withdrawal, an insurance company must file a written statement of intent containing details of the reasons for its actions. Emergency rule 4ER92-15 activated JUA on a temporary basis to provide residential property coverage to policyholders of insurers that became insolvent as a result of Hurricane Andrew (Florida Department of Insurance, 1994).

Since 1992, a number of state legislature and special sessions were passed to address the property insurance crisis (Florida House Committee on Insurance, 1993, 1995; Florida Senate Committee on Banking and Insurance, 1997). The fist legislation, House Bill No. 33-A, took effect on December 15, 1992. The bill contained three important elements. First, it ratified the emergency fix established by the department of insurance when the legislature activated JUA; Second, it authorized certain municipalities and counties to issue up to $500 million in tax free municipal bonds to fund the shortfall in the FIGA caused by the storm-related insolvencies Third, JUA was created to be an insurer of last resort for persons unable to obtain coverage in the voluntary market (Florida House Committee on Insurance, 1993; Mittler, 1997).

The legislature changed the property insurance market in the state. The CAT Fund was established after enactment of the 1993 law with a tax exemption. Thereby the fund has grown without having to pay taxes on its receipt of annual premiums and investment earnings, estimated to be 35 percent of the total (Florida House Committee on Insurance, 1995). The CAT Fund is designed to provide cheaper reinsurance to insurers, and insurers are expected to lower premiums charged to insureds due to the CAT Fund coverage. Another issue was about insurers' intention to cancel or non-renew policies in high risk counties, and the moratorium phase-out was set up and extended. The moratorium, which took effect on November, 14, 1993, prohibited an insurer from canceling or non-renewing more than 5 percent of its homeowners' policies in the state in any 12-month period and 10 percent of its policies in any county (Florida House Committee on Insurance, 1995).

Over the evolvement and enactment of legislation over a decade after Hurricane Andrew, the government-run insurance programs, such as the Florida Citizens, have contributed to the restoration of the market while arguably become competing to the private insurance sectors (Klein, 2008). 2007 legislature further acerbated the situation. It expanded the CAT Fund coverage for the 2007, 2008 and 2009 seasons, and provided an additional amount of CAT coverage of up to $10 million dollars at a 50 percent of premiums discount to small and new insurers. Eligible insurers for such coverage purchase included limited apportionment companies that began writing business in 2007 and insurers approved to participate in 2006 or 2007. Accordingly, insurers are expected to file their rates reflecting the savings or reduction in loss exposure due to the expanded CAT Fund. The legislature also rescinds the approval rate increase that took effect January 1, 2007 and required Citizens to provide refunds to persons who have paid this rate. It also imposed up to a 10 percent of premium assessment on all nonhomestead policyholders if a deficit occurs until 2008 (Florida Office of Insurance Regulation, 2008).

With the presence of big catastrophic hurricane risks as well as regulation and legislature favorable to residents, the demographic changes in Florida has exhibited the trend which will be introduced in the following section.

2.3 Population Growth Influenced by the Risks, Insurance and Regulation

As we discussed above, the regulation on property insurance market subject to catastrophe hurricane risks has significantly impacted the private market by largely expanding government-run insurance programs. Subsidization from low risk areas to high risk areas at the expense of tax-payers' money may arise in the case. Perceiving the government's generous financial support to hurricane-prone zones, the residents and/or migrants to Florida may have stronger incentives to take advantage of this favorable public policy by moving to such areas without bearing the corresponding risks.

Since the 1980s, the state of Florida has experienced rapid population growth significantly above the national population growth rate. The National Ocean and Atmosphere Administration (2008) documented the largest rate of population change 1980 to 2003 occurred in coastal counties. Flagler County located in the southeast of Florida increased 470 percent, followed by Osceola County at 318 percent during the period. As the office of Economics and Demographic Research (EDR) reported, the state growth rates were nearly 33 percent and 23.5 percent in the '80s and '90s, respectively. From 2000 to 2009, Florida's population grew by 17.7 percent over the eight-year period to 18,851,975. Currently, Florida remains the fourth largest state behind California, Texas and New York (EDR, 2009).

Natural population increase and migration contribute to population increase. Natural increase refers to the difference between births and deaths, while domestic and international migration also contribute to population growth. According to the EDR's Florida demographic summary, in the period from April 1, 2000, to April 1, 2008, the natural increase accounted for 14.4 percent of Florida's growth, and net migration accounted for 85.6 percent. Further about 35.2 percent of Florida's total net migration is due to international migration estimated by the Census Burea, which could be explained by the labor force movement from Mexico and South America countries to Florida due to its economic prosperity and convenient location. Generally, big cities in the coastal areas that offer plenty of job opportunities, such as Miami and Palm Beach, have attracted more immigrants to relocate there. In terms of age, the population aged 85 and older has grown fastest in the last two decades, increasing by 61.2 percent during the '90s and forecasted to increase by 55.8 percent between 2000 and 2010 (EDR, 2009). Florida has increasingly become a "retirement magnet" as a migratory destination for retirees in recent decades (Frey, 2003).

The above statistics show that the population in Florida has been growing significantly over the past decades whereas migration plays an important role to the population growth. With respective to hurricane risks, the availability of insurance coverage and insurance price has been a big issue for both migrants and residents. In this case, the government regulation or financial support to insureds may have effect on individuals' decision – stay or move in or move out of Florida. There is great deal of literature on the effect of public policies on population growth or migration, which will be introduced in the flowing section.

3. Economics of Government Regulation and Intervention

3.1 Competitive Market and Market Failure

In economic theory, a perfect competitive industry requires large numbers of sellers and buyers, a homogeneous commodity, free entry and exit, perfect information, and prices determined by the interaction of supply and demand. In the long-run equilibrium state of a competitive industry, the marginal cost of production is equal to the price, economic profits are zero; and each firm operates at the lowest unit cost. Thus, resources are employed at maximum production efficiency under competition. Competition decentralizes and disperses power between buyers and sellers. The resource is allocated through the interaction of supply and demand on the market, and not through the conscious exercise of power held in private hands (e.g., under monopoly) or government hands (i.e., under state enterprise or government regulation). Hence, competitive market processes solve the economic problem impersonally, and not through the personal control of entrepreneurs or bureaucrats. A competitive market system sets no barriers for entries and exits, which entails freedom of opportunity for individuals. Individuals can freely choose what to trade, only constrained by their own talents, abilities and financial capitals (Scherer, 1979).

In reality perfect competition can not be realized, but "workable competition" can be attained, which functions well and provides most of the benefits of a perfect competition (Scherer, 1979). A workably competitive market generally is characterized by numerous sellers and buyers, low entry and exit barriers, good information, and the absence of artificial restrictions on competition. Workable competition reasonably approximates the conditions for perfect competition to the degree that little regulation is required to achieve an efficient allocation of resources (Scherer & Ross, 1990). Cummins and Weiss (1991) analyzed the structure and conduct of property-liability insurance industry and showed that this market is competitively structured, with numerous firms competing for business in most lines and low entry barriers.

However, market failures occur under certain market conditions, such as market power, externalities, incomplete information, transaction costs, etc. (see Bator, 1958; Williamson, 1971). In the context of insurance industry, given its relatively lower market concentration and lower entry barriers (Cummins & Weiss, 1991), market failures include severe asymmetric information problems and principal-agent conflicts, which imply that the information problems arguably are the industry's most important market imperfections[11].

Asymmetric information problems exist when one party to a transaction have superior information that the other does not have. Insurance consumers, particularly individuals and

[11] See Pauly (1968), Pauly (1974), and Akerlof (1970), Rothschild and Stiglitz (1976).

households, face significant challenges in judging the financial conditions of insurers due to their limited knowledge and lack of professional expertise. Also, some individuals may have difficulty properly understanding the complex insurance contracts and products. On the other hand, insurance consumers have better information about their risks, and high risk buyers have more incentives to purchase insurance, which adverse selection problem arises. The insurance market may fail in this case (Akerlof, 1970).

Principal-agent problems arise when insurance consumers have difficulty monitoring and controlling the behavior of insurers after they purchase policies and pay premiums. The insurer might make high risk investments that are hazardous to policyholders' interests by failing to fulfill its obligations to policyholders. In case of insurer insolvency, it is very difficult for policyholders to recover funds or force the insurer to meet its obligations. Moreover, the problem can be exacerbated because of unequal resources and bargaining power between insurers and individual consumers.

Besides incomplete information, market power can also lead to market failure. Market power is the ability of one or a few sellers (or buyers) to influence the price of a product or service. In the insurance context, for instance, one or several big insurers in certain business lines could exercise collusion price to consumers for excessive returns, which leads to an inefficient allocation of resources and harm consumers' benefits.

To fix the above market failures, theories of regulation and governmental interference have been proposed and applied to enhance economic performance, which will be introduced in the next part. A detailed review of these theories may not be necessary, but it is important to understand the implications to stakeholders in insurance markets, including insurers, policyholders, legislators and regulators.

3. 2 Theories of Government Regulation

Economic analysis of government regulation has proceeded rapidly[12]. There are several explanations for regulation, each mirroring a facet of reality. One is the "pubic interest theory", where regulation is required to correct matters and serve the public interest in case market failures occur (see Bonbright, 1961). In the insurance context, the public interest argues that the regulation of insurer solvency is used to address the inefficiency caused by costly information and agency problem (Munch & Smallwood, 1981). Insurers have diminished incentives to maintain a high level of financial safety because their personal assets are not at risk for unfunded obligations to policyholders that would arise from insolvency. It is costly for policyholders to assess an insurer's financial condition. Insurance is a technical and complicated subject, and the true financial strength of an insurance company can only be determined by expert examination. There is also embedded principle-agent problem – insurers can increase their risk after policyholders have purchased policy and paid premiums.

A second hypothesis states that regulation occurs because there are well-organized vested interests expecting to benefit from regulation (see Jordan, 1972; Peltzman, 1976; and Stigler, 1971). This "interest group pressure" theory suggests that regulation is acquired by groups with their own interests and is designed and operated primarily for groups' benefit. Under this scenario, regulators are motivated to maximize political support rather than economic efficiency. Meier (1988) further set up a model to explain the ideological motivation of regulators. In his model of the political economy of insurance regulation, he hypothesized that the insurance industry should favor regulatory policies that benefit it and oppose policies that restrict it. Meier observed that the insurance industry is not a monolith and that different segments of the insurance may have different views with respect to certain regulatory issues. The ability of the

[12] For example, see Alfred (1970), and Schmalensee (1979).

industry to influence regulation is hypothesized to be a function of its political resources, including its size and wealth.

Insurance is important to the welfare of the individuals, households, firms and the overall economy, and it warrants close government attention. It also implies that the public interest should be the paramount consideration in guiding government intervention, though regulators are also influenced by political factors. Hence, the rationale for government intervention in case of market failures is based on promoting or restoring economic efficiency. Optimal regulation should be directed by an ideal set of policies that attempt to replicate the conditions of a competitive market and maximize social welfare.

Another aspect of insurance regulation in practice is how social preferences impact the public policy used to enhance efficiency in a free market economy. For example, the public would prefer lower premiums in general regardless the real risk status. Lower prices suppressed by regulation might benefit consumers in the short-run until firms leave the market and the supply of insurance contracts. This artificially-induced unavailability of insurance seems against the public interest in the long-run, but there is strong political support for low prices. In this sense, the regulation or public polices influenced by voters or special interest groups may diverge from the economic rationale, resulting adverse consequences or “government failures”.

3.3 Potential Problems Caused by Regulation and Intervention

Not all market failures may be corrected by government regulation and intervention. The crowding out effect is one of inefficiencies caused by government intervention in the market, which means government spending will crowd out private enterprises. If government spending is financed through tax increases, that will reduce individuals’ after-tax income and then reduce their spending. If government spending is through borrowing, the higher government demand for saving will drive up interest rates which, in turn, will thwart private investment. In the insurance markets, the establishment of government insurance programs, such as residual markets and state-run insurance providers, can make private firms exit the market if the government providers sell below the actual costs. Thus, private insurers with higher capital costs and other expenses are unable to provide a competitive price and are forced to leave the market.

Another potential problem induced by government intervention is cross subsidization, which pertains to the practice of charging higher prices to one group to subsidize lower prices for another group. Faulhaber (1975) analyzed the issue of cross-subsidization in enterprises with economies of joint production. He found that subsidization of prices in an otherwise competitive market would lead to inefficient entry and instability of the joint enterprises. The Florida insurance residual market provider, the Florida Citizens is a good example in this case. To make insurance coverage available to every applicant, the state of Florida provides protection in the form of subsidized prices to high risk residents who are either unable to purchase insurance from voluntary market or are reluctant to pay private market prices. The Florida Citizens has been established to help alleviate availability problems and, in some cases, to charge relatively lower prices to its policyholders. When the Florida Citizens losses exceed its claims-paying capacity in a single year, it is required by state law to impose a statewide assessment on most lines of business in the state. By law, insurers my recoup the amount from all policyholders as part of the homeowners insurance rate-making process in the state,[13] where low risk policyholders subsidize the high risk policyholders. Also, state general revenue funds may be appropriated to offset the

[13] To cover 2004's shortfall, Citizens imposed a 6.8 percent surcharge on policyholders, amounting to about $100 per $1500 in premiums (Insurance Information Institute, 2008).

deficit.[14] This divergence of price and cost leads to inefficiency with the suboptimal allocation of resources.

