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The Contagion of Mass Shootings: The Interdependence of Large-Scale Massacres and Mass Media Coverage

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ABSTRACT

Mass public shootings have generated significant levels of fear in the recent years, with many observers criticizing the media for fostering a moral panic, if not an actual rise in the frequency of such attacks. Scholarly research suggests that the media can potentially impact the prevalence of mass shootings in two respects: (i) some individuals may be inspired to mimic the actions of highly publicized offenders; and (ii) a more general contagion process may manifest as a temporary increase in the likelihood of shootings associated with a triggering event. In this study of mass shootings since 2000, we focus on short-term contagion, rather than imitation that can traverse years. Specifically, after highlighting the sequencing of news coverage prior and subsequent to mass shootings, we apply multivariate point process models to disentangle the correlated incidence of mass public shootings and news coverage of such events. The findings suggest that mass public shootings have a strong effect on the level of news reporting, but that news reporting on the topic has little impact, at least in the relative short-term, on the subsequent prevalence of mass shootings. Finally, the results appear to rule out the presence of strong self-excitation of mass shootings, placing clear limits on generalized short-term contagion effects. Supplementary files for this article are available online.

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1. Introduction

Defined as the gun-involved killing of four or more victims within 24 hr, mass public shootings are exceptionally uncommon events that account for fewer than 1% of all homicides in the United States annually (Krouse and Richardson 2015). Despite their rarity, these seemingly senseless massacres disproportionately stoke public fear and shape public policy. Nearly half of Americans express fear of being killed in a mass shooting (Brenan 2019), and one-third avoid public spaces and events to reduce their risk of victimization (American Psychological Association 2019). Widespread concern has fueled demands for enhanced gun control, increased access to mental health treatment, and even government monitoring of social media for threatening messages.

Highly publicized events can influence future occurrences of similar episodes in multiple ways. With respect to mass killings in particular, notorious cases have been shown to inspire others who may empathize with the assailant or simply seek their own opportunity for fame (Langman 2018). Often referred to as a "copycat effect" (see Coleman 2004), this process of imitation is typically substantiated through isolated anecdotes (Helfgott 2015). In contrast, the term "contagion" characterizes the more general spread of a phenomenon through a population identified by patterns in the statistical rate of events (Fagan et al. 2007).

With respect to contagion, various statistical methods have been employed to study the clustering of homicides and other violent crimes across temporal and spatial dimensions. Several studies have relied on self-exciting point process models, such as the Hawkes process and its derivatives, which predict the future occurrence of crime based on the incidence of past events and other factors (see Mohler et al. 2011). These models can separate "epidemic" crime—that which is diffused across space and time by contagion effects—from "endemic" or background crime, which may also exhibit spatiotemporal clustering, but is triggered spontaneously (see Reinhart 2018). Mohler (2014), for example, examined gun crime data for Chicago and found that a model incorporating self-excitation contagion effects outperformed ones considering only correlative effects, such as fixed "hotspot" maps (see also Mohler 2013). Loeffler and Flaxman (2018) analyzed shootings data for Washington, DC based on the city's acoustic gunshot detection system, concluding that epidemic violence was far rarer than endemic violence and, therefore, that any contagion effects must be relatively small.

When applied to frequent and spatially dense crime types, point process models can be used to estimate temporal and spatial effects simultaneously. However, mass shootings—particularly those with large numbers of fatalities—are low-frequency events offering relatively small sample sizes that make the identification of both temporal and spatial effects challenging. However, the widespread national media attention often given to these events would make spatial effects less pronounced. Further supporting the notion of nationalized

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reaction, public opinion research (e.g., Barney and Schaffner 2019) has revealed only weak or nondetectable local effects on public attitudes following mass shootings.

1.1. The Contagion of Mass Killing

Recent research on the media's influence on homicide has centered on one of its most extreme and visible manifestations—mass shootings—largely in response to growing public concern and suggestions of an emerging epidemic (see, e.g., Follman 2014). With the media as a catalyst, contagion can be seen in two distinct forms. Copycatting, which Langman (2017) has characterized as "specific contagion," reflects cases in which a highly publicized mass shooter is adopted as a role model by an assailant who attempts to carry out a similar act of carnage. By contrast, "general contagion" operates when an assailant perceives such attacks as being somewhat commonplace, thereby facilitating a similar act.

Moving beyond anecdotal accounts of copycat behavior, several studies have empirically evaluated the overall contagion of mass murder, however, with mixed outcomes (Gould and Olivares 2017). In one of the earliest studies, Stack (1989) found that network TV news coverage of multiple murders (defined as two or more victims killed in one day) did not impact suicide or homicide rates.

More recently, Towers et al. (2015) used a self-excitation modeling strategy on both school shootings and mass killings, concluding that incidents are temporarily contagious for approximately two weeks, producing an average of 0.2–0.3 subsequent attacks. Despite the fact that Towers et al. (p. 9) explain that their work was motivated by the hypothesis that media attention mediates the contagion effect, their widely reported claim of a short-term contagion was advanced without any attempt to include a measure of media coverage in the models. As such, it must be assumed implicitly that all school and mass shooting incidents receive substantial national coverage and that all types of mass shootings are equally contagious. While individuals may imitate the actions of someone similar with whom they can identify (Huesmann and Taylor 2006), it is questionable that, for example, a middle-aged man who annihilates his family would inspire a teenage school shooter or a gangster to execute his rivals.

Although a few mass killers are ubiquitously known due to their infamy, most are relatively obscure, with coverage of their crimes largely limited to local news stories. Duwe (2004), for example, found that only 45% of all mass killings in the United States between 1976 and 1999 were reported in *The New York Times*, often regarded as the nation's "paper of record." Accordingly, two studies replicating the work of Towers et al. (2015) with the same data found no evidence of contagion when mass killings were disaggregated by type—public, family, and burglary/robbery (King and Jacobson 2017)—or when a measure of public attention (via Google Trends) was considered (Lankford and Tomek 2018). In response, Towers et al. (2018) argued that the discrepancies in results are related to their use of unbinned methods, which increase the model's power to detect significant effects. In any case, to the extent that contagion is operative, it would be more pronounced in connection to widely publicized mass shootings in public settings, as opposed to those that occur in private residences or that are related to ongoing criminal activity.

Prior research has also documented contagion effects for less lethal acts in schools and other public spaces, with varying claims about their role in instigating future attacks (Kissner 2016; Garcia-Bernardo et al. 2018; Jetter and Walker 2018). Utilizing data on individuals actively engaged in killing or attempting to kill people in a confined and populated area (so-called "active shooters"), Kissner (2016) found that the risk of an active shooter event increased by 27% for each event occurring in the preceding two weeks. Curiously, Kissner did not find a significant effect for shorter time periods (e.g., one week) and the result for the two-week period was only marginally significant at the 10% level. More recently, Jetter and Walker (2018) examined the impact of *ABC World News Tonight* coverage of shootings on the subsequent likelihood of shootings with at least four victims killed or injured, using deaths associated with natural disasters as an instrumental variable. Although this half-hour news program typically has a viewership of about 8 million, they found that the 3.7% average airtime coverage of shootings explained 58% of the variation in mass shootings.

Consistent with the evidence described above, quantitative studies have identified short-term contagion related to school shootings. Kostinsky et al. (2001) and Simon (2007) found that school bomb threats spiked significantly in the wake of the 1999 Columbine High School massacre, although it is unclear whether the threats themselves increased or that authorities were just more apt to take notice of vague references to Columbine in the weeks following the shooting (Fox and Burstein 2010). Finally, focusing on social media as a vehicle for contagion, Garcia-Bernardo et al. (2018) concluded that the probability of a school shooting doubles when tweets mentioning the words "school" and "shooting" increase from 10 per million to 50 per million during the preceding week. However, they failed to identify a contagion effect with respect to mass shootings outside of the school context.

