FEAR-BASED BUYING AND INVESTOR CONFIDENCE: EXPLORING MASS SHOOTINGS' INFLUENCE ON THE STOCK RETURN OF FIREARM MANUFACTURERS IN THE U.S.

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ABSTRACT

The mass shooting is always a sensitive topic in America and it hurts the society a lot. Some pieces of literature have already proved that mass shootings will have impacts on the stock market and investors' economic behavior. We are going to narrow down the study area to the firearms industry instead of the total market. To explore the relationship between the stock return of firearms' industry and mass shootings, we conducted a thorough analysis including descriptive and fundamental analysis, non-parametric test and a GARCH (1, 1) model. We first identify two uptrends after the event day, which is resulted from investor confidence and fear-based buying individually. Then, we use a GARCH model to quantify effects from shooting events on the firearms industry and found 0.181% and 0.533% incremental for daily and weekly in the event window. We also decompose the event window into two different windows according to two uptrends and have 1.1% and 0.521% abnormal return for each. The results show that the first event window is related to the date of mass shootings more closely while the second is not.

BIOGRAPHICAL SKETCH

Jiacheng Cao was born in Baoding, China, which is a small city in the north of China. He graduated from Renmin University of China in 2013 and decided to search more opportunities in Cornell in 2017. With knowledge of macroeconomics and intern experience in financial institutions, he decides to extend his research fields to finance.

ACKNOWLEDGMENTS

First of all, I want to mourn for the people who have been hurt by the shooting events. I believe everyone deserves a better life without any shooting events and terrorism and we all need to try to contribute to the construction of it. I am looking forward to studying on this topic deeper and with more effort.

I appreciate the support of my parents. Without their support and encouragement, I may not have a chance to attend Cornell and seize an opportunity to know this world better. I would like to thank myself who made the decision to give up other choices in hand and heading for studying abroad. It was such a fortune that I made this decision without any hesitation.

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CHAPTER 1

INTRODUCTION

Gun policy has been argued between the Democratic Party and the Republican Party during a long period. Each time after a mass shooting, the gun policy will be concentrated and argued about for a long time among the politicians and citizens in America. During the period when Barack Obama was the president, he initiated a pool for controlling guns. The result of this pool was out of 99% at that time, indicating most citizens have the intention to control the selling and use of guns. However, this intention has never been applied to real life. In this condition, mass shootings are still happening in a high frequency.

Figure 1 shows that the United States has an incredible death rate from gun violence under comparing with other developed countries. The United States ranks the 9^{th} among the world on indicators of socioeconomic success, including education, the medical system and happiness of citizen. However, the U.S. ranks 31^{st} high on the death rates of gun violence in the world while other developed countries have really low rates of gun violence like Canada and Japan (sources: IHME). In addition, the U.S. with other 6 countries can account for over 50% death in gun violence events among the world in 2016. America takes 14.8% of it as the only developed country among those 6 countries. The United States not only ranks high in homicide incidents but also suicide incidents. It represents 35.3% suicide incidents out of the total among the world. As for the U.S. itself, figure 2 shows that there are nearly 53,100 incidents involving gun violence in America and results in 13,592 death and 26,280 injuries. Especially we should pay attention to the gun violence targeted on children and teens, which may generate more effect on society. There are 627 children and 2,467 teenagers get killed or injured in 2018, which is such an astonishing number (sources: Gun violence Archive). Also, campus shootings and mass shootings are reported by social media much more frequently than the general type of shootings after the occurrence because children and teenagers are sensitive groups to get involved. In average, the United States nearly has one school shootings per week during 2018, which is a terrifying number for the citizens.

All of these incidents have effects on the country. They are not limited to society and politics, but also include the capital market. There are some unique thoughts on gun controlling and using in the U.S. while other countries may not have. For example, possessing guns in China, Japan or Korea is illegal so that there will not be any firearm manufactory can sell guns to citizens. They may blame on the firearm industry after gunshot events happened because of the poor control of guns and this depression may bring down the stock return of these companies if they are publicly traded. However, citizens in the U.S. may assign their blame on the security condition instead. For example, after the mass shootings happen in Santa Fe High School on May and Jewish community in Pennsylvania in October last year, the solution is to strengthen security by arming teachers or working stuff guns individually. They may not blame on the firearm industry and they may turn to buy more guns from manufactories in the opposite, which may benefit the firearm industry and their stock return. So this is the initial motivation for us to write this paper to verify our assumption.

What is the uniqueness of this paper? First of all, we are going to focus on the mass shootings happened in the U.S. only. This topic has not been explored well before while it always has great attractions. Second, we are going to focus on a specific industry instead of the total market. Considering some industries may not be sensitive to shooting events, we are going to concentrate on the firearm industry, which is a directly related industry. Third, we may have some comparable groups of different types of companies in our samples. For example, we may have three different groups including the manufactories, gun selling companies and companies associated with NRA. We want to explore the abnormal return of these different groups to see where the blame goes. Finally, we extend the event window to different time periods to capture any shock and compare them.

What do we find? First of all, we find out that firearm industry outperforms the total market in a trading month after the gunshot events happened and falls to a relatively lower level but still higher than the level before the event. However, we identify two uptrends during this period, which are resulted from two different reasons. Secondly, we explore the true driving force of these two uptrends. For the first trend, we believe it results from the good expectation from investors because of the short persistence. For the second trend, we conduct a fundamental analysis and find out an incremental on revenue, which lasts for nearly two quarters and we prefer to call it fear-based buying as the literature before. We believe the second uptrend is related to this outperformance on their sales because of the long persistence and time-matching with the releasing time of financial documents. Thirdly, we use a GARCH model to identify the average abnormal return in the event window, which is 0.181% for daily return and 0.533% for weekly return. After that, we find out that the abnormal return in the second uptrend is not closely related to mass shootings while the first one is significantly affected by mass shootings. This result leads us to speculate that the first uptrend is associated with the date when mass shootings happened and the second one is related to the releasing of financial documents.

This paper contains five parts. First of all, we will go through a literature review to find support for our study and make some adjustments to form our framework. Secondly, we will explain our data and its resources. Thirdly, we will briefly describe our methodology. We will illustrate our methods individually because we adopt different methods in different parts of the analysis.

CHAPTER 2

LITERATURE REVIEW AND HYPOTHESIS

2.1 Literature Review

Considering there are few studies related to our topic, we start from two similar research fields, which are terrorism and political events. There are many papers studying the relationship between stock market and terrorism since 1965. Most of these studies focus on three fields, which are the total market, the investors' behavior and analysts' forecasts. For the total market, Karolyi and Martell (2010) examined the effect of the terrorist attack on the capital market since 1995 to 2002, covering 75 terrorism events and identified a -0.83% stock price reaction after terrorism events happened. Besides, Hamilton (1983) found that it may take a longer time for a developed country to forget the terrorism. Karolyi and Martell also found that terrorism in developed countries are much easier to go through higher negative price reactions. As for the investors' behavior, some studies argue that the fear of the terrorism will affect investors' economic behaviors in a long time period (Becker and Rubinstein, 2004). In the area of analysts' forecasts, Antoniou, Kumar, and Maligkris found that analysts who are local to the terrorism events are more pessimistic than average forecasts, which may bring negative fluctuation to the stock market.

There are also massive researches about the effect of political events on the capital market, which uses the traditional way of studying daily stock return and event studies (Warner, Brown, 1983). For the general study, some papers study the various political events' effect on the stock market, including elections, governmental policies change and so on (Niederhoffer, Gibbs and Bullock, 1970, Peel and Pope, 1983). They actually did not find enough evidence to support their hypothesis about the effect of general political events on the stock market but still provide meaningful results. Recently, more and more papers discover the underlying relationships between political events and the stock market and find a way to scale the effects (Chan and Wei, 1996, Bittlingmayer, 1998).

Political events and terrorism have some similar characteristics with shooting events. They are non-economic events. They are made by humankind with unpredicted power and motivations. They are public information accessed to all investors. Based on these similarities, we can use some conclusions as support in our paper. We believe mass shootings will have effects on stock market and firearms industry because it generates fear to the market. What we want to explore is whether the effect is positive or negative and how large is it.

However, political events and terrorism are slightly different from gun violence events. Political events are somehow anticipated. For example, citizens in America always have anticipation to the results of elections and they may have prepared for it. But gun violence events are totally unpredicted. Political events may not generate nation-wide fear or anger, such as elections or tax policy reform. In contrast, gun violence will generate fear or anger in nation-wide, especially the mass shootings and campus shootings. As for terrorism, shooting events have a narrower definition. Terrorism is related to politics or religion more often and usually initiated by foreigners. Gun violence can be included in the broad type of terrorism but it has its own characteristics. Shooting events happen regionally and have a higher frequency.

So we need to adjust the assumptions and definitions in the papers we mentioned before and make our own assumptions.

There are limited studies concentrating on the effect of mass shootings. Cross and Pruitt found out that mass shootings perform significant effects on targeted companies by using Newton CT shooting and Aurora shooting as their random sample (Cross, Pruitt, 2013). However, they only include two single companies and two single mass shooting events in their study. Wallace explored the relationship between mass shootings and gun sales after mass shootings. Results suggest that mass shootings may bring out incremental on gun sales (Wallace, 2015).

We construct a framework based on the traditional way of doing researches on daily return and event study. But we have made some adjustments in this framework. First of all, we redefine some concepts. We redefine the event days of gunshot events as 21 trading days after gunshot happened, which is the interval of $[T_0, T_{21}]$. We should not take days before gunshot events as event days because these events cannot be anticipated. Second, we define the event window as $[T_{-21}, T_{21}]$ so that we can compare the effect of mass shootings before and after the event day. Also, we made some extension to the event window to see if they are going to fall back to the normal level. Thirdly, we adjust our study target to a specific industry instead of the total market. In this condition, the abnormal return may be more obvious to identify. The effect on the total market may be smoothed by some industries which are not sensitive to shooting events.

Based on our framework and adjustments, we adopt a top-down approach to start from the result we have and explore the reason behind the results. First of all, we will identify the effect of mass shootings on the stock market and firearms industry. Secondly, if there do exist some abnormal effects, we will explore the real reasons behind it and find the main driving forces. Thirdly, we will quantify the average level of abnormal return in our parametric model. Finally, we will compare three different groups of companies and make a conclusion of investors' reaction to shooting events. We will run both of nonparametric test and parametric test in our paper to reach our conclusions.

2.2 Hypothesis

Based on all the related papers we read and the study we concentrate on, we propose some hypothesis. The shooting events we include in our sample are all known nationwide and cause more than 10 fatalities and we believe these events have attracted enough focus and have effects on the stock market and firearms industry. Based on the literature review and our assumptions and intuition about this topic, we made such four hypotheses.

H_1: The return of the firearms industry will experience higher volatility in the event window.

H_2: The abnormal return of our portfolio will be positive

H_3: There may exist some fear-based buying after mass shootings

H_4: Investor confidence and increasing gun sales may be the reason for any possible shock on stock return

CHAPTER 3

DATA AND FACTORS

3.1 Gun violence events

We collect 16 massive gunshot events since 1990 from CNN, Washington Post, Gun Violence Archive and Wikipedia. The criteria we select our samples are based on the fatalities and social effect. If we are going to study the effect of gun violence events on the stock market, we may concern the attention of investors. We first derive the sample of all shooting events happened in the United States since 1990 and filter them by the fatalities. Considering the huge volume, we are not able to filter them one by one so we use a two-step method to select our samples. First of all, we select all the gunshot events with more than 10 fatalities since 1990 and search all the events on CNN and Washington Post to see if there were reports about them. Secondly, we compare the mass shootings recorded in Wikipedia because it is widely used, which includes 24 events, and delete the events which are not recorded in Wiki. Figure 1 shows a sample of 16 gunshot events.

