The Impact of the September 11 Attack on Insurance Companies

by

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Abstract

On September 11, 2001, terrorists launched a devastating attack against the United States using four commercial airplanes fully loaded with jet fuel as lethal weapons, and both the 110-story towers of the World Trade Center in New York City collapsed. During the following weeks a financial market collapse, especially in the airplane, service and insurance companies, was triggered by the terrorist attacks. However, interestingly, the insurance industry is the only one that survived this financial market disaster. The aim of this paper is to understand the real impact of the September 11 terrorist attacks on the insurance industry. An event study analysis, based on market returns for the S&P 500 Stock Index and for a portfolio of 48 insurers, is employed to investigate the market reaction to the occurrence of terrorist attacks. Using the multivariate regression model (MVRM) methodology, I test the market reaction for the whole insurance industry and for each insurance company and subsample, on September 17, the first trading day after the attacks. My findings support the hypothesis that attacks had a significantly negative impact on the stock prices of the insurance industry on September 17. However, over a relatively long time period, the attacks have a significantly positive impact on almost half of the sampled companies. For each sample and subsample, the market reaction is different, that is to say, the market distinguished among insurers. In addition, cross-section results suggest that the market was able to distinguish between different companies according to their leverage, that is to say, those companies with higher leverage were thought to be more risky and were the most penalized by the market.

1. Introduction

September 11, 2001, will be remembered as one of the most shocking days in American history. On that day, three hijacked jetliners hit the World Trade Center in New York and the Pentagon outside Washington and a fourth hijacked plane crashed into a field in Pennsylvania. The airplanes were loaded with fuels which ignited gigantic explosions, and hellish blazes that created intense heat and extreme temperatures, causing the seemingly invincible steel beams of the buildings to melt. Both towers of the World Trade Center were destroyed and the Pentagon was severely damaged, killing more than two thousand people. The costs of the destruction of human life and property caused by the tragic events are believed to be one of the largest in American history.

Moreover, the September 11 terrorist attacks not only hit New York, the heart of the American economy, but also triggered a devastating decline in the world economy. In fact, since late 2000, growth had slowed sharply in almost all major regions of the world, with the burst of the information technology (IT) bubble from the late 1990's, leading to a potential decline in trade growth and financial markets. However, according to all researchers and organizations including the IMF, there seemed to be a reasonable prospect of recovery in late 2001 and 2002. But the tragic events of September 11 and their aftermath destroyed all hopes of a world economy recovery, contributing to a sharp deterioration in confidence across the globe and a surprising decline in commodity markets and financial markets. The unexpected terrorist attacks on the U.S. may have altered the confidence of both consumers and investors in a negative way, resulting in

transmission through the economy and the rest of the world through normal business cycle and trade channels. In addition, commodity markets weakened sharply all over the world, due to reduced demand for commodities caused by September 11.[1]

Indeed, all the declines in the world economy caused by September 11 should have been captured by financial markets immediately, and thus financial markets can provide timely information about the level of uncertainty in the economy. Soon after the terrorist attacks, trading on Wall Street was stopped. At the same time, panic spread through almost all financial markets in the world including London, Paris and Frankfurt.[2] Not surprisingly, on September 17, 2001, the first trading day of the New York Stock Exchange after September 11, the whole financial market in the U.S. began to drop in a free fall, especially three specific sectors: airlines, service industries and insurance companies. It was definitely a disaster for investors during the weeks following the terrorist attacks, with 10 percent of market value vanishing.[3]

However, interestingly, among three sectors which I mentioned above, the insurance industry is the only one that was damaged by a large number of claims resulting from the terrorists attacks, but recovered soon after the attacks through individuals' heightened uncertainty and interest in security in the future.[4] After September 11, individuals were

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[1] All the information in this paragraph on the world economy including the change in consumer confidence, the decline of commodity markets and financial markets, from late 2000, the time of burst of IT bubble, to late 2001, the time after September 11 terrorist attacks, is from IMF (2001).

[2] Information on the stock prices in Frankfurt, London and Paris on September 11, 2001 is from *Yahoo*'s historical data from its local websites in Germany, the U.K.& Ireland and France, respectively. I will discuss the markets' collapse in London, Paris and Frankfurt after the terrorist attacks in detail in section 2.

[3] Figures are from IMF (2001).

[4] I discuss why the insurance industry is the only one that was damaged severely by September 11 but recovered soon after in section 2.

willing to pay higher premiums to insurance companies in order to avoid losses caused by future disasters like September 11. That is to say, the increasing demand for insurance allowed insurers to raise premiums to get higher profits, leading to a quick rebound in the stock prices of insurance companies. Interestingly, soon after the whole market collapsed, the financial market began to rise up gradually, with relative equity for insurance brokers, including the reinsurance subsector that was particularly affected by the attacks, rising by around 10 percent in the United States and Europe. Pushed by the insurance sector, the Dow Jones Industrial Average rose from a low of 8235.8 on September 21 to above 10000 points in October, and the S&P 500 rose from a low of 865.8 points on September 24 to above 1100 points in October.[5] However, unlike the insurance industry, other sectors like airlines and the service industry were severely damaged by the terrorist attacks but did not recover soon after. That is to say, the insurance industry is the only one that recovered from the September 11 terrorist attacks very soon.[6] For this reason, I focus my examination of the impact of the September 11 terrorist attacks on the insurance sector in my paper, using the event study methodology with a sample of forty-eight insurance companies.

The aim of my research is to understand the real impact of this catastrophe on the stock market value of U.S. insurance companies. I focus my examination on forty-eight insurance companies, using the multivariate regression model (MVRM) methodology.

[5] Figures are from IMF (2001).
[6] I will discuss the impacts of September 11 on these three specific sectors in section 2 in detail.

The results of the investigation support the discussion above: the impact of the shocking events of September 11 is significantly negative in the short period around the occurrence of the event, but in the long run, the attack has a significant positive impact on almost half of the sampled companies. My research contributes to an understanding of how a harmful disaster may affect the whole economy.

This paper is organized as follows: Section 2 contains an overview of the September 11 terrorist attacks and the whole financial market collapse after the events, especially for three specific sectors: airlines, services and insurers, which were deeply affected by the attack. Section 3 begins by briefly reviewing previous research using event studies and then discusses in detail how a standard event study, using the multivariate regression model methodology (MVRM) and a cross-section analysis, can be used to examine the effects of the September 11 terrorist attacks on insurance companies. In the last part of this section, I discuss how I selected the data. In Section 4 and Section 5, the results and conclusions related to the study are presented in detail.

2. What the Market Think of the September 11 Tragedy

The world changed forever on September 11, 2001. On the morning of September 11, 2001, four passenger airplanes, fully loaded with jet fuel as a lethal weapon, were hijacked almost simultaneously over the United States. Two passenger planes crashed into the World Trade Center in New York, the symbol of global capitalism and wealth, destroying the 110-story twin towers, along with several neighboring commercial

buildings in Manhattan, the heart of the world's most famous financial district, killing all aboard the planes and approximately 2000 people on the ground; another one hit the Pentagon outside Washington and part of the Pentagon building was severely damaged by blazing blast and fire, killing all on board the aircraft and more on the ground. Within the hour, the fourth airliner crashed down in Pennsylvania, killing everyone aboard.[7] Table 1 lists all the major events related to the terrorist attacks from September 11 to December 9 2001, which were reported in Washington Post, BBC news website, CNN news website and other major media.

Unlike other major natural or manmade disasters such as hurricanes, earthquakes, floods, etc., the attacks of September 11, 2001, resulted in not only the massive loss of innocent life and destruction of property, but also immediate and overwhelming adverse effects upon the global economy all around the world. Although many analysts expected the September 11 terrorist attacks to cost the insurance industry between $20 billion and $60 billion,[8] eclipsing the losses caused by Hurricane Andrew when it devastated much of South Florida in 1992 in the worst natural disaster in U.S. history, according to the U.S. National Income and Product Accounts (NIPA), the estimated direct loss to property from the September 11 attacks is about $16 billion and other insurance losses are about $5.2

[7] Information about the September 11 terrorist attacks are provided by many media, including *CNN*, *BBC News*, *Washington Post*, etc. You may also find detailed stories about September 11 on many websites, such as www.september11news.com, september11.archive.org, etc.

[8] Analysts' and reporters' estimates of the total insurance losses from September 11, published soon after the tragic events, differ, but most writers estimate that it varied from $20 billion to $60 billion, which is definitely the largest loss in U.S. history. For example, Markman and Kessler (2002) estimated the total insurable losses to be between 60 and 70 billion, and in a report written by the Insurance Information Institute (2002), the total insurable losses of the terrorist attacks are $40.2 billion.

billion. Total costs are hence around 0.25 percent of annual U.S.GDP.[9] This seems to be a somewhat smaller microeconomic impact, compared to other disasters like Florida's Hurricane Andrew in 1992, which caused $40 billion in insured losses and $80 billion in total economic damage, and Northbridge's earthquake in California in early 1994, estimated to have caused $20 billion in property and structual damage and 16 billion in insured losses.[10]

However, looking beyond its short-term direct impact on property and insurance losses, the negative effects of the terrorist attacks of September 11 on the global economy, especially on financial markets, are far beyond everyone's imagination. As we know, the collapsed World Trade Center held the world's most powerful financial players, such as J.P. Morgan & Chase, Morgan Stanley, Citi Group, and four hundred other companies including bankers, insurers, asset managers and securities dealers. Besides, on Wall Street, the most distinguished financial street in the world, millions of dollars of financial transactions were made daily with a value of $2 trillion; the New York Stock Exchange, which has a total market capitalization of $17 trillion for its 3000 members,[11] is just a few blocks away from the devastated Trade Center towers. For these reasons, the financial market was no doubt the first one to respond to the tragic events. In the day after the devastating series of terrorists attacks, the New York Stock Exchange and the Nymex

[9] Figures are from IMF (2001).
[10] Many researchers and reporters provided detailed information of Hurricane Andrew in 1992 and Northride's earthquake in 1994. For example, Hartwig (2002) analyzes the economic impact resulting from Hurricane Andrew in 1992, and Boarnet (1996) examines the effect of the 1994 Northbridge earthquake, especially the effect of the transportation damage on business activity.
[11] Figures are from Flynn (2002).

commodities exchange were evacuated, and trading was suspended temporarily for four days until September 17. The world's largest high-tech stock market, the Nasdaq, also suspended all its trading for the day, as did the American Stock Exchange. Following the attacks, terrible consequeces began to spread throughout the main stock markets of the world. On September 11, European stock markets dropped sharply, with Frankfurt down 8.6%, London losing 5.7% — its biggest one day drop since 1987 — and Paris plunging 7.4%.[12] As expected, on September 17, the first trading day of the US stock market after the attack, a whole market collapse was triggered by the September 11 terrorist attacks. The stock market declined approximately 10% in its first week following the terrorist attacks on the U.S., with the Dow Jones Industrial Average dropping from 9603.4 on September 10 to its low 8242.3 on September 24, and the S&P 500 falling from 1092.54 on September 10 to a low of 965.8 21 on September 21.[13] All major stock markets experienced rapid, sharp price declines, reflecting expectations about the adverse effects of the tragedy on corporate profitability and future firm valuations.