A moral hazard problem may also arise with the provision of government insurance programs as well. Hansen and Imrohoroglu (1992) studied the potential welfare loss of unemployment insurance with liquidity constraints and moral hazard. The authors found that if the replacement ratio can be arbitrarily set, insureds may incur moral hazard by choosing not to work with the coverage of unemployment insurance. As a result, unemployment insurance can be actually harmful to the economy rather than improve it. Pauly (1974) analyzed conditions to attain the competitive equilibrium when both provision and competitive marketing of supplementary coverage are permitted to exist side by side. Since "supplementary purchases raise the probability of loss and hence raise the expected loss of the purchaser within the public program as well as the loss in any private insurance", a premium for public insurance should be assessed on those who buy supplementary coverage, even if the public insurance were provided through general taxes. Using this reasoning, a moral hazard problem may arise in the Florida homeowner insurance market where state-run and private reinsurance coexist in the market at the same time. Further, catastrophe reinsurance is sold by the state and available for all insurers to purchase at lower prices compared to other private reinsurance in the market. With reinsurance purchased from the Florida CAT Fund at relatively lower costs, insurers are expected by legislators and regulators to provide more coverage to insureds at lower prices (Florida House Committee on Insurance, 1995; Florida Senate Committee on Banking and Insurance, 1997; Florida Office of Insurance Regulation, 2008).While possibly crowding out private reinsurance, the provision of the low cost reinsurance fund may encourage insurers, which are not at good

[14] To offset Citizens' 2005 deficit, hurricane insurance bill (SB 1980) was passed by the state legislature in May 2006, provided for a $715 million appropriation of state general revenue dollars to the fund (Insurance Information Institute, 2008).

financial conditions, to enter or stay in a risky market. Thus, we see the possibility of state-funded insurance programs induced moral hazard.

3.4 Migration and the Effect of Public Programs

A number of studies have examined the incentives for population, and specifically the relationship between the migration and public policies (for example, Conway & Houtenville, 1998; Davies, 2001; Sjaastad, 1962; Rosenzweig & Wolpin, 1988). Human migration has its costs and returns, and it can be treated as a means in promoting efficient resource allocation when it is related to correct income disparities (Sjaastad, 1962). Money returns and non-money returns, such as climate, cultural environment, could attract people to move to another county or state across the country.

In terms of money returns, the public policies or programs, which may influence income or benefits received by residents, may impact people's decision to relocate. For example, Rosenzweig and Wolpin (1988) employed a conditional logit approach to estimate the model of interstate migration in the United States from 1986 to 1996. They found that the variables of population, distance, per capital income and unemployment rate had effects on the population migration. It is worth noticing that the coefficients of per capital income and unemployment rate changed substantially over the study period according to findings. In addition, Conway and Houtenville (1998) investigated whether elderly migrants were affected by state fiscal policies and discussed the possible consequences. In their model, the migration flows were estimated as a function of the states' amenities, cost of living composition of government spending and alternative specification of the tax system. They concluded that elderly migration was influenced by state fiscal policy. In the context of the migration to Florida, this paper attempts to analyze the effect of the government-run insurance programs on the demographic change over the study period.

In sum, the residual market and government intervention in the Florida's homeowner insurance markets, which are applied to correct the alleged private insurance market's failure, may induce different types of inefficiencies, such as crowding-out of private risk bearing activities, cross subsidies and moral hazard. In the next section I propose the hypothesis to analyze the effects of price regulation and government intervention on the private insurance market and demographic movements. Further, we assess the interaction of private markets and government regulation empirically in the next section.

4. Empirical Tests

4.1 Hypotheses

The significant growth in population and economic development in coastal areas arguably have been attributable to the increases in hurricane losses in recent years. In certain high risk areas, however, subsidized homeowner insurance and flood insurance are readily available in the market to property owners at a lower cost. Migrants, who perceive the benefits of government insurance, could have more incentives to move to higher risk areas because insurance premiums are below their social costs. This selectivity trend may indicate the "moral hazard" which arises among migrants due to the favorable public policy. Hence, Hypothesis I is derived as follows:

Hypothesis I: *Migration to Florida's high risk areas is positively associated with subsidies from government insurance programs.*

With respective to insurers in private insurance market, the presence of government-run program, such as the Flood Insurance and the CAT Fund, may entail moral hazard problem in the market. Rather than measure risks actuarially and take on appropriate amount of risks with adequate surplus, insurers may be encouraged to over-underwrite risks beyond their capacities. In contrast to the goal of correcting market failure by government intervention, inefficiency is caused in this case. Therefore, Hypothesis II is stated as follows:

Hypothesis II: *Insurers in the private sector assume more risks in hurricane-prone areas with the provision of the CAT Fund and Flood Insurance.*

Meanwhile, the Florida Citizens may "crowd-out" the private insurers due to its lower subsidized premiums. Compared to the CAT Fund and the Flood Insurance, the presence of the Florida Citizens could decrease the insurance purchase from private insurers. So Hypothesis II is proposed to estimate insurers' overall market responses to the public policies in the Florida's homeowner insurance market subject to huge catastrophic losses.

4.2 Data

A panel data covering private property insurance companies, government-run insurance programs and demographic changes in Florida from 1997 to 2007 is constructed to test the hypotheses established above.

The Florida population information by county by year is obtained from the Florida Demographic Estimating Conference and Florida Demographic Forecast, [15] and then the population growth is calculated accordingly. Since net migration accounted for 85.6 percent of total population growth of Florida from April 2000 to April 2008 (EDR, 2009) and information on net migration is not available at county level, the population growth rate is applied to reflect the demographic changes in counties across Florida during the study period. Florida population

[15] See http://edr.state.fl.us/conferences/population/demographic.htm

in 2000 and 2007 and homeowner insurance exposures in 2007 are presented in Table 6. We see that Flagler, Sumter and Osceola are the three fastest-growing counties, with growth rates of 87.8 percent, 68.3 percent and 40.6 percent respectively. Monroe County, which is the southwestern most county in Florida which includes the Florida Keys, has experienced negative population growth of -0.8 percent from 2000 to 2007. However, Palm Beach, a county on the South Eastern coast, has the growth rate of 14 percent, increasing from 1.1 million to 1.3 million. In sum, significant population growth has been observed for some counties relatively far away from costal zones, while population has decreased for some places most close to the oceans. It may imply that the potential huge losses from hurricanes hamper the population growth in some risky areas. With the county income data from Bureau of Economic Analysis in the Department of Commerce,[16] per capital income at county level in Florida is calculated.

The QUASR database provides homeowner insurance information by firm by county from 1997 to 2007. The phrase of QUASR is the abbreviation of the *QUA*rterly Supplementary *R*eports, which are prepared by the insurers doing business in Florida and reported to the state's Office of Insurance Regulation.[17] Homeowner insurance direct written premiums, exposures and policy numbers in force by firm, by county and by year within the study period are available in the database. The market share of Florida Citizens in terms of exposures, direct written premiums and policy numbers in force are calculated accordingly.

The CAT Fund reinsurance purchase by private insurers, which is measured by the percentage of CAT Fund reinsurance out of the total reinsurance purchases, is computed from annual reports by NAIC for each insurer in each year. In the dataset, the mean of CAT Fund purchase is 8.3 percent, suggesting an insurer on average cedes 8.3 percent of its business

[16] See http://www.bea.gov/regional/reis/
[17] See http://www.floir.com/pdf/qsr_1b.pdf.

portfolio to the CAT Fund, leaving almost 90 percent of business to the private reinsurance market.[18] In terms of Flood Insurance in Florida, the information on the direct written premiums, policy numbers in force, the amount of coverage, claims numbers and the amount paid by county by year are obtained from Federal Emergency Management Agency that operates the program.

To control for firm characteristics, firm-specific variables of assets, return on equity, liquidity and leverage ratios are collected from A.M. Best Company.[19] The amount of assets signals the size of an insurance company; return on equity indicates the profitability of a firm; liquidity refers to the ability of an asset to be converted into cash quickly and without a price discount; leverage measures the ability of a firm to meet its financial obligations.

This is a three-dimensional dataset at firm, county and year levels, which allows the empirical tests to be applied from different perspectives. The variable definitions and data source are listed in Table 5, and the descriptive statistics of variables will be discussed in the following part.

4.3. Estimated Equations

With the panel data on insurance companies, private and government insurance purchases and claims in the Florida homeowners insurance market from 1997 to 2007, the proposed hypotheses on the effect of government regulation and intervention on the private insurance sector, i.e. if there are any moral hazard problems related to public policies, are tested below.

- Hypothesis I Test - Estimated Equations (1) – (3)

$$PG_{i,t} = \alpha_{10} + \beta_{11} FC^{EXP}{}_{i,t} + \beta_{12} FI^{COV}{}_{i,t-1} + \beta_{13} D_1 + \beta_{14} D_2 + \beta_{15} D_3 + \beta_{16} Income_{i.t} + \beta_{17} Crime_{i,t} + \varepsilon_{i,t} \quad (1)$$

[18] It is important to note that the NAIC data does not allow one to separate reinsurance purchases by line of primary business or by state of primary insurance sales. Thus, we look at the percentage of reinsurance from the Florida CAT fund as being solely from Florida risks.

[19] Since NAIC annual reports do not directly provide financial ratios of insurers, such as return on equity, liquidity and leverage, in annual reports, we use these ratios from A.M. Best Company, which computes financial ratings and ratios based on the specified formula.

$$PG_{i,t} = \alpha_{20} + \beta_{21}FC^{DPW}{}_{i,t} + \beta_{22}FI^{DPW}{}_{i,t-1} + \beta_{23}D_1 + \beta_{24}D_2 + \beta_{25}D_3 + \beta_{26}Income_{i,t} + \beta_{27}Crime_{i,t} + \varepsilon_{i,t} \quad (2)$$

$$PG_{i,t} = \alpha_{30} + \beta_{31}FC^{PIF}{}_{i,t} + \beta_{32}FI^{PIF}{}_{i,t-1} + \beta_{33}D_1 + \beta_{34}D_2 + \beta_{35}D_3 + \beta_{36}Income_{i,t} + \beta_{37}Crime_{i,t} + \varepsilon_{i,t} \quad (3)$$

where $PG_{i,t}$ = Population growth in county i at year t; $FC^{EXP}{}_{i,t}$ = Market share of Florida Citizens in exposures in county i in year t; $FC^{DPW}{}_{i,t}$ is the market share of Florida Citizens in direct written premiums in county i in year t; $FC^{PIF}{}_{i,t}$ is the market share of Florida Citizens in policy numbers in force in county i in year t; $FI^{COV}{}_{i,t-1}$ = Log of flood insurance coverage in county i in year $t-1$; $FI^{DPW}{}_{i,t-1}$ = Log of flood insurance direct written premiums in county i in year $t-1$; $FI^{PIF}{}_{i,t-1}$ = Log of flood insurance policy numbers in force in county i in year $t-1$; D_1 = Dummy variable for South Atlantic area; D_2 = Dummy variable for Gulf Coast area; D_3 = Dummy variable for Panhandle area; $Income_{i,t}$ = Per capital county income for county i in year t; $Crime_{i,t}$ = Non-violent crime rate for county i in year t. $\varepsilon_{i,t}$ = Error term for county i in year t;

The population migration in Florida is of our interest to test the possible effects of public policies in the property insurance on the demographic changes subject to catastrophic hurricane risks. Further, net migration rates for each county in the state could be appropriate measures for such demographic changes due to the potential subsidization between high and low risk areas in this case. The net migration rate, however, is not available at county level, so the population growth rate is used instead in my study because the migration accounted for 85.6 percent of population growth from April, 2000 to April, 2008 according to Economic Demographic Research (EDR, 2009). As discussed in section 3, a number of studies examined the incentives for population growth, and specifically the relationship between the migration and public policies (for example, Conway & Houtenville, 1998; Davies, 2001; Sjaastad, 1962; Rosenzweig

& Wolpin, 1988). Some economic and societal measures were examined to be related to the population migration, such as per capital income, unemployment rate and tax rate. Since the empirical test in this paper is designed at the county level with an intention to see the microstructure of migration in Florida especially between high and low risk areas, the corresponding variables at county level are therefore needed. In terms of unemployment and tax rate, such variables are only available at state level. To approximate these economic measures, the non-violent crime rate at county level is adopted instead.

The participation of the Florida Citizens and Flood Insurance are measured by direct written premiums, exposures and policy numbers in force, which are included in regressions (1) – (3) respectively. Risk area dummies indicate the relatively catastrophic risk level of a county with respective to its distance to oceans. Figure 5 shows the territories for each risk area in the state map of Florida, and Table 1 lists the counties which belong to each risk area. Table 7.1 summarizes the descriptive statistics of variables included in equations (1) – (3). There are 670 observations in total for 67 counties from 1998 to 2007. The maximum population growth rate in Florida is 13.3 percent, while it can be as low as -4.4 percent. The Florida Citizens accounts for 35 percent of the total homeowners insurance market at maximum and does not cover some certain counties, resulting an average market share of around 2 percent. Flood insurance coverage, exposures and policy numbers in force are taken logarithm to make commensurable to other variables in regression equations. To control for population size, these three variables are normalized by population. On average, per capital county income is around $14602 and the non-violent crime rate per 100 population is around 7 percent.