3.2 Stock return data

There are over 5,000 data in my sample based on the 16 events we select. Considering our events sample is not big enough, we decide to use the daily stock return to increase the frequency of the data. First of all, we select the S&P 500 index as the reflection of the total stock market because we believe the S&P 500 consistent is more broad and representative. We get the daily return data of the S&P 500 from CRSP and take them as the benchmark for the portfolio we will construct after. Then, we define the event window as the 21 trading days after the day when the gunshot event happened, which is T_0 in the paper. For analyzing the trend of stock return, we extend the interval to $[T_{-21}, T_{64}]$, which is long enough to see the trend clearly.

For the portfolios we construct, we first find the SIC code of our targeted companies and industries in the library of Kenneth R. French. The firearms industry code is between 3480 and 3489. We collect all the companies have ever been publicly traded from 1990 to 2018. Secondly, we search daily stock return data on WRDS according to the SIC code we specified before. Thirdly, we apply the event window concept we defined before in this section too. Finally, we process the data to get the data we want to use in our model we will describe after. We calculate the abnormal return, cumulative abnormal return and turnover in each event and aggregate all the events together to calculate an average value. All these factors are calculated on value-weighted.

3.3 Profitability Data

To explore the reasons for the fluctuation, we decide to make some fundamental analysis of our constructed portfolio. There would be two possible reasons for the fluctuation, which are an increase in profitability and another one is investors have a good expectation for the portfolio. Profitability data are easier to get and more objective so we collect some important profitability data from WRDS, including sales, earnings, ROA and ROE. Due to the difficulty to acquire daily sales and earnings data, we prefer quarterly data instead. Figure 2 shows all factors we used in our paper and illustrate how we calculate them.

Considering that all events are recorded based on the calendar date, we decide to use calendar quarters on financial data instead of fiscal quarters. The standard calendar quarters are January, February, and March (Q1); April, May, and June (Q2); July, August, and September (Q3); and October, November, and December (Q4). We are interested in the comparison between the month before gunshot events and the month after gunshot events so that we can see if there is an increase in profitability after gunshot events. We have covered 114 calendar quarters since 1990 Q1 and we also dropped some abnormal data in our sample. For example, the return of equity (ROE) on 2008 Q1 approaches 1000%, which was caused by one abnormal data of a specific company so we delete that record to make it more comparable. Basically, we assign a different value to different quarters.

Basically, we will run into some problems when we process the data, such as the problem of overlapping and quarters located in different years. First of all, we are trying to assure that we make each quarter in the same year. For those cannot be adjusted, we will allow at most 1 quarter locates in the other year. Secondly, we have 3 events run into the problem of overlapping because they happened in the same quarter or happened in consecutive quarters. For these quarters, we will allow two consecutive Q_T. For example, we have two gunshot events happened in 2012 are located in 2012 Q3 and 2012 Q4 individually. We assign number 2 to both Q3 and Q4 and locate the Q_{T+1}, which is the first quarter in 2013.

In this section, we still calculate the factors based on the value-weighted adjustment. We have the quarterly shares outstanding on the end date of each quarter. In addition, we have the highest and lowest price during that period, which we can use to calculate the average price. Then we calculate the enterprise value as below:

$$Enterprise\ Value = \frac{(shares_{beginning} + shares_{end})}{2} \times \frac{(P_{highest} + P_{lowest})}{2} \quad (1)$$

After we have the enterprise value of each company, we can calculate the weight and get different weights in each quarter so that we can have our value-weighted profitability data.

CHAPTER 4

METHODOLOGY

4.1 Summary

We apply the classic event study methodology to our samples, which are brought up by FFJR (1969) and developed by Warner and Brown (1985). Now that we are not focusing on the abnormal return on each event individually, we do not run MVRM model in this paper. There are a lot of empirical results indicate that daily stock return is not normally distributed, which allows us to do some non-parametric test. So before we conduct our parametric model, we first go through a nonparametric test to verify that the gunshot events will bring more volatility to the firearms industry on event days than non-event days. Then we run trend analysis and fundamental analysis to analyze the endogenous driver for the fluctuation. Finally, we use a GARCH (1, 1) model to quantify the abnormal return and compare firearms with the total market and other portfolios we constructed.

There are four parts in this section. Part one is the methodology of the nonparametric test, which is the Wilcoxon rank-sum test. Part two and three are about the fundamental analysis trying to find out the endogenous driver. Part four illustrate the GARCH model we adopt in this paper.

4.2 Wilcoxon Rank-Sum Test

First of all, we should make sure that shooting events do have effects on the stock market and firearm industry. If we get a positive conclusion, we may keep on exploring more details. The nonparametric model gives us a lot of options to test a sample not subjected to a normal distribution. Additionally, the sample we derived before is unmatched because gunshot events are unusual items and it can be divided into two unmatched samples. Finally, we decide to run a Wilcoxon rank-sum test to detect the distribution and compare the two samples. The reason we select this test is that it is appropriate for the purpose of comparing the unmatched samples, which are not subjected to a normal distribution.

We use the stock return data from 2007 to 2018, since it contains most of the sixteen events. Then we define the event days as 20 trading days after the gunshot event happened. Traditionally, other paper will define event days as an interval of $[T_{-5},\ T_5]$ because news can be leaked or anticipated. However, gunshot events are unpredictable and may generate volatility to the market in a longer period. Furthermore, we take daily volatility as the variable to be tested, which is actually the square of the daily return. The calculation is also employed by other papers before (Chan, Wei, 1996).

$$R_t = \ln \frac{P_t}{P_{t-1}} \tag{2}$$

$$\sigma = \mathrm{E}\left({R_t}^2\right) - (E(R_t)^2) \tag{3}$$

There are some studies have already proved that the mean daily stock return in a long period should be zero. So if we assuming that the mean return is zero, we will have $E(R_t)^2$ as zero, which indicates that $\sigma = \mathrm{E}\left({R_t}^2\right)$. So we rewrite the formula as:

$$\sigma = (\ln \frac{P_t}{P_{t-1}})^2 \tag{4}$$

Furthermore, we consider the volatility of our targeted industry, which is the firearms industry, after we test the volatility of the stock market. It can be calculated in two ways, which are close to close volatility and open to open volatility[1]. Because some gunshot events happened during the trading hours while some happened after the market is closed. So we test them separately across all the market and the results are analyzed in the next section.

4.3 Descriptive Analysis

We derive a relative huge sample ranging from 1990 to 2018, which contains nearly 38,000 data. We would not use all of them because of the absence of some data. However, we still have more than thousands of data. So we decide to run a basic descriptive analysis based on all effective data.

First of all, we calculate abnormal return and cumulative abnormal return as below.

$$AR_{i,t} = R_{i,t} - r_{i,t} \tag{5}$$

$$CAR_{i,t} = (1 + AR_{i,1}) \times \cdots \times (1 + AR_{i,t-1}) \times (1 + AR_{i,t}) \tag{6}$$

We take $R_{i,n,t}$ as the daily stock return of company i at the time t and the same to other factors. The reason we take stock return instead of price as our factors is that prices are not as clean as returns under the effects of enterprise value, shares and dividends. We can see the real change of intrinsic value indicated by the stock return. Considering we are going to concentrate on the abnormal return caused by shooting events, we should subtract the return of the total stock market, which is $r_{i,t}$.

[1] A method adopted in Chan, Y. C., & Wei, K. J. (1996). Political risk and stock price volatility: the case of Hong Kong. Pacific-Basin Finance Journal, 4(2-3), 259-275.

We take $CAR_{i,n,t}$ as the cumulative stock return so that we can see the trend of this stock in the event window. Abnormal return can be both negative and positive and will change in a relatively larger scale than the cumulative abnormal return. So if we want to identify the effect of gunshot events on the intrinsic value of stocks, the cumulative one is preferred. We use the $(1 + AR_{i,n,1})$ as the initial value of the cumulative return of a stock and multiply it after by daily data. In order to see the performance of the firearms industry, we calculate abnormal return and cumulative abnormal return for both the stock market and firearms industry so that we can compare two results.

Also, we use turnover as an indicator to identify the direct reaction from investors to the gunshot events, which represents the frequency of trading. We do the calculation as below.

$$Turnover_{i,t} = \frac{VOL_{i,t}}{Share\ out_{i,t}} \tag{7}$$

$VOL_{i,n,t}$ and $Share\ out_{i,n,t}$ represent the traded volume and the shares outstanding of company i at the time t accordingly. The turnover is a good indicator of the reaction of the stock market and investors to the gunshot events.

4.4 Fundamental Analysis

Briefly speaking, the fluctuation of the stock return should be contributed by two drivers: profitability and expectation. The former one is more related to the company while the latter one is talking about the expectation of investors.

In this part, we first analyze the profitability of our portfolio to see if there is any significant endogenous growth. We conduct a fundamental analysis based on the quarterly financial data we described before. The analysis consists of three parts, including profitability analysis, Dupont analysis and liquidity analysis. The profitability analysis is going to extract the main reason for the fluctuation of stock return. We include ROA, ROE and growth rate of revenue in this part to roughly see the trend. The Dupont analysis part is a more detailed analysis of profitability. We want to use 3-step Dupont analysis and 5-step analysis to see the most important driver for the change of ROE and ROA. Finally, we will conduct a liquidity analysis, which includes the current ratio and account receivable ratio. For a mature company and industry, account receivable will be straightforward data to see if the revenue has been experienced a strong trend of increasing. So we adapt current ratio and account receivable ratio as our indicators.

In a word, the fundamental analysis is a part following the section of descriptive analysis and nonparametric test. We would like to figure out the real reason for the potential fluctuation and prepare for the parametric study.

4.5 Parametric model

Descriptive analysis and fundamental analysis ignore some statistics problem of our sample, such as auto-related. So we need to use a parametric model to test our assumptions.

Theoretically, the abnormal return of firm n will be the differences between its return without dividends and the return of the market. However, there will exist some error terms or other noises in this market model. So we rewrite it as:

$$AR_{i,n,t} = R_{i,n,t} - \hat{\beta} r_{i,t} - \hat{\alpha} \tag{8}$$

In this formula, $\hat{\alpha}$ is a constant and $AR_{i,n,t}$ is the real error term, which should be written as:

$$R_{i,n,t} = \hat{\beta} r_{i,t} + \hat{\alpha} + \varepsilon_{i,n,t} \tag{9}$$

Both of the market model and OLS model are assuming that they have identical expectations and variances, which leads us to the problem of conditional heteroscedasticity and bias the estimation. The dependent problem becomes much more severe when it satisfies three conditions: heterogeneity of abnormal return, heterogeneity of residual variance and homogeneity of event windows. To solve these problems, more and more scholars begin to use Multivariate Regression Model (MVRM) and ARCH model (Chan, Wei, 1996; Chen, Bin, Chen, 2005). Traditional studies have already proved that it would be appropriate to use autoregressive conditional heteroskedasticity because the return data may have volatility clustering.

Based on these studies, we construct a model, including a dummy variable D_t. It equals to one if that day is in the event window $[T_{-21}, T_{21}]$ while it would be zero if that day is not located in the event window. We take the return of our portfolio as the sum of three parts, which are the market return, abnormal return and an error term. The market return has clustering volatility and should take lag terms into consideration so that we modeled the market return of $[RM_{t-n,} RM_{t+n}]$ in equations. For the part of the abnormal return, we add a dummy variable in our model to solve the conditional variance and take the parameter θ_{it} as the abnormal return. We take the aggregated data to run the ARCH model and the $\hat{\theta}_{i,t}$ we get in this process is actually the average abnormal return across different events. Considering we do not care about if different events have different effects on the firearms industry, we will not estimate them separately.

The basic ARCH model has two equations, which are mean equations and variance equation. In the mean equation, the mean of our sample will be explained by some independent variables and a constant.

$$R_{it} = \alpha_{it} + \beta_{it} \quad (10)$$

And the variance equation is like:

$$e_t^{\ 2} = \alpha_t + \gamma_1 e_{t-1}^{\ 2} + \varepsilon_{it} \quad (11)$$

In this model, we can test the hypothesis that there is no ARCH effect in our error term, which means there is no volatility clustering effect in our data.

$$H_0: \gamma_1 = 0$$

$$H_1: \gamma_1 \neq 0$$

After going through these two basic equations, we could move on to simply model our sample. The model can be written as:

$$R_{it} = \alpha_i + \beta_{i1} RM_{t-n} + \cdots + \beta_{in} RM_t + \cdots + \beta_{in} RM_{t+n} + \theta_{it} \times D_{it} + \varepsilon \quad (12)$$

However, for most financial data, it would be usual to have such volatility in a long time period, which means we may have infinite lag terms in the ARCH (n) model. This is too complicated to do the analysis. So we move on to the GRACH model, which is more simple and neat by reducing parameters which should be estimated.

