The Impact of School Shootings on Birthrates in America

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Introduction

Few events in America generate the same level of devastation and grief as mass shootings. There is now a predictable cycle following one of these events: a grieving nation, a paralyzed political system, and finger-pointing and assigned blame. For weeks, the nation is greeted by devastating images on national news and inflammatory rhetoric. Additionally, America faces a normalized high level of gun violence apart from these high-profile shootings compared to similar nations. Smaller scale gun violence, including accidents, suicides, and homicides take a consistent but tragic toll on the communities in which they take place.

Shootings at America's schools are especially taxing on the nation's psyche. Tragically, these have become increasingly frequent since the shooting at Columbine High School in 1999. The number of school shootings has increased, with more occurring post-1990 than between 1760-1990, even as violence as a whole decreases at schools (Duplechain and Morris 2014, 145). The toll that these events take on affected individuals and communities is made manifest in the proliferation of memorials, vigils, and calls for action. What is less clear is how these events embed themselves and persist in the community's memory, potentially creating lingering and pernicious effects for decades and generations to come. While the entire nation is witness to the short-term and immediate effects of a school shooting, understanding these long-term impacts is essential to solving the policy impasse.

My research will analyze how school shootings impact a community's fertility and birthrate. Research has been done into the psychological effects on a community after a shooting, suggesting that those who experienced the event first- and secondhand may have lingering effects (this will be discussed in detail in the literature review). To understand the full effects, however, we must look beyond the immediate generation to the next. A community that is forced to bury its children and experience the aftereffects of that event will likely change decisions made about family and children.

Understanding these results is critical to fully addressing the needs of a community that has experienced violence.

I chose to address birthrates and fertility specifically to find out whether school shootings and the resulting news coverage impacts how families make fertility decisions – and thus, whether these events impact the perceived (or subconscious) costs and benefits of having children. Whether or not these effects are stronger or weaker in communities that are less normalized to violence is of interest as well. For instance, the high-profile shooting in Sandy Hook, CT could have a more measurable impact precisely because it is unusual in that area. It is likely that well-off, rural, and/or white counties will be more impacted by school shootings. Much of this comes down to how violence in these communities is covered in these communities, which will be discussed in more detail. Interacting with demographic and economic information will allow me to paint a more complete picture of these questions.

Though research has been done into the psychological impacts of a school shooting, there is nothing that has been done directly on fertility and school shootings. Research on family and localized economics and school shootings in general seems to be sparse, so I hope that this research can branch into a new way of analyzing these tragedies. The closest related work to this paper is Berrebi and Ostwald's study on terrorism and fertility – another instance of discrete, random violent acts impacting fertility decisions. This paper largely serves as a model for my research.

To address this question, I will build a theoretical model based on the work of Gary Becker. I will demonstrate how school shootings could impact the costs and incentives of raising children, and how that could subsequently impact fertility decisions. I will then address the question using quantitative data from government departments and new outlets to look for significant effects on fertility within a county based on the occurrence and scale of a school shooting. I will use appropriate statistical methods in my model in order to account for potential biases and unobserved factors across time and within individual counties in America.

The theoretical aspect of this approach will allow me to tie together Becker's framework of fertility with the existing psychological and sociological research that has been done on the topic of school shootings. For example, lingering PTSD across the community could impact the costs and ability of parents to invest in having children. Quantitatively, I can test the theory and see the size and significance of the effects.

In the next section, I review the relevant literature. This is followed by a section describing the theoretical model used and the approach of my research. Next, I discuss the data used for my research, followed by a section describing my empirical methods. Then I share my empirical results. Finally, I discuss the implications of my results and the possibility for future research in this area.

Literature Review

The starting point of my research will be the fertility model proposed by Gary Becker. Becker suggests that the demand for children by a family or individual is a function of the expected utility of having children and the costs associated with raising them (Becker 2009, 138). Becker goes a step further to describe demand for children as being a trade-off as parents balance quantity of children with investing more into the quality of each child (145). This will provide the theoretical framework for my hypothesis. Much of the following research, whether economics, psychology, sociology, or otherwise, can be tied into one of Becker's variables and predicted to shift the fertility rates of the community. Becker's research is discussed in more detail later.

There has been a small amount of research done on the effects of school shootings on family and local economics. Students' performance in school following a shooting can be negatively impacted (Beland and Kim 2016, 123). Most relevantly, Abouk and Adams find that private school enrollment increases between 10-12% in areas affected by a school shooting, especially rural and suburban communities (2013, 297). This finding suggests that parents may place higher value on the quality of children in the wake of a school shooting. Supporting this conclusion, and feeding into my hypothesis, are findings that school shootings often create a public fear and panic, even while the statistical likelihood of violence occurring is declining (Burns and Crawford 1999, 147). Following Columbine, a majority of Americans believed that similar violence could occur in their own communities (Saad 1999). This type of uncertainty has long been an effect, and goal, of terror attacks.

