Does Economic Insecurity Really Impact on Gun Violence at US Schools?

Supplementary Information

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I. Supplementary Notes

Detailed Data Description

For the main analysis, we relate data on school shootings and unemployment rates at a monthly frequency for the sample period 1990-2013, at the US national, regional, and county levels.

Data on school shootings are obtained from Pah et al (2017), containing 381 events from six original datasets pertaining to school violence.[1] Events are included on the basis of three inclusion criteria: (1) the shooting must involve a firearm being discharged, even if by accident; (2) it must occur on a school campus; and (3) it must involve students or school employees, either as perpetrators, bystanders or victims.

We mapped each of these shooting events to the respective counties where they took place and consider only the 213 counties that had one or more shooting events in our analysis. The county level data allows us better to evaluate the extent to which local labor market prospects are related to school shootings. Supplementary Figure 1 illustrates the county-level distribution of the school shootings. Shootings occurred with higher frequency in the counties of Los Angeles, Cook, Wayne, Shelby,

[1]These include: The Brady Campaign; The School Associated Violent Deaths (SAVD) report from the National School Safety Center; Schultz et al.; Slate Magazine; Virginia Tech Review Panel; and Wikipedia.

Washtenaw, and Harris. These counties coincide with the cities of Los Angeles, Chicago, Detroit, Memphis, Dallas, and Houston, respectively. Except Dallas, these cities belong to the city-sample considered by Pah et al (2017).

Seasonally-adjusted unemployment rates were obtained from the Bureau of Labor Statistics (BLS). At the county level, unemployment rates were only available on a non-seasonally adjusted basis from BLS's Local Area Unemployment Statistics (www.bls.gov/lau). We seasonally adjusted the county-level data using the Census Bureau's X13 procedure.

We follow Pah et al (2017) when defining regions by partitioning the U.S. according to geography and socioeconomic similarity. They broadly correspond to the 8 regions defined by the U.S. Bureau of Economic Analysis, with the exceptions that New England and Mid-Atlantic are merged and the non-contiguous states, Alaska and Hawaii, are dropped from the sample (since only two shooting events took place there).[2] The number of monthly shooting incidents differs substantially between regions. The Great Lakes, Pacific, Southeast, and Southwest regions have experienced a larger number of shooting events, with a noticeably increased rate in recent history. Whereas US regional average unemployment qualitatively experience the same general trend as the national level, there are distinct quantitative differences in unemployment rates between the regions.

We also relate school shootings to alternative economic indicators. Data on monthly national consumer confidence is obtained from the Organization for Economic Co-operation and Development (OECD). Data on labor force status flows are obtained from the Current Population Survey (Household Survey) conducted by the Bureau of Labor Statistics. Job finding rates are defined as net monthly flows from unemployment to employment, normalized by beginning-of-month unemployment. Similarly, separation rates are defined as net monthly flows from employment to unemployment, normalized by beginning-of-month employment.

We consider five alternative definitions of mass shootings. The first four are obtained from the dataset compiled by Mother Jones[3]. In our baseline, we define mass shootings as the three deadliest shootings on US territory, yielding the following 3 massacres: Virginia Tech (32 fatalities), Newtown Sandy Hook (28 fatalities), and Luby's massacre (24 fatalities). These stand out as much deadlier than the remaining mass shootings in the sample, with the next largest event having 14 fatalities (see

[2]The resulting 7 regions consist of: (i) the Northeast (Connecticut, Delaware, District of Columbia, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, Vermont), (ii) Great Lakes (Illinois, Indiana, Michigan, Ohio, Wisconsin), (iii) Plains (Iowa, Kansas, Minnesota, Missouri, Nebraska, North Dakota, South Dakota), (iv) Southeast (Alabama, Arkansas, Florida, Georgia, Kentucky, Louisiana, Mississippi, North Carolina, South Carolina, Tennessee, Virginia, West Virginia), (v) Southwest (Arizona, New Mexico, Oklahoma, Texas), (vi) Rocky Mountain (Colorado, Idaho, Montana, Utah, Wyoming), and (vii) Far West (California, Nevada, Oregon, Washington).

[3]Data was obtained online from http://www.motherjones.com/politics/2012/12/mass-shootings-mother-jones-full-data

Supplementary Figure 2). We first consider four yearly dummies following these three shootings. Second, we weight the three deadliest shootings by the number of fatalities. Third, we broaden our definition of mass shootings to the 10 deadliest shootings (these mass shootings have minimum 10 fatalities). Finally, we consider a very broad definition of mass shootings, which comprises the full sample from Mother Jones' database. This database documents public mass shootings in which the motive appeared to be indiscriminate killing, satistfying the following criteria: (i) minimum four fatalities, (ii) the killings were carried out by a lone shooter, (iii) the shootings occurred in a public place, (iv) perpetrators who died or were wounded during the attack are not considered in the victim counts, and (v) includes a handful of cases known as "spree killings" in which the killings occured in more than one location in a short period of time, otherwise fitting the aforementioned criteria. In our sample period 1990-2013, we have 59 such mass shooting incidents. Our fifth and final mass shooting indicator is obtained from an alternative source to ensure robustness. In particular, we use the dataset on mass shootings compiled by Duwe (2007) and subsequently updated by the author. This dataset records 92 mass public shootings over the sample period, 50% more than Mother Jones sample.

To investigate the effect of mass shootings on US gun ownership, we use data on monthly gun background checks using the National Instant Criminal Background Check System (NICS), obtained from the FBI for the period spanning December 1998 to December 2013. The Brady Act, implemented by the FBI in 1998, mandates Federal Firearms License dealers to run background checks on their buyers using the NICS to determine whether prospective buyers are eligible to purchase firearms. As a result, background checks can be used as a reasonable proxy for gun purchasing demand.

We also collected quarterly data on Canadian unemployment from the OECD for the period 1955 to 2017 and information on Canadian school shootings from Wikipedia at https://en.wikipedia.org/wiki/School_shooting.

II. Supplementary Discussion

(i) The Impact of Unemployment on School Shootings

To begin with, we estimate the Poisson regressions of Pah et al (2017):

$$\mathbb{E}\left[S_m | u_m, m_s\right] = e^{\beta_0 + \beta_1 u_m + \beta_2 m_s} \tag{1}$$

where S_m denotes the number of school shootings per month, u_m is the unemployment rate, m_s is a dummy for the summer months and $\mathbb{E}$ is the expectations operator. We include regional and county level fixed effects, respectively, to control for unobserved heterogeneity when analyzing subnational data. The object of interest is β_1, the relationship between unemployment and the expected number of school shootings (controlling for the summer months).

The results are reported in Supplementary Table 1. β_1 is statistically significant at the US level (column 1), at the regional level (column 2) *and* at the county level (column 4). However, while unemployment is significant in (1), it accounts for very little of the variation in the number of school shootings. At the county level, for example, the R^2 is 0.0742 for (1) when including unemployment and 0.0706 when we eliminate it (that is, including only fixed effects and the summer dummy).

Pah et al (2017) argue that the arrival rate of school shootings has varied over time in a step-wise manner. They estimate four different regimes for the school shooting arrival rate, 1990:1-1992:9, 1992:10-1994:6, 1994:7-2007:2 and 2007:3-2013:12. Given this, we re-estimate equation (1) for each of these sub-periods and for each geographical level. The results are reported in Supplementary Table 2. Unemployment is insignificantly different from zero within *all* of these different regime-geographical level combinations at any conventional confidence. Moreover, the point estimates of β_1 are actually negative for around half of the sub-samples.

