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Summary

The United States experiences mass shootings which cause the American public to respond in various ways. One measurable aspect is the demand for firearms following a shooting. Using the Federal Bureau of Investigation's National Instant Criminal Background Check System to proxy firearm sales, I create an ARMA model that estimates which characteristic of a mass shooting dictates the largest firearms purchase response. I find that President Obama's tenure caused 210,000 more firearms sales per month. I also find that if the mass shooter was an internationally influenced terrorist, firearms sales increased by about 420,000 for the two-month period.

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I. Introduction

On June 14, 2017, many Americans woke up to the news that four people, including a Republican congressman, were shot while practicing for the Congressional Baseball Game for Charity. Members of both parties quickly denounced the politically motivated violence, and the Governor of Virginia, Terry McAuliffe, among other Democrats, called for tighter firearm control measures.

There is a paradoxical nature of mass shootings, gun regulation rhetoric, and firearm sales. Throughout the Obama and Trump administrations, there has been a recurring sequence of events: (1) a mass shooting occurs, (2) politicians (usually Democrats) call for an increase in gun control measures, and (3) gun sales surge. This trend has been noticed by investors. Following the 2017 Las Vegas shooting, stock prices for firearm manufacturers Ruger and Smith & Wesson temporarily jumped. To investors and gun owners, mass shootings create concern that weapons will be more difficult to acquire, which encourages gun sales after the event.

The *New York Times* released an interactive graph illustrating this trend in June 2016. After a mass shooting or a political call for increased gun control, a spike in the number of guns sold would soon follow. For example, the graphic, adjusted for seasonality, shows a blip following President Obama's election and the Sandy Hook Elementary School shooting (Figure 1.1). This circumstantial evidence suggests a positive correlation between mass shootings and demand for guns.
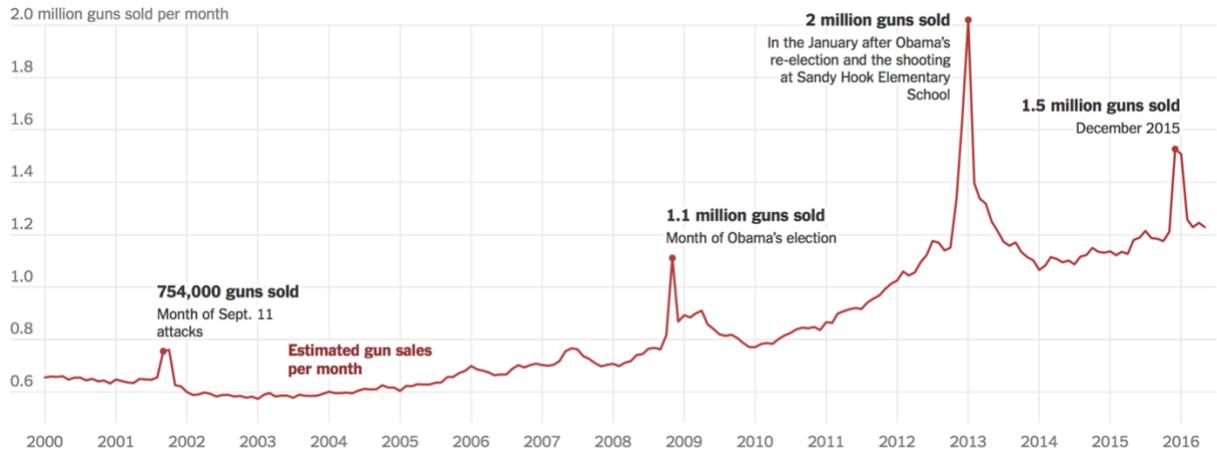
Figure 1.1. The New York Times graphic illustrating a correlation between keystone events and gun sales. Graph updated to June 2016.

This paper analyzes the change in the number of background checks in relation to notable mass shootings. Following a mass shooting, the basic facts emerge: the quantity of people killed, the quantity of people injured, the political response, and the perpetrator's motive. These quantifiable factors are used as controls to determine whether they impact gun sales. I find that mass shootings, internationally associated terrorists, and Obama's tenure are the most influential forces behind surges in gun sales.

