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Publicly Announced Speed Limit Enforcement and Its Impact on Road Safety – Evidence From the German Blitzmarathons

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Diskussionsbeitrag Nr. V-75-17

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Abstract

This paper studies a unique traffic law enforcement campaign in Germany and its impact on road safety. Key features of the campaign are (1) repeated one-day lasting massive speed limit monitoring (so called Blitzmarathons) and (2) a media campaign that informs the public in advance about the timing, extent, and purpose of the speed limit monitoring. Using administrative records on all police reported vehicle crashes in Germany from 2011 to 2014 and generalized difference-in-differences estimations, we find an eight percent reduction in the number of traffic accidents and a nine percent reduction in the number of slightly injured during Blitzmarathon-day compared to regular days. The effect begins to emerge with the onset of the media campaign, one to three days before a Blitzmarathon. However, while the initiators of the Blitzmarathons intended a permanent change in road safety, we do not find that the reduction in traffic accidents persists beyond a Blitzmarathon-day. In terms of mechanisms, we show that a substitution of traffic from motorized vehicles to other modes of transport not targeted by the Blitzmarathons does not drive our results, and we demonstrate that overall driving speed is lower during a Blitzmarathon-day compared to other days. Given the general relevance of traffic law enforcement strategies, our result have important implications for policy makers beyond the German context.

JEL classification: H76, K42, R41
Keywords: traffic, law enforcement, safety, accidents

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1 Introduction

Road traffic injuries are the ninth leading cause of death worldwide. Each year, about 1.2 million people die in a road traffic accident and another 20 to 50 million people are injured, generating economic costs of one to three percent of a country's GDP annually (WHO, 2015; OECD, 2016). While most of these traffic fatalities occur in middle- and low-income countries, traffic accidents continue to constitute an important risk factor for injuries and deaths in high-income countries. For example, in Germany and in the US, traffic accidents are the leading cause of death for young people aged 15 to 24; there is no other age group that bears a higher risk of dying in a traffic accident (Statistisches Bundesamt, 2014; Kochanek et al., 2016). The main contributing factor to traffic accidents is inappropriate behavior of road users and, more particularly, excessive or inappropriate speed (speeding). In the OECD, speeding accounts for around 30 percent of all fatal accidents (WHO, 2013; OECD, 2016). In their global status report on road safety, the World Health Organization (WHO) brings forth that even though most countries have enacted speed limits, the enforcement of these laws is inadequate (WHO, 2013).

In the last years, several countries have adopted different speed limit enforcement strategies that focus on either increasing the detection probability of and fines for speeding or nudging drivers to behave more responsibly on the road. For example, in 2013, Switzerland has substantially elevated fines for speed limit violations; in addition, excessive speeding may result in the confiscation of the vehicle and up to four years of imprisonment. Switzerland has also prohibited the dissemination of information about locations of speed traps. Since 2003/2004, Austria and Italy have started to install so called section controls that measure speed limits over a longer distance in addition to regular, punctual speed traps. The European Union established a network of traffic police forces in 1996 that recently started to carry out regular pan-European speed limit monitoring initiatives. The US is currently discussing technical devices that electronically cap speeds for trucks. In contrast, Australia's enforcement strategy builds on nudging. The country has launched a media campaign in 2007 that targets young male drivers and emphasizes that driving is not prestigious ("no one thinks big of you"). Similarly, in 2014, the government of Northern Ireland published videos of traffic accidents on national TV to visualize the consequences of speeding.

This paper studies a unique speed limit enforcement campaign in Germany that builds on regular one-day lasting massive speed limit monitoring (so called Blitzmarathons) in combination with a media campaign that informs the public in advance about the timing, extent, and purpose of the speed limit monitoring. We evaluate the Blitzmarathons in terms of their effectiveness in reducing the occurrence and the severity of traffic accidents, using a generalized difference-in-differences approach that exploits variation in the treatment over time and across states. Our analysis draws on rich administrative daily accident data in combination with self-collected data on speed limit enforcement. Data on news media coverage of the campaign, Google search trends, and Twitter statistics allow us to assess the public awareness of the Blitzmarathons. To identify the mechanisms of the Blitzmarathon effect, we rely additionally on administrative data on hourly driving speed and traffic volume.

We draw four conclusions. First, days of a Blitzmarathon show a significant reduction in the number of traffic accidents and road casualties compared to regular days. The number of traffic accidents falls by 7.5 percent; the number of slightly injured by 8.5 percent. For the number of severely and fatally injured, we find similar effects. Due to large standard errors, however, the reductions in the number of severely and fatally injured are statistically not significant. Second, the effect of the Blitzmarathons on the number and the severity of accidents begins to appear with the onset of the media campaign, one to three days before an actual Blitzmarathon. However, the effect is not persistent and disappears immediately with the end of a Blitzmarathon. Extending the speed limit monitoring by additional seven days continues to reduce the number and the severity of accidents. Third, male drivers, accidents on federal roads with a speed limit of 50 km/h to 100 km/h, and accidents in the afternoon and evening drive the effect of the Blitzmarathons. There is also an indication that young drivers and drivers in their early 50s contribute to the effect. Fourth, in terms of mechanisms, we find evidence that more responsible driving during the Blitzmarathons induces the reduction in the number and in the severity of accidents. There is no indication of a systematic substitution of traffic from motorized vehicles to other modes of transport not targeted by the Blitzmarathons.

Our paper relates to two strings in the economics literature. The first related literature studies the effect of traffic regulations on traffic accidents. Ashenfelter and Greenstone (2004) and van Benthem (2015) find that a rise in the speed limit by 10 mph in the US increased traffic fatalities by 35 to 44 percent. The introductions of stricter traffic regulations are generally effective in reducing traffic fatalities. These regulations include mobile phone texting bans (Abouk and Adams, 2013) and the use of safety devices, like helmets, seat belts, airbags, and child restraints (Levitt and Porter, 2001; Cohen and Einav, 2003; Levitt, 2008; Dee, 2009; Doyle and Levitt, 2010; Markowitz and Chatterji, 2015). However, whether the police can primarily enforce these laws, i.e., stop and fine drivers for any violation, is important for the effect of these laws (Cohen and Einav, 2003; Abouk and Adams, 2013). Deangelo and Hansen (2014) show that a layoff of roadway troopers due to budget cuts in Oregon substantially reduced traffic citations and increased traffic injuries and fatalities. Using budgetary shortfalls as an instrument for traffic citations, Makowsky and Stratmann (2011) find that issuing more traffic tickets reduces the number and the severity of motor vehicle accidents.[1]

Luca (2015) studies an intervention that is similar to the Blitzmarathons. The author studies two one-week lasting periods of the “Click-it-or-ticket” campaign in Massachusetts.

[1]More broadly, this paper relates to the economics literature on governments' efforts to reduce risky health behavior, i.e., restricting the purchase or use of goods that relate to adverse health outcomes (Kelly and Rasul, 2014; Cotti et al., 2015; Marcus and Siedler, 2015), imposing excise taxes on these harmful goods (Gruber and Mullainathan, 2005; Fletcher et al., 2010; Cotti et al., 2015), or disseminating information about the risk of consuming harmful goods (Avery et al., 2007; Wisdom et al., 2010; Bollinger et al., 2011).

The campaign targets seat belt use through increasing traffic tickets for violations of the seat belt law. The author argues that, in Massachusetts, the campaign induces police officers to target other offenses as well.[2] Using the campaign as an instrument for the number of issued traffic tickets, Luca (2015) finds that traffic tickets significantly reduce the total number of accidents and the number of injuries. However, Luca draws on data from Massachusetts only, and the concurrence of the study period with the September 11 attacks as well as the focus of the campaign on holiday periods exacerbate the problem of potentially absorbing time trends.

Our paper also relates to the literature that analyzes the effect of increasing the presence of the police on different crime rates. Increasing the presence of the police is equivalent to (subjectively) increasing the conviction probability for an offense. Theoretically, an increase in the probability of conviction reduces the number of offenses (Allingham and Sandmo, 1972; Becker, 1974; Cowell, 1990). Empirically, exogenous increases in the presence of the police reduce violent crimes, e.g., murder, assault, and robbery, as well as property crimes, such as burglary and motor vehicle thefts (Levitt, 1997; Di Tella and Schargrodsky, 2004; Klick and Tabarrok, 2005; Evans and Owens, 2007; Draca et al., 2011; Machin and Marie, 2011).

The Blitzmarathons differ from other traffic enforcement campaigns by increasing repeatedly and temporarily the presence of the police who can stop and fine drivers for any traffic law violation in combination with a media campaign that informs the public about the campaign. While the Blitzmarathon campaign started out in Germany, it became a pan-European effort in 2015. Ireland is continuing the Blitzmarathons as the "national slow down day" since 2015. However, until now, there is no official estimate by the initiators of the campaign regarding the Blitzmarathons' effectiveness in reducing the occurrence and the severity of traffic accidents. Politicians and interest groups of the police have doubted positive effects for road safety. As a consequence, in the recent Blitzmarathon in 2016, several federal sates in Germany did not participate, also because of the high planning effort and excessive use of police resources (Spiegel Online, 16-04-2016; Frankfurter Allgemeine, 20-04-2016). Moreover, given the general relevance of traffic law enforcement strategies, our results have important implications for policy makers in designing adequate interventions beyond the German and European context.

In general, rationales that justify government interventions targeting road behavior are allocative or paternalistic motives. Rational individuals trade off own costs and benefits of their driving behavior, e.g., speeding decreases travel time at the expense of an increase in the accident risk and fines for violating the speed limit (if the police detect the violation). However, an individual's risky road behavior also increases the accident risk for others. For example, in Germany, 75 percent of all accidents and 53 percent of all fatal accidents represent a collision between two vehicles or a vehicle and a pedestrian (Statistische Ämter,

[2]Massachusetts has a secondary seat belt law. The police cannot stop and fine drivers for not using a seat belt. However, if a driver commits an offense that allows the police to stop the vehicle, the police can issue traffic tickets for seat belt law violations.

n.d.). In addition to the external costs on others, hyperbolic discounting causes time inconsistent behavior that induces negative externalities on the individual's future self. In other words, the individual's short-run utility function misreports the true costs of accidents.

The outline of the paper is as follows. Section 2 provides background information about the intervention under study. Section 3 describes the data. Section 4 outlines our empirical strategy. In Section 5, we present our main results. Section 6 studies heterogeneous effects and Section 7 analyzes underlying mechanisms. We conclude in Section 8.