Importantly, as Abouk and Adams' research hints at, it is likely that these effects are not equal across all communities. Although school shootings occur more frequently in urban schools than rural, newspapers spent more time covering the rural shootings (Menifield et al. 2001). The authors also found evidence of priming based on the race and gender of both perpetrators and victims. White men were oftengiven an excuse of outside social factors (such as bullying or economic opportunity), while men of color were more typically held personally responsible (Menifield et al. 2001, 461). This suggests not only that all shootings are not covered equally, but that rural, white, or wealthy communities may be more prone to a narrative of a sympathetic tragedy.

A limitation on the school shooting research is that much of it comes in the aftermath of the Columbine shooting around the turn of the millennium. The most common types of research around this time seem to be media analyses and psychological studies of the communities and perpetrators. With the creation of the Washington Post's database in 2018 and others like it in recent years, more quantitative studies such as this one are becoming possible. However, it also means that much of the existing literature on school shootings does not take more recent instances into account.

To get around the lack of research on school shootings and to further make my theoretical case, I will be drawing on literature on terrorist attacks. Though there are important differences between the two, terrorism and school shootings are both unexpected, seemingly random occurrences of violence that leave lasting effects on a community. Often, neither occur within the context of a larger conflict, such as a civil war. Both tend to target places that are seen as symbolic or innocent – schools, hospitals, places of worship, etc – and typically victims are "everyday people," rather than officials or celebrities.

Most relevantly, existing research finds a link between terrorism and declining fertility rates, both total fertility rate and crude birth rate (Berrebi and Ostwald 2014, 1). Fertility is affected in two major ways: the nationwide birthrate the year after an attack, as well as the total number of births that women in the country are expected to have in a lifetime (2014, 1). This suggests that these attacks leave lasting effects, both on individuals and the community at large. As well as lasting the lifetimes of those affected, it also suggests that a dip in birthrate follows in the years after an attack.

Berrebi and Ostwald's findings and methods are a proof-of-concept for my own research. Their findings are at the country level, which gives them a larger number of variables than are available at the county level in America. They use longitudinal data at the country level and they include 170 countries and terrorism data between 1970 and 2007 (Berrebi and Ostwald, 2014). They account for country-specific laws and institutions that may impact the tendency towards terrorism, as well as GDP per capita and geographic measures. Because I will be using county level data, I will have many more observations per year and my data will be more specific geographically. My data also has a shorter timeframe available. They are also able to draw on a larger body of research into the quantitative factors that predispose an area to terrorism, which does not exist for terrorism. Similar research does not exist in the same numbers in regards to school shootings.

Because Berrebi and Ostwald are researching a similar question, their methodology provides a starting point for my own research. They use fixed effects, first differences, and instrumental variables (these methods will be defined later). These approaches are taken because they consider terrorism to be an endogenous explanatory variable and attacks are likely to correlate with country level and time invariant unobservable factors. For the instrumental variables, they use lagged variables of terrorism in neighboring areas (Berrebi and Ostwald, 8). As mentioned, there has been less research on the causes of school shootings, so finding an instrumental variable is less straightforward. Below are the models that they use to account for these correlations:

Fixed effects model:

$$fertility_{i,t+1} = \beta \cdot \ln(terrorism_{i,t-j}) + \alpha \cdot demographic_{i,t} + \delta \cdot economic_{i,t} + \theta \cdot social_{i,t} + \rho \cdot year_t + \phi \cdot country_i + \mu_{i,t} \quad (1)$$

First differenced model:

$$\Delta fertility_{i,t+1} = \beta \cdot \Delta\ln(terrorism_{i,t-j}) + \alpha \cdot \Delta demographic_{i,t} + \delta \cdot \Delta economic_{i,t} + \theta \cdot \Delta social_{i,t} + \rho \cdot \Delta year_t + \Delta\mu_{i,t} \quad (2)$$

Second stage:

$$fertility_{i,t+1} = \ln(terrorism_{i,t-1})\alpha + pop\_char_{i,t}\rho + year_t\beta_t + country_i\lambda_i + \mu_{it} \quad (3)$$

First stage neighboring terrorism:

$$\ln(terrorism_{it-1}) = \sum_{k=1}^{2}(near\_terr_{i,t-k})\omega_{t-k} + pop\_char_{it}\rho + year_t\beta_t + country_i\lambda_i + \varepsilon_{it} \quad (4)$$

As well as their explanation of the variable categories, which has inspired my own model:

$fertility_{i,t+1}$	Total fertility rate or crude birth rate in country i, year $t+1$.[2]
$terrorism_{i,t-j}$	Terrorism attack incidents in country i, year $t-j$ where j ranges from 0 to 1 (i.e., terrorist attacks in current year and lagged year)
$demographic_{i,t}$	Population size, % of urban population in country i, year t.
$economic_{i,t}$	GDP *per capita* (constant 2000 US$), general government final consumption expenditure GFCE (% of GDP) in country i, year t.
$social_{i,t}$	Civil liberties in country i, year t.
$year_t, country_i$	Year and country fixed effects.
$\Delta outcome_{i,t}$	$(outcome_{i,t} - outcome_{i,t-1})$ or $(outcome_{i,t-j} - outcome_{i,t-j-1})$.

