THE IMPACT OF THE SEPTEMBER 11, 2001 TERRORIST ATTACKS ON US INSURERS' USE OF DERIVATIVES

Viviana Lou

A Thesis
In
The John Molson School of Business

Presented in Partial Fulfillment of the Requirements
For the Degree of Master of Science in Administration (FINANCE) at
Concordia University
Montreal, Quebec, Canada

April 2006

Your file Votre référence
ISBN: 0-494-14374-6
Our file Notre référence
ISBN: 0-494-14374-6

ABSTRACT

The Impact of the September 11, 2001 Terrorist Attacks on US Insurers' Use of Derivatives

Viviana Lou

In this thesis, we examine the impact of the September 11, 2001 terrorist attacks on the risk management of insurance companies, and investigate whether these companies are more likely to use derivatives to hedge their market risk after the attack. We test whether insurer's market risk exposures are lower after 2001. We then study how the companies' market risk exposures and their use of derivatives are affected by different firm characteristics. We also survey privately owned insurers to determine the importance of derivatives in their risk management, and how they responded to the terrorist attacks.

By looking at insurers' quarterly and annual market risk exposures, it is found that there is no discernible difference between property/casualty and life/health insurers during the period studied, and that the fluctuations and trend of their risk exposures are very similar. Our examination of quarterly market risk exposures shows that except for equity risk exposure which is found to be increasing, we do not have strong evidence to show that insurers' market risk exposures are lower after 2001. Although the survey results show that some users of derivatives increase their use of these hedging tools, results from a regression analysis do not show strong support for the hypothesis that insurers are more likely to hedge with derivatives after the September 11, 2001 terrorist attacks. We conclude that the terrorist attacks have prompted changes in risk management and operation strategies of some insurers, but have not increased the likelihood that insurers will use derivatives in risk management.

Acknowledgements

I would like to thank my supervisor Dr. Latha Shanker for her patience and guidance throughout the whole process. I would also like to thank Dr. Seoungpil Ahn and Dr. Ian Rakita for their valuable remarks and suggestions.

I would like to thank all my friends for their help and encouragement. Finally, I would like to thank my family for their spiritual and financial support over the years that I spent in the MScA program.

Table of Contents

List of figures

List of Tables

The Impact of the September 11, 2001 Terrorist Attacks on US Insurers' Use of Derivatives

1. Introduction

Academic theory states that by reducing a company's exposure to different risks (such as risks caused by fluctuations of interest rates, exchange rates, commodity prices, etc.), risk management helps to increase the company's value. Noticing the benefits of risk management, firms are focusing more on controlling their risks than before. This can be proved by the tremendous increase in the use of derivatives to manage financial risk during the last two decades, and the introduction of many new hedging instruments (services) to the market. For this reason, risk management becomes now a more important issue in corporate finance than ever before and is an issue that every manager should be aware of. However, despite the gain documented, it is observed that some firms hedge while others do not. Given the nature of their business, being able to adjust their risk management is especially important for insurance companies. The purpose of this study is to determine the changes in the risk management behavior of insurance companies due to the occurrence of an extreme event, namely, the terrorist attacks on September 11, 2001 on the World Trade Centers in New York. Among the different hedging techniques, we especially test whether insurers became more likely to use derivatives after 2001[1].

The 9/11 terrorist attacks caused catastrophic losses of life and property that were

[1] Although government can also act as an insurer in society, in this thesis, we refer solely to non-governmental insurers. Public insurers are referred to as listed firms, whereas private insurers are referred to as insurers that are privately-held.

covered by insurance companies. The whole insurance industry was threatened by these unprecedented losses. It is known that the survival of insurance companies and the availability of insurance at reasonable rates are crucial for our economy. Insurance companies can only survive if they can manage their total risk properly, which is composed of underwriting risk and financial risk. Underwriting risk is managed by charging premiums or by purchasing reinsurance, whereas financial risk can be managed by using derivatives. We expect that the September 11, 2001 terrorist attacks have increased the underwriting risk of insurance companies. Since premiums cannot be increased without limits and reinsurance is also costly, insurance companies cannot limit underwriting risk beyond a point. Therefore, we expect that insurance companies would have responded by increasing their hedging of financial risk by using derivatives. If insurers do manage their financial risks more diligently after the terrorist attacks, we expect that the market risk exposures of insurers will be lower in 2002-2004 than in 1998-2000.

Previous studies that are done on insurers' use of derivatives [Hoyt (1989), Colquitt and Hoyt (1997), and Cummins, Philips and Smith (2001)] only examine the determinants of firms' hedging decisions, and they only consider a study period of one year. However, since an insurer's characteristics do change over time (either due to the economy, changes in operation strategies, etc.), it is reasonable to believe that its hedging policy will also change accordingly. Therefore one of the innovations in this study is to examine whether and how insurers' hedging policies change over time. Furthermore, only a few event studies on 9/11 have been done in the finance area, and none of them is related to hedging decisions (use of derivatives), thus, the consideration of the impact of

an extreme event on the insurance industry is new. We study the risk management of insurance companies because compared to other industries, good risk management is especially important to insurers in order to survive. On the other hand, proper risk management of insurers also benefits their customers; since it allows insurers to provide all types of insurance products without charging sky-rocketing premiums.

To conduct this study, the market risk exposures and the use of derivatives of 89 public U.S. insurers, (of which 62 are property-casualty insurers and 27 are life-health insurers) are observed during the period 1998-2004. Firm characteristics of these companies are also observed in order to determine how these characteristics affect an insurer's market risk exposures and its use of derivatives. Surveys are sent to 400 private U.S. insurers (of which 200 are property-casualty insurers and 200 are life-health insurers) to further understand the importance of derivatives in insurers' risk management strategies and the impact of the terrorist attacks on the insurance industry.

While studying the market exposures of insurers during 1998-2004, a discernible increasing trend of companies' equity risk exposures is found, whereas no trend is observed in insurers' exposures to foreign exchange risk, interest rate risk and credit risk. We find that companies' market risk exposures are not significantly lower during 2002-2004, when compared to those of 1998-2000. Therefore, regression results do not support the hypothesis that insurers hedge their financial risks more after 2001. Results obtained from regressions also show that, in general, whether an insurer uses derivatives or not has no effect on its market risk exposures. It is also observed that insurers do not become more likely to use derivatives after September, 11 2001. Responses from the survey show that the role of derivatives in insurers' risk management is less important

than expected. Furthermore, about half of the respondents state that their companies changed the risk management strategy since the terrorist attacks and that some users of derivatives have increased their use of derivatives. The study concludes that the September 11th, 2001 attacks affect insurers' risk management and their operations, however, the impact is not as large as expected, especially with respect to their use of derivatives.

The remainder of this thesis is organized as follows. Chapter 2 gives information on insurance companies and the important role they play in the economy. Chapter 3 describes risks that insurers encounter and their risk management. Chapter 4 provides details on the 9/11 terrorist attacks and their impact. Chapter 5 explains the purpose of the research and the reasoning behind our hypothesis. Chapter 6 summarizes relevant studies that have been done on this issue. Chapter 7 explains the contribution of the study and how we will test our hypothesis. Chapter 8 describes the sample and the measurements of insurers' market risk exposures using stock prices. Chapter 9 describes market risk exposures of insurers computed from stock prices. Chapter 10 describes firm characteristics that may affect an insurer's market risk exposures. Results and discussion of the tests are also given in this chapter. Chapter 11 first describes firm characteristics that may affect an insurer's use of derivatives, and then provides results and discussion of the tests. Chapter 12 describes the questionnaire sent to private insurers, summarizes the responses and discusses the results. Finally, conclusions are provided in Chapter 13.

2. Insurance companies and their role in our economy

In general, the main roles of insurers are to pool risks from customers and to bear these risks that are transferred to them. The main functions of an insurer can be summarized as follows: marketing and underwriting, billing and collecting premiums, investing and managing assets, investigating and settling claims made under policies, and paying expenses associated with these functions (AICPA 2003). Insurers act as financial intermediates, they not only protect the insured from possible financial loss, but, some life and health insurers also provide savings and investment services. An insurance company's ownership can take one of two basic forms: stock insurance companies or mutual insurance companies. Stock insurance companies are publicly held and disclosure of financial information is required. As mutual insurance companies are held by their policyholders, public disclosure of financial information is not mandatory. The insurance industry is a highly regulated industry; in the U.S., insurers' operations and financial situation are closely monitored by the state. In order to assure that insurers are able to pay all the claims, many measures are taken by the government. For example, insurers are obliged to maintain their reserves, their surplus and risk-based capital at a certain level; their settling of premiums rates are monitored; they have to use specific valuation method of assets that is imposed on them, etc.

Concerning their underwriting activities, the important lines of insurance provided by property-casualty (later referred as P/C) insurers are: fire and allied lines which provide protection against damage caused by fire, windstorm, etc.; an inland marine line which protects property that is transported by sea; a workers' compensation line which compensates employees for injuries or illness related to their work; an automobile line

which covers injury of insured, damage of the automobile and liability to others for losses caused by the insured; a multiple peril line provides a package of property and liability coverage; professional liability provides coverage to professionals on liability caused by error and malpractice related to the services they provide; fidelity bonds protect employers against any losses due to misconduct of employees; surety bonds compensate the third party for losses arising from the insured's failure to fulfill its responsibility that is bound by contracts. These lines can be broadly classified as personal lines and commercial lines.

Life-health (later referred to as L/H) insurers provide life insurance contracts which pay benefits upon the insured's death with fixed terms or variable terms. Universal life policy and variable life policies are products which allow the policyholder to earn higher rates of return than traditional policies. L/H insurers also provide accident and health insurance contracts which cover medical expenses of the insured during the coverage period. Other contracts include annuity contracts where benefits are distributed to the contract holder during a determined or undetermined period. The contracts mentioned can either be sold on an individual or group basis. Non-insurance contracts are also provided, such as investments contracts which are comparable to other financial products offered by other financial institutions. Group plan administrative services, investment advisory services, and other back-office services are other non-insurance services that can be received from L/H insurers.

The importance of insurance in our economy is evident. Given the wide varieties of insurance and investment products offered by insurers, every individual and corporation is touched by their services in some way. In some cases, the purchase of

insurance is even mandated by government. For example, all auto owners are required to buy auto liability insurance. In other cases, for activities where more than one party is involved, one of the parties might require the counterparty to buy insurance such that its benefits are protected. For example, creditors might require investments of borrowers to be covered by insurance. On the other hand, insurance plays a very important role in the development of the economy. The presence of insurance allows individuals and corporations to transfer all or part of their risk to the insurers, which allows them to take riskier investments which might not be taken otherwise. Without the coverage of insurance, many important activities and events (such as the Olympics) would be halted. By reducing financial insecurity, the insured's need for having a reserve for possible future losses is reduced, thus increasing capital. Since insurers can manage risks more efficiently and more effectively than individuals do, risk-pooling allows insurers to improve the overall efficiency of the economy. As social insurance provided by the government only satisfies our basic needs for insurance, private insurance does not only help to improve social stability, it also alleviates the burden of the government by reducing the needs for social insurance. Finally, insurers' role as financial institutions also enhances channeling of capital, thus reducing transaction costs and increasing the liquidity of the economy.

3. Risks that insurers encounter and their risk management

Two of the main types of risks encountered by insurers are underwriting risks and financial risks. Underwriting risks arise from insurers' underwriting activities, such as losses caused by occurrence of adverse events. Financial risks arise from fluctuations of interest rates, equity returns, exchange rates, credit spreads, etc. which may cause a mismatch between assets and liabilities, discrepancies between the expected and the actual cash flows, etc.

3.1. Underwriting risks

Due to their risk-bearing functions, risk management plays a much more important role in the insurance industry than in any other industry. In order to stay in business, it is crucial for insurers to effectively control the risks embedded in their insurance policies portfolio. Insurers face losses that can be categorized as predictable, less predictable or catastrophic. Predictable losses are usually retained, whereas catastrophic losses are usually reinsured, therefore, less-predictable losses are left for insurers to manage [Trieschmann, Gustavson, and Hoyt (2001)]. Since these less-predictable losses could be substantial, they play a very important role in insures' underwriting risks.

Except for losses caused by undesirable incidents such as accidents or storms, insurers are exposed to many other risks through their underwriting activities. For example, insurers are exposed to credit risk when they purchase reinsurance, since there is a risk that the reinsurer will not have the financial capacity or willingness to make the payments. In the case that a significant amount of recovery cannot be collected, there

could be an adverse effect on insurers' financial condition. Insurers can also be exposed to concentration risk when they have a large proportion of premiums reinsured by the same reinsurer, or they have a high concentration of the insurance portfolio in any particular industry, geographic area, product line, etc. Insurers pay very close attention to concentration risk, because high exposure to this risk is usually the cause of catastrophic losses. Being highly regulated, risk also arises from changes in regulation; the passing of any new act or new law can force insurers to change its operations. Insurers also have litigation exposures, which can produce sizeable losses. Moreover, the pricing of insurance greatly relies on knowledge and past experience, underwriting of any new product and occurrence of any new event can always increase underwriting risks of insurers. Increase in uncertainties makes the pricing process more difficult, thus causing mispricing more easily. Since pricing involves estimating the present value of possible future losses, wrong estimation of discount rates will also cause mispricing. If an insurer overestimates its risk-bearing capacity, it could underwrite risks for amounts higher than its capacity (AICPA), thus resulting in deficit.

Purchase of reinsurance is a very common risk management technique used by insurance companies to manage their underwriting risks. Since an insurance company will sometimes write insurance which has risk higher than its willingness and its capacity to bear, it will spread the risk by having another company, the reinsurer, underwrite part of the risk. Although reinsurance provides a very effective way to hedge, this technique is relatively more expensive than others. One of the ways to transfer its risks to the insured is to increase premiums. However, as insurance pricing is regulated by the state, insurers can only increase premiums to a limited extent. Given that high risk individuals

and corporations are more likely to buy insurance, to solve the adverse selection problem, insurers use a selective underwriting strategy by rejecting high risk customers. Insurers also create financial products that help to transfer their risks. Insurance securitization is one of those techniques that is gaining more and more attention. In order to minimize credit risk, insurers select reinsurers with a high credit rating and monitor closely the financial conditions of their reinsurers. To control their concentration risk, continuous monitoring is used. For example, companies set upper limits on the proportion of premiums collected from each geographical area, each product line, each industry, each group of related industries, etc. Insurers also purchase reinsurance from more than 1 reinsurer. For example, insurers usually cede their premiums to at least 5 different reinsurers. Derivatives (e.g. weather derivatives, catastrophe bonds) can also be used to manage underwriting risks, but they are not as commonly used as reinsurance for this purpose.

3.2. Financial risks

The largest part of insurance companies' assets consists of investment available for sale, while the largest part of their liabilities consists of reserves of unpaid claims. Therefore, insurers' exposure to financial risks is highly correlated with the composition of their investment portfolio. Their investment portfolio generally consists of government bonds, municipal bonds, foreign government bonds, (domestic and foreign) corporate bonds, real estate, mortgage loans and equity. Note that insurers also invest in derivatives from time to time. However, they only invest in small amounts, since their trading in derivatives is closely monitored by regulators. In many states, speculative

investment in derivatives is either prohibited or limited [Cummins, Philips and Smith (1997)].

Since insurers invest heavily in debt securities, they are exposed to interest rate risk. Liabilities such as unpaid losses and loss expense usually have long duration, especially for L/H insurers, and are therefore very sensitive to changes in interest rates. An adverse change in interest rates would cause devaluation of insurers' debt investments portfolio. Furthermore, it could have other serious consequences because it may cause contract holders to withdraw funds (for L/H insurers), and may prompt debt issuers to make their payments in advance. On the other hand, companies with foreign investments are exposed to currency risks. However, insurers can also be exposed to currency risks without having any foreign investments. In some cases, the insured might require that benefits be paid in a foreign currency when a loss occurs (this has to be specified in the insurance contract). Insurers are exposed to credit risk due to their large debt investments portfolio. Since equity securities are also included in their investment portfolio, insurance companies are exposed to equity price risks. Note that the use of derivatives does not only help to manage risks, it can also expose the company to substantial credit risk as well. Although insurers have very limited debt, it also exposes companies to interest rate risk.

Insurers mostly manage their financial risks through close monitoring and a combination of asset class, country, industry, and security level diversification. To manage interest rate risk, insurers monitor the duration of assets and liabilities, and adjust these when there is a significant mismatch. For managing foreign exchange risk, they will match the amount of foreign currency denominated assets with liabilities. Insurance

companies also monitor the financial condition of debt issuers to assure their creditworthiness to reduce credit risk. They also limit the percentage of investments invested in each asset class, county, etc. to avoid high concentration of investments in one specific category. This will reduce the company's exposure to a certain type of risk associated with that specific investment. To reduce their credit risk exposures, insurers mostly invest in investment grade bonds. For most insurers, about 70%-100% of the debt investment portfolio consists of government bonds and municipal bonds. Investment in equity securities is generally limited, thus equity risk is generally low. Thus, most of the insurers will just retain equity risk, and if they choose to manage it, derivatives are usually used. All the market risks mentioned can be managed by using financial derivatives; these include interest rate swaps, index options, default swaps, foreign currency futures, etc. However, not all the insurers choose to use derivatives to manage their market risks.

4. The September 11, 2001 terrorist attacks and their impact

4.1. 9/11

In the morning of September 11 of 2001, four commercial jets departed from Boston, Newark and Washington, with 266 people on board in total, and were hijacked by 19 terrorists after takeoff (TIME 2001). In less than 2 hours, two of the hijacked planes crashed into the World Trade Center in New York City, one crashed into the Pentagon and the other crashed in Pennsylvania. Soon after the crashes, the North and South towers at the World Trade Center, and one side of the Pentagon collapsed. This attack shocked the whole country, not only because those attacked buildings were some of the most important symbols of the U.S., but the scale of the losses and casualties were astonishing. It is estimated that about 3000 lives were taken by these horrible attacks, with most dying instantly after the crashes and collapses (TIME 2001). Outside the U.S., many countries also expressed their anger and concern, not only because foreigners were also among those killed, but also because of the ruthlessness of the attacks[2] . The costs attributed to this event are unimaginable and cannot be calculated; to date, even the exact total economic costs (due to loss of life, loss of property, disruption of activities, expense on cleanup, etc.) associated are still uncertain. Since the attack, The United States government has raised the alert level to the highest level for a long period. The government also tightened security in the country, especially at the borders and airports. It is believed that the impact of the 9/11 attacks on security, politics, culture, religion and international relation of America are not only great, but will also be long lasting.

[2] www.answers.com

"Nothing will ever be the same", the headline of a special edition on this issue (Philadelphia City Paper), depicted perfectly the huge impact of this tragic event on U.S. and on other countries as well. For many people, September 11 had "changed everything" and is now viewed as a date or cut-point, which separates two very different worlds [Dudziak (2003)]. The idea that they are "no longer as safe as they thought" becomes pervasive among Americans. Many historians even compare the effects to those of the Cold War, and the Second World War not only in terms of culture, but also psychology. The idea that another attack might take place at any time and in an unexpected way increases the level of uncertainty among Americans.

4.2. Impact on People's Risk Aversion

Given that one's risk aversion is influenced by his/her experience, his control and the worst case scenario (Disenchanted Dictionary), it is expected that occurrence of an extreme event will change one's risk tolerance. Although there is no academic study that documents how the 9/11 attacks altered people's risk perception, this can be observed in daily life. Furedi (2002) states that "there seems to be a tendency to embrace the idea of society under threat", in his report released in the Association of Insurance and Risk Managers Conference. He shows how this is reflected through the increase in travel security measure, building security, mail delivery and security, protection of records and data and activity dispersal by companies. It is also observed that some people become unwilling to take airplanes, while others moved out of New York and other big cities. According to a survey, a number of people even felt reluctant to work in tall buildings

(TIME 2002). Although some of these behaviors may be considered as irrational, they show how people tend to be more (or even overly) risk averse than before 9/11.

4.3. Impact on the economy and the financial market

The damage that resulted from the attack interrupted the running of many activities. For example, although no stock exchange was physically hit by the attack, they were affected by the damage of communication equipments near the World Trade Center area. The most important stock exchanges in the U.S. (the American Stock Exchange, the Nasdaq and the New York Stock Exchange) were all closed for a few days, and it was one of the longest closures in the history. From this example, we can already imagine how the economy and financial market were also seriously hit. In the week following the reopening of exchanges, the Dow Jones Industrial Average experienced its largest drop ever in one week: the index fell 1369.7 points (14.3%) during that week[3]. Moreover, declines in short-term interest rates, 10-year bond yields and the dollar were also observed. The airline industry was severely affected, because like the stock exchanges, the air space of North America was also closed for a few days due to the attacks. Even after reopening, the number of people traveling by air dropped dramatically. The number of business travels and tourists reduced significantly as well. The airline industry faced a huge loss of USD7.7 billion (even after deducting an after-tax compensation of USD4 billion from the federal government)[4], and to date, the industry still has not totally recovered. The estimated total economic losses that New York City endured due to 9/11 are about USD83 billion. Other economic impacts were cancellation of numerous events,

[3] www.answers.com

[4] http://www.house.gov/transportation/aviation/09-24-02/09-24-02memo.html

interruption of business, a drop in commercial rents and occupancy rates in the New York City area, etc. Given the importance of the U.S. in the international market, the global economy was also hit by this attack. While notable drop in stocks indices (such as the S&P 500 and NASDAQ) were observed, a drop was also found in many foreign stocks indices (such as TOPIX, Euro STOXX, FTSE 100, etc.) shortly after the attack[5].

4.4. Impact on insurers

Shortly after the attack, insurance companies did not experience a very sharp drop in their stock prices as did airliners. This means that the immediate effect of 9/11 on the insurance industry was not as strong as that on the airline industry. However, the total losses that insurers (particularly P/C insurers and reinsurers) suffered are much higher. Note that, of the USD83 billion economic loss faced by New York City due to this event, more than half the loss was covered by insurers. Since some claims are not settled yet, the total loss is still unclear. However, the most recent estimated loss for the global insurance industry is about USD44 billion (the estimated loss provided earlier by different sources ranged from USD30 to USD70 billion) [Wolstein (2004)]. Regardless of the exact amount, it is certainly higher than the loss caused by Hurricane Andrew, the costliest natural disaster in US history, which was about USD24.5 billion. Note that in 2001, the US P/C insurance industry had an after-tax loss of USD7.9 billion, its first-ever annual loss in history [Richardson (2002)].

Some measures have been taken by New York State to alleviate the situation and to prepare for future terrorism claims. However, if a similar attack happens again, it is unclear whether insurers will be able to absorb another loss of this magnitude. Although

[5] http://www.imf.org/external/pubs/ft/weo/2001/03/

9/11 did not affect directly the claims costs of insurers in foreign countries, it prompted an increase in reinsurance costs and tougher reinsurance terms. It also prompted insurers around the world to review their underwriting activities and pricing methods, and to consider excluding coverage of losses stemming from terrorist attacks.

The exact total loss of insurers resulting from this event is still uncertain because most of the claims are very complex. Unlike many other catastrophic events, claims related to 9/11 involve many more different issues. For example, damage done to the foundation of buildings around WTC, damage caused by the spread of fire after the crash, dispute of the 2 events issue (whether crashes of the two towers are two separate events or one event)[6], dispute on the act of war issue (whether all damages resulted from war)[7], damage done to the health of people cleaning the site, lawsuits filed by insurers of WTC against airlines, etc. Since many legal disputes concerning the insurance coverage and claims are still proceeding, any undesirable verdict could further raise the total loss of the insurance industry in U.S.

Although 9/11 did shock the whole insurance industry, different types of insurers are touched by this event to a different extent. For example, L/H insurers are less affected by this devastating event because death benefits are limited and clearly defined. Among the total insured losses, life insurers will pay approximately 9% and non-life insurers will pay about 91%. (Wolstein). However, despite the difference in the magnitude of their loss, we should not ignore the impact of 9/11 on L/H insurers. While P/C insurers are used to dealing with catastrophic losses, 9/11 is the first catastrophic loss

[6] It is debatable whether the collapses of the North Tower and the South Tower should be considered as two separate events or one event. Since it is defined in the contract that the insured will only be paid at most a certain amount for losses caused by each event, the insured will be able to get higher compensation if they are considered as 2 events.

[7] War exclusion statement is included in all P/C contracts.

that L/H insurers ever encountered. Financial losses arising from loss of life are substantial, but the largest losses mostly arise from accident and health claims, since medical treatment can be lengthy and very costly. Other than victims who were directly injured during the attack, masses of toxic debris resulting from the collapses also caused serious damage to many people's health. Health claims caused by the huge amount of toxic debris associated with the collapse of buildings could be substantial, since many residents, rescue-recovery workers, office workers, etc. could be affected. By 2004, about half of the rescue-recovery workers and volunteers claimed that they had problems related to respiratory systems or psychological problems[8]. Since not all the adverse affects on health caused by 9/11 emerge immediately, claims are becoming more complicated and losses could be much higher than expected (with the growth of medical costs).

4.5. Response of the government

When an attack of such gravity takes place, it is very important that the government intervenes immediately in order to stabilize society and to prevent any economic crisis. To ease the situation, the U.S. government set up the Sept. 11th Victim Compensation Fund[9], passed the Air Transportation Safety and System Stabilization Act[10], etc. It also took some measures to prevent collapse of the insurance industry, but to assure availability of terrorism insurance at the same time.