2 Background

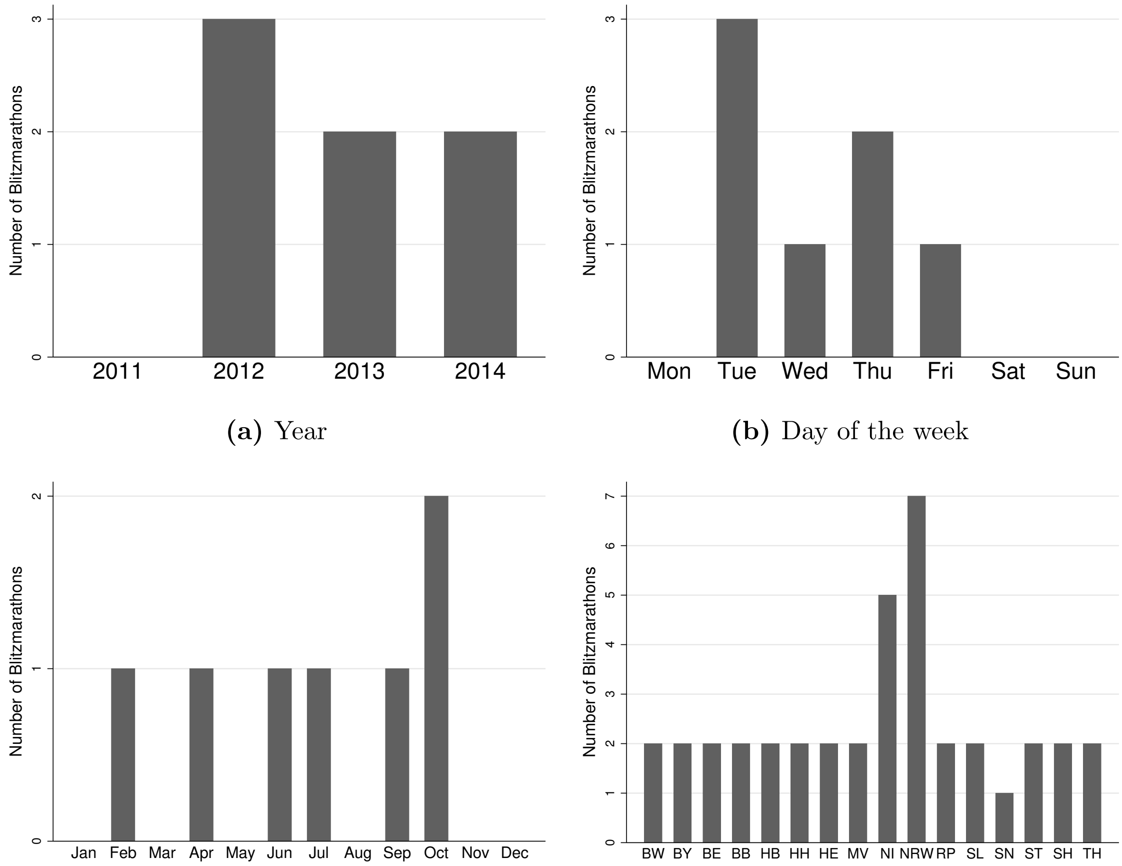
In 2012, the German federal state of North Rhine-Westphalia initiated the first Blitzmarathon as a state-wide campaign to reduce traffic fatalities. Key features are (1) one-day lasting massive speed limit monitoring by the police (through the installation of temporary speed traps) and (2) a media campaign that informs the public in advance about the purpose of the speed limit monitoring and the locations of the speed traps. After the first two Blitzmarathons in North Rhine-Westphalia in 2012, the federal state of Lower Saxony joints the campaign. Eventually, on October 10, 2013, 15 German federal states, all 16 states except Saxony, participated in a one–day Blitzmarathon.[3] Bavaria prolonged the one–day lasting controls by an additional week. In total, there were seven one–day Blitzmarathons and two Blitzmarathon extension periods between 2012 and 2014 with varying participation of the German federal states. This sums to 1,194 treatment days at the county level for the one–day Blitzmarathons and 1,344 treatment days at the county level for the two Blitzmarathon extension periods. Appendix Table B1 provides an overview of the Blitzmarathon dates and participation of the federal states.

Figure 1 summarizes the variation in the occurrence of a Blitzmarathon across years, days of the week, months of the year, and federal states in our sample period. The figure focuses on the one-day lasting Blitzmarathons; we analyze the effect of the extension periods in Bavaria separately. Variation in the occurrence of a Blitzmarathon exists across all four dimensions in Figure 1. Importantly, this variation allows us to estimate the causal effect of the Blitzmarathons on traffic accidents, taking out time- and state/county-specific effects.

In general, speed limit violations may lead to a warning, a regulatory offense, or a criminal offense. Fines start at 10 euro (driving 10 km/h above the speed limit outside any city) and may go up to 700 euro (driving above 70 km/h above the inner city speed limit). In addition, the driver's license may be suspended for up to three months. Repeated speeding may result in the complete suspension of the driver's license. The penalty system

[3] Saxony had planned a traffic safety campaign targeting schools and kindergartens from October 7 to 18, 2013. The Blitzmarathon on October 10, 2013, overlaps with this period. We treat the campaign in Saxony and the Blitzmarathon on October 10, 2013, as two separate campaigns. In our empirical analysis, we test the robustness of our findings by controlling for other traffic safety campaigns, including the described campaign in Saxony.

Figure 1
Distribution of One–Day Blitzmarathons Across Time and Federal States



Notes: The figure plots the number of one-day Blitzmarathons across years [Panel (a)], days of the week [Panel (b)], months of the year [Panel (c)], and federal states [Panel (d)] between 2011 and 2014. The labels in Panel (d) refer to "BW": Baden-Wuerttemberg, "BY": Bavaria, "BE": Berlin, "BB": Brandenburg, "HB": Bremen, "HH" Hamburg, "HE" Hesse, "MV": Mecklenburg-Western Pomerania, "NI": Lower Saxony, "NRW" North Rhine-Westphalia, "RP": Rhineland-Palatinate, "SL": Saarland, "SN": Saxony, "ST": Saxony-Anhalt, "SH": Schleswig-Holstein, "TH": Thuringia. Bavaria prolonged two one-day Blitzmarathons by seven days; we analyze the effect of these extensions separately.

has changed within our study period. While the new system keeps the fine amounts unchanged, drivers may lose their driver's license after committing fewer traffic violations compared to the old system. In our empirical strategy, we account for this change by including time fixed effects.[4]

While the police are officially detecting speed violations during a Blitzmarathon, they can fine drivers for other offenses as well. Press releases after the Blitzmarathons reveal that the police also prosecute wearing no helmets, using no seat belt, talking on the phone, driving under the influence of drugs and alcohol, and possessing no driver's license. However, the initiators of the campaign emphasize that the goal is not to boost state revenues through traffic fines. The idea is to increase the awareness of speeding through publicly announced massive speed limit enforcement and to therewith reduce the incidence of traffic accidents. To underline the awareness-concept, school children sometimes help the police during a Blitzmarathon by rewarding commendable drivers with sweets.[5]

Speed Limit Enforcement on a Blitzmarathon and on a Regular Day

Speed limit enforcement in Germany is a combination of automated permanent (stationary) speed traps and temporarily installed speed traps, i.e., mobile radar or laser speed measurement systems that allow for a geographical flexible and easy speed monitoring. During the Blitzmarathons, the police increase temporary speed traps. To contrast speed limit enforcement during a Blitzmarathon and speed limit enforcement on a regular day, we collected information on permanent speed traps, temporary speed traps on a regular day, and temporary speed traps on a Blitzmarathon day.

The information about permanent speed traps stems from "blitzer.de", a for-profit organization that offers speed trap warnings through their homepage and app.[6] blitzer.de's editorial staff collects information about permanent speed traps through screening of radio news, websites, and social media posts. Moreover, the company sends cars on a tour to check on permanent speed traps several times a year to validate the activation of the speed traps. In 2011, before the first Blitzmarathon, there were on average 9.0 stationary speed traps per county. Analyzing data from 2014, we see a modest increase of on average 1.2 stationary speed traps over our study period. This increase is mostly driven by the state of Hesse, where the number of permanent speed traps increased on average by 8.8 per county. To control for these changes in the empirical analysis, we introduce county-specific time effects. It is important to add that the effect of permanent speed traps on driving behavior might differ from the effect of temporary speed traps: the police can locate temporary speed traps at different places every time they are set up, while permanent

[4]The German system builds on the allocation of points for different traffic violations. The more severe the violation, the more points a driver receives. Each driver has an account that stores all points from past traffic violations. If a driver has crossed a certain threshold of points, he or she will lose his or her driver's license. The point system has changed May 1, 2014.

[5]For instance, the "Westfalen Blatt" reports on September 17, 2014: "Those drivers who follow traffic regulations get sweets [from the children]. Those who drive too fast receive a lemon with an unhappy looking smiley."

[6]There is no public institution that collects data on this type of regular enforcement.

speed traps remain fixed to a location. Hence, a county with a high number of temporary speed traps induces much more uncertainty to drivers with respect to the probability of being convicted for speeding than a county with the same number of permanent speed traps.