II. Literature Review

Unfortunately, literature on this topic is sparse. American gun advocacy organizations successfully lobbied legislators to include a big provision in a 1996 spending bill. The provision, called the Dickey Amendment, prevented the Center for Disease and Control from using federal dollars to fund gun violence related research. As a result, there is minimal publicly-funded evidence.

There are, however, several empirical papers and medical research articles that investigate some facet of the legal, financial, political, and public health effects. Luca et al. (2016) finds a high impact of mass shootings on proposed gun policies, depending on the

political party in control of the state legislature. Overall, one mass shooting increases the number of firearm bills by 15%. For Republican-controlled legislatures, the number of enacted laws increase by 75% after a mass shooting with the intent of loosening gun restrictions. Gopal and Greenwood (2017) investigate the relationship between mass shootings and stock prices of the two publicly traded firearm companies, Ruger and Smith & Wesson. They find an unclear conclusion. In the short term, there is an increase in demand which should increase the stock price. However, in the long term, the business model is called into question which should decrease the stock price. Depetris-Chauvin (2015) focuses on a potential 2008 Obama presidency and gun sales. This study utilizes data from a futures market on the outcome of the election and the corresponding number of background checks for gun purchases. It finds a large "Obama effect," where an unusual increase in the demand for guns was driven by fears of then President-elect Obama's gun-control policy. Finally, Barry et al. (2013) and Kellerman and Rivara (2013) examine the issue through a public health lens. They illustrate several scenarios where various levels of government actively prevent research on gun violence and public health.

III. Data

i) Gun sales

Gun sales data can only be estimated through a proxy, as there are no public gun sales data either at the state or federal level. Following the passage of the Brady Handgun Violence Prevention Act of 1993, with the Federal Bureau of Investigation (FBI) implementing the system in 1998, every transaction at a gun store requires a background check. This request is called the National Instant Background Check System (henceforth, NICS). Every NICS request implies that an attempt to buy at least one gun. This proxy, however, is an imperfect measure of gun sales because an individual could purchase multiple guns in one transaction, or their transaction

could be denied due to legal prevention of ownership. Brauer (2013) created a survey asking gun salesmen the typical number of firearms sold during a transaction and finds that every background check averages 1.1 firearm sales (110 sales/100 checks). This suggests that NICS slightly underestimates the number of firearms sold at stores.

In addition to the traditional retail method of purchasing guns, there are methods to circumvent NICS. For example, there are exemptions for concealed carry permit holders in addition to the so-called "gun show loophole." In some states, a Concealed Pistol License[1] holder can substitute the weapons license for a background check. This is known as the Brady exemption. The logic is that those who have acquired the license have already passed a background check, making additional checks redundant. Commercial weapons dealers must have a Federal Firearms License (FFL) in order to participate in intrastate and interstate commerce. The "gun show loophole," however, allows an individual without a FFL to exchange a gun without going through NICS for a private party sale. The law says that if the seller possesses a FFL, they must conduct a background check; but, the law does not state the need for a check if they do not have a FFL. The amount and proportion of private sales in relation to total sales is unknown.

In the meantime, NICS is the best publicly available indicator of gun sales in the country. Intuition would suggest that the estimate provided by NICS is low—it is more likely for an individual to purchase multiple guns compared to the number of denied background checks. In 2016, the FBI denied approximately 100,000 checks out of an average of 14 million background checks completed—a relatively small amount.

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[1] Each states' labeling of the practice varies. Other names include Concealed Carry Weapon License, License To Carry, and Concealed Handgun License.

ii) Defining controls

There are several controls in the estimation. First, there are dummy variables that characterize the event: domestic terrorism, international terrorism, mass shooting, calls for gun control, and mental health of the perpetrator. See Table 3.1 for characteristics of the event. Second, there are variables that capture the severity of the event, specifically the quantity of fatalities and the quantity of injuries. Third, there is a trend to account for the general increase in background checks since December 1998. Fourth, the unemployment rate captures the economic conditions of the country. The hypothesis is that people anticipate higher crime during an economic downturn, therefore leading to more weapon purchases for personal protection.