2. The Present Study

Although researchers have documented certain sensational homicides that inspired copycats, only a few studies to date have focused specifically on the statistical contagion of mass murder, particularly mass shootings with large numbers of fatalities. As a whole, this burgeoning body of literature suffers from several key limitations, which may explain the contradictory findings.

First, some studies assume that the public is generally aware of all mass killings, despite evidence that most do not make national news (Duwe 2004). In addition, failing to account for transmission in the form of publicity may skew results in favor of finding evidence of contagion, since incidents may be clustered in time but not necessarily as a result of direct imitation or general contagion (Towers et al. 2015; Kissner 2016; Towers et al. 2018). Albeit a secondary concern, the studies that do include measures of publicity typically rely exclusively on a single outlet (e.g., newspapers, television, or social media), which may not be indicative of all media coverage (Stack 1989; Garcia-Bernardo et al. 2018; Jetter and Walker 2018; Lankford and Tomek 2018). Furthermore, there is no universally accepted definition of mass shooting, leading researchers to conflate more inclusive constructs with the most extreme events. Most studies invoking the traditional definition of mass murder (four or more killed in a single incident), for example, fail to find contagion effects (King and Jacobson 2017; Lankford and Tomek 2018), while those employing broader definitions often do (Kissner 2016; Garcia-Bernardo et al. 2018; Jetter and Walker 2018;). Finally, with the exception of King and Jacobson (2017), prior work has failed to account for the (dis)similarity of events, essentially assuming that all types of mass killings are equally contagious, despite evidence to the contrary.

By addressing these limitations, the current study advances the literature on the contagion of mass shootings by (i) using multiple measures of news coverage, including 16 major daily newspapers, the Associated Press (AP) national wire, and network television news broadcasts; (ii) emphasizing those incidents most likely to be inspire others, especially high-fatality mass shootings in public settings; and (iii) using robust analytic methods to identify the interconnections between mass shootings and news coverage of the topic.

2.1. Data Sources and Variables

There is much confusion and disagreement surrounding the definition of the term "mass shooting," not to mention debate over its prevalence and trends (Fox and Levin 2015). Specifically, there is no consensus concerning the appropriate victim count threshold, whether that threshold should be based on fatalities alone or all victims both deceased and surviving, and whether cases should be excluded based on victim–offender relationship, motive or location. At least for the purpose of examining the newsworthiness and potential contagion of mass shootings, it is reasonable to focus the analysis on those cases that indeed receive the most publicity, specifically mass shootings with large numbers of fatalities and especially those that occur in public locations. Indeed, these are the kind of mass shooting incidents that scare Americans the most, as they can occur at any time, at any place, and to anyone.

We define a mass public shooting as an incident with at least four victims fatally shot in a public location within a 24-hr period and absent of other criminal activity, such as robberies, drug deals, and gang conflict. The specific inclusion rules are as follows: (i) at least four of all victims were killed by gunfire; (ii) at least four of the victims were killed in a public place or else at least half of all fatalities occurred in a public place; and (iii) the shooting did not occur in a private residence, although those in a nonprivate residence (e.g., group home or motel) are included. After compiling a list of all cases from nine available databases,[1] we evaluated each incident to determine if it qualified as a mass public shooting by the criteria indicated above. For purposes of comparison, we also assembled data on all mass shootings with at least four victim fatalities, regardless of location or type. As a result of this case-by-case assessment, we identified a final list of 89 mass public shootings (MPS) and 503 mass shootings (MS) more generally from 2000 through 2018 that resulted overall in 694 and 2571 victim fatalities, respectively.

Several measures of media coverage were constructed by consulting two electronic news archives for print and broadcast stories related to the topic of mass shootings. We searched the "Major Newspapers" and "Associated Press Domestic Wire" sources in *Nexis*® using a set of eight alternative phrases ("mass shooting," "mass killing," "rampage killing," "shooting massacre," "mass murder," "mass shooter," "mass murderer," and "mass killer") to avoid any biases related to the changing ways in which news agencies tended to characterize mass shootings. A total of 16 major daily newspapers were consistently included in *Nexis*® throughout the 19-year time frame, and these were then weighted by their circulation figures.[2] Because this group of daily newspapers is dominated by east coast publications (e.g., three in New York City and three in Pennsylvania), the AP national wire provided a useful check on any regional biases in major newspaper coverage of events. We also searched the *Vanderbilt Television News Archive* using more generic terms ("shooting" and "shooter") to ensure a sufficient volume of stories from the limited array of networks included in this resource.

For the study of media contagion, we generated day-by-day tallies from January 1, 2000 through December 31, 2018 of the number and lengths of news stories in major daily papers (MP), the AP national wire, and network television news broadcasts (TV) on the general topic of mass shootings. These daily counts of media content were then merged with a binary indicator of whether there was a mass shooting on each date (there was never more than one) and, if so, the number of victims killed.

Table 1 provides summary statistics on the 6940 daily counts for the news and mass shooting variables. As shown, all variables were heavily skewed. Not surprisingly, the five dates with the most news coverage were following the two largest incidents: the June 12, 2016 Pulse Nightclub shooting in Orlando and the October 1, 2017 shooting during an open-air music festival in Las Vegas. Because the story counts and lengths were quite different in magnitude across the three news sources, many of the analyses to follow are based on standardized values for the sake of comparability. Also, because of the strong Spearman's rank-order correlations between story counts and their aggregate lengths (0.96 for MP, 0.99 for AP, and 0.97 for TV), from here on we focus only on story counts to avoid excessive redundancy in results.[3]

As also shown in Table 1, the 18% share of mass shootings that occurred in public settings tended to claim much larger numbers of victims: 7.8 on average for the 89 MPS compared to 5.3 for the entire pool of 487 MS. The greater lethality of MPS in addition to the fear associated with shootings that target victims

[1]The data sources used to cull the pool of potential cases came from various organizations and individuals: the Associated Press/USA Today/Northeastern University Mass Killing Database; the FBI's Active Shooter Events; the FBI's Supplementary Homicide Reports; The Washington Post; Mother Jones; Everytown for Gun Safety; the Stanford University Geospatial Center; Grant Duwe; and Louis Klarevas.

[2]The 16 newspapers were *The Atlanta Journal-Constitution, The Daily Oklahoman, The Detroit News, The Minneapolis Star Tribune, The New York Daily News, The New York Post, The New York Times, The Orange County Register, The Philadelphia Daily News, The Philadelphia Inquirer, The Pittsburgh Post-Gazette, The San Diego Union Tribune, The St. Louis Post-Dispatch, The Tampa Bay Times, The Washington Post,* and *USA Today*.

[3]Pearson's correlations were nearly as strong for MP (0.92) and AP (0.89), but smaller for TV (0.46). In the latter case, some extreme outliers (e.g., special reports of extended length on a few mass shootings) suppressed the product-moment correlation between daily story counts and aggregate lengths.

Table 1. Descriptive statistics for MPS and MS and daily news coverage, 2000–2018.

Variable	Minimum	Maximum	Mean	Standard deviation	Skewness
Mass public shooting incidents (MPSincs)	0	1	0.013	0.113	8.662
Mass public shooting victims (MPSvics)	0	58	0.100	1.299	26.951
Mass public shooting victims per incident (MPSvics_per)	4	58	7.798	8.506	4.197
Mass shooting incidents (MSincs)	0	2	0.070	0.268	3.653
Mass shooting victims (MSvics)	0	58	0.370	1.719	12.690
Mass shooting victims per incident (MSvics_per)	4	58	5.280	4.029	8.651
Major newspaper stories (MP_count)	0	206	3.700	8.154	10.172
Major newspaper words (MP_length)	0	155,602	3,394.075	7300.705	7.358
AP wire stories (AP_count)	0	33	0.448	1.255	7.852
AP words (AP_length)	0	42,088	375.640	1390.279	11.143
TV stories (TV_count)	0	27	1.030	1.796	3.911
TV seconds (TV_length)	0	108,970	270.150	1768	40.726

$N = 6,940$ days, 89 MPS incidents, 487 MS incidents.

more or less indiscriminately would tend to make these incidents especially newsworthy and, thus, potentially contagious (see Duwe 2000; Fox et al. 2020).