Literature exists describing the damage that terrorism does to the psychology of a community as well. A year after the attacks on September 11, New Yorkers remained concerned about the potential for future attacks, and this anxiety increased when surrounded with further emergency preparations (Boscarino et al. 2003). The NYC metropolitan area had a higher prevalence of PTSD following the attacks as well (Schlenger et al. 2002). Eckstein and Tsiddon find that terrorism can affect the larger economic output of a region as well, predicting that Israel's economy suffered by roughly 5% over the course of three years as a result of terror attacks across the nation (2004). While this is a macroeconomics study, it shows that unexpected violence impact people's future beliefs and actions (impacting investment and government spending), leading to long-run consequences. If long-run decisions around investment change, it is possible that long-run decisions about children could change as well.

Following Columbine, there was an increase in the literature surrounding the psyche and mood of those who experience school shootings. The effects turn out to be similar in some ways to communities that have faced terrorist attacks. PTSD has been found at the community level, evidence of the presence of widespread trauma and impacting providers' the ability to treat at a wider scale (Palinkas et al, 2012). Reporters have also been found with trauma after covering these events (Simpson and Coté 2006, 193). Other studies note the negative effect on public health and its spread to all aspects of the community as a whole (Weintraub et al. 2001). It is likely that the resulting effects from school shootings could have similar impacts as they do after acts of terrorism.

In my research, I hope to provide the missing link between the effects of school shootings and their impact on a community's fertility that Berrebi and Ostwald uncovered for terrorism. Scholars have noted the relative lack of research that has been done into the long-term effects of a school shooting (Muschert 2007, 75). Given that random acts of violence such as terrorism and school shootings create fear, anxiety, and lasting psychological effects, in addition to tragic losses, it would make sense that school shootings would impact fertility in a similar way. Because school shootings specifically harm children, this connection is more direct.

Approach and Theory

My theory will primarily be based off of the work of Becker, as discussed above, as well as the work of Dr. Turchi (1975). Both lay out a model of fertility as an economic decision, based largely on parental income and opportunity cost and the expected utility of a child (Becker 2009). Turchi extends Becker's approach to also account for sociological factors, such as how norms dictate the cost spent on a child (Turchi, 1975).

Becker proposes that children's costs depend on goods and services, the time of parents, and real income, offset by any economic contributions made by the child (Becker 2009, 138). However, Becker complicates this by adding in the dynamics of quantity and quality to explain why fertility rates have decreased as real incomes have increased in the last century, even though children are presumably a normal good. The answer is that parents trade off their spending on children between quality and quantity – investing more in each child or into more children as income increases. Abouk and Adams' research of the shift towards private schooling after a shooting could reflect this phenomenon (2013).

A school shooting, as a shock to an otherwise stable community, could impact these input variables. This logic is also used when modeling the effects of terrorism on fertility (Berrebi and Ostwald 2014, 2). Because a school shooting, like a terrorist attack, is a discrete event, there should be a distinct difference following the incident. This is opposed to more systemic or continual forms of violence such as gang violence, civil war, and high levels of crime.

A school shooting is unlikely to affect any of the monetary costs of children in the long-run. Goods and services are unlikely to get more expensive, the time of parents likely will not lose value, and real income may not be affected. As a result, a single event will not likely make an impact into the long-run equilibrium on fertility. This theory is contradicted by Berrebi and Ostwald finding that terrorist attacks do impact the total number of births in a woman's lifetime. However, terrorism also tends to be systemic because attacks typically come from organizations, rather than isolated individuals, as is more typical of school shootings. This could explain the effects lasting throughout the childbearing period.

I propose that school shootings might impact fertility in two mechanisms. First, I believe that the expected utility of a child could diminish in the wake of a school shooting. Becker discusses how rural fertility declined as education became less accessible and children were less useful working on farms (Becker 2009, 139). Similarly, if schools are seen as unsafe and possibly a fatal environment for children, potential parents may be reluctant to have more children. This thinking could also stem from PTSD and other effects becoming more prevalent across the community.