It is important to note that in this market disaster, three specific industry sectors — airlines, services and insurance companies — were badly hit in the immediate wake of the attacks. September 11 was the darkest day for airline industries worldwide. Almost immediately, a flood of announcements of layoffs, profit warnings and flight cuts broke

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[12] Information on the stock prices in Frankfurt, London and Paris on September 11, 2001 is from *Yahoo*'s historical data from its local websites in Germany, the U.K.& Ireland and France, respectively. For example, you may find daily data for the FTSC 100 index, which is the main index for the London stock market, at http://uk.table.finance.yahoo.com.

[13] For detailed data on the Dow and the S&P500 around September 11, 2001, please refer to *Yahoo*'s historical data (available at http://table.finance.yahoo.com).

out: airline passenger traffic was cut about 20 percent, 100,000 workers had been laid off and by December 2001 the U.S. airline sector had lost nearly 20 percent of its relative value since September 10, while in Europe and Japan the reduction was about 15 percent.[14]

In the years following September 11, several U.S. airline companies including United Airlines, Vanguard Airlines and US Airways suffered continuing losses with unserviceable debt burdens forcing bankruptcy. United Airlines, in particular, being the second largest U.S. airline company, was the sixth largest U.S. company to seek bankruptcy protection. Moreover, the problems even extend beyond the U.S. border to other countries. For example, Air Canada, Canada's largest airline company, was close to bankruptcy in late 2002 partly because of its employment contract with its workers.[15]

However, in fact, even before the attacks, many airline companies had already faced some financial problems. In order to compete with rivals, airlines have been under immense pressure to expand their scale, invariably on borrowed funds, with rising debt ratios and falling returns on investment, making them extremely vulnerable to jumps in financing costs. As early as August, Midway had already filed for bankruptcy, after experiencing a tremendous drop in business traffic.[16] Besides, in August 2001, lots of airline companies had announced their plan for eliminating jobs and costs including Air

[14] Figures are from IMF (2001).
[15] In fact, in 2003, Air Canada finally reached an agreement with workers union and thus it avoided bankruptcy.
[16] Please refer to Hatcher (2001).

Canada and British Airways.[17] The September 11 terrorist attacks were just an activator for the collapse of the whole airline industry, pushing the airline industry to endless abyss.

Service industries were also badly affected by September 11, including hotels, tourism, travel agents and restaurants. Immediately after the terrorist attacks, hotels throughout the Americas, including the U.S., Canada and the Caribbean reported increasingly high vacancies, with visitor demand dropping suddenly. U.S. hotel revenue per available room (RevPAR)[18] bottomed out in the week following the attack, down 37.3 percent over the previous year, and employment in this sector fell by 58,000. Moreover, the travel and tourism industry also suffered an immediate and unprecedented loss from the attacks, especially in regions dependent on foreign visitors, such as the Caribbean and portions of the Asia Pacific region. After September 11, the World Tourism Organization had to revise its forecasts for travel growth from 2.5-3.5% prior to the terrorist attacks to 1.5-2.0% post-terrorist attacks, although in 2000 it reported 699 million travelers, with a growth of 7.4%, one of the strongest increases in last decade.[19] In general, the service industries related to lodging, traveling and tourism were no doubt severely damaged from the September 11 terrorist attacks, which was reflected in their falling stock prices in the weeks following the attacks.

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[17] For more detail about airline companies in August 2001, please refer to Cheng (2001).

[18] RevPAR stands for revenue per available room and may be more correctly defined as total guestroom revenue per available room per day. It is typically calculated simply by multiplying a given hotel average daily room rate (ADR) by its occupancy rate.

[19] Please refer to Adler et al. (2002).

The insurance industry was one of the first business sectors to react to the September 11 attacks. As I noted above, the financial industry has long been well represented in Manhattan and a number of financial companies, including some of the biggest insurers, had offices in the WTC. For example, Aon Corp., whose services include risk management, insurance brokerage and reinsurance consulting, occupied floors 92 and 98 through 105 of the two WTC towers. Another big insurer, AIG, which has $268 billion in assets, has a large presence in downtown Manhattan, including some offices on the 53rd floor in the north tower and its headquarters, just blocks from the WTC.[20] In addition, during the disaster, not only were their property losses very huge, but they also lost a number of first-rate employees, some of them their chief leaders.

More importantly, the September 11 terrorist attacks caused one of the largest insurance losses ever recorded. The whole insurance industry was affected by large claims resulting from the attacks, including property insurance, life insurance and medical calamities. As well, the collapse of the World Trade Center was believed to be the single largest insurance loss in modern history.[21] Thus, shortly after September 11, insurance companies had to pay out huge sums of money. For example, Lloyds of London, the world's second largest commercial insurer and sixth largest reinsurance

[20] Information is taken from O'Donnell (2001).
[21] Please refer to Hogarth (2002).

group, experienced its largest single loss in its venerable 300 years due to a large number of insurance claims resulting from the attacks, causing a direct loss about £2 billion.[22]

Not surprisingly, when the stock market reopened on September 17 after a four-day shutdown, almost all companies in the insurance sector had experienced significant price erosion in their stocks. Some top insurance companies including Allianz, ING and AIG were shaken by the events and the stock price was pushed down very quickly. For example, Allianz's stock price fell down nearly 35% and AIG dropped nearly 8% in the week following September 11. Besides, since all major banks and other financial service companies are tightly bound to the destiny of insurers, the shock spread from the insurance companies to all financial companies, with the Amex broker/dealer index falling by 13%, the PHLX bank index down 6.2% and the S&P 500 bank index down 6.5%.[23]

Interestingly, the attacks on the World Trade Center did not destroy the insurance industry. In fact, soon after the market collapse, the whole industry recovered very quickly. For example, two months after September 11, the stock of the large German insurance group Allianz had risen 31% and that of another French insurer, Axa, had risen 44%.[24] That is to say, in spite of the short-term difficulties of meeting the payments attributable to September 11, insurance markets were seen to be very promising by all

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[22] Sources for information on Lloyds of London's losses in 2001 are from its annual report for 2001, which is available at www.lloyds.com.

[23] Information on the stock indices is from *Yahoo*'s historical data (avaliabe at http://table.finance.yahoo.com).

[24] Information about Alllianz's and Axa's stock prices is from *Yahoo*'s historical data (avaliabe at http://table.finance.yahoo.com).

investors. Why should investors believe that an industry that has just suffered huge damage will do exceptionally well in the future? The reason is obvious: Firstly, the attacks on the World Trade Center increased the demand for property and casualty insurance, as companies and individuals grasped that the probability of loss due to manmade disasters was higher in the U.S. than previously expected.[25] The demand for individual life insurance and annuities also went up as the September 11 terrorist attacks changed everyone's view of the future. Thus, when September 11 changed the demand for insurance, suppliers, the insurers, could be more selective with their customers and they could also increase prices. Secondly, the insurance companies had to increase prices because the probability of disasters like terrorism attacks may increase in the future. September 11 sent a signal that the world might be more risky than previously thought. That is to say, insurers had to increase their premiums to cover the losses that would arise more frequently in the future. So, above all, given the huge losses of September 11, insurance companies re-assessed risk levels and increased prices to sustain their profits and to meet the increasing demand for all kinds of insurance.

It is clear that the terrorist attacks of September 11, 2001 have greatly affected the insurance industry in the United States as well as the whole world. As I noted before, given a general sense of insecurity in the world, people may well be interested in demanding insurance against a wider range of risks, and insurance companies were likely to raise prices to meet the increasing demand for insurance and possibly to offset the

[25] Please refer to Hogarth (2002).

losses induced by September 11. However, unlike the airline industry and the service industry that were also hard hit by the events, the insurers recovered much more quickly, with relative equity prices for insurance brokers having risen by around 10 percent in the United States and in Europe between September 11, 2001 and the end of 2001.[26]

3. Methodology and Data

3.1 Brief Review of Previous Studies

Event study analysis is a standard method of measuring the reaction of a stock's price to some event or announcement, such as an accounting rule change, an earnings announcement, a change in regulations, a money supply announcement and the like. The event study analysis has been widely accepted as a standard methodology of analysis in finance and economics. Furthermore, event study analysis is used in the fields of law and policy analysis to provide a metric for measuring the impact of policy decisions and regulation changes and recently it has been introduced into marketing research as well.

To carry out an event study analysis we need to assume that stock prices reflect investors' assessments of a firm's present value and that events or public announcements may affect the investors' future evaluations of the firm as well. According to the Efficient Market Hypothesis (Welch 2000), if the stock price reflects the announcement of public information instantaneously and without bias, the market should be classified as

[26] Information is taken from IMF (2001).

semi-strong form efficient. Therefore, stock prices can only be changed by unanticipated events. Hence, if an abnormal movement in the stock price is observed, the event is said to have an impact on the firm and the excess returns are called "abnormal returns."

The long history of event studies perhaps began with the first published study by James Dolley (1933). However, the most famous and classic article about event studies is a paper written by Fama, Fisher, Jensen and Roll (FFJR) (1969). In their paper, FFJR examine the effect of the announcement of a stock split on stock prices using the "market model" with monthly data from 1926 to 1960. The event study methodology introduced by FFJR has been widely used in finance and economics ever since and it will be discussed later in this paper.

Although the event study methodology introduced by FFJR (1969) has been used pervasively by a number of researchers, there have been a few adjustments in the technique introduced by several scholars. Most of them deal with violations of the statistical assumptions, selection of different models, and designs for more specific hypothesis tests. For example, FFJR (1969) assume that the residuals are independent and identically distributed, but Binder (1998) found that the residuals not only differed across firms, but also were not independent if the event occurs during the same calendar time period for some firms which are in the same or related industries. Thus, in his paper, a Multivariate Regression Model (MVRM), more frequently used in recent research, is introduced to overcome the above statistical problems. In addition, different models are introduced and discussed by some researchers.