3. Results

The analytic results are divided into two parts. First, we display trends in mass public shootings and news coverage across the 19-year time frame, along with an examination of the average levels of news coverage leading up to and subsequent to mass shooting incidents. The second section then presents results of multivariate point process models of the self-excitation and cross-excitation of mass shootings and related news coverage. Finally, while the emphasis is on mass public shootings in light of the more extensive news coverage of these events (Duwe, 2000), the initial analyses are repeated for the collection of all mass shootings to take advantage of their greater frequency of occurrence.

3.1. *Trends and Patterns in Mass Shootings and News Coverage*

The growing awareness and concern associated with mass shootings raises the question as to whether there has been a genuine increase in risk or mainly a greater extent of unsettling news coverage. Figure 1 displays day-by-day patterns in the number of victims fatally shot in MPS along with the three measures of media coverage. For the first decade or so, there was no apparent change in the prevalence or severity of MPS. Since 2012, however, MPS incidents have increased in number and severity; 11 of the 14 incidents with double-digit death tolls and 4 of the 5 with more than 20 killed occurred since 2012. The figure also reveals clustering of cases in close temporal proximity during 2012 and 2018. It came as little surprise, therefore, that the annual survey of AP editors named mass shootings as the top story of both those years (see Crary 2012, 2018). The extent of news coverage of mass shootings has also increased since 2012, especially in the form of network television news reports, as reflected in the bottom panel of the figure.

The surge in the incidence and severity of MPS, as well as media coverage of the general topic, raises a fundamental question: Is the heightened news reporting encouraging more people to commit MPS or is the increasing carnage producing more news coverage as a response? Figure 2 specifically addresses this matter by focusing on the average news coverage in the 30 days prior to (i.e., lags −30 through −1) and the 30 days after a mass shooting (leads 1 through 30). Clearly, there is no increase in news coverage with respect to all three media sources in the days prior to a mass shooting. Not surprisingly, MPS do spark a surge in subsequent coverage, with spike and dissipation patterns varying by news medium (notwithstanding the different scales to the three news coverage measures).

The peak in average major newspaper (MP) coverage does not occur until Day 2 following a shooting. Given that these daily papers publish in the early morning hours, there is no increase in news coverage of the topic on Day 0—the same day as a mass shooting. Day 1 shows some increase: Whether a particular morning paper carries a story about a mass shooting the previous day depends on the time of day when the incident took place and the newspaper's time zone. For example, an east coast newspaper will not have any coverage of a nighttime shooting at a location in the west coast (such as the November 7, 2018 Borderline Bar and Grill shooting in Thousand Oaks, CA, that occurred at 11:20 pm PST) until Day 2. As for the AP national wire, the time lapse after a mass shooting until a wire report appears online may be just a matter of several hours. Thus, there is an increase in AP coverage of events on Day 0. However, the peak emerges on Day 1, as wire stories concerning nighttime shootings may not run until the next day. Finally, because of the availability of live video feeds by means of satellite trucks and helicopters, television networks can broadcast an event in rather short order. For example, TV cameras were on the scene of the December 14, 2012 Sandy Hook school shooting in time to capture powerful images of young children being led away from the building with tears still fresh in their eyes. The quick response time for television is then reflected in the peak occurring on the day of a shooting.

For all three news sources, the surge in coverage dissipates gradually as the days advance following a mass shooting. However, the pace at which this occurs varies by source of coverage. Given the number of news outlets in the MP grouping, as well as the number and variety of articles printed in daily papers, the increased focus on mass shootings remains somewhat elevated for about two weeks after an incident. In contrast, network television coverage slows to normal levels within about a week. After all, there are a limited number of networks and a limited amount of time they can devote to news, as well as many other topics competing for airtime.

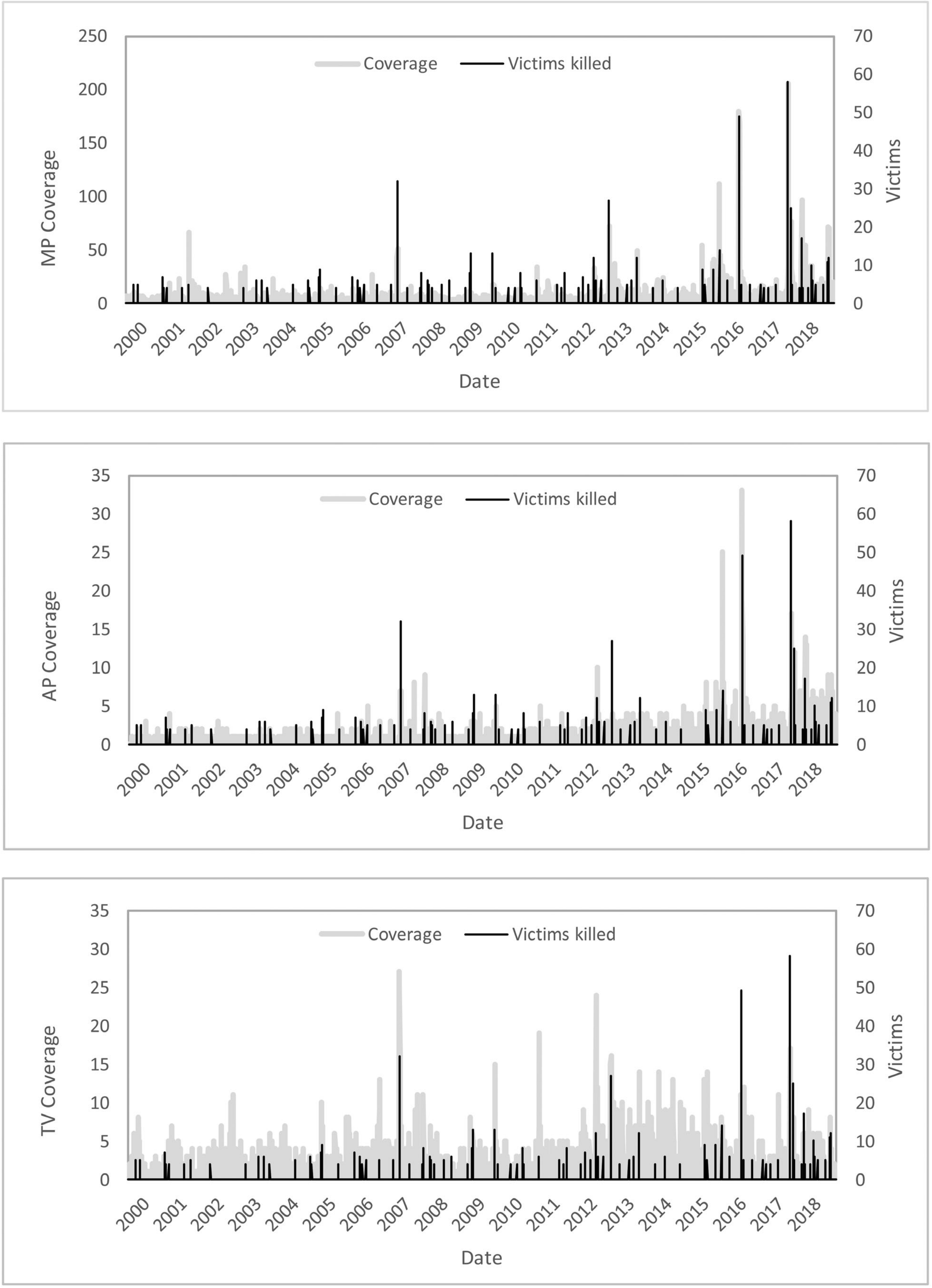

Figure 1. Daily major papers (MP), AP wire (AP), and network television news (TV) coverage with MPS victim count.