One might worry that the insignificance of unemployment derives from lack of within-regime variation in unemployment. This, however, is not the case. The standard deviation of unemployment within each of the four sub-periods chronologically corresponds to 0.84, 0.36, 0.66, and 1.75, whereas the standard deviation across the four sub-period means is 1.12, suggesting that the variance of unemployment is absorbed only in-part by the sub-period dummies.[4]

The insignificance of unemployment is confirmed if we alternatively estimate:

$$\mathbb{E}\left[S_m | u_m, m_s, r_j\right] = e^{\beta_0 + \beta_1 u_m + \beta_2 m_s + \beta_{3,j} r_j} \tag{2}$$

where r_j, $j = 1, 2, 3$, is a dummy variable that controls for the regimes with $j = 1$ indicating the 1992:10-1994:6 sub-sample, $j = 2$ indicating 1994:7-2007:2 and $j = 3$ indicating the last regime, 2007:3-2013:12. The results are reported in main Table 1 of our response. We find that $\beta_{3,1}$, $\beta_{3,2}$, and $\beta_{3,3}$ are significantly positive at each geographical level but β_1 is again insignificantly different from zero at every geographical level.

The r_j dummy can be thought of as a limited control for common time effects. The insignificance of unemployment is further confirmed by explicitly allowing for common time fixed effects in regional and county-level estimations of equation (1). In Supplementary Table 1 columns 3 and 5, we report the estimates of β_1 allowing for both location and common time fixed effects and in both cases unemployment is insignificant at any conventional confidence level.

In summary, equation (1) confirms Pah et al's (2017) regression results and we find that unemployment is also statistically significant even at the county level; this statistical significance, however, disappears once we control for the different regimes

[4]Note also that between cross sections we do not observe that counties that experience shootings have higher average unemployment. If anything, counties with school shootings have lower average unemployment, at 6.34%, compared to counties without, at 6.59%.

showing that the unemployment link to school shootings is at best a longer-term relationship.

To test this further, we decompose the unemployment and school shootings series using the Hodrick-Prescott filter (with smoothing parameter 129,600 commonly used for monthly data) into a business cycle component (capturing variability at business cycle frequencies of approximately 1.5 to 8 years) and a trend component (capturing lower frequency movements in the time series). In Supplementary Figure 3, we show that the correlation between unemployment and school shootings is almost zero at business cycle frequencies and is instead driven by longer-term trends.

The fact that the correlation structure derives mostly from low frequency fluctuations might indicate spurious correlation issues due to near random-walk behavior. To check this formally, we re-estimated (1) at the national level, replacing unemployment with simulated random walks for a sample period matching Pah et al (2017). Repeating this procedure 10,000 times, we generated the cumulative distribution function of the t-statistic for the random walk (see Supplementary Figure 4). The absolute value of the t-statistic exceeds the value 1.64 (1.96) in 62% (54%) of the cases. This does seem to indicate that spurious correlation may be an issue.

(ii) Contagion

We now argue that contagion may explain both the statistical significance of β_1 reported by Pah et al (2017) and the lack of significance of this parameter when change-points for the rate of school shootings are controlled for.

Supplementary Table 3 reports least squares estimates from the regressions:

$$S_{i,m} = \alpha + \lambda_i^{US} S_{US,m-1} + \alpha_i + \epsilon_{i,m} \tag{3}$$

where i =US (aggregate US), RE (regional) or CO (county) indicates the geographical level of the data and m indicates the date. The estimated coefficient λ_i^{US} is positive and significant at all geographical levels implying that the expected number of school shootings at the national, regional and county levels increase when past US-level shootings were high.[5] This evidence of persistence of school shootings contradicts the independent arrival rate assumption of the Poisson model. However, this contagion does not occur at the county level. Supplementary Table 4 reports the estimates of λ_i^{CO} when we replace US shootings $S_{US,m-1}$ with local level shootings $S_{i,m-1}$ as a regressor in equation (3)). The estimate of λ_{CO}^{CO} is insignificantly different from zero implying that there is no evidence that an increase in the number of school shootings in a given county increases the expected number of school shootings in that same county.[6]

[5] λ_i^{US} remains statistically significant if one also controls for lagged unemployment in equation (3).

[6] This is consistent with Towers et al (2015) findings that "the time between incidents was not significantly correlated to the distance between them" and "the Mantel test for temporal/geo-spatial

This impact of past national school shootings may plausibly derive from contagious effects of mass shootings. Supplementary Figure 5 illustrates the time paths of the number of school shootings and the average fatalities per incidence together with the timing of the three largest massacres in the sample period: Luby's shooting (1991), the Virginia Tech shooting (2007), and the Sandy Hook shooting (2012). Luby's shooting in occurred October 1991 when George Hennard shot dead 23 people and wounded 27 others in a restaurant in Texas; the Virginia Tech shooting took place in April 2007 when Seung-Hui Cho shot dead 32 people and wounded 17 others in two separate shootings at the Virginia Polytechnic Institute and State University in Blacksburg, Virginia; and the Sandy Hook shooting was in December 2012 when Adam Lanza shot dead his mother as well as 26 kids and staff members at the Sandy Hook Elementary School in Newtown, Connecticut.

It is evident that the number of school shootings rises persistently after each of these episodes. To explore this formally, we extend equation (1) to include dummy variables for the periods following each of these massacres:

$$\mathbb{E}\left[S_m|u_m, m_s\right] = e^{\beta_0+\beta_1 u_m+\beta_2 m_s+\beta_{3,i} d_i} \tag{4}$$

where d_i, $i = 1, 2, 3, 4$ is a dummy variable that takes the value of 1 for the first, second, third, and fourth years following each of the three massacres. Results are presented in main Table 1. We find that d_1, d_2, and d_3 are statistically significant at all geographical levels (and d_4 is significant at the regional level) indicating support of the contagion hypothesis. Moreover, β_1 is insignificantly different from zero once such contagion is accounted for. One possible interpretation of this result is that the different regimes estimated by Pah et al (2017) are related to the mass shootings.

We also estimate a specification where d_i, $i = 1, 2, 3$ is a dummy variable that takes the value of 1 for three years after Luby's shooting, the Virginia Tech shooting, and the Sandy Hook shooting, respectively (see Supplementary Table 5). Again the mass shootings are significant predictors of the number of school shootings and β_1 is insignificantly different from zero once such contagion is controlled for.

To ensure that our results are not driven by our selection of mass shootings, we consider alternative definitions. First, we weight the mass shootings by the number of fatalities. Second, we broaden our definition of mass shootings to the 10 deadliest shootings (these mass shootings have minimum 10 fatalities). Finally, we consider a very broad definition of mass shootings, which comprises the full sample from Mother Jones' database. In our sample period 1990-2013, we have 59 such mass shooting incidents.

When we control for contagion from these mass shooting incidents, we find that unemployment is not significant in explaining school shootings. This result is robust

clustering in the samples did not return significant p-values". Towers et al (2015) state that "this lack of temporal/geo-spatial correlation is consistent with what would be expected if the contagion process is potentially due, for instance, to widespread media attention given to mass killings and school shootings".

to all definitions of mass shootings, from the narrowest which considers only the three deadliest incidents, to the broadest which considers all incidents with minimum four shootings satisfying the public mass shootings criteria defined by Mother Jones (see Supplementary Table 6). Similarly, the results hold using Duwe data on mass shootings (see Table 1 in the main text).[7]

The very persistent contagion effects of mass shootings that we estimate (up to 3 years) are consistent with evidence that many school shooters were inspired by the Columbine and Virginia Tech massacres even after several years, see Mother Jones. An additional potential mechanism generating persistent effects is that shootings increase gun sales, see Studdert et al (2017). In line with this, in Supplementary Table 7 we show that the annualized growth rate of background checks needed for purchasing a gun rises significantly for several months after the mass shootings. This translates into a large permenent rise in the level of gun ownership (note, however, that the level eventually stabilizes since the growth rate turns negative at a 12-month horizon). Moreover, Siegel et al (2013) show that gun ownership is robustly correlated with firearm homicide rates.