To have a more clear view, we should notice the error term $\varepsilon \sim N(0, h_{it}^{\ 2})$. First of all, we will give the equation of the ARCH (n) model.

$$h_{it}^{\ 2} = \varphi_{i0} + \gamma_{i1} \varepsilon_{i(t-1)}^{\ 2} + \gamma_{i2} \varepsilon_{i(t-2)}^{\ 2} + \cdots + \gamma_{in} \varepsilon_{i(t-n)}^{\ 2} \quad (13)$$

In the GARCH model, we could simply add a lag term of the variance ${h_{it}}^2$ to the equation (13) and we can note the lag term as ${h_{i(t-n)}}^2$. In this way, we could rewrite the equation (13) as:

$$
{h_{it}}^2 = \varphi_{i0} + \gamma_{i1}{\varepsilon_{i(t-1)}}^2 + \gamma_{i2}{\varepsilon_{i(t-2)}}^2 + \cdots + \gamma_{in}{\varepsilon_{i(t-n)}}^2 + \beta_{i1}{h_{i(t-1)}}^2 + \cdots + \beta_{i(t-n)}{h_{i(t-n)}}^2 \qquad (14)
$$

Many studies will prefer the GARCH (1, 1) model with higher efficiency.

$$
{h_{it}}^2 = \varphi_{i0} + \gamma_{i1}{\varepsilon_{i(t-1)}}^2 + \beta_{i1}{h_{i(t-1)}}^2 \qquad (15)
$$

This is the GARCH (1, 1) model framework instead of the ARCH (n) model. ARCH model is the basic model in the section of time series studies. However, the GARCH model is neat and less complicated. It will not lose too many parameters needed to be estimated.

After applying the basic model before, we decide to decompose the average abnormal return to two different groups, which are the abnormal return in the first event window and second event window individually. Here is the decomposed model:

$$
R_{it} = \alpha_i + \beta_{i1}RM_{t-n} + \cdots + \beta_{in}RM_t + \cdots + \beta_{in}RM_{t+n} + \omega_{it} \times D_{it} + \tau_{it} \times D_{it} + \varepsilon
$$

In this model, we are going to use two dummy variables instead of a single dummy variable. For the dummy variable ω_{it}, we assign the value one to the days in the first event window and zero otherwise and we apply the same method to the second dummy variable τ_{it}. The error term has the same distribution as before.

CHAPTER 5

EMPIRICAL RESULTS

5.1 Wilcoxon test results

In this section, we run this test three times based on different measures. We test the volatility of the S&P 500 and firearms industry both. The null hypothesis is that the volatility of event days and non-event days are identical and the alternative hypothesis is that they are different from each other. Table 4 shows the result of the Wilcoxon test we run on the S&P 500, which have a P-value as 0.0289 on the significant level of 5%. This result is not strong enough to support our conclusion that gunshot events will bring volatility to the stock market. Our interpretation is that S&P 500 is a portfolio covers many industries and companies so its reaction to gunshot events may be smoothed. Also, gunshot events are different from terror attacks because gunshot events may not generate terrifying environment and will not increase the cost of safety for all kinds of enterprises.

Table 5 states the test we run on the firearms industry. We include two different calculations in this test, which are close-to-close volatility and open-to-open volatility. The former one has a p-value of 0.0001 and the latter one has a p-value of 0.0012, which are both significant at the level of 5%. It strongly supports our assumption that the gunshot events will bring more volatility to the stock market and the firearms industry.

From all panels, we can conclude that gunshot events will increase the volatility of stock return both to the total market and portfolio. Especially for the firearms industry, the p-value is smaller than 0.01, which is very significant. So we should make some detailed analysis to see if there is an uptrend or downtrend on stock return after the gunshot event happened.

5.2 Descriptive statistics results of firearms industry

As we described before, we construct a portfolio consists of all the publicly traded firearms companies and do some simple analysis of the return data.

First of all, we calculate the enterprise value based on the share outstanding and price data of each company. Secondly, we calculate the daily value-weighted abnormal return of this portfolio on each day. Finally, we draw out the trend of these return data.

The enterprise values we calculate is based on the average price of highest ask price and lowest bid price. In this way, we can avoid to have a negative price and be more reasonable to have an average price over a trading day instead of using the close price. We can identify that there will be two or three companies take account for most of the market weight over than 70%, which means this industry is relatively mature and concentrated so we had better use the value-weighted method to adjust the bias.

After we have the weight of each company in our portfolio, we calculate the value-weighted stock return and compare it with the stock market return. In this section, we are using trading days instead of the calendar day. So we actually have 21 trading days in a month. So we would like to compare the cumulative return in the time period of $[T_{-21,}T_{21}]$, which is both a lag of the event month before and after the gunshot events happened.

We can identify an obvious uptrend after the event day T_0 and this trend has not been weakened in 20 days after the event day. Even though the return of index has a small incremental, it should not be the main reason for the strong uptrend of the portfolio's return. This result is expected since the firearms industry is directly related to shooting events. In the S&P 500, other industries will smooth out the return fluctuation in a shorter period than the firearms industry. In order to compare the differences between the total stock market and portfolio we constructed, we put the two trends together, which is more straightforward.

Now that we identify an obvious return uptrend of our portfolio relative to the total stock market, we should focus on the abnormal return of our portfolio to see if there is any sharp incremental of the value-weighted abnormal return. Terrorism events may bring fear to all investors, which may lead to an uptrend on the premium of risk. In this way, we will have a higher cost of capital, which is the discount rate, and lower enterprise values. So the price and stock return of total market will experience huge volatility. However, gunshot events are not like terrorism. They may not bring the same volatility to the total market. So it would be more straightforward for us to study the firearms industry and explore their abnormal return.

Figure 2 gives us a clear view of the trend of abnormal return, which is a strong uptrend after T_{22}, which is the date when gunshot events happened. We take 22 trading days as a month and we have 66 days in total, which means we are exploring the abnormal return of a month before gunshot events and 2 months after gunshot events. We identify two uptrends in the event window. One is starting from T_{22} to T_{54} while another starts from T_{55} to T_{66}. This consecutive uptrend is somehow unexpected because we believed the effect of gunshot events would not keep for such a long time. However, the second trend of incremental has a smaller slope than the first one and may benefit from the compounded return. So we decide to extend our data to include one more month in our graph and found out the cumulative return falls back to the normal level at the end of the third month after gunshot events. We are curious about such a long persistence because it is not matched up with our assumption that the gunshot events will have a short-term effect on the firearms industry. So we decided to analyze the turnover data to see if there are any possible reasons for this.

We plot the equal-weighted turnover and value-weighted turnover in the same graph to see the consistency and get a better view. From the graph, we locate two significant fluctuations during this time period. The turnover increases sharply at the day when gunshot events happened from 13 to the level of over 25 in just a week. Then it came into the first period with a relatively stable turnover while the abnormal return is keeping goes up. During this period, the cumulative abnormal stock return rises sharply from 0.98 to 1.05. On the day of T_{45}, there is another significant fluctuation, which is extremely similar to 20 days before. Oppositely, we identify a downtrend of cumulative abnormal return after this significant fluctuation of turnovers. To see the results more clearly, we combined the data of return and turnover in a single graph. There is another uptrend of cumulative abnormal return after the T_{54} and have not shown a downtrend.

There are a few reasons to explain it. First, our portfolio experiences a month of positive abnormal return to arrive at such a high cumulative return. Basically, it will have an effect like compounded interest. The base number of cumulative abnormal return of that day is 1.03, which means even if a modest positive abnormal return can bring up our cumulative abnormal return. Second, we believe that there is asymmetric information on the stock return. Investors are confident about the performance of the firearms industry after the shooting events so they take a long position in the market after shooting events. After they earn most of the excess return, they believe the stock may fall back to the normal level before shooting events in the future, so they take a short position. However, other investors may have asymmetric information and believe they have captured a great investment opportunity because of the decreasing price. So there is a second-time clustered trading and simulate the cumulative abnormal return to experience another incremental.

As the supplemental of CAR, we calculate the periodic return based on the calculation of CAR. CAR will always be greater than 1 so we think the periodic return may be a great indicator too. We just subtract one from each CAR and get the periodic return. From figure5 and 6, we also identify two uptrends which are consistent with what we found on CAR trend and it is more straightforward. Comparing with the second uptrend, the first one has a shorter time period and smaller incremental. We explain the first uptrend as the good expectation or confidence of investors in the firearms industry. Because it happens immediately after the event day with a sharp increasing and end in a short time period, which is 15 days long. However, the second one persists nearly 50 days, which is nearly 3 trading months. We are curious about the second uptrend. If the market is efficient, the first uptrend of return should already include all expectations in it and it will not have another uptrend during the period when investors verify their expectations. We also analyze the weekly data and identify the same uptrends. However, weekly data is more helpful in plotting the abnormal return due to its lower frequency. We use the two standard error bands method to curve the abnormal return and find out it will approach zero at the end of the time period. The distance of upper bands and lower bands also guide us to predict the trend in the future. From figure 8, we can see the distance is getting larger in the end, which means the trend may become reversal in the next period, which is decreasing.

In the next section, we are going to focus on using fundamental analysis to analyze the profitability and see if there is really an endogenous driver for the second uptrend.

5.3 Fundamental analysis

After part of the nonparametric analysis and descriptive analysis, we believe that the stock return of the firearms industry will experience an uptrend in the following two months after gunshot events. In this section, we want to explore if there is an uptrend in their profitability. We assign 2 to the quarter when shooting events happened. Then we assign 1 to a quarter before, 3 to a quarter after and 4 to the 2^{nd} quarter after the event quarter. For the event happened near the end of quarters, we assign the month after the border as our event quarter. For example, if the shooting event happened in September, which is the end of Q3, we will take Q4 as our event quarter. This is the solution to the lagged reaction on financial data to the shooting events and makes sure the event quarters can reflect the real change.

First of all, we try to explore the changing of quarterly total revenue. We plot the revenue of four quarters, which are the event quarter and quarters around it in figure 5. We can identify there do exist an incremental on revenue in the event quarter, which is about 270 million. However, after the event quarter, the revenue drops immediately and falls back to the normal level as Q1, which is the quarter before the event quarter. We offer several explanations for it. First of all, people often fell depressed and fear after mass shooting events and they are aware of that gun control policy will not be tightened in a short time. To assure their safety, they will purchase more guns to protect themselves. Second, there are many shooting events happened in public properties, including shopping malls, churches and offices. After the shooting events, the security of these properties may be strengthened by their owners. For example, after the shooting event happened in the Jewish Community, they chose to buy more guns and employee more securities to make sure that the tragedy will not happen again.

However, there are many different kinds of revenue incremental. It may be endogenous, exogenous, temporary and permanent. So we need to concentrate on the change of their ROA and ROE[2].

From figure 6, we find some interesting results. The ROE and ROA basically keep the same trend, which indicates our portfolio has a relatively stable financial leverage level. However, there is a sharp uptrend in the event quarter and a downtrend after Q2 and get to the lowest level in Q3. Then it will bounce back to the level as Q1

[2] Return of assets and return of equity. We take the average level of assets and equity to make this calculation.

and Q2 in Q4. It seems like the mass shootings boost the ROA and ROE of the firearms industry temporarily, which may lead investors to inefficient pricing. So we decide to have a sight into the real profitability so we are going to go through a fundamental analysis.