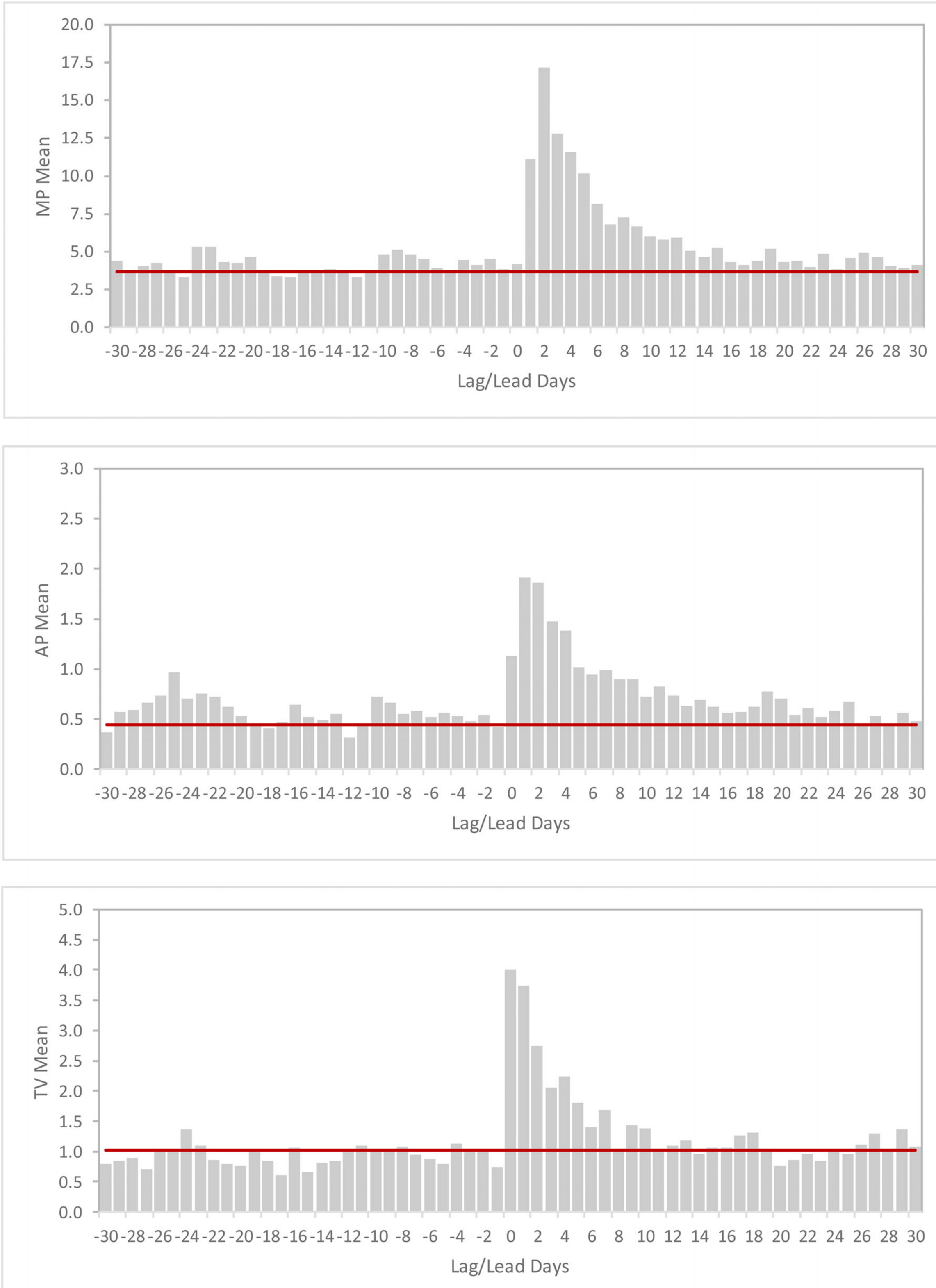

Figure 2. Daily major papers (MP), AP wire (AP), and network television news (TV) coverage before and after MPS (solid line set at the overall mean).

While the impact of MPS on related news coverage is clear and measurable, the effect of media coverage on future incidents is complicated by the rarity of this type of crime. Over the 19-year time frame, on average fewer than five mass public shootings occurred annually, for an average interval of 78 days between incidents. Therefore, a 30-day or even longer window may not detect an effect. As an alternative, mass shootings of all types (including family annihilations and felony-related mass killings) occur, on average, nearly twice monthly, and these were the basis for the analysis by Towers et al. (2015) that revealed a

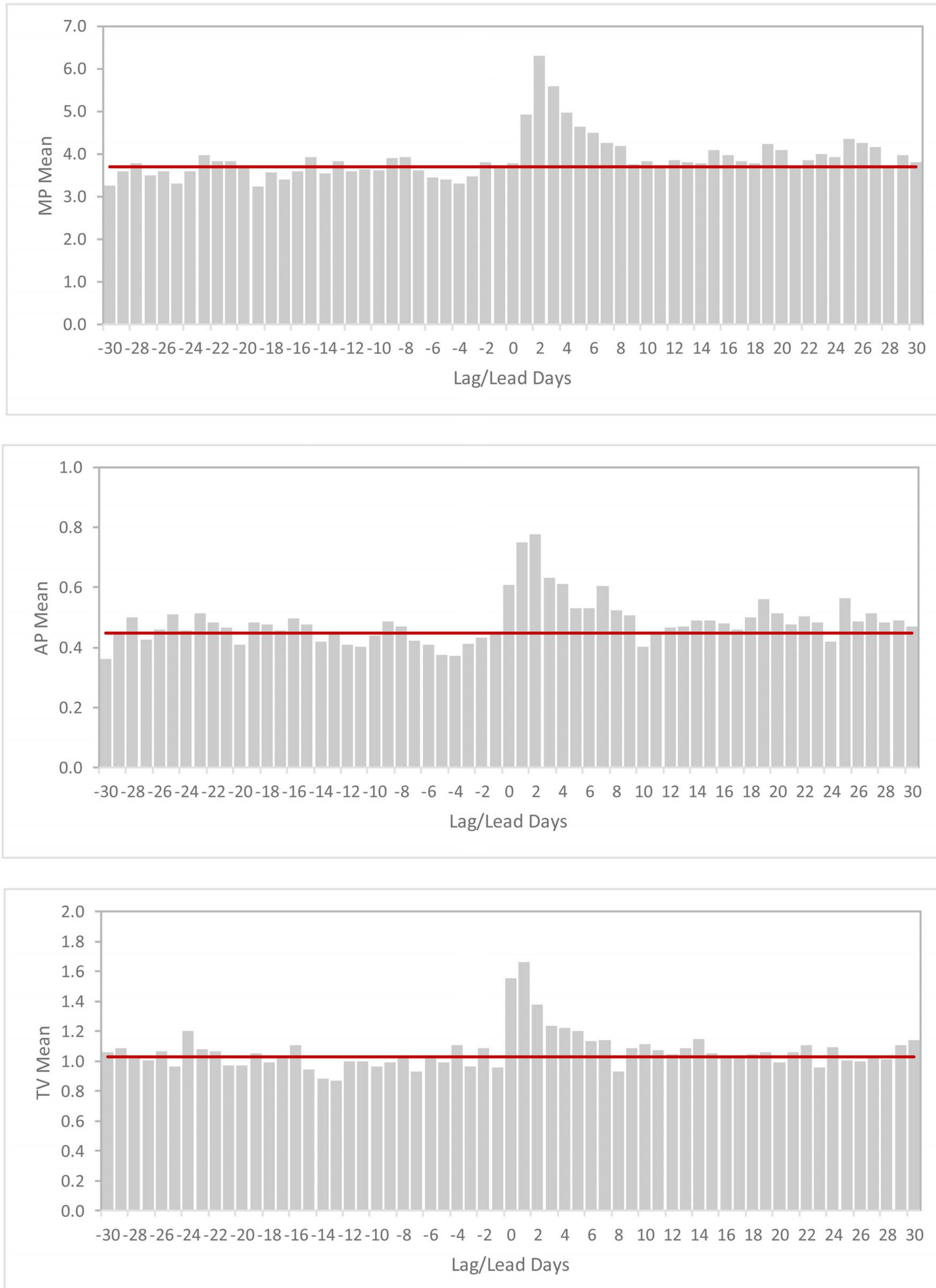

Figure 3. Daily major papers (MP), AP wire (AP), and network television news (TV) coverage before and after MS (solid line set at the overall mean).