One potential worry with these results is that unemployment may have predictive power for mass shootings. In Supplementary Table 8 we report the results of the Poisson regression where we relate the incidence of mass shootings to unemployment (and a summer constant). We find the coefficient on unemployment in this Poisson regression to be insignificant. This result is robust to the source of the data for mass shootings (column 1 reports results for our main data source while column 2 reports results using Duwe's database).

(iii) Alternative Economic Indicators

In addition to unemployment rates, Pah et al (2017) estimate how the number of school shootings is affected by consumer confidence. Here we show that the results reported above hold true when considering the link between school shootings and consumer confidence rather than the school shootings - unemployment relationship. Moreover, much of their discussion is centered around the impact of the school to work transition on school violence. Therefore, we also investigate how job finding rates and job separation rates correlate with school shootings.

Supplementary Table 9 reports the results of re-estimating equation (1) substituting unemployment with consumer confidence, job finding rates or job separation rates, respectively. β_1 has the predicted sign and is statistically significant for all three indicators: economic security (higher consumer confidence, higher job finding rates, and lower separation rates) is associated with reduced shootings, consistent with the arguments of Pah et al (2017).

In Supplementary Table 10 we report the results of estimating equation (4) when

[7] The two datasets identify the same shooting events as the three and ten deadliest incidents, therefore we report results only for all mass shootings when considering the Duwe data.

using each of these three alternative indicators as regressors instead of unemployment. As above, the estimates of β_1 become insignificantly different from zero once we control for periods following the three largest shooting massacres. Statistical insignificance is also robust to including sub-period dummies and dummies for the three massacres (see Supplementary Tables 11 and 12). Since these indicators are highly correlated with unemployment, they are subject to a similar spurious correlation.

(iv) Robustness Exercises

One might worry that our conclusions are sensitive to sampling errors and that they would change if we compute standard errors that are robust to heteroscedasticity or cluster them by states. To check this, Supplementary Table 13 repeats Supplementary Table 1 using robust standard errors or clustering by state. All conclusions remain unchanged. In Supplementary Table 14 we extend the results reported in Supplementary Table 2 to the case of robust standard errors. Again, no conclusions change. Supplementary Table 15 contains the results of estimating equation (2) using robust standard errors; all conclusions remain robust. Supplementary Table 16 contains the results when estimating (4) with robust standard errors or with state clustering and again conclusions reported earlier continue to hold true. Finally, Supplementary Table 17 is the equivalent of Supplementary Table 5 using robust standard errors or clustering and again no conclusions change.

Another issue concerns the fact that the Poisson model tends to underestimate the number of observations without shootings. One way of addressing this is to model shootings using a Zero Inflated Poisson (ZIP) model. This essentially allows zero observations to derive either from the Poisson process itself or from another binary process. In Supplementary Table 18 we report the estimates of equation (1) using the ZIP model where we specify the inflated model as a logit. We also report the Vuong test which tests the ZIP model against the standard Poisson model. The ZIP model is preferred to the standard Poisson model only at the 10 percent level for the national and regional data indicating that the earlier results in Supplementary Table 1 are appropriate.[8] Finally, Supplementary Table 19 applies the ZIP model to (2). Again, the standard Poisson model is preferred for the national data. For regional data instead, the test statistic prefers the ZIP model. In the latter case, there is mild evidence from the logit model that unemployment matters for whether shootings occur or not (but not for how many). The parameter is, however, only significant at the 10 percent level.

Thus, we conclude that the results are robust.

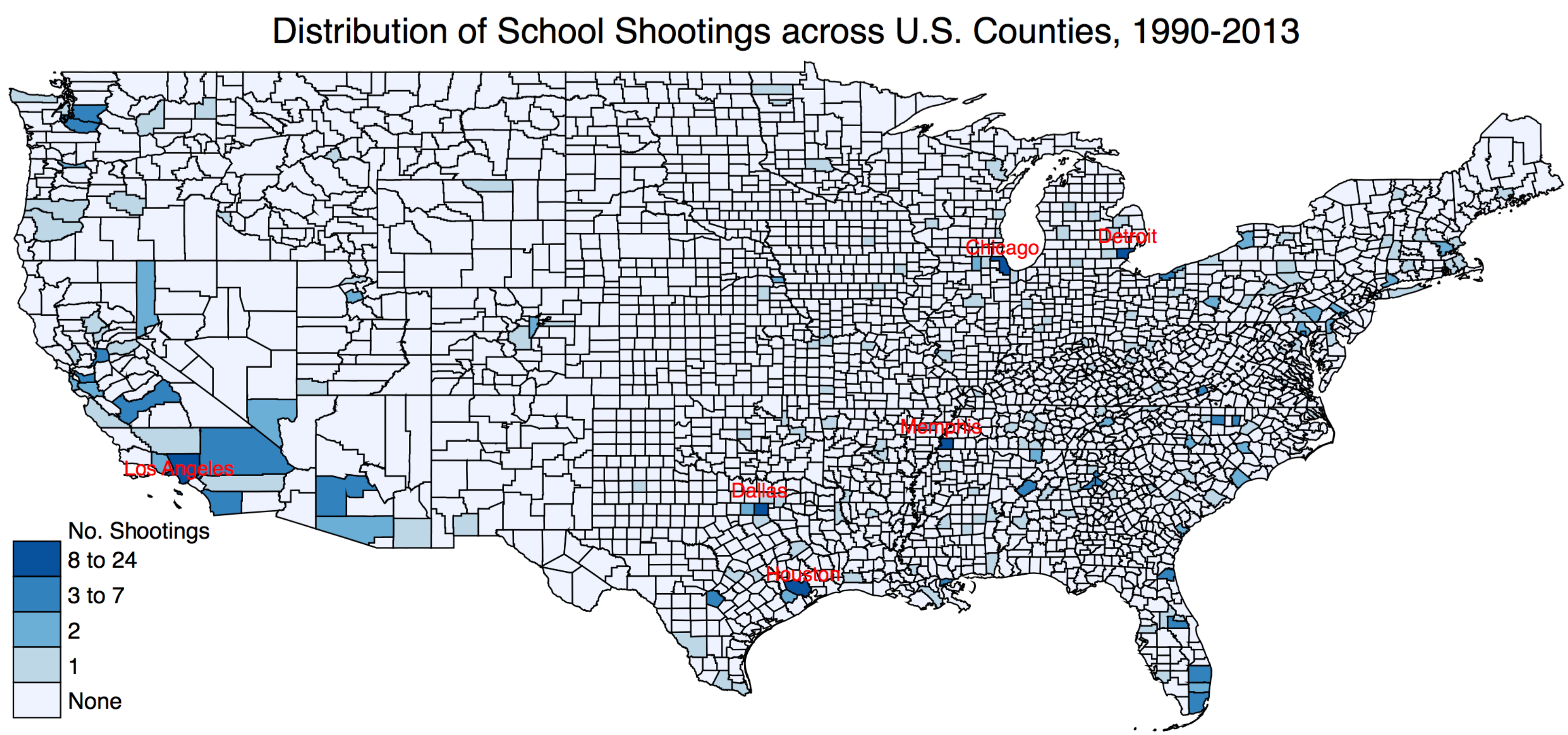
[8] We do not report ZIP estimates for county level data because the likelihood was not well-behaved when allowing for county level fixed effects.