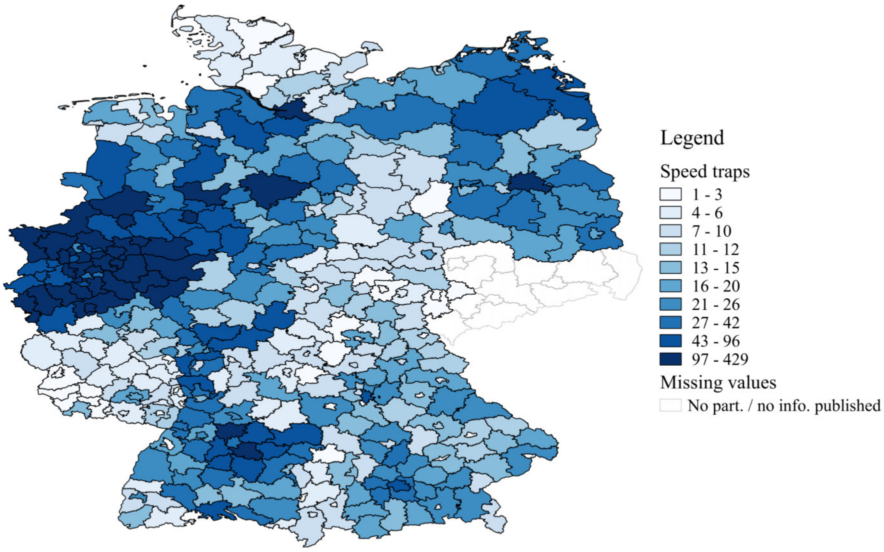
blitzer.de also provided us with data on regular temporary speed traps in each county. Data on regular temporary speed traps comes from blitzer.de's four million active users, who can easily report speed traps through the company's homepage or app. blitzer.de provided us with a list of all reported temporary speed traps in October 2015. According to the editorial staff, October is a representative month for speed enforcement with on average 5.8 temporary speed traps per day and county. Note that even if the number of temporary speed traps is not exhaustive (i.e. because blitzer.de is not aware of all temporary speed traps), the numbers document the expectations of the population about the level of enforcement on a regular day. However, if the Blitzmarathons cause temporary speed limit enforcement on a regular day to increase, we may underestimate the (actual and perceived) increase in speed limit enforcement on a Blitzmarathon-day using data from 2015. In fact, the initiators of the campaign in North-Rhine Westphalia have stated at least that the public should expect more speed controls also in the aftermath of a Blitzmarathon. Unfortunately, there is no data for the pre-treatment year in 2011.

The police announce the locations of the Blitzmarathon speed traps a few days before each Blitzmarathon through the local media. Reviewing all announcements, we can count the number of temporary speed traps in each county during each Blitzmarathon and relate this number to speed limit enforcement on any other day. For counties where the information could not be collected anymore through the media itself, we contacted the local police departments to send us the lists of speed traps they published through the media.[7] Appendix Figures B1 to B7 show the number of temporary speed traps in each county for each Blitzmarathon in the period from 2012 to 2014. The figures highlight once more the geographical variation in the treatment across federal states. In addition, the figures also show variation in the treatment within federal states through the varying number of temporary speed traps in each county. The average number of temporary speed traps during a Blitzmarathon is 24.3 per county.

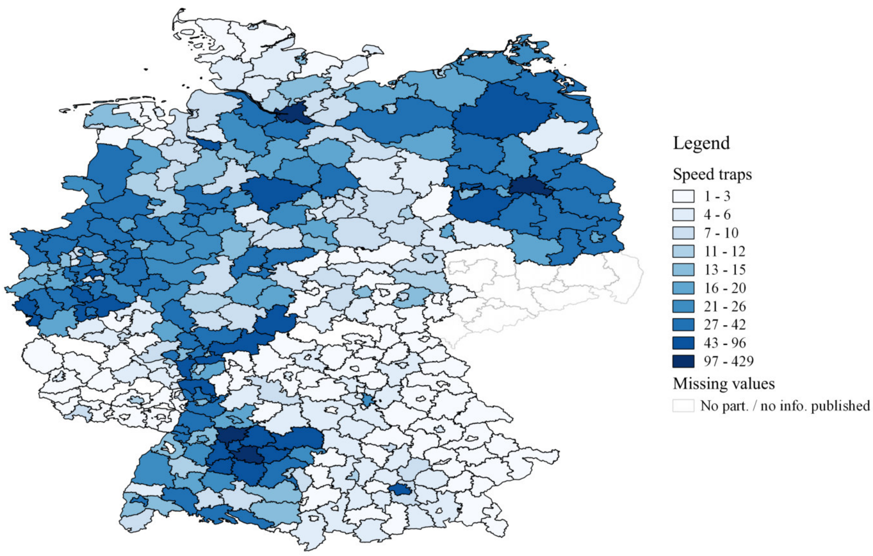
Adding to the number of temporary speed traps the number of permanent speed traps for both a regular day and a Blitzmarathon day, we can now contrast speed limit enforcement in Figure 2. On average, there are 33.2 speed traps per county on a Blitzmarathon-day and 14.7 speed traps on a regular day. Thus, speed limit enforcement doubles during a Blitzmarathon-day. If we focus only on a comparison of temporary speed traps, speed limit enforcement increases by a factor of four (24.3/5.8) during a Blitzmarathon. To put the treatment size even more into perspective, Table 1 exemplifies the treatment intensity for the federal state of North-Rhine Westphalia who participated in all Blitzmarathons.

[7]For North Rhine-Westphalia, we have missing information for one county during three Blitzmarathons, as the county did not announce the speed traps' locations in advance. Similarly, the state of Baden Wuerttemberg and Saxony did not announce the controls in advance for the fifth and seventh Blitzmarathon, respectively.

Figure 2
Speed Limit Enforcement on a Blitzmarathon and on a Regular Day



(a) Speed traps on a Blitzmarathon-day



(b) Speed traps on a regular day

Notes: The figure shows the total number of speed traps per county during a Blitzmarathon [Panel (a)] and during a regular day [Panel (b)]. The total number of speed traps is the sum of temporary and automated permanent speed traps. In Panel (a), temporary speed traps are the weighted average number of speed traps per county over all Blitzmarathons. Weights are the number of times a county has participated in a Blitzmarathon. The federal state of Saxony participated one time in a Blitzmarathon, but did not announce all speed traps in advance through the media.

Taking the length of the roads in North-Rhine Westphalia and dividing it by the number of total speed traps, we obtain the average distance in km at which a driver must expect a speed trap. We calculate this distance for a Blitzmarathon day and a regular day. Using an average driving distance of 24 km per day (Lenz et al., 2010), an average driver in North-Rhine Westphalia needs to expect at most one speed trap on the road on a regular day. This number increases by almost a factor of three on a Blitzmarathon–day. Focusing only on a comparison of temporary speed traps, drivers need to expect five times more speed traps on a Blitzmarathon–day than on any other day.

Table 1
Speed Limit Enforcement in North-Rhine Westphalia

	Regular day	Blitzmarathon–day
	(1)	(2)
(a) Total speed traps		
Temporary speed traps	475	2,379
Stationary speed traps	944	944
Total speed traps	1,419	3,323
Speed trap every x-th km	21	9
Expected number of speed traps per day	1.1	2.7
(b) Temporary speed traps		
Temporary speed traps	475	2,379
Temporary speed trap every x-th km	62	12
Expected number of speed traps per day	0.4	2.0

Note: The table shows speed limit enforcement in the federal state of North-Rhine Westphalia for a regular day [Column (1)] and a Blitzmarathon-day [Column (2)]. Total length of all roads is 29,582 km; average distance by car per day is 24 km (Lenz et al., 2010).

In a nutshell, the number of speed traps increases on average by a factor of two to four on a Blitzmarathon–day compared to a regular day. While an increase of two to four speed traps on a Blitzmarathon-day for every existing speed trap on a regular day is already indicative of the treatment intensity, there are two additional important notes. (1) On regular days, the local police departments decide on the exact locations of the speed traps. For the Blitzmarathons, the public is able to nominate locations. The public nominations might increase the information set of the police and target the controls more efficiently. For example, for the second Blitzmarathon in North-Rhine Westphalia, on July 3, 2012, more than 15,000 people nominated locations. The police implemented around 2,700 of these suggestions for the Blitzmarathon. (2) The increase in speed traps during a Blitzmarathon occurs simultaneously in all counties of a federal state. While the simultaneous state-wide increase in speed limit enforcement itself may affect driving behavior, the second key feature of the Blitzmarathons is the prior announcement of the timing, extent, and purpose of the campaign in the media.

News Media Announcement and Public Awareness

The police announcement of the speed traps' locations a few days before a Blitzmarathon informs the public about the intervention. The police announce the date of a Blitzmarathon itself one to one and a half weeks in advance. Local print media, radio, and television as well as online news sources would print the speed traps' locations as forwarded by the police starting around three days before a Blitzmarathon. While we do not impose the strong assumption that the public knows or remembers the exact locations of each and every speed trap, the lists of the speed traps in the media allow the public to form expectations about the extent of the speed controls in comparison to experiences from regular days. Together with a list of the speed traps' locations, the local media would also report about the risks of speeding, cite the current accident statistics of the county, illustrate the vulnerability of pedestrians and bicyclists, or quote police officers and politicians talking about the purpose of the Blitzmarathons.

The following quotes exemplify reporting in the local media in advance of a Blitzmarathon:

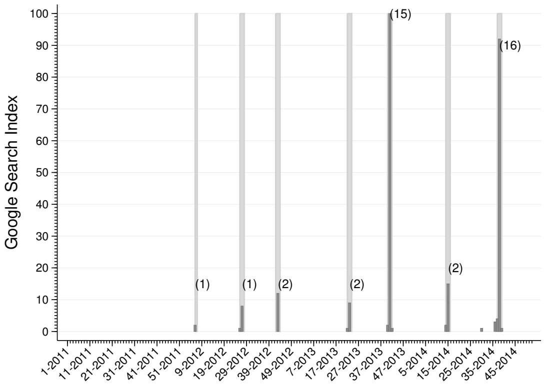
- With a car driving speed of 50 km/h, eight out of ten pedestrians survive in case of an accident. With a car driving speed above 65 km/h, it is the other way around: eight out of ten pedestrians die in case of an accident. (Westdeutsche Zeitung, 02-07-2012)
- In the last year, there were 6,000 accidents in Freiburg, in which almost 1,200 people were slightly injured and 140 were severely injured. 6 people died. (Badische Zeitung, 09-10-2013)
- With this initiative [the Blitzmarathons] we want to increase the awareness that speeding possesses the highest risk [for traffic casualties] on German roads. With the Blitzmarathons, we want to promote a considerate driving culture on our roads. (Minister of Home Affairs Lower Saxony in Bersenbrücker Kreisblatt, 04-07-2014)

We argue that the massive media announcements make it very difficult not to know about the Blitzmarathons. To provide evidence for this predication, we look at (1) Google Trends' weekly search volume index for the word "Blitzmarathon", (2) the number of daily news media articles including the word "Blitzmarathon", available through the WISO-database, and (3) the number of Twitter Tweets including the word "Blitzmarathon".