Brown and Warner (1980) examined various models such as the market model, the market-adjusted model and the market mean return model, etc., widely used in event studies to measure stock price performance, using monthly data, and came to the conclusion that "a simple model methodology based on the market model performs well under a wide variety of conditions (p.205)." As far as the adjustment of the hypothesis is concerned, some more specific hypothesis tests are introduced by other scholars. In Binder (1985b), several new hypothesis tests, compared to the general one used by FFJR (1969), are designed to carry out event studies in the multivariate regression model. Brown and Warner (1985) discuss the issue of the power and robustness of the different hypothesis tests and the use of daily data. MacKinlay (1997) and Binder (1998) summarize the methodologies used in event study analysis since 1969, including hypothesis testing and the power of different hypothesis tests under the condition that each methodology is used systemically and thoroughly. The modifications proposed by researchers such as Brown and Warner and Binder have made a great contribution to the development of the event study methodology and led to the continuing use of event studies in economic and financial research.

There are four steps involved in carrying out an event study: identifying the event and announcement days; determining the selection of data and measuring the returns; measuring the abnormal return; and computing its statistical and economic significance. There are also several essential concepts that should be defined before carrying on: the event window, the estimation window, the post-event window and the estimation model.

The event window is the period in which an event occurs. The period of data used for estimation of parameters is called an estimation window. Generally the event window is not included in the estimation window in order to keep the coefficients unbiased. The post-event window is the period of data used in measuring the aftermath of the event.

Based on the way of calculating abnormal returns, the previous research can be divided into two broad categories, each of which is discussed below:

(1) *Abnormal returns are measured as residuals.* In this case a portfolio return is the dependent variable and only a single equation is estimated. *The Market model* is a statistical model and it is the most classical and maybe the most widely used one. It assumes a linear relationship between the return of any given stock and the return of the market portfolio. The traditional estimation model introduced by FFJR is the following:

$$R_{i,t} = \alpha_i + \beta_i R_{m,t} + \mu_{i,t},$$

where $R_{i,t}$ is the period t returns on security i and $R_{m,t}$ is the period t returns on the market portfolio, α_i and β_i are the parameters of the market model, and $\mu_{i,t}$ is a random component. First, each firm's stock return during the estimation window is regressed on the market's return during the same period. Then, the expected return, which is the return that would accrue to the security in the absence of the event being studied or any other unusual event, is computed. Third, the estimated expected return is subtracted from the actual return to get the abnormal return. The abnormal return, the unexpected announcement period return, contains the estimated impact of the event on the stock price, and is described by the following equation:

$$AR_{i,t} = R_{i,t} - \left(a_i + b_i R_{m,t}\right),$$

where $AR_{i,t}$ is the abnormal return of security i on day t during the event window, a_i and b_i are the OLS estimates of α_i and β_i, and $R_{i,t}$ and $R_{m,t}$ are defined above. The average of the abnormal returns, denoted AAR_t, is the average of the abnormal returns on day t for each event in the sample:

$$AAR_t = \frac{\sum_{i=1}^{n} AR_{i,t}}{n},$$

where n is the number of firms in the sample.

Next, the cumulative abnormal return, defined as the sum of the abnormal returns for each day in the given event window, is calculated as:

$$CAR_i = \sum_{t=a}^{b} AR_{i,t},$$

where CAR_i is the cumulative abnormal return for event i, a is the first day in i' s event window and b is the last day in i' s event window. Then, for a given event window, the average cumulative abnormal return to the full sample, which is the average over the sample of each CAR_i, is $ACAR$:

$$ACAR = \frac{\sum_{i=1}^{n} CAR_i}{n}.$$

Finally, the standard error of the averaged residuals is used to estimate the standard error of the average abnormal return.[27] Then, the hypothesis that the average abnormal return equals zero is tested. If the null hypothesis is rejected, the event has an impact on the stock prices of the sampled firms. The market model is extensively used in several

[27] The formula for the standard error is: $\sigma(\text{CAAR}) = \{\Sigma\sigma^2(\text{AAR}_t)\}^{1/2}$

scholarly articles in the leading academic journals. Barrett, Heuson, Kolb and Schropp (1987) employ this methodology to test the behavior of stocks in response to completely unanticipated events — e.g., fatal commercial airline crashes. Prazasnyski and Tai (1999) use this method to investigate the impact of the Malcolm Baldridge National Quality Award (MBNQA) on the stock performance of its recipients and reach an ambiguous result. Brady and Feinberg (2000) investigate the effects of EU merger control policy on specific European countries and specific sectors.

A few simpler models, such as the *Market-adjusted model* and the *Mean Adjusted Returns model*, are introduced by Brown and Warner (1980, 1985). The *Market-adjusted model* is defined as follows:

$$R_{i,t} = R_{m,t} + \mu_{i,t},$$

where $R_{i,t}$ and $R_{m,t}$ are the return of stock i and the market return at time t, respectively, and $\mu_{i,t}$ is the random variable. The abnormal return on any stock i is calculated as stock i's return minus the return on the market portfolio. Mathematically, we have:

$$AR_{i,t} = R_{i,t} - R_{m,t},$$

where $AR_{i,t}$ is the abnormal return for stock i at period t and $R_{i,t}$ and $R_{m,t}$ are defined above.

The *Mean Adjusted Returns model* is also introduced by Brown and Warner (1980,1985). Compared to other models, it is perhaps the simplest one:

$$R_{i,t} = K_i + \mu_{i,t},$$

where K_i is the constant mean return for stock i and $\mu_{i,t}$ is the time period t disturbance term for stock i. The mean adjusted returns model assumes that the normal returns are equal to a constant μ_i at time t for a given security i. The expected ex post return on security i in time period t is equal to K_i. As in the Market-adjusted model, the abnormal return on any stock i is determined by the difference between the observed return at time t and the expected return K_i:

$$AR_{i,t} = R_{i,t} - K_i,$$

where $AR_{i,t}$ is the abnormal return for stock i in period t and $R_{i,t}$ and K_i are defined above.

Typically researchers use the mean adjusted returns model or the market-adjusted model as an alternative or supplement to the market model. For example, Barnes and Ma (2002) use the market model and the market-adjusted model to investigate stock price reactions to the announcement of bonus issues in the stock market in China and both models lead to the same conclusion, that issues with a high bonus ratio usually attract positive returns for both Chinese (A-share traders) and foreign (B-share traders) residents. They also test the efficiency of the emerging markets and the results show that the B-share market displays stronger evidence for the semi-strong efficient market hypothesis than the A-share market. Another example is Sibley's (2001) paper. He employs the event study methodology, using both the market model and the mean adjusted returns model, to investigate the impact of presidential elections on nominal currency values for a group of Latin American countries between 1980 and 1996. The results from both models indicate that the presidential elections result in a statistically significant decline in nominal

currency values using two different models. In fact, Brown and Warner (1980,1985) find that the results produced by those simpler models never differ greatly from those generated by such more complicated models as the market model. In addition, Affleck-Graves et al. (2000) examine empirical issues associated with the use of bid-ask spreads in event study analysis and find that methods based on simpler models are powerful in detecting abnormal returns and work as well as the more sophisticated regression-based abnormal return model.

Compare to the statistical models discussed above, the *Capital Asset Pricing Model (CAPM)* and *Arbitrage Pricing Theory (APT)* can be classified as economic models, which are derived from specific economic theories of asset price formation. Indeed, economic models can be thought as statistical model with certain restrictions and the CAPM and the APT are the most common ones.

The use of the Capital Asset Pricing Model due to Sharpe (1964), John Lintner (1965) and Fisher Black (1972) was very popular in event studies of the 1970s. In their papers, they develop a model describing the pricing of capital assets under conditions of market equilibrium. The model states that under certain assumptions[28] the return on any capital asset for a single period will satisfy:

$$R_{i,t} = R_f + \beta_i \times \left(R_{m,t} - R_f\right) + \mu_{i,t}$$

where $R_{i,t}$ is the return on asset i at time t; $R_{m,t}$ is the return on the market portfolio; R_f is the riskless interest rate in Sharpe (1964) and Lintner's (1965) paper or the return on a

[28] For more details about the assumptions, please refer to Black (1972).

riskless asset for the period in Black's (1972) paper; β_i is the beta coefficient of the equation and equal to the slope of the regression line relating $R_{i,t}$ and $R_{m,t}$; and $\mu_{i,t}$ is the error term. When R_f varies over time, abnormal returns measured as CAPM prediction errors control for these changes since only beta is estimated during the estimation window. Choudhry (2002) examines the effect of the September 11 attacks on American companies associated with the conditional CAPM to combine the time-varying conditional variances and covariances and a GARCH model. The results show that most of the companies being investigated are affected by the September 11 attack despite differences in their sizes. However, several studies have found evidence inconsistent with the CAPM model, that is, the use of the restrictions imposed by the CAPM on the market model is not appropriate. This has led to the possibility that the results of the studies may be sensitive to the specific restrictions. Because of this potential problem, most researchers have begun to rely on statistical models to estimate expected returns during the event day in recent years.

Another common economic model, the Arbitrage Pricing Theory (APT), introduced by Stephen Ross (1976), is an asset pricing theory where the expected return of a given asset is a linear combination of multiple risk factors, defined as follows:

$$R_{i,t} = \delta_0 + \delta_{i1}F_{1t} + \delta_{i2}F_{2t} + \ldots + \delta_{in}F_{nt} + \mu_{i,t},$$

where $F_1, F_2, \ldots, F_n$ are the returns on the n factors that generate returns and the δ_{in} are the factor loadings. As in the case of the CAPM, researchers have found some problems with

the APT, in particular that these factors may have little explanatory power.[29] Thus, the use of both the CAPM and the APT has almost ceased because of their potential problems and statistical models, which are simple and reliable to researchers, have dominated event studies in recent years.

(2) *Abnormal returns are measured using dummy variables*. This model consists of a system of equations and each equation represents one firm. Rather than modelling abnormal returns as a prediction error as in the market model, several researchers have employed dummy variables in their estimation. A *Multivariate Regression Model (MVRM)* was first proposed by Gibbons (1980) and further developed by Schipper and Thompson (1983). The model consists of a system of Seemingly Unrelated Regressions (SUR) in a MVRM framework, and each firm is represented by a single equation. Binder (1985a, 1985b) discusses the MVRM technique and demonstrates the advantage of MVRM methodology over the better-known methodologies in testing joint hypothesis.

In their paper, Carter and Simkins (2002) measure the effect of the September 11th attack on airline stock returns using the MVRM methodology and find that the market is differentiated based on differences among the various airlines; i.e., the evidence reveals that there are significant negative abnormal returns for passenger and combined airlines compared to relatively smaller negative returns for airfreight firms. Since the MVRM methodology is usually used in measuring regulatory changes, Lamdin (2000) provides a discussion of implementing and interpreting event studies of regulatory changes with an

[29] Please refer to Brown and Weinstein (1985).

MVRM methodology. His conclusion is that the event study is a useful technique for the analysis of regulatory changes with its problems fully recognized. When Callen and Morel (2002) use the Enron-Anderson debacle to study whether equity markets react to auditor reputation, they use both univariate and multivariate regressions. The result indicates that events directly related to Enron had a smaller negative impact than the events directly related to Anderson.