For the 3-step Dupont analysis, it is useful to analyze both ROA and ROE. Considering we already have stable financial leverage, we plot net income margin and asset turnover in a single graph to compare the trend. From figure 7, we can see that the net income margin experiences a significant downtrend after gunshot events happened, decreasing from 7% to 3%, which is a significant loss for a mature industry. Even though we have a downtrend of assets turnover between Q2 and Q3, we can attribute it to the incremental of revenue in Q2 and the downtrend happened in Q3. We need to figure out the reason for the fluctuation of the net profit margin.

So we break down profit margin to EBIT margin, which is operating margin, and the burden of interest and tax. The EBIT margins on three quarters are 13.86%, 13.65%, 14.16% and 13.45% individually, which is very stable. This is consistent with the characteristics of such a mature industry.

From figure 8 we can identify that there is a significant downtrend of the tax burden and fluctuation of interest burden while the EBIT margin is relatively stable. Tax burden can be seen as 1 minus tax rate in a simple way. A high tax burden indicates the company has abilities to keep most of its pretax income. A downtrend of tax burden means a more heavy tax from the government and the company is losing more pretax income. After exploring our sample and data type, we consider this downtrend as a reasonable trend because of the characteristic of tax from both the state government and the federal government. Most of the government will begin to tax companies in December and January. We have more than 3 events happened at a very late date of a year. For example, the gunshot event happened in the elementary school in Connecticut occurred on the date of December 14^{th}, 2012. In this case, we may assign the next quarter as quarter 3, which will include the tax season in it. So the tax burden will have a sharp downtrend in quarter 3. The bouncing back of tax burden in Q4 also verify our thoughts.

After we explore the tax burden, we turn to study the interest burden. The interest burden indicates the portion of EBIT will be left to the company itself so that a higher interest burden leads to a higher ROE. Figure 8 shows a fluctuation of interest burden, which cannot be explained because there are many companies in our portfolio and they may have very different capital structure.

After running through a detailed Dupont analysis, we believe the profitability of the firearms industry has not changed during this period. The normal ROE should be around 5% and ROA should be around 2%, which is consistent with a mature industry. Combined with our analysis on their revenue, we can arrive at a conclusion that the firearms industry will experience a short term incremental on revenue without significant change on the operating ability. This incremental will end in the following two quarters. We have run some test on the seasonality on the sales of the firearms industry and find no strong support for it. Even if we do have seasonality in our samples, the Q1 to Q4 we assigned are different from calendar quarters so it may smooth out the effects of seasonality.

Recall the results we have in the section of descriptive analysis, the cumulative abnormal return will experience a sharp uptrend in the following month and show a short time downtrend after. Then there will show up another strong uptrend in the 2nd month after the event month. So we decide to extend our time period to a longer time to match up with our quarterly data to explore the duration of this uptrend of stock return. We calculate the cumulative abnormal return for the T_{-21} and take that day as the start point and T_{88} as the ending date, which is 3 months after the gunshot events happened. We can see that the first uptrend persists for nearly a month while the second uptrend exists nearly 3 months, starting from T_{50} to T_{100}, which is exactly 4 months after the event day. This time period covers a quarter in it so it offers some opportunities for investors to acquire information on the sales of the firearms industry. As we can see, the revenue of Q2 and Q3 are both higher than Q1 and Q4. So no matter where will the event day or event month located, investors will have a chance to get financial information in the open market. So we identify this uptrend resulting from the incremental of short-term revenue. As for the first uptrend, we believe they have no access to their daily sales data but they will have access to stock price and return data, so we attribute it to the good expectation of investors.

In a word, the incremental on revenue and ROA or ROE may be a guide for investors to make their decisions, which may lead to more and more investors to increase their holdings in the firearms industry. This can explain the second uptrend. After mass shootings boost up the revenue and other financial ratios, investors begin to increase their investments and bring up the stock return. However, most of them are not aware of that this incremental is temporary and expect this revenue is driven up by some endogenous factors. This mispricing may be used by institutional investors to arbitrage.

5.4 Parametric test results

In the nonparametric test part, we conclude that the first uptrend is the benefit of good expectation of investors and the second one results from the short time incremental on sales and ROA or ROE. We want to conduct some parametric test to quantify the effect of shooting events on the stock return.

First of all, we should decide whether we are using a 20 years period or just a 10 years period. We found most studies will try to include more events in their sample data to get more ideal results. In our sample, we only have 16 shooting events because we are focusing on the mass shootings reported by social media across the country and most of them happened in years between 2007 and 2018, which is the 10 years period. To have a better estimation, we are going to use the 10-year time period.

Secondly, we need to test if our sample data is a stationary time series. If the results are negative, we should make some adjustment to make it stationary and run our model then. We adopt the DF-GLS test to have a more robust result. From table 6 we can see that the test statistic is always bigger than the critical value of each significant level, which indicated we should reject the null hypothesis that our data sample has unit roots. So we do not have to adjust our data to fit in a time series study.

Thirdly, we should test if there is any volatility clustering existing in our data because we only need to adopt ARCH or GRACH when we run into the problem of volatility clustering. In this condition, we will have autoregressive conditional heteroscedasticity. We line out a simple two-way graph between the portfolio return and our time variable and the volatility clustering is obvious. There are four huge volatility pikes during this 10-year time period and other small pikes, which indicates there do exist volatility clustering in our sample data.

Then, we will conduct a more detailed analysis to explore the ARCH effect in our model. We may think of a very simple autoregressive model without the dummy variable or other independent variables. We just need to consider the lagged terms with our dependent variable. For example, we can consider the model like this:

$$R_{jt} = \alpha_{jt} + \beta_{jl} RM\mathrm{L} + \varepsilon$$

Where the RML is the lagged term of market return and j represents portfolios.

We can take this AR (P) as a one-vector VAR to identify how many lags we should include. We adopt the information rule to run the test and find that most test indicates we should use a seven lagged model, which is AR (5) model. In addition, two results indicate that we should use AR (2) model. Therefore we first use OLS to simply estimate the model and decide the number of lag terms. We find the model includes 2 lag terms is more consistent because the third and fourth lag terms are both not significant. However, if we take AR (2), the model would be too simple and we may lose some efficiency. So we decide to use AR (5) model, which is also significant.

Then we test the error term of this OLS result and we conclude that the error term has ARCH effect. All lags are significantly rejecting the null hypothesis that there are no ARCH effects in the error term. Based on all these results, we think it would be better for us to run an ARCH model. After we apply the information rule to the variance, we found that the volatility will last for a long period, which means there would be more and more lag terms to be included in our equation, which is too complicated to calculate. So we adopt GARCH (1, 1), which is actually an infinite ARCH model with a more neat result.

First of all, we run the GARCH (1, 1) model by assuming the error term is distributed as normal distribution and include the dummy variables D_t, which will be assigned as 1 if it is in the event window otherwise zero. The results indicate a strong GRACH effect in our model with both coefficients of ARCH and GARCH are significant with a sum nearly to 1, which is consistent with the mean reversion theory. Besides, the dummy variable is significant on the level of 1% with a positive coefficient of 0.00225, which means that our portfolio may have a 0.225% abnormal return on average in the event window.

As we said before, stock return data may not be distributed like the normal distribution and have sharp peaks or fat tails instead. So we test the normality of the error term by using the Jarque-Bera test, which is very efficient. The results reject the null hypothesis that the error term distributed normally at 1% significance level. So we draw out the distribution graph of our sample and find out a higher peak and fat tails than the normal distribution. We decided to add a distribution option in our ARCH model. Basically, we are assuming they have a t-distribution instead. The results are shown below. After the adjustment of our model, the dummy variable is still significant on 1% level and the abnormal return is 0.181% for trading days in the event window.

Finally, we also predict the forecasted variance. The results show that the volatility will persist in a long time period in the future and we believe the stock return of the firearms industry will still be sensitive to the gunshot events.

Since the lagged terms in our model are both not significant, we go back to our information rules test and find if we extend the lag terms to 8, the results suggest us to use AR (5) model so we are going to run the same model in the condition of 5-lagged terms in our model. We put two results in the same table to compare. It is interesting to identify that the fifth lagged term is significant on 5% significance level, which indicates that the stock return of market on the trading day T_{-5} will have a negative impact on the trading day T_0 because we have a negative coefficient as -0.053. Five trading days mean exactly a week before and after in calendar. We are curious about this coefficient so we decide to explore more on weekly data.

We covert our daily data to weekly data and the observation becomes 1,489. There are 52 trading weeks on average in a year. We first test the effect of the first week together with the event window. However, the results indicate there is nothing special on the first week and we have a 0.533% abnormal return for weeks in the event window. Then, we decompose the effect into two different components. We take the first four weeks in the event window as our observations for the first uptrend according to the figure of periodic return we showed before, which is $[T_0, T_{21}]$. The figure indicates the second uptrend starts from T_{50} and ends on T_{100}, so we allocate the 7^{th} – 16^{th} week after the event week to the observations of the second uptrend. We run the GARCH model again without the dummy variable *event* we used before because we are going to decompose it. The results show 1.098% and 0.521% incremental on the weekly return of our portfolio and they are significant on 5% and 10% level separately. We can conclude that mass shootings' effect on the first uptrend is more significant than the second uptrend. This is consistent with our assumption that the first uptrend is highly correlated with mass shootings while the second one is not. There are two reasons. First, the second uptrend is far from the day when mass shootings happened. So the effect from mass shootings may be weaker as time passes by. Also, we believe the first uptrend already incorporate investors' expectations on increasing revenue. However, our portfolio still experiences another huge increasing a month later. We attribute this to earnings surprise. The possible reason for this uptrend may be that investors find out the real incremental on sales is much higher than they thought. So this uptrend may be more closely related to the earnings announcement, which we can discuss in another solely paper.

After running the GARCH model on the firearms industry, we also briefly run the same model on our comparable portfolios. There are two sub-portfolios which may relate to shooting events. One of the comparable groups is the portfolio of gun-selling companies and another is companies associated with the NRA. The results suggest that the shooting events may not bring an abnormal return to the portfolio. Both of the tests are not significant at the 10% level. So we cannot conclude that shooting events will have effects on the related portfolios. However, we do have some interesting results to share. After the shooting events happened on February.14th in Parkland Douglas High School, which is a tragedy attracts a lot of attention, most of the companies in gun-selling portfolio announced they will strengthen their control of gun sales and stop selling guns directly in the store. In the meantime, a lot of companies associated with the NRA has announced to terminate the cooperation with them. We want to see if these announcements benefit them. Considering this is not our focus in our study, we just analyze their aggregated abnormal return in the event window of the shooting events in Parkland. We define event days as the date they made announcements. We found the abnormal return shows a clustering positive volatility in a week after event days. This related to another topic that showing social responsibility of CEOs may have positive effects on stock return.

As President Trump has not taken any actions on strengthen gun control, we believe investors actually have confidence in the party in power right now. Figure 14 and 15 show us the trend of power changing. Republicans are performing stronger since the 1990s while Democrats are getting weaker these years. There is a study indicates there are 62 mass shootings since 1982 and 25 of them happened after 2006 when the Republicans are performing well on taking power. So we believe the party in power may play an important role on the confidence of investors on the firearm industry, which is a topic we may discuss in another paper.

CHAPTER 6

CONCLUSIONS AND DISCUSSIONS

Our interests in this topic originate from the consecutive announcements leased by a lot of companies after the shooting events in Parkland. Most of them chose to terminate the cooperation with the NRA and stand on the opposite to them, which may be a strategy to keep their customers. I followed up their stock price, which shows a strong uptrend after the announcement. So we are wondering about the condition of the most directly associated industry after shooting events, which is the firearms industry.

In this paper, we start from the question of what is the trend of the firearms industry's stock return after shooting events. Basically, we found that stock return will experience two uptrends in different time periods. Then we concern about the reason for these uptrends. After a thorough analysis, we believe the first uptrend results from investors' confidence and good expectations. For the second uptrend, the incremental on revenue and ROA or ROE may offer us a great explanation. The incremental leads investors to buy in the stock. Finally, we use econometrics model to quantify this abnormal return and we derive the results as 0.181% and 0.533% for daily and weekly. Then we decompose the abnormal return on weekly data into two components, which are the first uptrend and the second uptrend. We conclude that these two uptrends have an abnormal return as 1.098% and 0.521% individually. Also, the abnormal return of the first uptrend is related to mass shootings more closed while the second uptrend is not very significant related.