(v) Evidence for Canada

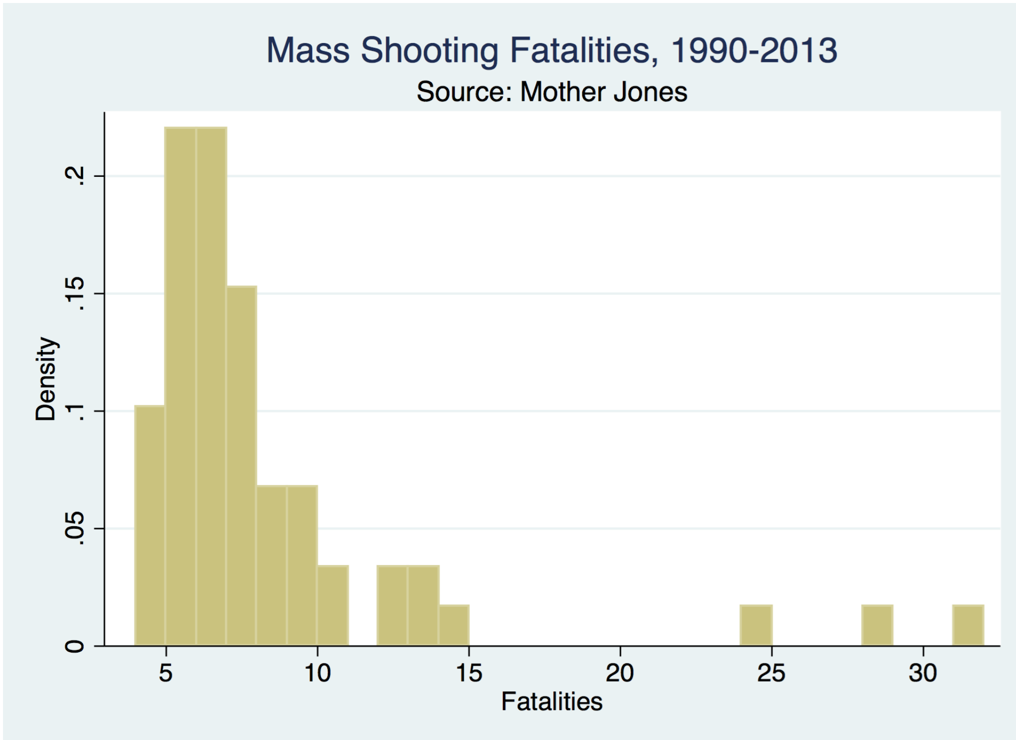
In principle, it would be very interesting to repeat Pah et al's (2007) analysis for other countries to examine cross-country evidence. Luckily, the U.S. stands out as special due to the high incidence of school shootings; such events are rare in most developed economies. Nonetheless, we repeated Pah et al's (2007) analysis for Canadian data. Since 1955 there have been 15 school shootings in Canada, and 12 out of these span the period 1976-2015. Allowing for quarterly time dummies, the estimate of β_1 in equation (1) is statistically insignificantly different from zero at any conventional confidence level (see Supplementary Table 20). Supplementary Figure 6 illustrates the time paths of unemployment and school shootings in Canada.

III. Supplementary Figures

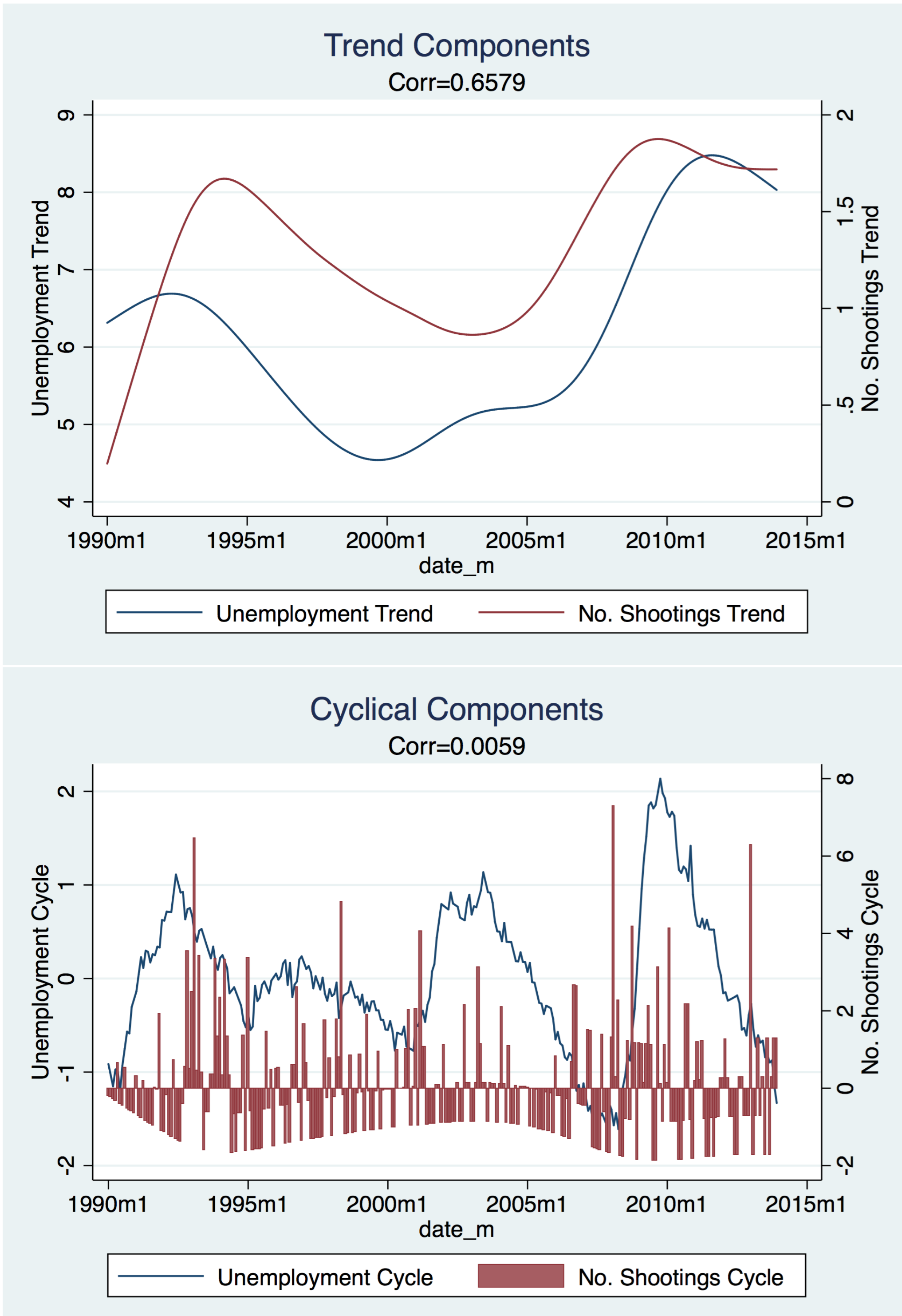
Supplementary Figure 1: Shootings in U.S. Counties



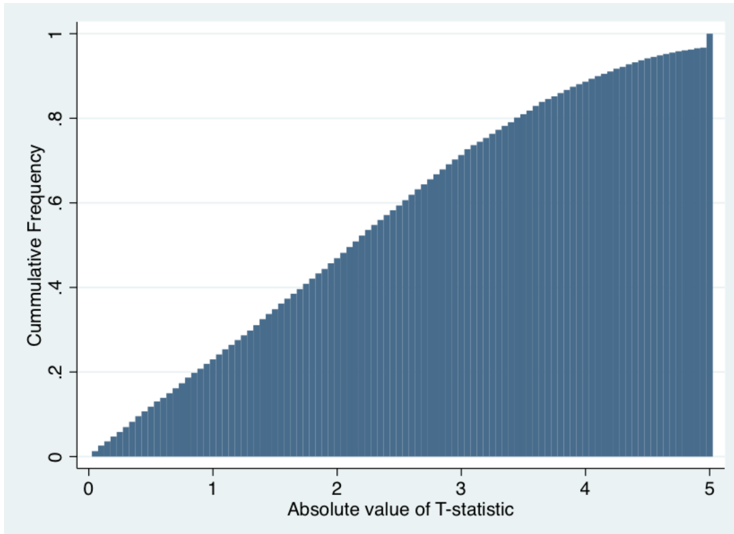
Supplementary Figure 2: Mass Shootings Histrogram