Recall that Hypothesis I states that population migration, which is reflected by population growth, is positively related to the provision of government insurance programs, such as the

Florida Citizens and the Flood Insurance, with the presence of moral hazard problem. Thus, the coefficients of Florida Citizens and Flood Insurance are expected to be positive, which suggests that people are inclined to move to hurricane-prone areas with subsidized insurance provided by state or federal governments. Moreover, the positive coefficients of risk area dummies indicate that these high-risk areas are different from the interior parts of the Florida state.[20]

In terms of potential moral hazard problem in the private market related to government regulation and intervention, risky insurers, especially which are less liquid and more leveraged, are hypothesized to aggressively underwrite homeowners insurance with the presence of Flood Insurance and CAT Fund. Therefore, the estimated equations for Hypothesis II are stated as follows:

- Hypothesis II Test - Estimated Equations (4) – (6)

$$\begin{aligned} HO^{EXP}{}_{k,i,t} = \alpha_{40} &+ \beta_{41} FC^{EXP}{}_{i,t} + \beta_{42} FI^{COV}{}_{i,t-1} + \beta_{43} PTCF_{k,t-1} + \beta_{44} APCT_{i,t} \\ &+ \beta_{45} D_1 + \beta_{46} D_2 + \beta_{47} D_3 + \beta_{48} Income_{i,t} + \gamma_{4,1} Size_{k,t} + \gamma_{4,2} ROE_{k,t} \\ &+ \gamma_{4,3} Leverage_{k,t} + \gamma_{4,4} Liquidity_{k,t} + \varepsilon_{k,i,t} \end{aligned} \tag{4}$$

$$\begin{aligned} HO^{DPW}{}_{k,i,t} = \alpha_{50} &+ \beta_{51} FC^{DPW}{}_{i,t} + \beta_{52} FI^{DPW}{}_{i,t-1} + \beta_{53} PTCF_{k,t-1} + \beta_{54} APCT_{,i,t} \\ &+ \beta_{55} D_1 + \beta_{56} D_2 + \beta_{57} D_3 + \beta_{58} Income_{i,t} + \gamma_{5,1} Size_{k,t} + \gamma_{5,2} ROE_{k,t} \\ &+ \gamma_{5,3} Leverage_{k,t} + \gamma_{5,4} Liquidity_{k,t} + \varepsilon_{k,i,t} \end{aligned} \tag{5}$$

$$\begin{aligned} HO^{PIF}{}_{k,i,t} = \alpha_{60} &+ \beta_{61} FC^{PIF}{}_{i,t} + \beta_{62} FI^{PIF}{}_{i,t-1} + \beta_{63} PTCF_{k,t-1} + \beta_{64} AP_{k,i,t} \\ &+ \beta_{65} D_1 + \beta_{66} D_2 + \beta_{67} D_3 + \beta_{68} Income_{i,t} + \gamma_{6,1} Size_{k,t} + \gamma_{6,2} ROE_{k,t} \\ &+ \gamma_{6,3} Leverage_{k,t} + \gamma_{6,4} Liquidity_{k,t} + \varepsilon_{k,i,t} \end{aligned} \tag{6}$$

where $HO^{EXP}{}_{k,i,t}$ = Log of exposures of homeowners insurance for insurer k in county i in year t; $HO^{DPW}{}_{k,i,t}$ = Log of direct written premiums of homeowners insurance for insurer k in county i in year t; $HO^{EIF}{}_{k,i,t}$ = Log of policy numbers in force of homeowners insurance for insurer k in

[20] South Atlantic, Gulf Coast and Panhandle areas are defined as high risk areas whereby the rest of areas refer to the interior part. See Table 1 for risk area categories definition.

county i in year t; $FC^{EXP}{}_{i,t}$ = Market share of the Florida Citizens in exposures in county i in year t; $FC^{DPW}{}_{i,t}$ = Market share of the Florida Citizens in direct premium written in county i in year t; $FC^{PIF}{}_{i,t}$ = Market share of the Florida Citizens of policy numbers in force in county i in year t; $FI^{COV}{}_{i,t-1}$ = Log of the Flood Insurance coverage in county i in year $t-1$; $FI^{DPW}{}_{i,t-1}$ = Log of the Flood Insurance direct written premiums in county i in year $t-1$; $FI^{PIF}{}_{i,t-1}$ = Log of the Flood Insurance policy numbers in force in county i in year $t-1$; $PTCF_{k,t-1}$ = Percentage of the CAT Fund reinsurance purchase out of total reinsurance for insurer k in year t; $APCT_{i,t}$ = Proxy of homeowners insurance price which is calculated as total premiums divided by total coverage in county i in year t; $AP_{k,i,t}$ = Proxy of insurer k 's homeowners insurance price which is calculated as premiums divided by coverage for insurer k in county i in year t; $Income_{i,t}$ = Control variable for county i at year t; D_1 = Dummy variable for South Atlantic area; D_2 = Dummy variable for Gulf Coast area; D_3 = Dummy variable for Panhandle area; $Size_{k,t}$ = Log of total assets for insurer k in year t; $ROE_{k,t}$ = Net income to equity for insurer k in year t; $Leverage_{k,t}$ = Debt to capital for insurer k in year t; $Liquidity_{k,t}$ = Proportion of liabilities covered by cash and short-term investment for insurer k in year t; $\varepsilon_{k,i,t}$ = Error term for insurer k in county i in year t.

The lags of the Flood Insurance and the CAT Fund from previous periods are adopted in the regressions, because the effects of those two programs on the demand for homeowners insurance are perceived to pass to the next period. For example, property owners make their decisions whether and to whom to purchase homeowners insurance based on the historical claim payments records of Flood Insurance in their communities.

The variables indicating government interventions, including the Florida Citizens market shares, the Flood Insurance and the CAT Fund purchase, are applied to examine the effects on insurers' risk-taking behaviors in the homeowners insurance market. Commensurately, the exposures, direct written premiums and policy numbers in force of the Florida Citizens are employed into regressions (4) – (6), respectively. In equation (4), the variable of $APCT_{i,t}$ proxies the homeowner insurance price as total direct written premiums divided by total exposures insured for a county in a year. It measures an average level of insurance premium at a county level. The firm characteristics of size, return on equity, leverage and liquidity are applied as control variables.

As suggested by the crowding-out effect of the residual market, the coefficients on Florida Citizens are expected to be negative, which means the residual market hinders the development of the private sector. In terms of state funded catastrophe reinsurance, it is expected to increase the coverage availability by private insurers as it provides relatively "cheaper" reinsurance and reduces the underwriting costs of primary insurers. The provision of flood insurance is expected to be positively associated with the amount of Florida's homeowner insurance for the flood insurance can be complements of homeowner insurance. The inclusion of firm factors, such as leverage and liquidity, are able to reflect what kind of firms are taking more risk exposures in the market under government subsidy and involvement. Firms with lower leverage and higher liquidity signify their sound financial capability, and will restore the market competition and enhance efficiency which perfectly meets the goal of government's regulation. If firms with higher leverage and lower liquidity are observed to aggressively underwrite high risks by filling coverage gaps left by other big retrenching insurers and ceding business to catastrophe fund at lower premiums, we may infer that government intervention and cross subsidization entails moral hazard problem in the market.

Table 7.2 lists the descriptive statistics of the variables in equations (4) – (6). The mean of the CAT Fund purchase is 8.3 percent for a firm, which shows that, on average, insurers obtain most of reinsurance coverage from the private market. The variable of Citizens market shares appear to be volatile, since the mean of market share in exposures is 1.5 percent with the standard deviation of 4.4 percent. Further, the maximum Citizen market share in exposures is 33 percent. The market share in direct written premiums and policy numbers in force follow the similar pattern, which implies that some counties with high hurricane risks are more covered by the Florida Citizens compared to other counties.

4.4 Results

4.4.1 Results of Hypothesis I Test

Recall that Hypothesis I states that migration to Florida high risk areas are positively associated with a subsidy from government programs, such as the Florida Citizens and the National Flood Insurance Program. With lower premiums provided by the government insurance programs in relatively high risk areas, people could obtain homeowners insurance coverage at lower prices. Then residents could be more attracted to relocate to Florida's high risk areas all other things being equal. With the inadequate insurance premiums and increasing exposures in these areas, the homeowners insurance market may incur devastating losses once hurricanes hit the state. In the extreme case, the private market may collapse and the government takes over the market.

The relationship between the population growth, the provision of the Florida Citizens and the Flood Insurance in the Florida homeowners insurance market are examined from 1998 to

2007. The empirical tests are performed at three levels: exposures, direct written premiums and policy numbers in force. Table 8.1 summaries the empirical results when the Florida Citizens market share in exposures and the Flood Insurance coverage are taken into account as the explanatory variables. Four random effect models with various sets of explanatory variables are applied according to Hausman test and presented in order. In Model A1 the variable of the Flood Insurance coverage is statistically significant with the estimated coefficient of 0.385, while Model A2 uses the lag of Flood Insurance coverage instead which shows a smaller effect on the population increase. The results can be explained as 1 percentage increase of the Flood Insurance coverage is associated with around 0.04 percent of population increase overall all others being equal. To control the population size effect, the Flood Insurance coverage is normalized by dividing the population. The coefficients of the normalized Flood Insurance coverage and the corresponding lag variable are still statistically significant as shown in Model C and D, which reconfirms that the provision of government programs is positively related to the population increase in the state of Florida. The Citizens market share in exposures, however, is not statistically significant to population changes in all four models as shown in Table 8.1. In addition, the control variable of income is statistically significant, and positively related to the population increase, which is consistent with the previous literature. Thus, the higher the income per capital, the higher the population growth rate is. In three scenario tests, the coefficients of the dummy of the South Atlantic area are significantly negative, which implies that the South Atlantic area experiences a low rate of population growth compared to the inner areas of Florida during the study period.

Table 8.2 provides the regression results when the government intervention is measured as direct written premiums. Model B1-B4, fixed effect or random effect models based on

Hausman test, are applied taking account into the direct written premiums of Flood Insurance, normalized direct written premiums and lags of those two variables, respectively. Among the four measures of the Flood Insurance provision, only the lag of the Flood Insurance direct written premiums is statistically significant and positively related to the population growth. The estimated coefficient is 0.253, which means that 1 percent increase of Flood Insurance premium in the previous year is associated with 0.003 percent of population growth. Table 8.3 shows the results when the Citizens market shares in policy numbers and Flood Insurance policy numbers in force are examined. In this case, only the variable of Flood Insurance policy numbers is statistically significant, and the positive coefficient implies a positive relationship between the Flood Insurance policy numbers and population growth.

To look into the county effect on the population growth in detail in line with other variables of interest, 67 counties are included in the regression to examine the specific effect of each county on the population growth. The omitted (or default) county in the regression is set to Miami-Dade County, and the other 66 counties are created as dummy variables. Table 8.4 provides the estimated coefficients on county population growth rate with county dummies. The same as previous tests, lag of the Flood Insurance coverage and the corresponding normalized variable are significantly positive, even to a large extent, at 1.18 and 1.399. The variable of income is positively associated with the population growth as well. With respective to the county dummies, surprisingly, most coefficients are statistically significant and positive, which means that these counties experience a higher population growth compared to Miami-Dade.

As discussed above, a couple of factors, such as the existence of residual insurance and Flood Insurance, can contribute to the population changes upon the occurrence of hurricanes. A "structural break" of growth rate before and after hurricanes, therefore, is expected in such circumstances. The effects on population growth rates of Florida two years before and after 2004-2005 hurricane seasons are examined accordingly by using Chow test. The results vary with or without inclusion of county dummies. When county dummies are omitted from other explanatory variables, the structural break does not exist by failing to reject the null hypothesis that effects of explanatory factors on growth rates are same before and after hurricane seasons. The addition of county dummies, however, generates a contrary result that suggests independent variables have different effects on growth rates before and after hurricanes.

In sum, the supportive evidences on Hypothesis I are found that migration within Florida is associated with the National Flood Insurance Program during the study period because the estimated coefficients of the variable of Flood Insurance are statistically significant and positive. Meanwhile, the presence of the Florida Citizens does not impose the significant effect on the population growth.

4.4.2 Results of Hypothesis II Test

Hypothesis II states that insurers in the private sector assume more risks in hurricane-prone areas with the provision of the CAT Fund and the Flood Insurance. This test is designed to examine the effects of government-funded insurance programs on the risk-taking behaviors of property insurance companies in Florida from 1998 to 2007. Table 8.5 provides the estimated coefficients on homeowner insurance exposures when the Citizens market share, CAT Fund purchases and Flood Insurance coverage are taken into account. Models D1 to D4 account for the explanatory variables of Flood Insurance coverage, normalized Flood Insurance coverage and lags of Flood Insurance coverage. All four models show that the presence of the Citizens is negatively related to the homeowner insurance exposures, and the provision of the CAT Fund and the Flood Insurance are positively associated with the private homeowners insurance exposures covered.

The estimated coefficient of the Citizens market share in terms of exposures is statistically significant and negative at -0.014, which means that 1 percent of Citizens expansion will reduce the private market in terms of exposures by 0.014 percent all others being equal. None of the previous literature, to my best knowledge, has empirically examined the effect of the residual market on the private sector, although a number of scholars indicate that the Florida Citizens has become more and more aggressive in its pricing and has discouraged the development of the private market (Grace & Klein, 2007; Klein, 2008). The state-funded reinsurance program, the CAT Fund, plays a significant role in boosting the private insurance market as 1 percent of catastrophe fund purchase leads to 14 percent increase in exposures covered all others being equal. The results also show that national flood insurance supplements the development of the homeowner insurance market to a lesser extent compared to the catastrophe fund. The insurance price variable at the county level, which is defined as homeowner insurance premiums divided by exposures by county, is statistically significant and negative when the regressor of the Flood Insurance coverage is normalized by population. The higher the price charged in a county, the lower the insured exposures.

County income is shown to be positively associated with homeowner insurance exposures, which suggest that wealthy counties have more exposures covered. In addition, Kuneuther et al (2009) showed that the income elasticity was positive for homeowners insurance in Florida. Firm characteristic variables describing firms' financial capacity and stability, such as assets and leverage, show a positive effect on the insurers' underwritten exposures. Higher leverage ratio implies firms borrow more debts to finance their business and may encounter financial problems when they fail to repay the debts on time. In this sense, the firms with higher leverage ratio can be regarded as financially risky insurers. Therefore, the evidence that the variable of leverage ratio is positive to exposures covered shows that risky firms aggressively underwrite in the market with the provision of government insurance programs. This finding supports the hypothesis of moral hazard problem arising from insurers. With respect to location effects, the South Atlantic area is statistically different from the interior parts of the state, and has a negative relationship with the homeowner insurance exposures.