We think this paper is slightly different from the papers before concentrating on political events and terrorism. A study of mass shooting events may be a good supplement to this field of research. First of all, we narrow down our study objects to the firearms industry and shooting events, which is a more specific study. Secondly, we use gun-selling companies and companies associated with the NRA as comparable groups and run the GRACH model again. The results suggest shooting events have no significant effect on them. At the very beginning, we thought citizens will assign their blame on firearms industry or gun selling companies because of the poor control of guns. However, the result shows the opposite thought and help us revise our assumptions. Firearms industry will not get hurt in the shooting events. On the opposite, they will benefit from the shooting events. Finally, we try to decompose the abnormal return in the event window to different groups which sounds like a process of stripping out two different event windows. The reason for this analysis is that we find out two uptrends before in the descriptive analysis and we want to quantify them and find their relations to mass shootings. The results suggest that the first uptrend is closely related to mass shootings while the second one is not.

We notify there are some drawbacks in our paper. For our sample, we could add more shooting events in. As social media develops at a faster pace, there are more and more shooting events will be reported publicly and more citizens will get access to these information quickly. So we can extend our sample larger. For the parametric test part, we could estimate different events individually or we can divide the events into different groups to see if they have different effects. For example, we can have a subgroup including campus shootings only and compare it with other events. Finally, we should consider the time difference. Some studies suggest that gun shock has already become a “new normal” to the stock market. So the abnormal return on mass shootings in recent 5 or 10 years would be different to before and we can explore on that by setting two models for two different time horizons.

There are still a lot of topics can be extended from this paper. We are curious about the stockholders of each company in the firearms industry. We believe their party may have some effects on the stock return of the firearms industry. Considering the existence of the NRA, we think it would be necessary to include political topics in our study. Also, we can discuss more about why the negative emotions of citizens do not reflect on the stock market as terrorism does. It would be a great point to start from our conclusion that the stock return of the firearms industry will benefit from the shooting events. In addition, we can pay attention to the two clustering peaks of turnovers. The investors come in can possess a lot of excess return while the investors come after the second peak may not have such a high return. Who are those investors? Are most of them institutional investors or individual investors? Finally, we can keep narrowing down the study objects to campus shootings and shooting events related to racial and religion. Both of these two types of shooting events usually will attract more attention from society and citizens may be more sensitive to these events.

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APPENDIX A

TABLES FOR DESCRIPTIVE ANALYSIS AND FUNDAMENTAL ANALYSIS

Table A. 1 Shooting events sample

	Event day	State	City	Place	Fatalities	Injured
1	1991/10/16	Texas	Killeen	restaurant	24	27
2	1999/04/20	Colorado	Littleton	High School	13	21
3	1999/07/29	Georgia	Atlanta	trading firms	12	13
4	2007/04/16	Virginia	Blacksburg	University	32	17
5	2009/11/05	Texas	Fort Hood	military base	13	42
6	2009/04/03	New York	Binghamton	civic centre	13	4
7	2012/07/20	Colorado	Aurora	Cinema	12	70
8	2012/12/14	Connecticut	Newtown	Elementary School	28	2
9	2013/09/16	Washington	Southeast	Navy Yard	12	3
10	2015/10/01	Roseburg	Oregon	UCC Campus	10	8
11	2015/12/02	California	Bernardino	Service center	16	17
12	2016/06/13	Florida	Orlando	nightclub	49	53
13	2017/11/06	Texas	San Antonio	Baptist church	25	20
14	2017/10/02	Nevada	Las Vegas	Mandalay Bay	58	851
15	2018/02/14	Florida	Parkland	High School	17	15
16	2018/05/18	Texas	Santa Fe	High School	10	13

Notes: This sample is not large enough to compare with other studies. However, we think shooting events is not like terrorism. Terrorism may attract more attention from citizens and it is nationwide while shooting events may not. Events like Santa Fe High School and Las Vegas shooting may attract a lot of attention. So we introduce fatalities and reported frequency as a selection criterion.

Table A. 2 Data description

Data	Description	
	Analysis	**Illustration**
ROA	Profitability Analysis	$ROA = Income/Average\ Assets$
ROE	Profitability Analysis	$ROE = Income/Average\ Equity$
Revenue	Sales Analysis	*We take the quarterly total revenue of our constructed portfolio as our input.*
Net profit margin	Dupont Analysis	$NI\ Margin = Income/\ Revenue$
Asset Turnover	Dupont Analysis	$Turnover = Rev/Average\ Assets$
Financial Leverage	Dupont Analysis	$Financial\ Leverage = Assets/Equity$
EBIT margin	Dupont Analysis	$EBIT\ Margin = EBIT/Rev$
Interest Burden	Dupont Analysis	$Interest\ Burden = EBT/EBIT$
Tax Burden	Dupont Analysis	$Tax\ Burden = NI/EBT$
Account Receivable ratio	Liquidity Analysis	$A/R\ Ratio = \frac{A}{R}/\ Assets$
Current Ratio	Liquidity Analysis	$Current\ Ratio = Curr.assests/Assets$

Notes: All financial data we use write in this table are quarterly data. We use them to calculate financial ratios and prepare for the fundamental analysis.

Table A. 3 Quarters selection

Value	Description	
	Numbers	**Illustration**
0	83	There are 83 quarters are not located in the event window, which covers the $[Q_{T-1}, Q_{T+1}]$.
1	11	There are actually 12 quarters located before Q_T, which is corresponding to the numbers of Q_{T+1}. However, we find few abnormal values in that month so we decide to delete this record.
2	12	There are 12 quarters have gunshot events happened in it. As we said before, we would allow consecutive Q_T in our sample.
3	11	There are 11 quarters we take as Q_{T+1}. This group of data is cleaner than Q_{T-1}.

Notes: This table shows the assigned value we have made for each quarter. Basically, we assign the value one to the quarter before events happened. We assign two as the value of quarters when shooting events happened and take the quarter after as value three. Besides, we assign value zero to all other quarters which are not located in the event window.

Table A. 4 Descriptive Statistics

Variable	Obs	Mean	Std.Dev.	Min	Max
Market Return	7181	.0003926	.011	-.09	.116
Portfolio Return (value-weighted)	7181	.0003849	.016	-.104	.191
Portfolio Return (equal-weighted)	7181	.0008305	.009	-.0783	.107
Value-weighted Turnover	7181	14.192	30.31	.299	705.74

Notes: This table is the descriptive statistics for our stock return data. We constructed our portfolio in both the value-weighted and equal-weighted way. Results suggest that we should use the value-weighted portfolio return data. In such a long time period, the stock return should obey the mean reversion rule, which means that the stock return will fall back to the mean level in a long time period.

APPENDIX B

TABLES FOR WILCOXON TEST AND GARCH MODEL

Table B. 1 Test for the S&P 500 from 2015 to 2018

a. Summary Statistics

	Numbers	Volatility	
		Mean	Standard deviation
Event day	77	0.00008	0.00017
Non-Event day	803	0.00007	0.00015
All day	880	0.00007	0.00016

b. Wilcoxon rank-sum Test for $\sigma^2{}_E = \sigma^2{}_N$

	Numbers of Event days	Numbers of non-event days	Z-Statistics	P-value
Values	77	803	-2.184	0.0289

Notes: This table is the results of the Wilcoxon rank sum test for the total market. We first calculated the standard deviation of the sample of event days and found out that the return of event days have higher volatility. Then we apply the Wilcoxon test and get a p-value of 0.0289, which is significant at 5% level. Not all industries are sensitive to the shooting events so that the effect may be smoothed out in a way.

Table B. 2 Test for the firearms industry from 2015 to 2018

a. *Summary Statistics*

	Numbers	Close-to Close Volatility		Open-to-Open Volatility	
		Mean	Standard deviation	Mean	Standard deviation
Event day	77	0.00125	0.00301	0.00133	0.00311
Non-Event day	803	0.00067	0.00172	0.00069	0.00143
All day	880	0.00072	0.00187	0.00744	0.00165

b. *Wilcoxon rank-sum Test for* $\sigma^2{}_E = \sigma^2{}_N$

	Numbers of Event days	Numbers of non-event days	Z-Statistics	P-value
Close-to-Close	77	803	-3.793	0.0001
Open-to-Open	77	803	-3.229	0.0012

Notes: This table is the results of the Wilcoxon rank sum test for the firearms industry. Comparing the standard deviation difference between event days and non-event days for the total market, the difference of the firearms industry is larger. Also, the p-value is much smaller and significant at 1% level. This result gives us strong supports that shooting events will have strong effects on the firearms industry.

Table B. 3 Results of DF-GLS Test for stock market

DF-GLS Test for the return of S&P 500				
Lags	DF-GLS Test Statistic	1% Critical Value	5% Critical Value	10% Critical Value
1	-42.665	-3.480	-2.845	-2.557
2	-32,445	-3.480	-2.844	-2.556
3	-28.325	-3.480	-2.844	-2.556
4	-26.360	-3.480	-2.843	-2.555
⋮				
27	-9.992	-3.480	-2.832	-2.545

Notes: We need to run a DF-GLS test to make sure our sample will not run into the problem of a unit root. Although there are many studies already verifies this conclusion, we still need to test our sample. We also run the same test for the firearms industry and get similar results to the total stock market. This indicates we do not have to make any adjustments to our sample data.

Table B. 4 LM test for ARCH effects

lags(p)	chi2	df	Prob>Chi2
1	116.203	1	0.0000
2	572.332	2	0.0000
3	588.864	3	0.0000
4	648.819	4	0.0000
5	774.030	5	0.0000

H0: no ARCH effects vs. H1: ARCH (p) disturbance

Notes: We adopt the LM test to explore the ARCH effect in our sample. Some studies before already proved that the LM test is a relatively efficient method to find the ARCH effect. (John.J.Binder, 1985). We find all the p-values on different lag terms are significant at the level of 1%, which suggested we should reject the null hypothesis and accept the alternative hypothesis.

Table B. 5 GARCH model results under different distributions for the firearms industry

	Normal Distribution		t-Distribution		
VARIABLES	r	ARCH	r	ARCH	lndfm2
L.mkr	-0.0214		-0.0316		
	(0.0254)		(0.0248)		
L2.mkr	-0.0258		-0.0298		
	(0.0248)		(0.0240)		
event	0.00225***		0.00181***		
	(0.000708)		(0.000630)		
L.arch		0.0549***		0.0615***	
		(0.00522)		(0.00967)	
L.garch		0.937***		0.928***	
		(0.00539)		(0.0107)	
Constant	0.000332	2.62e-06***	0.000484*	3.62e-06***	1.309***
	(0.000297)	(5.97e-07)	(0.000276)	(1.18e-06)	(0.165)
Observations	2,892	2,892	2,892	2,892	2,892

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Notes: This GRACH (1, 1) model is running based on the lag terms of two. The variable named as event is the variable represents whether the trading day is in the event window. The p-values under different distributions are both significant, indicating that shooting events have a significant positive return on the firearms industry. The value of lndfm2 indicates we should use the t-distribution instead of the normal distribution.