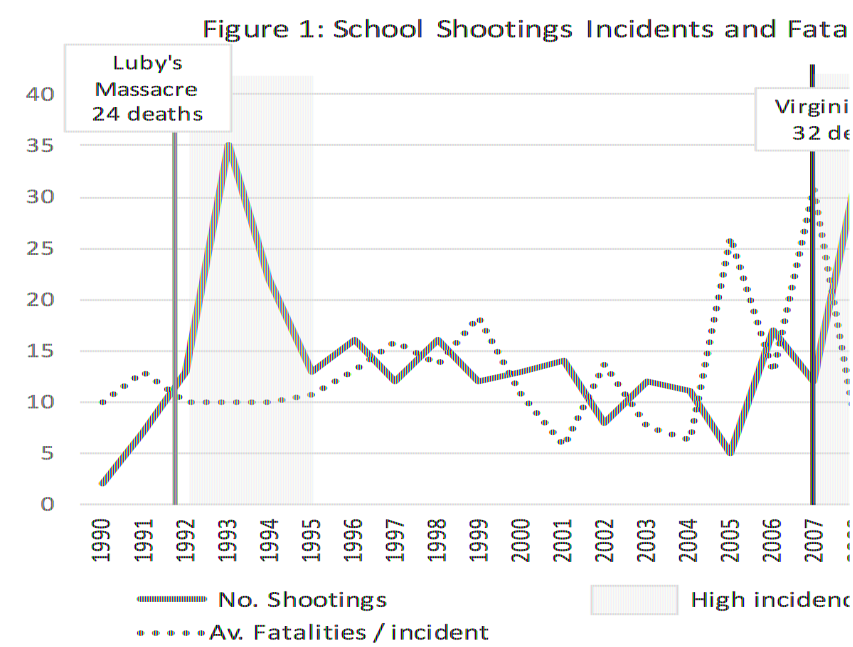
Supplementary Figure 3: Correlation for Trend vs. Cyclical Components (Hodrick-Prescott filter with $\lambda = 129,600$)



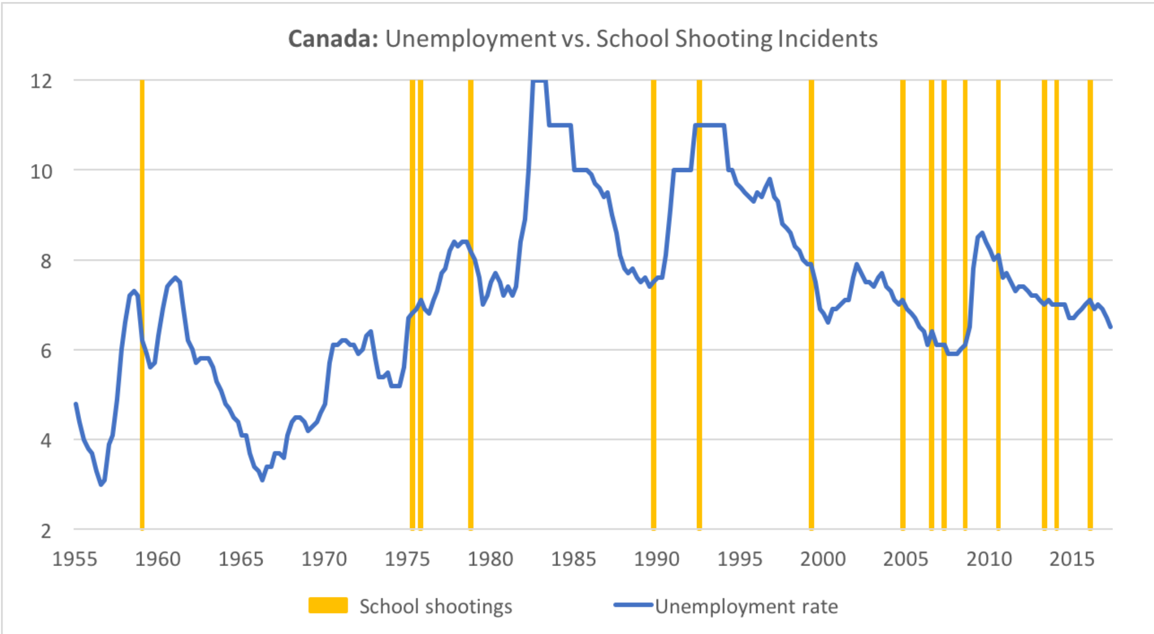
Supplementary Figure 4: Spurious Correlation: t-statistics for 10,000 Random Walks



Supplementary Figure 5: Timing of 3 Deadliest Mass Shootings



Supplementary Figure 6: Canada: School Shootings vs. Unemployment



IV. Supplementary Tables

Supplementary Table 1: Poisson Regression - Baseline

	(1) National No. Shootings	(2) Regional No. Shootings	(3) Regional No. Shootings	(4) County No. Shootings	(5) County No. Shootings
Unemployment	0.112***	0.105***	0.0357	0.0837***	0.0314
	(0.0300)	(0.0293)	(0.107)	(0.0238)	(0.0410)
Summer	-1.161***	-1.153***		-1.159***	
	(0.175)	(0.175)		(0.175)	
Constant	-0.236	-2.072***	-20.81	-6.515***	-23.19
	(0.200)	(0.221)	(11,600)	(1.046)	(4,640)
Observations	288	2,016	2,016	61,344	61,344
No. geographical units	1	7	7	213	213
Location fixed effects		✓	✓	✓	✓
Time fixed effects			✓		✓

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

Supplementary Table 2: Poisson Regression - by Sub-period

	(1)	(2)	(3)	(4)
Time sample	1990-1992	1992-1994	1994-2007	2007-2013
Geographical unit	National	National	National	National
Dependent variable	No. Shootings	No. Shootings	No. Shootings	No. Shootings
Unemployment	0.547	0.184	-0.186	-0.00419
	(0.402)	(0.348)	(0.122)	(0.0470)
Summer	-1.606	-1.639**	-1.023***	-1.059***
	(1.045)	(0.719)	(0.257)	(0.265)
Constant	-4.363	-0.0371	1.137*	0.819**
	(2.770)	(2.397)	(0.610)	(0.374)
Pseudo R-squared	0.0953	0.117	0.0551	0.0680
Observations	33	20	153	82

	(1)	(2)	(3)	(4)
Time sample	1990-1992	1992-1994	1994-2007	2007-2013
Geographical unit	Regional	Regional	Regional	Regional
Dependent variable	No. Shootings	No. Shootings	No. Shootings	No. Shootings
Unemployment	0.500	0.146	-0.195	-0.00215
	(0.402)	(0.358)	(0.120)	(0.0462)
Summer	-1.542	-1.640**	-1.017***	-1.052***
	(1.041)	(0.719)	(0.257)	(0.265)
Constant	-5.602*	-1.559	-0.603	-1.501***
	(2.901)	(2.461)	(0.593)	(0.418)
Pseudo R-squared	0.172	0.104	0.0870	0.156
Observations	231	140	1,071	574
Region FE	✓	✓	✓	✓

	(1)	(2)	(3)	(4)
Time sample	1990-1992	1992-1994	1994-2007	2007-2013
Geographical unit	County	County	County	County
Dependent variable	No. Shootings	No. Shootings	No. Shootings	No. Shootings
Unemployment	-	0.147	-0.0566	0.00419
	-	(0.211)	(.0635)	(0.0416)
Summer	-	-1.629**	-1.033***	-1.059***
		(0.719)	(0.257)	(0.265)
Constant	-	-26.282	-24.294	-4.283***
	-	(41371)	(22256)	(1.162)
Pseudo R-squared	-	0.3277	0.1444	0.1696
Observations	-	4,260	32,589	17,466
County FE	-	✓	✓	✓

Note: A Poisson regression could not be estimated at the county level for sub-period 1990-1992 due to non-concavity of the likelihood function.