short-term contagion of about two weeks. As shown in Figure 3, the same general pattern of news coverage appears surrounding all mass shootings as did for exclusively public ones. Again, there is no run-up in coverage prior to MS, but certainly a surge in reporting in the aftermath. Whereas the shapes in Figures 2 and 3 are similar, the peak is less pronounced for MS generally (a two-fold increase as compared to the four-fold jump for public shootings) and the dissipation is somewhat speedier. This reflects the fact that nonpublic mass killings, which represent the overwhelming majority of cases, produce far less news coverage than public massacres. In fact, as shown in Figure 4, incidents of nonpublic mass shootings have no appreciable effect

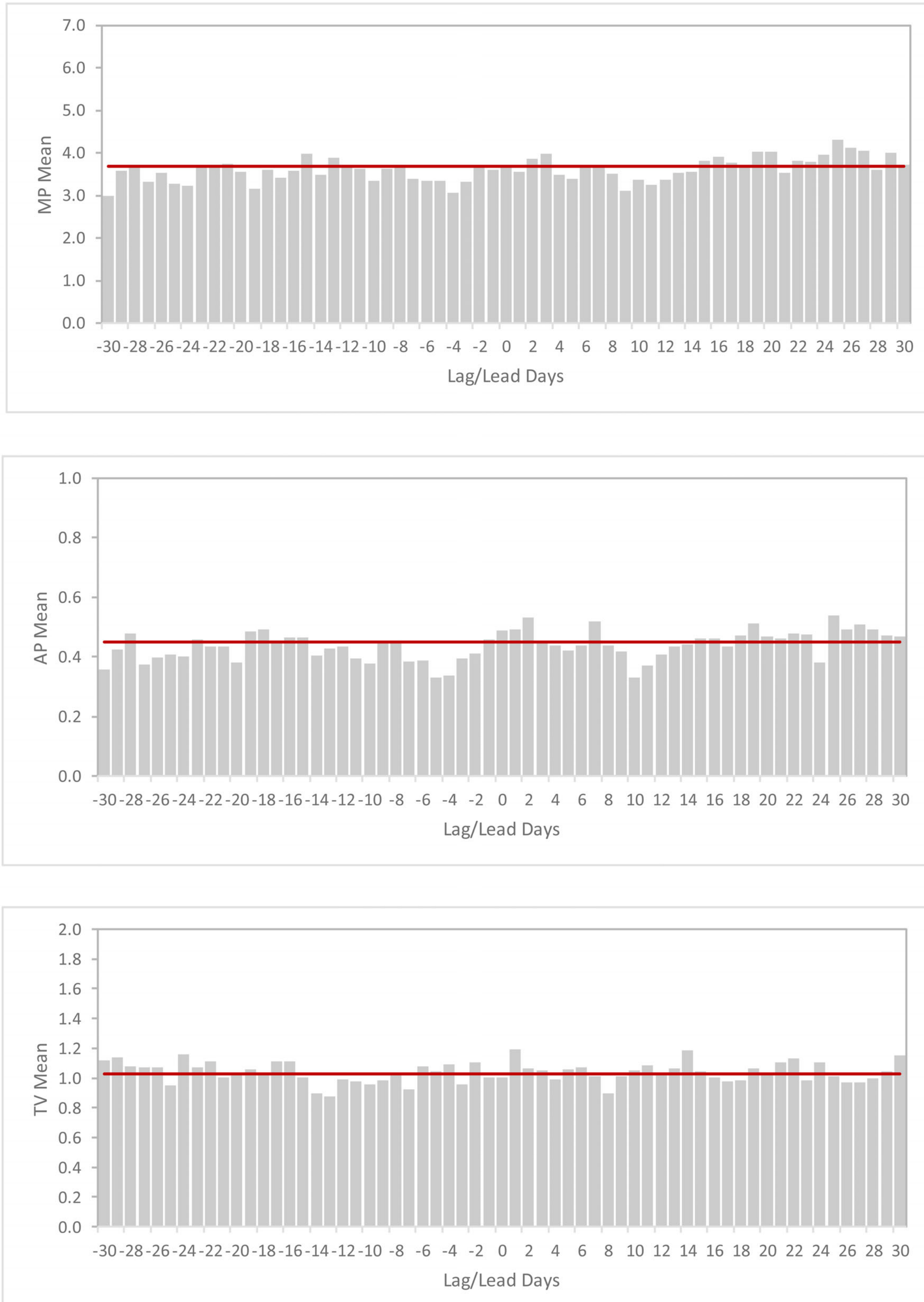

Figure 4. Daily major papers (MP), AP wire (AP), and network television news (TV) coverage before and after non-public MS (solid line set at the overall mean).

on the level of related news coverage. Furthermore, in terms of the potential for contagion, nonpublic massacres are typically precipitated by internal forces—family massacres by domestic discord, felony-related shootings by profit-seeking, and gang-related incidents by turf concerns (Fox et al. 2019). By contrast, media coverage as a precipitant, to the extent that it exists, would more likely be seen in the public shootings of innocent strangers and random bystanders. Thus, in what follows, models of the timing and interconnectedness of news coverage and mass shootings will focus only on incidents in public settings (results for all mass shootings are generally similar and available upon request).

3.2. Multivariate Point Process Models of MPS and News Coverage

Building upon the basic lead/lag patterns presented above, we next applied a multivariate (or "marked") self-exciting discrete time point process model to examine the interdependency between media coverage and both the incidence and severity of MPS.[4] In this generative Bayesian model, we infer the contagion properties of a point process network wherein the occurrence of one event type (such as a MPS) may excite a heightened probability of future events of the same class according to a fitted impulse response function, and may also cross-excite a higher probability of other event types (such as media coverage) occurring over the same time period.[5]

Our model is highly flexible to learn trends from the data without constraining the nature of the excitation effects; in particular, we fit a nonparametric impulse response function rather than assuming exponential decay (see, Towers et al. 2015). Furthermore, by integrating a random graph model (see Linderman and Adams 2015), we allow for structured correlation in the prior probability. This pools information across the excitation dependencies of the event-type variables, rather than assuming that all pairwise variable dependencies have a priori equal probability distributions. Details on point process models are provided in the technical appendix.

The nonparametric impulse response function $h_{k'\to k}$ represents how much each event from one process (k') excites another (k) over time. It is composed of 20 raised cosine basis elements distributed across lags d from 0 days to a maximum value denoted $D_{\max}$. To enable inference on the impulse response of self- and cross-excitation of shooting incidence and media coverage, $D_{\max}$ must be set to a value commensurate with the timescale for excitation. We identified two relevant timescales as (i) the average inter-arrival time between incidents (78 days for MPS) and (ii) the timescale for coverage following an event (typically $\ll$14 days, see Figure 2). As a result, we estimated models with $D_{\max}$ equal to 30 days ("short timescale") and then 365 days ("long timescale"); see the appendix for further discussion of sensitivity to this parameter.

Last, we define some useful statistics on the weighted impulse response function, $h_{k'\to k}$, to summarize the strength of excitation. We set an upper limit on the excitation effect based on the 97.5$^{\text{th}}$ percentile value inferred from the Bayesian model posterior, $H_{\max} = \max(h_{k'\to k,97.5\text{th}}[d])$. Because the coverage variables are standardized, the impulse response function for self- or cross-excitation of/by media coverage has an arbitrary unit scale. For the self-excitation of MPS, $H_{\max}$ represents the maximum number of future occurrences of event-type k that is excited for each occurrence of event-type k' per day.