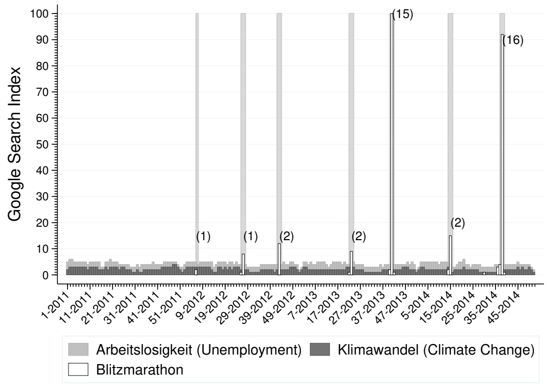
Importantly, the term "Blitzmarathon" was non-existing in the German language before 2012, when the initiators of the campaign created the term to describe the intervention. Panel (a) in Figure 3 shows Google Trends' weekly search volume index for the term "Blitzmarathon" between 2011 to 2014. Each gray bar marks a three week period: the week of a Blitzmarathon, the week before, and the week after. The numbers in parentheses indicate the number of participating states. To create the search volume index, Google Trends counts the weekly number of searches for a specific term and relates this number to the global maximum of weekly searches for that term. Hence, the week with the maximum number of searches for a specific term scores 100 in Google Trends' weekly search volume

Figure 3

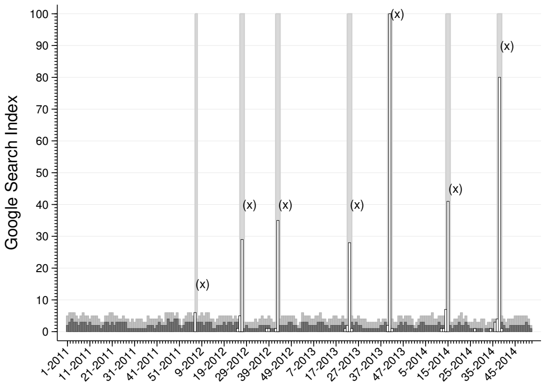
Google Trends' Weekly Search Volume Index for "Blitzmarathon", 2011 to 2014



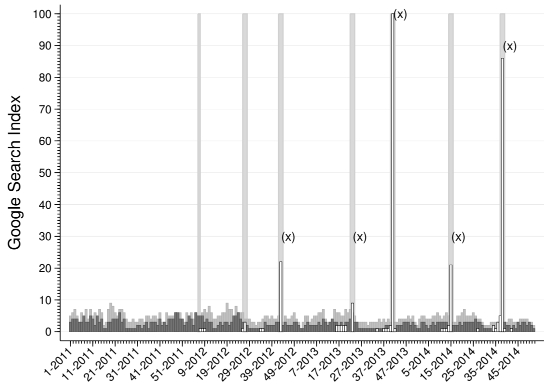
(a) Weekly search volume index



(b) Comparative weekly search volume index



(c) Comparative weekly search volume index, North Rhine-Westphalia



(d) Comparative weekly search volume index, Lower Saxony

Notes: Panel (a) shows Google Trends' weekly search volume index for the word "Blitzmarathon" for Germany. The numbers in parentheses indicate the number of participating states. Panel (b) compares the weekly search volume index for the word "Blitzmarathon" with the terms "Arbeitslosigkeit" (unemployment) and "Klimawandel (climate change). The numbers in parentheses indicate the number of participating states. Panel (c) compares the weekly search volume index for the word "Blitzmarathon" for North Rhine-Westphalia to the terms "Arbeitslosigkeit" (unemployment) and "Klimawandel (climate change). Participation in a Blitzmarathon is marked by "x". Panel (d) compares the weekly search volume index for the word "Blitzmarathon" for Lower Saxony to the two terms 'Arbeitslosigkeit" (unemployment) and "Klimawandel (climate change). Participation in a Blitzmarathon is marked by "x". The period corresponds to the years 2011 to 2014. Each gray bar marks a three week period: the week of a Blitzmarathon, the week before, and the week after. Google Trends assigns the maximum number of searches a value of 100; very low number of searches a value of zero. Source: Google Trends.

index. Google Trends assigns weeks with very low search volumes a zero.[8] Figure 3 (a) supports the non-existence of the term “Blitzmarathon” before 2012 and demonstrates that the Google search volume for “Blitzmarathon” is positively correlated with the date of a Blitzmarathon. However, in Figure 3 (a) we cannot quantify the public awareness, i.e., we cannot say anything about the size of the spikes, as the search volume index shows search volumes for a given term relative to all searches for that term. However, Google Trends allows us to compare search volumes of different terms, which enables us to relate the relative increases in Figure 3 (a) to relative changes of other searches.

Panels (b) to (d) in Figure 3 compare the weekly search volume index for the term “Blitzmarathon” to the terms “Arbeitslosigkeit” (unemployment) and “Klimawandel (climate change), two terms that are of a continuous public interest. Panel (b) makes the comparison for Germany, while Panels (c) and (d) limit the analysis to the state of North Rhine-Westphalia and Lower Saxony. As the initiator, North Rhine-Westphalia participated in all seven Blitzmarathons (“x” marks the dates). As the first to join the initiator, Lower Saxony participated in five Blitzmarathons together with North Rhine-Westphalia (“x” marks the dates). The relative comparison in Panels (b) to (d) reveals three important findings. (1) There are more searches for the term “Blitzmarathon” around a Blitzmarathon also relative to relative searches for “Arbeitslosigkeit” (unemployment) and “Klimawandel” (climate change). (2) Search volumes around a Blitzmarathon correlate with the participation of a state in a Blitzmarathon. (3) The first Blitzmarathon has received less attention compared to subsequent ones; the two nation-wide Blitzmarathons have overall and within states gained the most attention.[9]

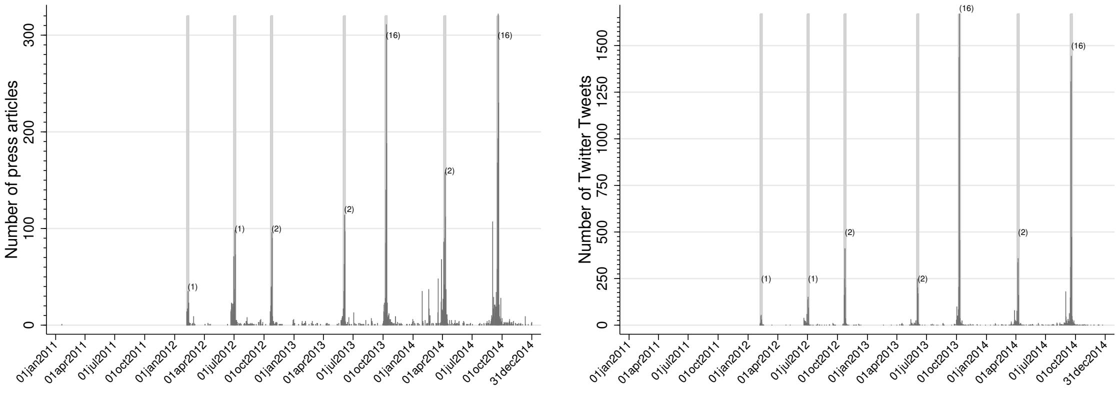
Panel (a) of Figure 4 plots the daily number of news media articles between 2011 and 2014 that mention the word “Blitzmarathon” either in the title or in the main text. The gray bars mark the Blitzmarathons including the three-day period before and after; the numbers in parentheses indicate the number of participating states. The data is available from WISO, a host which provides full text access to 60 million German speaking press articles from more than 150 regional and national newspapers, allowing a comprehensive media monitoring. As Figure 4 (a) shows, the mentioning of the word “Blitzmarathon” correlates highly with the occurrence of a Blitzmarathon. Moreover, media attention elevates already a few days in advance of a Blitzmarathon and remains elevated for a few days proceeding it. The former observation supports our argumentation that the public knows beforehand about the intervention. Appendix Figure B8 (a) shows that media

[8] If a person searches for the same term within a short period of time, Google eliminates repeated searches.

[9] Additional analysis for the other German federal states that participated in the Blitzmarathons on October 10, 2013 and September 18, 2014 support the finding that the search volume correlates with participating in a Blitzmarathon. If participating, the search volume is greatly increased also relatively to other important public topics. Moreover, comparing the word “Blitzmarathon” with general expressions for speed limit enforcement (“Radarkontrolle” and “Blitzer”), we find the very same pattern, suggesting that the word “Blitzmarathon” is not a substitute for these expressions during a Blitzmarathon-day.

Figure 4

Press Articles and Twitter Tweets including "Blitzmarathon", 2011 to 2014



(a) Daily number of press articles

(b) Daily number of Twitter Tweets

Notes: Panel (a) shows the daily number of press articles including the word "Blitzmarathon". Source: WISO. Panel (b) shows the number of daily Tweets including the word "Blitzmarathons". The period corresponds to the years 2011 to 2014. Source: Twitter. Each gray bar marks a Blitzmarathon-day, the period three days before and three days after a Blitzmarathon; the numbers in parentheses indicate the number of participating states.

coverage starts to increase on average three days before a Blitzmarathon; three days after a Blitzmarathon, the media rarely covers the topic.[10]

The analysis of Twitter data perpetuates once more the public awareness of the Blitzmarathon. Figure 4 (b) depicts the number of Tweets per day including the word "Blitzmarathon" between 2011 and 2014. In total, we extracted about 13,000 Blitzmarathon-Tweets that may belong to accounts of the media, private persons, or governmental organizations (including the police).[11] Figure 4 (b) remarkably resembles the Google and WISO figures, rupturing once more concerns that the public was not informed about the Blitzmarathon. Likewise, Appendix Figure B8 (b) reinforces that public attention increases a few days before a Blitzmarathon: the number of Twitter Tweets starts to increase around two days before a Blitzmarathon; two days after the Blitzmarathon, the campaign rarely receives attention on Twitter. Complementing this quantitative analysis, media sources reported that Twitter listed the hashtag "#Blitzmarathon" as the number one hashtag during the seventh Blitzmarathon (Handelsblatt, 19-09-2014).

Our analysis in this section shows that the public is aware of the Blitzmarathon-days, which greatly increase speed limit enforcement compared to regular days. To answer whether driving behavior and accidents respond to the Blitzmarathons, we explore the quasi-experimental nature of the Blitzmarathons, exploring both time and geographical

[10]Using the platform Lexis Nexis, which provides full text access to over 75 regional and national newspapers, yields very similar results compared to the WISO analysis.

[11]We extracted the Tweets manually from Twitter's advanced search, which contains a list of unfiltered Tweets for the search term. While APIs are available and generally make data collection easier, Twitter currently only allows to go back seven days in time.

variation in treatment exposure. More specifically, we test whether the Blitzmarathons affect the number and the severity of traffic accidents; we look at driving speed and analyze accident causes. To rule out that the Blitzmarathons crowd out traffic from the road, we test whether the number of cars and trucks on the road differ during Blitzmarathons compared to regular days.