Given the huge loss faced by insurers and their reluctance to provide terrorism coverage in the future, the U.S. government was forced to react swiftly. Shortly after the

[8] www.answers.com
[9] This alleviated the financial loss of victims or their families.
[10] This compensated the airline industry for losses incurred due to the attack.

attack, insurers sought help from the government. They requested for either permission of terrorism exclusion or financial backup from government if another attack ever took place. Absence of terrorism insurance would have a serious effect on the US economy, since many important activities would be cancelled. Therefore, the federal government took a big step by passing the Terrorism Risk Insurance Act of 2002, which became effective in November 2002[11]. According to this Act, all insurers are mandated to provide terrorism insurance on most commercial lines. It states that during the effective period, the government will provide backup of at most USD100 billion for the insurance industry for any loss in connection with terrorist attacks which exceeds USD5 million. On the other hand, insurers will have to pay a deductible which is equal to a certain percentage (which varies over time[12]) of its direct earned premiums in the previous year[13]. The passing of this Act implied that the government will no longer only be a regulator, but will also be the largest reinsurer of the country. Note that the presence of this act is very important, because right after 9/11, many insurers wanted to exclude terrorism from their coverage. After 9/11 and before the Terrorism Risk Insurance Act was passed, many projects had been halted due to the fact that corporations could not get any terrorism insurance. For example, some nonresidential construction projects had been put on hold, such as the proposed $400 million Hyatt Corp office building, which was to create 2500 jobs (Contingencies 2002). Although this Act does not free insurers from exposure to terrorist risk, it lessens their short-term financial burdens to some extent.

---

[11] The Act was originally effective from November 26, 2002 to December 31, 2005, but in December 2005, it was announced that the Act would be extended until December 31, 2007.
[12] 7% in 2003, 10% in 2004, 15% in 2005, 17.5% in 2006 and 20% in 2007.
[13] Information taken from annual report of year 2004 of Zenith National Insurance Corp, which is available at http://www.sec.gov/

5. Purpose of the study and reasoning of our hypothesis

The loss caused by this attack made insurers realize that they had ignored some risk factors, and that they should reorganize their risk management. Furthermore, on increase in risk aversion of insurers will also prompt them to manage their risks more diligently. Measures that can be taken to manage the increase in their underwriting risk are: 1) increasing premiums, 2) not providing any insurance against terrorism, 3) buying reinsurance and 4) hedging other risks to reduce their total risk exposure. Since the loss associated with 9/11 was provoked by a completely unexpected tragedy for which no premium had been collected [Hartwig (2002)], insurers can choose to shift the risk to policyholders by increasing premiums. However, insurers need an accurate and precise assessment (of likelihood and severity) to set up "appropriate" premiums that offset the risk borne, this may not be achieved as easily as one might think. In addition, terrorism risk is more unpredictable than other catastrophes [Hogarth (2003)], not only because a terrorist attack is a man-made event (which means it is not random), but US insurers do not have enough experience and information to price it. Therefore, it will be difficult for insurers to know by how much they should increase premiums. On the other hand, due to the intense competition in this industry and the passing of TRIA, insurers have to continue to offer such insurance without charging high premiums. The existence of reinsurance will not help insurers to reduce substantially the possible loss: as reinsurers also experienced huge losses due to this event, reinsurers either increased the premiums (some by 500%) or do not provide insurance for loss due to terrorism attacks. Note that, because they are less regulated, reinsurers can remove terrorism coverage without approval from state insurance departments, whereas primary insurers cannot

(Contingencies 2002). This means that insurers may not be able to get reinsurance, and even if they can, it could be so costly that they may be forced to retain the risk instead. Therefore, insurers are left with the last resort: hedging against risks. Note that the two main risks faced by the insurance companies are underwriting risk and financial risk. Given that insurers will not be able to fully eliminate the increase in their underwriting risks, we believe that insurers will try to further reduce their exposure to financial risk. This forced insurers to review their risk management strategy and we expect that they will search for new alternative risk transfer techniques.

Although derivatives have been used by insurers for hedging, the proportion of insurers active in derivatives trading is relatively low (according to the study of Cummins, Phillips and Smith (1997), in 1994, the proportion is about 6.9% for P/C insurers and 10.9% for H/L insurers). However, we expect that the increasing importance of derivatives in corporate risk management, and the quick developments of derivatives products will encourage higher participation of insurers in the derivatives market. Besides, derivatives instruments are risk management tools that provide quite an effective hedge with low price. Therefore, we expect that insurers would be more likely to use derivatives after 2001 in order to reduce their market risk exposure. Since the effect of 9/11 is stronger on P/C insurers than on L/H insurers, we expect that the changes in the use of derivatives to be more significant for P/C insurers.

6. Literature review

6.1. Studies on firms' risk exposures

Many studies have been done on firms' exposure to different risks. Among them, the relation between changes in stock prices and changes in value of an index (currency index, stock index, etc.) is commonly used as a proxy for the firm's exposure to a certain risk.

Among the studies done on firms' risk exposure, many are related to the effect of exchange rate risk exposure on firms' stock return. For example, Jorion (1990) and Bartov and Bodnar (1994) study multinational firms' exposure to foreign currency risk by using the sensitivity of changes in stock prices to changes in value of the U.S. dollar, and they find that exchange rates have little effect on stock returns of multinational firms. Dominguez and Tesar (2001) find in their study that there is no systematic relation between foreign currency exposure and firm size, industry, multinational status, foreign sales, international assets or industry-level trade and country. They also find that the exposure of a firm does vary with time. On the other hand, Choi and Prasad (1995) find that a firm's value is influenced by its exposure to foreign exchange risk. Firm characteristics such as foreign operating profits, foreign sales, etc. do affect its sensitivity to changes in foreign exchange rate.

Flannery and James (1984) study the correlation between stock returns and changes in interest rate. They find that firms' exposure to interest rates is related to the maturity composition of the firms' asset holdings (duration gap). In their study on exchange rate risk and interest rate risk exposures of commercial banks, Choi and Elyasiani (1996) find that the exchange rate risk betas are more significant than interest

rate risk betas. They observe the variations in both betas across time and across companies. Firm characteristics such as mortgage recourse exposure and foreign assets have significant positive relations with interest rate exposure and with exchange rate exposure respectively.

Instead of studying the effect of financial risk exposure, Tufano (1998) studies the exposure of the gold mining industry to gold prices. He also finds that exposures change considerably over time and differ across firms. His results show that gold firms' exposures to gold price are negatively related to gold prices and gold return volatility, and positively related to firm leverage.

6.2. Rationale for risk management

Given the many studies showing how firms are exposed to different risks and how these risks affect firms' value, the idea of risk management becomes more and more important. Some people argue that hedging does help to increase firms' value, while others disagree. Among the proponents, they argue that hedging helps to increase firm value by reducing expected taxes, the expected costs of financial distress, and agency cost. Many studies have been done to examine the rationale behind firms' hedging activities.

If hedging helps to stabilize earnings, firms should be able to gain tax benefits through hedging. Given that the firm's effective tax schedule is convex, reducing the volatility of earnings through risk management can reduce corporate taxes. The more convex is the tax schedule (i.e. the more volatile is the firm's pre-tax income stream), the

greater are the tax benefits [Mayers and Smith (1982) and Smith and Stulz (1985)], thus, the more likely it is that a firm will hedge.

Financial distress caused by having heavy debt can lead to bankruptcy and induce high costs (both direct and indirect), therefore, firms will try to minimize their probability of encountering it [Mayers and Smith (1982), and Smith and Stulz(1985)]. By reducing the variance of firms' value, hedging can help firms to reduce their exposure to financial distress; thus firms with high leverage ratio are expected to exhibit a greater tendency to hedge.

Finally, agency costs are mainly attributed to conflicts between interest of bondholders and shareholders. Documented by Mayers and Smith (1987), in situations where a firm is exposed to some hedgeable risks and has risky debt outstanding, once the casualty loss occurs, the value of the firm's assets will be reduced, thus increasing its leverage position. In this case, by realizing that the gains from any positive NPV project will accrue to bondholders, shareholders will decide to forego the project (causing underinvestment). However, being aware of this possibility, bondholders will require compensation by charging higher interest rates, unless the firms assure that this will not happen [Mayers and Smith (1987)]. In order to solve this problem, firms can reduce the probability that such a loss will occur through hedging (so that firms will get enough capital, and in the same time will have incentive to take all valuable projects). Therefore, hedging will be especially beneficial to firms with more growth opportunities, since they can then undertake all profitable projects.

Tax benefits, alleviation of financial distress and reduction of agency costs are some of the firms' hedging incentives. It is believed that economies of scale also play an

important role in firms' hedging decisions. Note that risk management is not costless, and it involves high fixed cost and transaction costs [Mian (1996)]. As a firm increases its hedging activities, the marginal cost of hedging will become lower. This means that hedging is relatively cheaper for large firms than for small firms. Moreover, effective hedging strategy requires experts with special knowledge, support of new technology and availability of information, which can be less accessible for small firms. Since large firms can benefit from economies of scale and informational economies, they should be more likely to hedge than small firms would.

6.3. General studies on the use of derivatives

The use of derivatives to manage risk did not gain much attention before the late 1980s, thus little literatures are found on determinants of firms' hedging decision before that time. Nance, Smith and Smithson (1993) are the first to study this issue in depth. In their paper, they study how tax, potential costs of financial distress, informational and transactional scale economies, agency cost and presence of substitutes for hedging affect a firm's decision on hedging. Focusing only on the use of off-balance-sheet hedging instruments, they study relationships between the use of derivatives and different firm characteristics (firms' tax effective function, leverage, size, growth of investment opportunities and other alternative of hedging). They find that there is a positive correlation between use of hedging and firm's convexity of tax schedule, size, and opportunity for growth, but negative correlation with leverage (which is in contrast with their hypothesis) and use of other substitutes.

Based on the paper mentioned previously, Mian extends the study on the determinants of corporate hedging decisions by using a larger sample. Rather than only considering hedgers and non-hedgers (like Nance, Smith and Smithson), he also considers interest-rate hedgers and currency-price hedgers separately. His results show that size and convexity of a firm's tax function have positive relation with hedging, though the evidence for supporting the tax hypothesis is weak. In contrast with previous findings, he finds that investment opportunity is negatively related to the probability of hedging (which is mainly driven by interest-rate hedgers). Although there is no differences in leverage between hedgers and non-hedgers, hedgers tend to have higher long term debt, lower liquidity and higher dividend yield. It is also found that regulated utilities are less likely to hedge; since bondholders can monitor managerial actions more easily (thus reducing contracting costs). In general, his results show support for the hypothesis that hedging exhibits economies of scale, but there is little (no) support for the tax hypothesis (financial distress costs hypothesis). On the other hand, by proposing new measures of the tax incentive to hedge and hedging activity, Shanker (2000) finds evidence that firms' tax incentive to hedge is an important determinant of its hedging activity.

While previous studies only concentrate on the characteristics that influence companies to have different hedging decisions, they do not address the issue of how those determinants are different across industries. Therefore, in the later period, more studies concerning different industries' risk management decisions are found. Unlike previous studies where only the probability of hedging is considered, the extent of the participation is also considered. Tufano (1996) studies the risk management practices of the North

American gold mining industry, to see whether firm's behavior in managing risk is consistent with what conventional theories (concerning financial distress risk, tax and dependence of external financing) predict. His findings do not support those hypotheses strongly. Moreover, he also tests how managerial characteristics (degree of ownerships) affect the decision. A similar study has been done by Haushalter (2000) on 100 oil and gas producers. He also finds that economies of scale induce higher probability of hedging, but inconsistent with previous findings, his results show that financial distress costs have a big impact on firms' degree of participation in hedging activities: firms with higher leverage and lower financial flexibility hedge more. In addition, he also takes into account firms' ability to hedge effectively (which has not been studied before), and finds that it has a positive relation with hedging.

Instead of studying the determinants of hedging decisions, there are also studies done on the actual benefits of using derivatives to hedge. In the study of Geczy, Minton and Schrand (1997) results show that larger firms and firms with higher foreign currency exposures are both more likely to hedge with currency derivatives. They also find that firms use of currency derivatives to reduce fluctuation of cash flows, which might have adverse effects on the firms' growth opportunity. It is also found that users of currency derivatives have lower book-to-market ratios than non-hedgers, which implies that hedgers are valued higher by investors. Choi and Elyasiani (1996) show that the use of derivative contracts reduces the banks' exposure to exchange rate risk and interest rate risk. The influence of derivatives is particularly important in the case of exchange rate betas. Schrand (1997) finds that off-balance-sheet derivatives activities of savings and loan associations are positively associated with lower stock price interest rate sensitivity.

Tufano (1998) finds that gold firm exposures are negatively related to the firm's hedging and diversification activities, which imply that hedging helps to reduce firms' exposure to gold prices. However, in their study, Hentschel and Kothari (2001) find that compared to firms that do not use financial derivatives, users do not have significantly lower risk exposure. Furthermore, results of a study done by Bali, Hume and Martell (2004) also show that hedging with derivatives do not reduce significantly firms' exposures to market risks (currency, interest rate and commodity value). Allayannis, Brown and Klapper (2001) examine the exchange rate hedging practices of firms that hedge foreign debt exposure in eight East Asian (EA) countries between 1996 and 1998. They find no significant difference between the stock performance of hedgers and nonhedgers during the financial crisis. Since the results obtained from different studies are mixed, it is still uncertain whether firms can really benefit from using financial derivatives.

6.4. Literature review on insurers' use of derivatives

Since the use of derivatives by insurers is only observed in recent years (insurers hedge most of their use through purchasing reinsurance [Cummins, Phillips and Smith (1997), later referred to as CPS], limited studies are found on this issue. Almost all of the studies examine factors that determine an insurer's decision on its use of derivatives. Focusing only on financial futures, Hoyt (1989) provides one of the earliest studies on the extent to which these derivatives are used by life insurers. From the results of a survey, he finds a positive relationship between size and usage of futures, which supports the economies of scale notion. However, he suggests that this may be partly due to the differences in the types of products offered by insurers of different size. The perception

of users and non-users is also examined. Generally, users find that benefits associated with usage of futures are higher than the cost, and non-users find that their lack of expertise in this area is their main reason for not using futures. This further supports the hypothesis regarding informational economies.

In a later study, Colquitt and Hoyt (1997) examine whether the use of futures and options by life insurers is affected by their contracting costs, taxes and investment policy. They examine both the firms' likelihood of hedging based on their characteristics and their extent of hedging. Results show that life insurers that are larger, have higher leverage, have higher levels of asset-liability mismatch, are publicly held (stock insurance companies), have higher ratios of separate account assets, are more likely to use derivatives for hedging, and their extent of participation is also higher.

As mentioned before, only in the later period do we find studies that are done on not only life insurers, but P/C insurers also. CPS (1997) examine the determinants of hedging decisions in L/H and P/C insurance companies separately. Focusing only on results for P/C insurers, they find that size is an important factor determining the use of derivatives, which again suggests economies of scale. Positive significant correlation is also found between involvement in derivatives and holdings of stock and real estate, percentage of reserves held as auto physical damage reserves. Consistent with Colquitt and Hoyt's finding, stock companies tend to be more involved in hedging, which is consistent with the managerial discretion hypothesis: managers who have a larger proportion of their wealth invested in the company will try to reduce the firm's risk through hedging.

In their later study, CPS (2001) extend their study by considering both the likelihood and the volume of insurance companies' participation in risk management activities, using the same sample. Concerning the likelihood of hedging, their results in this study are consistent with their previous findings. Based on the findings of Colquitt and Hoyt, they further investigate factors that determine the volume of hedging by insurers. They find that some variables that are found to be positively related to the likelihood of hedging are negatively related to the extent of participation, or vice versa: such as the percent of the asset portfolio in real estate, whether they have foreign assets, etc. They argue that these results are consistent with their marginal costs hypothesis: firms with higher risk tolerance (which makes them exposed to higher risk) are more likely to hedge, but due to their higher risk tolerance and the marginal costs imposed, their extent of participation is lower.

6.5. Literature review on the impact of 9/11

To date, many studies have been done on the impact of September 11, 2001. However, most of them study changes in legislation, the relation of the U.S. with other countries, counter-terrorism activities, national security etc. Little has been done on its impact on investor behavior or on the financial market.

Among the few studies done, an empirical study concerning the impact of 9/11 attacks on investor's risk aversion is done by Wrolstad and Krueger (2003). By observing changes in the betas, returns and slope of the market security line of 33 exchange-traded funds before and after 9/11, they find that investor's risk aversion increases dramatically after the event. Graham and Harvey (2001) also mention that they

observe an increase in market risk perceived by CFOs of U.S. corporations after September 11, 2001 crisis.

Regarding the impact of the attacks on the market, it is observed that after 9/11, there is a sharp increase in global equity market price volatility and transactions volumes. Furthermore, most of the major markets experience significant declines in price, which is caused by investors' negative anticipation towards profitability of firms [Choudhry (2003)]. Concerning changes in the financial sector and the economy, some studies have been done on these issues, but these are very limited. Focusing mainly on changes in the general business condition, Choudhry examines the time-varying betas of 20 U.S individual firms, and finds that only some firms' betas are affected (significant decrease) due to the change in market volatility. Examining the changes in correlation of global financial markets, Hon and Strauss (2003) find that international markets, especially the European market, become more correlated to the U.S market after 9/11. Finally, Burch, Emery and Fuerst (2003) find that after this event, closed-end mutual fund marker prices are discounted more from fund net asset values than before, which shows that the discount does reflect the sentiment of investors. Another study done by Glaser and Weber (2005) studies how 9/11 affects investors' expectations of the market. They found that return forecasts of investors are significantly higher after September 11, 2001, suggesting a belief in mean reversion. In their study, they also find that volatility forecasts are higher after the attack.

Limited studies are done on how 9/11 affects insurance companies. Among the studies, most of them focus on the availability of terrorism insurance, the passing of

TRIA, the importance of the government's intervention (in response to this attack), etc. No empirical study is done on the impact of 9/11 on insurers' risk management practices.

7. Contributions of the study and the general methodology

This study is important because so far, no one has questioned whether insurers will adjust their hedging strategy in response to a certain event, and if they do, how they would do so. Given the huge losses associated with 9/11, it will be particularly important to examine how insurers react to such an extreme event which might reoccur any time. The results of this study will allow us to understand the risk management of insurers much better. We will know whether insurers will try to reduce their financial risk when their underwriting risk increases (or whether they will just manage the increase in underwriting risk through reinsurance, despite the higher cost). We will know whether insurers respond to the September 11, 2001 attacks through adjusting their risk management. Results of this study will also give us a better insight of insurers' use of derivatives and whether they play an important role in insurers' risk management.

We first use stock prices to calculate insurers' quarterly and annual exposures to market risks (which include foreign exchange risk, interest rate risk, equity risk and credit risk) during the period 1998-2004. We then compare the exposures in different periods to observe the variation during the period studied. We regress the market risk exposures on firm characteristics to determine their relationship, and we also test whether market risk exposures are lower in 2002-2004. Based on previous studies, we also determine the important factors (firm characteristics, such as size, leverage, liquidity, use of reinsurance and investment opportunities) that affect an insurer's use of derivatives. By controlling these factors, we observe the impact of September 11, 2001 on insurers' use of derivatives. We survey private insurers to understand the actual impact of the 9/11

attacks on these insurers. Throughout the study, P/C insurers and L/H insurers are studied separately due to the difference in their products.

8. Data and measurement of risk exposures

We obtain our data of insurers' daily stock prices between January 1998 and December 2004 from the CRSP database. We only include fire, marine, and casualty insurers (SIC[14] 6331), surety insurers (SIC 6351), title insurers (SIC 6361), life insurers (SIC 6311), and accident and health insurers (SIC 6324)[15]. Other data such as daily value of S&P 500 index, 3-month U.S. Treasury Bills rate, value of a weighted-average foreign exchange index, returns of 5-years Treasury bonds and returns of Dow Jones corporate bonds index[16], are collected from different sources[17]. Data of firm characteristics are collected manually from annual reports (form 10-K) available on the website of the SEC[18]. The sample includes firms that have daily stock prices available from January 1998 to December 2004 (or at least 75 percent of the daily returns during the studied period) and annual reports (with complete data of certain firm characteristics) available from 1998 to 2004. Finally, 62 P/C insurers and 27 L/H insurers are included in the sample.

Insert Figure 1.1-1.3 about here

Figures 1.1 to 1.3 provide graphs showing average/median of daily returns by quarter of insurers during the January 1998-December 2004 period. From the first two

[14] Standard Industrial Classification.
[15] Property and casualty, surety and title insurers are grouped as P/C insurers in the study, whereas life and accident and health insurers are grouped together as L/H insurers.
[16] The Dow Jones Corporate Bond Index is an equal weighted bond index with 96 corporate bonds (from the industrial sector, utilities/telecom sector and financial sector).
[17] The value of the S&P 500 is extracted from CRSP; the 3-month U.S. T-Bills rate, the value of 5-year Treasury bonds and the value of a weighted-average foreign exchange index are collected from the Federal Reserves website (http://www.federalreserve.gov/); the value of the Dow Jones corporate bond index is collected from the Dow Jones Index website (http://averages.dowjones.com/mdsidx/).
[18] http://www.sec.gov

graphs, we can observe a sharp drop in insurers' average/median of daily return in the quarter of Jul- 2001. However, a sharp increase is also observed in the following quarter, which means that investors later adjust their expectations and they are generally optimistic about the future performance of insurers. Although insurers encounter huge losses due to the 9/11 attacks, this event is expected to lead to higher demand for insurance in the future. Average/median of daily returns (by quarter) on the S&P 500 index are also provided for comparison.

Firms' risk exposures are expressed as the sensitivity of firms' stock returns to changes in value of different indexes and changes in rates. The sensitivities of firms' returns to different macroeconomic factors (foreign exchange rate, interest rate, equity price, credit spread) are measured using the following multifactor model:

$$R_{it} = \alpha_i + \beta_{ie} R_{et} + \beta_{ir} R_{rt} + \beta_{im} R_{mt} + \beta_{is} (R_{ct} - R_{bt}) + e_{it} \qquad (1)$$

where R_{it} is the adjusted daily stock return of insurer i from time t-1 to t, R_{et} is the daily exchange rate of currencies of a large group of major U.S. trading partners against the U.S. dollar, R_{rt} is the daily 3-month U.S. Treasury bills interest rate, R_{mt} is the daily return on the S&P 500 index, R_{ct} is the daily return on an equally weighted portfolio of corporate bonds and R_{bt} is the daily return on a 5-year U.S. Treasury bond. The estimated β_{ie} obtained is the sensitivity of insurer i's stock return to changes in exchange rates, β_{ir} measures the sensitivity of the returns on stock i to changes in the risk-free interest rate, β_{im} measures the sensitivity of the return on stock i to returns on a portfolio of equity securities (S&P 500) and β_{is} measures the sensitivity of the returns on stock i to changes in the credit spread.

Tufano (1998) notes that if exposures are not stationary, it will be more appropriate to use daily data than to use weekly or monthly data to measure firms' exposures. He states that, however, measures might be biased if stocks are not traded frequently. Although most of the insurers' stocks are traded daily, thin trading problems do exist for some of the stocks, when no trade is executed for days. To correct for this, Dimson adjustments [suggested by Dimson (1979) and later corrected by Fowler and Rorke (1983)] of one lag and one lead term are used in this study as it is in Tufano's (1998) paper. To adjust for the thin trading problem, betas are first calculated as follows;

$$R_{it} = \alpha_i + \sum_{k=-1}^{k=1} \beta_{ie,k} R_{e,t+k} + \sum_{k=-1}^{k=1} \beta_{ir,k} R_{r,t+k} + \sum_{k=-1}^{k=1} \beta_{im,k} R_{m,t+k} + \sum_{k=-1}^{k=1} \beta_{is,k} (R_{c,t+k} - R_{b,t+k}) + e_{it} \quad (2)$$

In contrast with equation (1), in equation (2), one lag and one lead exposure are also calculated at the same time. For each exposure, betas are then adjusted in the following way;

$$\beta'_{i,t} = \beta_{i,t} + \frac{1+\rho_1+\rho_2}{1+2\rho_1}(\beta_{i,t-1} + \beta_{i,t+1}) \quad (3)$$

$\beta_{i,t}$, $\beta_{i,t-1}$ and $\beta_{i,t+1}$ are betas obtained from equation (2). ρ_1 and ρ_2 are the autocorrelation, with lag 1 and lag 2, of the respective returns or rates (R_{et}, R_{rt}, R_{mt} and R_{ct}).

Since multicollinearity will induce a bias in the estimation of betas obtained, it is important to see whether high correlations are found among changes in exchange rates, interest rates, returns on the S&P 500 and the credit spread.

Insert Table 1 about here

Panel A and B of Table 1 provide information on the correlation between the independent variables in each quarter and in each year. The correlations only provide us with some preliminary insight on the presence of multicollinearity. For a more formal test, the variance inflation factor (VIF)[19] in each quarter and in each year is also calculated for each independent variable. From the correlation matrix, we observe high correlations between changes in interest rates and credit spreads in some periods. However, from Panel C and D, we find that the VIF of these two variables are not very high (<10) most of the time, except in the quarter of Jul-2004 in which the VIF of interest rates and credit spreads are higher than 20. Therefore, multicollinearity is not expected to a have substantial impact on estimated betas.

[19] VIF is used to measure how collinearity among independent variables in a regression model affects the accuracy of estimation. It indicates whether the variances of the estimated regression coefficients are inflated as compared to when the X variables are not linearly related. A value that exceeds 10 is usually considered as an indication that the least squares estimates are possibly affected by multicollinearity [Neter, Kutner, Nachtshem, Wasserman (1996)]

9. Market risk exposures

The mean and median of unadjusted and adjusted betas are shown in the following Table 2. This table gives us a preliminary view of how different betas differ in different periods.