Secondly, school shootings could cause parents to shift investing more into quality rather than quantity. In the immediate aftermath, parents will want to know that their children are safe as they go into schools. One example of this, as mentioned, is that private school enrollments increase by about 10 percent following a school shooting (Abouk and Adams, 2013). The literature thus shows an example of communities increasing quality, which should presumably follow with communities decreasing quantity, if all else remains the same. As NYC experienced more anxiety with increased emergency preparations, this could also cause increased fear and anxiety if communities extensively compensate following a school shooting (Schlenger et al. 2002).

However, much of the potential effects of school shootings is likely less able to be quantified and modeled. Much of the research into community psychology in the aftermath of a shooting paints a grim picture. Whether the community is afflicted with panic, PTSD, or questions of meaning, many of these sinister and subliminal conditions could make having a child less desirable. Berrebi and Ostwald go to great lengths to show the connection between these subtle stresses and their impact on biological fertility, whether psychological or physiological (2014, 2). Many of these studies apply directly to warzones specifically, but the overall effect mirror many of those cited above, suggesting that collective trauma after violence could impact fertility.

Data

1. School Shootings Data

The Washington Post has developed a database of over 200 school shootings that have occurred since the shooting at Columbine High School in 1999 (Cox, et al., 2018). There is no database of school shootings kept by the federal government, so a database such as this is the most reliable option. The Washington Post database includes multiple layers of locational data, which plug into coding used by government agencies. This database has 221 school shootings since Columbine – all of which happen at elementary, middle, and high schools.

The Washington Post model also includes further data on shootings and schools that may be used for increased specificity beyond geography and casualties. Casualties are broken into injuries and fatalities, which allows me to account for the scale of the shooting. School size is also included, which could enable me to account for the percentage of the county's students and families that were present – although many school districts cross county lines. Further school information included is the range of ages taught at the school, whether the school is public or private, and the racial breakdown of the student population.

2. Demographic and County Data

For population data, I will use the American Community Survey (ACS) One Year Estimates. These estimates range from 2007 to 2017 and include communities that have at least 60,000 residents. There are also five year estimates available, which include all communities, but come at the cost of only giving two observation periods. In order to track birthrates over time, I will be using the one year version. These variables will provide both a birthrate as well as my control variables.

The downside of using the One Year Estimates is losing communities that have fewer than 60,000 residents. However, this will only account for losing around 15 shootings nationwide through eleven years. Although the five year estimates have more accurate data, they do not allow me to track year-over-year changes. Although there are supplemental estimates that include communities with 20,000 – 60,000 residents, these estimates do not include fertility data.

A complete list of important variables is below, but generally, the ACS allows me access to basic demographic, economic, and educational variables. Typically, these yearly estimates include roughly 800 counties per year, depending on data availability. I rescaled the population variable into thousands of people. Similarly, the median family income variable was recoded into quintiles in order to allow for a nonlinear relationship.

3. Fertility Data

The fertility data I use for my research comes from two sources. First, the ACS yearly estimates include a measure of the county's yearly birthrate – defined in the data as number of women who gave birth per 1,000 women aged 15-50 in the past 12 months. This variable is available on the county level by year.

My second source is birth data from the National Center for Health Statistics (NCHS), part of the CDC. This data provides a birthrate by county and year. The birthrate measures the total number of births in a year divided by total population. This data is available for fewer counties per year than the ACS, typically around 600 counties per year. The NCHS also has a fertility rate available, which measures the number of births in a year divided by women aged 15-44, however this statistic was not available for enough counties to run meaningful tests on it.

The NCHS will be my primary birthrate variable for a couple of reasons. First, it actually measures the actual number of births, rather than the number of women giving birth. Second, the NCHS sources their data from birth and hospital records, rather than survey responses. Although this limits the number of counties for which the data is available, this method will be more accurate. The ACS data will still be used, although its sole advantage is having more counties available per year.

Table 1: Summary Statistics of Key Variables

Variable name (county, year)	**N**	**Mean**	**S.D.**	**Min**	**Max**
Women 15-50 with births in past year per 1000 (ACS)	8393	54.85	15.28	12	157
Number of births divided by total population (NCHS)	5980	12.61	2.45	5.81	26.33
Total Population	8390	341,456.30	588046.3	62467	10170292
Median Family Income	8860	70796.61	17334.69	34451	156020.7
Unemployment Rate	8805	6.7	2.52	1.3	21.7
% with Bachelor's degrees or higher	8900	27.5	10.14	7.3	75.9
% white	8390	79	14.72	13.8	98.2
% black	8390	10.92	12.31	7.53	33.96
% enrolled in K-12	8390	17.1	2.37	5.04	25.67
% of enrolled students in public school	8390	89.83	4.78	5.04	25.67
% women aged 15-50	8243	24.15	2.33	7.53	33.96
Shooting Dummy (lagged 1 and 2 years)	8900			0	1
Deaths (lagged 1 and 2 years)	8900			0	26

Methodology

In order to measure the potential effects of school shootings on birthrates, I will use random and fixed effects models. A simple OLS model would not account for potential omitted variable bias or unobserved heterogeneity. The largest concern is unobserved time-invariant county-specific effects that could bias a simple OLS model. Random effects controls for this heterogeneity, but only if it is not correlated with any of the observed independent variables. Fixed effects include the means of each variable in order to also account for correlation between the time invariant heterogeneity and the observed variables. Fixed effects will neutralize this concern if the null hypothesis of exogeneity is rejected in the Hausman test. Otherwise, random effects is the most efficient estimator.