Research by Mansur, Cochran and Phillips (1991) examines the effects of the accident of the tanker Exxon Valdez on the stock prices of several other oil companies, employing the MVRM methodology. The results suggest that the market is efficient in absorbing the relevant news related to the accident and that it differentiated among different oil companies based on their exposure to the Trans-Alaska Pipeline.

3.2 Methodology and Hypothesis Testing

The very first step in carrying out an event study is to identify the event and announcement days. The events under investigation are usually mergers and acquisitions, capital changes of firms, regulatory actions, bad news and accidents, etc. The event this paper studies belongs to the last class.

After defining the event, a researcher should determine the announcement days or, in other words, the time span of the announcements involved; and the period of interest is the event window. Usually, the *Wall Street Journal* and *New York Times* are useful sources to help identify the announcements. Conceptually, the announcement date or the event day is the day on which the announcement is released, which is period zero$(t = 0)$.

However, in practice, the event window is always expanded into at least three days: one day before the announcement $(t = -1)$ and one day after the announcement $(t = 1)$. This is because researchers would like to allow for the possible leakage of information by including the day before the announcement and also capture the effects that occur after the announcement day (in case the market is closed that day) by adding the day after the announcement. In this case, considering the character of the event, it is almost impossible to have a leakage of information to investors, and the NYSE was shut down on September 11 after the first airplane crashed on the first building; therefore, I choose September 17 — the first open day after the attack — as my event window. Usually, the estimation window in previous studies that used daily returns ranged from 90 days to 120 days. Therefore, the estimation window in this paper is defined to be day –97 (April 23, 2001) to the day –1 (September 10, 2001) before the event day 0 (September 17, 2001). The post-event window is intended to be used for investigating the aftermath of the September 11 attacks till the end of the year. December is not included in the post-event window since Enron went bankrupt on December 2, 2001. To avoid the effects of Enron's debacle on the stock market, the post-event window is defined as day +1 (September 18, 2001) to day +53 (November 30, 2001).

The second step is to determine the selection of data and measure the stock returns of the firms involved. Researchers should decide which firms are to be included in their study and which are not, which stock index will be chosen to measure the market return, and whether daily data or monthly data are to be used to measure the stock returns. If

daily data are used, the stock returns can be measured using closing prices. The selection of data for this paper will be discussed in detail in the following section.

Measuring the abnormal returns and computing their statistical and economic significance are the most complicated steps. First of all, an estimation model is needed to construct an event study. The market model of FFJR is the most widely used one. The FFJR approach assumed the residuals are independent and identically distributed and the average normal return is normally distributed with mean zero. However, Binder (1985a) argued that there are three problems with this assumption. First, the abnormal returns are always different for each firm. Second, the residual variance differs across firms. Thirdly, if the event occurs during the same calendar period for some firms and these firms are in the same or related industries, the independence assumption is unlikely to hold. In my study of the effect of the September 11 tragedy on the insurance companies, the event occurs during the same calendar period for the sample firms and the sample firms are in the same industries, therefore, these assumptions are less likely to hold.

To get over the above statistical problems, I choose the multivariate regression model (MVRM) developed by Binder (1985a, 1985b) rather than a market model to investigate the overall market reaction to the September 11 tragedy on the insurance companies. The better-known market model requires three steps to compute the abnormal return; in comparison to that, the MVRM technique parameterizes the abnormal returns directly in the individual regression equations, using dummy variables.

The coefficients of the dummy variables can be used as the measure of the effect of

the event on the firms. The multivariate regression method allows the individual abnormal returns to be different across firms. It is assumed that the disturbances are independent and identically distributed within each equation, whereas their variances differ across equations. The other important assumption is that across equations, the contemporaneous covariances of the disturbance are not zero, but the noncontemporaneous covariances are all zero. The assumptions impose a particular framework on the variance-covariance matrix of the disturbance vector, and the generalized least squares method is suited to estimating the parameters of the system.

Since the variables of each equation are the same, the coefficients and their standard errors obtained using the MVRM are the same as those obtained by estimating each individual equation by ordinary least squares.[30] Therefore, there will be no efficiency gain from using the MVRM approach in the estimation of the coefficients. However, the MVRM framework allows heteroskedasticity across equations and contemporaneous dependence of the disturbances to be incorporated into the hypothesis testing. Thus, the major advantages of the MVRM approach over the FFJR approach are in its ability to allow the abnormal returns to differ across firms and to easily test joint hypotheses about the abnormal returns.

The MVRM model is:

$$R_{i,t} = \alpha_i + \alpha_i' D_s + \beta_i R_{m,t} + \beta_i' D_s R_{m,t} + \gamma_i D_{ew} + \varepsilon_{i,t},$$

where $R_{i,t}$ is the return for portfolio i on day t, $R_{m,t}$ is the return of the market index on

[30] Please refer to Greene (2000, section 15.4).

day t, α_i is the regression constant up to the event day for portfolio i, D_{ew} is a dummy variable equal to 1 on September 17 and 0 otherwise, α_i' is the shift in the regression constant i in the post-event period, β_i is the slope coefficient for portfolio i, β_i' is the shift of the slope coefficient reflecting a risk in the post-event period, D_s is a dummy variable equal to 1 after September 17 and 0 otherwise, γ_i is the abnormal return for portfolio i on the event day and $\varepsilon_{i,t}$ is a random disturbance.

Since the explanatory variables are the same for each of the N firms, the model can be described as a system of equations:

$$R_{1,t} = \alpha_1 + \alpha_1' D_s + \beta_1 R_{m,t} + \beta_1' D_s R_{m,t} + \gamma_1 D_{ew} + \varepsilon_{1,t}$$

$$R_{2,t} = \alpha_2 + \alpha_2' D_s + \beta_2 R_{m,t} + \beta_2' D_s R_{m,t} + \gamma_2 D_{ew} + \varepsilon_{2,t}$$

$$\vdots$$

$$R_{N,t} = \alpha_N + \alpha_N' D_s + \beta_N R_{m,t} + \beta_N' D_s R_{m,t} + \gamma_N D_{ew} + \varepsilon_{N,t}.$$

The above system of equations comprises a set of seemingly unrelated regressions (SUR) as defined by Zellner (1962). Following Zellner's method, the system can be expressed in partitioned form as:

$$\begin{pmatrix} R_1 \\ R_2 \\ \vdots \\ R_N \end{pmatrix} = \begin{pmatrix} X & 0 & \cdots & 0 \\ 0 & X & \cdots & 0 \\ \vdots & \vdots & & \vdots \\ 0 & 0 & \cdots & X \end{pmatrix} \begin{pmatrix} \beta_1 \\ \beta_2 \\ \vdots \\ \beta_N \end{pmatrix} + \begin{pmatrix} \varepsilon_1 \\ \varepsilon_2 \\ \vdots \\ \varepsilon_N \end{pmatrix}$$

where $R_i'=(R_{i,1}\ R_{i,2}\ \ldots R_{i,N})$ is a $1\times$N vector ; X is a K$\times$N matrix of independent variables which is the same for each equation in the system; β_i is a K$\times$1 vector of coefficients; and ϵ_i is a N$\times$1 vector of disturbances. It can be simply written as:

$$R = \tilde{X}\beta + \varepsilon .$$

The standard hypothesis of abnormal returns and other general tests can be done in this framework by testing linear restrictions on γ_i, α_i' and β_i'. Five hypotheses are tested as follows:

Hypothesis 1 (H1$_i$): $\gamma_i = 0 \forall i$;

Hypothesis 2 (H2): $\gamma_1 = \gamma_2 = \gamma_3 = \ldots = \gamma_n = 0$;

Hypothesis 3 (H3): $\gamma_1 = \gamma_2 = \gamma_3 = \ldots = \gamma_n$;

Hypothesis 4 (H4$_i$): $\alpha_i' = 0 \forall i$;

Hypothesis 5 (H5$_i$): $\beta_i' = 0 \forall i$.

Hypothesis 1 is used to test whether the abnormal return for each firm equals zero. Rejection of H1$_i$ indicates that the September 11 attacks have an impact on the firm. In order to know what the market thinks of the September 11 attacks, Hypothesis 2 is a joint test designed to test whether the abnormal returns equal zero for all firms simultaneously. Rejection of H2 suggests that the abnormal returns are jointly nonzero for the insurance industry. Given the character of the event, I expect a significant negative abnormal return. Hypothesis 3 is intended to test whether the effects of the attacks are the same for each company or whether the market differentiated based on differences among the various insurance companies. If H3 cannot be rejected, then all insurance companies faced the same penalty because of the September 11 attacks. Rejection of H3 indicates that the insurance companies do not all react in the same manner and that the market is able to treat various companies differently. Then it will be necessary to carry out a

cross-sectional investigation of the abnormal returns and it is hypothesized that the cross-sectional differences are based on the potential increase in the probability of bankruptcy after the attack

$H4_i$ and $H5_i$ are used to measure the shift in the regression constant (α_i') and the shift in the slope coefficient (β_i') reflecting a risk in the post-event window. Rejection of $H4_i$ and $H5_i$ indicates that the terrorist attack has long-term effects on each sampled insurance company. Tests of hypotheses will be performed for the whole sample of 48 companies and carried out on four subsamples separately as well.

Although there are plenty of statistics available to test joint hypotheses in the MVRM, the choice of which one to use is sometimes problematic because the distributions of many of them are only asymptotically known. The best-known test statistics in this context are the Wald statistic used by Zellner (1962) and Schipper and Thompson (1983), the F statistic, the Lagrange Multiplier (LM) statistic, and the Likelihood Ratio (LR) statistic. Rao (1973) derives an F-distributed statistic whose distribution is known to an accurate approximation. Binder (1985b) used this F-statistic to test his hypothesis about regulation and Carter and Simkins (2002) also use an F-statistic to test their hypothesis about the market reaction of airlines on the September 11 attacks. The F-statistic is used in this paper to test the joint hypotheses as well.

3.3 Data

In calculating market returns, previous studies always choose the indices that are most significantly related to the industries under investigation as the proxy for the market.

For example, when they measure the effect of the September 11 attack on airline stock returns, Carter and Simkins (2002) use the Dow Jones as the market return. The Vancouver Composite Index (VSE) is used as the market return in Brown and Burdekin's (2000) research on the Bre-X Minerals fraud about the world's largest gold deposit, since the VSE is probably the most steadily available proxy for the universe of junior mining stocks. In their paper judging the impact of the adoption of European Union (EU) merger controls and their subsequent enforcement on European share prices, Brady and Feinberg (2000) use the FT World-Europe index as a proxy for a general European-wide index.