Since h, as defined, is positive-definite, we can say that it is significantly different from zero if its median value is greater than the difference between its 16th and 84th percentile values (the "one sigma" range of its distribution). Accordingly, we define a significance statistic $S_H = H_{50\text{th}}/(H_{84\text{th}} - H_{16\text{th}})$, where the subscripts denote percentile values. This criterion for significance is similar to observing that the mean value is S_H standard deviations away from zero, but accounts for the positive-definite and nonsymmetric distribution of the posterior.

In total, we fit a variety of independent models addressing different data and model configurations. For the purpose of comparing the impulse response functions across variables, the three news coverage measures (MP, AP, and TV) were rescaled by dividing out their standard deviation and then rounding to integer values. The key statistics defined above are summarized for each model in Table 2, as described in the following subsections.

3.2.1. Two-Variable Models for MPS for Short and Long Timescales

First, we consider a simple two-variable model consisting of the daily count of MPS and the level of media coverage characterized by each of the three metrics with $D_{\max} = 30$ days. Figure 5 shows the weighted impulse response functions of the model (the functions $h_{k'\to k}[d]$) with each of the three types of media coverage represented as columns of the figure. Each line represents the posterior median of the function, with shaded regions indicating the associated 95% posterior interval.

The results suggest, first, that there is essentially no excitation effect on MPS ($H_{\max} < 0.002$). The impulse response functions acting on the MPS variable (top row of Figure 5) are statistically indistinguishable from zero ($S_H < 0.01$), for the self-excitation of MPS on both subsequent MPS and the excitation of coverage on shootings. The modest number of MPS (89 over the 6940 observation days) limits the statistical power of the analysis. However, the Bayesian modeling approach allows for a robust characterization of the upper limit of underlying contagion effects through the $H_{\max}$ statistic. We further explore the dependence of our modeling on sample size in the technical appendix, concluding that self-excitation effects larger than one excited event per four MPS would be detectable given the available data.

Second, the cross-excitation effect of MPS on media coverage (solid blue lines in the bottom row of Figure 5) is strong ($H_{\max} \approx 0.4 - 0.5$) and highly significant ($S_H > 2$), consistent with earlier results. Note that the impulse response function is fitted with a nonparametric method and thus is not constrained to have an exponential shape or to decay monotonically, although the fitted results do resemble exponential decay, falling by an order of magnitude effectively to zero after three days. The timescale of the fitted impulse response is sharper than the observed time distribution of media coverage shown previously in Figure 2 because of the additional self-excitatory component. The structure of the model is such that MPS directly impact coverage levels in the following three days, and that coverage propagates forward in time and triggers subsequent

[4]The U.S. population growth is not controlled for in this model; because population grows as a smoothly varying function on long timescales (years/decades), it would not be a significant confounder with temporal contagion effects decaying on short timescales (weeks/months).

[5]We did not include a spatial component in the analyses to follow. Almost without exception, mass public shootings with numerous fatalities become national stories, and regional differences in the coverage are minimal (see Fox et al., 2020). Although local coverage of nearby incidents tends to be more extensive, there does not appear to be short-term spatial clustering of mass public shootings. In fact, the closest shootings temporally (in El Paso, TX on August 3, 2018, and then in Dayton, OH the following day) were separated by 700 miles. News about the El Paso shooting would have reached Dayton, as it did everywhere in the United States, but the source would not have been the *El Paso Times*.

Table 2. Upper limits and significance statistics of MPS and coverage excitation effects for the multivariate point process models

Model type	Media type	Timescale	Effect of	Statistic	Effect on: Shootings	Coverage	High-severity shootings	Low-severity shootings
Two variable	MP	Short	Coverage	H_{max}	0.00018	0.46019	–	–
Two variable	MP	Short	Coverage	S_H	0.00703	9.80646	–	–
Two variable	AP	Short	Coverage	H_{max}	0.00014	0.27891	–	–
Two variable	AP	Short	Coverage	S_H	0.00565	5.57367	–	–
Two variable	TV	Short	Coverage	H_{max}	0.00010	0.33971	–	–
Two variable	TV	Short	Coverage	S_H	0.00814	10.42222	–	–
Two variable	MP	Short	Shootings	H_{max}	0.00161	0.75036	–	–
Two variable	MP	Short	Shootings	S_H	0.00812	3.28462	–	–
Two variable	AP	Short	Shootings	H_{max}	0.00194	0.51325	–	–
Two variable	AP	Short	Shootings	S_H	0.00715	2.46947	–	–
Two variable	TV	Short	Shootings	H_{max}	0.00141	0.75254	–	–
Two variable	TV	Short	Shootings	S_H	0.00498	2.42404	–	–
Two variable	TV	Long	Coverage	H_{max}	0.00002	0.12107	–	–
Two variable	TV	Long	Coverage	S_H	0.00632	14.13551	–	–
Two variable	TV	Long	Shootings	H_{max}	0.00031	0.32999	–	–
Two variable	TV	Long	Shootings	S_H	0.00618	2.29154	–	–
Two variable	TV	Long	Coverage	H_{max}	0.00004	0.12712	–	–
Two variable	TV	Long	Coverage	S_H	0.00414	14.33748	–	–
Two variable	TV	Long	Shootings	H_{max}	0.00308	0.05711	–	–
Two variable	TV	Long	Shootings	S_H	0.00049	1.05653	–	–
Three variable	MP	Short	Coverage	H_{max}	–	0.42186	0.00012	0.00010
Three variable	MP	Short	Coverage	S_H	–	7.55905	0.00538	0.00711
Three variable	AP	Short	Coverage	H_{max}	–	0.26416	0.00011	0.00017
Three variable	AP	Short	Coverage	S_H	–	5.63862	0.00563	0.00487
Three variable	TV	Short	Coverage	H_{max}	–	0.33610	0.00004	0.00007
Three variable	TV	Short	Coverage	S_H	–	9.95017	0.00937	0.00817
Three variable	MP	Short	High severity shootings	H_{max}	–	1.80285	0.01323	0.01193
Three variable	MP	Short	High severity shootings	S_H	–	3.41898	0.00045	0.00043
Three variable	AP	Short	High severity shootings	H_{max}	–	1.91932	0.01265	0.01614
Three variable	AP	Short	High severity shootings	S_H	–	3.72031	0.00045	0.00196
Three variable	TV	Short	High severity shootings	H_{max}	–	1.66999	0.01190	0.01167
Three variable	TV	Short	High severity shootings	S_H	–	2.67964	0.00026	0.00040
Three variable	MP	Short	Low severity shootings	H_{max}	–	0.04952	0.00358	0.00098
Three variable	MP	Short	Low severity shootings	S_H	–	0.16068	0.00381	0.00585
Three variable	AP	Short	Low severity shootings	H_{max}	–	0.02668	0.00570	0.00089
Three variable	AP	Short	Low severity shootings	S_H	–	0.00021	0.00470	0.00586
Three variable	TV	Short	Low severity shootings	H_{max}	–	0.03917	0.00539	0.00088
Three variable	TV	Short	Low severity shootings	S_H	–	0.00105	0.00228	0.00291

coverage by self-excitation. That leads to the third conclusion: that the self-excitation of coverage ($H_{\max} \approx 0.3 - 0.4$) has a magnitude and timescale comparable to the excitation from the shootings themselves, and this behavior is consistent across the three media types. Last, the magnitude of excitation is similar across all three media types, although somewhat smaller for AP stories, similar to the observations of Figure 2.

Figure 6 illustrates the nature of this model, showing the rate function of each variable over time, $\lambda(t)$, alongside the observed rate of MPS events, zoomed in on a narrow time window surrounding the shooting at the Emanuel African Methodist Episcopal Church in Charleston, SC. The plot reveals how the shooting immediately triggered major paper (MP) coverage (in print the following day) and how that, in turn, triggered additional coverage by self-excitation.