Dummy Variable Terms	Definition
Domestic terrorism	Inspired by or associated with American-based movements that espouse extremist ideologies of a political, religious, racial, or environmental nature (e.g. anti-government views, racial supremacy).
International terrorism	Inspired by or associated with designated foreign organizations or nations (e.g. ISIL, al-Qaeda).
Mass shooting	No official consensus. FBI defined mass murderer if 4 or more killed in an event. Commonly accepted and used derived definition would be 4 or more shot in one incident.
Call for control/Obama	A presidential call for gun control immediately following the event; "official" address of the incident. President Obama is the only president that has called for controls following an incident.
Mental health	Perpetrator has a history of mental health problems, checking-in to mental health facilities, or plea of insanity in court.

Table 3.1. Terrorism definitions provided by the FBI.

iii) List of events

Using the definitions in Table 3.1., the daunting reality is that a mass shooting occurs in America nearly every day[2]. With only monthly data on background checks, I restricted the number of mass shooting events to those that are "nationally recognized." These events are particularly gruesome, usually involving high levels of fatalities or injuries, or an attack on a defenseless population such as church-goers or children. I only consider events directly addressed at the presidential level ranging from a press conference to Twitter tweets. These salient events usually reignite the conversation about American society's cultural values and priorities. The list of events is presented on Table 3.2.

Event	Location	Date
Columbine High School shooting	Columbine, CO	April 20, 1999
Virginia Tech shooting	Blacksburg, VA	April 16, 2007
Election victory of president-elect Barack Obama	National	November 4, 2008
Tucson shooting (Rep. Gabby Giffords incident)	Tucson, AZ	January 8, 2011
Aurora movie theater shooting	Aurora, CO	July 20, 2012
Sandy Hook Elementary School shooting	Newtown, CT	December 14, 2012
African Methodist Episcopal Church shooting	Charleston, SC	June 17, 2015
Planned Parenthood shooting	Colorado Springs, CO	November 27, 2015
San Bernardino shooting	San Bernardino, CA	December 2, 2015
Orlando nightclub shooting	Orlando, FL	June 12, 2016
Dallas police shooting	Dallas, TX	July 7, 2016
Congressional baseball practice shooting	Alexandria, VA	June 14, 2017
Las Vegas strip shooting	Las Vegas, NV	October 1, 2017

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[2] The *Gun Violence Archive* tracks mass shootings that occur every day across the United States that fit the definition.

| Sutherland Springs church shooting | Sutherland Springs, TX | November 5, 2017 |
| Stoneman Douglas High School shooting | Parkland, FL | February 14, 2018 |

Table 3.2.

IV. Methodology

i) Data cleaning and adjustments

When a mass shooting occurs, a dummy can be marked for the following variables: *dterror*, *iterror*, and *mentalhealth*. There are two incidents where none of these variables are marked: Las Vegas and Columbine. Otherwise, these categories are treated as mutually exclusive. For example, if the perpetrator had mental health issues, neither *dterror* or *iterror* are marked. A tree diagram illustration is as follows:
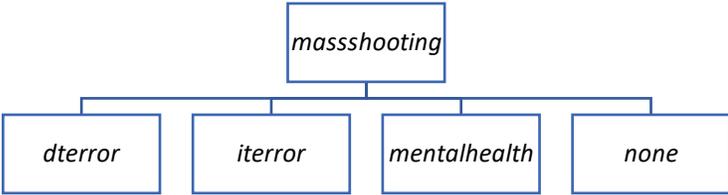
I also use the quantity of fatalities and injuries as independent variables in order to test whether the severity of the mass shooting impacts gun sales.

The FBI only publishes the number of monthly background checks, and this coarse data imposes several limitations. First, there is a time lag in observing the response to the event. In conjunction with the monthly data points, it is difficult to determine the approximate event response time. To account for this, each event is marked for two months to capture precipitating effects. For example, the Tuscon shooting occurred in January of 2009, and the relevant dummy variables are marked for both January 2009 and February 2009.