Table B. 6 2 lag terms and 5 lag terms model results under t-distribution

	2-lagged model		5-lagged model		t-distribution
VARIABLES	r	ARCH	r	ARCH	lndfm2
L.mkr	-0.0316		-0.0323		
	(0.0248)		(0.0249)		
L2.mkr	-0.0298		-0.0302		
	(0.0240)		(0.0242)		
L3.mkr			-0.00664		
			(0.0244)		
L4.mkr			-0.000406		
			(0.0241)		
L5.mkr			-0.0563**		
			(0.0241)		
event	0.00181***		0.00184***		
	(0.000630)		(0.000632)		
L.arch		0.0615***		0.0610***	
		(0.00967)		(0.00961)	
L.garch		0.928***		0.928***	
		(0.0107)		(0.0106)	
Constant	0.000484*	3.62e-06***	0.000520*	3.58e-06***	1.309***
	(0.000276)	(1.18e-06)	(0.000277)	(1.17e-06)	(0.164)
Observations	2,892	2,892	2,889	2,889	2,889

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Notes: This GRACH (1, 1) model is running based on the lag terms of five. It is very interesting to have the fifth lag term significant at the level of 5%. Five trading days is actually a calendar week, which indicates the investors may have a lag reaction to shooting events. We speculate that investors may be curious about the attitude of the government. If the government, especially the president, have present a positive attitude toward the policy of gun control, investors may choose to dump most shares they possessed of the firearms industry. The dummy variable is still significant in this case, showing a significant and positive effect from shooting events on stock return.

Table B. 7 GARCH (1, 1) model results of gun-selling companies

	2-lagged model		5-lagged model	
VARIABLES	r	ARCH	r	ARCH
eventdays	2.98e-05		3.25e-05	
	(8.92e-05)		(8.89e-05)	
L.spr	-0.0717***		-0.0726***	
	(0.0230)		(0.0232)	
L2.spr	-0.0628***		-0.0630***	
	(0.0205)		(0.0206)	
L3.spr			0.00150	
			(0.0219)	
L4.spr			-0.0123	
			(0.0216)	
L5.spr			-0.0689***	
			(0.0231)	
L.arch		0.0420***		0.0420***
		(0.00359)		(0.00362)
L.garch		0.948***		0.949***
		(0.00362)		(0.00368)
Constant	0.000609***	1.86e-06***	0.000649***	1.82e-06***
	(0.000225)	(2.52e-07)	(0.000227)	(2.55e-07)
Observations	2,892	2,892	2,889	2,889

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Notes: After we found out shooting events will bring a positive abnormal return to the firearms industry, we are curious about where would the investors assign their blame on. This is the result of GARCH (1, 1) on the portfolio of gun-selling companies. However, we have not found any significant incremental of positive abnormal return after shooting events. They are significantly affected by the lag terms, which is consistent with the characteristic of stock return.

Table B. 8 GARCH (1, 1) model result of companies associated with NRA

	2-lagged model		5-lagged model	
VARIABLES	r	ARCH	r	ARCH
L.mkr	-0.00133		-0.00352	
	(0.0305)		(0.0305)	
L2.mkr	0.00228		0.00178	
	(0.0291)		(0.0294)	
L3.mkr			-0.0165	
			(0.0282)	
L4.mkr			-0.00367	
			(0.0288)	
L5.mkr			-0.0504*	
			(0.0302)	
event	-1.43e-05		-1.28e-05	
	(8.28e-05)		(8.33e-05)	
L.arch		0.112***		0.111***
		(0.00993)		(0.00987)
L.garch		0.865***		0.867***
		(0.0101)		(0.0101)
Constant	0.000559**	7.41e-06***	0.000610**	7.30e-06***
	(0.000260)	(7.79e-07)	(0.000262)	(7.80e-07)
Observations	2,892	2,892	2,889	2,889

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Notes: As we did not find any incremental on the return of gun-selling companies, we turn to the portfolio consists of companies associated or cooperated with NRA. NRA plays an import role in America politics. We construct a very rough portfolio included companies from different industries so we do not expect to have significant results on lag terms. However, the dummy variable is also not significant, which leads to the conclusion that shooting events have no significant effects on companies associated with the NRA.

Table B. 9 GARCH Model for weekly data of firearm industry

	Without the effect of the first week		With the effect of the first week	
VARIABLES	week_return	ARCH	week_return	ARCH
L.week_mkr	0.0305		0.0299	
	(0.0408)		(0.0408)	
L2.week_mkr	0.0382		0.0376	
	(0.0420)		(0.0422)	
event	0.00533**		0.00460*	
	(0.00256)		(0.00269)	
L.arch		0.0386***		0.0383***
		(0.0104)		(0.0104)
L.garch		0.950***		0.950***
		(0.0137)		(0.0137)
if_firstweek			0.0124	
			(0.00794)	
Constant	0.00243**	1.84e-05*	0.00243***	1.82e-05*
	(0.000943)	(9.90e-06)	(0.000942)	(9.89e-06)
Observations	1,480	1,480	1,480	1,480

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Notes: In this model, we use the weekly data to extend our event window and see if the effects of shooting events are still significant. Also, we found out that the market return on the fifth lag term is relatively significant, which represents a trading week. So we added another dummy variable with one if the timing is in the first week and zero otherwise. The results indicate the trading weeks in the event window will have 0.53% cumulative abnormal return weekly. However, whether the week is the first week is not significant or we can see it is only significant at a level on 10%. If we expand our sample size, we may have a better result.

Table B. 10 Decomposed Effects For Two Uptrends Based on Weekly Data

	Decomposition for two uptrends		
VARIABLES	week_return	ARCH	lndfm2
L.week_mkr	0.0244		
	(0.0404)		
first_uptrend	0.0110**		
	(0.00444)		
second_uptrend	0.00521*		
	(0.00310)		
L.arch		0.0383***	
		(0.0104)	
L.garch		0.950***	
		(0.0137)	
Constant	0.00235**	1.84e-05*	1.409***
	(0.000928)	(1.00e-05)	(0.240)
Observations	1,481	1,481	1,481

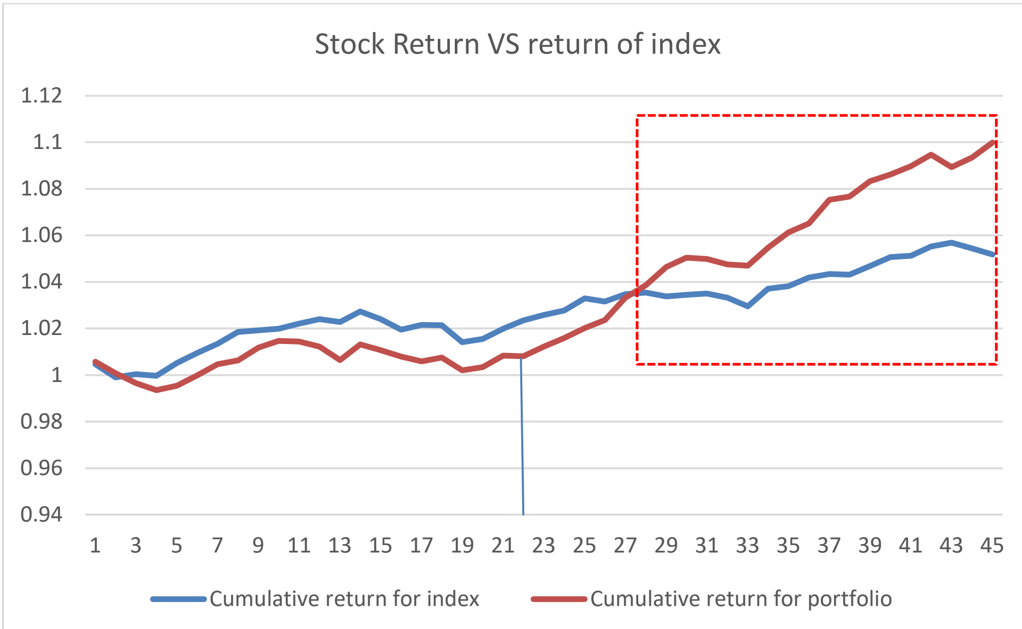
Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Notes: We generate two different dummy variables to test the sensitivity of two different uptrends to mass shootings. The first dummy variable is *first_uptrend*, we assign value one to it if it is a week in the first trading month and zero otherwise. The second dummy variable is *second_uptrend*, we did the same value assigning as before. Also, we did not include the dummy variable *event* we used before in this model because these two dummy variables have already covered all event window and they can help us decompose the effect in event window. From results above, we are able to conclude that mass shootings have more significant effect on the first uptrend than the second uptrend.

APPENDIX C

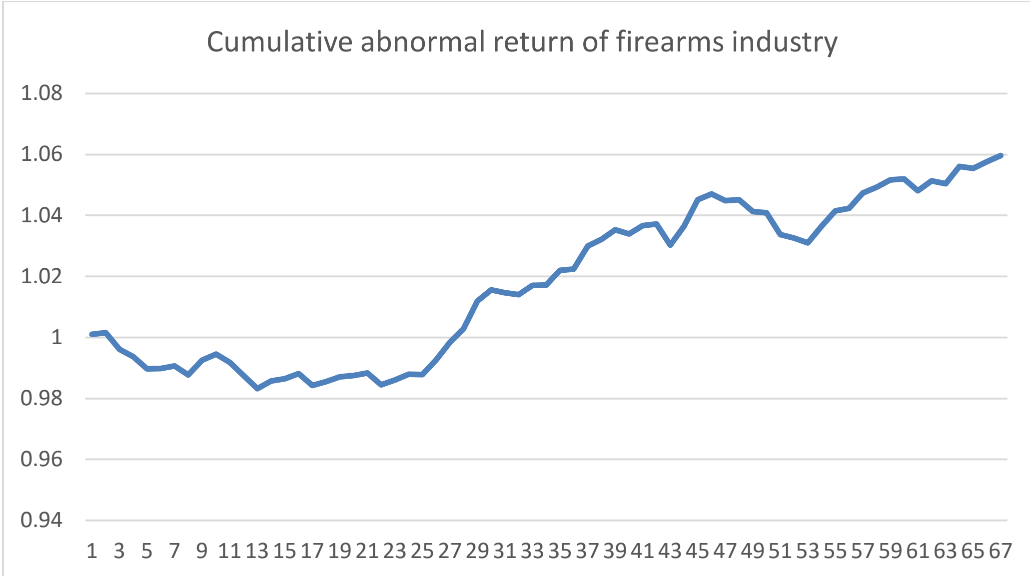
FIGURES USED IN OUR PAPER

Figure 1 Firearms industry outperform the stock market after shooting events



Notes: The blue line represents the cumulative return of S&P 500 in the event window while the red one represents the cumulative return of firearms industry in the event window. We identify a significant uptrend starting from the trading day T_{22}, which is the event day we defined before. The cumulative return begins to increase after event day and it will last a week. Then the slope becomes steeper after a week and brings the cumulative return to a higher level. An interesting phenomenon is that the cumulative return has a second uptrend 10 days after event day.

Figure 2 Cumulative abnormal return of firearms industry



Notes: After we identify there are two uptrends after event days, we want to have a more straightforward view of the abnormal return. The graph shows a significant uptrend between $[T_{22}, T_{45}]$, which is 23 trading days. In other words, the incremental of abnormal return will last for nearly a month after the event day. The slope has been decreasing after a month. However, the CAR has not fallen back to the normal level before. We have some explanations offered in the text before.