A robust Hausman test will reveal which of the two is the better estimator. The Hausman test tests the null hypothesis of exogeneity. If the null hypothesis is rejected, meaning that there is correlation between the observed variables and county-level time invariant unobservables, then fixed effects is the only consistent estimator between the two. Random effects only remains consistent if the null hypothesis is not rejected, meaning that as the sample size increases, estimates converge on the actual values When the null is not rejected, random effects is the more efficient estimator between the two, so that is the favored estimator in that case.

Model:

$$birthrate_{i,t+1} = \beta_1 \cdot (shooting_{i,t-j}) + \beta_2 \cdot (demographics_{i,t}) + \beta_3 \cdot (economics_{i,t}) + \beta_4 \cdot (education_{i,t}) + \beta_5 \cdot (year_t) + \beta_6 \cdot (county_i) + \mu_{i,t}$$

Variables:

- *Fertility*$_{i,\, t+1}$: birth rate or fertility rate by county *i* in year t+1, allowing for lagged effects from other variables.
- *Shooting*$_{i,\, t-j}$: dummy of the occurrence of a school shooting in the county *i* and year *t – j*, where j ranges from 0 to 1 (whether a shooting occurred in the previous two years)
- Demographics$_{i,t}$: Population size in 1,000s, % of population that is white, % of population women aged 15-50 in year *t* and county *i*

- *Economics*$_{i,t}$: unemployment rate, quintile of family income in county *i* and year *t*
- *Education*$_{i,t}$: % of population enrolled K-12, % of K-12 students in public and private schooling, % of population with bachelor's degree or higher in county *i* and year *t*
- *Year*$_t$, *county*$_i$: Year and county fixed effects

In addition to that basic model, I will also run a model including interaction terms. These terms will see if certain factors make a county's fertility more likely to respond to a school shooting. Specifically, I will be testing whether or not income quintiles, race, and proportion of K-12 students lead to a different impact on fertility when interacted with a shooting. The rationale behind these variables are to represent communities where violence is less normalized, or communities where children make up a larger percentage of the population, could make the danger seem more relevant. The difference in media coverage is likely to play a role as well. For this interaction model, I will also be using random and fixed effect models.

$$birthrate_{i,t+1} = \beta_1 \cdot \left(shooting_{i,t-j}\right) + \beta_2 \cdot \left(demographics_{i,t}\right) + \beta_3 \cdot \left(economics_{i,t}\right) + \beta_4 \cdot \left(education_{i,t}\right) + \beta_5 \cdot \left(year_t\right) + \beta_6 \cdot \left(county_i\right) + \alpha_1 \cdot \left(shooting_{i,t-j} \cdot income_{i,t}\right) + \alpha_2 \cdot \left(shooting_{i,t-j} \cdot race_{i,t}\right) + \alpha_3 \cdot \left(shooting_{i,t-j} \cdot enrollment_{i,t}\right) + \mu_{i,t}$$

As a supplement to both the regular and interaction-based model, I will run models where only one variable of interest is featured at a time in order to account for potential collinearity. For the regular model, I ran regressions with control variables and each of the four violence variables (shooting dummy and death count, at one and two year lags). The interaction model will be the same, except that I will run it with both the base variable and one interaction term at a time. For the income quintiles, I will include them all simultaneously.

Using an instrumental variables approach as well as the above models would have been ideal. Instrumental variables allows the model to control for variation between observed variables and both the time invariant and time variant unobservables, rather than only the time invariant. However, the current research does not offer clear hints on proven instrumental variables, or data availability limits the ability to run this type of model. This would have controlled for a possible endogenous relationship between school shootings and the fertility of a specific county.