Insert Table 2 about here

From the table, we can see that exchange rate exposures of P/C and L/H are quite different. For both groups of insurers, we observe that firms' exposures to exchange rate risk, interest rate risk and equity price risk are higher in 2002-2004 than in 1998-2000, while credit spread betas are higher in 1998-2000. This is true for unadjusted and adjusted betas. If we focus on betas in 2001, we observe that the interest rate betas and credit risk betas are relatively much lower than in other periods. Note that unadjusted and adjusted betas can be quite different too, in some cases the sign of the betas are even different.

Insert Figures 2.1.1-2.4.2 about here

Insert Figures 3.1.1-3.4.2 about here

Figures 2.1.1.-2.4.2. and Figures 3.1.1.-3.4.2. show the mean and median of market risks exposures during January 1998-December 2004 of P/C and L/H insurers respectively. From the graphs of P/C and L/H insurers' exposures, we observe that

market exposures fluctuate across time. We also observe that exposures are also different across companies. This is consistent with findings of previous studies: market risk exposures vary over time and within industry. Market risk exposures are more firm-specific rather than industry-specific. With the exception of the equity price exposure, which demonstrates an increasing trend (for both groups of insurers), no discernible trend or cycle is observed in the other exposures. When comparing unadjusted and adjusted betas, in general, their time series exhibit similar patterns. From the graphs and tables, it is very difficult to conclude whether betas are different in the two periods. Therefore, further investigation is necessary.

We observe that betas are more stable in some periods and fluctuate more in others. In general, whatever we observe in time series of P/C insurers' exposures, we also observe in exposures of L/H insurers. It seems that P/C and L/H are exposed to market risk in a very similar way. When looking at insurers' market risk exposures in the quarter of Jul-2001 (the quarter in which the 9/11 attacks took place), we do not observe any substantial changes: exposures in that quarter are not very different from exposures in other quarters. This is also true for the following quarter (Oct-2001), which means that the terrorist attacks do not have any immediate effect on insurers' market risk exposures. In order to verify whether what we observe is unique to the insurance industry, quarterly market risk exposures of US banks are also calculated for comparison purposes[20]. However, we only provide time series of unadjusted betas.

Insert Figures 4.1-4.4 about here

20 Daily returns of 242 (during Jan 1998-Dec 2004) listed U.S. banks are obtained from the CRSP database. The same (unadjusted) market risk exposures are calculated using the same methodology.

Similar to what we found for insurers, we observe that betas of banks fluctuate in time, and they are different for different banks. The increasing trend of equity price exposures that we detect previously in insurers is also found in banks, which means that it is not solely observed among insurers.

10. Determinants of insurer's market risk exposures

10.1. Methodology

To come to any conclusion on how insurers' risk exposures are affected by 9/11, more tests have to be done, and we should control for other factors that might also affect an insurer's market risk exposures. In the previous chapter, in order to observe clearly how market exposures change during the period studied, quarterly market exposures are calculated. This is because, compared to annual betas, high frequency betas allow us to observe better whether there is any pattern and whether there is any immediate change due to 9/11. However, since quarterly reports (Form 10-Q) do not contain as much information as annual reports do, annual exposures are used when testing how different firm characteristics affect an insurer's market risk exposures. The mean and the median of annual market risk exposures are summarized in the following table:

Insert Table 3 about here

Note that the same sample and data is used to conduct the test, and exposures are also computed as in the previous section. To conduct the test, different firms' market risk exposures are regressed on the respective annual firm characteristics, where a dummy variable is added to the regression to test whether exposures are higher after 2001. The regression equation is defined as follows:

$$EXP_{it} = \alpha + \beta_1 FC1_{it} + \beta_2 FC2_{it} + ... + \beta_N FCN_{it} + \beta_{9/11} DUM9/11_{it} + e_t \qquad (4)$$

where EXP_{it} is the risk exposures, which is the annual beta calculated previously, of insurer i at time t (to exchange rate risk, interest rate risk, equity risk or credit risk); β_1...

β_N are sensitivities of exposure to different firm characteristics; FC1...FCN are different firm characteristics that will be defined later.

10.2. Independent variables

Since different market risk exposures are affected by different firm characteristics, a separate regression is run for each risk exposure. However, they may also be affected by some similar variables too. Therefore, we include some general variables (that are included in all regressions) and some exposure-specific variables (which are only included in the specific regression) in each regression. General variables include SIZE, REINSURANCE and DUM9/11, which are defined as follows:

SIZE: Total assets are used to measure the effect of size on insurers' risk exposures. Larger firms usually have more types of operations (larger varieties in products they sell), have business with more companies and have investments in more different categories. It is expected that these varieties will increase the company's probability of exposure to different market risks. Therefore, we expect that this variable will have a positive relation with market risk exposures.

REINSURANCE: The amount of written premiums that is ceded to reinsurers divided by total assets (to adjust for the effect of size) is used to measure the effect of reinsurance. By buying reinsurance, insurers can reduce their underwriting risks. This will allow them to bear higher financial risks. However, insurers with more premiums ceded might also be those who are exposed to higher underwriting risk or have higher risk aversion, and they might also want to hedge their financial risk contemporaneously. Therefore, the expected sign of this variable is ambiguous.

DUM9/11: This is a dummy variable that equals 1 if the exposure is for any year after 2001, and equals 0 otherwise. This variable measures whether insurers' market risk exposures are higher after 2001. As insurers realize the increase in the underwriting risk that they are exposed to which cannot be eliminated, we expect that they will try to mange their financial risks more diligently using derivatives. Assuming that they are able to hedge effectively by using derivatives, their market risk exposures should be lower after 2001. We expect this dummy variable to be negatively related to the risk exposures.

Exposure-specific variables that we include in the exchange rate exposure regressions are HEDGE_EX, FOREIGN_PRE and FOREIGN_BONDS. They are defined as follows:

HEDGE_EX: This is a dummy variable which equals 1 if the company uses derivatives to hedge exchange rate risk, and equals 0 otherwise. Assuming that the user of derivatives can hedge effectively, their risk exposures should be lower than non-users'. We expect this variable to be negatively related to risk exposures.

FOREIGN_PRE: The amount of net premiums that is written outside the U.S. divided by total assets. By writing insurance outside the U.S., insurers will be exposed to exchange rate risk since the premiums they receive and the benefits they pay might be denominated in a foreign currency. Their exposure should be larger when larger amounts of premiums are written in foreign countries. This variable is expected to have a positive relation with exposures.

FOREIGN_BONDS: The amount of investments invested in foreign bonds divided by total assets. An increase in the amount of foreign assets that an insurer possesses

should increase its exchange rate exposure. It is because even if transactions take place infrequently, the company is still exposed to translation risk: fluctuations in currency rates will still affect the value of foreign assets. We expect to observe a positive relation between this variable and exposures.

Exposure-specific variables included in the interest rate risk exposure regressions are HEDGE_INT, FIXED_INV and CHANGE_FIXED, which are defined as follows:

HEDGE_INT: This is a dummy variable which equals 1 if the company uses derivatives to hedge interest rate risk, and equals 0 otherwise. Assuming that users of derivatives can hedge effectively, their risk exposures should be lower than non-users'. We expect this variable to be negatively related to risk exposures.

FIXED_INV: The percentage of total investments invested in fixed income securities. As insurers mainly invest in fixed income securities (with different durations), any change in interest rates may have substantial effects on the value of their investment portfolio. Risk exposures of the company should increase as a larger proportion of investments is invested in fixed income securities, thus we expect to observe a positive relation between these variables.

CHANGE_FIXED: The total amount of fixed income securities purchased minus the amount that is sold during that period, divided by total assets. If interest rate risk is greatly affected by the amount of investments in fixed income securities, any changes in that amount should cause immediate changes in risk exposures too. The increase in the net change in fixed income securities should trigger increases in risk exposures; therefore, this variable is expected to have a positive relation with risk exposure.

Exposure-specific variables that we include in the equity risk exposure regressions are HEDGE_EQ, EQ_INV and CHANGE_EQ, which are defined as follows:

HEDGE_EQ: This is a dummy variable which equals 1 if the company uses derivatives to hedge equity price risk, and equals 0 otherwise. Assuming that users of derivatives can hedge effectively, their risk exposures should be lower than non-users'. We expect this variable to be negatively related to risk exposures.

EQ_INV: The total amount of investments in equity securities divided by total assets. Insurers are exposed to equity price risk in many ways, such as having business with firms from different industries. Consumers' need for insurance also depends on market conditions, etc. However, it will be difficult to collect data to measure the effect of these types of firm characteristics. Although insurers do not invest heavily in equity securities (usually investing from 5% to 20% of total investments), the amount of equity securities possessed by an insurer should also affect its equity price exposure to a certain extent. We expect that the increase in investments of these equity securities should increase the company's risk exposure. Thus a positive relation is expected.

CHANGE_EQ: The total amount of equity securities purchased minus the total amount sold during that period, divided by total assets. If the amount invested in equity securities is an important determinant of insurer's equity risk exposure, changes in that amount should cause immediate changes in risk exposures too. Increase in the net change of equity securities should trigger an increase in risk exposures. This variable is expected to be positively related with equity risk exposure of the company.

Exposure-specific variables that we include in the credit risk exposure regressions are HEDGE_CR, FIXED_INV and FIXED_GRADE, and they are defined as follows:

HEDGE_CR: This is a dummy variable which equals 1 if the company uses derivatives to hedge credit risk, and equals 0 otherwise. Assuming that users of derivatives can hedge effectively, their risk exposures should be lower than non-users'. We expect this variable to be negatively related to risk exposures.

FIXED_INV: Percentage of total investments invested in fixed income securities. Given the importance of bonds in the investment portfolio of insurers, insurers are definitely exposed to credit risk. Although insurers are very careful when selecting their fixed income investments (they check for ratings of issuers), they are still exposed to credit risk to some extent. It is believed that an increase in the proportion of investments in fixed income securities will increase credit risk exposure of the insurer.

FIXED_GRADE: This is the percentage of fixed income investments that are non-investment grade bonds. Issuers of non-investments grade bonds have lower credit quality and are more likely to default than other issuers (of investment grade bonds). This implies that an increase in the proportion of investments in this category will raise insurers' credit risk exposures. Therefore, a positive relation between this variable and risk exposures is expected.

The definition and the expected sign of all the independent variables are summarized in the following table:

Insert Table 4 about here

In order to better understand firms that are included in our sample, the following table provides the mean and median of the firm characteristics that are included in the regression:

Insert Table 5 about here

From the table, we observe that the average size of P/C and L/H insurers is more or less the same, but the medians show that the proportion of small firms is larger among P/C insurers. Given that the ratio of total liabilities to total assets is higher for L/H insurers, this implies that they have higher leverage. In general, P/C insurers seem to be larger users of reinsurance. Although their percentage of premiums written outside the U.S. is more or less the same, L/H insurers have more investments in foreign bonds. Both groups of insurers have about 80% of their investments invested in fixed income securities, but L/H insurers invest more in non-investment grade bonds than P/C insurers. Regarding net changes in their fixed income securities, P/C insurers have increased their investment in fixed income securities during the period studied. The statistics show that P/C insurers invest more in equity securities, and when looking at the net change in equity securities, P/C insurers also have a higher increase than L/H insurers (which implies the lower importance of equity securities to L/H insurers).

In order to verify whether multicollinearity of independent variables will affect our results, the correlation between X variables (firm characteristics) of each regression is computed and is shown in the following tables.

Insert Table 6 about here

Insert Table 7 about here

Except for a few variables, in general, we do not find very high correlations between independent variables. For both groups of insurers, the percentage of net premiums written outside the U.S. has a high correlation with size-adjusted amount of investments in foreign bonds. For L/H insurers, the correlation between these two variables is even higher (0.75) than that for P/C insurers (0.52). Furthermore, in the L/H insurers case, the size-adjusted amount of investments in foreign bonds is also found to be highly correlated (0.79) with total assets. If we only look at firm characteristics of P/C insurers, we observe a correlation of about 0.5 between total assets and insurers' decision to hedge equity risk with derivatives. Other than this, we do not find high correlations among other variables. However, higher correlations between variables are found among firm characteristics of L/H insurers. For example, size (total assets) is highly correlated with firms' decision to hedge interest rate risk and credit risk using derivatives, it is also correlated with the percentage of total investments in fixed income securities. Overall, although we find high correlations among some variables, but since the other correlations are quite low, we do not expect multicollinearity to have substantial adverse effects on our results.

10.3. Results

In Table 8 and Table 9, for each type of risk exposure (exchange rate risk, interest

rate risk, equity risk and credit risk), four sets of results are given. The first two columns provide results of regressions using unadjusted betas as dependent variables (betas calculated that are not adjusted for the effect of thin trading), whereas the other two columns provide results of regressions using adjusted betas as dependent variables. For each type of beta (adjusted and non-adjusted), two sets of results are given. In column 1 and 3, data of 2001 is included in the regressions; we study relationships between exposures and firm characteristics using observations of 1998-2004. In column 2 and 4, the data for 2001 is excluded from the test; so that we only use observations from 1998-2000 and 2002-2004. Since the 9/11 attacks took place in 2001, in this event study, 2001 is considered as the "event-year". Due to the terrorist attacks, risk exposures of 2001 that we calculate using stock prices might be "abnormal" or biased, and thus will affect our results. Therefore, in order to see whether the inclusion of 2001 will influence the test results, two sets of results are presented for comparison. We will refer to regressions in columns 1, 2, 3 and 4 in Table 8 and 9 as regression 1, 2, 3 and 4 respectively.

10.3.1. Results: P/C insurers

Results obtained from the regression of risk on exposures-firm characteristics for the two groups of insurers will be presented separately, and we will discuss the results in a later section. Given that different firm characteristics are used for different risk exposures, we will summarize the results of these exposures individually. All the regression results of P/C insurers are given in Table 8.

Insert Table 8 about here

From Panel A, which shows results of regressing exchange rate exposures on firm characteristics, the results of all the four different regressions are very similar: among all the independent variables, only the beta of the DUM9/11 variable is significant at the 1 or 5 percent levels. However, in contrast with what we hypothesize, this beta is positive, which implies that insurers' exchange rate exposures are actually higher during 2002-2004. We observe that the adjusted R square is very low (close to 0) in most cases, which means that a very low proportion of the variance in exposures can be predicted from the firm characteristics included in the regressions.

Panel B shows results of regressing interest rate exposures on firm characteristics. In regression 2 (in column 2) in which unadjusted betas are used, none of the variables is significant. In the other three regressions (columns 1, 3 and 4), only one variable (size-adjusted amount of premiums ceded) is negatively significant at 10 percent level. This means that insurers with larger amount of premiums ceded have smaller interest rate risk exposures. The adjusted R square of the four regressions are all negative, which indicates that the mean risk exposure is in fact a better predictor (of the real exposure) than the firm characteristics that we selected.

The results of regressing equity exposures on firm characteristics are found in Panel C. The results of the four regressions are very similar. Among the independent variables, the hedging dummy variable (whether the company uses derivatives to hedge equity risk), size-adjusted amount of premiums ceded and the 9/11 dummy variable (whether the risk exposure is for years after 2001) are significant at 5 or 1 percent levels in all the regressions. On the other hand, the beta of the size-adjusted amount of equity securities possessed by the company is only significant at the 10 percent level in one of

the regressions (column 4). The positive significant beta of the hedging dummy variable and of the 9/11 dummy variable suggests that insurers who use derivatives to hedge have higher risk exposures and that insurers actually have higher exposures after 2001. These two observations are contrary to what was expected. Moreover, the significant negative relation between risk exposure and size-adjusted amount of equity securities possessed by the company is also different from our expectation. When comparing the adjusted R square obtained, we observe that the value is higher when we use unadjusted betas (about 0.2, compared to about 0.13). In general, the adjusted R square is relatively high compared to that of the previous regressions.

Panel D shows the last set of results of P/C insurers. Results from the regressions of credit exposures on firm characteristics show that almost all of the independent variables are not significant. The only exception is the beta of percentage of investments invested in fixed income securities, where the beta is positively significant in the first 2 regressions (using unadjusted betas). Once again, values of adjusted R square are all negative in this case, which implies a poorly fitted model.

10.3.2. Results: L/H insurers

Results of regressing exposures on firm characteristics for L/H insurers are reported in Table 9.

Insert Table 9 about here

Results of regressing exchange rate exposures on firm characteristics presented in

Panel A show that when using unadjusted betas as dependent variables, none of the betas of firm characteristics in the regression are significant. Whereas when adjusted betas are used, only the 9/11 dummy variable has a significant positive beta. As we observed for P/C insurers, values of all the adjusted R squares are very low.

Panel B summarizes results obtained from regressions that test the determinants of firms' interest rate risk exposures. Regressions which exclude 2001 give a better fit of the model, but even so, only one of the independent variables has a significant relationship with risk exposure. In two of those regressions (columns 2 and 4), the beta of the 9/11 dummy variable is significantly negative. Whereas in regression 3, the only variable that is significant is the 9/11 dummy variable, but it is positive in this regression. Note that no variable is significant in regression 1.

From Panel C, we observe that insurers' decision to use derivative to hedge equity risk, their size-adjusted amount of equity securities, their total assets and the 9/11 dummy variable have a significant (at 1 percent level) relation with insurers' equity risk exposures. However, in contrast to our hypothesis, the results show that users of derivatives have higher exposures than non-users, and insurers' risk exposure is higher after 2002-2004. The size-adjusted net change in equity securities and size-adjusted amount of premiums ceded are two other variables that have significant betas in some of the regressions. In regressions 1 to 4, we find that the values of adjusted R square are quite high.

In Panel D, we observe that in each regression, only one of the variables has a significant relationship with insurers' credit risk exposure. In three of the four regressions, the beta of 9/11 dummy variable is found to be significant and negative (in

regression 1, 2 and 4). The beta of total assets is only significant in regression 3. In all the regressions, adjusted R square is very low and is close to 0.

10.4. Discussion of results

Overall, although values of adjusted R square are quite low in most of the cases, the models of L/H insures generally have better fits than those in the P/C insurers' case. Results show that whether we include data of 2001 in our regressions has little effect. In most of the cases, exclusion of 2001 in the test slightly improves the adjusted R square of regressions. However, the improvement is very small. This implies that exposures in 2001 are not as abnormal as expected. On the other hand, the use of adjusted betas do not always improve adjusted R square (in some cases, adjusted R square is even lower), even improvement in R square is observed, it is usually very small. This means that thin trading is not a serious problem in this study. Since similar results are obtained from the four regressions, we will discuss all the results together.

Given that for the two groups of insurers, the same firm characteristics are used to test the same hypothesizes, we will discuss the results of P/C and L/H insurers together. The different types of variables will be discussed separately. However, we will also group some of the exposure-specific variables (that are served to test similar hypothesizes) together and discuss their results at the same time. For example, we will discuss results of all of the hedging dummy variables together to explain how the use of derivatives influences an insurer's market risk exposure. We discuss net change in fixed income securities and net change in equity securities together. We also discuss amount of foreign bonds, amount of equity securities, percentage of investments in fixed income

securities, percentage of fixed income securities below investment grade contemporaneously to see how the composition of insurers' investment portfolio affects their risk exposure.

From the tables of results, we observe that the hedging dummy variables (HEDGE_EX, HEDGE_INT, HEDGE_EQ and HEDGE_CR, which are used to test whether users of derivatives have lower risk exposures) are only significant in the equity risk exposure-firm characteristics regressions. This implies that the use of derivatives do not have any effect on most of the insurers' market risk exposures. This might be due to the low volume of insurers' use of derivatives. Given that insurers are still not big users of derivatives, the difference in risk exposure between user and non-user could be much smaller than what we expected. Among P/C insurers, users of financial derivatives have lower equity risk exposures than non-users; this provides support for the hypothesis that insurers can reduce their risk exposures using derivatives. On the other hand, L/H insurers who use derivatives actually have higher equity exposures; we suspect that it might be related to firms' ability to hedge effectively. It is well known that if derivatives are not used properly, it will expose company to higher risk. However, since we cannot obtain information on insurers' hedging effectiveness (by using derivatives), we are not able to arrive at any clear conclusion. Another explanation for our results is that even if hedging with derivatives does reduce exposures, it might not be reflected completely in stock prices. Stock prices reflect the perception of investors, but investors might not have enough information to assess the effect of derivatives on a firm's risk exposure. Even if information is available, not all of the investors will be able to make accurate assessments from it, as it is very difficult to know whether the company is hedging effectively with

derivatives.

The results show that the size variable (SIZE) is not significant in most of the cases, except in the four regressions of equity risk exposures on firm characteristics and in one of the regressions of credit risk exposure on firm characteristics for L/H insurers (where results show support for our hypothesis that size has a positive relationship with risk exposure). This means that the role played by size in determining risk exposure of insurers is less important than we expected. It could be that firms adjust their extent of hedging according to their size. The results of previous studies show that size is an important determinant of hedging, and larger firms are more likely to hedge and to hedge more. Even if larger firms do have higher risk exposures, their greater effort in hedging should reduce their higher risk exposure associated with their size.

Two variables concerning annual net changes in investment are included in the regressions, which are the size-adjusted net change in fixed income securities (CHANGE_FIXED) and in equity securities (CHANGE_EQ). The results show that these two variables are not significant in most of the cases. This implies that the net changes in investments (in one year) will not affect firms' risk exposure. This might be due to the fact that the net changes are small. We suspect that unless the net change is extremely large, it might not increase the risk exposure and its effect might not be captured by stock price as well. Furthermore, even if the changes in investments influence risk exposure, the effect might not show up immediately, since the market may need time to absorb the effect of those changes. The net change in equity securities is only significant in two of the regressions for L/H insurers, and the sign is consistent with our expectation.

The size-adjusted amount of foreign bonds (FOREIGN_BONDS), amount of equity securities (EQ_INV), percentage of investments in fixed income securities (FIXED_INV), percentage of fixed income securities below investment grade (FIXED_GRADE) are the variables that we use to check the effect of insurers' investments on their risk exposures. The results show that in general, the effects of these variables on risk exposure are very low; in most of the cases, these variables are not significant. The percentage of total investments in fixed income securities is found to have a significant and positive relationship with credit risk exposure in two of the regressions of P/C insurers. The amount of equity securities is significant in one of the regressions for P/C insurers and in all the regressions for L/H insurers. Nonetheless, in contrast with what we expected, the sign is negative. The possible explanation is that while increasing its holding in equity securities, an insurer will also increase its effort in hedging equity risk to control their exposure to this risk.

The size-adjusted amount of premiums ceded (REINSURANCE) is only significant in some regressions, and this variable remains insignificant most of the time. This means that reinsurance has an insignificant effect on insurers' risk exposures. For P/C insurers, reinsurance is found to have a negative and significant relationship with companies' interest rate risk and equity risk exposure. We expect that companies who manage their underwriting risk to a higher extent (using reinsurance) are also those who are more risk averse. This could reflect the possibility that these companies are also more likely to manage their financial risk, thus they also have lower market risk exposures. However, for L/H, this variable is shown to have a positive and significant relationship with equity risk exposure in one of the regressions. This might imply that by managing

one type of risk, L/H insurers will allow their exposure to other type of risks to be higher. Since the variable is only significant in one regression, the evidence is weak.

Among L/H insurers, we observe that the 9/11 dummy variable (DUM9/11) is significant in many regressions, which means that risk exposures of L/H insurers are significantly different in the two periods (1998-2000 or 1998-2001 and 2002-2004). For P/C insurers, exchange rate exposures and equity exposures are found to be different. Nevertheless, unlike what we expected, exchange rate risk exposures and equity risk exposures are higher after 2001. Note that the increase in equity risk exposure in 2002-2004 might not be related to the 9/11 attacks, because an increasing trend of this risk exposure has been observed during 1998-2004. On the other hand, L/H insurers have lower interest rate exposure (in 2 of the 4 regressions) and lower credit risk exposure after 2001. This could show that insurers' manage their risk exposures selectively.

The percentage of premiums written outside the U.S. (FOREIGN_PRE) is only significant in two of the regressions for L/H insurers. The positive sign is consistent with what we hypothesized. The insignificance of this variable in other regressions (of P/C and L/H insurers) might be due to the fact that sometimes even if insurers write insurance outside the U.S. they can still require that the premiums and benefits be paid in USD. In this way, an increase in foreign business does not always increase the company's exchange rate risk exposure at the same time.

Overall, for both groups of insurers, only the equity regressions of risk exposures on firm characteristics have good fits. We attribute the insignificance of most of the variables to the betas calculated using stock prices. We suspect that except for equity risk exposures, stock prices do not reflect much information on other risk exposures. It is

observed that when we compute betas using equation (1), only the equity risk beta is significant in all the cases, whereas the other betas are usually insignificant. This might also explain the insignificance of betas of many firm characteristics that are thought to be related to firms' risk exposure. As a result, it is necessary to find an alternate way to measure a firm's risk exposures. Besides, the choice of index that we use might also affect our results. In one of their studies, Dominguez and Tesar (2001) attribute the weak evidence of systemic exchange-rate exposure (found in existing studies) to the problem of using a trade-weighted basket of currencies. Since companies might not be exposed to different currencies with the same weights as the basket, the use of this type of index may not reflect accurately the currency risk exposure of companies.

