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## An examination of risk adjusted returns and catastrophic events caused by terrorist attacks

### Abstract

Although most insurance policies have exclusions for payment as a result of a terrorist attack, there are many indirect impacts of having a policy whose returns are affected by the stock market reaction to a terrorist event. It is imperative for insurers to have models which accurately reflect the systematic risks associated with the aftermath of terrorist attacks. This paper examines 8 separate acts of terror and their effect on risk adjusted return. We find that there is a significant shock, with markets displaying negative and significant abnormal returns in the days following a terrorist attack. However, one week after the terrorist event there are no significant abnormal returns. Also, the risk adjusted returns are not significantly different than other periods.

**Keywords:** terrorist attack, financial markets, event study.

### Introduction

In recent years, the potential exposure that insurers face due to acts of terrorism has increased greatly. With CIA officials saying that a terrorist attack on U.S. soil is almost a certainty in the next year, insurers should consider the potential impact of a terrorist attack on policies with significant stock market exposure. In particular, the product of variable life insurance has significant systematic risk.

There is significant empirical evidence that indicates an increase in the frequency and size of terrorist attacks (Enders and Sandler, 2000). Specifically, this is attributed to an increase in religious based terrorist attacks (Stern, 2003). Although insurers prohibit payment for terrorist attacks, it can still be indirectly affected by the event. For example, a terrorist attack can impact policy terms and payments or even negate a policy altogether. A company that was located in the world trade center may cover various types of insurance for their employees including health, accidental death, and liability. All of these policies would be subject to cancellation because the business may not be in operation following the attack.

The purpose of this paper is twofold. First, we examine the impact of terrorist events on U.S. stock markets. Second, we look at the modified risk adjusted returns in relation to overall portfolio risk. Our findings suggest that in the short term there is a negative and significant impact. However, one week after the event the abnormal returns are no longer significant and in most cases turn positive.

### 1. Literature review

**1.1. Impact of terrorism on business.** Since 1998, business activities have become the primary target of international terrorist attacks according to the U.S. State Department (2003) in a review of global

terrorism. In a study of the impact of terrorism at the individual firm level, Karolyi and Martell (2006) identified 75 terrorist attacks between 1995 and 2002 in which publicly traded firms were the targets. Their event-study analysis found a negative stock price reaction of  $-0.83\%$  on the day of the attack on DJIA with an average loss per firm per attack of \$401 million in firm market capitalization.

With an increase in the direct impact of terrorist attacks on businesses, the effect of terrorism on national and international economies and capital markets has become an area of research interest. The impact of terrorism should be measured in terms of the direct economic damage as well as the indirect cost to the economy as a whole through a loss in consumer and investor confidence as reflected in shifts in financial markets. The economic consequences of terrorist attacks have both short-term and long-term effects.

**1.2. Impact of terrorism on financial markets.** Considerable research has examined the impact of terrorism on U.S. and global financial markets. Chen and Siems (2004) examined the impact of 14 terrorist/military attacks since 1915 on U.S. capital markets as compared to the global capital market effect of two more recent events – Iraq's 1990 invasion of Kuwait and the September 11, 2001 terrorist attacks. Their findings suggested that U.S. capital markets display the least abnormal returns and recover quicker from terrorist attacks than other global capital markets. They found evidence that U.S. markets have become more efficient in absorbing the shock inherent in terror attacks over time and have continued to effectively perform their economic function. Eldor and Melnick (2004) reached a similar conclusion in their study of the impact of terror attacks on stock and foreign exchange markets.

**1.3. Impact of terrorism on the insurance industry.** Other studies have examined the effects of shock events on industry portfolios. For instance,

Cummins, Lewis and Wei (2006) conducted an event study of 89 large operational loss events in the U.S. insurance industry and 403 large bank operational loss events during the period 1978-2003. The study found significant negative stock price responses in both industries with a larger average response for insurers as compared to banks.

The terrorist attack on the World Trade Center (WTC) on September 11, 2001 was by far the biggest loss event for the insurance industry. Doherty, Lamm-Tennant, and Starks (2003) studied the price reaction of insurance company stock following 9/11. They examined how insurance companies were able to rebound quickly from the biggest losses by far to their industry by testing the effect of leverage, level of new capital, expected growth, and losses on stock performance subsequent to 9/11.