There are several instances where two mass shootings occur within three months, causing a monthly overlap when capturing precipitating effects. For example, the Las Vegas and Sutherland Springs shootings happened during October and November of 2017, respectively. For these events, the middle month (November, in this case) will have dummies marked in more than one of the mass shooting categories. Additionally, that month will also have the sum of the quantity of fatalities and the quantity of injuries from both events.

The call for control dummy variable can alternatively be viewed as an Obama dummy variable. While gun control is a common agenda for the Democratic Party, President Obama has repeatedly called for stronger regulations not only following mass shootings, but during the annual State of the Union speeches, town hall meetings, debates, interviews, and other public appearances. This indicates that the call for control is not limited to mass shooting events, but it is a common theme throughout his entire time in office. Therefore, a call for control is marked throughout his tenure. It is unmarked for all other presidents since 1998.

V. Econometric Analysis

i) ARMA Model

Firearm sales illustrate time series behavior due to seasonality. There is high demand every year during the fall and winter hunting season. As a result, it would be appropriate to use an ARMA model. Trended Dickey-Fuller and Phillips-Perron tests reject the null hypothesis, indicating that the series does not have a unit root. The optimal number of lags is determined by the lowest Akaike Information Criterion. To estimate the number of background checks based on the defined variables and controls previously listed, the following ARMA(P,Q) model is presented:

$$checks_t = \alpha + \sum_{p=1}^{P} \beta_p * checks_{t-p} + \sum_{q=1}^{Q} \Theta_q * \varepsilon_{t-q} +$$

$$\chi * trend_t + \delta * unemployment_t + \phi * callcontrol_t +$$

$$\gamma_1 * massshooting_t +$$

$$\eta_1 * dterror_t + \eta_2 * iterror_t +$$

$$\lambda_1 * mentalhealth_t +$$

$$\rho_1 * qfatalities_t + \rho_2 * qinjuries_t + \varepsilon_t$$

In this estimation, P is the number of lags for $checks_t$ or the autoregressive (AR) element of the model, and Q is the number of lags for ε_t or the moving average (MA) element of the model. The *unemployment* variable is the monthly percentage of unemployment intended to capture economic conditions. The following are dummy variables: *callcontrol*, *dterror*, *iterror*, *massshootings*, and *mentalhealth*. Definitions for these abbreviations can be found in Table 3.1. The variables *qfatalities* and *qinjuries* measure the quantity of fatalities and the quantity of injuries, respectively, in order to account for the severity of the event.

ii) ARMA Results

Running various ARMA models, Model 1 is the exogenous, baseline model that captures the positive conditions of the country such as the increase in guns over time, the unemployment rate, and the Obama presidency. Model 2 considers the motive of each incident: did the perpetrator have a terrorism motive? If so, what was the source of inspiration? Model 3 determines the effect of the perpetrator's mental health on gun sales because many politicians have claimed that mental health is a significant reason for mass shootings, particularly President Trump. Model 4 measures the response based on the severity of the event. Model 5 evaluates all the independent variables together.

NICS	Model 1	Model 2 (Motive)	Model 3 (Mental health)	Model 4 (Severity)	Model 5
Trend	7 011*** (2 123)	6 791*** (1 937)	6 734*** (1 842)	6 717*** (1 847)	6 580*** (1 983)
Unemployment	-2 997 (37 510)	-12 247 (33 030)	-14 214 (37 290)	-17 007 (32 329)	-16 458 (29 664)
Call for control/Obama	192 749 (117 784)	181 140** (90 852)	207 526* (121 294)	229 444* (118 840)	209 229** (89 817)
Mass shooting	-	63 726** (29 301)	-66 (48 772)	-81 577** (35 312)	-164 077*** (42 819)
Domestic terrorism	-	29 172 (48 945)	-	-	182 679*** (50 128)
International terrorism	-	385 555*** (34 193)	-	-	383 465*** (60 453)
Mental health	-	-	154 535*** (53 742)	-	193 697** (95 063)
Quantity of fatalities	-	-	-	13 077*** (1 458)	6 040* (3 586)
Quantity of injuries	-	-	-	-1 180*** (211)	-340 (419)

Table 5.2. OPG standard errors in parentheses.