11. Determinants of insurers' use of derivatives

11.1. Methodology

In order to isolate the effect of 9/11 on insurers' use of derivatives, five control variables are included in the regression. These control variables are selected based on previous research on the determinant of companies' hedging decisions and also the availability of related data. Results obtained from some of the previous papers show that these variables affect a firm's hedging decision to some extent (while other studies show no or little support). All of the variables are selected to test either the hypothesis of economies of scale, reduction of financial distress costs, etc. that were mentioned earlier. Although the tax advantages obtained through hedging are documented in many papers, due to the unavailability of data, no variable is included in the regression to test the tax benefits hypothesis. The same variables will be used for P/C and L/H insurers. The same sample is used here as in the previous section, where the annual firm characteristics are all collected manually from company's annual reports (Form 10-K of years 1998-2004) obtained from the website of the SEC.

To conduct the test, six regressions will be run for each group of insurers, and two sets of results are reported for each regression. In regressions 1 to 4, companies' uses of derivatives (1 if insurer uses derivatives to hedge in that year, and 0 otherwise) to hedge the specific market risk are regressed on different firm characteristics. We add a dummy variable in the regression in order to test whether firms are more likely to use derivatives to hedge after 2001. In the first four regressions, we consider insurers' use of derivatives to hedge exchange rate risk, interest rate risk, equity risk and credit risk separately. In regressions 5, we consider insurers' hedging of all these risks simultaneously; the

dependent variable equals 1 if the insurer uses derivatives to hedge at least one of these risks and 0 otherwise. This allows us to test the overall determinants of insurers' hedging decision. From the results obtained, we can see whether firm characteristics only affect insurers' use of derivatives in general, or they also affect insurers' use of derivatives to hedge a specific risk. In regression 6, we also consider insurers' hedging of all the four risks simultaneously; the dependent variable can take any integer value from 0 to 4, depending on the number of market risks that insurers use derivatives to hedge. This allows us to study the determinants of insurers' extent of hedging[21]. Once again, in order to see whether the results will be different when excluding observations of 2001, two sets of results are given for each regression. The general regression equation is defined as follows:

$$DerivativeUser_{it} = \alpha + \beta_1 LIQUIDITY_{it} + \beta_2 LEVERAGE_{it} + \beta_3 REINSURANCE_{it} + \beta_4 GROWTH_{it} + \beta_5 SIZE_{it} + \beta_{9/11} DUM9/11_{it} + e_t \quad (5)$$

where the independent variables will be defined in the next section.

11.2. Independent variables

LIQUIDITY: If a company is illiquid, the risk of financial distress should increase, therefore, we expect that the illiquidity of insurers will affect the hedging decision as leverage does. Although it seems that liquidity is (negatively) correlated to leverage, given that some firms may increase their debt to take advantage of tax payment (or to maintain a certain capital structure), robustness tests must be performed in order to conclude whether inclusion of both variables will cause the

[21] Since we are not able to obtain data on the amount of derivatives that insurers use, here, the extent of hedging represents the number of financial risks managed by insurers, rather than the volume of their derivatives participation (which is tested in the study of CPS (2001)).

problem of multicollinearity. The proxy we use is the cash-to-asset ratio (as CPS (2001) do). We expect a negative relationship.

LEVERAGE: Having a large amount of debt can result in financial distress costs, such as the direct costs associated with bankruptcy or the indirect costs such as loss of reputation, etc. which can be very huge. Therefore, firms with high leverage are deemed to be more likely to hedge. For an insurance company, leverage refers to how it uses its surplus or capital to write policies[22]. Usually, the ratio of net written premiums to surplus is a good proxy for the company's leverage. We expect that this variable will be positively related with an insurer's decision to use derivatives.

REINSURANCE: Since reinsurance is used as a substitute or complement of financial derivatives for hedging, it will be important to include this factor, as this may be one of the factors that make insurance companies' hedging decisions different from that of other industries. The ratio of reinsurance ceded to total direct premiums plus reinsurance assumed is used as a proxy. By buying reinsurance, insurers can reduce their underwriting risks. This will allow them to bear higher financial risks, and thus they will be likely to hedge with derivatives. However, insurers with more premiums ceded might also be those who are exposed to higher underwriting risk or have higher risk aversion, and they might also want to hedge their financial risk contemporaneously. Therefore, the expected sign of this variable is ambiguous.

GROWTH: According to the results of Nance, Smith and Smithson (1993), firms with more investment opportunities tend to be hedgers, while Mian (1996) finds the

[22] S&P 500 industrial analysis (Concordia Library Database).

opposite. Since financial distress will also cause firms to forego valuable investments, firms with more growth opportunities are expected to be more involved in hedging activities (to reduce volatility of their cash flow). Although CPS (2001) also take this factor into account where they use the proportion of new premium volume that arises from the reinvestment of policyholder dividends and coupons from existing policies as a proxy, we use growth in revenue. We expect to observe a positive relationship.

SIZE: Since evidence of economies of scale and informational economies has been documented in many studies, size is expected to play an important role in the participation decision, due to the marginal costs associated [CPS (2001)]. Following CPS (2001), we use the logarithm of total assets as a proxy[23]. We expect to observe a positive relationship between this variable and insurer's decision of using derivatives.

DUM9/11: In order to test whether there is change in the likelihood of using derivatives, a dummy variable is added to the regression equation. This dummy variable will be equal to 1 if the observation is taken from years after 2001 (2002-2004) and 0 otherwise. We hypothesize that this variable will be positively related to the dependent variable.

Table 10 summarizes hypotheses tested, variables included, expected sign of betas and the proxy used for each of the independent variables.

Insert Table 10 about here

[23] Often groups that tend to have larger values also tend to have greater within-groups variability. A logarithm transformation will often make the within-group variability more similar across groups. The use of value in the logarithmic scale will ease analysis of the results (http://www.tufts.edu/~gdallal/logs.htm).

The following table provides some statistics of the independent variables, which gives us some idea about the companies that are included in our sample.

Insert Table 11 about here

By comparing the two groups of insurers, we can see that they have more or less the same liquidity ratio. P/C insurers tend to have a larger proportion of their premiums ceded, and they also have higher growth rate than L/H insurers. On the other hand, L/H insurers have higher leverage and are larger too.

To assure that results will not be affected by multicollinearity, correlation matrices of the independent variables are given.

Insert Table 12 about here

The correlation matrices show there is no high correlation between variables for both groups of insurers. The only exception is the correlation between size and liquidity of L/H insurers, but since the correlation is still lower than 0.6, we do not expect that this will have any adverse influence on our results.

11.3. Results

11. 3.1. Results: P/C

Results of the two groups will be summarized separately, and a discussion of all the results will be given later. Results of each regression will be summarized separately. Regressions results of P/C insurers are given in Table 13.

Insert Table 13 about here

Panel A shows how different firm characteristics affect an insurer's decision on use derivatives to hedge exchange rate risk. From the two sets of results, liquidity, leverage, size and the 9/11 dummy variables are significant (at least at 5 percent level) in this regression. However, except for size, all of the variables have a sign that is different from what we expected. Results show that P/C insurers with higher liquidity and lower leverage are more likely to hedge. Besides, more insurers use derivatives to hedge exchange rate risk during 1998-2000. Results in the two regressions (including 2001, and excluding 2001) are very similar and the adjusted R square of both sets of results is about 0.37.

In Panel B, we observe that only two variables (size and leverage) have a significant relationship (at least at the 5 percent level) with insurer's decision to hedge interest rate risk with derivatives. Similar to what we observe in the previous table, leverage is also negatively related with insurers' likelihood of using derivatives. Results in the two regressions (including 2001, and excluding 2001) are again very similar and the adjusted R square is about 0.30.

Liquidity and size are also found to be significantly related to insurers' decision to hedge equity risk with derivatives. The 9/11 dummy variable is another variable that is significant in this regression. All these variables are significant at the 1 or 5 percent level. However, the sign of liquidity and the 9/11 dummy variable contradicts our expectation. The exclusion of data for 2001 in our regression does not change the results, and the adjusted R square of the two regressions is about 0.45.

Panel D shows that liquidity, size and the 9/11 dummy variable are important determinants (significant at 1 or 5 percent level) of insurers' decision to hedge credit risk. Different from what we observe in the previous regressions (of the other market risks), the sign of all of the significant variables is consistent with our hypothesis; larger insurers with lower liquidity are more likely to hedge and more insurers use derivatives after 2001. The adjusted R square is about 0.13, which is relatively lower than that of the previous regressions.

In Panels E and F, when we consider insurers' hedging of the four market risks together, the results obtained are similar to those obtained when we consider hedging of each risk separately. Leverage and size are found to be significant in Panels E and F, and liquidity is only significant in Panel F. Leverage and liquidity both have a sign that is opposite to what we expected. Note that adjusted R square of Panel F (testing relationship between insurers' extent of hedging market risks and their different firm characteristics) is as high as 0.52, whereas it is about 0.32 for Panel E.

11.3.2. Results: L/H

Results for L/H insurers are presented in Table 14.

Insert Table 14 about here

From Panel A, we find that among the six independent variables included, four of them are significantly related to L/H insurers' decision to hedge exchange rate risk with derivatives. All of these variables are significant at the 1 percent level. Similar to what we observe among P/C insurers, L/H insurers with higher liquidity and lower leverage are also more likely to hedge their exchange rate risk. In this regression, size and reinsurance are positively related to the dependent variable. This implies that larger insurers who use reinsurance to a higher extent are also more likely to hedge with derivatives. Observe that for the two sets of results, the adjusted R square is about 0.45.

Panel B shows that liquidity, leverage and size are found to be significantly related to insurers' decision to hedge interest rate risk. The liquidity variable is found to be positive again. For leverage and size, their positive sign is the same as what we hypothesized. The adjusted R square for both sets of results is about 0.28.

In Panel C, results show that liquidity and leverage are significant, thus they affect firms' decision to hedge equity risk with derivatives. Their relationship (i.e. sign) is consistent with what we expected. There is a slight difference between the two sets of results; the 9/11 dummy variable is only significant when observations of 2001 are excluded from the regression. The adjusted R square is lower than 0.08, which is relatively low compared to that of other regressions.

Leverage, reinsurance, size and the 9/11 dummy variable are found to be significant when studying determinants of insurers' decision to hedge credit risk. While

reinsurance and size are positive, leverage and the 9/11 dummy variable have signs different from what we expected. All the variables are at least significant at the 5 percent level. The adjusted R square is about 0.23.

In Panel E, where we consider insurers' decision of hedging any market risk, only the size variable is significant. The adjusted R square is about 0.12. On the other hand, in Panel F where we study the determinants of insurers' extent of hedging, we find that four of the six independent variables are significant. Among these four variables, only the sign of liquidity is different from our hypothesis. Other significant variables include reinsurance, size and the 9/11 dummy. The adjusted R square is about 0.40.

11.4. Discussion of results

In general, by excluding observations of 2001 from our regressions, we do not get results that are very different, and the adjusted R square is not always improved. In most of the cases, the results obtained are very similar. Variables which are significant in the regression when we include observations of 2001 are also significant when we exclude them. Overall, the adjusted R square of all the regressions is generally high. It is observed that variables that are significant in one regression are also the same variables that are significant in other regressions. When comparing the results of Panels A-D with results of Panels E and F, they are very similar. This implies that whether we consider insurers' decision of hedging each risk separately or all the risks simultaneously, the results obtained are similar.

The liquidity variable (LIQUDITY) is found to be significant in many regressions. The results show that P/C insurers and L/H insurers with lower liquidity are

more likely to hedge their credit risk and equity risk respectively. However, in all the other regressions, its sign is positive and this implies that insurers with higher liquidity are more likely to hedge. Therefore, the evidence supporting the theory that insurers use derivatives to reduce financial distress costs is very weak. This contradicts the rationale that insurers with lower liquidity are more likely to face financial distress, and therefore should have a higher tendency to hedge with derivatives. This could reflect that insurers do not use derivatives due to their lower liquidity, but those who have higher liquidity are also those who manage their risk more carefully. They are more likely to use different types of risk management techniques in order to assure the company's stability.

Similar to the liquidity variable, the leverage variable (LEVERAGE) is also significant in many regressions. However, from the results obtained, they also show little support for the rationale that insurers use derivatives to minimize financial distress cost. Although this variable is found to be positively related to L/H insurers' decision to hedge interest rate risk and equity rate risk with derivatives, it is found to be negatively related to insurers' use of derivatives in other regressions. As mentioned before, we suspect that insurers do not decide to hedge such that they can have higher leverage; these insurers that have lower leverage are more risk averse, thus, they will also try to manage other risks simultaneously. Instead of managing one risk and tolerate higher exposure to other risks, these risk averse insurers try to minimize their exposure to any type of risk. In the study done by Nance et al., they also find that leverage is negatively related with firms' use of derivatives. They argue that since firms with more growth opportunities usually have lower leverage, leverage is also a proxy for growth. Therefore, the negative sign observed is consistent with the underinvestment hypothesis. However, in our study, the

growth variable is not significant. Therefore, our results do not show strong support for their reasoning.

The reinsurance variable (REINSURANCE) is only found to be significant and positive in three regressions of L/H insurers. This variable is found to affect L/H insurers' decision to hedge exchange rate risk and credit risk with derivatives, and their extent of hedging. This implies that instead of treating derivatives as substitutes for hedging, insurers use derivatives and reinsurance at the same time to enhance their risk management. In general, we only have evidence showing that reinsurance is a determinant of L/H insurers' hedging decision, but this does not apply to P/C insurers.

Different from what we expected, the growth variable (GROWTH) is not significant in any of the regressions. Therefore, we do not have any evidence showing that growth affects insurers' hedging decision.

The size variable (SIZE) is the only variable that is significant (at the 1 percent level) in almost all of the regressions (the only exception is that it is not an important determinant of L/H insurers' decision to hedge equity risk). In all the cases, this variable is always positive, which is consistent with our hypothesis. This shows strong support for the important role that economies of scale play in insurers' use of derivatives. This is also consistent with results of many studies that are done on this issue.

From the results, we find that the effect of 9/11 (DUM9/11) on insurers' use of derivatives is mixed for P/C insurers, while its effect on L/H insurers is generally positive. It is shown that P/C insurers are more likely to hedge some risks with derivatives after 2001, while appearing to be less likely to hedge other risk after 2001. On the other hand, we observe that L/H insurers are more likely to hedge (two of the four

market risks), and they also increase their hedging extent after 2001. The selective increase in use of derivatives for a certain risk could reflect the fact that when insurers want to reduce their overall financial risk exposure, they do not necessarily increase their hedging of all of the market risks they are exposed to. They might decide to hedge some of the market risks that they think are more important, that is cheaper to hedge or on which they have better knowledge, etc. A possible explanation for the weak evidence we have is that derivatives might be cheap hedging tools for current users, but it might be very costly for non-users to start using derivatives. Besides, when used inappropriately, derivatives could increase a firms' risk instead.

12. Surveys

12.1. Sample

In order to know more about how insurers are actually affected by the 9/11 terrorist attacks, we also send surveys to insurers to ask them questions on this issue. Surveys were sent to Chief Financial Officers of 400 private insurers (200 P/C insurers and 200 L/H insurers) operating in U.S. According to the information given by the National Association of Insurance Commissioners (NAIC)[24], in 2003, there were more than 2500 P/C and about 1000 L/H insurers operating in U.S. Although the number of P/C insurers is more than double of L/H insurers, we include the same number of insurers from each sector in our sample. This is done to assure that enough responses will be received from each sector. Hoping to include users of derivatives in the sample, the sample is selected such that relatively large insurers are included (e.g. written premiums larger than 10 million). CFOs are asked to answer questions mainly concerning the importance of derivatives in the company's risk management and the impact of 9/11 attack on the company. Among the 400 surveys sent, 61 responses were received (37 responses from P/C insurers and 24 responses from L/H insurers), and the response rate is about 15.3%.

12.2. Results

In the Table 15, questions posed to insurers are given, and we also provide three sets of results. In column 1, we summarize all responses without making any

[24] Since insurance companies are regulated at the state level, there are differences in regulation and in financial reporting methods between states. To solve this problem, state insurance regulators created NAIC to coordinate the regulation of insurers in different states and to improve the exchange of information between the different regulators.

differentiation between P/C insurers and L/H insurers. In columns 2 and 3, we summarize responses according to the group of insurers they belong to. In most of the questions, insurers are only asked to answer "yes" or "no", whenever an insurer answers "yes", we count the response as 1. The number given in the three columns is the number of respondents who answer "yes" for that specific question. For questions where insurers are asked to offer a rating (from 1 to 5), the number we report is the average rating given by the respondents. Responses that we receive from private insurers are summarized in Table 15.

Insert Table 15 about here

Responses show that for insurers who encountered losses due to the 9/11 attacks, the loss is higher than any other that they faced before. If we compare the two groups of insurers in our sample, a higher proportion of P/C insurers have losses due to this event. We observe that most of the insurers have a risk management program. Among the insurers who use derivatives in their investments, 19 of them also use derivatives for hedging purpose. Although almost 40% of respondents use derivatives to hedge, derivatives do not play a very important role in insurers' risk management. Compared to P/C insurers, a larger proportion of L/H insurers are users of derivatives, this is consistent what CPS (2001) observe in their study. Yet, even though derivatives can be used to hedge underwriting risk, results show that they are mainly used to manage financial risks. Among users of derivatives, about 60% of them claim that they increase their use of derivatives (to hedge) after September 11, 2001. Some of them also increase the amount

of derivatives in their investments. About 40% of the respondents state that the 9/11 terrorist attacks prompted them to change their risk management strategy. Remodeling of terrorist risk is one of the measures taken by insurers to deal with the possible occurrence of another terrible attack. Only very few insurers claim that they increase their use of reinsurance after the attack. When they are asked what is (are) the main cause of the huge loss (due to the attack) suffered by the insurance industry, most of them attribute it to underestimation of terrorist risk and concentration risk. Although they think that another attack in the future is possible, they believe its likelihood is not very high.

12.3. Discussion of results

The presence of a risk management program in most of the insurers reaffirms that it is especially important for insurers to control their risk in order to survive. Although derivatives become more widely used by insurers than before, their use of this hedging instrument is still limited. This could be because they still do not posses enough knowledge in this area or they perceive that the effectiveness of this instrument is not as high as traditional methods. A better understanding on this issue will require further investigation. We observe that a higher proportion of L/H insurers use derivatives to hedge than P/C insurers. This might be due to the nature of their products. Since L/H insurers sell many types of insurance/saving products that are sensitive to changes in different indices and interest rates, the best way to hedge the risks associated with these products might be through the use of financial derivatives. Results show that some insurers changed their risk management strategy after the 9/11 attacks. Among these insurers, some of them do not have any loss caused by this event; this shows how great is

the impact of this attack on insurers. This is especially true for P/C insurers, since about 50% of them (among the respondents) claim they changed their risk management strategy, and about 40% changed their operations in other ways. There is strong evidence that hedgers increased their use of derivatives after September 11, 2001. This might reflect the fact that insurers do manage their financial risks more diligently after the attack. However, due to unavailability of data, we are not able to test empirically whether hedgers increased their volume of participation in the derivatives market. In general, insurers do not choose to increase their use of reinsurance to hedge the increase in their underwriting risk. This may be explained by higher cost and low availability mentioned before. Most of the insurers attribute the high loss (suffered by the industry) to the underestimation of terrorist risk and concentration risk. This also explains why remodeling of terrorist risk and stringent underwriting are the most common changes implemented by insurers. Although some insurers also choose to increase premiums, the proportion is lower than we expected. We suppose that this is due to regulation and the clientele effect. When we ask insurers how likely they think another attack is, we are hoping that this will help us to explain what we observe; if insurers think that the likelihood is low, we should not be surprised to find that few changes are made by insurers after September 11, 2001. Overall, the estimated likelihood that another attack will reoccur is about 3.3 (this is the average rating offered by respondents), therefore, it is consistent with the fact that we only observe half of the respondents respond to the attack by adjusting their risk management or operations.

13. Conclusions

In this thesis, we test the impact of the September 11, 2001 terrorist attacks on insurers' use of derivatives. We hypothesize that in order to reduce total risk exposures, that insurers manage their market risks using derivatives more diligently after 2001. In general, our results do not show strong support for our hypothesis. Some of the market risk exposures of insurers are lower after 2001, but an increase is found in other market risk exposures. Although our empirical results provide evidence that L/H insurers are more likely to hedge with derivatives after 2001, results of P/C insurers are mixed. From our survey results, we find that derivatives do not play an important role in insurers' risk management. This helps us to explain the weak evidence showing that insurers are more likely to use derivatives after 9/11. Even if they decide to hedge their market risks to a higher extent, they will choose to use other techniques. Furthermore, our empirical results also show that users of derivatives do not necessarily have lower market risk exposures, and this further supports the unimportance of derivatives to insurers. Overall, our survey results show that 9/11 prompts changes in risk management and operations of insurers, and increase in use of derivatives among users. However, our empirical results do not strongly support that both groups of insurers become more likely to use derivatives to hedge their financial risks after the terrorist attack. Besides, instead of focusing more on managing their market risks (as we hypothesize), the survey results suggest that many different measures are also taken by insurers to prevent any substantial loss caused by future attacks.

In general, although we observe that some insurers change their hedging strategy due to 9/11, the impact of this event (on insurers' risk management) is smaller than we

expected and less than 50% of insurers report any changes. First, we suspect that this could be because changes in risk management or use of any new hedging techniques (such as derivatives) require a considerable investment of money and time, as well as information. Therefore, little immediate effect can be observed in the early years after occurrence of an extreme event. In addition, our sample includes firms which did not encounter losses due to 9/11, which do not have operations in New York, and which sell insurance products that are not exposed to much terrorist risk. Different results might be obtained if we focus only on firms that have direct losses stemming from the attack. Moreover, the backup program offered by the government might also be one of the causes; since it helps to reduce the burden of the insurance industry in case another terrorist attack takes place shortly after 9/11. However, as the U.S. government becomes more reluctant to renew TRIA[25], insurers will have to reduce their dependence on the aid from the government. In the future when the government reduces its role as a reinsurer, more changes in insurers' risk management might be observed, since they will have to bear all the risks by themselves. However, as time passes and no attack occurs, insurers' risk aversion might become lower, and they might exhibit a lower tendency to hedge the terrorist risk too. Given the many cases of fraud that have recently been reported among insurers, we think that this might also contribute to what we observe; in that if insurers are able to assure their profitability through different illegal activities, the need for managing their increase in underwriting risk will be lower.

Future research includes repetition of the same test, but using better proxies of market risk exposures. As mentioned before, we believe that stock prices do not capture

[25] The U.S. government claims that the presence of TRIA actually reduces the competitiveness of insurers, since they might manage their risks less diligently than they would otherwise.

properly all the market risk exposures of insurers. Since it might be inappropriate to assume that changes in any index will prompt immediate changes in firms' stock prices, as pointed out by Bartov and Bodnar (1994), we could perform similar tests using lagged data and compare the results. Another thing that could be done is to compare the estimated risk exposures given by the insurer with the risk exposures that we calculate. In this way, we will have a better idea of the accuracy of our measures. However, not all of the insurers provide information concerning their exposures to each kind of risk. In this study, when testing firm characteristics that may affect the company's market risk exposures, we use the same characteristics for both groups of insurers, and this might be inappropriate. The same proxies (of leverage, liquidity, etc.) are used for the determinants of firms' hedging decision. It might be better if different proxies are used for different groups of insurers, since they are different in many ways. As the survey results show that some insurers increase their use of derivatives, it will also be interesting to test this empirically to see whether we get similar results.

References

Allayannis, G., G.W. Brown, and L.F. Klapper, 2001, Exchange Rate Risk Management: Evidence from East Asia, Working Paper, The World Bank in its series Policy Research Working Paper Series with number 2606

American Institute of Certified Public Accountants, Inc., 2003, Audits of Property and Liability Insurance Companies

Bali, Turan G., Susan R. Hume, and Terrence F. Martell, 2004, Does Hedging with Derivatives Reduce the Market Risk Exposure?, Working paper, Zucklin School of Business

Bartov, Eli, and Gordon M. Bodnar, 1994, Firm Valuation, Earnings Expectations, and the Exchange-Rate Exposure Effect, *The Journal of Finance*, Vol. 44, No. 5

Burch, Timothy R., Douglas R. Emery and Michael E. Fuerst, 2003, What Can "Nine-Eleven" Tell Us About Closed-end Fund Discounts and Investor Sentiment, 2003, *Financial Review*, Vol. 38, No. 4, November 2003

Choi, Jongmoo Jay, and Elyas Elyasiani, 1996, Derivative Exposure and the Interest Rate and Exchange Rate Risks of U.S. Banks, Working paper, Temple University

Choi, J.J. and A.M. Prasad, 1995, Exchange rate sensitivity and its determinants: A firm and industry analysis of U.S. multinationals, *Financial Management*, 24, Autumn, 77-88

Choudhry, Taufiq, 2003, September 11 and Time-Varying Beta of United States Companies, Working paper, Bradford University School of Management

Colquitt, L. Lee, and Robert E. Hoyt, 1997, Determinants of Corporate Hedging Behavior: Evidence from the Life Insurance Industry, *Journal of Risk and Insurance*, 64(4): 649-671.