Table 8.6 summarizes the regression results on homeowner insurance direct written premiums. The variables of the Flood Insurance premiums, lag of the Flood Insurance premiums, normalized and lag of normalized Flood Insurance are included in Model E1 to E4 respectively. The presence of the CAT Fund and the Flood Insurance are tested to be statistically significant and positive to the homeowner insurance premiums. With respective to firms' characteristics, the variables of size, return on equity, leverage and liquidity are shown to be statistically significant. While the size, return on equity and leverage are positively related to the homeowner insurance premiums, the variable of liquidity is negatively associated with the homeowner insurance premiums. Since liquidity captures how rapidly firms convert assets into cash, lower liquidity indicates the insurers may have difficulty in paying claims caused by catastrophic losses when they are not able to convert assets into cash quickly. Hence, the negative relationship between the liquidity and the homeowner insurance premiums implies that firms with lower liquidity, surprisingly, are underwriting more homeowner insurance. This finding supports the hypothesis of moral hazard problem that risky insurers adversely underwrite more homeowner insurance with the provision of government insurance programs, such as the CAT Fund and the Flood

Insurance. Table 8.7 presents the results when the homeowner insurance policy numbers in force are examined in regressions, which generate similar results as shown in Table 8.6.

To examine the specific effects of each county on homeowner insurance, 66 county dummies are included in the empirical tests. The regression results are presented in Table 8.8, Table 8.9 and Table 8.10. The omitted county is Miami-Dade, and the estimated coefficients of each county show the relative effect on the homeowner insurance purchase with respect to Miami-Dade. To be concise, eight counties from four risk categories in the state are selected, and the estimated coefficients of these representative counties are reported in the tables. As reported in Table 8.8, the estimated coefficients of County Clay and Volusia in North Atlantic area, Sarasota in Gulf Coast, and Franklin in Panhandle area are statistically significant and positive to the homeowners insurance exposures. It implies that more exposures are likely to be covered in these areas in the state of Florida relative to Miami-Dade. This finding is consistent with the observation of Klein (2008) that insurers had retrenched from the hurricane-prone zones after catastrophic losses in the last two decades. The pattern, however, is not obvious when homeowner insurance premiums and policy numbers in force are considered. In sum, the county effect on the homeowner insurance seems to be mixed in this case.

To investigate the specific firm effect on the private insurance market, firm dummies are included in the regression analysis. There are 254 firms in the dataset in total, which were in business in Florida from 1997 to 2007. State Farm is set as the omitted firm, and the other 253 firms are denoted as dummies. Table 8.11 presents the estimation results with the selected counties and firms' dummies. Four representative insurers are chosen based on the firm size and the time they are in business: 1) Allstate Insurance Company, a big insurer; 2) Lumbermens Mutual Casualty Company, a medium-sized company; 3) Merastar Insurance Company, new entrant since 2000; and 4) Auto Club South Insurance Company, a new insurer since 2005. Allstate shows no statistically significant effect on the homeowners insurance exposures compared to State Farm, which could be explained by the similar big size of those two firms. The estimated coefficients of Lumbermens and Auto Club are statistically significant and positive, implying those two insurers are more willing to underwrite business in Florida compared to State Farm. It is worth noticing that, as a regional insurer with a short business history, Auto Club aggressively underwrites in hurricane-prone areas.

From the empirical results, the Florida Citizens is observed to compete with the private insurance market by reducing the homeowner insurance market to a limited extent. The provision of government-run insurance programs has promoted the expansion of the insurance market in Florida partly as hoped by regulators and legislators. Meanwhile, less liquid insurers and new insurers in the market seek to underwrite more homeowner insurance in the market with the subsidy from the government, where moral hazard may be the case.

5. Conclusion

The state of Florida has suffered from a number of large hurricane losses for years. How to provide stable and sustainable insurance to property owners in the state has been of interest to legislators and regulators. Florida Citizens, as well as other government-funded insurance programs, such as the CAT Fund and the Flood Insurance, were established to address the issue of coverage availability. This essay examines the effects of those public policies on Florida's population growth and the private insurance market from 1998 to 2007 by setting up two hypotheses and carrying on empirical tests,. The supporting evidence suggests that the public policies, which impose heavy insurance regulation and involvement in the private market, may create moral hazard problems in the homeowner insurance market in Florida.

To test the effect of public policies on the people's incentives to move to high-risk areas, the migration to Florida is hypothesized to be positively associated with the implementation of government insurance, such as the Florida Citizens or the Flood Insurance. Due to the major contribution of migration to population growth and data limitation, the annual population growth rates by county in Florida are used instead. I find that the provision of the Flood Insurance is positively associated with the population growth in the state of Florida, while the coefficient of Citizens is not statistically significant. The risk of flood is excluded from the residential insurance policies because of its "uninsurable" characteristics, but the insurance coverage for such risk is critical to the financial security of residents in hurricane-prone areas in Florida. By providing Flood Insurance to property owners in the high risk zones, the federal government fills the gap which may however entail cross subsidization between high and low risks. The results suggest that flood insurance lures more people to live in higher-risk areas than they would otherwise, which could be explained by moral hazard problem that migrants take advantage of subsidized insurance provided by the federal government at lower premiums.

In terms of homeowner insurance market, private insurance companies are hypothesized to assume more risks in the hurricane-prone areas with the provision of the CAT fund and the Flood Insurance, while the Citizens may compete with the development of the private market. The results show that the CAT fund and the Flood Insurance are positively associated with the exposures of insurers, and the Florida Citizens is negatively related to the underwriting of insurers. Besides, the income elasticity of homeowners insurance demand is positive, which is consistent with the previous literature. The location of counties, however, does not have strong effect on the risk-taking behavior of private insurers. However, insurers with less liquidity and high leverage are found to underwrite more homeowner insurance, which imposes a severe moral hazard issue in the homeowner insurance market. Meanwhile, some new entrants, small regional insurers, to the market are found to aggressively write business compared to the big insurance companies such as Allstate and State Farm. These new players have filled the coverage gap left by the retrenching companies as expected to insurance regulators and legislatures, but their lack of underwriting experiences and financial capability may make them fail to meet their obligations when hurricane strikes the state of Florida.

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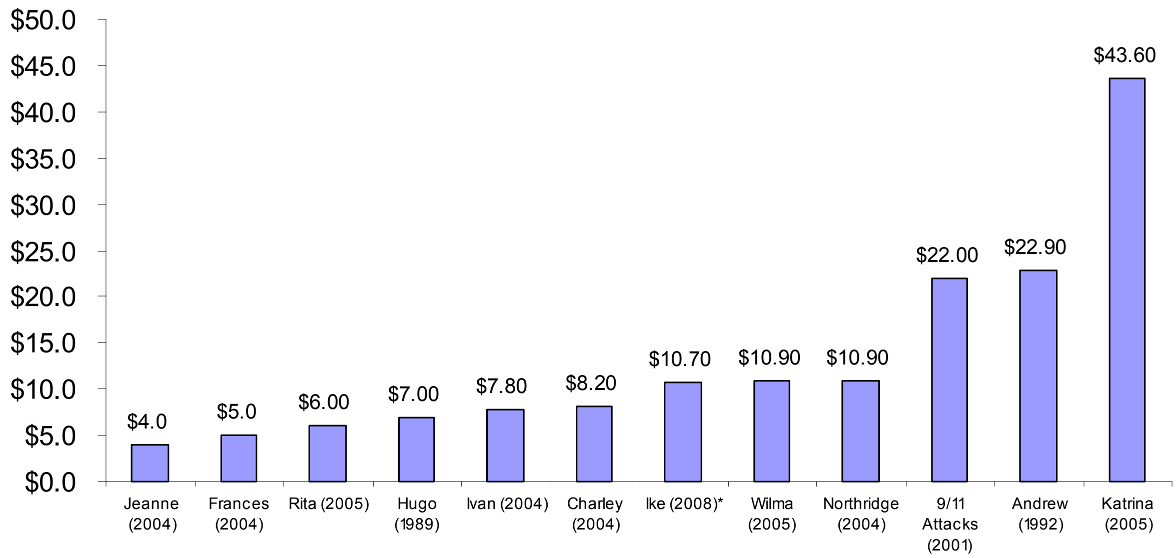
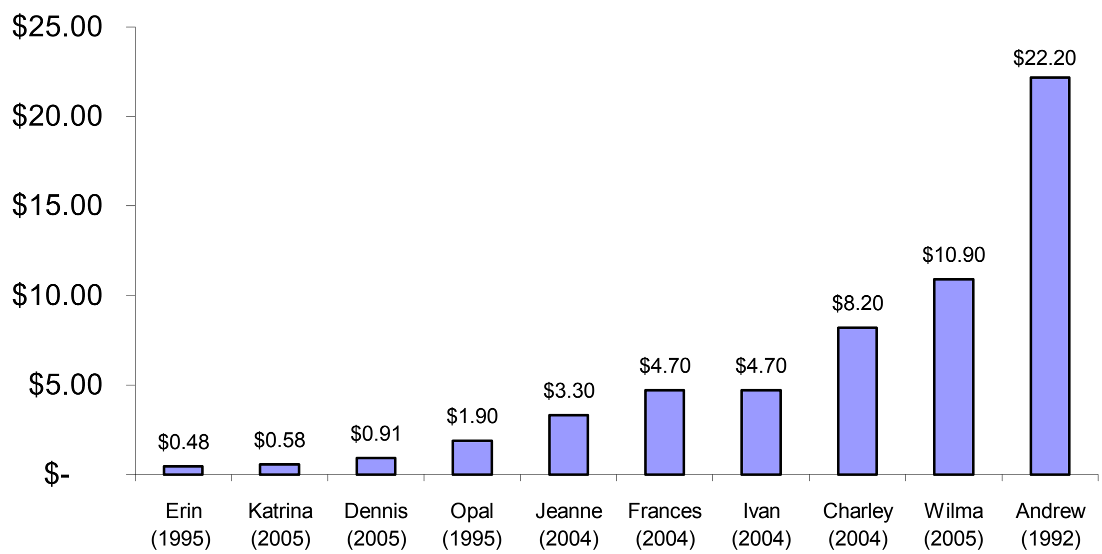
Figure 1
Insured Losses of 12 Costliest Disasters in U.S. History
(2007 $Billions)



*
PCS estimates as of 12/15/08.
Sources: ISO/PCS; AIR Worldwide, RMS, Eqecat; Insurance Information Institute inflation adjustments, 2008.

Figure 2
Insured Losses* of Florida's 10 Costliest Hurricanes,
1980 – 2007 (2007 $Billions)



*Florida losses only
Sources: Insurance Information Institute inflation adjustments, 2008.

Figure 3

Comparison of Homeowners Insurance Rate per $1000 by County
Florida: 1997, 2000 and 2003

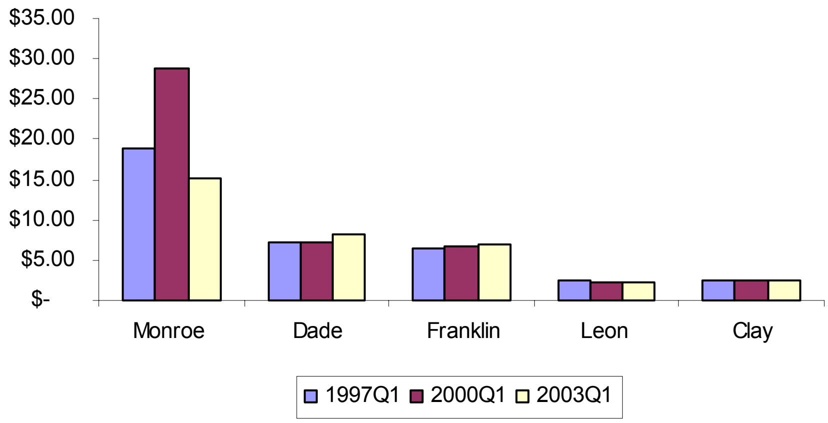


Figure 4
Comparison of Homeowners Insurance Rate per $1000 by County
Florida: 2003, 2006 and 2007