AR(1)	0.909*** (0.060)	0.834*** (0.066)	0.864*** (0.072)	0.894*** (0.067)	0.918*** (0.074)
AR(2)	-0.232** (0.091)	-0.061 (0.106)	-0.148 (0.102)	-0.160* (0.094)	-0.13 (0.116)
AR(14)	0.098 (0.071)	0.048 (0.075)	0.066 (0.076)	0.069 (0.077)	0.064 (0.084)

Standard errors in parentheses.

(1) Monthly dummies are included in each model but omitted from Table 5.2 for brevity. Full results are available upon request.

*(2) * $p<0.10$; ** $p<0.05$; *** $p<0.01$*

(3) All AR coefficients fall between -1 and 1.

(4) For brevity, only AR(1), AR(2), and AR(14) are shown. Actual computations run from AR(1) through AR(14). Full output is available upon request.

Table 5.2 presents the results of several ARMA models. First, across all models,

unemployment was insignificant. This suggests the rejection of the initial hypothesis that relates

unemployment and the number of firearms sold. Second, Obama's tenure had a large impact on weapon sales. In Model 5, each month of his presidency caused an average increase of about 210,000 more background checks.

Based on the tree diagram in the methodology, the mass shooting factor must be attached to another variable. The mass shooting variable carries a negative sign, and it is often combined with domestic terrorism, international terrorism, or mental health, therefore resulting in a net positive value. As previously mentioned, Las Vegas and Columbine are the only two shootings that do not follow this pattern. If the perpetrator is a terrorist, where that influence comes from has a differential effect. If the shooter's motive came domestically from fringe, American-based movements, there is approximately a 183,000 increase. If the motive came from overseas, however, the reaction to purchase firearms is more than twice as large with a 383,000 increase. This could imply that firearms owners are very sensitive, and they have a particular fear of foreign ideologies influencing people inside the United States.

The model also indicates that mental health of the perpetrator contributes to firearms purchases. The significance of mental health suggests that these individuals' actions cause concern among those who choose to purchase firearms. It may not be the fact that they conducted a shooting, but it suggests that purchasing firearms are a counterbalance to the perceived threat.

Moving from Model 4 to Model 5, the quantity of fatalities and injuries become less significant, indicating that the severity of the event is overshadowed by the simple fact that the event occurred. A "correction" factor may be an explanation for the negative sign for those who are only injured in a shooting.

VI. Conclusion

Using monthly FBI NICS data, I estimate an ARMA model controlling for several exogenous factors. I find that President Obama's tenure, mental health of the perpetrator, and internationally-influenced terrorists significantly contribute to an increase in sales; the increase ranges from several thousand to several hundred thousand background checks in the time period following the event. The country's economic health, captured by the unemployment rate, is statistically insignificant in all models. The severity of the event varied in significance, depending on the model used.

The results of this study suggest several conclusions. First, mass shootings increase firearm sales, but the overall increase is dependent on who commits these shootings. If it was conducted by a domestic terrorist, the results show that there would be a modest increase in the number of background checks. If it was an internationally-influenced terrorist, background checks surge by at least 200,000, such as in the aftermaths of the San Bernardino and the Orlando mass shootings. Second, among long-time firearm owners or first-time purchasers, there was a particular fear of President Obama's ideology. Though there was no notable firearm-related legislation at the federal level during his tenure, his calls for gun control instilled uncertainty of the future availability of firearms. This caused a large reactionary increase in sales. Third, there is a fear of internationally influenced terrorists conducting mass shootings in the United States. Ideologies perpetuated by ISIS and other organizations have arrived stateside, and a lack of perceived ability to contain the scope of this new threat also creates uncertainty. This is less like domestic terrorism where common motives like racial extremism and anti-government views have been well documented and experienced in American history.

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