Cummins, J. David, Richard D. Phillips, and Stephen D. Smith, 1997, Corporate Hedging in the Insurance Industry: The Use of Financial Derivatives by US Insurers, *North American Actuarial Journal*, 1:13-39

Cummins, J. David, Richard D. Phillips, and Stephen D. Smith, 2001, Derivatives and Corporate Risk Management: Participation and Volume Decisions in the Insurance Industry, *The Journal of Risk and Insurance*, Vol. 68, No. 1, 51-92

Dimson, Elroy, 1979, Risk measurement when shares are subject to infrequent trading, *Journal of Financial Economics*, 71, pp.607-636

Disenchanted Dictionary, http://www.disenchanted.com/dis/dictionary.html

Dominguez, Karthryn M.E., and Linda L. Tesar, 2001, Exchange Exposure, Working paper, National Bureau of Economics Research

Dudziak, Mary L., 2003, September 11 in History: A Watershed Moment? Introduction, Working paper, Duke University Press

Flannery, Mark J., and Christopher M. James, 1984, The Effect of Interest Rate Changes on the Common Stock Returns of Financial Institutions, *Journal of Financial Economics*, 39, pp.1141-1153

Fowler, David J., and C. Harvey Rorke, 1983, Risk Measurement When Shares are Subject to Infrequent Trading Comment, *Journal of Financial Economics*, 12, pp.279-283

Furedi, Frank, 2002, Refusing to be terrorised: managing risk after September 11, AIRMIC Conference, University of Kent

Geczy, Christopher, Bernadette A. Minton, and Catherine Schrand, 1997, Why Firms Use Currency Derivatives, *The Journal of Finance*, Vol. 52, No. 4, pp.1323-1354

Glaser, Markus, and Martin Weber, 2005, September 11 and Stock Return Expectations of Individual Investors, *Review of Finance*, Vol. 9, No. 2, pp. 243-279

Graham, John R., and Campbell R. Harvey, 2001 Expectations of Equity Risk Premia, Volatility and Asymmetry from a Corporate Finance Perspective, Working paper, Duke University

Hartwig, Robert P., 2002, One Hundred Minutes of Terror that Changed the Global Insurance Industry Forever, Insurance Information Institute, http://server.iii.org/yy_obj_data/binary/693021_1_0/sept11paper.pdf

Haushalter, G. David, 2000, Financing Policy, Basis Risk, and Corporate Hedging: Evidence from Oil and Gas Producers, *The Journal of Finance*, Vol. 55, No. 1, pp. 107-152.

Hearing on Financial Condition of The Airline Industry, http://www.house.gov/transportation/aviation/09-24-02/09-24-02memo.html

Hentschel, Ludger, and S.P. Kothari, 2001, Are Corporate Reducing or Taking Risks with Derivatives?, *The Journal of Financial and Quantitative Analysis*, Vol. 36, No. 1 (Mar, 2001), pp. 93-118

Hogarth, Robin, 2003, Insurance and Safety after September 11, 2001: Coming to Grips with the Costs and Threats of Terrorism, Working paper, University Pompeu Fabra-Department of Economics and Business

Hon, Mark, and Jack Strauss, 2003, Contagion in Financial Markets After September 11-Myth or Reality?, Working paper, Saint Louis Universit-Madrid Campus, Spain and Saint Louis University-Department of Economics.

Hoyt, Robert E., 1989, Use of Financial Futures by Life Insurers, *Journal of Risk and Insurance*, 56(4): 740-749

Jorion, Phillipe, 1990, The Exchange-Rate Exposure of U.S. Multinationals, *Journal of Business*, Vol. 63, no. 3, pp. 331-345

Kinsley, Michael, 2002, How to live a rational life, TIME, September 1, 2002

Mayers, D., and C.W. Smith, 1982, On the corporate demand for insurance, *Journal of Business* 55, 281-296

Mayers, D., and C.W. Smith, 1987, Corporate insurance and the underinvestment problem, *Journal of Risk and Insurance* 54, 45-54

Mcgeary, Johanna, and David Van Biema, 2001, The New Breed of Terrorist, TIME Canadian edition (Special Issue), September 24, 2001

Mian, Shehzad L., 1996, Evidence on Corporate Hedging Policy, *Journal of Financial and Quantitative Analysis*, 31: 419-439

Nance, Deana R., Clifford W. Smith, Jr., and Charles W. Smithson, 1993, On the Determinants of Corporate Hedging, *Journal of Finance*, 48: 267-284

Richardson, Anne, 2002, Aftermath, Contingencies July/August 2002

Schrand, Catherine M., 1997, The Association Between Stock-Price Interest Rate Sensitivity and Disclosures about Derivative Instruments, *The Association Review*, Vol. 72, No. 1, pp. 87-109

September 11 attacks,
http://www.answers.com/topic/september-11-attacks?method=22

Shanker, L., 2000, An Innovative Analysis of Taxes and Corporate Hedging, *Journal of Multinational Financial Management*, 10, 237-255

Smith, Clifford W. and Rene M. Stulz, 1985, The Determinants of Firms' Hedging Policies, *Journal of Financial and Quantitative Analysis*, 20: 391-405

The Global Economy After September 11, December 2001, http://www.imf.org/external/pubs/ft/weo/2001/03/

Tufano, Peter, 1996, Who Manages Risk? An Empirical Examination of Risk Management Practices in the Gold Mining Industry, *The Journal of Finance*, Vol. 51, No. 4. (Sep., 1996), pp. 1097-1137.

Tufano, Peter, 1998, The Determinants of Stock Price Exposure: Financial Engineering and the Gold Mining Industry, *The Journal of Finance*, Vol 53, No. 3 (June., 1998), pp. 1015-1052

Trieschmann, James S., Sandra G. Gustavson, and Robert E. Hoyt, 2001, Risk Management and Insurance, 11th ed., South-Western College Publishing

Wolstein, Charles, 2004, Casualty Actuaries in Reinsurance: Terrorism Seminar-Alternative Solutions Session, http://www.casact.org/coneduc/care/0904/handouts/wolstein.ppt

Wrolstad, Mark and Thomas Kreger, 2003, The impact of September 11 on investors'risk aversion, *Journal of Investing*, Vol 12, Iss.2; p.72

Figure 1.1.

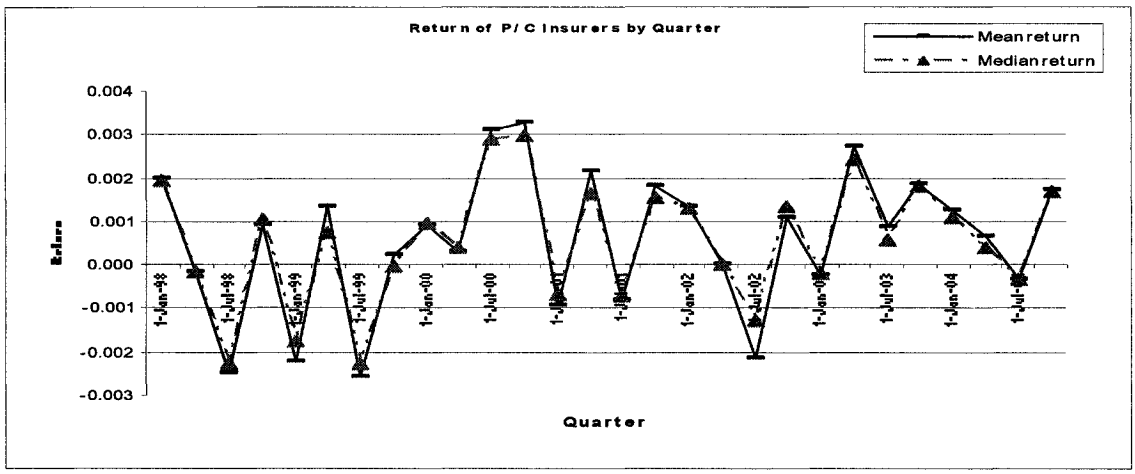

Figure 1.2.

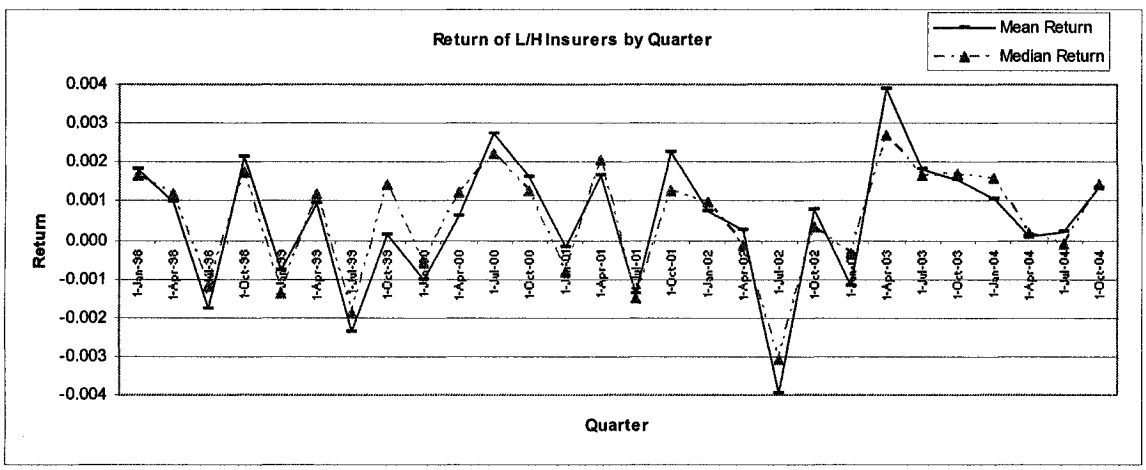

Figure 1.3.

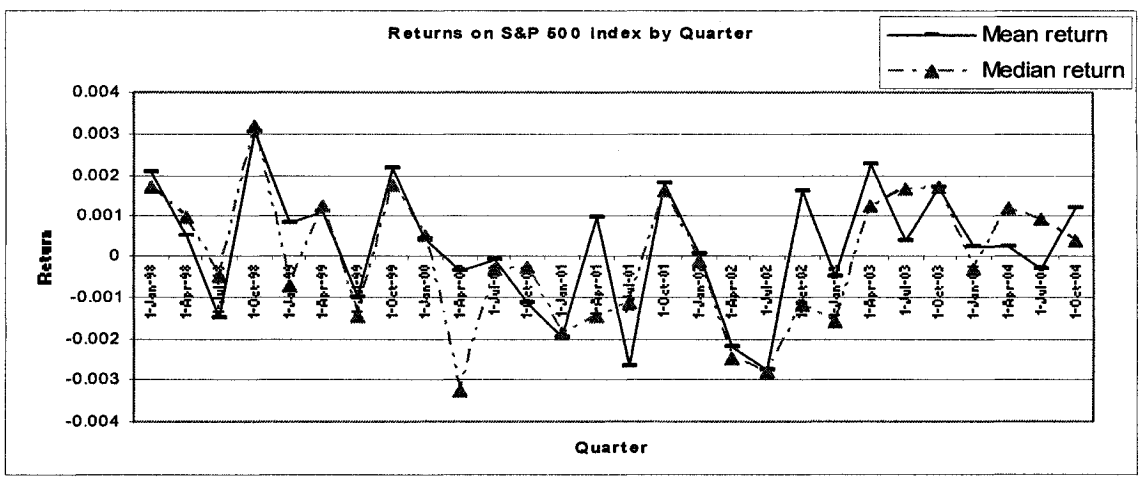

Table 1. Correlations and VIF by quarter of different indices

Panel A: Correlation between market indices (by quarter)

	Exchange rate vs Interest rate	Exchange rate vs Equity return	Exchange rate vs Credit Spread	Interest rate vs Equity return	Interest rate vs Credit spread	Equity return vs Credit Spread
1-Jan-98	-0.0617	0.0611	0.2693	0.1321	-0.0483	0.0615
1-Apr-98	0.2160	0.2594	0.1355	-0.0134	-0.1303	0.1807
1-Jul-98	-0.0846	0.1241	0.2199	0.0501	-0.8739	0.0156
1-Oct-98	-0.1974	-0.1576	-0.0392	-0.0077	-0.7281	0.1892
1-Jan-99	-0.0002	-0.0483	-0.0738	0.0453	-0.6698	0.0242
1-Apr-99	-0.1479	-0.2316	-0.0657	-0.0134	0.6465	0.1100
1-Jul-99	-0.0171	-0.3193	-0.0180	0.0290	0.6903	0.1065
1-Oct-99	0.0395	-0.2985	-0.0229	0.0145	-0.8592	0.0151
1-Jan-00	0.0936	0.1820	0.1741	0.1533	0.5978	0.1956
1-Apr-00	-0.0124	0.0863	0.3613	-0.0197	-0.1096	0.0497
1-Jul-00	0.0054	0.2619	-0.0553	0.1200	-0.5487	0.0062
1-Oct-00	-0.1856	-0.0943	0.2919	-0.1174	-0.7817	0.1210
1-Jan-01	0.1487	0.1094	-0.0044	0.0837	0.3572	0.1374
1-Apr-01	0.1558	0.0369	0.1532	0.1093	0.4911	0.1895
1-Jul-01	0.1569	-0.0368	-0.2221	0.0818	-0.8333	-0.0399
1-Oct-01	-0.0012	-0.2789	-0.0507	0.0991	0.1170	0.2899
1-Jan-02	0.1102	0.0763	0.0193	0.1260	-0.0785	0.0281
1-Apr-02	-0.0454	-0.1787	0.1107	0.0214	-0.3755	0.0785
1-Jul-02	-0.0787	-0.1911	-0.1732	-0.0514	-0.5038	0.3581
1-Oct-02	-0.0387	-0.2405	-0.0417	0.1520	0.9243	0.1708
1-Jan-03	0.1225	-0.3218	-0.0090	0.0930	0.3014	0.0393
1-Apr-03	0.1771	-0.0780	-0.1765	0.2211	-0.3986	0.0270
1-Jul-03	-0.0107	-0.1368	0.2646	-0.0098	0.2810	0.0089
1-Oct-03	-0.0582	-0.3389	-0.1236	-0.0674	0.5549	-0.0184
1-Jan-04	-0.0431	0.0621	0.1025	-0.0949	0.4369	-0.0430
1-Apr-04	0.1046	0.3796	0.0146	0.0449	0.3033	0.1624
1-Jul-04	0.0019	0.0583	-0.0602	0.1842	-0.9688	-0.0943
1-Oct-04	-0.0644	-0.0041	0.0289	0.0359	-0.8959	0.0115

Panel B: Correlation between market indices (by year)

	Exchange rate vs Interest rate	Exchange rate vs Equity return	Exchange rate vs Credit Spread	Interest rate vs Equity return	Interest rate vs Credit spread	Equity return vs Credit Spread
1998	-0.1204	0.0732	0.1336	-0.0446	-0.9350	0.0760
1999	0.0438	-0.2009	0.0260	0.0428	0.1402	-0.0184
2000	-0.0293	0.0906	0.1138	-0.0194	0.4105	0.0170
2001	-0.0371	-0.0115	-0.0766	-0.0576	0.4367	0.0976
2002	-0.0330	-0.1530	-0.0798	-0.0197	-0.2801	0.1142
2003	0.0477	-0.1882	0.0000	0.0182	0.4820	-0.0478
2004	0.1056	0.1344	-0.0984	0.0621	-0.8584	-0.0625

Table 1: Correlations and VIF by quarter of different indices (Continued)

Panel C: VIF of market indices (by quarter)

	Exchange Rate	Interest Rate	Equity Return	Credit Spread
1-Jan-98	1.0841	1.0245	1.0255	1.0823
1-Apr-98	1.1492	1.0809	1.1003	1.0688
1-Jul-98	1.1184	4.5128	1.0274	4.6912
1-Oct-98	1.1344	2.4452	1.0875	2.4335
1-Jan-99	1.0117	1.8334	1.0092	1.8405
1-Apr-99	1.0930	1.7911	1.0908	1.7721
1-Jul-99	1.1147	1.9190	1.1314	1.9398
1-Oct-99	1.1018	3.8440	1.1030	3.8374
1-Jan-00	1.0565	1.5600	1.0673	1.6099
1-Apr-00	1.1574	1.0133	1.0082	1.1653
1-Jul-00	1.0830	1.4702	1.1028	1.4531
1-Oct-00	1.1189	2.5860	1.0349	2.7443
1-Jan-01	1.0384	1.1772	1.0324	1.1682
1-Apr-01	1.0331	1.3299	1.0377	1.3614
1-Jul-01	1.0567	3.3053	1.0112	3.3727
1-Oct-01	1.0862	1.0193	1.1884	1.1023
1-Jan-02	1.0170	1.0342	1.0216	1.0084
1-Apr-02	1.0500	1.1677	1.0467	1.1916
1-Jul-02	1.0855	1.4196	1.1924	1.6322
1-Oct-02	1.0614	6.8677	1.0916	6.9105
1-Jan-03	1.1480	1.1402	1.1382	1.1025
1-Apr-03	1.0593	1.2963	1.0819	1.2219
1-Jul-03	1.1081	1.0958	1.0221	1.1806
1-Oct-03	1.1519	1.4520	1.1399	1.4630
1-Jan-04	1.0240	1.2557	1.0126	1.2590
1-Apr-04	1.1874	1.1163	1.2058	1.1370
1-Jul-04	1.0845	20.4593	1.2042	20.0013
1-Oct-04	1.0084	5.1618	1.0111	5.1388

Panel D: VIF of market indices (by year)

	Exchange Rate	Interest Rate	Equity Return	Credit Spread
1998	1.022	8.000	1.016	8.053
1999	1.045	1.025	1.045	1.021
2000	1.028	1.212	1.009	1.226
2001	1.006	1.251	1.022	1.265
2002	1.031	1.089	1.035	1.106
2003	1.041	1.311	1.043	1.310
2004	1.029	3.808	1.021	3.803

Table 2: Mean and median of insurers' quarterly market risk exposures

Panel A: Exchange rate risk exposures

		PC		LH	
		Mean	**Median**	**Mean**	**Median**
Unadjusted	**whole period**	-0.0658	-0.0333	0.0428	0.0353
	1998-2000	-0.1217	-0.0969	-0.0100	0.0483
	2001	0.0368	0.0301	0.0945	-0.0494
	2002-2004	-0.0440	-0.0153	0.0779	0.0353
Dimson	**whole period**	-0.0631	0.0333	0.1322	0.1230
	1998-2000	-0.4065	-0.2680	-0.1963	-0.2028
	2001	0.1449	0.1609	0.1079	0.0871
	2002-2004	0.2108	0.2047	0.4648	0.4450

Panel B: Interest rate risk exposures

		PC		LH	
		Mean	**Median**	**Mean**	**Median**
Unadjusted	**whole period**	71.8155	-20.4485	80.6420	9.2963
	1998-2000	-32.4549	0.9753	68.5963	41.6565
	2001	-113.5824	-102.4642	-157.3381	-142.8035
	2002-2004	237.8853	29.0831	172.4033	127.0673
Dimson	**whole period**	161.2170	23.9341	225.8531	122.9105
	1998-2000	-53.1948	20.6478	210.6153	186.0310
	2001	-33.9429	-56.1749	-76.2670	-85.7077
	2002-2004	440.4028	125.2899	341.6162	189.6385

Panel C: Equity price risk exposures

		PC		LH	
		Mean	**Median**	**Mean**	**Median**
Unadjusted	**whole period**	0.5695	0.5453	0.5690	0.5561
	1998-2000	0.4498	0.4458	0.4466	0.4363
	2001	0.5580	0.5058	0.5168	0.4933
	2002-2004	0.6931	0.6697	0.7082	0.7104
Dimson	**whole period**	0.6048	0.5777	0.6290	0.6187
	1998-2000	0.4916	0.4409	0.5078	0.5061
	2001	0.5791	0.5388	0.4722	0.4856
	2002-2004	0.7265	0.6985	0.8011	0.7738

Table 2: Mean and median of insurers' market risk exposures (Continued)

Panel D: Credit risk exposures					
		PC		LH	
		Mean	Median	Mean	Median
Unadjusted	**whole period**	73.9116	17.9617	15.9406	-37.4455
	1998-2000	211.5805	182.7202	219.4232	169.0616
	2001	-544.0370	-402.0932	-385.2223	-307.2009
	2002-2004	142.2256	67.3131	-51.8718	-45.8360
Dimson	**whole period**	23.2997	-30.5021	-0.5908	-85.3975
	1998-2000	204.7423	205.8643	299.5356	146.8519
	2001	-591.6093	-409.5204	-293.0635	-256.1244
	2002-2004	46.8269	-19.1760	-199.6534	-125.6216

Figure 2.1.1.

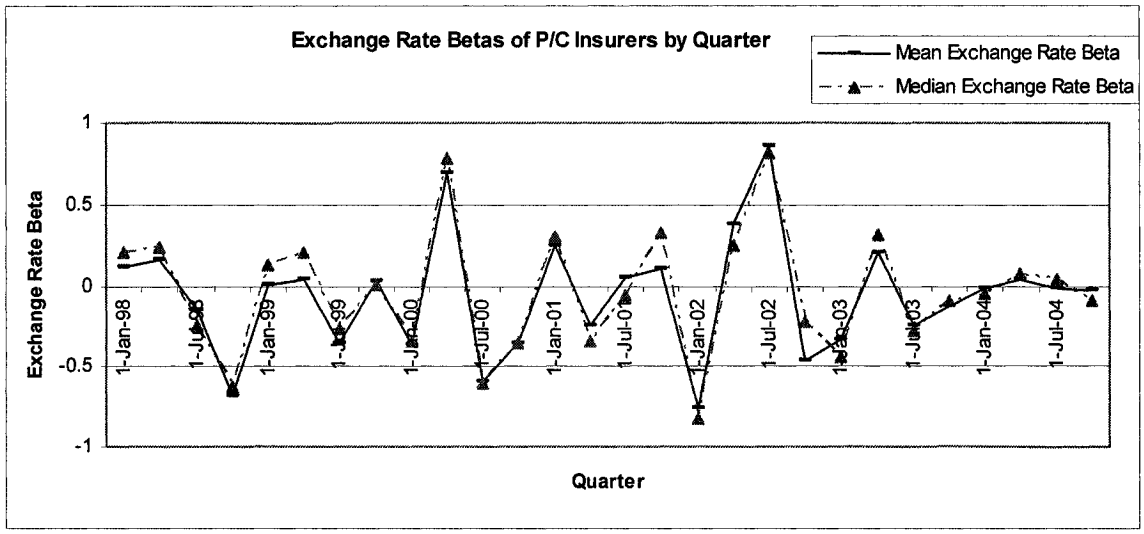

Figure 2.1.2.

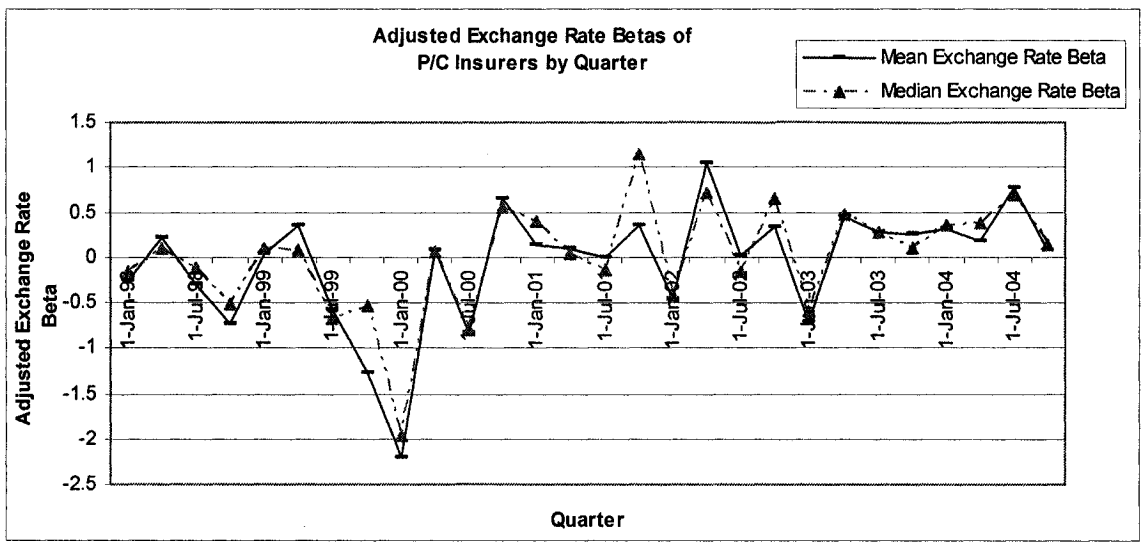

Figure 2.2.1.

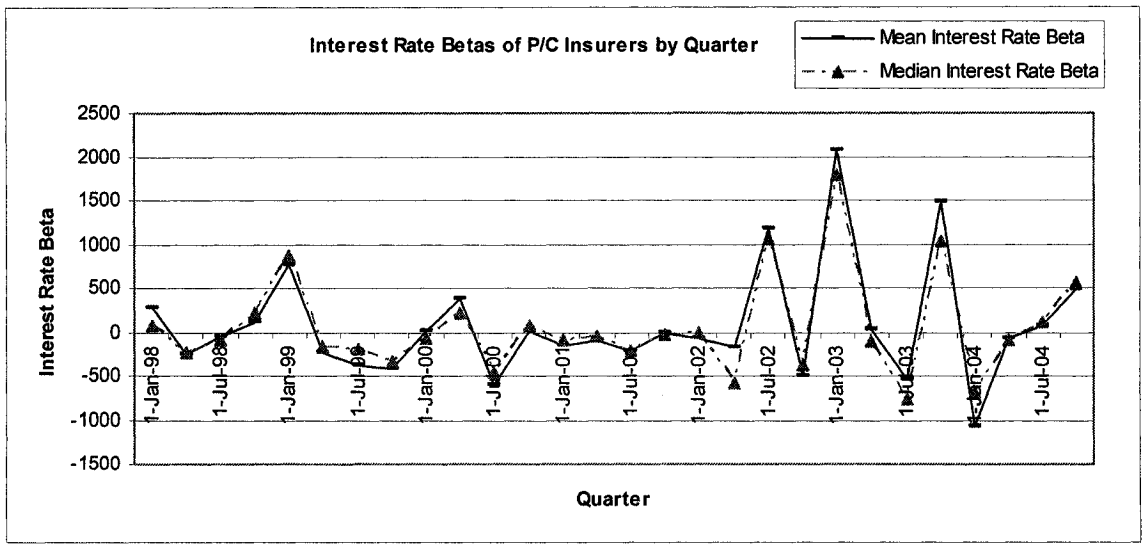

Figure 2.2.2.