Results

Table 2: Random and Fixed Effects model - control variables				
Birthrate Source: NCHS and ACS	NCHS		ACS	
Random or Fixed effects	RE	FE	RE	FE
% Bachelor's or higher	-0.009	0.008	-0.142	0.083
	(0.040)	(0.110)	(0.001)	(0.401)
% People of color	0.051	0.013	0.049	0.271
	(0.000)	(0.178)	(0.045)	(0.169)
% Enrolled K-12	-0.002	-0.113	1.245	-1.469
	(0.876)	(0.000)	(0.000)	(0.000)
% of students in public school	-0.007	-0.009	-0.029	-0.126
	(0.032)	(0.001)	(0.536)	(0.032)
% Women aged 15-50	-0.092	-0.141	-0.447	-0.081
	(0.000)	(0.000)	(0.001)	(0.767)
Unemployment Rate	-0.035	-0.030	-0.158	-0.002
	(0.000)	(0.000)	(0.110)	(0.984)
Total Population (per 1000)	-0.00005	-0.004	-0.0005	-0.016
	(0.637)	(0.000)	(0.310)	(0.018)
Median Family Income – Q1	-0.122	-0.301	5.047	3.433
	(0.102)	(0.000)	(0.000)	(0.019)
Median Family Income – Q2	-0.057	-0.198	4.518	3.468
	(0.378)	(0.001)	(0.000)	(0.007)
Median Family Income – Q3	0.007	-0.087	2.781	2.043
	(0.897)	(0.095)	(0.001)	(0.068)
Median Family Income – Q4	0.038	-0.024	1.661	1.071
	(0.396)	(0.568)	(0.017)	(0.239)
Robust Hausman P-value		0.000		0.000
Number of Counties	579	579	817	817
Number of Observations	5917	5917	7972	7972
Year effects	Yes	Yes	Yes	Yes

Table 2 shows the results of the control variables used in the model. Again, the fixed effects estimator is the best estimator (and the only consistent estimator) due to the results of the Robust Hausman test. Overall, many of the expected variables are significant. It is likely that many of these variables are correlated, such as educational attainment and unemployment rate or income, which could mitigate the significance of variables. I again primarily focus on the NCHS data. The variables reflecting children (enrolled %, % in public school) carry significance, as well as total county population. Percentage of women of childbearing age and unemployment rate are significant in the NCHS, but not the ACS.

In previous versions of my model, I only included the median family income, rather than dividing it into quintiles. Since that change, the shift in results overall has been interesting. Typically, whiteness variables have become more significant, where the income variable carried most of the significance in the past. Specific income quintiles also become more significant as a result also. It appears that income loses significance as the counties become richer, although this effect could overlap with other variables, both observed and unobserved. Specifically, the unemployment rate is highly significant in the NCHS, which could overlap with how rich a county is. Relatedly, the rate of educational achievement is not significant in this model, but because education is often intertwined with income, it could play a role as well.

Table 3 shows the results of the initial random and fixed effects models, as well as the results of the relevant robust Hausman tests. As noted in the table, the shooting dummies and death counts do not have a significant effect on the birthrates relative to either the total population or population of women aged 15-50. Due to the aggregated nature of these variables, as well as the typically small scale of these shootings, this is not entirely unexpected.

Table 3: Random and Fixed Effects model of birthrate on shootings					
Birthrate Source: NCHS and ACS		NCHS		ACS	
Model: Random or Fixed effects		RE	FE	RE	FE
Shooting dummy (1 year lag)		-0.011	0.008	0.535	0.721
		(0.853)	(0.885)	(0.687)	(0.589)
Shooting dummy (2 year lag)		-0.076	-0.025	-0.334	0.099
		(0.214)	(0.656)	(0.805)	(0.942)
Death count (1 year lag)		-0.016	-0.016	-0.243	-0.260
		(0.450)	(0.414)	(0.616)	(0.594)
Death count (2 year lag)		-0.008	-0.009	-0.119	-0.120
		(0.698)	(0.619)	(0.806)	(0.806)
Robust Hausman P-value			0.000		0.000
Number of Counties		579	579	817	817
Number of Observations		5917	5917	7972	7972
Year effects		Yes	Yes	Yes	Yes

Although the results are largely insignificant, the majority of the coefficients are negative, which is the same direction posited by my hypothesis. The NCHS birthrate results show that all four shooting variables could have a negative effect, if any. The ACS measurement is only negatively impacted by the death variables in this model. That distinction could imply that fatal shootings are those most likely to have a depressing effect on birthrates.

The robust Hausman test in both measures of the birthrate rejects the null hypothesis. The null hypothesis of the Hausman test is that the covariance between the time-invariant error term and the independent variables is equal to 0, which would make random effects the better estimator. This result means that fixed effects is the more efficient estimator and, more importantly, is the only consistent estimator between the two. I will primarily be discussing the results from the fixed effects models as a result. This result is true of all of my models.

There are two potential issues with this initial model that may prevent the discovery of possibly significant results. First, there is the potential for strong correlation between the four variables related to shootings. In order to address the problem of correlated variables of interest, I ran the same model using only one of the four variables at a time, along with the control variables. It is possible that the correlation led the model to spread their effect across the four variables, leading them all to appear insignificant.