Cummins and Lewis (2003) compared the response of equity markets to three large loss events – the WTC terrorist attack, the Northridge earthquake, and Hurricane Andrew. Their study of 43 U.S. property-casualty insurers found that the WTC event had a larger and more sustained negative impact on insurer stock prices than either the Hurricane Andrew or the Northridge Earthquake. They determined that insurer financial ratings were an important predictor of post-loss stock performance.

Chen et al. (2008) separated the short-term “claim effect” and long-term “growth effect” of catastrophes and capital shocks on the insurance industry. They demonstrated that catastrophic claims have a negative effect on short-run, but not long-run, profitability. They found that firm financial strength was a statistically significant predictor of long-run recovery.

While previous literature has documented the effects of various catastrophic events on insurance companies stock and documented the growth post-catastrophe of those stocks, no paper has measured the risk adjusted returns and abnormal returns specifically associated with a terrorist event. This paper bridges that gap by examining the effects of the macroeconomic shock of terrorist attacks on stocks and how insurers should adjust to appropriately manage portfolio risk.

## 2. Data and methods

To study the macroeconomic shock of major terrorism events on the U.S. stock market, the authors used 8 specific terrorist events, starting with the bombing of the World Trade Center in 1993. We start with this attack because this is where the frequency of the attacks increases. The following are the eight attacks we measure:

- ◆ World Trade Center I – February 26, 1993
- ◆ Sarin Gas Attack on Tokyo, Japan – March 20, 1995

- ◆ Federal Building Bombing at Oklahoma City – April 19, 1995
- ◆ Attack on U.S. Barracks at Khobar Towers, Saudi Arabia – June 26, 1996
- ◆ Atlanta Olympics Bombing – July 27, 1996
- ◆ Bombings on U.S. Embassies in Kenya and Tanzania – August 7, 1998
- ◆ Attack on USS Cole, Yemen – October 12, 2000
- ◆ World Trade Center – September 11, 2001

The methodology is based on a variation of event study suggested by Peterson (1989) and MacKinlay (1997). The modified risk adjusted returns follow models suggested by Sharpe (1966) and Valentine and Kooti (2007). The Standard and Poors 500 (S&P 500) daily returns compiled via the Center for Research in Security Prices (CRSP) were used for the purpose of this study. The reason that the S&P 500 was used is that it represents approximately 70% of overall market capitalization. The abnormal rate of return used in this study is based on a 30-day estimation period for daily abnormal returns and a 6-week estimation period for weekly abnormal returns. The abnormal return is calculated using the following:

$$r_a = r_t - r_e,$$

where  $r_a$  = abnormal return,  $r_t$  = actuarial return,  $r_e$  = expected return.

The abnormal rate of return measures the deviation of the market, in this case the S&P 500, from the average return or expected rate of return for the 30-day estimation period. The positive or negative impact of a terrorism event is calculated by determining if the abnormal rate of return is significantly different from zero.

The Sharpe Ratio (Sharpe, 1966) has been widely used as an assessment of portfolio risk. The Ratio consists of the following:

$$S = \frac{R - R_f}{\sigma} = \frac{E[R - R_f]}{\sqrt{\text{var}[R - R_f]}}$$

where  $R$  is the asset return,  $R_f$  is the return on a benchmark asset, such as the risk free rate of return,  $E[R - R_f]$  is the expected value of the excess of the asset return over the benchmark return, and  $\sigma$  is the standard deviation of the stock. However, this model has shortcomings which limit its applicability in measuring overall portfolio risk in an event study.

The Valentine-Kooti Ratio (2007) uses the following:

$$Ra = \frac{Ar}{\sigma},$$

where  $A_r$  is the abnormal return as estimated by the Peterson model and  $R_a$  is the risk adjusted return. The impact of using this ratio as opposed to the Sharpe Ratio is that the ratio takes into account an estimation period during which “normal” returns occurred prior to an event. By using these “abnormal” returns as opposed to just taking into account a risk free rate, we obtain a more accurate measure of risk in that it shows how much the event impacted actual returns as opposed to looking at returns in a “vacuum”.

## 2. Results

In the event of a terrorist attack, insurers must be able to measure any impacts, direct or indirect, on their overall portfolio risks. Our study measures the impact (1) directly on stock performances and (2) to

measure the risk adjusted return of each terrorist event. Seven of the eight terrorist events caused the S&P 500 to have an abnormally negative return 1 day after the event. However, we see a distinct change when we look at the week following the event in aggregate.