We repeated the analysis over longer timescales, with $D_{\max} =$ 180 days. This tests the possibility that self-excitation of mass shootings occurs over longer periods of time, given that these events have an average inter-arrival time of 78 days. The results of this model are essentially equivalent to those of the $D_{\max} =$ 30 days model. In particular, there is no significant self- or cross-excitation of MPS at any timescale.

3.2.2. Three-Variable Models for MPS on Short and Long Timescales

Finally, we examined the role of MPS severity in terms of victim count. We expanded the model to three-variable excitatory process networks for MPS in which the shooting incidence variable is split into higher- and lower-severity components. High-severity shootings are defined as those with six or more victim fatalities.[6] We again find that the self-excitation of shootings is not significant. The results for lower-severity events, which represent the majority of incidents ($N = 51$), are similar to that for the two-variable models ($H_{\max} < 0.001$), while results for high-severity events, limited by the smaller sample size ($N = 38$), have a somewhat weaker upper limit ($H_{\max} < 0.02$).[7]

As shown in Figure 7, the excitation of media coverage is dominated by higher-severity shootings (orange lines; $H_{\max} \approx 1.25 - 1.5$), with the more numerous lower-severity events (blue lines) contributing negligibly to exciting coverage ($S_H < 0.2$).

[6]This breakpoint was chosen to ensure a sufficient number of cases in both categories and is consistent with how others have defined mass shootings with large death tolls (see, e.g., Klarevas 2016).

[7]As a natural consequence of the Bayesian probability model, the posterior upper limit on the self-excitation rate inferred from the data are generally of order $1/N$, the inverse of the number of observations.

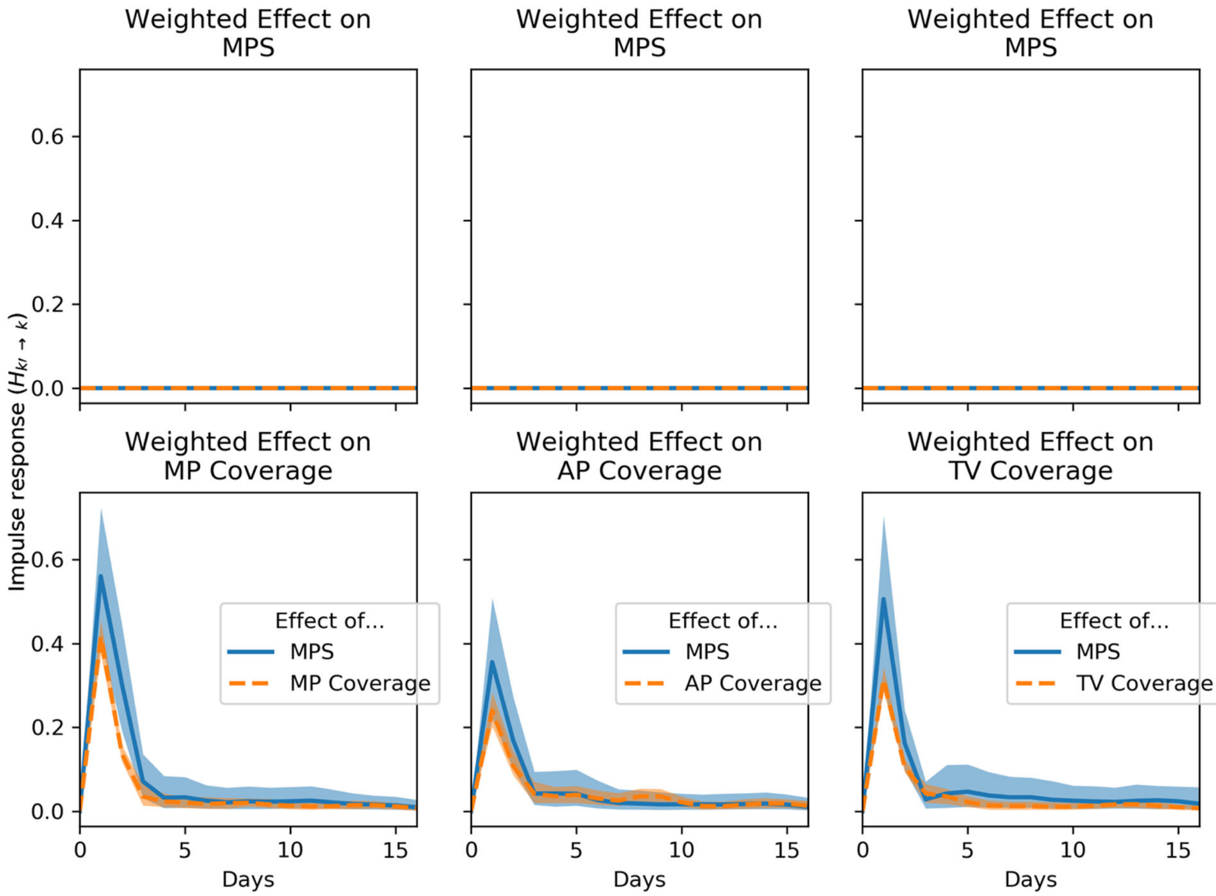

Figure 5. Fitted impulse response functions for two-variable (MPS incidence and media coverage) excitatory process networks with each model (column) fit with coverage metrics from MPs, the AP, and network television (TV).

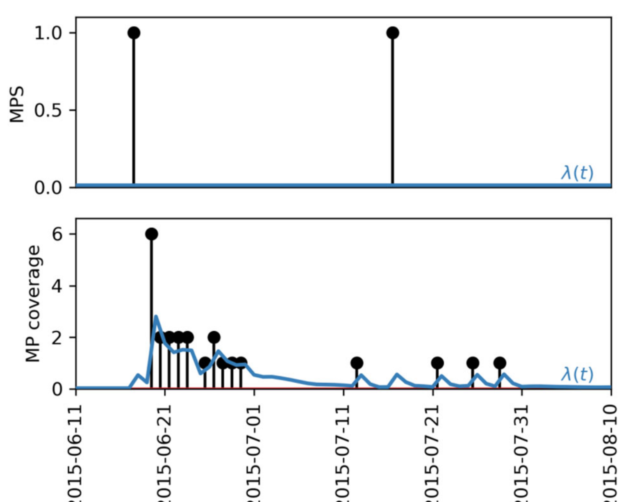

Figure 6. A limited-time excerpt of the fitted rate (blue line) of the two-variable (MPS incidence and media coverage) excitation model using MP coverage against the true value of each variable (black stems).

The higher-severity events are responsible for exciting coverage at approximately three times the rate of coverage self-excitation, and these results are similar across media types. In the technical appendix, we explore in detail the choice of the severity threshold and certain hyperparameters of the model, reinforcing the conclusion that there is no evidence of shootings exciting further shootings regardless of the values of these parameters.

4. Discussion

The notion that highly publicized events may inspire the commission of future acts, both in the short-term or long-term, has been a major avenue of recent studies of mass shootings. Research by Towers et al. (2015) is often cited in the press as proof of short-term contagion (see, e.g., Zarembo 2016). However, that there is some temporal clustering of events does not necessarily mean that media coverage of mass shootings leads to a heightened risk or additional incidents as a result. As Lankford and Tomek (2017, p. 2) argued, "incident clusters could theoretically be attributable to many other social and environmental factors, such as political cycles, stock market gains or losses, or other news events unrelated to crime." Clustering can also reflect the operation of chance. The findings presented here, based on analyses explicitly incorporating measures of media reporting along with mass shooting incidents from 2000 through 2018, suggest that news coverage does not inspire additional attacks, at least not in the relative short-term. Specifically, although news coverage related to mass shootings across multiple media sources is indeed linked to excitation from high-severity events, mass shootings themselves are distributed without significant contagion effects in the form of either self-excitation or cross-excitation from media coverage.