There are several choices of market proxy to calculate market returns in the U.S. market, such as Standard and Poor's 500 index (S&P 500), the Dow Jones and the NASDAQ Composite Index. Widely regarded as the best single gauge of the U.S. equities market, the S&P 500 index includes a representative sample of 500 leading companies in leading industries of the U.S. economy. The Dow Jones is composed of the 32 most traded stocks of the NYSE. Currently there are three more Dow Jones Indexes. The first is the Dow Jones Industrial Average (DJIA), which is composed of 30 industrial stocks. The Dow Jones Transport Average (DJTA) is composed of 20 stocks belonging to the transport industry (by rail, land or air) and finally the DJUA (Dow Jones Utility Average) is composed of 15 stocks belonging to the electrical and gas sectors. The NASDAQ Composite Index is an index that covers the price movements of all stocks traded on the NASDAQ Stock Market. Today the NASDAQ Composite includes over 5,000 companies, more than most other stock market indexes. However, companies

traded on NASDAQ are typically smaller and newer ones and most are technology stocks, such as Microsoft and Intel.

I use the S&P 500 index to compute the market return since neither the Dow Jones nor NASDAQ Composite Index has a significant correlation with the financial market and the insurance industry. In contrast, the S&P 500 index comprises 500 companies that account for 85% of the dollar value of all NYSE stocks, plus leading American Stock Exchange and NASDAQ stocks. It provides a broad indicator of the movement of stock price levels and changes. Although the S&P 500 focuses on the large-cap segment of the market, with over 80% coverage of U.S. equities it is also an ideal proxy for the total market. Therefore, the S&P 500 index is more appropriate in reflecting the shock that affected happened to the insurance industry.

The sample size for previous studies varies a lot, from under twenty in Mansur, Cochran and Phillips (1991)'s study of the Exxon Valdez accident's impact on oil companies, to over 500 in Callen and Morel (2002)'s investigation of the Enron-Anderson debacle. The size of the sample depends on the total number of firms in the industry examined; for example, Carter and Simkins (2002) use only eighteen airlines and four airfreight carriers as their sample since the total number of airlines is small and twenty companies are representative. The sample for this study of the impact of the September 11 attacks contains forty-eight insurance companies whose stocks are traded on the New York Stock Exchange and NASDAQ Stock Market. I listed all the insurance companies on the NYSE and NASDAQ Stock Market and divided them into four

categories according to *Yahoo! Finance*: Accident & Health, Life, Miscellaneous, and Property & Casualty. There are altogether 171 insurance companies: twenty-one in accident & health, forty-six in life, eighteen in miscellaneous, and eighty-six in property & casualty. Then I listed them alphabetically in each category and selected every third one to get fifty-seven companies. However, two of the firms cannot be included in the sample because they did not even exist in 2001, and seven companies with very small capital valuation and trading volume are eliminated since their price data are not always available on a daily basis. Altogether nine firms are eliminated and the resulting sample contains forty-eight companies, subdivided as follows: six accident & health insurance companies, thirteen life insurance companies, five miscellaneous insurance companies and twenty-four property & casualty insurance companies.

Daily stock returns are calculated from stock prices obtained from *Yahoo! Finance* (http://finance.yahoo.com). The market returns and stock returns are measured by:

$$Returnst(t) = (Price(t)-Price(t-1))/Price(t-1),$$

where *Price(t)* is the stock price/index value on day *t* and *Price(t-1)* is the stock price/index value on day *t-1*.

Some descriptive data about the companies in the sample are presented in Table 2 of the appendix. The market capitalizations for each company are included in Table 2. The forty-eight companies account for 35.78 percent of the market share of the insurance industry. The average market capitalization of subsample 1 is $3244.91 million and it accounts for 18.34 percent of the market share of the accident & health insurance industry.

The average market capitalization of subsample 2 is $9891.65 million and it accounts for 41.52 percent of the market share of the life insurance industry. The average market capitalization of subsample 3 is $1962.65 million and it accounts for 24.41 percent of the market share of the miscellaneous insurance industry. The average market capitalization of subsample 4 is $14591.94 million and it accounts for 41.52 percent of the market share of the property & casualty insurance industry.

Table 2 also contains financial data such as total assets, net income, total equity, etc. for each sample. The financial statements and the statistical ratios can be obtained at *EDGAR online* (www.edgar-online.com) and *MultexInvestor* (www.multex.com). The financial statements of those companies whose data cannot be found at the two former websites were downloaded directly from the companies' own websites.[31]

4. Empirical Results

4.1 Tests of Hypotheses

The results of the estimation of the multivariate regression model (MVRM) and the hypothesis tests to investigate the impact of the September 11 attacks on the insurance companies in the United States are presented in Table 3. Table 3 is divided into four parts according to the four subsamples.

Reviewing the estimation results and $H1_i$ for subsample 1, accident & health, I find

[31] The companies are: Credit Suisse Group (CSR) www.credit-suisse.com; Radian Group Inc.(RDN) www.radianmi.com and 21st Century Insurance (TW) www.i21.com.

that four out of the six insurance companies have negative abnormal returns on the September 17 trading day. However, the abnormal returns are relatively small compared to the other categories and only one of them can be said to be statistically significant at the 5% level of significance. That is to say the September 11 attacks only had an impact on Sierra Health Services Inc. among the six accident & health insurance companies.

In contrast, the companies in subsample 2 suffered much more. Subsample 2 contains the life insurance companies and all thirteen firms in this group exhibit negative abnormal returns. Furthermore, four of the thirteen companies display abnormal returns at the 1% level of significance, four of the thirteen companies display abnormal returns at the 5% level of significance and two of the thirteen companies display abnormal returns at the 10% level of significance. The abnormal returns range from -0.0018 for the MONY Group Inc. to -0.0968 for AXA. These results seem reasonable. For example, comparing the destruction of property and lives through terrorist attacks and natural disasters, although the property loss may not be very different between two kinds of catastrophe, the terrorist attacks destroyed many more lives than most natural catastrophes. It is fair to assume that all those people, or at least most of them, were covered by various kinds of life insurance. Therefore, thinking of the over 2000 lives lost in the September 11 terrorist attacks, the life insurance companies had to pay out a huge amount of money. Consequently, there would be a shock to their investors' confidence.

An examination of the miscellaneous insurance companies in subsample 3 indicates that four out of five companies have negative abnormal returns, and only Willis Group

Holdings Ltd. has a significant negative abnormal return at the 1% significance level. In subsample 4, twenty-two out of the twenty-four property & casualty insurance companies have negative abnormal returns. Eight of the twenty-two companies display abnormal returns at the 1% level of significance, three of the twenty-two companies display abnormal returns at the 5% level of significance and two of them display abnormal returns at the 10% level of significance. The results for these two subsamples indicate that the September 11 attacks had some effect on some of these companies, although not on all of them.

The test of Hypothesis 2, that the abnormal returns are jointly equal to zero for all firms, has been carried out both within each subsample and for the whole industry. The *F*-statistic for the test of Hypothesis 2 in subsample 1 is 1.6323, with a p-value of 0.1350, suggesting that the null hypothesis cannot be rejected. This result indicates that the six accident & health insurance companies jointly experienced no abnormal returns on September 17, 2001.

On the other hand, tests of Hypothesis 2 in the other three subsamples—life, miscellaneous, and property & casualty insurance companies—all resulted in a strong rejection of the null hypothesis. The *F*-statistics are 8.2363 (p-value 0.0000), 20.1205 (p-value 0.0000), and 5.7894 (p-value 0.0000) for subsamples 2, 3 and 4, respectively. The results of the tests suggest that the abnormal returns are jointly nonzero for subsamples 2, 3 and 4 separately, which means the terrorist attacks had an impact on life, miscellaneous and property & casualty insurance companies. Furthermore, the joint test

for Hypothesis 2 in all companies results in an F-statistic of 9.1208 with a p-value of 0.0000. Therefore, in general, the September 11 attacks have an effect on the whole insurance industry in the United States. These findings are, in general, consistent with my expectation of the reaction to the attacks.

Hypothesis 3 is intended to test whether the reaction to the September 11 catastrophe was the same for all firms within a subsample. For subsample 1, the calculated F-statistic is 1.9202 and the null hypothesis can only be rejected with 10% significance. The results of the H3 test for subsamples 2, 3 and 4 all suggest that the null hypothesis can be rejected at the 1% significance level. Clearly, in those subsamples, the market treats different companies in the same group differently. A test of Hypothesis 3 for all the insurance companies in the sample also shows significant power to reject the null hypothesis; the F-statistic is 8.5370 with a p-value of 0.0000. This result indicates that the market is able to differentiate based on differences among the various insurance companies, and not all insurance companies are penalized by the same amount.

The results of tests of $H4_i$ and $H5_i$ to measure the effect of the event on the post-event date are also shown in Table 3. Looking at the shift in the regression constant — $H4_i$ — first, I found that thirty-three out of the forty-eight companies have a negative shift in α_i'; however, only Vesta Insurance Group of subsample 4 has a significant negative shift at the 5% level. For $H5_i$, seven of the forty-eight sampled companies have a negative shift in β_i'. One company displays a negative shift at the 5% significance level, and another one displays a negative shift at the 10% significant level. Forty-one

companies have a positive shift in β_i' after the attack and among them nine have a positive shift at the 1% significance level, nine have a positive shift at the 5% significance level and four have a positive shift at the 10% significance level. These results suggest that the market believed the event of September 11 would have long-term effects on some of the sampled firms and the insurance industry.

In fact, the results from my estimation are consistent with what happened to the insurance industry after the attack. As I mentioned before, although the insurance industry itself suffered grievous losses in the World Trade Center attacks, the industry recovered quickly. At first, the industry would be affected by large claims resulting from the attacks, and a number of insurance companies whose headquarters and offices in the World Trade Center were directly destroyed which also caused hardship to the industry. However, at the same time, the attacks made people more aware of uncertainty and more interested in security. This uncertainty, in turn, stimulates people to take action to avoid the losses caused by such negative events by taking out insurance. The insurance companies, on the other side, could raise the premiums since the world is more risky and gain from it. The effects of the higher premiums dominate finally. In the long run, not only did the industry recover immediately after the attack, some companies even performed even much better than before the attacks, and most of the observed values of the coefficient β_i' are positive. This fact supports the argument that in the long run, the attack has no negative significant impact on insurance companies and furthermore it has a positive significant impact on almost half of the sampled companies.

The rejection of H3 indicates that not all firms were penalized in the same way. Next, I examine the cross-section of abnormal returns to determine what information the market may have used to differentiate between the companies' stocks price in reaction to the September 11 attacks.