With the exception of the U.S. Embassy bombings and 9/11, the S&P 500 had a positive abnormal weekly return following the event. Also, even after adjusting for risk, only the two aforementioned events had a negative risk adjusted return. After the market absorbed the initial macroeconomic shock, market settled down and reached an equilibrium point. Although the initial reaction was a 2 day negative return, markets quickly adjusted and the terrorist attacks had little impact on the longer run return. The following table shows the results of the study.

Table 1. Abnormal returns on the S&P 500 Stock Index following terrorist attacks

Event	World trade center bombing	Tokyo sarin gas attack	Oklahoma city bombing	Saudi Arabia attack barracks	Atlanta Olympic bomb	U.S. Embassy bombings	USS Cole Yemen	World trade center attacks
Date	26 Feb 1993	20 May 1995	19 April 1995	26 June 1996	27 July 1996	7 Aug 1998	12 Oct 2000	11 Sept 2001
1 day return								
30 day estimation	0.00036	0.00158	0.00134	0.00036	0.00080	-0.00123	-0.00881	-0.00583
1 day return	-0.00014	0.00125	-0.00089	-0.00612	-0.00785	-0.00017	-0.02961	-0.06832
1 day abnormal	-0.00049	-0.00033	-0.00223	-0.00648	-0.00865	0.00107	-0.02080	-0.06249
2 day return								
30 day estimation	0.00036	0.00158	0.00134	0.00036	0.00080	-0.00123	-0.00881	-0.00583
2 day return	-0.00418	-0.00216	0.00073	0.00626	0.00690	-0.00579	0.07874	-0.01549
2 day abnormal	-0.00454	-0.00374	-0.00060	0.00590	0.00610	-0.00456	0.08755	-0.00966
Weekly return:								
6 week estimation	0.00215	0.00947	0.00803	0.00217	0.00480	-0.00740	-0.05286	-0.03498
Weekly return	0.01135	0.01099	0.01329	0.00772	0.04135	-0.01336	0.00476	-0.17104
Abnormal return	0.00920	0.00152	0.00526	0.00556	0.03655	-0.00596	0.05761	-0.13606
Risk adjusted return	0.33440	0.05540	0.19132	0.20207	1.32923	-0.21665	2.09500	-4.94753

Source: The Impact of 9/11.

The attacks of September 11<sup>th</sup> had a wide reaching effect on the stock markets. They were distinctly unique in that the attacks were a direct hit on financial markets. The other events were attacks on targets that were not directly related to the stock market. The data surrounding 9/11 is different from the other attacks in the following ways:

1. The attacks resulted in financial markets being shut down for four consecutive days. Not even World Wars I and II could do that.
2. Because of the market being shut down, the abnormal returns contain more information than the other events do, which were reflected in the next calendar day.
3. Because the attacks were carried out on live television, there was a likely psychological impact that was reflected in the market (Rubin, 2004).

## Conclusion

Previous research has indicated the U.S. markets have lower abnormal returns than global markets when responding to macroeconomic shocks (Chen and Siems, 2004). The focus of our research is mainly to address the issue of risk adjusted returns and how they affect the overall portfolio risk of insurers, including those who carry products heavily invested in the stock market such as variable life. The paper looks at eight distinct terrorist attacks and examines the one day, two day, and one week abnormal returns associated with those events.

The predominant opinion in the literature stream is that a major terrorist attack will have a negative effect on stock returns (Rubin, 2004). This study shows that with the exception of the September 11<sup>th</sup> attacks, markets show a strong resiliency. Although one and two day returns are primarily negative, the

week-long abnormal returns and risk adjusted returns tend to turn positive. The macroeconomic shock caused by a terrorism event could have a short-term negative impact, but there is no statistically significant long-term negative impact on the U.S. stock market. After the market absorbed the initial macroeconomic shock of a terrorist event, the market settled down and reached an equilibrium point quickly, indicating an increased level of efficiency (Chen and Siems, 2004). This equilibrium point is reached at a reasonably short period of time (within a week of an event). Thus, unless a terrorist attack is a direct and severe attack on

financial markets, there is no long-term impact on security prices.

This paper adds to the existing literature by examining risk adjusted portfolio return in the aftermath of a terrorist event. The policy implications for insurers involve three key findings. First, overall risk does increase in the days following a terrorist event. Second, that risk subsides over time, often completely dissipating within a week. Third, insurers should not adjust their portfolios in the aftermath of a terrorist event to compensate for risk.

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