Our analysis differs from Towers and colleagues in two important respects. First, whereas the Towers model included all mass shootings, most of which were family- and felony-related incidents, we focused solely on public shootings, which both

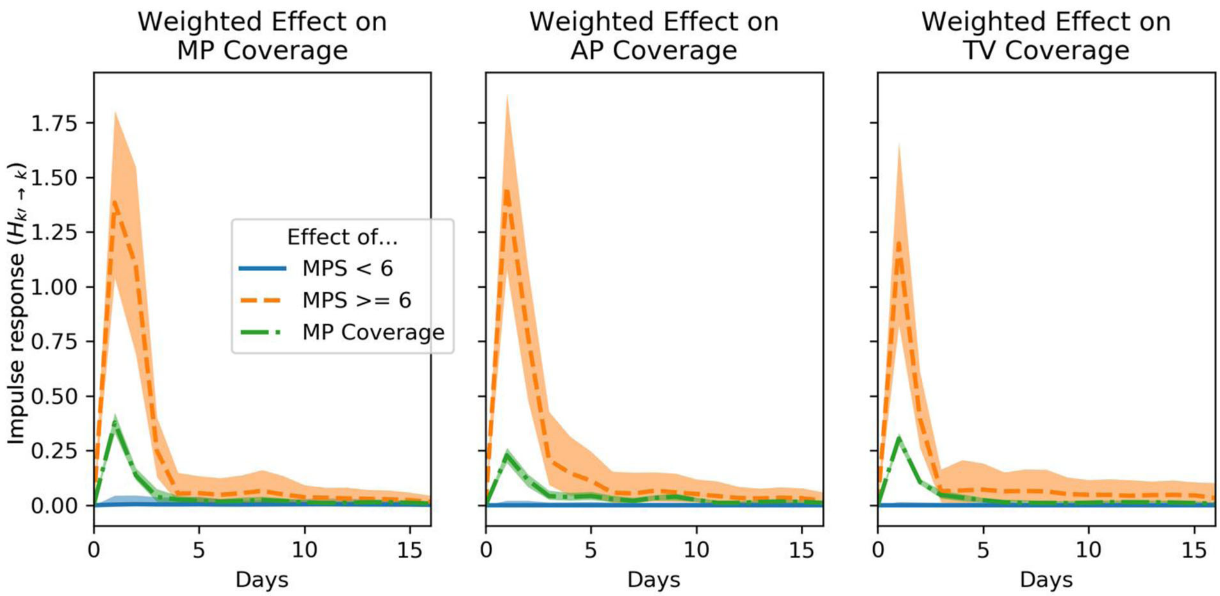

Figure 7. Fitted impulse response functions for the effect of MPS on MPs, AP, and network television (TV) coverage based on a three-variable excitatory process.

generate the most media coverage and would tend to be far more responsive to external forces, such as the media. Next, whereas Towers analyzed a univariate model of the timing of mass shootings, we explicitly incorporated in multivariate model levels of media coverage, often cited as a prominent transmitter of contagion effects. Of course, future research might consider incorporating various exogenous factors (e.g., unemployment rates, gun availability, and measures of social disorganization) as well.

Notwithstanding these advances, the results reported here are subject to certain limitations. For example, all three measures of news coverage involved traditional outlets rather than the various types of social media. However, social media activity with regard to mass shootings correlates strongly with more traditional media coverage, which would argue against shortening the analytic time frame (and thus reducing the number of incidents) to accommodate data pertaining to social media of relatively recent popularity.[8] Moreover, social media platforms and usage have expanded dramatically over the past few years, limiting the validity of such measures for analyzing temporal effects.

An additional point of caution involves the impact on statistical power as a consequence of the modest number of mass public shootings since 2000, an issue addressed in the appendix. However, it would not be fruitful to broaden the definition of mass shooting in terms of victim type or count. As shown, non-public mass shootings rarely receive much media coverage; the same holds for assaults in which multiple victims are injured but few, if any, are killed. In addition, other forms of mass shootings—such as family massacres, as well as incidents associated with robberies, gang conflict, or illicit drug trade—do not receive much media coverage beyond the local area (see Duwe 2000).

5. Conclusion

Even though there does not appear to be short-term contagion linked to newspaper and television coverage of mass shootings, a different form of contagion—one that is associated with the social climate of fear—may be much more pervasive and powerful. Excessive worry over the risk of mass shootings and endless discussions of the issue among neighbors, on social media, and in political debate can play into the mindsets of malcontents and hatemongers. The public's obsession over rare, although dreadful, events can serve as a constant reminder for angry and dispirited individuals that the standard course of action in response to profound disappointment and sense of injustice is to pick up a gun and open fire on those perceived to be responsible.

As an examination of "general contagion" rather than "specific contagion" (see Langman 2017), our findings do not address the kind of impact that intense coverage of certain mass killings may have on the aspirations and actions of various copycat assailants and wannabes, often years after the fact. Indeed, there are certain types of mass shootings, such as a hate-inspired attack on a particular class of victims or a school shooting in response to bullying, that would have a greater potential for copycatting than incidents involving motivations unique to the assailant. In such cases, of course, it is unclear whether the handful of infamous and iconic mass killers inspires others to kill or just provides a model for how or where to kill. Whatever the nature and source of imitation, the recent series of high-visibility mass shootings has invigorated the "No Notoriety" movement, composed of several prominent members of the media (including CNN's Anderson Cooper) and a growing number of academics (see Lankford and Madfis 2017). They urge the news media to avoid frequently repeating the names of mass killers or showing their images.

[8]Using Spearman's rank-order correlation because of the highly skewed nature of the data, we found that monthly counts of Tweets and Google searches on the topic of mass shootings from 2013 through December 2018 had correlations of 0.806 and 0.834, respectively, with the major papers (MP) measure of news coverage. In addition, an analysis of daily Tweet counts about mass shootings before and after actual incidents reveals a pattern that is consistent with that shown in Figure 2 for conventional media.

The idea that the identities of people who commit unspeakable acts should themselves remain unspoken is certainly understandable. However, it is hardly reasonable, practical or even possible for the names and images of mass killers to remain sealed from public awareness. The name, image, as well as basic demographic information about an assailant is newsworthy, just as much as are descriptions of those who were killed. The conventional wisdom among journalists appears to support and defend such practices, according to a large-scale survey of the working media (see Dahmen et al. 2018).

That said, the media regrettably does sometimes cross the ethical line from stating the basic facts about an offender to reporting on superfluous details about that the person's life and lifestyle. Even if media coverage does not demonstrably excite short-term contagion effects, the news media would be wise, for example, to limit coverage of the assailant to the essential facts (e.g., demographic characteristics, details about the weapons used and their acquisition, motive, and criminal justice processing), while avoiding gratuitous details about the offender's background and planning process that add little or nothing to our understanding of events. Similarly, the media should only publicize excerpts from the writings or recorded statements by mass shooters, enough to characterize intent without giving them a public platform for their ideas and beliefs. In addition, a simple headshot of a mass killer is appropriate, but publishing photographs in which an assailant has deliberately posed with weapon in hand for effect tends to promote him or her as a powerful individual.

Beyond these modest changes in the style of news reporting on sensational crimes and criminals, the findings presented here indicate that the media are not responsible for any short-term clustering of mass shootings. Moreover, blaming the media for various spikes in mass shootings diverts attention away from efforts to deal with more fundamental issues, such as the value of universal background checks, the availability of large-capacity magazines, and access to mental health services.

The objective of this analysis was to incorporate measures of media coverage in models of the general contagion of mass public shootings. There are, of course, many interesting avenues for future research on the independence of media coverage and mass shootings. For example, what has been the impact of reporting on breaking news stories by means of social media platforms? What effect do the theme and tone of news stories have on the audience and the potential for copycat attempts? In addition, are there regional differences regarding the extent and style of news reporting on mass shootings, particularly of local incidents? The scholarly literature on mass shootings has expanded tremendously in the recent years, with Google Scholar entries regarding mass shootings having tripled over the past decade. As the body of research on mass shootings continues to grow, the role and impact of the media should remain a fruitful focus of empirical investigation.

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Supplementary Materials

The Appendix for this article is available in the online supplementary files.

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