4.2 Cross-Sectional Study

The use of cross-sectional models will reinforce the conclusion of the event study by relating the abnormal returns to specified firm characteristics. Since the reactions of different firms are not the same, a cross-sectional regression is used to investigate which characteristics of the firms are related to the abnormal returns. In order to find the cross-sectional determinants of a stock's reaction, the cross-section method provides insight into the relationship between the characteristics of the firm and the reaction of the stock price. The procedure is to use ordinary least squares (OLS) to estimate an equation explaining the firms' abnormal returns. In the regression equation, the abnormal return is the dependent variable and multiple characteristics of the firm that may be related to the event are the independent variables.

In this case, the estimated abnormal returns for each insurance company on September 17 ($\hat{\gamma}_i$) are used as the dependent variable. Several measures of financial conditions and management effectiveness are the independent variables. Four dummy variables to represent four different categories of insurance companies are also included on the right hand side of the regression model. The cross-sectional regression is listed as follow:

$$\hat{\gamma}_i = \alpha_1 CASH_i + \alpha_2 LTDEQ_i + \alpha_3 ROA_i + \alpha_4 S_1 + \alpha_5 S_2 + \alpha_6 S_3 + \alpha_7 S_4 + \mu_i$$

where $CASH_i$ is the cash and cash equivalent over total assets for insurance company i; $LTDEQ_i$ is the ratio of long-time debt to total equity for insurance company i, a measure of leverage; ROA_i is the average quarterly return on assets for the four quarters prior to September 11; S_1 is a dummy variable equal to one if the company belongs to subsample 1; S_2 is a dummy variable equal to one if the company belongs to subsample 2; S_3 is a dummy variable equal to one if the company belongs to subsample 3; S_4 is a dummy variable equal to one if the company belongs to subsample 4; and μ_i is a random disturbance term with zero mean.

Cash and cash equivalents is an element recorded on the balance sheet. It reports the value of cash and its equivalents. Those assets that are cash or can be converted into cash immediately usually include bank accounts and marketable securities, such as bonds and Banker's Acceptances. The total assets are a company's total current assets plus total noncurrent assets. Total assets can also be found on a company's balance sheet. The ratio of cash and cash equivalent to total assets is used as a measure of the liquidity of a firm.

The ratio of long-time debt to total equity is a measure of leverage. This ratio looks at the company's capital base. A firm with significantly more debt than equity is considered to be highly leveraged. Leverage increases one's risk and decreases one's financial strength, which is an important indicator of the amount of business risk the company is taking. The stronger a company is from a financial standpoint, the less risky it is. When business conditions turn bad, financially stronger companies have more staying

power and they are less likely to face insolvency. Companies with a lower level of leverage would have a better chance to survive the crisis. Therefore, I expect an inverse relationship between leverage and abnormal returns.

ROA (Return On Assets) is the ratio of a company's net profit to its total assets, expressed as a percentage. Sometimes this is referred to as Return on Investment. ROA is a useful indicator of a company's ability to operate profitably. ROA measures how well a company's management uses its assets to generate profits, or in other words management effectiveness.

Finally, to investigate how the market differentiates among different subsamples, four dummy variables, S_1, S_2, S_3 and S_4 are added to the cross-sectional regression, and each dummy variable indicates one category of insurance companies, respectively. If a significant coefficient estimate is found for one or more of the dummies, it would suggest that the market distinguished between different subsamples and that the subsample with a negative and significant coefficient was penalized more by the market than the others.

The data used in cross-sectional estimation is taken from the financial statements available prior to September 11, 2001 (e.g., quarterly report of June 2001) of the insurance companies and the data are listed in Table 2.

The results of the cross-sectional estimation are reported in Table 4. The F-statistic indicates that the joint hypothesis that all the coefficients are equal to zero is rejected at the 5% significance level. The ratio of long-time debt to total equity is found to be useful in explaining the cross-sectional abnormal returns of the insurance companies. The

coefficient of the explanatory variable *LTDEQ* is negative and equal to -0.0343, with 10% significance. The result suggests that the market was able to distinguish between different companies according to their leverage. Those companies with higher leverage were thought to be more risky and were the most penalized by the market.

There is also negative relationship between the abnormal return and the dummy variables S_2 and S_4 both with 10% significance. S_2 and S_4 represent life insurance companies and property & casualty insurance companies, respectively. This finding suggests that the abnormal returns for life insurance companies and property & casualty insurance companies were more negative than the others. This confirms the earlier observations that subsample 2 and subsample 4 have the highest proportion of significant abnormal return numbers among all four groups. The evidence that life insurance companies and property & casualty insurance companies were penalized more indicates that the market differentiated between the industries and that the market believed that the September 11 attack would affect the companies in life insurance and property & casualty insurance. In addition, there is no statistical significance for the measures of liquidity, management effectiveness or the other two dummies.

5. Conclusion

The tragic events of September 11 provide a unique opportunity to understand how powerfully a manmade disaster can influence the world's economy. The September 11 terrorist attacks not only destroyed the World Trade Center and damaged the Pentagon,

but triggered a devastating decline in the world economy as well. During the weeks following their occurrence, the tragic events burned billions of dollars in paper wealth in financial markets, with the Dow Jones Average and S&P 500 index shrinking nearly 15 percent. It is very interesting that among those specific sectors that were badly hit by the terrorist attack, the insurance industry was the one that recovered very quickly. In my research, I analyze the reaction of insurer stock prices, in both the short term and the long term, to determine whether the events had an impact on the stock prices of insurers, using the event study methodology. I use the multivariate regression model (MVRM) to test a number of hypotheses including whether the terrorist attack has effects on each sampled insurance company both in short term and long term and whether the stock price reaction for each insurance firm is the same. Furthermore, I estimate cross-section regressions to determine which firm-specific characteristics affected the abnormal returns.

Using a sample of forty-eight firms, I find a significant negative relation between the terrorist attack and the abnormal returns on September 17, 2003, the first trading day after September 11. That is to say, this disaster definitely triggered a shocking collapse for insurers due to its historical loss of human life and property. However, comparisons between subsamples reveal that the real effects of the events on each subsample were different. Life insurance companies, miscellaneous insurance companies and property & casualty insurance companies appear to have been affected particularly badly, but accident & health insurance companies seem not to have been influenced by the events. Over a longer-term period, the results suggest that all the insurers luckily survived the

disaster due to the individuals' awareness of risk after the terrorist attacks. Moreover, I find that the financial market was able to distinguish between different companies according to their leverage, as measured by the ratio of long-time debt to total equity in the cross-sectional abnormal returns of the insurance companies. The result suggests that those companies with higher leverage were considered to be more risky and were penalized most by the market. I also find that the abnormal returns are also related to the category the company is in and the results suggest that life insurance companies and property & casualty insurance companies were penalized more, but I do not find statistical significance for measures of cash and cash equivalent over total assets and management performance.

Overall, combining the results of the event study and the related cross-sectional analysis, I find that the September 11 terrorist attacks had significant negative effects, both in an economic and a statistical sense, on the value of firms involved in the insurance industry only on the date of occurrence of the events, and there is some strong evidence that life insurance companies, miscellaneous insurance companies and property & casualty insurance companies are the ones that endured a more difficult bear market. Companies with higher leverage appear to have been more risky investments during this market collapse caused by the terrorists attacks.

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Table 1. Chronology of Events

Date	Important Event
Sept.11	Hijacked jetliners hit the World Trade Center in New York and the Pentagon outside Washington. A fourth hijacked plane crashes into a field in Pennsylvania. Trading on Wall Street is stopped immediately.
	8:46 A.M. United Airlines Flight 11 from Boston crashes into the North Tower of the World Trade Center.
	9:03 A.M. United Airlines Flight 175 from Boston hits the South Tower of the World Trade Center.
	9:21 A.M. Much of the downtown district shut down, including the nearby Financial district. All stock markets are evacuated, including the American Stock Exchange, the New York Mercantile Exchange and the World Financial Center, which houses the NYMEX.
	9:25 A.M. The Federal Aviation Administration halts all flight operations at the nation's airports for the first time in U.S. history.
	9:45 A.M. American Airlines Flight 77 crashes into the Pentagon.
	10:05 A.M. The south tower of the WTC collapses.
	10:10 A.M United Airlines Flight 93 crashes in a wooded area in Pennsylvania, after passengers confront hijackers.
	10:28 A.M. The north tower collapses. About two thousand people lose their lives when the WTC Twin Towers collapse, including hundreds of New York City firemen and policemen who are sent to rescue WTC workers.
	8:30 P.M. President George W. Bush addresses the nation and vows to "find those responsible and bring them to justice."
Sept.12	In Europe, the Frankfurt Stock Exchange and London Stock Exchange were reopened after being evacuated in the evening of September 11. In the United States, Bush labels attacks "acts of war" and asks Congress to devote $20 billion to help rebuild and recover.
Sept.17	The Federal Reserve cuts its key interest rate to try to keep the economy from plunging into a recession. Investors send stocks reeling on Wall Street's first day of trading since the attacks.
Sept.29	In a national radio address, Bush says the nation's defense against more attacks will be to "aggressively and methodically" disrupt and destroy terrorism. Thousands rally in Washington, D.C., San Francisco, and Barcelona, Spain to discourage armed retaliation. Anti-war protests draw hundreds in Austin, Texas, and Athens, Greece.
Oct. 7	American and British forces unleash missile attacks against Taliban military targets and bin Laden's training camps inside Afghanistan. The Afghan opposition also launches an attack.
Oct. 19	U.S. ground forces battle in Afghanistan, opening a new phase of the war on terrorism after nearly two weeks of fierce air strikes, a defense official said. (Continued)

(Continued)

Date	Important Event
Oct. 26	U.S. President George W. Bush signs the anti-terrorism bill into law.
Dec. 2	Enron, one of the biggest firms in the U.S., files for Chapter 11 bankruptcy protection in New York court. It is the biggest such filing in U.S. history up to that time.
Dec.9	The world's second largest carrier, United Airlines, files for bankruptcy in a court in Chicago, marking the air travel sector's biggest corporate failure to date. It is notable that three of the hijacked airplanes in the terrorist attacks of September 11 are from United Airlines.

Note: All important events on and after September 11, 2001 are listed as described in reports in the BBC News website (www.BBC.com), Washington Post website (/www.washingtonpost.com) and www.september11news.com.

Table 2. Selected Financial Data for the Sampled Companies (30 June 2001)

The financial statements and the statistical ratios can be obtained at *EDGAR online* and *MultexInvestor*, for the quarterly report ending on 30 June 2001. The unit is million US dollars.