3 Data

Accident Data

Our primary data source is the police reported accident statistic that includes all police reported vehicle crashes in Germany and spans the period from 2011 to 2014. The statistical offices of the German federal states (Statistische Ämter) maintain the data and make it available for research purposes.[12] The data compares to the Fatality Analysis Reporting System (FARS) data but includes also non-fatal accidents and additional information on the circumstances of each accident. Each accident record has detailed information about the number of slightly, severely, and fatally injured as well as on characteristics of the scene of the accident and people involved (e.g., age, gender, speed limit, and time of accident). For our sample period, we have information about 1.5 million police reported accidents.

We construct the sample used for analysis as follows: we exclude accidents where the person who caused the accident was conducting a train or omnibus, as these follow different traffic regulations and/or are not the target of the Blitzmarathons. In our main sample, we exclude accidents where the person who caused the accident was a bicyclist or a pedestrian. As described in the media quotes in section 2, the police motivate the Blitzmarathons also with the vulnerability of bicyclists or pedestrians in motor vehicle accidents. Feeling more protected during the Blitzmarathons, bicyclist or pedestrian might change their behavior, i.e., by behaving more risky. In additional analyses, we will therefore also look at accidents where the person who caused the accident was a bicyclist or pedestrian. Because the Blitzmarathons focus on regular working days and weekends, we drop all days with a public holiday in any state. Moreover, as public holidays are often used for short getaways, we also drop long weekends and the day before a long weekend, which span the days from Wednesday (Thursday) to Sunday when the public holiday is a Thursday (Friday); or the days from Friday to Monday (Tuesday) when the public holiday is a Monday (Tuesday). Finally, for each county, we aggregate all accidents to the day level so that our unit of observation is the daily number of accidents in each county.

Our sample includes the daily number of accidents, slightly injured, severely injured, and fatally injured for each of the 402 counties in Germany from 2011 to 2014. Panel (a)

[12] The police report all accidents with slightly, severely, or fatally injured to the statistical offices. In addition, the police report accidents with material damages when (1) at least one vehicle is non-roadworthy and (2) the accident involves a traffic offense, e.g., speeding or ignoring the right of way. Accidents where the involved parties reach a private agreement without giving notice to the police do not appear in our data.

in Table 2 summarizes these variables used in the empirical analysis. The police register on average 2.4 accidents per day and county, summing to around 950 accidents per day in Germany. In these 950 accidents, 770 people are slightly injured, 150 severely injured, and 8 fatally injured. In supplementary analyses, we use additional information on specific characteristics of the accident scene and on the person who caused the accident.

Table 2
Summary Statistics

Variable	N	Mean	S.D.	Min	Max
(a) Accidents					
Number of					
accidents	493,518	2.362	3.132	0	75
slightly injured	493,518	1.916	3.061	0	73
severely injured	493,518	0.367	0.774	0	32
fatally injured	493,518	0.021	0.157	0	8
(b) Traffic volume [1,000 vehicles/h]					
Number of					
passenger vehicles (freeway)	35,188,176	0.921	0.900	0	7.475
trucks (freeway)	35,188,176	0.166	0.160	0	2.172
passenger vehicles (federal roads)	40,898,880	0.252	0.335	0	6.320
trucks (federal roads)	40,898,880	0.023	0.034	0	0.513
Number of					
passenger vehicles (federal roads) [q/v–data]	20,462,014	0.265	0.265	0	6.821
trucks (federal roads) [q/v–data]	20,433,158	0.021	0.036	0	3.135
(c) Driving speed [km/h]					
passenger vehicles (federal roads) [q/v–data]	20,244,303	70.748	17.674	1	254
trucks (federal roads) [q/v–data]	17,501,447	64.273	13.670	1	153
(d) Weather control variables					
Mean temperature ($^{\circ}C$)	493,518	9.712	7.321	-19.1	30.6
Precipitation (mm)	493,518	1.980	4.558	0.0	111.4
Snow cover	493,518	0.070	0.254	0	1
Missing mean temperature	493,518	0.008	0.089	0	1
Missing precipitation (mm)	493,518	0.009	0.097	0	1
Missing snow cover	493,518	0.117	0.322	0	1
(e) Vacation control variables					
Last school day before a school vacation	493,518	0.011	0.106	0	1
School vacation	493,518	0.229	0.420	0	1
Last day of a school vacation	493,518	0.010	0.099	0	1

Notes: The table shows the number of observations, mean, standard deviation, minimum, and maximum for the variables in the data. Panels (a), (d), and (e) are based on county-day observations; Panels (b) and (c) are based on monitor-hour observations.

Traffic Volume and Driving Speed Data

In addition to the police reported accident statistic, we draw on data on hourly traffic volume from the Federal Highway Research Institute (Bundesanstalt für Straßenwesen, BASt) that spans the period from 2011 to 2014 and covers 345 out of 402 counties. Inductive loops embedded in the road pavement measure the hourly numbers of passenger vehicles (cars and motorbikes) and trucks passing a monitoring station. Hence, our unit of observation is the hourly number of passenger vehicles and trucks at each monitoring station. In total, we have traffic volume information from 1,220 automated monitoring stations on freeways and 1,408 automated monitoring stations on federal roads. Appendix Figure B9 shows the distribution of traffic volume measurement stations across Germany. Panel (b) in Table 2 summarizes the traffic volume data. On average, 900 motorized vehicles and 160 trucks pass a monitoring station on freeways every hour. The traffic volume on federal roads is considerably lower with 250 passenger vehicles and 20 trucks passing a monitoring station every hour.

There is no official organization that collects data on driving speed. However, we were able to receive hourly driving speed data from the state of Hesse (Hessen Mobil) as well as from the state of North Rhine-Westphalia (Landesbetrieb Straßenbau NRW) for the Ruhr area, a large region in the state. Using inductive monitoring loops or infrared detectors, driving speed is reported as the average hourly driving speed in km/h for passenger vehicles and trucks passing a monitoring station. Hence, our unit of observation here is the hourly driving speed for passenger vehicles and trucks at each monitoring station. Importantly, the police do not use the inductive loops or infrared detectors for speed limit enforcement. Moreover, because of the loops being embedded in the road pavement and infrared detectors being rather small, the monitoring is not prominent compared to speed cameras used for enforcement. In total, we have information from 1,017 monitoring stations on federal roads spanning the period from 2012 to 2014 and covering 39 counties. Appendix Figure B10 shows the distribution of driving speed measurement stations across the two areas from which we have information. Panel (c) in Table 2 summarizes the driving speed data. Passenger vehicles pass a monitoring station with on average 71 km/h; trucks with 64 km/h. The mean is in line with an average driving speed on federal roads between 50 km/h and 100 km/h.[13] As the driving speed data also provides information about traffic volume, we can compare the driving speed data that covers a part of Germany with the traffic volume data discussed in the previous paragraph. The means for traffic volume are very comparable in the two data sets: in the driving speed data, 260 passenger vehicles and 20 trucks pass a monitoring station every hour, which is almost identical to the figures for federal roads presented previously (see Panel (b) in Table 2).

Weather and Vacation Data

Finally, we collected data on school vacations and weather for the years 2011 to 2014 that we link to the accident, traffic volume, and speed data. Information on school vacations comes from the Standing Conference of the Ministers of Education and Cultural Affairs of the German federal states (Sekretariat der Ständigen Konferenz der Kultusminister). From this data, we generate a dummy variable equal to one if schools in a county are on vacation. In the same manner, we generate dummy variables for the last school

[13] Notice that we do not know the exact speed limit at each monitoring station. Hence, the analysis of the driving speed data focuses on the overall driving speed that may be within or above the speed limit on the road.

day before a school vacation and the last day of a school vacation. Weather data comes form the National Meteorological Service of Germany (Deutscher Wetterdienst, DWD) and contains information about the daily temperature in $^{\circ}C$, the amount of precipitation in mm, and snow cover for 523 weather stations. For each county, we use the weather station that is the closest to the center of the county. We impute missing values in the weather data with the daily mean value in the data. In the empirical analysis, we will include indicators for missing values.[14]

4 Empirical Strategy

We estimate the effect of the Blitzmarathons on traffic accidents using a linear generalized difference-in-differences specification. Our empirical strategy largely follows Bauernschuster et al. (2017) who estimate the effect of public transit strikes on various traffic related outcomes. In its standard specification, our difference-in-differences estimation equation takes the form:

$$Y_{ct} = \beta_0 + \beta_1(\mathit{Blitzmarathon}_{st}) + \beta_3 X_{ct} + \mu_y + \pi_m + \rho_d + \theta_c + \epsilon_{ct} \tag{1}$$

where Y_{ct} refers to the number of accidents or the number of road casualties on date t in county c. $\mathit{Blitzmarathon}_{st}$ denotes our variable of interest and equals one if a Blitzmarathon is in force in state s on date t and zero otherwise. When exploring the intensity of the treatment, we replace the variable *Blitzmarathon* with a variable that returns the number of temporary speed traps in county c if a Blitzmarathon is in force in state s on date t and zero otherwise. We control for a full set of time fixed effects: year (μ_y), month-of-year (π_m), and day-of-week (ρ_d) fixed effects absorb any time-varying shocks that are common to all counties, e.g., differences in traffic volume and, thus, accidents across days of the week. X_{ct} includes controls for weather conditions at the day and county level and controls for school vacations. Variables for weather conditions include the daily temperature in $^{\circ}C$, the amount of precipitation in mm, a dummy for snow cover, and three dummies indicating missing values for daily temperature, precipitation, and snow cover, respectively. The variables for school vacation include a dummy for school vacation, a dummy for the last school day before a school vacation, and a dummy for the last day of a school vacation. The inclusion of county fixed effects (θ_c) absorbs any permanent heterogeneity at the county or state level. ϵ_{ct} is an idiosyncratic error. Given the grouped structure of our data, we cluster standard errors at the county level to allow for serial correlation within counties.