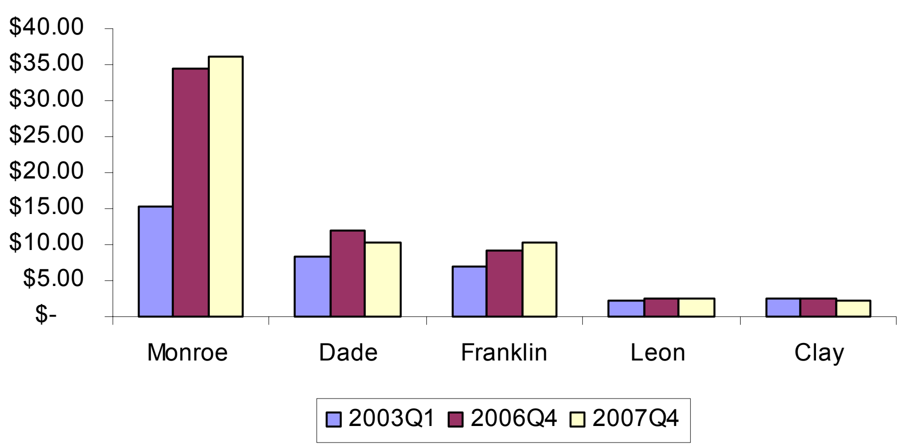


Figure 5
Florida State County Map

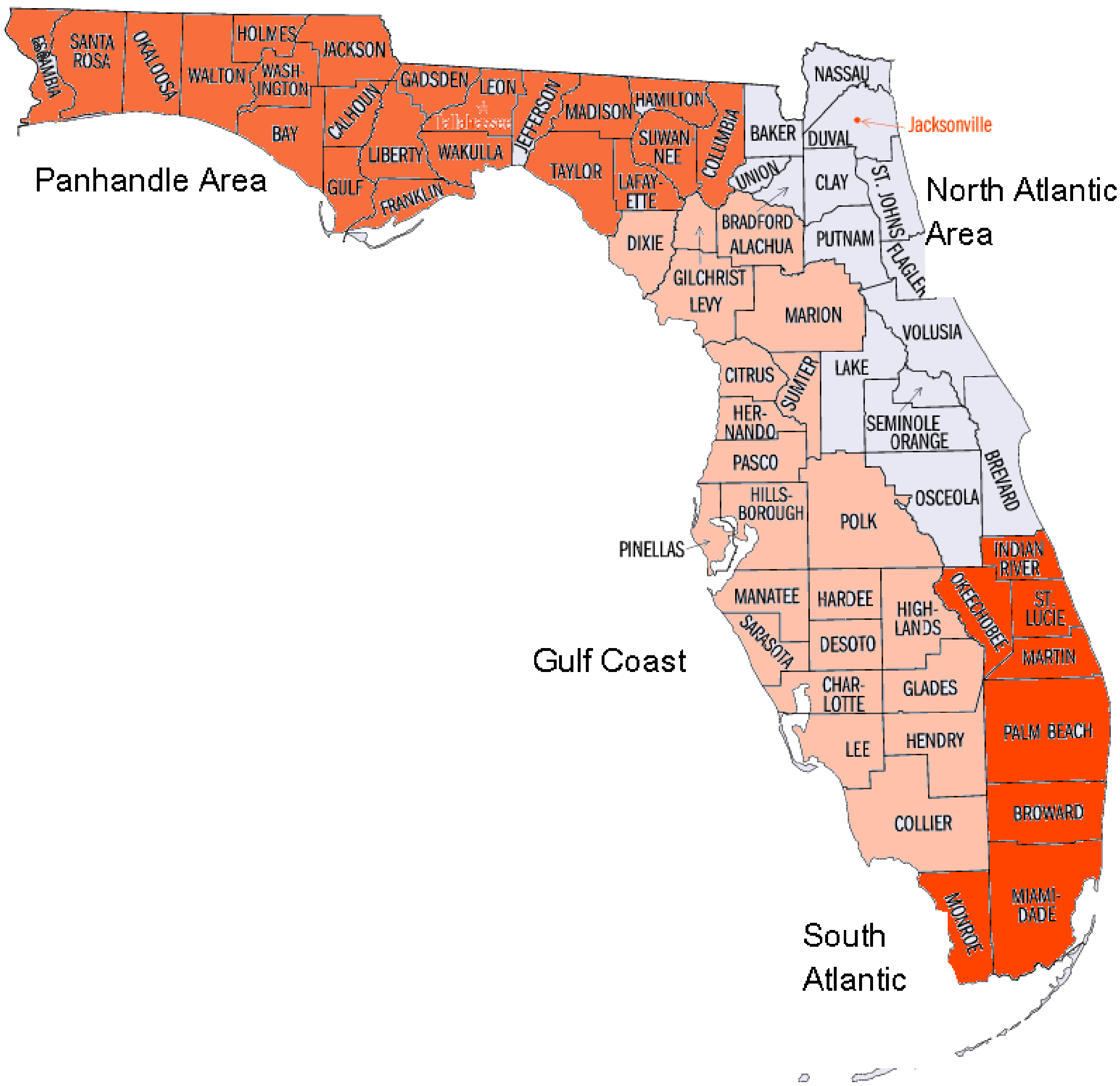
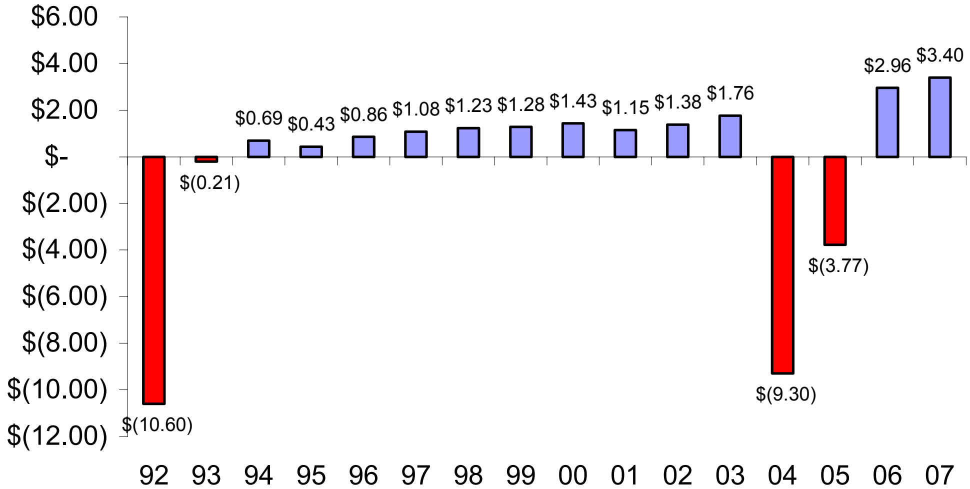
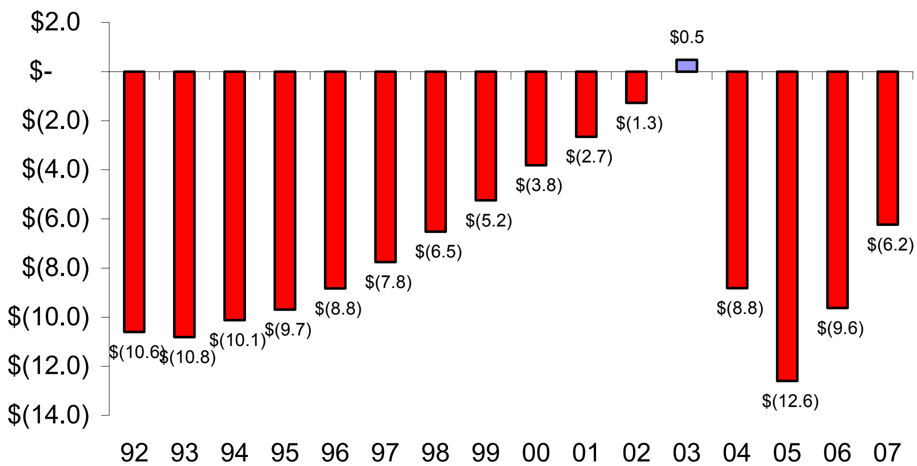


Figure 6
Underwriting Gains (Losses) of Florida Homeowner Insurance*
1992-2007 ($Billions)



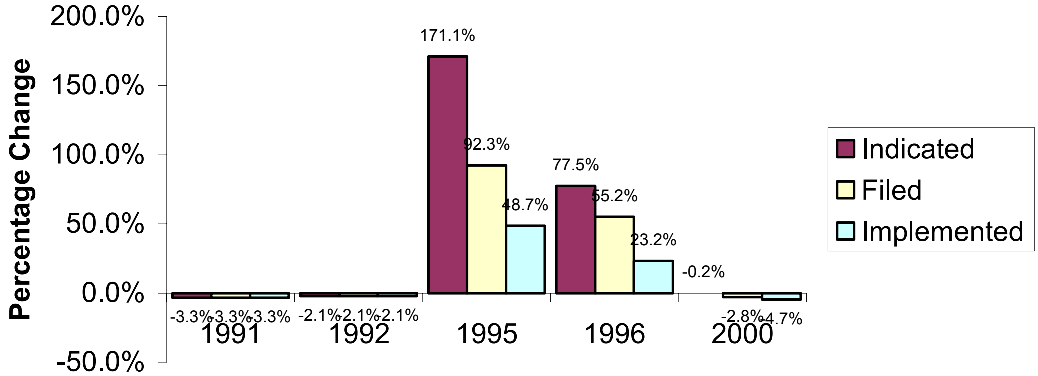
*Does not include Citizen Property Insurance Corporation
Source: Insurance Information Institute

Figure 7
Accumulative Underwriting Gains (Losses) of Florida Homeowner Insurance*
1992-2007 ($Billions)



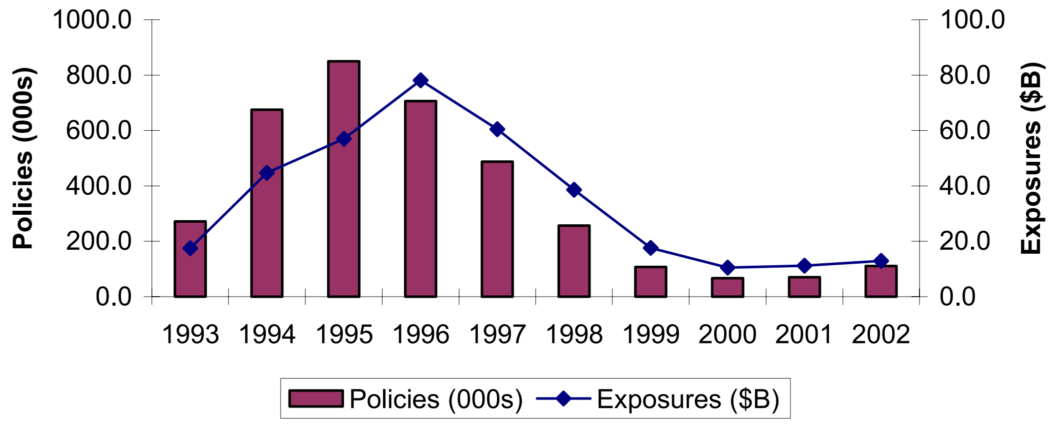
*Does not include Citizen Property Insurance Corporation
Source: Insurance Information Institute

Figure 8
ISO Loss Cost Filings: Florida Homeowners Insurance
1991, 1992, 1995, 1996 and 2000



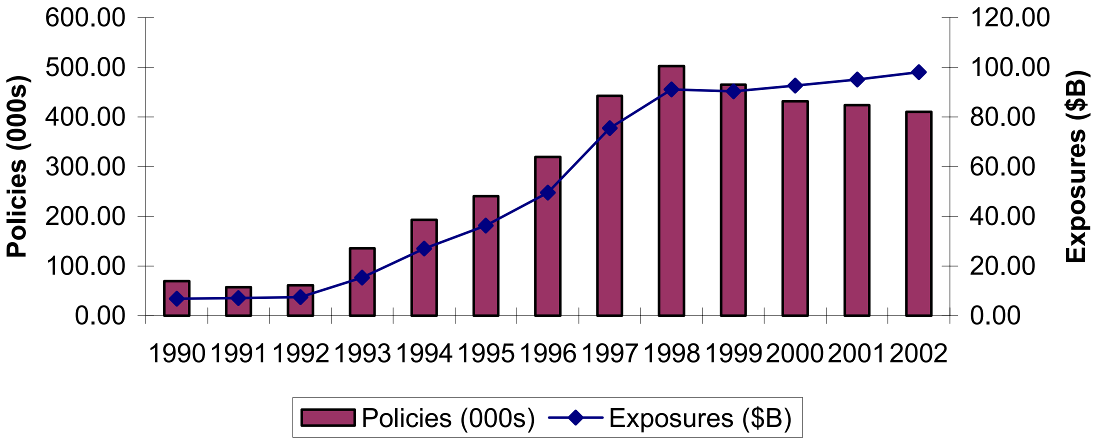
Source: Insurance Service Office

Figure 9
Florida Residential Property and Casualty Joint Underwriting Association
Policy Numbers and Exposures from 1993 to 2000



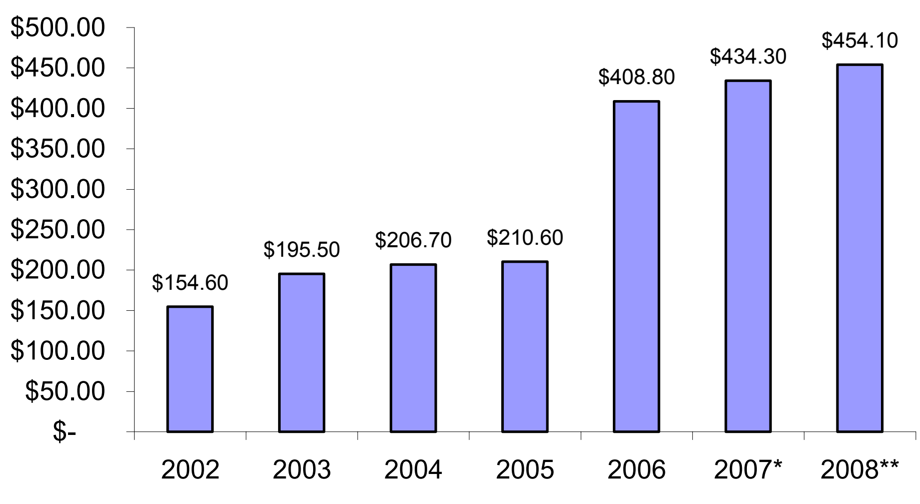
Source: FRPCJUA

Figure 10
Florida Windstorm Underwriting Association
Policy Numbers and Exposures: 1990 - 2002



Source: Insurance Information Institute, Florida Insurance Council

Figure 11
Florida Citizens Exposures to Losses (Billions)
2002-2008



*Florida Citizens data, as of March 31, 2007.
**As of April, 30, 2008.
Source: PIPSO; Florida Citizens; Zurich American Insurance Co; Insurance Information Institute