Firm	Net Income	Cash & Cash Equivalent	Long-term Debt	Total Assets	Total Liabilities	Total Equity	ROA (%)	Market Cap
Subsample 1								
American Medical Security (AMZ)	1.466	12.123	35.658	461.010	242.166	218.844	0.14	269.23
Cobalt Corporation (CBZ)	-3.796	31.359	15.068	722.631	498.708	223.923	0.75	860.3
Humana Inc. (HUM)	25.000	603.000	147.000	4,160.000	2,593.000	1,420.000	0.56	3000
Oxford Health Plans, Inc. (OHP)	74.799	380.955	140.000	1,594.559	833.851	620.708	6.55	3430
Sierra Health Services, Inc. (SIE)	2.795	131.447	208.816	1,118.636	1,023.083	95.553	0.37	589.93
WellPoint Health Networks (WLP)	99.929	764.974	936.344	6,963.550	5,076.164	1,887.386	7.00	11320
Subsample 2								
AXA (AXA)	70.300	1,379.700	3,026.600	102,373.300	95,622.700	6,750.600	0.59	29940
Credit Suisse Group (CSR)	2,580.480	3,818.640	130,448.640	1,690,184.160	1,626,429.000	63,755.160	0.33	39340
FBL Financial Group (FFG)	11.218	121.309	40.000	4,934.784	4,224.591	531.688	1.16	688.15
Great American Financial (GFR)	5.600	16.200	144.400	8,097.000	7,167.600	711.500	0.78	617.08
Jefferson-Pilot Corporati (JP)	135000	53.000	150.00	27,908.000	24,319.000	3,289.000	1.86	6290
Lincoln National Corporat (LNC)	301.939	1,501.898	712.365	96,431.234	91,375.296	5,055.938	0.48	6290
MetLife, Inc.(MET)	320.000	4,748.000	2,309.000	254,777.000	236,920.000	16,763.000	0.37	21320
MONY Group Inc. (MNY)	22.300	760.700	585.300	26,084.800	23,900.100	2,184.700	0.48	1530
Nationwide Fncl. Svcs.(NFS)	113.900	62.800	298.400	92,081.200	88,512.300	3,268.900	0.41	5050
Presidential Life Corp.(PLFE)	12.363	4.632	100.000	3,291.418	2,834.799	456.619	0.66	446.19
Reinsurance Group of Am.(RGA)	30.514	155.792	318.003	6,212.159	5,324.025	888.134	1.33	2030
StanCorp Financial Group (SFG)	26.000	19.600	161.700	6,160.100	5,211.400	948.700	1.44	1670

Table 2 (continued)

Firm	Net Income	Cash & Cash Equivalent	Long-term Debt	Total Assets	Total Liabilities	Total Equity	ROA (%)	Market Cap
Sun Life Financial Inc. (SLF)	215.000	4,486.000	3,859.000	58,824.000	49,737.000	7,366.000	0.59	13380
Subsample 3								
Arthur J. Gallagher & Co. (AJG)	23.056	100.930	114.309	1,215.239	854.155	333.791	8.07	2560
First Health Group Corp. (FHCC)	25.329	12.089	62.500	516.326	248.301	268.025	15.31	2490
InsWeb Corporation (INSW)	-7.193	10.214	1.203	71.826	7.992	63.834	28.06	23.44
Quotesmith.com, Inc.(QUOT)	-2.605	7.868	0.107	25.375	1.941	23.435	-28.46	19.80
Willis Group Holdings Ltd (WSH)	17.000	141.000	909.000	8,712.000	8,124.000	569.000	0.32	4720
Subsample 4								
Argonaut Group, Inc.(AGII)	1.900	17.200	73.200	1,545.000	1,077.400	467.600	-1.36	280.90
American Int'l Group, Inc(AIG)	3,159.000	248.000	2,845.000	333,191.000	289,358.000	42,655.000	2.03	150530
Alfa Corporation (ALFA)	31.748	6.314	30.680	1,624.819	1,131.850	492.969	4.53	1010
Berkshire Hathaway Inc.(BRKA)	773.000	7,143.000	3,660.000	148,766.000	88,706.000	58,730.000	0.39	115500
CNA Financial Corporation (CNA)	-1,762.000	142.000	2,468.000	65,268.000	57,456.000	7,593.000	0.11	4700
Donegal Group Inc.(DGICB)	5.651	4.430	28.200	479.931	358.916	121.015	2.06	133.33
Hartford Financial Servic (HIG)	226.000	324.000	2,263.000	177,927.000	169,448.000	8,479.000	0.57	14860
Investors Title Company (ITIC)	0.840	7.168	0.224	61.276	21.349	39.927	9.06	76.34
Loews Corporation (LTR)	-1,415.200	165.400	5,835.400	74,386.700	62,733.100	9,681.400	1.09	7490
Meadowbrook Insurance Gro(MIG)	-7.482	38.621	53.464	689.299	610.519	78.780	-0.73	119.86
MGIC Investment Corp.(MTG)	161.218	12.320	408.426	4,170.889	1,390.558	2,780.331	14.48	5140
Navigators Group, Inc(NAVG)	2.314	2.537	22.000	672.294	525.536	146.758	1.04	277.19
Ohio Casualty Corp.(OCAS)	16.651	22.553	210.487	4,506.289	3,420.138	1,086.151	0.92	881.06
PAULA Financial (PFCO)	0.215	7.190	5.813	198.860	160.792	38.068	1.37	8.24
PICO Holdings, Inc.(PICO)	-2.462	9.540	14.525	379.950	178.160	198.127	-1,.27	163.36

Table 2 (continued)

Firm	Net Income	Cash & Cash Equivalent	Long-term Debt	Total Assets	Total Liabilities	Total Equity	ROA (%)	Market Cap
Radian Group Inc.(RDN)	91.852	47.299	324.043	4,083.507	1,929.090	2,114.417	10.62	4150
Everest Re Group, Ltd.(RE)	26.565	18.121	594.140	7,316.680	5,608.684	1,707.996	2.49	4170
Royal & Sun Alliance Insu(RSA)	-742.400	449.600	875.200	110,948.800	99,724.800	11,224.000	-0.39	23400
SAFECO Corporation (SAFC)	-897.200	179.400	718.500	29,025.500	24,485.500	3,696.800	0.11	4900
Stewart Information Svcs.(STC)	15.438	70.734	50.794	609.813	291.874	317.939	7.26	505.05
21st Century Insurance (TW)	5.797	3.333	60.513	1,360.457	643.300	717.157	2.10	1180
Unico American Corp.(UNAM)	-1.097	0.115	7.299	123.374	73.901	49.473	0.21	25.42
Vesta Insurance Group(VTA)	7.052	76.328	86.428	1,784.517	1,476.977	277.790	-0.62	85.83
XL Capital Ltd.(XL)	840.032	1,676.981	1,294.673	18,715.683	13,036.369	5,679.314	2.20	10620

Table 3. Estimation of the MVRM and the Results of the Hypotheses Testing

This table presents the results of the estimation of the following multivariate regression model (MVRM):

$$R_{i,t}=\alpha_i+\alpha_i' D_s+\beta_i R_{m,t}+\beta_i' D_s R_{m,t}+\gamma_i D_{ew}+\epsilon_{i,t},$$

$R_{i,t}$ is the return for portfolio i on day t, $R_{m,t}$ is the return of the market index on day t, α_i is the regression constant up to the event day for portfolio i, D_{ew} is a dummy variable equal to 1 on September 17 and 0 otherwise, α_i' is the shift in the regression constant i in the post-event period, β_i is the slope coefficient for portfolio i, β_i' is the shift of the slope coefficient reflecting a risk in the post-event period, D_s is a dummy variable equal to 1 after September 17 and 0 otherwise, γ_i is the abnormal return for portfolio i on the event day and $\epsilon_{i,t}$ is a random disturbance. This table also presents the results of tests of $H1_i$, $H4_i$ and $H5_i$ with their standard errors (in parentheses) and hypotheses 2 and 3 with their F-statistics. Statistical significance at the 10%, 5% or 1% level is indicated by *, **, or ***, respectively.

	Intercept	D_s	MKT	D_s *MKT	D_{ew}	R-Square
Subsample1 Accident & Health						
American Medical Security (AMZ)	0.0032	0.0056	0.0494	0.0391	-0.0008	0.0043
	(0.0046)	(0.0078)	(0.4416)	(0.6478)	(0.0504)	
Cobalt Corporation (CBZ)	0.0036	-0.0028	-0.0104	0.1027	-0.0157	0.0022
	(0.0044)	(0.0074)	(0.4192)	(0.6149)	(0.0478)	
Humana Inc. (HUM)	0.0044	-0.0035	1.0957***	0.1976	0.0099	0.1964
	(0.0030)	(0.0050)	(0.2830)	(0.4152)	(0.0323)	
Oxford Health Plans, Inc. (OHP)	0.0020	-0.0030	0.3994*	0.5444	-0.0409	0.1458
	(0.0024)	(0.0040)	(0.2258)	(0.3313)	(0.0258)	
Sierra Health Services, Inc. (SIE)	0.0075*	-0.0093	-0.0518	2.0646***	-0.0995**	0.1754
	(0.0040)	(0.0067)	(0.3794)	(0.5566)	(0.0433)	
WellPoint Health Networks (WLP)	0.0026	-0.0009	0.5642***	-0.0840	0.0021	0.1117
	(0.0019)	(0.0031)	(0.1777)	(0.2606)	(0.0203)	
Test of H2: $\gamma_1 = \gamma_2 = \gamma_3 = \ldots = \gamma_n = 0$						1.6582
Test of H3: $\gamma_1 = \gamma_2 = \gamma_3 = \ldots = \gamma_n$						1.9202*

Table 3 (continued)