Standard errors in parentheses

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

Supplementary Table 3: Panel Regression - Impact of Past National Shootings

	(1)	(2)	(3)
Geographical unit	National	Regional	County
Dependent variable	No. Shootings	No. Shootings	No. Shootings
No. National Shootings (-1)	0.172***	0.0239***	0.000806***
	(0.0574)	(0.00692)	(0.000217)
Summer	-0.949***	-0.135***	-0.00445***
	(0.204)	(0.0245)	(0.000768)
Constant	1.336***	0.191***	0.00627***
	(0.132)	(0.0160)	(0.000499)
R-squared	0.1235	0.0251	0.0010
Observations	287	2,009	61,131
No. geographical units	1	7	213
Location fixed effects		✓	✓

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

Supplementary Table 4: Panel Regression - Impact of Past Local Shootings

	(1)	(2)	(3)
Geographical unit	National	Regional	County
Dependent variable	No. Shootings	No. Shootings	No. Shootings
No. Shootings (-1)	0.172***	0.0509**	0.00239
	(0.0574)	(0.0223)	(0.00407)
Summer	-0.949***	-0.149***	-0.00515***
	(0.204)	(0.0240)	(0.000745)
Constant	1.336***	0.216***	0.00749***
	(0.132)	(0.0129)	(0.000374)
R-squared	0.1235	0.0284	0.0008
Observations	287	2,009	61,131
No. geographical units	1	7	213
Location fixed effects		✓	✓

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

Supplementary Table 5: Poisson Regression - Controlling for 3 Deadliest Shootings

	(1)	(2)	(3)
Geographical unit	National	Regional	County
Dependent variable	No. Shootings	No. Shootings	No. Shootings
Unemployment	0.0356	0.0350	0.0357
	(0.0343)	(0.0332)	(0.0258)
Summer	-1.157***	-1.150***	-1.156***
	(0.175)	(0.175)	(0.175)
Luby	0.598***	0.615***	0.599***
	(0.144)	(0.142)	(0.141)
Virginia Tech	0.653***	0.662***	0.651***
	(0.146)	(0.146)	(0.141)
Sandy Hook	0.691***	0.706***	0.688***
	(0.215)	(0.214)	(0.212)
Constant	0.00742	-1.897***	-6.156***
	(0.211)	(0.231)	(1.050)
Pseudo R-squared	0.108	0.122	0.0812
Observations	288	2,016	61,344
No. geographical units	1	7	213
Location fixed effects		✓	✓

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

Supplementary Table 6: Alternative Definitions of Mass Shootings

Dependent variable	(1) National No. Shootings	(2) National No. Shootings	(3) National No. Shootings	(4) National No. Shootings
Unemployment	0.0270	0.0192	-0.0283	0.0746
	(0.0378)	(0.0409)	(0.0460)	(0.0502)
Within 1-12 months of 3 deadliest shootings	0.615***			
	(0.166)			
Within 13-24 months of 3 deadliest shootings	0.774***			
	(0.171)			
Within 25-36 months of 3 deadliest shootings	0.698***			
	(0.186)			
Within 37-48 months of 3 deadliest shootings	0.262			
	(0.202)			
Within 1-12 months of 3 deadliest shootings (weighted by fatalities)		0.0200***		
		(0.00550)		
Within 13-24 months of 3 deadliest shootings (weighted by fatalities)		0.0257***		
		(0.00604)		
Within 25-36 months of 3 deadliest shootings (weighted by fatalities)		0.0243***		
		(0.00701)		
Within 37-48 months of 3 deadliest shootings (weighted by fatalities)		0.00999		
		(0.00735)		
Within 1-12 months of 10 deadliest shootings (weighted by fatalities)			0.0134***	
			(0.00447)	
Within 13-24 months of 10 deadliest shootings (weighted by fatalities)			0.0253***	
			(0.00532)	
Within 25-36 months of 10 deadliest shootings (weighted by fatalities)			0.0180***	
			(0.00622)	
Within 37-48 months of 10 deadliest shootings (weighted by fatalities)			0.00217	
			(0.00561)	
No. mass shooting fatalities in last 1-12 months				0.00675**
				(0.00299)
No. mass shooting fatalities in last 13-24 months				0.0115***
				(0.00407)
No. mass shooting fatalities in last 25-36 months				0.00253
				(0.00531)
No. mass shooting fatalities in last 37-48 months				-0.00485
				(0.00515)
Summer	-1.131***	-1.129***	-1.118***	-1.127***
	(0.178)	(0.178)	(0.178)	(0.178)
Constant	0.0982	0.155	0.191	-0.248
	(0.220)	(0.233)	(0.216)	(0.213)
Observations	252	252	252	252
Pseudo R-squared	0.115	0.111	0.112	0.0991

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

Supplementary Table 7: Gun Purchases 12-month Growth Rate (NICS Background Checks)

	(1)	(2)	(3)	(4)
Geographical unit	National	National	National	National
Mass shooting definition	3 deadliest	3 deadliest (weighted)	10 deadliest (weighted)	Mass fatalities
Dependent variable	%ΔGun purchases	%ΔGun purchases	%ΔGun purchases	%ΔGun purchases
Mass shooting (-1)	36.38***	1.169***	0.852***	0.715***
	(7.454)	(0.250)	(0.222)	(0.183)
Mass shooting (-2)	20.72***	0.685***	0.523**	0.456**
	(7.454)	(0.250)	(0.222)	(0.183)
Mass shooting (-3)	15.67**	0.513**	0.303	0.334*
	(7.454)	(0.250)	(0.222)	(0.181)
Mass shooting (-4)	8.210	0.263	0.321	0.370**
	(7.454)	(0.250)	(0.227)	(0.184)
Mass shooting (-5)	-0.0585	-0.00811	0.217	0.398**
	(7.454)	(0.250)	(0.227)	(0.182)
Mass shooting (-6)	-3.835	-0.119	0.0719	0.181
	(7.454)	(0.250)	(0.228)	(0.181)
Mass shooting (-7)	-4.788	-0.153	-0.215	-0.0482
	(7.454)	(0.250)	(0.228)	(0.182)
Mass shooting (-8)	-10.35	-0.337	-0.148	-0.0804
	(7.454)	(0.250)	(0.220)	(0.180)
Mass shooting (-9)	-5.183	-0.161	-0.206	-0.0309
	(7.454)	(0.250)	(0.220)	(0.181)
Mass shooting (-10)	1.945	0.0722	-0.131	0.00945
	(7.454)	(0.250)	(0.221)	(0.181)
Mass shooting (-11)	-7.609	-0.234	-0.344	-0.221
	(7.454)	(0.250)	(0.221)	(0.182)
Mass shooting (-12)	-15.62**	-0.471*	-0.449**	-0.339*
	(7.454)	(0.250)	(0.221)	(0.182)
Constant	5.773***	5.759***	5.658***	2.867**
	(0.870)	(0.878)	(1.002)	(1.295)
Observations	169	169	169	169
R-squared	0.228	0.213	0.168	0.194

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

Supplementary Table 8: Poisson Regression - Mass Shootings

	(1)	(2)
	National (MJ)	National (Duwe)
VARIABLES	No. mass shootings	No. mass shootings
Unemployment	0.0862	0.0436
	(0.0771)	(0.0635)
Summer	-0.269	0.0136
	(0.323)	(0.241)
Constant	-2.063***	-1.425***
	(0.511)	(0.414)
Observations	288	288