Table 4: Random and Fixed Effects model of birthrate on individual shooting variables				
Measurement Source:	NCHS		ACS	
Estimator: Random or Fixed Effects	RE	FE	RE	FE
Independent Variable of Interest:				
Shooting - 1 year lag	-0.014	-0.0015	0.426	0.581
	(0.812)	(0.978)	(0.743)	(0.656)
	0.000		0.000	
Shooting - 2 year lag	-0.078	-0.030	-0.414	-0.002
	(0.190)	(0.587)	(0.754)	(0.999)
	0.000		0.000	
Deaths - 1 year lag	-0.015	-0.014	-0.015	-0.196
	(0.466)	(0.460)	(0.466)	(0.680)
	0.000		0.000	
Deaths - 2 year lag	-0.012	-0.010	-0.130	-0.095
	(0.563)	(0.599)	(0.784)	(0.842)
	0.000		0.000	
Number of Counties	597	597	817	817
Number of Observations	5917	5917	7972	7972
Year effects	Yes	Yes	Yes	Yes

The results of this model appear in Table 4. Similarly to the original model, the results come back insignificant once again. Again, all of the robust Hausman tests point to the fixed effects estimator as being necessary. Once the fixed effects model controls for the county-level fixed effects, almost all observations become less significant. This could point to an unobserved correlation between the shooting variables and an unobserved factor.

The second drawback of the initial model is the absence of interaction terms that allow us to investigate how different types of communities respond to violence. The interaction terms used in this model are the percentage of white residents, percentage of population enrolled in K-12 education, and median family income quintiles interacted with either the shooting dummies or the death counts. These variables were selected to account for demographics and economics, as well as reflecting the existing research hypothesizing that whiter and more rural communities get more coverage of school shootings.

Table 5: Fixed Effects model of NCHS birthrate on shooting dummy interaction terms				
Length of lag	One Year		Two Years	
Shooting dummy (1 year lag)	0.256	(0.607)	-0.200	(0.736)
Shooting x % White	-0.003	(0.339)	-0.003	(0.500)
Shooting x Income – Q1	0.260	(0.125)	0.294	(0.101)
Shooting x Income – Q2	0.178	(0.324)	0.134	(0.483)
Shooting x Income – Q3	0.064	(0.739)	0.009	(0.960)
Shooting x Income – Q4	0.119	(0.468)	0.056	(0.741)
Shooting x Enrolled	-0.008	(0.745)	0.014	(0.634)

Table 5 highlights the results of the terms interacted with the shooting dummies with models for both one and two year lags. Of note are the results of the first quintile of median family income. These results suggest that poorer communities could have higher birthrates following a shootings, rather than lower, which fits with my hypothesis, especially if these counties get less coverage of shooting in their locales. As discussed in the data section, the NCHS is my primary dataset for birthrates. For the previous model, as well as the following models, I only use the NCHS data for simplicity and reliability.

Table 6: Fixed Effects model of NCHS birthrate on deaths dummy interaction terms				
Length of Lag	One Year		Two Years	
Death count (1 year lag)	-0.255	(0.812)	0.616	(0.573)
Deaths x % White	-0.006	(0.322)	-0.008	(0.167)
Deaths x Income – Q1	0.147	(0.205)	0.195	(0.130)
Deaths x Income - Q2	0.077	(0.539)	0.032	(0.815)
Deaths x Income – Q3	-0.047	(0.745)	-0.110	(0.359)
Deaths x Income – Q4	0.013	(0.904)	-0.046	(0.687)
Deaths x Enrolled	0.038	(0.369)	0.002	(0.959)
Number of Counties	579	579	817	817
Number of Observations	5917	5917	7972	7972
Year effects	Yes	Yes	Yes	Yes

Table 6 shows the results of the model using interaction terms with the death count on both a one year and two year lag in separate models. The two year variable in particular shows more potential significance than the one year does. Like the shooting model, the lowest income quartile demonstrates the result closest to significance, again showing a positive impact on birthrate in the poorest counties. The interaction term with whiteness also demonstrates a possible significance, though not crossing any major threshold, which could mean that white communities have lower birthrates as a result of fatalities in a school shooting.