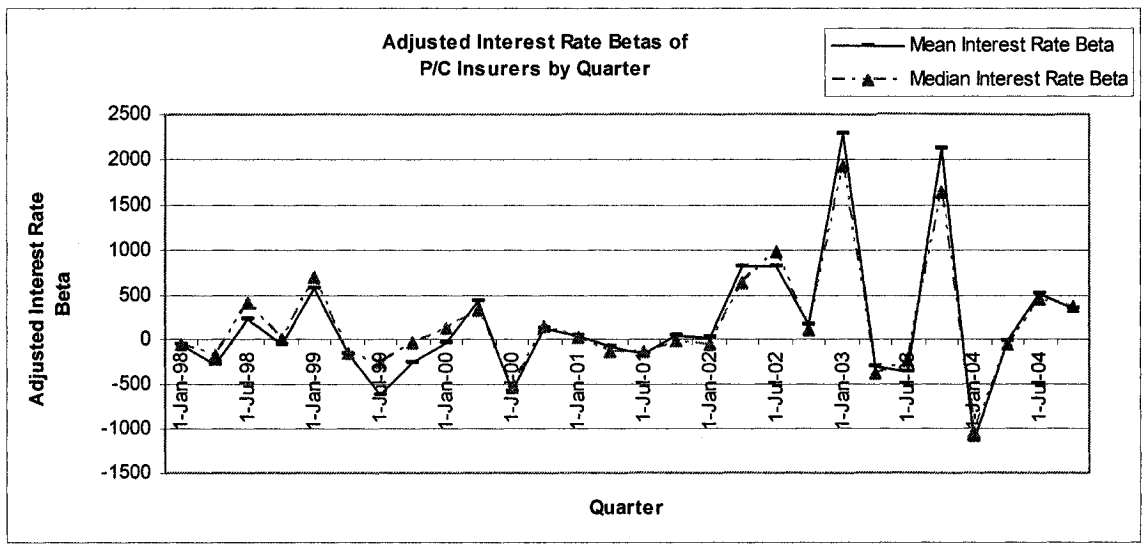

Figure 2.3.1.

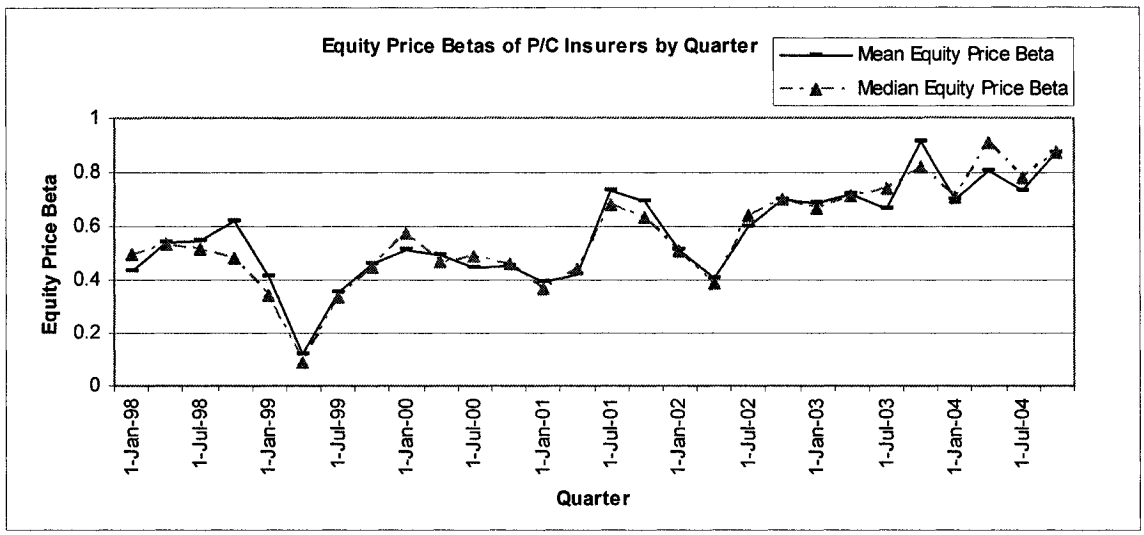

Figure 2.3.2.

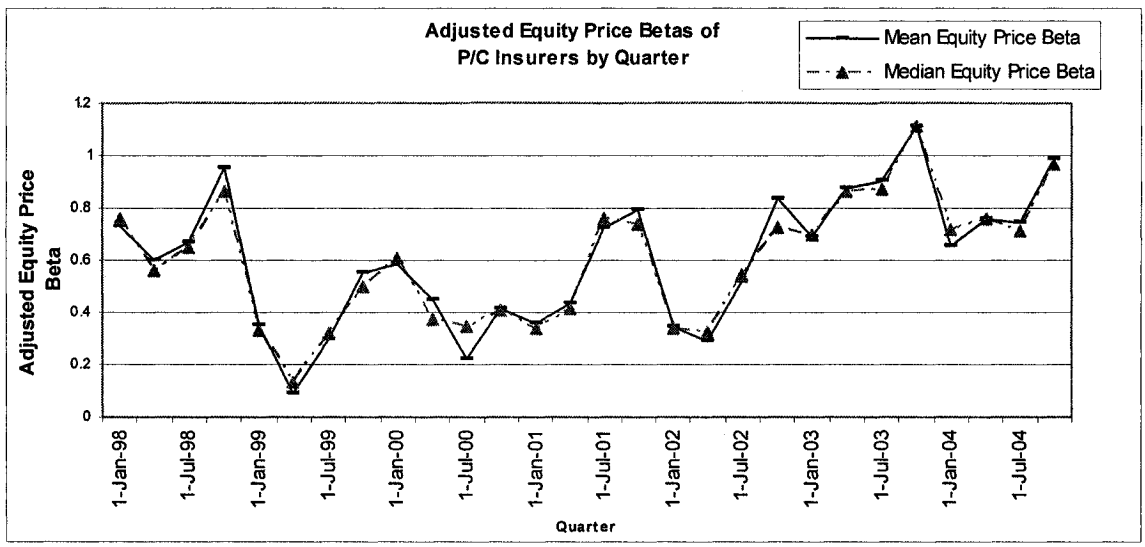

Figure 2.4.1.

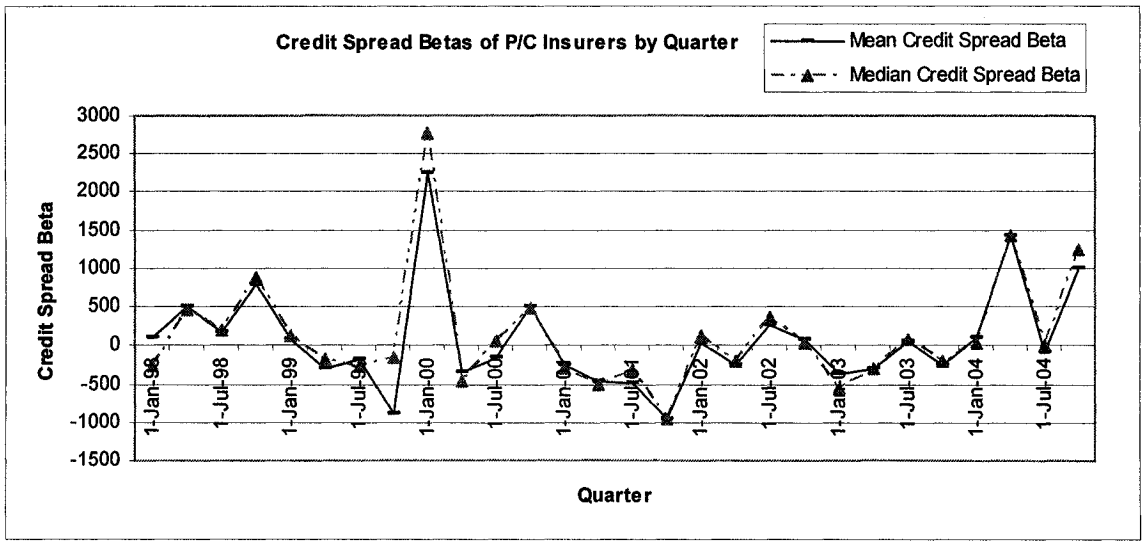

Figure 2.4.2.

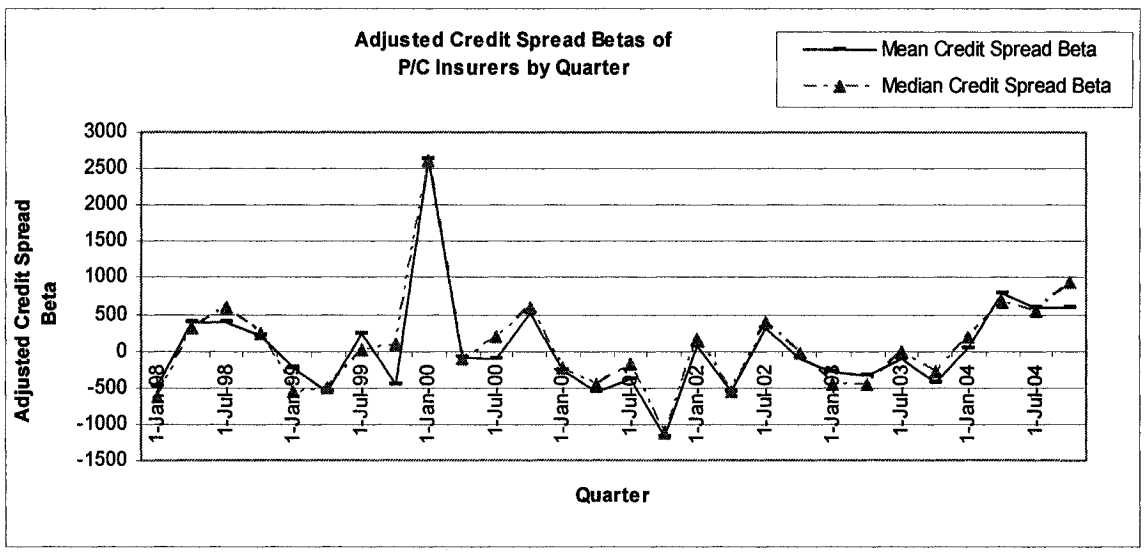

Figure 3.1.1.

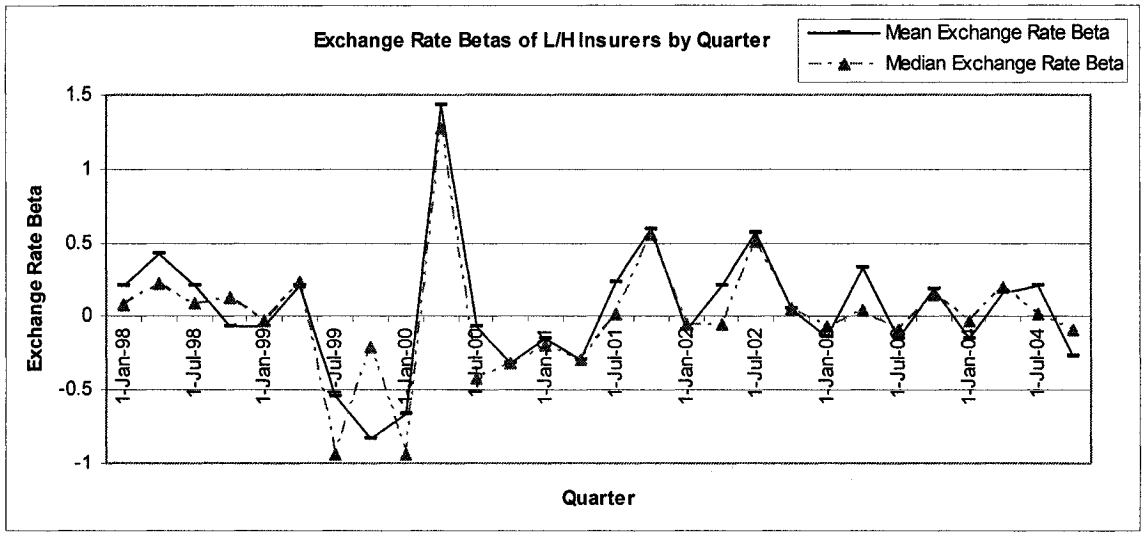

Figure 3.1.2.

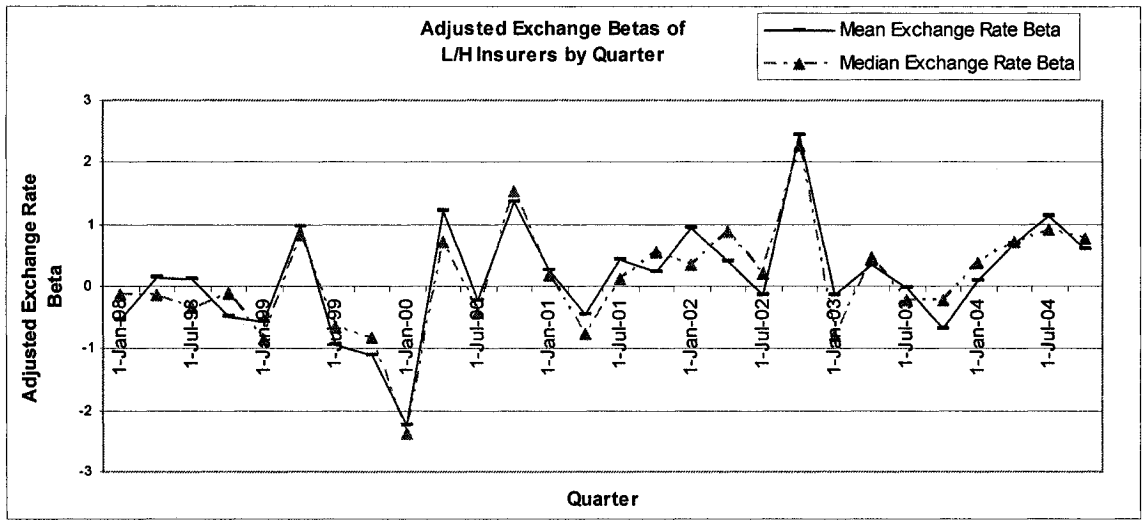

Figure 3.2.1.

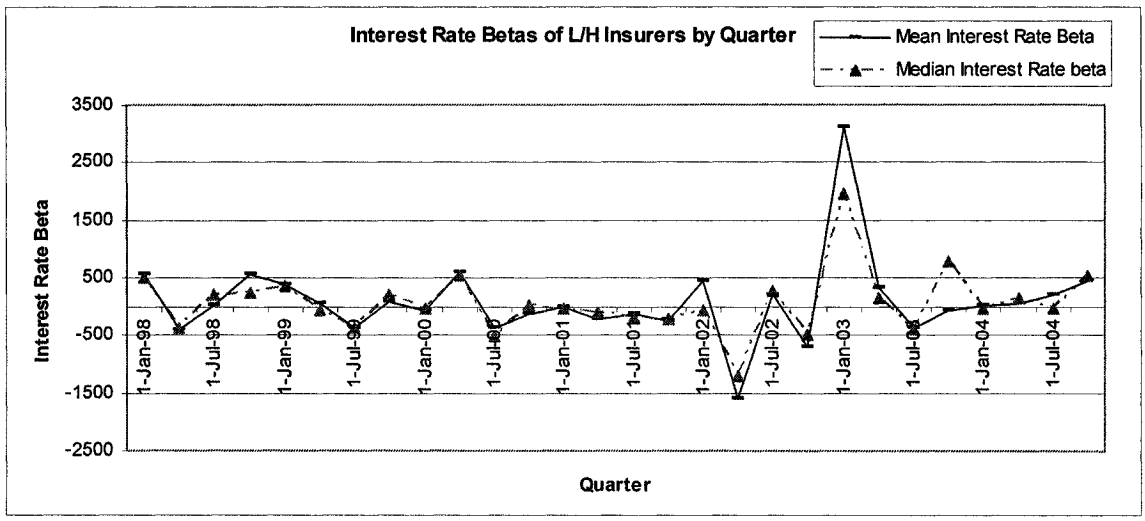

Figure 3.2.2.

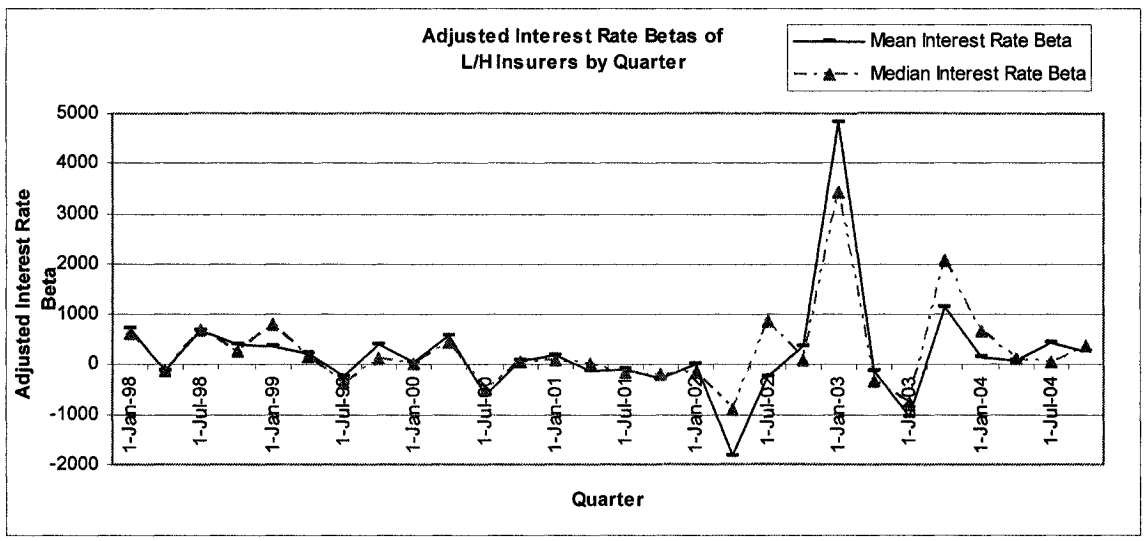

Figure 3.3.1.

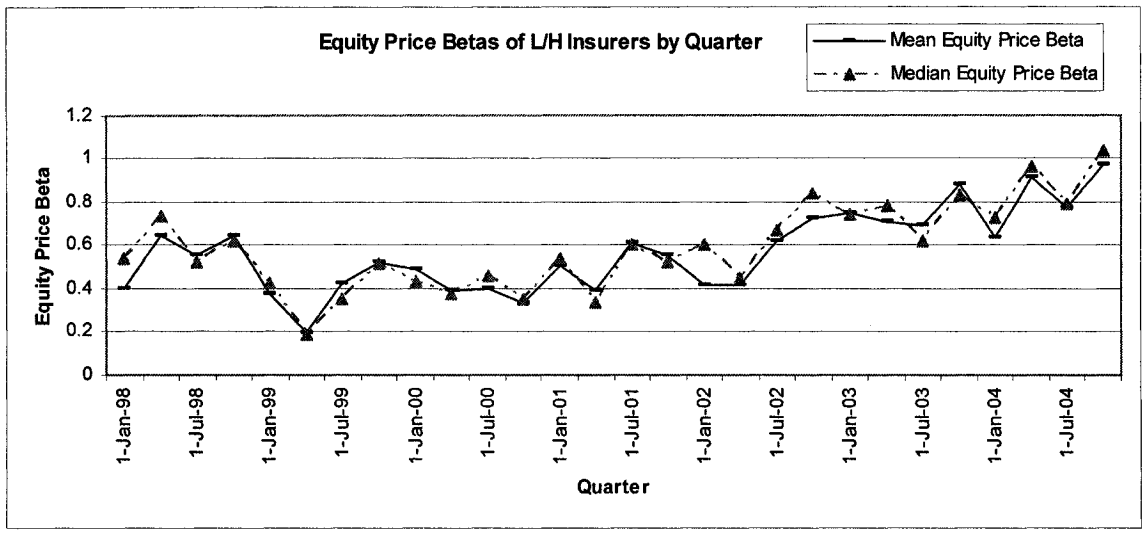

Figure 3.3.2.

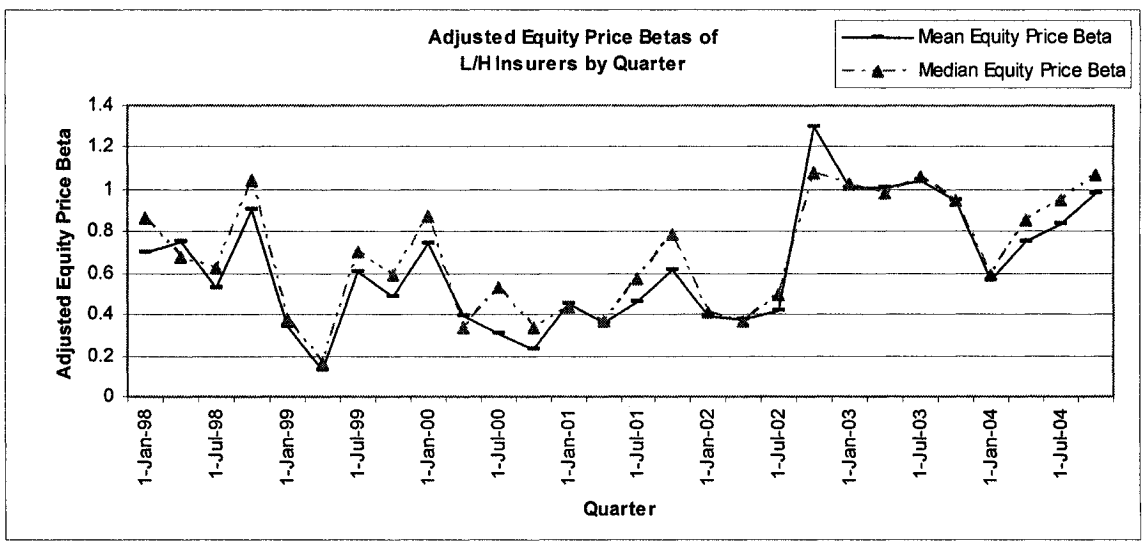

Figure 3.4.1.

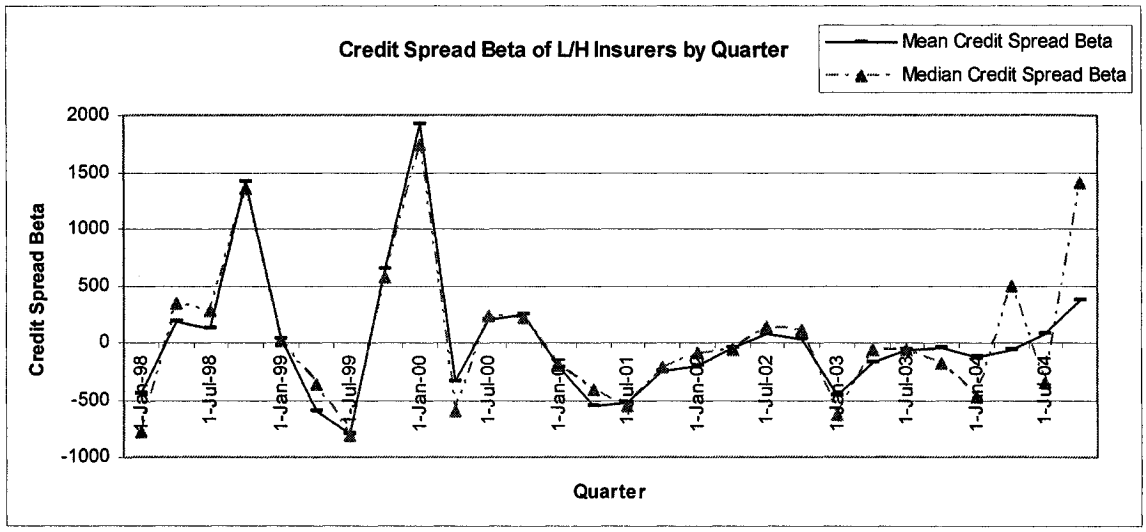

Figure 3.4.2.