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

Supplementary Table 9: Poission Regression for Consumer Confidence, Job Finding and Separation Rates

	(1)	(2)	(3)
Geographical unit	National	National	National
Dependent variable	No. Shootings	No. Shootings	No. Shootings
Consumer confidence index	-0.0939***		
	(0.0338)		
Job finding rate (UE/U)		-3.936***	
		(1.065)	
Separation rate (EU/E)			70.70***
			(26.60)
Summer	-1.155***	-1.164***	-1.166***
	(0.175)	(0.175)	(0.175)
Constant	9.842***	1.445***	-0.548
	(3.371)	(0.265)	(0.390)
Pseudo R-squared	0.0703	0.0771	0.0703
Observations	288	287	287
No. geographical units	1	1	1

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

Supplementary Table 10: Poission Regression for Consumer Confidence, Job Finding and Separation Rates (Controlling for 3 Deadliest Shootings)

	(1)	(2)	(3)
Geographical unit	National	National	National
Dependent variable	No. Shootings	No. Shootings	No. Shootings
Consumer confidence index	-0.00469		
	(0.0431)		
Job finding rate (UE/U)		-0.645	
		(1.231)	
Separation rate (EU/E)			51.15
			(41.45)
Within 1-12 months of 3 deadliest shootings	0.626***	0.608***	0.652***
	(0.180)	(0.171)	(0.164)
Within 13-24 months of 3 deadliest shootings	0.808***	0.789***	0.659***
	(0.194)	(0.169)	(0.206)
Within 25-36 months of 3 deadliest shootings	0.764***	0.734***	0.619***
	(0.166)	(0.170)	(0.198)
Within 37-48 months of 3 deadliest shootings	0.313	0.289	0.205
	(0.193)	(0.194)	(0.207)
Summer	-1.134***	-1.132***	-1.131***
	(0.178)	(0.178)	(0.178)
Constant	0.717	0.418	-0.435
	(4.345)	(0.340)	(0.558)
R-squared	0.1142	0.1145	0.1160
Observations	252	252	252
No. geographical units	1	1	1

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

Supplementary Table 11: Poission Regression for Consumer Confidence, Job Finding and Separation Rates (with Sub-period intercepts)

	(1)	(2)	(3)
Geographical unit	National	National	National
Dependent variable	No. Shootings	No. Shootings	No. Shootings
Consumer confidence index	0.0134		
	(0.0585)		
Job finding rate (bop)		1.259	
		(1.626)	
Separation rate (bop)			40.14
			(32.91)
Summer	-1.107***	-1.109***	-1.111***
	(0.176)	(0.175)	(0.175)
1992-1994	1.921***	1.909***	1.928***
	(0.311)	(0.307)	(0.307)
1994-2007	0.915***	0.869***	1.035***
	(0.313)	(0.292)	(0.307)
2007-2013	1.530***	1.552***	1.540***
	(0.291)	(0.302)	(0.292)
Constant	-2.053	-1.012**	-1.353**
	(5.800)	(0.498)	(0.610)
Pseudo R-squared	0.146	0.145	0.146
Observations	288	287	287
No. geographical units	1	1	1

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

Supplementary Table 12: Poission Regression for Consumer Confidence, Job Finding and Separation Rates (Controlling for 3 Deadliest Shootings)

	(1)	(2)	(3)
Geographical unit	National	National	National
Dependent variable	No. Shootings	No. Shootings	No. Shootings
Consumer confidence index	0.0322		
	(0.0435)		
Job finding rate (bop)		-1.360	
		(1.269)	
Separation rate (bop)			6.264
			(29.83)
Summer	-1.161***	-1.160***	-1.162***
	(0.175)	(0.175)	(0.175)
Luby	0.668***	0.607***	0.622***
	(0.143)	(0.140)	(0.151)
Virginia Tech	0.788***	0.638***	0.693***
	(0.171)	(0.148)	(0.145)
Sandy Hook	0.794***	0.644***	0.746***
	(0.217)	(0.227)	(0.208)
Constant	-3.021	0.576*	0.132
	(4.371)	(0.339)	(0.419)
Pseudo R-squared	0.108	0.108	0.107
Observations	288	287	287
No. geographical units	1	1	1

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

Supplementary Table 13: Baseline Poisson Regression with Robust SE

	(1)	(2)	(3)	(4)
Geographical unit	National	Regional	County	County
Dependent variable	No. Shootings	No. Shootings	No. Shootings	No. Shootings
Unemployment	0.112***	0.105***	0.0837***	0.0837***
	(0.0354)	(0.0298)	(0.0254)	(0.0209)
Summer	-1.161***	-1.153***	-1.159***	-1.159***
	(0.196)	(0.184)	(0.175)	(0.140)
Constant	-0.236	-2.072***	-6.515***	-6.515***
	(0.244)	(0.224)	(1.029)	(0.269)
Pseudo R-squared	0.0762	0.107	0.0742	-
Observations	288	2,016	61,344	61,344
No. geographical units	1	7	213	213
Standard error adjustment	Robust	Robust	Robust	State Cluster
Location fixed effects		✓	✓	✓

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Supplementary Table 14: Poisson Regression by Sub-period with Robust SE

	(1)	(2)	(3)	(4)
Time sample	1990-1992	1992-1994	1994-2007	2007-2013
Geographical unit	National	National	National	National
Dependent variable	No. Shootings	No. Shootings	No. Shootings	No. Shootings
Unemployment	0.547	0.184	-0.186	-0.00419
	(0.380)	(0.264)	(0.132)	(0.0657)
Summer	-1.606	-1.639***	-1.023***	-1.059***
	(1.118)	(0.444)	(0.237)	(0.338)
Constant	-4.363*	-0.0371	1.137*	0.819
	(2.571)	(1.775)	(0.667)	(0.550)
Pseudo R-squared	0.0953	0.117	0.0551	0.0680
Observations	33	20	153	82

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Supplementary Table 15: Poisson Regression with Sub-period Intercepts and Robust SE

	(1)	(2)	(3)	(4)
Geographical unit	National	Regional	County	County
Dependent variable	No. Shootings	No. Shootings	No. Shootings	No. Shootings
Unemployment	-0.0167	-0.00824	0.00895	0.00895
	(0.0572)	(0.0456)	(0.0319)	(0.0268)
Summer	-1.107***	-1.101***	-1.108***	-1.108***
	(0.190)	(0.183)	(0.175)	(0.140)
1992-1994	1.939***	1.936***	1.931***	1.931***
	(0.322)	(0.315)	(0.307)	(0.395)
1994-2007	0.918***	0.925***	0.956***	0.956***
	(0.319)	(0.307)	(0.289)	(0.348)
2007-2013	1.541***	1.525***	1.510***	1.510***
	(0.329)	(0.312)	(0.293)	(0.396)
Constant	-0.620	-2.589***	-6.783***	-6.783***
	(0.472)	(0.408)	(1.083)	(0.443)
Pseudo R-squared	0.146	0.139	0.0889	-
Observations	288	2,016	61,344	61,344
No. geographical units	1	7	213	213
Standard error adjustment	Robust	Robust	Robust	State Cluster
Location fixed effects		✓	✓	✓

Robust standard errors in parentheses
*** $p<0.01$, ** $p<0.05$, * $p<0.1$

Supplementary Table 16: Poisson Regression Controlling for 3 Deadliest Shootings with Robust SE