Table 1

Risk Areas Categories in Florida

Areas	Number	Counties
North Atlantic area	15	Baker, Bradford, Brevard, Clay, Duval, Flagler, Lake, Nassau, Orange, Osceola, Putnam, Seminole, St. Johns, Union, Volusia
South Atlantic area	8	Broward, Dade, Indian River, Martin, Monroe, Okeechobee, Palm Beach, St. Lucie
Gulf Coast area	22	Alachua, Charlotte,Citrus, Collier, Desoto,Dixie, Gilchrist, Glades, Hardee, Hendry, Hernando, Highlands, Hillsborough, Lee,Levy, Manatee, Marion, Pasco, Pinellas, Polk, Sarasota, Sumter
Panhandle area	22	Bay, Calhoun, Columbia, Escambia, Franklin, Gadsden, Hamilton, Holmes, Jackson, Jefferson, Lafayette, Leon, Liberty, Madison, Okaloosa, Santa Rosa, Suwannee, Taylor, Wakulla, Walton, Washington

Table 2
Homeowners Insurance Market Concentration
Forida: 1992-2007

Year	CR4	CR8	CR20	HHI
1992	59.3%	70.9%	85.2%	1,440
1993	59.5%	71.6%	85.6%	1,438
1994	60.0%	71.9%	86.7%	1,236
1995	60.2%	72.2%	87.4%	1,406
1996	57.5%	71.5%	87.0%	1,266
1997	50.0%	63.8%	82.9%	1,046
1998	51.3%	64.9%	83.1%	920
1999	50.1%	62.7%	80.0%	846
2000	48.0%	61.2%	78.7%	776
2001	47.5%	60.1%	78.4%	783
2002	46.4%	59.2%	79.6%	829
2003	45.0%	59.9%	81.7%	839
2004	44.9%	61.4%	83.8%	832
2005	42.2%	60.0%	78.7%	714
2006	39.2%	54.5%	75.6%	695
2007	36.0%	48.5%	65.9%	612

Source: NAIC Financial Database; author's calculation

Table 3
Changes in Leading Insurers' Market Share
Florida -- 1992, 2003, 2005, 2007

	2007			2005		
Name	Rank	DPW	MS(%)	Rank	DPW	MS(%)
State Farm	1	1,560,467,341	22.0%	1	1,175,850,317	20.7%
USAA	2	379,397,010	5.4%	6	253,944,356	4.5%
Tower Hill	3	321,833,252	4.5%	4	285,914,090	5.0%
Allstate	4	288,283,830	4.1%	2	495,663,212	8.7%
Nationwide	5	250,339,974	3.5%	5	274,916,784	4.8%
Liberty Mutual	6	239,255,396	3.4%	7	172,170,305	3.0%
ARX Holding Corp Grp	7	217,663,690	3.1%	12	116,834,632	2.1%
AIG	8	175,568,026	2.5%	10	119,271,708	2.1%
Universal Ins Grp	9	173,729,567	2.5%	15	81,510,111	1.4%
Chubb & Son	10	164,855,442	2.3%	9	124,290,363	2.2%
Hartford	11	133,295,258	1.9%	12	117,478,875	2.1%
Travelers	12	109,165,275	1.5%	8	124,905,507	2.2%
Southern Farm Bureau	13	108,252,804	1.5%	16	78,785,158	1.4%
21st Century Holding Grp	14	100,481,479	1.4%	17	77,513,454	1.4%
Zurich	15	91,934,700	1.3%	19	65,032,155	1.1%
Homewise	16	75,028,968	1.1%			
Cypress Holdings Grp	17	74,980,353	1.1%	20	62,995,348	1.1%
Allianz	18	74,980,353	1.1%	22	54,853,987	1.0%
GeoVera Holdings Inc Grp	19	71,529,892	1.0%	13	111,695,287	2.0%
Northern Capital Grp	20	56,019,026	0.8%			
	2003			1992		
Name	Rank	DPW	MS(%)	Rank	DPW	MS(%)
State Farm	1	901,469,903	23.4%	1	653,427,313	30.5%
USAA	3	201,975,410	5.2%	3	95,171,018	4.4%
Tower Hill	13	73,239,148	1.9%			
Allstate	2	437,218,328	11.4%	2	436,329,616	20.3%
Nationwide	4	192,647,854	5.0%	5	88,595,495	4.1%
Liberty Mutual	8	122,342,962	3.2%	12	32,534,992	1.5%
ARX Holding Corp Grp	15	65,451,493	1.7%			
AIG	11	78,866,913	2.0%	53	3,771,785	0.2%
Universal Ins Grp						
Chubb & Son	9	101,325,909	2.6%	6	62,874,910	2.9%
Hartford	10	93,951,838	2.4%	9	49,288,247	2.3%
Travelers	7	135,849,259	3.5%	4	89,664,452	4.2%
Southern Farm Bureau	14	68,017,879	1.8%	71	1,781,096	0.1%
21st Century Holding Grp	25	19,446,950	0.5%			
Zurich	20	38,742,883	1.0%	50	3,404,647	0.2%
Homewise						
Cypress Holdings Grp	18	50,992,727	1.3%			
Allianz	19	47,652,724	1.2%	26	11,658,623	0.5%
GeoVera Holdings Inc Grp						
Northern Capital Grp						

Source: NAIC Financial Database; author's calculation

Table 4

Profitability of Florida Homeowner Insurance

1985-2007

Year	**Profit on Insurance Transactions**	**Return on Net Worth**
1985	-5.3%	-4.8%
1986	3.2%	13.1%
1987	8.7%	22.3%
1988	5.7%	17.0%
1989	5.6%	16.2%
1990	4.3%	13.3%
1991	0.5%	6.9%
1992	-657.4%	-714.9%
1993	-19.9%	-16.1%
1994	21.8%	35.4%
1995	6.0%	13.1%
1996	22.0%	33.6%
1997	22.2%	31.5%
1998	22.1%	29.3%
1999	22.1%	28.6%
2000	23.1%	31.3%
2001	15.2%	23.1%
2002	19.1%	29.0%
2003	23.3%	35.7%
2004	-172.7%	-183.3%
2005	-62.0%	-53.4%
2006	27.4%	31.1%
2007	29.6%	39.0%
Average	-27.6%	-22.7%

Source: NAIC

Table 5
Variables Descriptions and Data Source

Variable	Lable	Definition	Source
Population Growth in Percentage	PG	Population growth rate in percentage	Florida Demographic Database
HO Exposures	HO^{EXP}	Log of exposures of homeowner insurance	QUASR database by Florida OIR
HO Premiums	HO^{DPW}	Log of direct written premiums of homeowner insurance	QUASR database by Florida OIR
HO Policy Numbers	HO^{PIF}	Log of policy numbers in force of homeowner insurance	QUASR database by Florida OIR
Citiznes Market Share in Exposures	FC^{EXP}	Florida Citizens' market share in exposures	NAIC financial database
Citizens Market Share in Premiums	FC^{DPW}	Florida Citizens' market share in direct written premium	NAIC financial database
Citizens Market Share in Policy Numbers	FC^{PIF}	Florida Citizens' market share in policy numbers in force	NAIC financial database
CAT Fund Purchase in Percentage	PTCF	The percentage of FHCF purchase out of total reinsurance arrangements	NAIC financial database
Flood Insurance Coverage	FI^{COV}	Log of coverages of flood insurance	FEMA
Flood Insurance Direct Written Premiums	FI^{DPW}	Log of direct written premiums of flood insurance	FEMA
Flood Insurance Policy Numbers in Force	FI^{PIF}	Log of policy numbers in force of flood insurance	FEMA
Flood Insurance Coverage Normalized by Population	FI^{COV}	Log(coverages of flood insurance/population)	FEMA
Flood Insurance Direct Written Premiums Normalized by Population	FI^{DPW}	The direct written premiums of flood insurance divided by population	FEMA
Flood Insurance Policy Numbers per 100 Population	FI^{PIF}	The policy numbers in force of flood insurance per 100 population	FEMA
Price Proxy at Firm Level	AP	Homeowner insurance direct written premiums divided by exposures for a firm	NAIC financial database
Price Proxy at County Level	APCT	Homeowner insurance direct written premiums divided by exposures in a county	NAIC financial database
Per Capital County Income	Income	County income divided by population	Regional Economic Information System, Bureau of Economic Analysis, U.S. Department of Commerce
Crime Rate per 100 Population	Crime	Index crime and offense per 100 population	Florida Department of Law Enforcement*
Size	Size	Log of toal assests of a firm	A.M. Best Company
Return on Equity	ROE	Net income divided by equity of a firm	A.M. Best Company
Leverage	leverage	Consolidated balance sheet debt-to-capital ratio (unadjusted)**	A.M. Best Compnay
Liquidity	Liquidity	Current liquidity measured as the proportion of liabilities covered by encumbered cash and unaffiliated investments***	A.M. Best Company

*http://www.fdle.state.fl.us/Content/FSAC/Data---Statistics-(1)/UCR-Offense-Data/UCR-Offense-Data.aspx, accessed May 30, 2009
**http://www.ambest.com/ratings/methodology/operatingleverage.pdf, accessed May 30, 2009
***http://www.ambest.com/ratings/pcbirpreface.pdf, accessed May 30, 2009

Table 6

Florida Population and Exposures by County

County	2000 Census	2007 Estimate	Percent Change %	Amount of Insurance in Force 2007
Alachua	217,955	247,561	13.6%	17,827,240,280
Baker	22,259	25,623	15.1%	1,348,378,811
Bay	148,217	167,631	13.1%	12,586,771,068
Bradford	26,088	29,055	11.4%	1,133,397,020
Brevard	476,230	552,109	15.9%	57,082,266,488
Broward	1,623,018	1,765,707	8.8%	115,290,869,824
Calhoun	13,017	14,477	11.2%	550,949,311
Charlotte	141,627	164,584	16.2%	24,066,309,445
Citrus	118,085	140,124	18.7%	16,814,847,331
Clay	140,814	184,644	31.1%	18,641,380,452
Collier	251,377	333,858	32.8%	49,525,058,778
Columbia	56,513	65,373	15.7%	3,638,539,542
DeSoto	32,209	33,983	5.5%	100,454,591,030
Dixie	13,827	15,808	14.3%	2,031,871,749
Duval	778,879	897,597	15.2%	577,614,299
Escambia	294,410	311,775	5.9%	72,740,574,134
Flagler	49,832	93,568	87.8%	19,968,192,375
Franklin	9,829	12,249	24.6%	13,080,503,792
Gadsden	45,087	49,398	9.6%	594,290,097
Gilchrist	14,437	17,106	18.5%	2,311,470,770
Glades	10,576	11,055	4.5%	799,006,340
Gulf	14,560	16,815	15.5%	524,942,963
Hamilton	13,327	14,705	10.3%	746,673,324
Hardee	26,938	27,520	2.2%	456,693,400
Hendry	36,210	39,651	9.5%	1,148,293,667
Hernando	130,802	162,193	24.0%	1,758,620,277
Highlands	87,366	98,727	13.0%	18,060,699,830
Hillsborough	998,948	1,192,861	19.4%	9,149,914,909
Holmes	18,564	19,464	4.8%	112,445,467,925
Indian River	112,947	139,757	23.7%	745,802,728
Jackson	46,755	50,416	7.8%	16,880,820,302
Jefferson	12,902	14,494	12.3%	2,457,765,219
Lafayette	7,022	8,215	17.0%	925,876,518
Lake	210,527	286,499	36.1%	271,354,636
Lee	440,888	615,741	39.7%	35,517,372,279
Leon	239,452	272,896	14.0%	75,154,288,189
Levy	34,450	40,045	16.2%	23,603,547,362
Liberty	7,021	7,772	10.7%	2,024,996,007
Madison	18,733	19,944	6.5%	276,895,382
Manatee	264,002	315,890	19.7%	798,725,451
Marion	258,916	325,023	25.5%	37,737,346,676
Martin	126,731	143,737	13.4%	29,899,253,925
Miami-Dade	2,253,779	2,462,292	9.3%	21,138,801,053
Monroe	79,589	78,987	-0.8%	893,437,140
Nassau	57,663	69,569	20.6%	7,793,853,621
Okaloosa	170,498	196,540	15.3%	18,701,002,644
Okeechobee	35,910	39,030	8.7%	2,454,039,365
Orange	896,344	1,105,603	23.3%	110,868,392,437
Osceola	172,493	266,123	54.3%	26,710,935,648
Palm Beach	1,131,191	1,295,033	14.5%	133,911,245,419
Pasco	344,768	434,425	26.0%	41,572,776,403
Pinellas	921,495	944,199	2.5%	80,612,478,554
Polk	483,924	581,058	20.1%	51,908,243,583
Putnam	70,423	74,799	6.2%	4,070,010,021
St. Johns	123,135	173,935	41.3%	14,156,310,578
St. Lucie	192,695	271,961	41.1%	44,357,891,298
Santa Rosa	117,743	142,144	20.7%	48,831,600,512
Sarasota	325,961	387,461	18.9%	29,996,924,818
Seminole	365,199	425,698	16.6%	25,781,710,716
Sumter	53,345	89,771	68.3%	9,003,517,248
Suwannee	34,844	39,608	13.7%	2,013,769,854
Taylor	19,256	22,516	16.9%	1,016,728,303
Union	13,442	15,722	17.0%	444,515,319
Volusia	443,343	508,014	14.6%	46,818,533,388
Wakulla	22,863	29,417	28.7%	1,791,589,546
Walton	40,601	57,093	40.6%	4,763,219,424
Washington	20,973	23,719	13.1%	1,182,885,047
Total	15,982,824	18,680,367	16.9%	1,632,443,885,844

Source: QUASR database from Florida Office of Insurance Regulation
Florida Demographic database.