The identification of our coefficient of interest (β_1) arises from variation in the participation in a Blitzmarathon over time and federal states. Our key identifying assumption is

[14]Missing values on snow cover are mainly concentrated in the summer time and the imputed values should produce very credible proxies. Dropping missing values instead of imputing them from the data produces very similar results.

that conditional on time and county fixed effects, weather conditions, and vacations, accidents in treated and untreated units follow a common path through time in the absence of the treatment. Hence, conditional on county and time fixed effects, weather conditions, and vacations, the Blitzmarathon is an exogenous event that is uncorrelated with unobservable factors and β_1 gives us the causal effect of the Blitzmarathons. Importantly, β_1 gives us the combined effect of (1) increasing speed limit enforcement and (2) inducing a media campaign that informs the public about the timing, extent, and purpose of the speed limit monitoring. Note that we cannot necessarily distinguish between (1) and (2) even when we include the number of temporary speed traps during the Blitzmarathons instead of the Blitzmarathon dummy, as the extent to which a county increases speed traps might very well correlate with the media coverage.

To check the robustness of our findings, we introduce further controls to the main model in equation 1. In additional specifications, we allow for county-specific time effects that control, for instance, for the already mentioned county-specific changes in automated permanent speed traps. In the most extensive specifications, we also introduce county-specific weather and vacation effects that are relevant when, for example, vacations in a given county cause traffic volume and, thus, potentially accidents to elevate more in a given county than in other counties.

In specifications where we estimate the effect of the Blitzmarathons on traffic volume and driving speed, we replace the county fixed effects with monitoring station fixed effects. Because traffic volume and driving speed data is hourly data, we additionally include hour-of-day and hour-of-day$\times$day-of-week fixed effects. To account for the varying number of monitoring stations within counties, we weight observations with probability weights of the inverse of the number of stations within each county.

5 Main Results

The Effect of the Blitzmarathons on Traffic Accidents

Table 3 reports our main results for the effect of the Blitzmarathons on the number of traffic accidents and road casualties for several specifications. For convenience, we only report the estimates of our key explanatory variables. The point estimate in Column (1) in Panel (a) suggests that the number of traffic accidents decrease by 0.12 during a Blitzmarathon-day compared to a regular day (significant at the one percent level). The introduction of controls for weather and vacations in Columns (2) and (3) slightly increases the point estimate. In Column (4), we introduce interactions between the time and county fixed effects. The point estimate is robust to the inclusion of these county-specific time effects. Likewise, the results in Columns (5) and (6) that introduce the county-specific weather and vacation effects, respectively, are very similar in magnitude to the results from the previous specifications. The point estimate from our most extensive and therefore preferred specification [Column (6)] suggests that the number of accidents during a Blitzmarathon decrease by 7.5 percent compared to regular days.

Table 3

The Effect of the Blitzmarathons on Traffic Accidents

	(1)	(2)	(3)	(4)	(5)	(6)
(a) Number of accidents						
[Mean: 2.362; N: 493,518]						
Blitzmarathon	-0.121^{***}	-0.146^{***}	-0.171^{***}	-0.174^{***}	-0.161^{***}	-0.178^{***}
	(0.044)	(0.045)	(0.045)	(0.046)	(0.046)	(0.047)
R^2	0.669	0.671	0.672	0.706	0.709	0.710
[Mean: 2.362; N: 493,458]						
No. of speed traps	0.001	0.001	0.000	-0.005^{***}	-0.005^{***}	-0.006^{***}
	(0.003)	(0.003)	(0.003)	(0.002)	(0.002)	(0.002)
R^2	0.669	0.671	0.672	0.706	0.709	0.710
(b) Number of slightly injured						
[Mean: 1.916; N: 493,518]						
Blitzmarathon	-0.126^{**}	-0.132^{**}	-0.154^{***}	-0.165^{***}	-0.155^{***}	-0.163^{***}
	(0.052)	(0.052)	(0.052)	(0.052)	(0.051)	(0.052)
R^2	0.582	0.583	0.584	0.620	0.623	0.624
[Mean: 1.916; N: 493,458]						
No. of speed traps	0.002	0.002	0.002	−0.005	-0.005^{*}	-0.006^{*}
	(0.004)	(0.004)	(0.004)	(0.003)	(0.003)	(0.003)
R^2	0.582	0.583	0.584	0.621	0.623	0.624
(c) Number of severely injured						
[Mean: 0.367; N: 493,518]						
Blitzmarathon	-0.036^{*}	−0.032	-0.035^{*}	−0.031	−0.029	−0.033
	(0.022)	(0.022)	(0.022)	(0.022)	(0.022)	(0.022)
R^2	0.123	0.124	0.124	0.130	0.130	0.128
[Mean: 0.367; N: 493,458]						
No. of speed traps	−0.001	−0.001	−0.001	-0.001^{*}	-0.001^{*}	-0.001^{*}
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
R^2	0.123	0.124	0.124	0.130	0.130	0.128
(d) Number of fatally injured						
[Mean: 0.021; N: 493,518]						
Blitzmarathon	−0.002	−0.001	−0.002	−0.001	−0.001	−0.001
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
R^2	0.122	0.123	0.124	0.129	0.129	0.128
[Mean: 0.021; N: 493,458]						
No. of speed traps	0.001	0.001	0.001	0.001	0.001	0.002
(×) 100	(0.013)	(0.013)	(0.013)	(0.014)	(0.014)	(0.014)
R^2	0.007	0.007	0.007	0.005	0.005	0.002
County FE	×	×	×	×	×	×
Time FE	×	×	×	×	×	×
Weather		×	×	×	×	×
Vacation			×	×	×	×
County × Time FE				×	×	×
County × Weather					×	×
County × Vacation						×

Table 3 continued

Notes: The table shows the effect of the Blitzmarathons on the number of traffic accidents [Panel (a)], slightly injured [Panel (b)], severely injured [Panel (c)], and fatally injured [Panel (d)]. Each column in each row presents a separate regression. All regressions are run at the county-day level. "Blitzmarathon" is as a dummy variable indicating the Blitzmarathon in each county; the variable "No. of speed traps" counts the number of temporary speed traps during a Blitzmarathon. For 60 treatment days, the number of speed traps is not available. All regressions include county and time fixed effects. Time fixed effects include day-of-week, month-of-year, and year fixed effects. Weather controls include atmospheric temperature, amount of precipitation, and a dummy for snow cover. Additionally, we include dummies indicating missing atmospheric temperature, missing amount of precipitation, and missing snow cover. Vacation controls include dummies for school vacation, the last school day before a school vacation, and the last day of a school vacation. County × Time, County × Weather, and County × Vacation are interaction of county indicators with all time fixed effects, weather controls, and vacation controls, respectively. The reported R-squared is the adjusted R-squared. Standard errors (in parentheses) are clustered at the county level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

The second part of Panel (a) replaces the Blitzmarathon dummy with the number of temporary speed traps during a Blitzmarathon, as a measure of the intensity of the treatment. Remember that we do not argue that this exercise separates the effect of the speed limit enforcement from the media campaign. Instead, we expect that the media coverage correlates with the number of speed traps. The point estimate for the number of speed traps in Panel (a) Columns (1) to (3) is positive but very close to zero and statistically insignificant. In Column (4), when we introduce interactions between the time and county fixed effects, the point estimate turns negative and becomes statistically significant at the one percent level. In Columns (5) and (6), the effect remains negative and highly significant. The result from our preferred specification [Column (6)] suggests that each additional temporary speed trap during a Blitzmarathon reduces the number of accidents by 0.006. Multiplying the point estimate with the mean number of temporary speed traps during a Blitzmarathon predicts a reduction in the number of accidents by $0.006 \times 24 = 0.144$; this mean effect is very comparable in magnitude to the effect from the specifications including the Blitzmarathon dummy.

Panels (b) to (d) repeat the exercises from Panel (a) for the number of slightly injured, severely injured, and fatally injured. The point estimates are overall again very stable across the different specifications and when we focus on the Blitzmarathon dummy. Our preferred specification in Column (6) suggest that the number of slightly injured, severely injured, and fatally injured decrease by 8.5 percent, 9.0 percent, and 4.8 percent, respectively, during a Blitzmarathon compared to regular days. While the precision of the point estimate for the number of slightly injured is high (significant at the one percent level), the large standard errors for the number of severely or fatally injured do not indicate statistical significance. When replacing the Blitzmarathon dummy with the number of speed traps during a Blitzmarathon and multiply the resulting point estimates with the mean number of temporary speed traps during a Blitzmarathon, we get again very comparable effects for the number of slightly injured ($0.006 \times 24 = 0.144$) and severely injured ($0.001 \times 24 = 0.024$). Given the comparability of specifications including the Blitzmarathon dummy and specifications including the number of speed traps, we focus in the following on specifications with the Blitzmarathon dummy. Dividing the number of accidents in accidents with material damage, accidents with slightly injured, accidents with severely injured, and accident with fatally injured buttresses that the Blitzmarathons reduce the number of accidents overall but also accident severity (Appendix Table B2).

In sum, the results from Table 3 show that the Blitzmarathons cause a significant reduction in the number of traffic accidents and road casualties on a Blitzmarathon–day compared to regular days. However, the initiators of the Blitzmarathons intended a permanent change in road safety. Therefore, in a next step, we ask how persistent the effect of the Blitzmarathons is over time.

The Effect of the Blitzmarathons on Traffic Accidents over Time

To estimate the effect of the Blitzmarathons over time, we include dummy variables for the time spanning the 15 days before and after a Blitzmarathon. We group the days before and after in intervals of three days so that we add in total ten dummy variables to our preferred specification [Column (6) in Table 3]. The dummy variables indicate how the accidents in the treated units evolve before and after a Blitzmarathon relative to the untreated units. If - conditional on county and time fixed effects, weather conditions, and vacations - the accidents in treated and untreated units follow a common path through time in the absence of the treatment, we should not find an effect of the "before" dummy variables on traffic accidents. Thus, including dummies for the time before a Blitzmarathon constitutes a falsification test.

Table 4 depicts the results for the number of accidents and the number of slightly injured, severely injured, and fatally injured when we include the ten time dummies. We draw three conclusions from this exercise. First, the small and imprecisely estimated point estimates for the time 4 to 15 days before a Blitzmarathon corroborate our identification strategy throughout all four outcomes. 4 to 15 days before a Blitzmarathon, accidents in treated units do not evolve differently than accidents in untreated units. Second, there is a quantitatively important and precisely estimated reduction of 4.7 percent in the number of accidents and a 5.4 percent reduction in the number of slightly injured one to three days before a Blitzmarathon [Columns (1) and (2)].[15] Importantly, the timing of these reductions remarkably coincides with the onset of the media coverage and Twitter Tweets before a Blitzmarathon (Appendix Figure B8). Note that also the number of severely injured substantially falls (by 5.2 percent) one to three days before a Blitzmarathon, however, as the reduction on the Blitzmarathon-day itself, the reduction right before a Blitzmarathon is imprecisely estimated for the number of severely injured [Column (3)]. Third, the effect of the Blitzmarathons on traffic accidents disappears immediately after the termination of the one-day lasting speed limit monitoring, rebutting any claims that the Blitzmarathons have a persistent effect on traffic accidents. This last result raises the

[15] Appendix Table B3 shows the results when we divide the number of accidents into the number of accidents with only material damage, accidents with slightly injured, accidents with severely injured, and accident with fatally injured. The table reveals that the reduction in the number of accidents stems from accidents with slightly injured.