Table 7: Fixed Effects model of NCHS birthrate on individual interaction terms								
Length of Lag	One Year				Two Years			
Base Variable:	Shootings		Deaths		Shootings		Deaths	
	Interaction	Base	Interaction	Base	Interaction	Base	Interaction	Base
Base x % White	-0.003	0.272	-0.008	0.594	-0.003	0.164	-0.008	0.626
	(0.261)	(0.270)	(0.134)	(0.143)	(0.429)	(0.514)	(0.096)	(0.102)
Base x Income – Q1	0.256	-0.124	0.134	-0.014	0.293	-0.122	0.172	-0.009
	(0.132)	(0.320)	(0.246)	(0.455)	(0.103)	(0.330)	(0.180)	(0.638)
Base x Income - Q2	0.191		0.071		0.162		0.041	
	(0.281)		(0.573)		(0.383)		(0.762)	
Base x Income – Q3	0.048		-0.070		0.019		-0.100	
	(0.801)		(0.629)		(0.909)		(0.400)	
Base x Income – Q4	0.101		-0.016		0.032		-0.086	
	(0.533)		(0.877)		(0.848)		(0.440)	
Base x Enrolled	-0.007	0.123	0.057	-1.048	0.017	-0.326	0.036	-0.691
	(0.782)	(0.781)	(0.124)	(0.119)	(0.555)	(0.518)	(0.249)	(0.242)
# Counties	579							
# Observations	5917							
Year effects	Yes		Yes		Yes		Yes	

Similar to my initial model, I also tested only one interaction variable at a time, as well as controls and the "base" violence variable. For example, one model included controls, the one year lagged shooting dummy, and its interaction with the whiteness variable. For the income model, I included all quintiles simultaneously. The results are displayed in Table 7. Each row shows an interaction term with the results of both the base and interaction variables. For this model, like the others, the Hausman test demonstrated that fixed effects was necessary, and those are the only included results. Like other models, I also chose only to include NCHS data.

The model did not dramatically increase the significance of any results. However, two important results hold from previous models. The lowest quintile of income (Q1) continues to show more possible significance than other variables in the shooting interaction terms for both one and two year lags. Though the results do not cross typical significance thresholds, these represent a basis for future research.

The second important result is the interaction of deaths and whiteness, especially at the two year lag. Here, the significance of the interaction term meets the 10% threshold for significance. This could indicate that whiter communities are more impacted by fatal shootings than more diverse communities. These results again line up with my hypothesis and theory. There are few other results of note, although the one year lag for death count comes close to becoming significant at the 10% level for enrollment and whiteness interactions. Interestingly, the base variable is negative and the interaction is positive. This suggests that there may be a possible relationship where communities with a higher proportion of K-12 students are less susceptible to negative effects from fatal shootings. The reverse is true for whiteness, with the interaction term driving potential lowering of the birthrate.

Conclusion

This research attempted to empirically identify a relationship between school shootings and yearly birthrates. Although my research failed to identify a robust relationship between the two, I believe there are still ways to delve deeper into this path of study. As demonstrated, more specification seemed to lead to more significant results. Perhaps with more specific data, especially geographically, it would be easier to find a significant relationship. With more data, it would be prudent to control for gun violence as a whole, which could allow more unusual shootings to stand out in the model.

Another possible route of further explanation has to do with media markets and exposure. This couples with my hypotheses of communities that are less normalized to violence being more sensitive to it. Controlling for where shootings were covered by news outlets, and for how long, could uncover new results as well. It is unlikely that counties themselves line up with where a shooting was covered. Lining counties up to TV markets or obtaining data on the coverage of these shootings could allow this path of research.

The results from Berrebi and Ostwald beg the question: what is the essential difference between terrorism and school shootings in impacting fertility? One difference is typically the scale and visibility of attacks. Terrorist attacks, even the nonfatal, are often designed for visibility and signaling. School shootings, on the other hand, are often not. While many of the widely covered school shootings can be easily considered terrorist attacks, many are not. For example, suicides and homicides are included in the umbrella of school shootings, but do not carry the same threatening posture towards the entire community that a larger attack might.

Many terrorist organizations are organized around ideologies, which gives the group a cohesiveness and agenda absent from many school shooters. This type of unrest could correlate with a larger societal unrest or uneasiness that could play into birth and fertility rates as well. School shootings tend not to have organizational backing that lend credence to a larger ideological divide.

While salient at the time of writing, perhaps my focus on school shootings in particular was too specific, and better conclusions could be drawn from measuring mass shootings in general. There were a number of reasons I opted against this approach to begin with. For one, the definition of mass shooting is far from fixed, and almost every database or article on these occurrences use a slightly different one.

School shootings are inherently more specific, for better or for worse. Second, there are many more mass shootings, regardless of definition. Some define mass shootings as a shooting with two or three deaths, which creates a large potential dataset that would be difficult to amass. The matter of gun research has sometimes become politicized as well, making these larger questions harder to ask. With further research, and more time, one could track down databases of shootings and winnow them based on the chosen definition. Finally, the defining factor came into play here as well. Mass shootings share the characteristic of multiple deaths, while school shootings share their location amongst children, which I believed could move the needle of the birthrate.

The biggest takeaway from my research for further study is that not all shootings cause equal reactions. While generic violence variables were uniformly insignificant, the interaction terms came much closer to having a robust effect on birthrate. This result leads me to believe that these interaction terms should be the focus in future research, to further dive into how varying communities are affected.

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