Table 7
Descriptive Statistics in Regression Equations

Table 7.1 Descriptive Statistics for Equations (1) – (3)

Variable	Number of Observations	Mean	Standard Deviation	Minimum	Maximum
Population Growth in Percentage	670	2.337	1.889	-4.395	13.302
Citizens Market Share in Exposures	670	1.543	4.265	0.000	32.633
Citizens Market Share in Premiums	670	2.540	5.666	0.000	39.340
Citizens Market Share in Policy Numbers	670	2.017	5.036	0.000	35.900
Flood Insurance Coverages	670	19.823	2.681	13.842	25.207
Flood Insurance Premiums	670	13.986	2.465	8.419	18.784
Flood Insurance Policy Numbers	670	8.002	2.484	2.639	12.960
Flood Insurance Coverages Normalized by Population	670	8.386	1.629	5.026	11.488
Flood Insurance Premiums Normalized by Population	670	34.416	55.213	0.620	436.913
Flood Insurnace Policy Numers per 100 Population	670	8.087	16.117	0.180	365.967
Income	670	25.841	8.665	12.572	59.390
Crime Rate per 100 Population	670	7.028	2.986	0.000	24.581

Table 7.2 Descriptive Statistics for Equations (4) – (6)

Variable	Number of Observations	Mean	Standard Deviation	Minimum	Maximum
HO Exposures	52,313	15.679	2.607	0.000	24.061
HO Premiums	53,710	10.135	2.600	0.000	18.738
HO Policy Numbers	53,684	3.460	2.408	0.000	11.271
CAT Fund Purchase in Percentage	35,303	8.289	15.643	0.000	100.000
Citizens Market Share in Exposures	55,736	1.492	4.428	0.000	32.633
Citizens Market Share in Premiums	55,736	2.338	5.734	0.000	39.340
Citizens Market Share in Policy Numbers	55,736	1.859	5.113	0.000	35.900
Flood Insurance Coverages	55,729	20.350	2.520	13.842	25.207
Flood Insurance Premiums	55,729	14.465	2.330	8.419	18.760
Flood Insurance Policy Numbers	55,729	8.532	2.354	2.639	12.960
Flood Insurance Coverages Normalized by Population	55,611	8.570	1.557	5.026	11.488
Flood Insurance Premiums Normalized by Population	55,611	35.075	50.182	0.620	436.913
Flood Insurance Policy Numers per 100 Population	55,611	8.762	15.204	0.180	365.967
Price Proxy at County Level	55,729	0.003	0.003	0.000	0.043
Price Proxy at Firm Level	52,809	0.117	10.047	0.000	181.600
Income	55,729	15.055	1.609	11.540	18.255
Size	21,898	19.220	4.114	7.015	24.358
Return on Equity	21,898	6.708	14.358	-48.600	53.100
Leverage	21,898	5.234	3.868	0.300	32.700
Liquidity	21,898	1.383	1.260	0.230	9.999

Table 8.1
Random Effects Estimates of Government Intervention Measured in terms of Exposures, 1998-2007
Dependent variable is County Population Growth Rate in Percentage terms

Independent Variables	Random-Effect Model A1	Random-Effect Model A2	Random-Effect Model A3	Random-Effect Model A4
Citizens Market Share in Exposures	-0.009	-0.009	-0.001	-0.008
	(0.017)	(0.019)	(0.018)	(0.019)
Flood Insurance Coverage	**0.385**			
	(0.134)***			
Lag of Flood Insurance Coverage		**0.354**		
		(0.139)**		
Flood Insurance Coverage Normalized by Population			**0.315**	
			(0.128)**	
Lag of Flood Insurance Coverage Normalized by Population				**0.379**
				(0.132)***
Income	-0.335	-0.290	0.029	0.005
	(0.217)	(0.224)	(0.136)	(0.140)
Crime Rate	0.026	0.008	0.025	0.009
	(0.030)	(0.033)	(0.030)	(0.033)
Dummy for South Atlantic area	**-1.183**	**-1.932**	**-1.851**	**-2.014**
	(0.662)***	**(0.677)*****	**(0.665)*****	**(0.681)*****
Dummy for Gulf Coast	-0.432	-0.511	-0.420	-0.507
	(0.485)	(0.496)	(0.485)	(0.497)
Dummy for Panhandle area	-0.737	-0.780	-0.750	-0.811
	(0.521)	(0.532)	(0.520)	(0.534)
Observations	670	603	670	603
R-squared	0.1792	0.1857	0.1779	0.1885

1. The estimation of fixed and random effects are based on Hausman test.
2. The results of year dummies are not reported in the table.
3. * , ** and *** denote significance at 10%, 5% and 1% levels respectively.

Table 8.2
Fixed and Random Effects Estimates, Government Intervention Measured in terms of Direct Written Premiums, 1998-2007
Dependent variable is County Population Growth Rate in Percentage terms

Independent Variables	**Fixed-Effect Model B1**	**Random-Effect Model B2**	**Fixed-Effect Model B3**	**Random-Effect Model B4**
Citizens Market Share in Direct Written Premiums	0.007	-0.007	0.002	-0.008
	(0.016)	(0.018)	(0.016)	(0.018)
Flood Insurance Direct Written Premiums	-0.121			
	(0.292)			
Lag of Flood Insurance Direct Written Premiums		**0.253**		
		(0.131)*		
Flood Insurance Direct Written Premiums			0.001	
Normalized by Population			(0.003)	
Lag of NFIP Premiums/Population				0.004
				(0.003)
Income	**0.468**	-0.118	0.178	0.171
	(0.952)***	(0.201)	(0.128)	(0.130)
Crime Rate	0.041	0.008	0.021	0.005
	(0.032)	(0.033)	(0.030)	(0.033)
Dummy for South Atlantic area		**-1.886**	**-1.589**	**-1.845**
		(0.686)***	**(0.698)****	**(0.713)*****
Dummy for Gulf Coast		-0.589	-0.386	-0.512
		(0.507)	(0.506)	(0.516)
Dummy for Panhandle area		0.839	-0.729	-0.834
		(0.541)	(0.544)	(0.555)
Observations	670	603	670	603
R-squared	0.0854	0.1549	0.1029	0.1184

1. The estimation of fixed and random effects are based on Hausman test.
2. The results of year dummies are not reported in the table.
3. * , ** and *** denote significance at 10%, 5% and 1% levels respectively.

Table 8.3
Fixed and Random Effects Estimates, Government Intervention Measured in terms of Policy Numbers in Force, 1998-2007
Dependent variable is County Population Growth Rate in Percentage terms

Independent Variables	Fixed-Effect Model C1	Random-Effect Model C2	Fixed-Effect Model C3	Random-Effect Model C4
Citizens Market Share in Policy Numbers	-0.001	-0.008	0.005	-0.007
	(0.016)	(0.018)	(0.013)	(0.018)
Flood Insurance Policy Numbers	**0.266**			
	(0.121)**			
Lag of Flood Insurance Policy Numbers		0.115		
		(0.125)		
Flood Insurance Policy Numbers Normalized by			0.001	
Population in Percentage			(0.004)	
Lag of Flood Insurance Policy Numbers				-0.004
Normalized by Population in Percentage				(0.004)
Income	-0.153	0.038	**4.103**	0.188
	(0.194)	(0.199)	**(0.946)*****	(0.129)
Crime Rate	0.022	0.003	0.042	0.005
	(0.030)	(0.033)	(0.031)	(0.033)
Dummy for South Atlantic area	**-1.665**	**-1.760**		**-1.623**
	(0.772)***	**(0.679)*****		**(0.688)****
Dummy for Gulf Coast	-0.460	-0.498		-0.454
	(0.487)	(0.500)		(0.511)
Dummy for Panhandle area	-0.100	-0.801		-0.759
	(0.249)	(0.536)		(0.549)
Observations	670	603	670	603
R-squared	0.1614	0.1496	0.0852	0.1073

1. The estimation of fixed and random effects are based on Hausman test.
2. The results of year dummies are not reported in the table.
3. * , ** and *** denote significance at 10%, 5% and 1% levels respectively.

Table 8.4
Estimated Coefficients on County Population Growth Rate with County Dummies
1998 - 2007

Independent Variables	Model A5	Model A6	Model B5	Model C5
Citizens Market Share in Exposures	0.012	0.005		
	(0.018)	(0.020)		
Lag of Flood Insurance Coverage	**1.180**			
	(0.400)* **			
Lag of Flood Insurance Coverage Normalized by Population		**1.399**		
		(0.496)* **		
Citizens Market Share in Direct Written Premiums			0.007	
			(0.016)	
Lag of Flood Insurance Direct Written Premiums			-0.121	
			(0.291)	
Citizens Market Share in Policy Numbers				0.005
				(0.016)
Lag of Flood Insurance Policy Numbers				0.220
				(0.202)
Income	**3.100**	**3.499**	**4.166**	**3.899**
	(1.001)* **	**(1.073)*** **	**(0.952)*** **	**(0.965)*** **
Crime Rate	**0.054**	0.037	0.041	0.044
	(0.031)*	(0.065)	(0.032)	(0.031)
Dummy for County Clay	**16.145**	**14.293**	**13.277**	**14.050**
	(2.770)* **	**(3.041)*** **	**(2.819)*** **	**(2.670)*** **
Dummy for County Volusia	**8.642**	**7.483**	**7.465**	**7.709**
	(1.767)* **	**(1.959)*** **	**(1.791)*** **	**(1.728)*** **
Dummy for County Broward	0.578	-0.081	0.924	0.840
	(0.596)	(0.683)	(0.585)	(0.587)
Dummy for County Monroe	**10.615**	**7.431**	**11.008**	**10.834**
	(2.915)* **	**(3.421)*** **	**(2.915)*** **	**(2.911)*** **
Dummy for County Hendry	**21.609**	**18.894**	**18.259**	**18.986**
	(4.357)* **	**(4.870)*** **	**(4.404)*** **	**(4.268)*** **
Dummy for County Sarasota	**14.474**	**12.893**	**13.172**	**13.455**
	(2.506)* **	**(2.802)*** **	**(2.555)*** **	**(2.480)*** **
Dummy for County Franklin	**24.335**	**20.021**	**24.385**	**24.344**
	(5.358)* **	**(6.161)*** **	**(5.400)*** **	**(5.374)*** **
Dummy for County Leon	**13.453**	**12.182**	**9.377**	**10.375**
	(2.521)* **	**(2.743)*** **	**(2.458)*** **	**(2.267)*** **
Observations	603	603	603	603
R-squared	0.5924	0.5965	0.5866	0.5872

1. Miam-Dade is set as the default county in the regression. The other eight county dummies from four risk territories as reported: 1) North Atlantic area: Clay and Volusia; 2) South Atlantic area: Broward and Monroe; 3) Gulf Coast area: Hendry and Sarasota; 4) Panhandle area: Franklin and Leon. Most of the remaining county dummies which are not reported are statistically significant.
2. The results of year dummies are not reported in this table.
3. * , ** and *** denote significance at 10%, 5% and 1% levels respectively.

Table 8.5
Estimated Coefficients on Homeowners Insurance Exposures
1998-2007

Independent Variables	Model D1	Model D2	Model D3	Model D4
	Dependent Variable = Log (Homeowner Insurance Exposures)			
Citizens Market Share in Exposures	**-0.014** **(0.005)*** **	**-0.014** **(0.006)***	**-0.014** **(0.004)*** **	**-0.019** **(0.005)*** **
CAT Fund Purchase in Percentage	**0.14 6** **(0.003)*** **	**0.146** **(0.003)*** **	**0.144** **(0.003)*** **	**0.136** **(0.003)*** **
Flood Insurance Coverage	**0.089** **(0.014)*** **			
Lag of Flood Insurance Coverage		**0.077** **(0.013)*** **		
Flood Insurance Coverage Normalized by Population			**0.075** **(0.013)*** **	
Lag of Flood Insurance Coverage Normalized by Population				**0.079** **(0.014)*** **
Homeowner Insurance Premiums over Exposures at County Level	-38.291 (8.077)	-35.955 (8.043)	**-34.284** **(7.972)*** **	**-32.616** **(7.872)*** **
Log of County Income	**0.731** **(0.022)*** **	**0.748** **(0.021)*** **	**0.806** **(0.014)*** **	**0.780** **(0.014)*** **
Size	**0.427** **(0.010)*** **	**0.427** **(0.010)*** **	**0.420** **(0.010)*** **	**0.395** **(0.010)*** **
Return on Equity	0.001 (0.001)	0.001 (0.001)	0.001 (0.001)	0.001 (0.002)
Leverage	**0.123** **(0.005)*** **	**0.123** **(0.005)*** **	**0.132** **(0.005)*** **	**0.130** **(0.005)*** **
Liquidity	-0.009 (0.029)	-0.010 (0.029)	-0.004 (0.031)	-0.037 (0.031)
Dummy for South Atlantic Area	**-0.028** **(0.064)*** **	**-0.276** **(0.064)*** **	**-0.267** **(0.065)*** **	**-0.253** **(0.067)*** **
Dummy for Gulf Coast	0.051 (0.042)	0.055 (0.042)	**0.073** **(0.044)***	**0.084** **(0.045)***
Dummy for Panhandle Area	0.011 (0.049)	0.012 (0.049)	0.043 (0.050)	0.042 (0.052)
Observations	17,101	17,054	17,101	17,054
R-squared	0.3671	0.3668	0.3659	0.3667

1. The results of year dummies are not reported in this table.

2. * , ** and *** denote significance at 10%, 5% and 1% levels respectively.