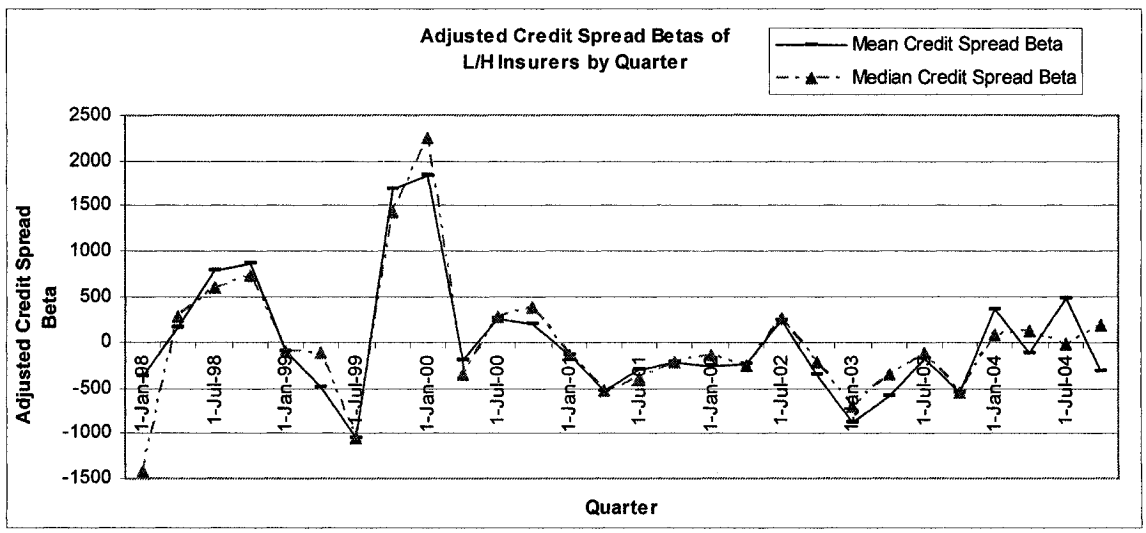

Figure 4.1.

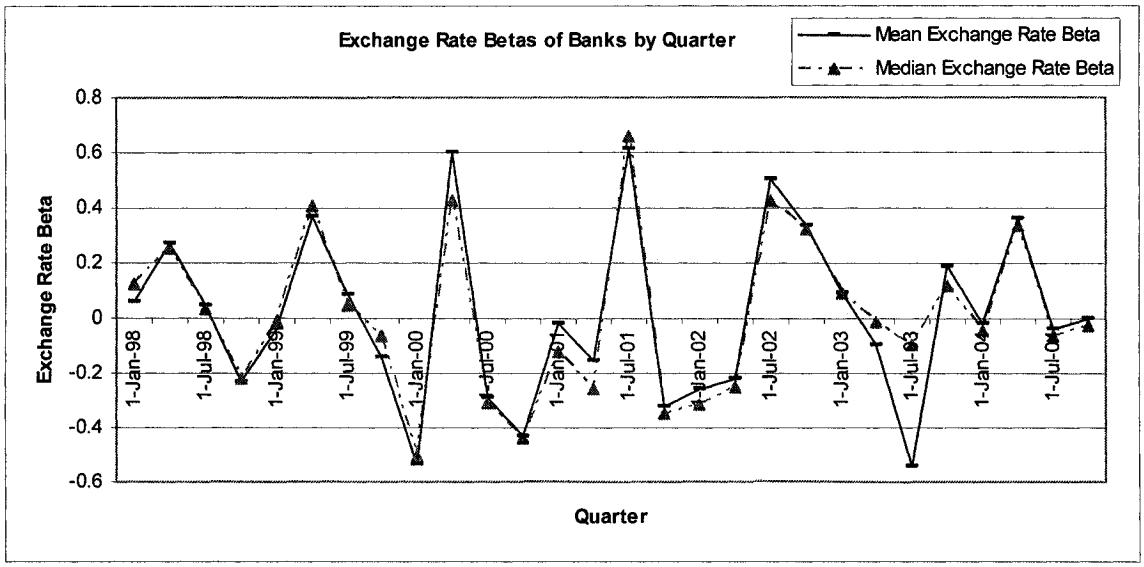

Figure 4.2.

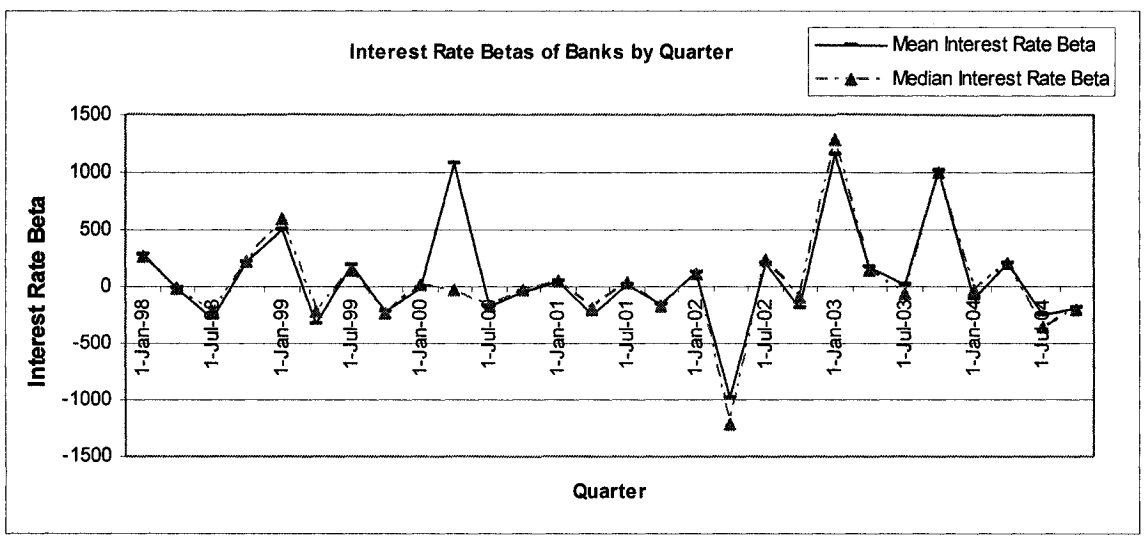

Figure 4.3.

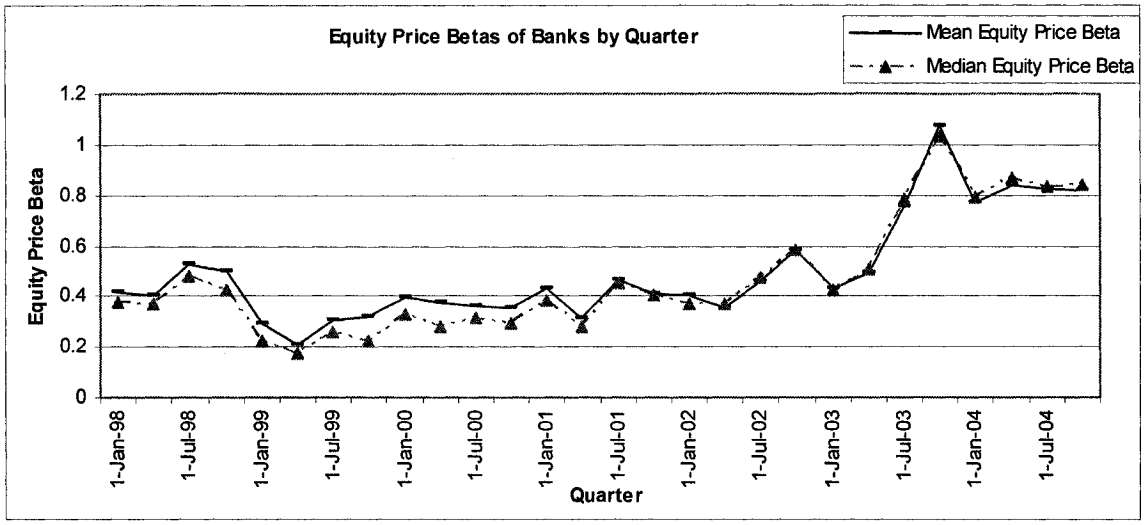

Figure 4.4.

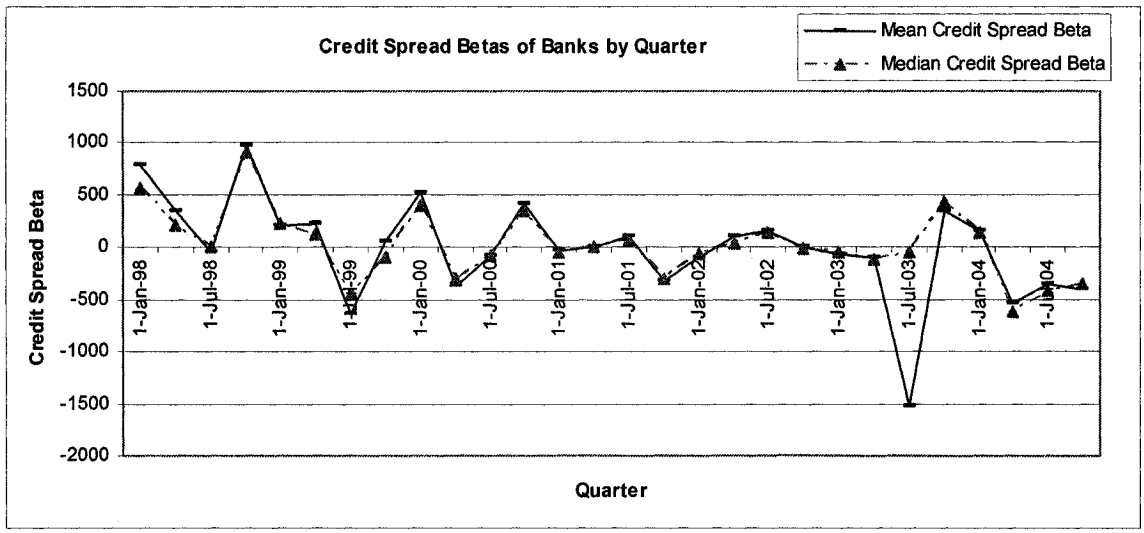

Table 3: Mean and median of insurers' annual market risk exposures

Panel A: Exchange rate risk exposures					
		PC		LH	
		Mean	Median	Mean	Median
Unadjusted	whole period	-0.0301	-0.0187	0.0571	-0.0124
	1998-2000	-0.0760	-0.0735	0.0066	-0.0296
	2001	-0.1055	-0.1772	-0.0200	-0.0392
	2002-2004	0.0409	0.0242	0.1327	0.0454
Dimson	whole period	-0.0432	-0.0555	0.1040	0.0364
	1998-2000	-0.1792	-0.2073	-0.1944	-0.3052
	2001	-0.1348	-0.0922	-0.0839	-0.1960
	2002-2004	0.1232	0.1449	0.4617	0.4685

Panel B: Interest rate risk exposures					
		P/C		L/H	
		Mean	Median	Mean	Median
Unadjusted	whole period	39.7277	11.9654	38.0041	14.0026
	1998-2000	68.7052	61.8807	94.2754	56.8946
	2001	0.5292	-3.0982	3.1276	2.3094
	2002-2004	23.8164	2.8861	-5.9949	14.2530
Dimson	whole period	26.0011	7.5189	-1457.4888	-7.3965
	1998-2000	48.5827	40.5223	108.7701	25.4820
	2001	3.8406	-2.4629	-10484.3404	-8094.0194
	2002-2004	10.8064	-2.5447	3.2058	23.3897

Panel C: Equity price risk exposures					
		P/C		L/H	
		Mean	Median	Mean	Median
Unadjusted	whole period	0.5798	0.5694	0.5813	0.5579
	1998-2000	0.4723	0.4340	0.4588	0.4101
	2001	0.5229	0.5423	0.4996	0.5033
	2002-2004	0.7063	0.7242	0.7296	0.7676
Dimson	whole period	0.6304	0.6173	0.6318	0.5751
	1998-2000	0.5554	0.5124	0.5390	0.4848
	2001	0.4864	0.4818	0.4398	0.4494
	2002-2004	0.7536	0.7633	0.7874	0.7345

Table 3: Mean and median of insurers' annual market risk exposures (Continued)

Panel D: Credit risk exposures					
		P/C		L/H	
		Mean	Median	Mean	Median
Unadjusted	**whole period**	-77.6337	-35.3505	-77.3489	-54.0158
	1998-2000	-21.9882	31.5135	36.6876	60.5590
	2001	-206.6606	-199.4653	-168.3486	-176.8103
	2002-2004	-90.2703	-37.5182	-159.7413	-78.0057
Dimson	**whole period**	-75.6607	-36.6064	-434.4147	-51.5872
	1998-2000	-50.9277	10.8048	41.3874	40.6056
	2001	-157.8768	-138.0246	-2661.5694	-4343.0694
	2002-2004	-72.9883	-37.0941	-162.3630	-65.9237

Table 4: Summary of variables used to test insurers' market risk exposures

Panel A: Exchange rate risk		
Variables	**Expected sign**	**Proxy**
HEDGE_EX	-	Dummy variable which equals to 1 if the company uses derivatives to hedge exchange rate risk, and 0 otherwise
FOREIGN_PRE	+	Percentage of net premiums generated from international busines
FOREIGN_BONDS	+	Amount of investments invested in foreign bonds. This variable is size-adjusted (i.e. divided by total assets).
SIZE	+	Total assets of the company
REINSURANCE	+/-	Amount of premiums that is ceded to reinsurers. This variable is size-adjusted (i.e. divided by total assets
DUM9/11	-	Dummy variable which equals to 1 if the exposure calculated is from 2002-2004, and 0 otherwise

Panel B: Interest rate risk		
Variables	**Expected sign**	**Proxy**
HEDGE_INT	-	Dummy variable which equals to 1 if the company uses derivatives to hedge interest rate risk, and 0 otherwise
FIXED_INV	+	Percentage of total investments that is invested in fixed-income securities.
CHANGE_FIXED	+	Total amount of fixed-income securities purchased minus total amount of sold during that period. This variable is size-adjusted (i.e. divided by total assets)
SIZE	+	Total assets of the company
REINSURANCE	+/-	Amount of premiums that is ceded to reinsurers. This variable is size-adjusted (i.e. divided by total assets
DUM9/11	-	Dummy variable which equals to 1 if the exposure calculated is from 2002-2004, and 0 otherwise

Table 4: Summary of variables used to test insurers' market risk exposures (Continued)

Panel C: Equity price risk		
Variables	**Expected sign**	**Proxy**
HEDGE_EQ	-	Dummy variable which equals to 1 if the company uses derivatives to hedge equity risk, and 0 otherwise
EQ_INV	+	Total amount of investments invested in equity securities. This variables is size-adjusted (i.e. divided by total assets)
CHANGE_EQ	+	Total amount of equity securities purchased minus total amount of sold during that period. This variable is size-adjusted (i.e. divided by total assets)
SIZE	+	Total assets of the company
REINSURANCE	+/-	Amount of premiums that is ceded to reinsurers. This variable is size-adjusted (i.e. divided by total assets)
DUM9/11	-	Dummy variable which equals to 1 if the exposure calculated is from 2002-2004, and 0 otherwise

Panel D: Credit risk		
Variables	**Expected sign**	**Proxy**
HEDGE_CR	-	Dummy variable which equals to 1 if the company uses derivatives to hedge credit risk, and 0 otherwise
FIXED_INV	+	Percentage of total investments that is invested in fixed-income securities.
FIXED_GRADE	+	Percentage of total fixed-income securities investments that is invested in non-investment grade bonds.
SIZE	+	Total assets of the company
REINSURANCE	+/-	Amount of premiums that is ceded to reinsurers. This variable is size-adjusted (i.e. divided by total assets)
DUM9/11	-	Dummy variable which equals to 1 if the exposure calculated is from 2002-2004, and 0 otherwise

Table 5: Mean and median of some of the characteristics of insurers included in our sample

Panel A: P/C	Mean *(in thousand, except percentage)*	Median *(in thousand, except percentage)*	Mean *(size adjusted)*	Median *(size adjusted)*
Total assets	19712890.29	2670089.00		
Premiums ceded	505109.04	106556.00	0.0601	0.0353
Percentage of net premiums from foreign business	0.1222	0.0000		
Foreign government fixed maturity securities	834560.90	499.00	0.0174	0.0004
Percentage of investment in fixed income securities	0.7934	0.8370		
Purchase of fixed income security	5863761.50	580116.50	0.3158	0.2146
Sales of fixed income security	5086543.44	402096.50	0.2710	0.1687
Net change in fixed income securities	777218.06	85784.50	0.0448	0.0373
Equity security	1457557.56	173600.00	0.0880	0.0394
Purchase of equity security	449049.30	45800.00	0.1292	0.0142
Sales of equity security	483320.49	50768.00	0.0809	0.0145
Net change in equity securities	-34271.19	0.0000	0.0483	0.0000
Percentage of fixed income securities that are non investment grade bonds	0.0357	0.0110		

Table 5: Mean and median of some of the characteristics of insurers included in our sample (Continued)

Panel B: L/H				
	Mean *(in thousand, except percentage)*	**Median** *(in thousand, except percentage)*	**Mean** *(size adjusted)*	**Median** *(size adjusted)*
Total assets	19423202.02	4817356.00		
Premiums ceded	2250725.75	43342.00	0.1000	0.0084
Percentage of net premiums from foreign business	0.1024	0.0000		
Foreign government fixed maturity securities	1077483.80	10862.00	0.0319	0.0012
Percentage of investment in fixed income securities	0.7969	0.8210		
Purchase of fixed income security	2714717.05	1147931.00	0.2301	0.1650
Sales of fixed income security	2226298.28	852116.00	0.1958	0.1199
Net change in fixed income securities	488418.77	151127.00	0.0343	0.0312
Equity security	1031906.65	36494.00	0.0154	0.0058
Purchase of equity security	53191.48	14662.00	0.0149	0.0016
Sales of equity security	56134.97	17502.37	0.0156	0.0023
Net change in equity securities	-2943.49	63.19	-0.0007	0.0000
Percentage of fixed income securities that are non investment grade bonds	0.0482	0.0500		

Table 6: Correlation matrix of independent variables used to test risk exposures of P/C insurers

Panel A: Exchange rate risk						
	HEDGE_EX	*FOREIGN_PRE*	*FOREIGN_BONDS*	*SIZE*	*REINSURANCE*	*DUM9/11*
HEDGE_EX	1.0000					
FOREIGN_PRE	0.3915	1.0000				
FOREIGN_BONDS	0.4472	0.5155	1.0000			
SIZE	0.4815	0.2704	0.2349	1.0000		
REINSURANCE	-0.1023	-0.0920	-0.0386	-0.1368	1.0000	
DUM9/11	-0.0084	-0.0166	0.1132	0.0496	0.0259	1.0000

Panal B: Interest rate risk						
	HEDGE_INT	*FIXED_INV*	*CHANGE_FIXED*	*SIZE*	*REINSURANCE*	*DUM9/11*
HEDGE_INT	1.0000					
FIXED_INV	-0.0425	1.0000				
CHANGE_FIXED	-0.0862	0.1597	1.0000			
SIZE	0.3556	-0.1972	-0.0070	1.0000		
REINSURANCE	-0.2495	0.0709	0.1003	-0.1335	1.0000	
DUM9/11	0.1138	0.0218	0.2646	0.0373	0.0138	1.0000

Panel C: Equity price risk						
	HEDGE_EQ	*EQ_INV*	*CHANGE_EQ*	*SIZE*	*REINSURANCE*	*DUM9/11*
HEDGE_EQ	1.0000					
EQ_INV	-0.0376	1.0000				
CHANGE_EQ	-0.0134	-0.0041	1.0000			
SIZE	0.5039	-0.0150	-0.0088	1.0000		
REINSURANCE	-0.0554	-0.0250	0.0166	-0.1316	1.0000	
DUM9/11	0.0281	0.0185	-0.0216	0.0500	0.0209	1.0000

Panel D: Credit risk						
	HEDGE_CR	*FIXED_INV*	*FIXED_GRADE*	*SIZE*	*REINSURANCE*	*DUM9/11*
HEDGE_CR	1.0000					
FIXED_INV	-0.0610	1.0000				
FIXED_GRADE	0.1189	-0.0893	1.0000			
SIZE	0.1607	-0.0797	0.1830	1.0000		
REINSURANCE	-0.1032	-0.0272	-0.1205	-0.0479	1.0000	
DUM9/11	0.1551	0.0628	-0.0748	0.1180	-0.0307	1.0000

Table 7: Correlation matrix of independent variables used to test risk exposures of L/H insurers

Panel A: Exchange rate risk

	HEDGE_EX	*FOREIGN_PRE*	*FOREIGN_BONDS*	*SIZE*	*REINSURANCE*	*DUM9/11*
HEDGE_EX	1.0000					
FOREIGN_PRE	0.3423	1.0000				
FOREIGN_BONDS	0.3568	0.7487	1.0000			
SIZE	0.7915	0.0696	0.1445	1.0000		
REINSURANCE	-0.1285	-0.1022	-0.0616	0.0283	1.0000	
DUM9/11	0.0301	-0.0320	-0.0007	0.0481	-0.0277	1.0000

Panal B: Interest rate risk

	HEDGE_INT	*FIXED_INV*	*CHANGE_FIXED*	*SIZE*	*REINSURANCE*	*DUM9/11*
HEDGE_INT	1.0000					
FIXED_INV	0.0686	1.0000				
CHANGE_FIXED	-0.0177	0.4166	1.0000			
SIZE	0.5117	-0.0503	-0.0809	1.0000		
REINSURANCE	0.1578	-0.0194	-0.0226	0.0259	1.0000	
DUM9/11	0.1076	-0.0624	0.1459	0.0497	-0.0303	1.0000

Panel C: Equity price risk

	HEDGE_EQ	*EQ_INV*	*CHANGE_EQ*	*SIZE*	*REINSURANCE*	*DUM9/11*
HEDGE_EQ	1.0000					
EQ_INV	-0.1284	1.0000				
CHANGE_EQ	0.0166	0.0376	1.0000			
SIZE	0.2991	-0.2285	0.0518	1.0000		
REINSURANCE	0.1594	0.0434	0.0572	0.0261	1.0000	
DUM9/11	0.1423	-0.1289	0.0554	0.0534	-0.0308	1.0000

Panel D: Credit risk

	HEDGE_CR	*FIXED_INV*	*FIXED_GRADE*	*SIZE*	*REINSURANCE*	*DUM9/11*
HEDGE_CR	1.0000					
FIXED_INV	-0.0994	1.0000				
FIXED_GRADE	0.2746	0.0524	1.0000			
SIZE	0.4586	-0.2499	0.1819	1.0000		
REINSURANCE	-0.0790	0.0250	-0.0307	0.0251	1.0000	
DUM9/11	0.2694	0.0531	-0.0044	0.0469	-0.0316	1.0000

Table 8: Results of regressions testing P/C insurers' market risk exposures

Panel A: Exchange rate risk				
	1	2	3	4
	Unadjusted	**Unadjusted** *(without 2001)*	**Dimson**	**Dimson** *(without 2001)*
INTERCEPT	-0.0984	-0.0783	-0.1863	-0.1699
	*(-2.0957**)*	*(-1.5072)*	*(-2.5140**)*	*(-2.0586**)*
HEDGE_EX	0.0364	0.0401	0.0458	0.0550
	(-0.4188)	*(-0.4295)*	*(0.3333)*	*(0.3708)*
FOREIGN_PRE	-0.0515	-0.1178	-0.1062	-0.2652
	(-0.3589)	*(-0.7944)*	*(-0.4688)*	*(-1.1257)*
FOREIGN_BONDS	-0.8274	-0.9600	-1.0774	-1.0334
	(-0.8377)	*(-0.9632)*	*(-0.6908)*	*(-0.6525)*
SIZE	9.9411E-11	-1.3831E-10	4.1235E-10	1.9849E-10
	(0.1784)	*(-0.2254)*	*(0.4686)*	*(0.2036)*
REINSURANCE	0.0686	-0.0050	0.0721	-0.1382
	(0.2028)	*(-0.0142)*	*(0.1348)*	*(-0.2448)*
DUM9/11	0.1396	0.1396	0.2986	0.3162
	*(2.4082**)*	*(2.2909**)*	*(3.2621***)*	*(3.2646***)*
Adjusted R Square	0.0020	0.0048	0.0138	0.0203
Observations	423	363	423	363

* Significant at the 10% level, ** Significant at the 5% level, *** Significant at the 1% level (two-tail test)

Table 8: Results of regressions testing P/C insurers' market risk exposures (Continued)

Panel B: Interest rate risk				
	1	2	3	4
	Unadjusted	**Unadjusted** *(without 2001)*	**Dimson**	**Dimson** *(without 2001)*
INTERCEPT	53.0546 *(0.7782)*	65.8100 *(0.8329)*	30.4640 *(0.4746)*	41.2090 *(0.5534)*
HEDGE_INT	-5.0184 *(-0.1615)*	-5.3922 *(-0.1490)*	-3.6018 *(-0.1231)*	-3.6656 *(-0.1075)*
FIXED_INV	14.9316 *(0.1821)*	20.2569 *(0.2133)*	28.8431 *(0.3736)*	30.4933 *(0.3407)*
CHANGE_FIXED	106.5154 *(0.6675)*	221.4769 *(1.0715)*	127.1857 *(0.8465)*	245.9505 *(1.2627)*
SIZE	2.4937E-09 *(0.0100)*	3.5775E-08 *(0.1197)*	-3.0698E-09 *(-0.0131)*	3.2254E-08 *(0.1145)*
REINSURANCE	-269.0239 *(-1.6580*)*	-306.6100 *(-1.6423)*	-291.9577 *(-1.9110*)*	-333.9433 *(-1.8982*)*
DUM9/11	-23.2648 *(-0.8206)*	-46.3679 *(-1.3839)*	-26.1537 *(-0.9797)*	-44.4594 *(-1.4082)*
Adjusted R Square	-0.0055	-0.0025	-0.0020	0.0012
Observations	416	356	416	356

* Significant at the 10% level, ** Significant at the 5% level, *** Significant at the 1% level (two-tail test)

Table 8: Results of regressions testing P/C insurers' market risk exposures (Continued)