Table 4
The Effect of the Blitzmarathons on Traffic Accidents over Time

	Number of accidents (1)	Number of slightly injured (2)	Number of severely injured (3)	Number of fatally injured (4)
13–15 days before	-0.060^{*}	-0.007	0.010	0.003
	(0.031)	(0.040)	(0.017)	(0.003)
10–12 days before	-0.012	-0.032	0.013	-0.000
	(0.028)	(0.033)	(0.013)	(0.003)
7–9 days before	-0.031	-0.019	-0.014	0.002
	(0.035)	(0.035)	(0.013)	(0.003)
4–6 days before	0.049	0.006	-0.004	-0.001
	(0.047)	(0.050)	(0.017)	(0.003)
1–3 days before	-0.112^{***}	-0.105^{***}	-0.019	-0.001
	(0.036)	(0.036)	(0.015)	(0.002)
Blitzmarathon	-0.188^{***}	-0.172^{***}	-0.032	-0.001
	(0.046)	(0.051)	(0.021)	(0.005)
1–3 days after	0.005	0.034	0.000	-0.000
	(0.033)	(0.038)	(0.016)	(0.003)
4–6 days after	-0.059^{*}	-0.041	0.006	0.004
	(0.034)	(0.040)	(0.016)	(0.004)
7–9 days after	-0.005	-0.017	0.020	-0.001
	(0.033)	(0.036)	(0.014)	(0.003)
10–12 days after	-0.018	-0.056	0.012	0.006
	(0.034)	(0.038)	(0.016)	(0.004)
13–15 days after	-0.003	-0.031	0.003	-0.003
	(0.034)	(0.039)	(0.015)	(0.003)
Mean	2.362	1.916	0.367	0.021
R^2	0.710	0.624	0.128	0.002

Notes: The table shows the effect of the Blitzmarathons +/− 15 days on the number of traffic accidents [Column (1)], slightly injured [Column (2)], severely injured [Column (3)], and fatally injured [Column (4)]. We group the 15 days before and after a Blitzmarathon in three-day intervals. Each column presents a separate regression. All regressions are run at the county-day level (N: 493,518). "Blitzmarathon" is as a dummy variable indicating the Blitzmarathon in each county. All regressions include county and time fixed effects, weather controls, vacation controls, and interactions of county indicators with all time fixed effects, weather controls, and vacation controls, respectively. Time fixed effects include day-of-week, month-of-year, and year fixed effects. Weather controls include atmospheric temperature, amount of precipitation, and a dummy for snow cover. Additionally, we include dummies indicating missing atmospheric temperature, missing amount of precipitation, and missing snow cover. Vacation controls include dummies for school vacation, the last school day before a school vacation, and the last day of a school vacation. The reported R-squared is the adjusted R-squared. Standard errors (in parentheses) are clustered at the county level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

question of whether a persistent effect would be expected if the Blitzmarathons would last for more than one day.

In addition to the one-day lasting Blitzmarathons, the state of Bavaria extends each Blitzmarathon by additional seven days. Importantly, there is no difference in the implementation of the Blitzmarathon extensions compared to the one-day Blitzmarathons (Bavarian Ministry of the Interior, for Building and Transport, personal communication November 16, 2015). However, even though treatment exposure during the extension periods is similar to the one-day Blitzmarathons, drivers may become more familiar with the speed traps' locations during the extension periods, leading to responsible driving only at the exact speed traps' locations. As only the state of Bavaria extends the Blitzmarathons,

Table 5

The Effect of the Blitzmarathon–Extensions on Traffic Accidents

	Number of accidents (1)	Number of slightly injured (2)	Number of severely injured (3)	Number of fatally injured (4)
(a) Blitzmarathon in Bavaria				
[N: 492,516]				
Blitzmarathon (Bavaria)	−0.106	−0.159*	0.036	−0.001
	(0.084)	(0.087)	(0.046)	(0.012)
Mean	2.361	1.915	0.367	0.021
R^2	0.709	0.624	0.128	0.002
(b) Blitzmarathon Extension in Bavaria				
[N: 493,668]				
Extension Blitzmarathon	−0.104***	−0.139***	0.002	0.005
	(0.031)	(0.034)	(0.015)	(0.004)
Mean	2.360	1.914	0.367	0.021
R^2	0.709	0.624	0.128	0.002

Notes: The table shows the effect of the Blitzmarathons and the Blitzmarathon extensions in Bavaria on the number of traffic accidents [Column (1)], slightly injured [Column (2)], severely injured [Column (3)], and fatally injured [Column (4)]. Each column presents a separate regression. All regressions are run at the county-day level. The sample in Panel (a) drops all one-day Blitzmarathons outside of Bavaria; the sample in Panel (b) drops all one-day Blitzmarathons and adds the observations for the two extension periods. "Blitzmarathon (Bavaria)" is as a dummy variable indicating the Blitzmarathon in Bavaria. "Extension Blitzmarathon " is a dummy variable indicating the Blitzmarathon extension in Bavaria. All regressions include county and time fixed effects, weather controls, vacation controls, and interaction of county indicators with all time fixed effects, weather controls, and vacation controls, respectively. Time fixed effects include day-of-week, month-of-year, and year fixed effects. Weather controls include atmospheric temperature, amount of precipitation, and a dummy for snow cover. Additionally, we include dummies indicating missing atmospheric temperature, missing amount of precipitation, and missing snow cover. Vacation controls include dummies for school vacation, the last school day before a school vacation, and the last day of a school vacation. The reported R-squared is the adjusted R-squared. Standard errors (in parentheses) are clustered at the county level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

we first estimate the effect of the Blitzmarathons for the state of Bavaria only. We do so by dropping all Blitzmarathon–days outside the state of Bavaria. As Bavaria participated only twice, we therewith reduce the number of treatment days at the county level substantially to $2 \times 96 = 192$. Moreover, as Bavaria's participation in the one-day Blitzmarathons occurs simultaneously throughout Germany, variation in the treatment stems from time variation only. Table 5 (a) presents the results of this exercise. The point estimate of the Blitzmarathon dummy in Columns (1) to (4) is partially imprecisely estimated but mostly comparable to our main effects [Column (6) in Table 3]. To estimate the effect of the Blitzmarathon extensions in Bavaria on traffic accidents, we now drop all one–day Blitzmarathons and add the observations for the two extension periods.[16] In this analysis, we can again explore variation in the treatment across time and counties; the number of treatment days at the county level sum to $96 \times 14 = 1,344$. The results in Table 5 (b) depict that continuous publicly announced speed limit enforcement (at least for seven days) keeps reducing the number of traffic accidents and slightly injured.[17]

Comparison with Another Traffic Law Enforcement Campaign

Even though accidents quickly return to a normal level after a Blitzmarathon, the effect of the Blitzmarathons on traffic accidents on the Blitzmarathon-day itself is quantitatively important. To put the effect size even more into perspective, we contrast the Blitzmarathon-effect with another large traffic law enforcement campaign: the TISPOL operations. The Traffic Information System Police is a network of traffic police forces within the European Union and carries out pan-European traffic law enforcement operations with focuses on speed, seat belt use, and driving under the influence of alcohol and drugs.[18] TISPOL operations usually last for one week without prior announcement of the geographical concentration of the police enforcement effort. While there are a few media reports informing about the TISPOL operations, in general, TISPOL operations receive much less attention than the Blitzmarathons. For instance, while the news articles search with the word "Blitzmarathon" yields 5,027 articles for seven Blitzmarathons [see Figure 4 (a)], the word "TISPOL" receives only 123 hits for 23 TISPOL operations in the same period. Moreover, the size of the enforcement is much smaller compared to the Blitzmarathons. While during a TISPOL operation from April 18 to 24, 2011, 300 police officers controlled driving speeds throughout Germany, more than 13,000 did so during the nation-wide Blitzmarathons in 2014. Table 6 contrasts the effect of the Blitzmarathons with the effect of the TISPOL operations empirically by including a dummy to our preferred model that equals one if a TISPOL operation is in force and zero otherwise. Even

[16] Likewise, in the analysis where we look at the one–day Blitzmarathons, we have dropped the two Blitzmarathon extension periods.

[17] We lack the statistical power to show how the effect of the seven-day extension periods evolves within these seven days, given that this would reduce the number of treatment days to 96 for each day of the extension period.