	Intercept	D_s	MKT	D_s *MKT	D_{ew}	R-Square
Subsample 2 Life						
AXA (AXA)	-0.0005	-0.0014	0.8852***	1.0599***	-0.0968***	0.4935
	(0.0022)	(0.0036)	(0.2046)	(0.3001)	(0.0233)	
Credit Suisse Group (CSR)	-0.0018	0.0022	0.4613**	0.8660***	-0.0505**	0.2883
	(0.0021)	(0.0035)	(0.1993)	(0.2924)	(0.0227)	
FBL Financial Group (FFG)	-0.0014	-0.0027	0.1585	0.7294***	-0.0363**	0.2045
	(0.0016)	(0.0027)	(0.1541)	(0.2260)	(0.0176)	
Great American Financial (GFR)	0.0016	-0.0024	0.1934**	-0.0461	-0.0076	0.0665
	(0.0010)	(0.0017)	(0.0943)	(0.1383)	(0.0108)	
Jefferson-Pilot Corporati (JP)	0.0006	-0.0009	0.5009***	0.3804***	-0.0456***	0.5333
	(0.0010)	(0.0016)	(0.0914)	(0.1340)	(0.0104)	
Lincoln National Corporate (LNC)	0.0019	-0.0024	0.7474***	0.1486	-0.0245*	0.4201
	(0.0013)	(0.0022)	(0.1229)	(0.1803)	(0.0140)	
MetLife, Inc. (MET)	0.0007	-0.0005	0.6011***	0.2186	-0.0367**	0.3452
	(0.0014)	(0.0024)	(0.1326)	(0.1945)	(0.0151)	
MONY Group Inc. (MNY)	0.0002	-0.0012	0.4192***	0.4394**	-0.0018	0.2416
	(0.0014)	(0.0024)	(0.1361)	(0.1996)	(0.0155)	
Nationwide Fncl. Svcs. (NFS)	0.0028	-0.0020	0.5453**	0.0753	-0.0667**	0.1455
	(0.0025)	(0.0043)	(0.2407)	(0.3531)	(0.0275)	
Presidential Life Corp (PLFE)	0.0008	-0.0006	0.2159	0.5616**	-0.0866***	0.3163
	(0.0015)	(0.0026)	(0.1473)	(0.2161)	(0.0168)	
Reinsurance Group of Am. (RGA)	0.0020	-0.0021	0.5280***	0.1348	-0.0104	0.1443
	(0.0019)	(0.0032)	(0.1780)	(0.2611)	(0.0203)	
StanCorp Financial Group (SFG)	0.0019	0.0010	0.4881***	0.6340**	-0.0899***	0.3655
	(0.0018)	(0.0031)	(0.1737)	(0.2548)	(0.0198	

Table 3 (continued)

	Intercept	D_s	MKT	D_s *MKT	D_{ew}	R-Square
Sun Life Financial Inc. (SLF)	0.0019	-0.0045	0.5762***	0.4882**	-0.0338*	0.3212
	(0.0016)	(0.0028)	(0.1557)	(0.2284)	(0.0178)	
Test of H2: $\gamma_1 = \gamma_2 = \gamma_3 = \ldots = \gamma_n = 0$						8.2363***
Test of H3: $\gamma_1 = \gamma_2 = \gamma_3 = \ldots = \gamma_n$						4.7922***
Subsample 3 Miscellaneous						
Arthur J. Gallagher & Co. (AJG)	0.0011	0.0024	0.7225***	-0.6712**	0.1902***	0.3475
	(0.0020)	(0.0034)	(0.1895)	(0.2779)	(0.0216)	
First Health Group Corp. (FHCC)	0.0110	-0.0126	-0.6624	1.0064	-0.0169	0.0042
	(0.0140)	(0.0236)	(1.3312)	(1.9527)	(0.1519)	
InsWeb Corporation (INSW)	-0.0062	0.0208	0.5963	-0.0829	-0.1245	0.0522
	(0.0080)	(0.0013)	(0.7594)	(1.1140)	(0.0866)	
Quotesmith.com, Inc. (QUOT)	0.0117	-0.0113	1.0454	0.3662	-0.0653	0.0344
	(0.0080)	(0.0014)	(0.7643)	(1.1211)	(0.0872)	
Willis Group Holdings Ltd (WSH)	0.0008	0.0005	-0.5188*	0.7733*	-0.1152***	0.0728
	(0.0032)	(0.0055)	(0.3086)	(0.4527)	(0.0352)	
Test of H2: $\gamma_1 = \gamma_2 = \gamma_3 = \ldots = \gamma_n = 0$						20.1205***
Test of H3: $\gamma_1 = \gamma_2 = \gamma_3 = \ldots = \gamma_n$						17.9442***
Subsample 4 (Prop. & Casualty)						
Argonaut Group, Inc. (AGII)	0.0029	-0.0027	1.4064***	0.3097	-0.0046	0.2153
	(0.0037)	(0.0062)	(0.3508)	(0.5146)	(0.0400)	
American Int'l Group, Inc (AIG)	0.0000	0.0011	0.4163***	0.6201***	-0.0234*	0.3910
	(0.0013)	(0.0021)	(0.1192)	(0.1749)	(0.0136)	
Alfa Corporation (ALFA)	-0.0016	-0.0010	0.4467**	0.2822	0.0066	0.1046
	(0.0021)	(0.0036)	(0.2041)	(0.2994)	(0.0233)	
Berkshire Hathaway Inc. (BRKA)	-0.0000	0.0012	0.0208	0.3135*	-0.0578***	0.1650

Table 3 (continued)

	Intercept	D_s	MKT	D_s *MKT	D_{ew}	R-Square
	(0.0013)	(0.0022)	(0.1237)	(0.1814)	(0.0141)	
CNA Financial Corporation (CNA)	-0.0019	0.0022	0.2698	0.6484**	-0.0639***	0.2413
	(0.0018)	(0.0031)	(0.1759)	(0.2580)	(0.0200)	
Donegal Group Inc. (DGICB)	0.0001	-0.0023	0.0720	-0.3467	-0.0161	0.0196
	(0.0022)	(0.0037)	(0.2093)	(0.3071)	(0.0239)	
Hartford Financial Servic (HIG)	0.0013	-0.0033	0.6510***	0.6848***	-0.0211	0.3935
	(0.0015)	(0.0026)	(0.1445)	(0.2120)	(0.0165)	
Investors Title Company (ITIC)	0.0011	-0.0049	0.1952	0.4968	-0.0945***	0.1197
	(0.0026)	(0.0043)	(0.2448)	(0.3591)	(0.0279)	
Loews Corporation (LTR)	-0.0016	0.0040	0.1728	0.6403**	-0.0410*	0.1404
	(0.0021)	(0.0036)	(0.2004)	(0.2939)	(0.0229)	
Meadowbrook Insurance Gro (MIG)	0.0014	-0.0112	0.3646	1.5552**	-0.0383	0.1296
	(0.0044)	(0.0074)	(0.4176)	(0.6125)	(0.0476)	
MGIC Investment Corp. (MTG)	0.0014	-0.0038	0.5411***	0.5400*	-0.0441**	0.2375
	(0.0021)	(0.0035)	(0.1972)	(0.2893)	(0.0225)	
Navigators Group, Inc (NAVG)	0.0038	-0.0036	-0.1521	0.1153	-0.0597**	0.0357
	(0.0025)	(0.0043)	(0.2422)	(0.3553)	(0.0276)	
Ohio Casualty Corp. (OCAS)	0.0051*	-0.0016	0.5895**	0.2164	-0.0503	0.1223
	(0.0028)	(0.0048)	(0.2710)	(0.3975)	(0.0309)	
PAULA Financial (PFCO)	-0.0178**	-0.0242	2.4798*	-2.2944*	-0.0178	0.0716
	(0.0089)	(0.0015)	(0.8497)	(1.2464)	(0.0969)	
PICO Holdings, Inc. (PICO)	0.0010	-0.0001	0.3854**	0.2812	-0.0695***	0.2012
	(0.0020)	(0.0033)	(0.1866)	(0.2738)	(0.0213)	
Radian Group Inc. (RDN)	0.0081	-0.0086	1.4246	-0.1128	0.0213	0.0137
	(0.0014)	(0.0024)	(1.3683)	(2.0071)	(0.1561)	

Table 3 (continued)

	Intercept	D_s	MKT	D_s *MKT	D_{ew}	R-Square
Everest Re Group, Ltd. (RE)	-0.0004	0.0037	0.1570	1.2343***	-0.1156***	0.3750
	(0.0020)	(0.0034)	(0.1946)	(0.2854)	(0.2219)	
Royal & Sun Alliance Insu (RSA)	-0.0006	0.0009	0.7088***	0.5378	-0.1220***	0.2977
	(0.0027)	(0.0046)	(0.2574)	(0.3776)	(0.0294)	
SAFECO Corporation (SAFC)	0.0017	-0.0013	0.4426***	0.5583**	-0.0068	0.2687
	(0.0015)	(0.0026)	(0.1461)	(0.2143)	(0.0167)	
Stewart Information Svcs. (STC)	0.0004	0.0009	0.1868	0.6141*	-0.0640***	0.1187
	(0.0022)	(0.0038)	(0.2124)	(0.3116)	(0.0242)	
21st Century Insurance (TW)	0.0015	-0.0028	0.1899	0.5423**	-0.0179	0.1098
	(0.0019)	(0.0032)	(0.1784)	(0.2617)	(0.0204)	
Unico American Corp. (UNAM)	0.0010	0.0024	0.3215	0.5268	-0.1157**	0.0900
	(0.0043)	(0.0073)	(0.4109)	(0.6027)	(0.0469)	
Vesta Insurance Group (VTA)	0.0075	-0.0197**	0.5389	0.8867	-0.0123	0.0722
	(0.0053)	(0.0090)	(0.5090)	(0.7466)	(0.0581)	
XL Capital Ltd. (XL)	0.0018	0.0012	0.1712	1.0997***	-0.1200***	0.3741
	(0.0020)	(0.0033)	(0.1870)	(0.2744)	(0.0213)	
Test of H2: $\gamma_1 = \gamma_2 = \gamma_3 = \ldots = \gamma_n = 0$						5.7894***
Test of H3: $\gamma_1 = \gamma_2 = \gamma_3 = \ldots = \gamma_n$						6.7572***
Joint tests for all companies:						
Test of H2: $\gamma_1 = \gamma_2 = \gamma_3 = \ldots = \gamma_n = 0$						9.1208***
Test of H3: $\gamma_1 = \gamma_2 = \gamma_3 = \ldots = \gamma_n$						8.5370***

Table 4. Cross-Sectional Regression of Abnormal Returns

This table presents the results of the cross-sectional regression of abnormal returns for the insurance companies on September 17, 2001 using the equation:

$$\gamma_i = \alpha_1 CASH_i + \alpha_2 LTDEQ_i + \alpha_3 ROA_i + \alpha_4 S_1 + \alpha_5 S_2 + \alpha_6 S_3 + \alpha_7 S_4 + \mu_i$$

where $CASH_i$ is the cash and cash equivalent over total assets for insurance company i, $LTDEQ_i$ is the ratio of long-time debt to total equity for insurance company i (a measure of leverage), ROA_i is the average quarterly return on assets for the four quarters prior to September 11, S_1 is a dummy variable equal to one if the company belongs to subsample 1, S_2 is a dummy variable equal to one if the company belongs to subsample 2, S_3 is a dummy variable equal to one if the company belongs to subsample 3, S_4 is a dummy variable equal to one if the company belongs to subsample 4, and μ_i is a random disturbance term with zero mean. Statistical significance at the 10%, 5% or 1% level is indicated by *, **, or ***, respectively.

Parameter	CASH	LTDEQ	ROA	S1	S2	S3	S4
	0.18867	-0.0343*	-0.0627	-0.0200	-0.0352*	-0.0029	-0.0272*
	(0.3071)	(0.0982)	(0. 6422)	(0.5810)	(0.0672)	(0.9190)	(0.0725)
F-Statistic	2.834**						