Figure 3 Turnover analysis of firearms industry

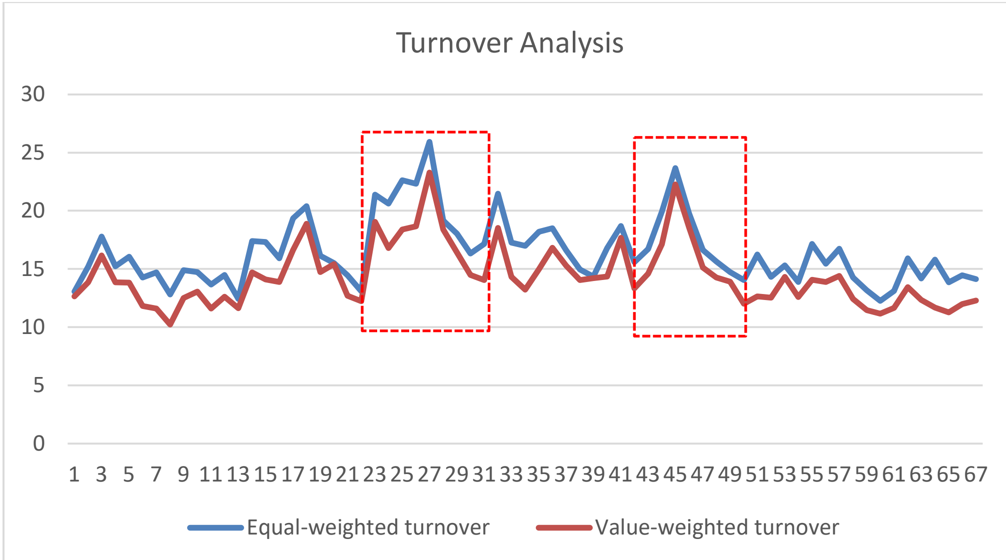
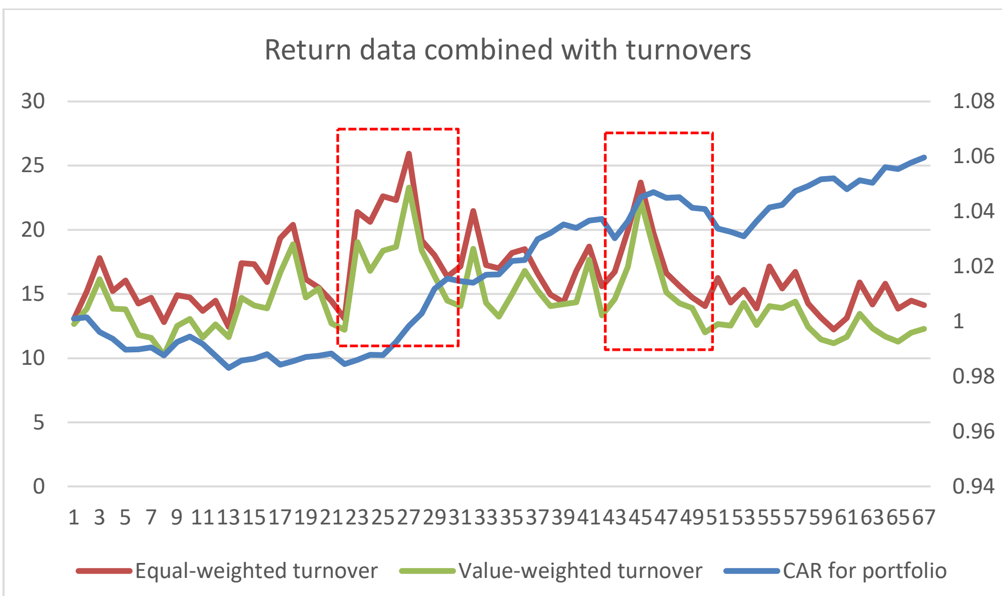
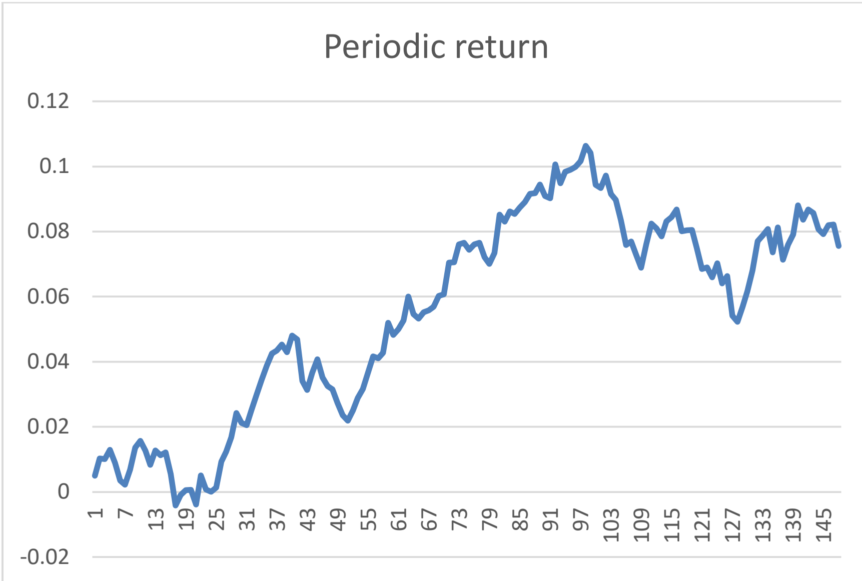


Figure 4 Cumulative abnormal return combined with turnovers



Notes: We put these two figures together to illustrate our conclusions. The turnovers are always fluctuating around the level of 15. There are two significant peaks in the event window, which are consistent with two uptrends of cumulative abnormal return. Also, the peaks of turnovers will show up before the uptrend of CAR. This result will help us understand the confidence of investors better.

Figure 5 The periodic return of firearms industry based daily data



Notes: We calculate the periodic return by deducting one from each cumulative abnormal return and have the same trend. We can see that the periodic return in the first uptrend approaches 4% but only persist for nearly 10 days. However, the periodic return in the second uptrend performs great and has been increasing for over 2 months. This uptrend is obviously more related to the incremental on revenue we find out before.

Figure 6 Two standard error bands of periodic return

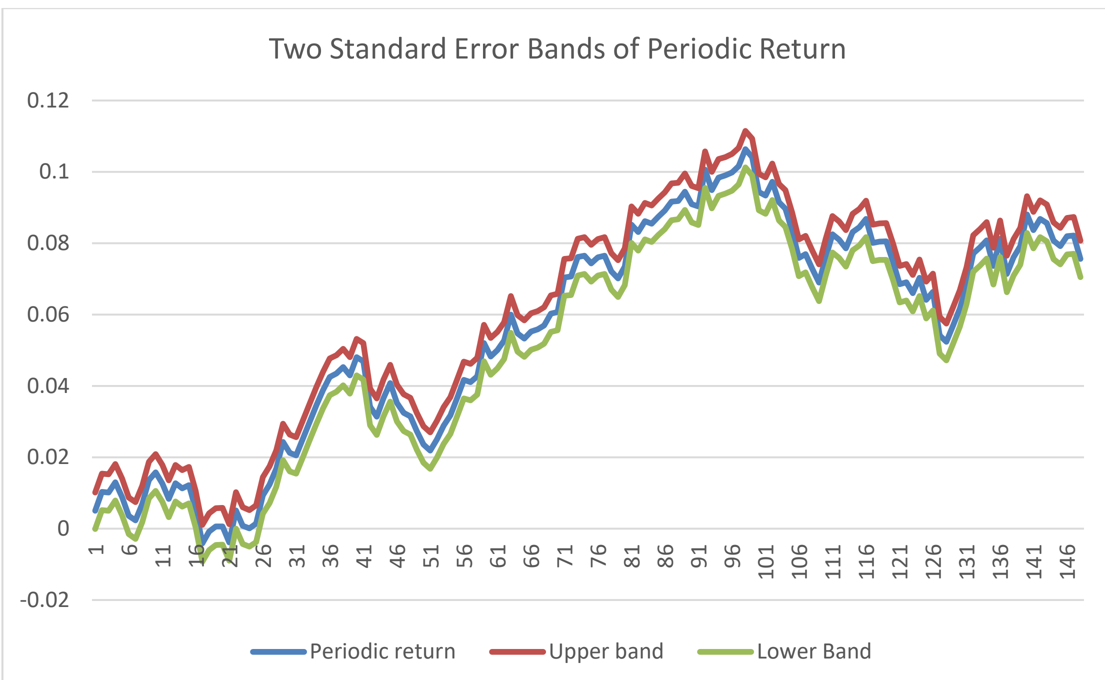
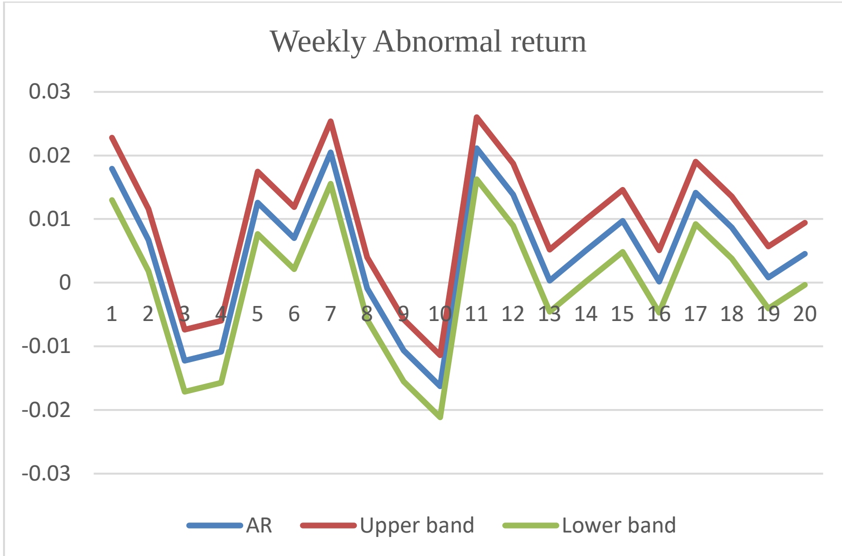
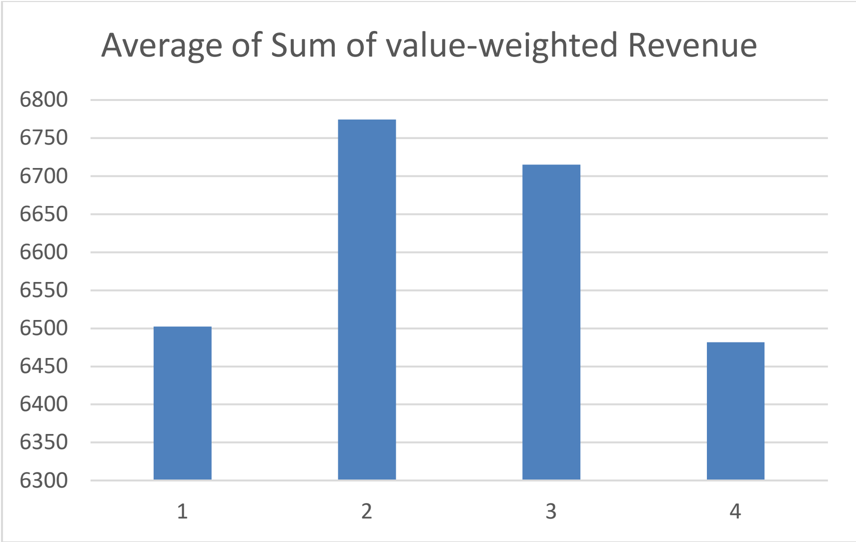


Figure 7 Trend analysis of weekly abnormal return data



Notes: In this figure, we used weekly data so that we can extend our event window to a period consistent with quarterly data. In our sample, a trading month includes 4 trading weeks so we decide to use 16 weeks as our event window, which is 4 months in calendar. We take $[Week_1, Week_4]$ as our first month and the 5th as the event week. The event week is also the beginning of our event window and we extend it to the end of $Week_{20}$, which constitutes 4 months after the event week. We can identify that the abnormal return is relatively stable after the 13th week and show a steady trend of maintaining at a level near zero. Comparing with the cumulative abnormal return, the abnormal return has not added substantial incremental on the cumulative return in the 4th month after the shootings. The high level of the cumulative return is based on a huge incremental before and it has compounded advantage.

Figure 8 Quarterly revenues before and after mass shootings



Notes: Quarter 2 is the event quarter while others are one or two lags of the event quarter. We explored the revenue data sorting by quarters. We assigned two to the event quarter and one to the quarter before the event quarter. Also, we give value three and four to the following quarters. Because a quarter includes 16 weeks and it may smooth out the effect so we try to make the month when shooting events happened as the beginning of a quarter. For example, if the shootings happened in March, which belongs to quarter one, we will assign the next quarter as our event quarter. In this way, we found an incremental on revenue in the event quarter. The revenue will have an obvious decreasing trend after the event quarter and fall back to the level as the quarter before event quarter. This is consistent with our assumptions.