Panel C: Equity price risk				
	1	2	3	4
	Unadjusted	**Unadjusted** *(without 2001)*	**Dimson**	**Dimson** *(without 2001)*
INTERCEPT	0.5194 *(19.3250***)*	0.4924 *(16.4174***)*	0.5778 *(16.3152***)*	0.5940 *(15.3948***)*
HEDGE_EQ	0.1243 *(2.6273***)*	0.1363 *(2.6774***)*	0.1273 *(2.0429**)*	0.1331 *(2.0328**)*
EQ_INV	-0.0804 *(-1.6163)*	-0.0768 *(-1.5427)*	-0.1074 *(-1.6390)*	-0.1092 *(-1.7058*)*
CHANGE_EQ	-5.0234E-03 *(-0.5713)*	-5.1823E-03 *(-0.5364)*	-4.5003E-03 *(-0.3884)*	-5.5232E-03 *(-0.4444)*
SIZE	4.2304E-10 *(1.3376)*	5.6154E-10 *(1.5743)*	4.8773E-10 *(1.1703)*	7.2659E-10 *(1.5835)*
REINSURANCE	-0.8299 *(-4.1485***)*	-0.7420 *(-3.5159***)*	-0.9102 *(-3.4531***)*	-0.8911 *(-3.2826***)*
DUM9/11	0.2358 *(7.1120***)*	0.2509 *(7.0978***)*	0.2379 *(5.4456***)*	0.2138 *(4.7022***)*
Adjusted R Square	0.2067	0.2300	0.1367	0.1448
Observations	331	284	331	284

* Significant at the 10% level, ** Significant at the 5% level, *** Significant at the 1% level (two-tail test)

Table 8: Results of regressions testing P/C insurers' market risk exposures (Continued)

Panel D: Credit risk				
	1	2	3	4
	Unadjusted	**Unadjusted** *(without 2001)*	**Dimson**	**Dimson** *(without 2001)*
INTERCEPT	-103.4917 *(-2.7601***)*	-69.5970 *(-1.6016)*	-86.2013 *(-2.3476**)*	-72.0504 *(-1.7027*)*
HEDGE_CR	-4.7437 *(-0.0598)*	57.6531 *(0.6454)*	14.8336 *(0.1911)*	63.2303 *(0.7269)*
FIXED_INV	2.1831 *(1.96208**)*	2.0735 *(1.6898*)*	1.1801 *(1.0830)*	1.8361 *(1.5365)*
FIXED_GRADE	330.4239 *(0.8765)*	385.1663 *(0.8864)*	298.6303 *(0.8089)*	365.0507 *(0.8627)*
SIZE	-1.0813E-07 *(-0.0424)*	-1.3807E-08 *(-0.0050)*	-4.9590E-07 *(-0.1984)*	-7.7797E-07 *(-0.2848)*
REINSURANCE	30.6464 *(0.3062)*	40.8218 *(0.3698)*	-5.9705 *(-0.0609)*	-20.5911 *(-0.1916)*
DUM9/11	-16.3564 *(-0.4000)*	-60.8353 *(-1.3306)*	-2.8880 *(-0.0721)*	-24.8830 *(-0.5589)*
Adjusted R Square	-0.0036	-0.0017	-0.0108	-0.0064
Observations	391	335	391	335

* Significant at the 10% level, ** Significant at the 5% level, *** Significant at the 1% level (two-tail test)

Table 9: Results of regressions testing L/H insurers' market risk exposures

Panel A: Exchange rate risk				
	1	2	3	4
	Unadjusted	**Unadjusted** *(without 2001)*	**Dimson**	**Dimson** *(without 2001)*
INTERCEPT	-0.0026	0.0237	-0.0832	-0.1273
	(-0.0302)	*(-0.2450)*	*(-0.6053)*	*(-0.8793)*
HEDGE_EX	0.0350	0.0845	-0.3836	-0.4246
	(0.1474)	*(0.3292)*	*(-1.0057)*	*(-1.1055)*
FOREIGN_PRE	0.1090	-0.0485	1.1888	1.2455
	(0.2484)	*(-0.1051)*	*(1.6849*)*	*(1.8038*)*
FOREIGN_BONDS	0.1771	-0.0884	-1.7069	-1.6348
	(0.2333)	*(-0.1092)*	*(-1.3987)*	*(-1.3499)*
SIZE	-1.3879E-09	-1.9140E-09	9.2994E-11	-1.2159E-10
	(-0.4406)	*(-0.5703)*	*(0.0184)*	*(-0.02421)*
REINSURANCE	-0.1180	-0.1171	-0.3688	-0.2867
	(-0.7936)	*(-0.7358)*	*(-1.5434)*	*(-1.2033)*
DUM9/11	0.0264	0.0223	0.4694	0.5133
	(0.2485)	*(0.1956)*	*(2.7439**)*	*(3.0121***)*
Adjusted R Square	-0.0227	-0.0307	0.0471	0.0620
Observations	191	163	191	163

* Significant at the 10% level, ** Significant at the 5% level, *** Significant at the 1% level (two-tail test)

Table 9: Results of regressions testing L/H insurers' market risk exposures (Continued)

Panel B: Interest rate risk				
	1	2	3	4
	Unadjusted	**Unadjusted** *(without 2001)*	**Dimson**	**Dimson** *(without 2001)*
INTERCEPT	38.2433	56.3769	-2258.8698	76.4759
	(-0.8274)	*(1.0123)*	*(-2.7602***)*	*(1.3146)*
HEDGE_INT	63.4058	88.0335	-669.6828	111.3744
	(0.9677)	*(1.1531)*	*(-0.5772)*	*(1.3964)*
FIXED_INV	-2.7483	-3.5973	53.4434	-5.0371
	(-0.6406)	*(-0.7666)*	*(0.7036)*	*(-1.0276)*
CHANGE_FIXED	187.4990	281.9709	-5795.6497	406.4595
	(0.4441)	*(0.5845)*	*(-0.7753)*	*(0.8067)*
SIZE	2.6795E-07	2.1161E-07	2.8092E-06	-3.8532E-07
	(0.2486)	*(0.1701)*	*(0.1472)*	*(-0.2966)*
REINSURANCE	18.2819	16.9265	-502.9307	-11.4613
	(0.2403)	*(0.1916)*	*(-0.3733)*	*(-0.1242)*
DUM9/11	-85.3152	-119.9103	2856.8154	-141.4063
	(-1.5018)	*(-1.8068*)*	*(2.8402***)*	*(-2.0396**)*
Adjusted R Square	-0.0113	-0.0057	0.0131	-0.0005
Observations	192	164	192	164

* Significant at the 10% level, ** Significant at the 5% level, *** Significant at the 1% level (two-tail test)

Table 9: Results of regressions testing L/H insurers' market risk exposures (Continued)

Panel C: Equity price risk				
	1	2	3	4
	Unadjusted	**Unadjusted** *(without 2001)*	**Dimson**	**Dimson** *(without 2001)*
INTERCEPT	0.4694	0.4545	0.5216	0.5472
	*(11.7250***)*	*(9.5297***)*	*(9.9295***)*	*(8.8214***)*
HEDGE_EQ	-0.1635	-0.1588	-0.1794	-0.1872
	*(-3.2206***)*	*(-2.7338***)*	*(-2.6933***)*	*(-2.4773**)*
EQ_INV	-2.3774	-2.3347	-2.8885	-3.0584
	*(-2.9244***)*	*(-2.5470**)*	*(-2.7079***)*	*(-2.5652**)*
CHANGE_EQ	4.4080	3.7419	10.0554	10.0572
	(1.3516)	*(1.0164)*	*(2.3497**)*	*(2.1002**)*
SIZE	5.2752E-09	5.4915E-09	6.3457E-09	6.9488E-09
	*(6.4923***)*	*(5.9620***)*	*(5.9520***)*	*(5.8001***)*
REINSURANCE	0.1059	0.1085	0.0424	0.0423
	(1.6861)*	*(1.5283)*	*(0.5145)*	*(0.4585)*
DUM9/11	0.2286	0.2360	0.2301	0.1969
	*(4.9084***)*	*(4.4632***)*	*(3.7653***)*	*(2.8635***)*
Adjusted R Square	0.3167	0.3044	0.2702	0.2646
Observations	331	284	331	284

* Significant at the 10% level, ** Significant at the 5% level, *** Significant at the 1% level (two-tail test)

Table 9: Results of regressions testing L/H insurers' market risk exposures (Continued)

Panel D: Credit risk				
	1	2	3	4
	Unadjusted	**Unadjusted** *(without 2001)*	**Dimson**	**Dimson** *(without 2001)*
INTERCEPT	80.0464	124.5502	89.9458	124.5502
	(0.4015)	*(0.5515)*	*(0.0424)*	*(0.5515)*
HEDGE_CR	11.3900	25.2666	-941.8171	25.2666
	(0.0803)	*(0.1604)*	*(-0.6230)*	*(0.1604)*
FIXED_INV	-117.9867	-104.4997	-1310.5882	-104.4997
	(-0.5066)	*(-0.3955)*	*(-0.5282)*	*(-0.3955)*
FIXED_GRADE	-92.0193	-282.1650	-3883.9254	-282.1650
	(-0.0724)	*(-0.2031)*	*(-0.2868)*	*(-0.2031)*
SIZE	3.8825E-07	6.1524E-07	2.7517E-05	6.1524E-07
	(0.2829)	*(0.4019)*	*(1.8824*)*	*(0.4019)*
REINSURANCE	64.2859	74.5734	286.3633	74.5734
	(0.6672)	*(0.6959)*	*(0.2790)*	*(0.6959)*
DUM9/11	-163.3651	-217.9515	584.1051	-217.9515
	*(-2.2027**)*	*(-2.6320***)*	*(0.7393)*	*(-2.6321***)*
Adjusted R Square	0.0017	0.0162	-0.0041	0.0072
Observations	191	163	191	163

* Significant at the 10% level, ** Significant at the 5% level, *** Significant at the 1% level (two-tail test)

Table 10: Definition of independent variables used to test insurers' use of derivatives, hypothesis that we test and the expected sign

Variable	Hypothesis	Participation decision	Proxy
LIQUIDITY	Financial distress	-	cash-to-asset ratio.
LEVERAGE	Financial distress	+	ratio of net written premiums to surplus.
REINSURANCE	Use of alternative hedging method	+/-	ratio of reinsurance ceded to total direct premiums plus reinsurance assumed.
GROWTH	Loss of investment opportunities	+	growth in revenue.
SIZE	Economies of scale	+	logarithm of total assets as proxy.
DUM9/11	Increase in underwriting risks	+	dummy variable that will be equal to 1 if the observation is taken from years after 9/11/2001 and 0 otherwise.

Table 11: Statistics of independent variables used in testing insurers' use of derivatives

	P/C		L/H	
	Mean	**Median**	**Mean**	**Median**
LIQUIDITY	0.0290	0.0110	0.0292	0.0125
LEVERAGE	1.3010	1.2398	6.3362	1.5288
REINSURANCE	0.1960	0.1362	0.1718	0.1179
GROWTH	0.1464	0.1056	0.1321	0.0878
SIZE	15.0186	14.7596	15.4903	15.4033

Table 12: Correlation matrix of independent variables used in regressions testing insurers' use of derivatives

Panel A: P/C

	LIQUIDITY	LEVERAGE	REINSURANCE	GROWTH	SIZE	DUM9/11
LIQUIDITY	1.0000					
LEVERAGE	0.3101	1.0000				
REINSURANCE	-0.0908	-0.2858	1.0000			
GROWTH	0.0780	0.0129	0.0909	1.0000		
SIZE	-0.0631	0.0423	-0.1002	0.0912	1.0000	
DUM9/11	0.1084	0.1200	-0.0577	0.0340	0.1211	1.0000

Panel B: L/H

	LIQUIDITY	LEVERAGE	REINSURANCE	GROWTH	SIZE	DUM9/11
LIQUIDITY	1.0000					
LEVERAGE	-0.0992	1.0000				
REINSURANCE	-0.1342	0.0416	1.0000			
GROWTH	0.1065	-0.0385	0.1202	1.0000		
SIZE	-0.5518	0.1767	0.0970	-0.1375	1.0000	
DUM9/11	-0.0007	0.0259	-0.0667	0.0265	0.0856	1.0000

Table 13: Results of regressions testing P/C insurers' use of derivatives

Panel A: Exchange rate risk		
	1998-2004	**1998-2004** *without 2001*
INTERCEPT	-1.8308 *(-13.0853***)*	-1.7967 *(-11.9378***)*
LIQUIDITY	1.0292 *(2.9481***)*	1.0786 *(2.8778***)*
LEVERAGE	-0.0547 *(-2.7406***)*	-0.0661 *(-3.0424***)*
REINSURANCE	0.1148 *(1.4180)*	0.0227 *(0.2658)*
GROWTH	-0.0054 *(-0.0797)*	0.0860 *(1.0102)*
SIZE	0.1392 *(15.4603***)*	0.1389 *(14.2555***)*
DUM9/11	-0.0771 *(-2.3645**)*	-0.0896 *(-2.5466**)*
Adj R Square	0.3738	0.3783
Observations	407	349

Panel B: Interest rate risk		
	1998-2004	**1998-2004** *without 2001*
INTERCEPT	-1.7946 *(-10.3770***)*	-1.7664 *(-9.3819***)*
LIQUIDITY	0.1487 *-0.3446*	0.2550 *-0.5439*
LEVERAGE	-0.0676 *(-2.7424***)*	-0.0752 *(-2.7693***)*
REINSURANCE	-0.0426 *(-0.4254)*	-0.0449 *(-0.4193)*
GROWTH	0.0727 *(-0.8684)*	0.0693 *(-0.6504)*
SIZE	0.1484 *(13.3354***)*	0.1471 *(12.0701***)*
DUM9/11	0.0073 *(-0.1818)*	0.0069 *(-0.1558)*
Adj R Square	0.3167	0.3070
Observations	407	349

* Significant at the 10% level, ** Significant at the 5% level, *** Significant at the 1% level (two-tail test)

Table 13: Results of regressions testing P/C insurers' use of derivatives (Continued)

Panel C: Equity price risk		
	1998-2004	**1998-2004** *without 2001*
INTERCEPT	-2.0279 *(-16.2947***)*	-2.0300 *(-15.1548***)*
LIQUIDITY	1.0529 *(3.3909***)*	1.1401 *(3.4178***)*
LEVERAGE	-0.0047 *(-0.2629)*	-0.0089 *(-0.4597)*
REINSURANCE	0.0451 *(-0.6262)*	0.0188 *(-0.2467)*
GROWTH	-0.0236 *(-0.3924)*	0.0439 *(-0.5796)*
SIZE	0.1469 *(18.3375***)*	0.1478 *(17.0408***)*
DUM9/11	-0.0588 *(-2.0270**)*	-0.0734 *(-2.3439**)*
Adj R Square	0.454500714	0.461535134
Observations	407	349

Panel D: Credit risk		
	1998-2004	**1998-2004** *without 2001*
INTERCEPT	-0.5262 *(-5.7419***)*	-0.5308 *(-5.3610***)*
LIQUIDITY	-0.4809 *(-2.1032**)*	-0.4947 *(-2.0065**)*
LEVERAGE	-0.0062 *(-0.4769)*	-0.0059 *(-0.4107)*
REINSURANCE	-0.0442 *(-0.8326)*	-0.0308 *(-0.5470)*
GROWTH	-0.0671 *(-1.5123)*	-0.0805 *(-1.4376)*
SIZE	0.0392 *(6.6503***)*	0.0387 *(6.0319***)*
DUM9/11	0.0722 *(3.3802***)*	0.0849 *(3.6676***)*
Adj R Square	0.1394	0.1441
Observations	407	349

* Significant at the 10% level, ** Significant at the 5% level, *** Significant at the 1% level (two-tail test)

Table 13: Results of regressions testing P/C insurers' use of derivatives (Continued)

Panel E: All exposures		
	1998-2004	**1998-2004** *without 2001*
INTERCEPT	-1.8760 *(-10.6836***)*	-1.8163 *(-9.4932***)*
LIQUIDITY	0.5802 *(-1.3243)*	0.7221 *(-1.5156)*
LEVERAGE	-0.0847 *(-3.3807***)*	-0.0946 *(-3.4263***)*
REINSURANCE	0.0829 *(-0.8160)*	0.0143 *(-0.1311)*
GROWTH	0.0746 *(-0.8778)*	0.1085 *(-1.0022)*
SIZE	0.1570 *(13.8898***)*	0.1541 *(12.4417***)*
DUM9/11	0.0001 *(-0.0014)*	0.0003 *(-0.0060)*
Adj R Square	0.334610953	0.322610825
Observations	407	349

Panel F: Extent of hedging		
	1998-2004	**1998-2004** *without 2001*
INTERCEPT	-6.1795 *(-17.7549***)*	-6.1240 *(-16.1443***)*
LIQUIDITY	1.7498 *(2.0150**)*	1.9789 *(2.0950**)*
LEVERAGE	-0.1332 *(-2.6840***)*	-0.1560 *(-2.8512***)*
REINSURANCE	0.0732 *(-0.3633)*	-0.0342 *(-0.1583)*
GROWTH	-0.0234 *(-0.1390)*	0.1187 *(-0.5531)*
SIZE	0.4737 *(21.1493***)*	0.4725 *(19.2394***)*
DUM9/11	-0.0564 *(-0.6950)*	-0.0712 *(-0.8034)*
Adj R Square	0.5282	0.5232
Observations	407	349

* Significant at the 10% level, ** Significant at the 5% level, *** Significant at the 1% level (two-tail test)

Table 14: Results of regressions testing L/H insurers' use of derivatives

Panel A: Exchange rate risk		
	1998-2004	**1998-2004** *without 2001*
INTERCEPT	-2.4998	-2.3822
	*(-10.4350***)*	*(-9.2518***)*
LIQUIDITY	2.3760	2.2521
	*(3.4527***)*	*(2.9004***)*
LEVERAGE	-0.0044	-0.0042
	*(-4.2328***)*	*(-3.7106***)*
REINSURANCE	0.5133	0.4824
	*(3.7328***)*	*(3.2295***)*
GROWTH	-0.1112	-0.1034
	(-1.2865)	*(-1.1438)*
SIZE	0.1681	0.1608
	*(11.4402***)*	*(10.1631***)*
DUM9/11	-0.0246	-0.0205
	(-0.5579)	*(-0.4241)*
Adj R Square	0.4796	0.4511
Observations	182	157

Panel B: Interest rate risk		
	1998-2004	**1998-2004** *without 2001*
INTERCEPT	-2.3032	-2.1349
	*(-6.7804***)*	*(-5.8507***)*
LIQUIDITY	3.9558	3.7355
	*(4.0540***)*	*(3.3947***)*
LEVERAGE	0.0030	0.0030
	*(2.0714**)*	*(1.9208**)*
REINSURANCE	0.1906	0.1917
	-0.9777	*(-0.9058)*
GROWTH	-0.1645	-0.1806
	(-1.3424)	*(-1.4096)*
SIZE	0.1697	0.1596
	*(8.1447***)*	*(7.1205***)*
DUM9/11	0.0370	0.0355
	(-0.5915)	*(-0.5172)*
Adj R Square	0.3082	0.2842
Observations	182	157

* Significant at the 10% level, ** Significant at the 5% level, *** Significant at the 1% level (two-tail test)

Table 14: Results of regressions testing L/H insurers' use of derivatives (Continued)

Panel C: Equity price risk		
	1998-2004	**1998-2004** *without 2001*
INTERCEPT	0.1631 *(-0.4368)*	0.1679 *(-0.4304)*
LIQUIDITY	-2.1065 *(-1.9633**)*	-2.6646 *(-2.2651**)*
LEVERAGE	0.0039 *(2.4235**)*	0.0036 *(2.1328**)*
REINSURANCE	-0.0061 *(-0.0282)*	0.0743 *(-0.3283)*
GROWTH	-0.0380 *(-0.2820)*	-0.0281 *(-0.2048)*
SIZE	0.0109 *(-0.4761)*	0.0088 *-0.3658*
DUM9/11	0.0997 *(-1.449)*	0.1324 *(1.8046*)*
Adj R Square	0.062119176	0.077050608
Observations	182	157

Panel D: Credit risk		
	1998-2004	**1998-2004** *without 2001*
INTERCEPT	-1.1504 *(-5.2685***)*	-1.1323 *(-4.8801***)*
LIQUIDITY	0.7562 *(-1.2056)*	0.5231 *(-0.7477)*
LEVERAGE	-0.0024 *(-2.5130**)*	-0.0024 *(-2.3903**)*
REINSURANCE	0.2498 *(1.9928**)*	0.2963 *(2.2014**)*
GROWTH	-0.0816 *(-1.0361)*	-0.0839 *(-1.0303)*
SIZE	0.0741 *(5.5327***)*	0.0720 *(5.0527***)*
DUM9/11	0.1459 *(3.6299***)*	0.1608 *(3.6840***)*
Adj R Square	0.236061364	0.250980884
Observations	182	157

* Significant at the 10% level, ** Significant at the 5% level, *** Significant at the 1% level (two-tail test)

Table 14: Results of regressions testing L/H insurers' use of derivatives (Continued)

Panel E: All exposures		
	1998-2004	**1998-2004** *without 2001*
INTERCEPT	-1.0154 *(-2.8168***)*	-0.8651 *(-2.2441**)*
LIQUIDITY	1.4370 *(-1.3877)*	0.8504 *(-0.7315)*
LEVERAGE	0.0017 *(-1.0928)*	0.0018 *(-1.0561)*
REINSURANCE	0.0919 *(-0.4441)*	0.1510 *(-0.6755)*
GROWTH	-0.1797 *(-1.3815)*	-0.1793 *(-1.3245)*
SIZE	0.1037 *(4.6900***)*	0.0926 *(3.9115***)*
DUM9/11	0.0502 *(-0.7563)*	0.0807 *(-1.1127)*
Adj R Square	0.133229922	0.122839854
Observations	182	157

Panel F: Extent of hedging		
	1998-2004	**1998-2004** *without 2001*
INTERCEPT	-5.7902 *(-8.3800***)*	-5.4815 *(-7.2877***)*
LIQUIDITY	4.9815 *(2.5098**)*	3.8461 *(1.6956*)*
LEVERAGE	0.0002 *(-0.0667)*	0.0001 *(-0.0304)*
REINSURANCE	0.9477 *(2.3893**)*	1.0446 *(2.3943**)*
GROWTH	-0.3954 *(-1.5858)*	-0.3960 *(-1.4994)*
SIZE	0.4229 *(9.9761***)*	0.4012 *(8.6818***)*
DUM9/11	0.2580 *(2.0277**)*	0.3081 *(2.1780**)*
Adj R Square	0.4280	0.4098
Observations	182	157

* Significant at the 10% level, ** Significant at the 5% level, *** Significant at the 1% level (two-tail test)

Table 15: Survey results

	Aggregate	PC	HL
Number of responses received	61	37	24

Questions	Aggregate	PC	HL
1- Did the company suffer losses due to the terrorist attack on September 11, 2001? (yes-1, no-0)	21	14	7
If yes, how do the losses compare to the average loss in the previous five years? (substantially lower-1, lower-2, more or less the same-3, higher-4, substantially higher-5)	3.93	3.86	4
2- Does the company have any risk management program? (yes-1, no-0)	55	32	23
3- Does the company use derivatives (options, futures, swaps, caps, floors, etc.) in the investment? (yes-1, no-0)	24	14	10
4- Does the company use derivatives for hedging purposes? (yes-1, no-0)	23	12	11
How important are derivatives in the firm's risk management strategy? (least important-1, very important-5)	2.18	2	2.33
Are derivatives used to reduce financial risk (such as interest rate risk, exchange rate risk, etc)? (yes-1, no-0)	24	14	10
Are derivatives used to reduce underwriting risk? (yes-1, no-0)	3	2	1
5- Did the company increase its position in derivatives since September 11, 2001? (yes-1, no-0)	15	8	7
For hedging purposes? (yes-1, no-0)	14	7	7
For investing purposes? (yes-1, no-0)	8	6	2

Table 15: Survey results (Continued)

Questions	Aggregate	PC	HL
6-Did the company change its risk management strategy due to the terrorist attack on September 11, 2001? (yes-1, no-0)	24	18	6
7- Did the company change its investment strategy since the terrorist attack on September 11, 2001? (yes-1, no-0)	9	4	5
8- Did the terrorist attack on September 11, 2001 affect the company in any way other than changes in investment and risk management strategy?	25	16	9
How? (each company may give more than one answer)			
Increase in premiums	8	6	2
Remodeling of terrorism risk	12	9	3
More stringent underwriting	9	8	1
	(other answers include, exit of product line, capital management, changes in reinsurance contract, etc)		
9- Since the event, does the company have a larger proportion of its policies reinsured? (yes-1, no-0)	6	3	3

Table 15: Survey results (Continued)

Questions	Aggregate	PC	HL
10- What is (are) the cause(s) of the substantial loss in the insurance industry due to the terrorist attack on September 11, 2001? (each company may give more than one answer)			
Underestimation of concentration risk	27	15	12
Underestimation of terrorism risk	32	22	10
Acknowledging right amount of terrorism risk but charging of lower than appropriate premiums due to intense competition	5	3	2
Huge investment loss accumulated from the previous years	1	0	1
What happened was just beyond imagination	16	9	7
11- On the scale of 1 to 5, 5 being very likely and 1 being very unlikely, how likely do you think a similar attack will occur again in the U.S.?	3.37	3.47	3.27