	(1)	(2)	(3)	(4)
Geographical unit	National	Regional	County	County
Dependent variable	No. Shootings	No. Shootings	No. Shootings	No. Shootings
Unemployment	0.0270	0.0259	0.0281	0.0281
	(0.0418)	(0.0370)	(0.0355)	(0.0228)
Summer	-1.131***	-1.125***	-1.131***	-1.131***
	(0.192)	(0.186)	(0.178)	(0.141)
Within 1-12 months of 3 deadliest shootings	0.615**	0.629***	0.614***	0.614***
	(0.245)	(0.194)	(0.165)	(0.193)
Within 13-24 months of 3 deadliest shootings	0.774***	0.788***	0.771***	0.771***
	(0.196)	(0.167)	(0.161)	(0.127)
Within 25-36 months of 3 deadliest shootings	0.698***	0.715***	0.694***	0.694***
	(0.178)	(0.174)	(0.174)	(0.176)
Within 37-48 months of 3 deadliest shootings	0.262	0.278	0.258	0.258
	(0.229)	(0.202)	(0.185)	(0.213)
Constant	0.0982	-1.841***	-5.963***	-5.963***
	(0.258)	(0.237)	(1.037)	(0.275)
Pseudo R-squared	0.115	0.131	0.0863	-
Observations	252	1,764	53,676	53,676
No. geographical units	1	7	213	213
Standard error adjustment	Robust	Robust	Robust	State Cluster
Location fixed effects		✓	✓	✓

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Supplementary Table 17: Poisson Regression Controlling for 3 Deadliest Shootings with Robust SE

	(1)	(2)	(3)	(4)
Geographical unit	National	Regional	County	County
Dependent variable	No. Shootings	No. Shootings	No. Shootings	No. Shootings
Unemployment	0.0356	0.0350	0.0357	0.0357*
	(0.0427)	(0.0368)	(0.0279)	(0.0217)
Summer	-1.157***	-1.150***	-1.156***	-1.156***
	(0.192)	(0.183)	(0.175)	(0.140)
Luby	0.598***	0.615***	0.599***	0.599***
	(0.167)	(0.145)	(0.143)	(0.128)
Virginia Tech	0.653***	0.662***	0.651***	0.651***
	(0.201)	(0.167)	(0.142)	(0.162)
Sandy Hook	0.691**	0.706***	0.688***	0.688***
	(0.297)	(0.226)	(0.210)	(0.249)
Constant	0.00742	-1.897***	-6.156***	6.156***
	(0.269)	(0.243)	(1.030)	(0.272)
Pseudo R-squared	0.108	0.122	0.0812	-
Observations	288	2,016	61,344	61,344
No. geographical units	1	7	213	213
Standard error adjustment	Robust	Robust	Robust	State Cluster
Location fixed effects		✓	✓	✓

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Supplementary Table 18: Zero-Inflated Poission Regression

	(1)	(2)	(3)	(4)
Geographical unit	National		Regional	
Dependent variable	No. Shootings	Inflate	No. Shootings	Inflate
Unemployment	0.0754**	-0.265	0.0912**	-0.0565
	(0.0332)	(0.222)	(0.0378)	(0.140)
Summer	-1.166***	-0.0570	-1.297***	-0.954
	(0.387)	(2.574)	(0.240)	(1.510)
Constant	0.149	-0.187	-1.974***	-14.85
	(0.232)	(1.329)	(0.265)	(1,287)
Observations	288	288	2,016	2,016
No. geographical units	1	1	7	7
No. zero observations	107	107	1700	1700
Vuong test statistic	1.471*	1.471*	1.426*	1.426*
Location fixed effects			✓	✓

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

Supplementary Table 19: Zero-Inflated Poission Regression with Sub-period Intercepts

	(1)	(2)	(3)	(4)
Geographical unit	National		Regional	
Dependent variable	No. Shootings	Inflate	No. Shootings	Inflate
Unemployment	-0.0917**	-0.964	0.0110	1.026*
	(0.0464)	(0.707)	(0.0427)	(0.529)
Summer	-1.032***	1.081	-1.092***	0.0393
	(0.189)	(1.213)	(0.201)	(0.993)
1992-1994	1.571***	-17.10	1.101***	-4.539*
	(0.457)	(2,340)	(0.375)	(2.429)
1994-2007	0.409	-14.42	0.350	-1.112
	(0.457)	(580.0)	(0.353)	(1.117)
2007-2013	1.340***	-1.366	0.614*	-23.09
	(0.442)	(1.509)	(0.355)	(2,148)
Constant	0.258	5.278	-1.999***	-22.13
	(0.549)	(4.377)	(0.445)	(1,543)
Observations	288	288	2,016	2,016
No. geographical units	1	1	7	7
No. zero observations	107	107	1700	1700
Vuong test statistic	1.461*	1.461*	2.716***	2.716***
Location fixed effects			✓	✓

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

Supplementary Table 20: Canada: Poisson Regression

	(1)	(2)
	Canada	Canada
Sample	1955-2017	1976-2015
	No. school shootings	No. school shootings
Unemployment	0.0237	-0.429
	(0.129)	(0.266)
Quarter 2	0.288	1.083
	(0.764)	(1.155)
Quarter 3	0.304	1.374
	(0.764)	(1.118)
Quarter 4	0.303	1.080
	(0.764)	(1.155)
Constant	-3.216***	-0.316
	(1.108)	(2.240)
Observations	250	160
Pseudo R-squared	0.00228	0.0648

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

Supplementary Table 21: Correlation of Unemployment with Various Measures of School Violence, 1992-2014

Correlations of unemployment with:	
School-associated violent deaths of all persons (includes students, staff, and other nonstudents)	
Total	-0.27
School-associated - homicides	-0.37
School-associated - suicides	0.18
Legal interventions	0.16
Unintentional firearm related deaths	-0.22
Undetermined violent deaths	0.05
Homicides at school of youth ages 5-18 at school	-0.30
Ratio of homicidies at school to total homicides of youth ages 5-18 at school	-0.04
Suicides at school of youth ages 5-18	-0.25
Ratio of suicides at school to total suicides of youth ages 5-18	-0.26
No. nonfatal victimizations against students ages 12-18 at school	
Total	-0.27
Theft	-0.26
All violent	-0.27
Serious violent	-0.21
Rate of victimization per 1000 students at school	
Total	-0.21
Theft	-0.21
All violent	-0.21
Serious violent	-0.17
No. nonfatal victimizations against students ages 12-18 away from school	
Total	-0.29
Theft	-0.29
All violent	-0.29
Serious violent	-0.25
Rate of victimization per 1000 students away from school	
Total	-0.24
Theft	-0.24
All violent	-0.24
Serious violent	-0.19

Data sources: Centers for Disease Control and Prevention (CDC); U.S. Department of Justice, Bureau of Justice Statistics; and Federal Bureau of Investigation and Bureau of Justice Statistics.

[1] A school-associated violent death is defined as "a homicide, suicide, or legal intervention (involving a law enforcement officer), in which the fatal injury occurred on the campus of a functioning elementary or secondary school in the United States," while the victim was on the way to or from regular sessions at school, or while the victim was attending or traveling to or from an official school-sponsored event.

[2] "At school" includes on school property, on the way to or from regular sessions at school, and while attending or traveling to or from a school-sponsored event.

[3] "Serious violent victimization" includes the crimes of rape, sexual assault, robbery, and aggravated assault. "All violent victimization" includes serious violent crimes as well as simple assault. "Theft" includes attempted and completed purse-snatching, completed pickpocketing, and all attempted and completed thefts, with the exception of motor vehicle thefts. Theft does not include robbery, which involves the threat or use of force and is classified as a violent crime. "Total victimization" includes theft and violent crimes. Data in this table are from the National Crime Victimization Survey (NCVS); due to differences in time coverage and administration between the NCVS and the School Crime Supplement (SCS) to the NCVS, data in this table cannot be compared with data in tables that are based on the SCS. Detail may not sum to totals because of rounding.