Figure 9 The trend of ROA and ROE in different quarters

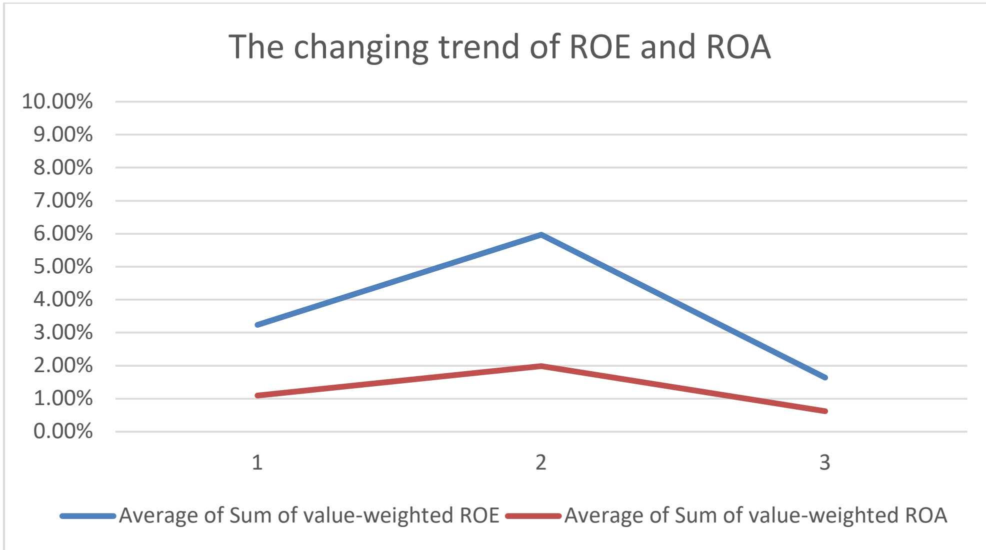
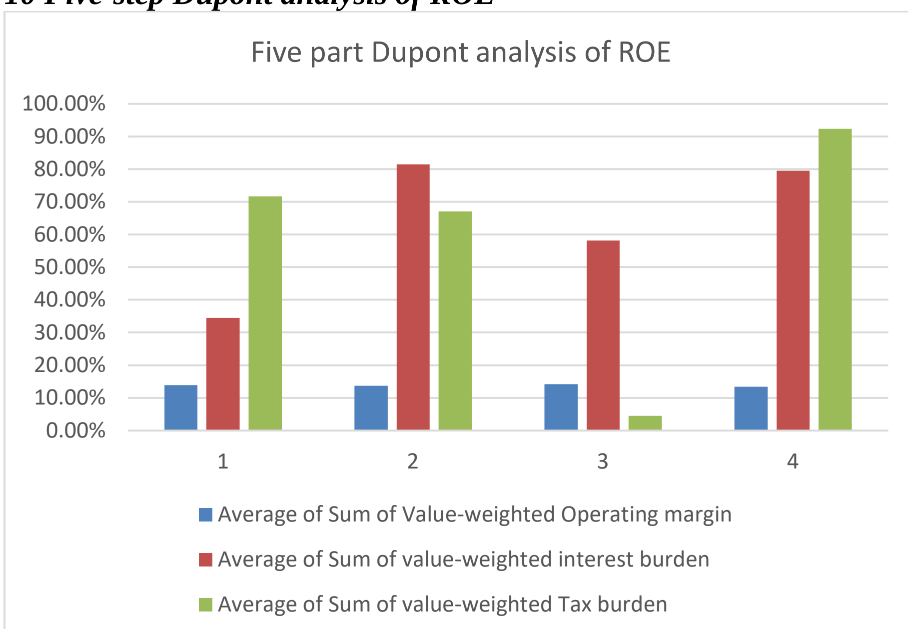
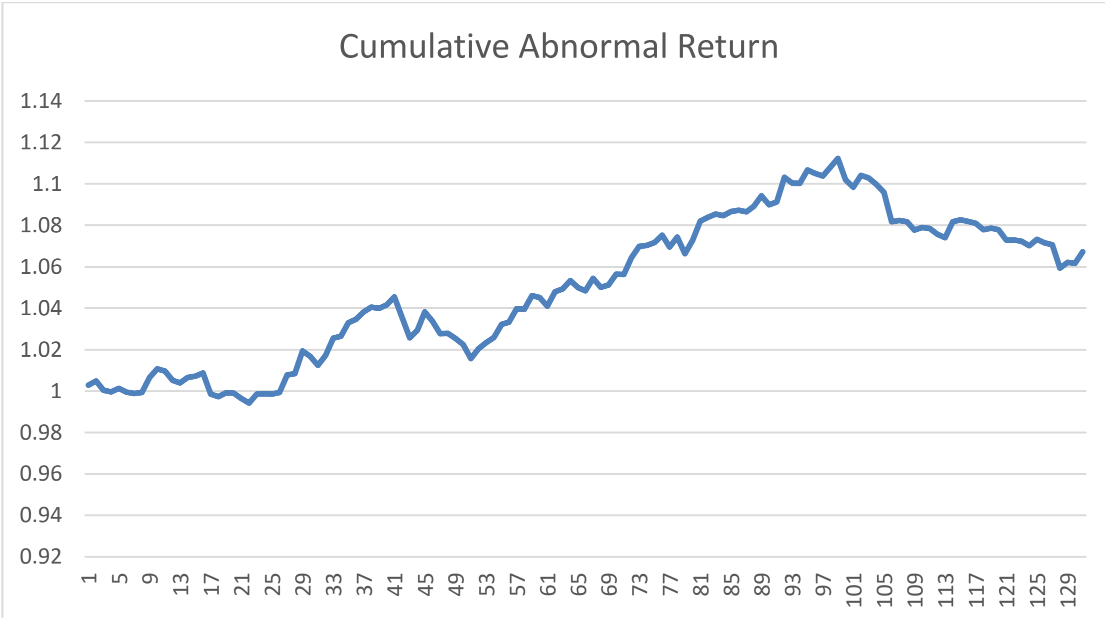


Figure 10 Five-step Dupont analysis of ROE



Notes: In this figure, quarter 2 represents the event quarter while others are one or two lag terms of quarters. After we run a five step Dupont analysis, we find out that tax is the main reason for the decreasing of NI margin. We cannot give the exact explanation to it because different companies may have different effective tax rate. We can only conclude that the operating ability and profitability of firearms industry has no substantial increasing.

Figure 11 CAR of firearms industry in 4 months after shooting events



Notes: Even though the cumulative abnormal return will increase at a slower pace after, we still want to see if the CAR will fall back. So we extend the event window to 3 months after event day. We can see the slope is getting flatter since a month after the event day. Finally, we identify a sharp downtrend in the end of the 3rd month and drop back to a relatively normal level and the downtrend seems will last for a longer time.

Figure 12 Clustering volatility of firearms industry

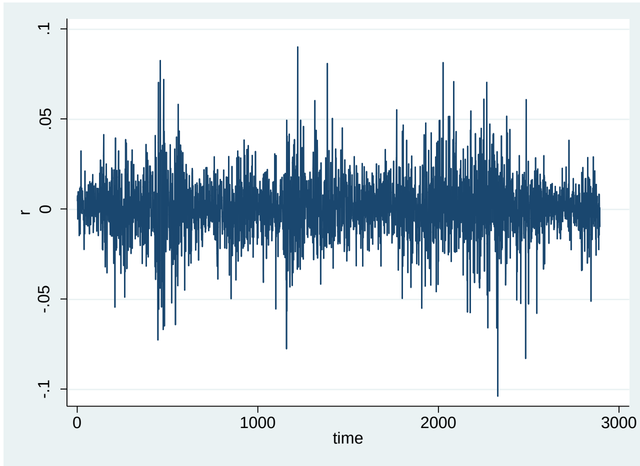
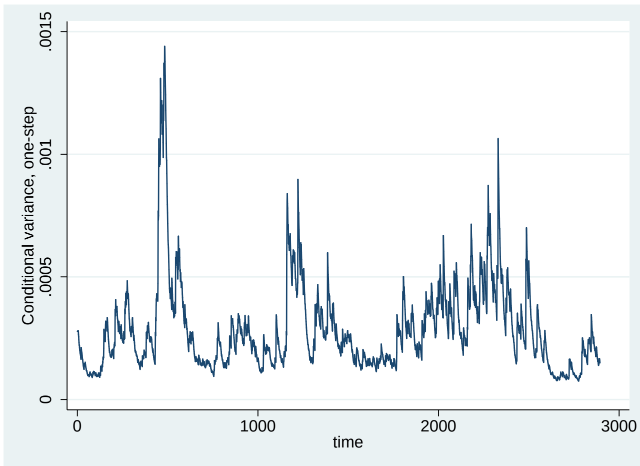


Figure 13 Forecasted volatility in the future



Notes: The first graph is the picture of the historical volatility of firearms industry's stock return and the second one is the forecasted volatility in the future we derived from GARCH model. The clustering volatility will always be a characteristic of firearms industry's return.

Figure 14 Percentage of Republican on the control of power since 1978

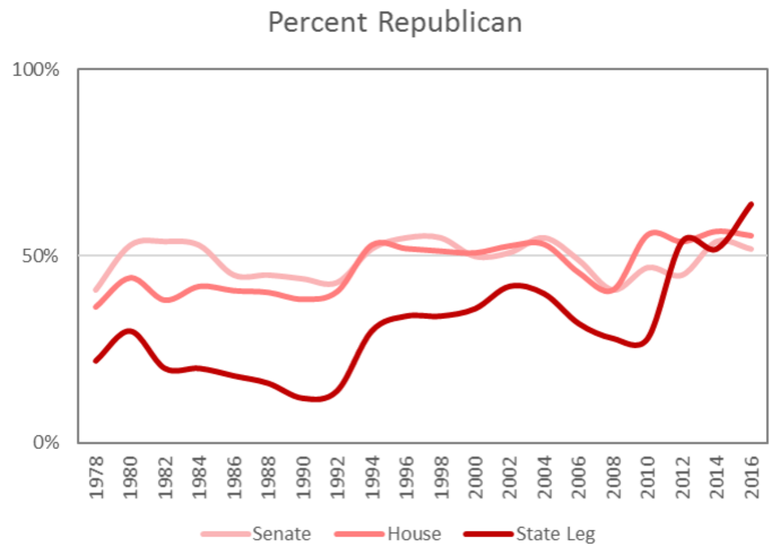
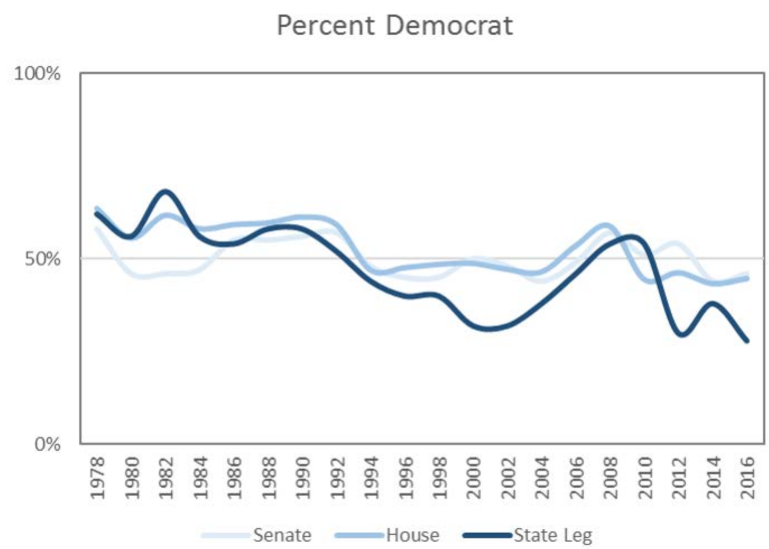


Figure 15 Percentage of Democrat on the control of power since 1978



Notes: These two pictures draw a straightforward trend of the changing of power in America. Democrat behaves weaker since 1980s. The Republican took the power since 1990s and dominate the politics in America in most time. Generally speaking, Democrat will advocate the gun control policy while Republican will not.