Table 8.6
Estimated Coefficients on Homeowners Insurance Direct Written Premiums
1998-2007

	Dependent Variable = Log (Homeowner Insurance Premiums)			
Independent Variables	**Model E1**	**Model E2**	**Model E3**	**Model E4**
Citizens Market Share in Premiums	0.004 (0.005)	0.006 (0.005)	**0.007 (0.004)***	0.006 (0.005)
CAT Fund Purchase in Percentage	**0.114 (0.015)*****	**0.133 (0.003)*****	**0.137 (0.003)*****	**0.131 (0.003)*****
Flood Insurance Premiums	**0.058 (0.014)*****			
Lag of Flood Insurance Premiums		**0.110 (0.015)*****		
Flood Insurance Premiums Normalized by Population			**0.003 (0.001)*****	
Lag of Flood Insurance Premiums Normalized by Population				**0.003 (0.001)*****
Homeowner Insurance Premiums over Exposures at County Level	-8.445 (7.448)	-7.157 (7.426)	**-18.718 (8.280)****	**-21.721 (8.462)*****
Log of County Income	**0.678 (0.022)*****	**0.684 (0.022)*****	**0.785 (0.013)*****	**0.780 (0.013)*****
Size	**0.312 (0.011)*****	**0.312 (0.011)*****	**0.325 (0.010)*****	**0.323 (0.011)*****
Return on Equity	**0.006 (0.001)*****	**0.006 (0.001)*****	**0.003 (0.001)****	0.001 (0.001)
Leverage	**0.097 (0.005)*****	**0.098 (0.005)*****	**0.125 (0.005)*****	**0.125 (0.005)*****
Liquidity	**-0.056 (0.030)***	**-0.057 (0.030)***	**-0.042 (0.031)***	**-0.059 (0.032)***
Dummy for South Atlantic Area	0.063 (0.071)	0.058 (0.071)	0.037 (0.064)	0.061 (0.067)
Dummy for Gulf Coast	**0.142 (0.046)*****	**0.143 (0.046)*****	**0.140 (0.044)*****	**0.150 (0.046)*****
Dummy for Panhandle Area	**0.111 (0.053)****	**0.112 (0.053)****	**0.136 (0.050)*****	**0.125 (0.053)****
Observations	14,327	14,286	14,327	14,286
R-squared	0.3364	0.3368	0.3421	0.3388

1. The results of year dummies are not reported in this table.
2. * , ** and *** denote significance at 10%, 5% and 1% levels respectively.

Table 8.7
Estimated Coefficients on Homeowners Insurance Policy Numbers in Force 1998-2007

Independent Variables	Dependent Variable=Log(Homeowner Insurance Policy Numbers)			
	Model F1	**Model F2**	**Model F3**	**Model F4**
Citiznes Market Share in Policy Number	-0.001 (0.005)	0.001 (0.005)	0.001 (0.004)	-0.001 (0.005)
CAT Fund Purchase in Percentage	**0.132** **(0.003)*****	**0.129** **(0.003)*****	**0.132** **(0.003)*****	**0.126** **(0.003)*****
Flood Insurance Policy Number	**0.061** **(0.013)*****			
Lag of Flood Insurance Policy Number		**0.056** **(0.016)*****		
Flood Insurance Policy Numbers/Population in Percentage			0.001 (0.001)	
Lag of Flood Insurance Policy Numbers/Population in Percentage				0.001 (0.001)
Homeowner Insurance Premiums over Exposures at Firm Level	0.003 (0.005)	0.003 (0.005)	0.003 (0.005)	0.024 (0.017)
Log of County Income	**0.683** **(0.020)*****	**0.715** **(0.010)*****	**0.756** **(0.012)*****	**0.749** **(0.012)*****
Size	**0.229** **(0.009)*****	**0.233** **(0.010)*****	**0.230** **(0.009)*****	**0.219** **(0.010)*****
Return on Equity	**0.005** **(0.001)*****	**0.009** **(0.001)*****	**0.005** **(0.001)*****	**0.005** **(0.001)*****
Leverage	**0.115** **(0.004)*****	**0.096** **(0.005)*****	**0.115** **(0.004)*****	**0.115** **(0.005)*****
Liquidity	**-0.058** **(0.029)****	**-0.083** **(0.027)***	**-0.057** **(0.029)****	**-0.086** **(0.029)****
Dummy for South Atlantic Area	**-0.427** **(0.055)*****	**-0.395** **(0.060)*****	**-0.395** **(0.056)*****	**-0.388** **(0.058)*****
Dummy for Gulf Coast	**0.076** **(0.020)***	**0.116** **(0.042)*****	**0.090** **(0.040)****	**0.090** **(0.042)****
Dummy for Panhandle Area	**0.111** **(0.046)****	0.090 (0.049)	**0.114** **(0.047)****	**0.101** **(0.049)****
Observations	16,028	15,985	16,020	14,524
R-squared	0.3305	0.3303	0.3301	0.3252

1. The results of year dummies are not reported in this table.

2. * , ** and *** denote significance at 10%, 5% and 1% levels respectively.

Table 8.8
Estimated Coefficients on Homeowners Insurance Exposures with County Dummies 1998-2007

Independent Variables	Dependent Variable=Log(Homeowner Insurance Exposures)	
	Model D5	**Model D6**
Citizens Market Share in Exposures	**-0.010** **(0.006)***	**-0.011** **(0.006)***
CAT Fund Purchase in Percentage	**0.147** **(0.003)*****	**0.146** **(0.003)*****
Flood Insurance Coverage	**0.339** **(0.162)*****	
Lag of Flood Insurance Coverage		-0.011 (0.043)
Homeowner Insurance Premiums over Exposures at County Level	8.493 (13.242)	12.977 (13.057)
Income	**0.992** **(0.403)*****	**1.261** **(0.380)*****
Size	**0.430** **(0.010)*****	**0.430** **(0.010)*****
Return on Equity	0.002 (0.001)	0.001 (0.001)
Leverage	**0.123** **(0.005)*****	**0.123** **(0.005)*****
Liquidity	-0.008 (0.029)	-0.009 (0.029)
Dummy for County Clay	**2.461** **(1.113)****	1.653 (1.080)
Dummy for County Volusia	**1.516** **(0.694)****	**1.191** **(0.691)***
Dummy for County Broward	0.263 (0.185)	**0.389** **(0.176)****
Dummy for County Monroe	0.359 (1.184)	0.352 (1.191)
Dummy for County Hendry	2.854 (1.758)	1.853 (1.736)
Dummy for County Sarasota	**2.942** **(1.005)*****	**2.571** **(1.007)****
Dummy for County Franklin	**3.700** **(2.159)***	**3.615** **(2.176)***
Dummy for County Leon	**2.508** **(1.005)*****	1.388 (0.904)
Observations	17,101	17,054
R-squared	0.3848	0.3847

1.Miam-Dade is set as the default county in the regression. The other eight county dummies from four risk territories as reported: 1) North Atlantic area: Clay and Volusia; 2) South Atlantic area: Broward and Monroe; 3) Gulf Coast area: Hendry and Sarasota; 4) Panhandle area: Franklin and Leon. Most of the remaining county dummies which are not reported are statistically significant.

2. The results of year dummies are not reported in this table.

3. * , ** and *** denote significance at 10%, 5% and 1% levels respectively.

Table 8.9
Estimated Coefficients on Homeowners Insurance Premiums with County Dummies 1998-2007

Independent Variables	Dependent Variable=Log(Homeowner Insurance Premiums) Model E5	Model E6
Citizens Market Share in Premiums	-0.002 (0.007)	-0.001 (0.006)
CAT Fund Purchase in Percentage	**0.135** **(0.003)*****	**0.135** **(0.003)*****
Flood Insurance Premiums	0.067 (0.172)	
Lag of Flood Insurance Premiums		0.043 (0.064)
Homeowner Insurance Premiums over Exposures at County Level	6.381 (15.461)	6.729 (15.427)
Income	**1.518** **(0.540)*****	**1.504** **(0.536)*****
Size	**0.313** **(0.011)*****	**0.314** **(0.011)*****
Return on Equity	**0.006** **(0.001)*****	**0.006** **(0.001)*****
Leverage	**0.098** **(0.005)*****	**0.098** **(0.005)*****
Liquidity	**-0.055** **(0.030)***	**-0.056** **(0.030)***
Dummy for County Clay	1.914 (1.595)	1.746 (1.523)
Dummy for County Volusia	1.135 (0.987)	1.042 (0.964)
Dummy for County Broward	0.075 (0.204)	0.049 (0.202)
Dummy for County Monroe	1.841 (1.646)	1.743 (1.652)
Dummy for County Hendry	3.000 (2.482)	2.783 (2.429)
Dummy for County Sarasota	**2.933** **(1.445)****	**2.808** **(1.422)****
Dummy for County Franklin	**5.027** **(3.049)***	4.838 (3.056)
Dummy for County Leon	1.601 (1.379)	1.443 (1.263)
Observations	14,327	14,286
R-squared	0.3519	0.3368

1.Miam-Dade is set as the default county in the regression. The other eight county dummies from four risk territories as reported: 1) North Atlantic area: Clay and Volusia; 2) South Atlantic area: Broward and Monroe; 3) Gulf Coast area: Hendry and Sarasota; 4) Panhandle area: Franklin and Leon. Most of the remaining county dummies which are not reported are statistically significant.

2. The results of year dummies are not reported in this table.

3. * , ** and *** denote significance at 10%, 5% and 1% levels respectively.

Table 8.10
Estimated Coefficients on Homeowners Insurance Policy Numbers in Force with County Dummies, 1998-2007

Independent Variables	Dependent Variable=Log(Homeowner Insurance Policy Number in Force) Model F5	Model F6
Citizens Market Share in Policy Numbers	-0.003 (0.007)	-0.003 (0.007)
CAT Fund Purchase in Percentage	**0.131** **(0.003)*** **	**0.131** **(0.003)*** **
Flood Insurance Policy Numbers	0.051 (0.081)	
Lag of Flood Insurance Policy Numbers		-0.015 (0.061)
Homeowner Insurance Premiums over Exposures at Firm Level	0.005 (0.005)	0.005 (0.005)
Income	**1.465** **(0.495)*** **	1.478 (0.491)
Size	**0.235** **(0.010)*** **	**0.236** **(0.010)*** **
Return on Equity	**0.009** **(0.001)*** **	**0.009** **(0.001)*** **
Leverage	**0.096** **(0.005)*** **	**0.096** **(0.005)*** **
Liquidity	**-0.079** **(0.027)*** **	**-0.081** **(0.027)*** **
Dummy for County Clay	**2.497** **(1.376)***	2.220 (1.394)
Dummy for County Volusia	**1.826** **(0.868)****	**1.711** **(0.878)****
Dummy for County Broward	**0.353** **(0.185)***	0.377 (0.184)**
Dummy for County Monroe	1.671 (1.500)	1.574 (1.510)
Dummy for County Hendry	3.320 (2.220)	2.987 (2.227)
Dummy for County Sarasota	**3.359** **(1.286)*** **	**3.206** **(1.300)****
Dummy for County Franklin	**5.421** **(2.785)***	**5.183** **(2.807)***
Dummy for County Leon	**2.143** **(1.143)***	1.851 (1.157)
Observations	14,053	14,012
R-squared	0.3645	0.3644

1.Miam-Dade is set as the default county in the regression. The other eight county dummies from four risk territories as reported: 1) North Atlantic area: Clay and Volusia; 2) South Atlantic area: Broward and Monroe; 3) Gulf Coast area: Hendry and Sarasota; 4) Panhandle area: Franklin and Leon. Most of the remaining county dummies which are not reported are statistically significant.

2. The results of year dummies are not reported in this table.

3. * , ** and *** denote significance at 10%, 5% and 1% levels respectively.

Table 8.11
Estimated Coefficients on Homeowners Insurance Exposures with County Dummies and Firm Dummies, 1998-2007

Independent Variables	Dependent Variable=Log(Homeowner Insurance Exposures) Model D7	Model D8
Citizens Market Share in Exposures	**-0.013** **(0.004)*****	**-0.014** **(0.004)*****
CAT Fund Purchase in Percentage	**0.348** **(0.106)*****	**0.026** **(0.005)*****
Flood Insurance Coverage	**0.026** **(0.005)*****	
Lag of Flood Insurance Coverage		-0.054 (0.032)
Homeowner Insurance Premiums over Exposures at County level	11.100 (9.382)	13.213 (9.358)
Income	**0.890** **(0.270)*****	**1.159** **(0.255)*****
Size	**0.075** **(0.023)*****	**0.075** **(0.023)*****
Return on Equity	**-0.007** **(0.001)*****	**-0.007** **(0.001)*****
Leverage	**0.110** **(0.009)*****	**0.123** **(0.005)*****
Liquidity	**-0.318** **(0.037)*****	**-0.319** **(0.037)*****
Dummy for County Clay	**1.054** **(0.417)****	0.674 (0.417)
Dummy for County Broward	0.255 (0.131)	**0.383** **(0.127)*****
Dummy for County Sarasota	**3.040** **(1.495)****	1.223 (1.479)
Dummy for County Leon	**1.829** **(0.723)****	**1.645** **(1.728)****
F1=Allstate General Insurance Company	-5.244 (30.320)	-1.686 (1.820)
F2=Lumbermens Mutual Casulty Company	-1.155 50.036	**3.436** **(1.058)****
F3=Merastar Insurance Company	-2.686 (26.042)	0.878 (1.065)
F4=Auto Club South Insurance Company	-1.207 (36.794)	**2.370** **(1.059)****
Observations	16,032	15,989
R-squared	0.6867	0.6868

1. Four representative insurers are reported in this table as Allstate General Insurance Company (big firm), Lumbermens Mutual Casulty Company (mid-size firm), Merastar Insurance Company (new entrant since 2000), and Auto Club South Insurance Compnay (new entrant since 2005).

2. Miam-Dade is set as the default county in the regression. The other four county dummies from four risk territories as reported: Clay in North Atlantic; Broward in South Atlantic; Sarasota in Gulf Coast; Leon in Panhandle area.

3. The results of year dummies are not reported in this table.

4. * , ** and *** denote significance at 10%, 5% and 1% levels respectively.