[18] TISPOL also carries out operations focusing on trucks and buses; in this analysis, we focus on TISPOL operations targeting passenger vehicles.

though the point estimates for the TISPOL operations have the expected signs, the point estimates are quantitatively small and imprecisely estimated. The point estimates for the Blitzmarathon dummies remain robust to controlling for TISPOL operations.[19]

Table 6

The Effect of the Blitzmarathons and TISPOL Operations on Traffic Accidents

	Number of accidents (1)	Number of slightly injured (2)	Number of severely injured (3)	Number of fatally injured (4)
Blitzmarathon	-0.178^{***}	-0.164^{***}	-0.033	-0.001
	(0.047)	(0.052)	(0.021)	(0.005)
TISPOL Operation	-0.007	-0.013	-0.005	-0.000
	(0.008)	(0.010)	(0.004)	(0.001)
Mean	2.362	1.916	0.367	0.021
R^2	0.710	0.624	0.128	0.002

Notes: The table shows the effect of the Blitzmarathons and TISPOL operations on the number of traffic accidents [Column (1)], slightly injured [Column (2)], severely injured [Column (3)], and fatally injured [Column (4)]. Each column presents a separate regression. All regressions are run at the county-day level (N: 493,518). "Blitzmarathon" is as a dummy variable indicating the Blitzmarathon in each county. All regressions include county and time fixed effects, weather controls, vacation controls, and interactions of county indicators with all time fixed effects, weather controls, and vacation controls, respectively. Time fixed effects include day-of-week, month-of-year, and year fixed effects. Weather controls include atmospheric temperature, amount of precipitation, and a dummy for snow cover. Additionally, we include dummies indicating missing atmospheric temperature, missing amount of precipitation, and missing snow cover. Vacation controls include dummies for school vacation, the last school day before a school vacation, and the last day of a school vacation. The reported R-squared is the adjusted R-squared. Standard errors (in parentheses) are clustered at the county level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

6 Heterogeneous Effects

Driver and Accident Scene Characteristics

Understanding how the Blitzmarathons affect traffic accidents requires a more in-depth analysis of which types of accidents respond to the campaign. Exploring all accident cases in our accident data, we can identify the following risk factors. One accident risk factor is the age of the driver. The accident risk is highest for drivers under the age of 26 and then falls steeply until age 40. The risk increases again for drivers in their late 40s, decreases for drivers in their 50s, and reaches a minimum in the late 60s. After age 60, the risk begins to rise once more. Another accident risk factor is gender; male drivers are responsible for 70 percent of all accidents and 80 percent of all fatal accidents. With respect to characteristics of the accident scene, around 45 percent of all accidents occur between 12:00 and 17:00, 60 percent at a speed limit of 50 km/h, and they primarily occur on federal roads. However, the severity of an accident clearly increases with the speed limit on the road: while only

[19] We also tested the robustness of the Blitzmarathon effect with respect to small scale traffic law enforcement campaigns (e.g., the previously mentioned campaign in Saxony) and the occurrence of national railway strikes; we find that the point estimate for the Blitzmarathon is very robust to this exercise for all four outcomes.

20 percent of all accidents occur at a speed limit of 100 km/h, this percentage increases to 50 percent for all fatal accidents.

We count the number of accidents for specific driver or accident scene characteristics and estimate how each of these created accident groups responds to the Blitzmarathons. Figure 5 shows the results of the described exercise.[20] We find the strongest effects for accidents where the person who caused the accident was very young (younger than 26 years), aged 51 to 55, elderly (older than 70 years), or male. In terms of the scene of the accident, the Blitzmarathons mostly affect accidents in the time between 12:00 to 17:00, on federal roads, and on roads with a speed limit of 50 km/h. Somewhat smaller effects can be seen for accidents after 17:00 and on roads with a speed limit of 70 to 100 km/h. We therefore find that the Blitzmarathons effectively reduce the number of accidents for those groups that bear the highest accident risk.

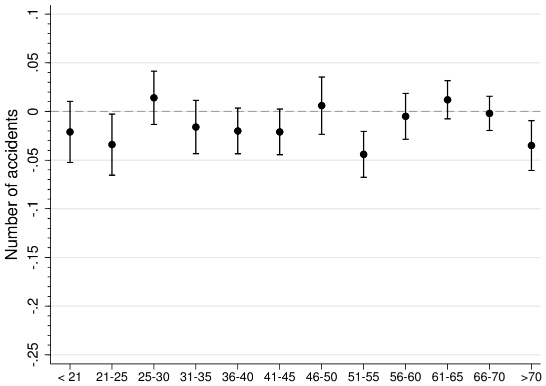
Importantly, we do not expect that accidents reduce for all types of roads. More specifically, we do not predict that accidents on roads with no speed limit or on freeways respond to the Blitzmarathons, as these are not the target of the Blitzmarathons and police presence should not increase on these roads on a Blitzmarathon-day.[21] Therefore, looking at the number of accidents on roads with no speed limit or on freeways serves as placebo test. The point estimates for the Blitzmarathon dummies in the regression on both the number of accidents on freeways and the number of accidents on roads without a speed limit are very close to zero, confirming that the placebo is in fact no outcome in the sense that it responds to the Blitzmarathons.

Until now, we have focused on accidents involving cars, motorbikes, and trucks. This brings into question whether drivers of one type of vehicle react more to the Blitzmarathons than others. Moreover, while the police clearly target motorized vehicles, the police presence may also affect the behavior of bicyclists and pedestrians. Figure 5 (f) shows the effect of the Blitzmarathons on the number of accidents where we divide the number of accidents into different types of road participation. This sample deviates from the sample described in Table 2, as we add the number of accidents where the person who caused the accident was a bicyclist or a pedestrian. The figure shows that car drivers cause the reduction in accidents during a Blitzmarathon-day. There is a small positive point estimate in the regression on the number of accidents where the person who caused the accident was riding a bicycle (significant at the 10 percent level). While it is likely that bicyclists drive more risky during a Blitzmarathon (because they feel better protected from motorized vehicles), the positive point estimate might also result from a switch from car use to bicycles. We will look at a change in traffic volume of passenger vehicles in the next section.

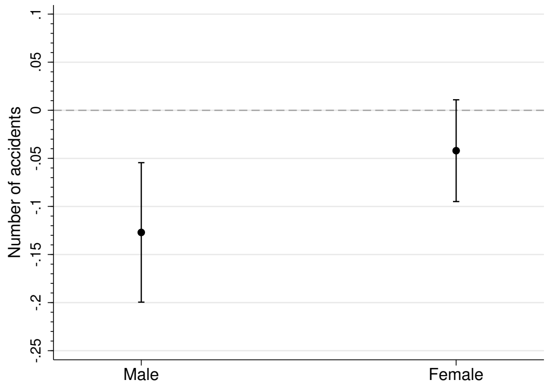
[20] Notice that we reduce the variation in the number of accidents substantially in this exercise. To not overfit the model, we estimate our basic model (equation 1), i.e., without the pairwise interactions between the county indicators and the time fixed effects, weather and vacation controls. Appendix Table B4 and Table B5 depict the point estimates and standard errors in a table for Panels (a) to (g) and Panel (f) in Figure 5, respectively. In addition to the division of the total number of accidents in groups, the table also categorizes the number of slightly injured, severely injured, and fatally injured.

[21] With some exceptions, there is generally no speed limit on freeways.

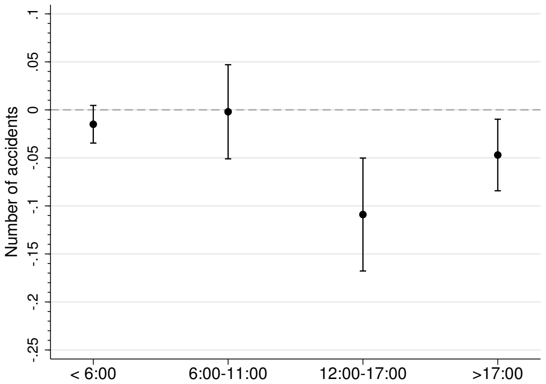
Figure 5
The Effect of the Blitzmarathons on Traffic Accidents by Driver and Accident Scene Characteristics



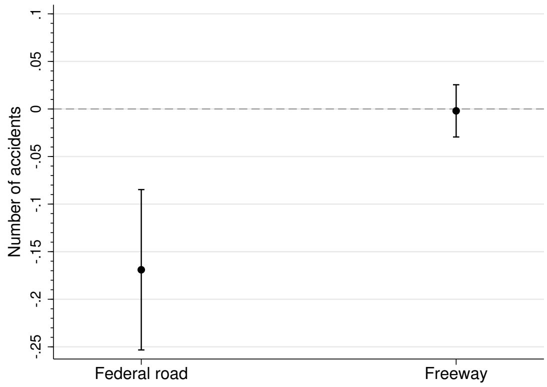
(a) Age of the driver



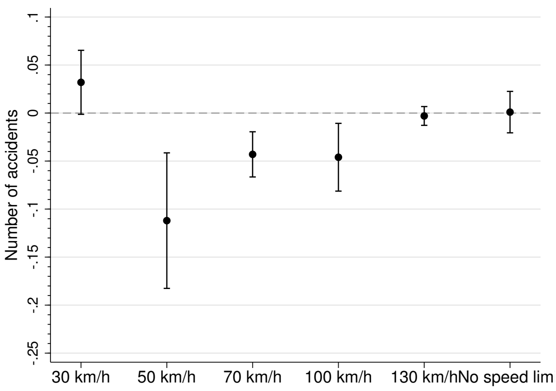
(b) Gender of the driver



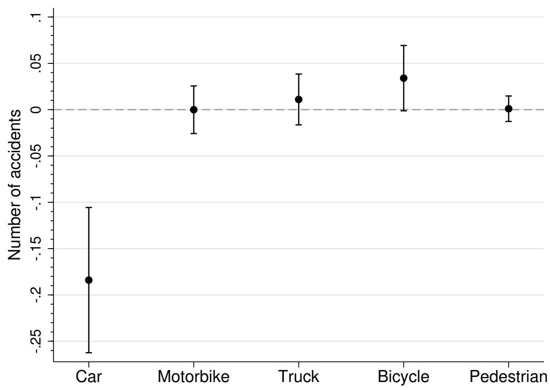
(c) Time of the accident



(d) Type of road



(e) Speed limit on the road



(f) Type of traffic participation

Notes: The figure shows the effect of the Blitzmarathons on the number of traffic accidents for different characteristics of the driver (person who caused the accident) or the scene of the accident. Panel (f) uses a sample that deviates from Table 2 by including also accidents where the person who caused the accident was a pedestrian or a bicyclist. The point markers indicate the point estimates of the variable Blitzmarathon; the whiskers represent the 95 percent confidence intervals. All regressions include county, day-of-week, month-of-year, year fixed effects; weather and vacation controls.

County Characteristics

We also study the heterogeneity of the Blitzmarathon-effect with respect to county characteristics. We first split the sample into urban and rural counties. While the total number of accidents is higher in urban than in rural counties, the risk of a an accident with severe injuries or fatalities is higher in rural than in urban counties. Appendix Table B6 (a) shows that accidents in rural counties seem to drive the effect of the Blitzmarathons on the overall number of accidents. However, in terms of fatally injured, we see a significant and large reduction in urban counties during a Blitzmarathon. In comparison, the corresponding point estimate in rural counties is positive and statistically insignificant at any conventional levels. Next, we split the sample in high and low accident risk counties. High risk counties are counties where the total number of accidents in 2011 per 100,000 population is above the 70th percentile; low risk counties are all other counties.[22] While the precision of the point estimates for the high risk counties is low, the estimates have the expected signs in all four outcomes and are generally larger than the estimates for the low risk counties.

Specific Federal States and Blitzmarathon Dates

To rule out that a specific Blitzmarathon or the participation of a specific state drives the Blitzmarathon-effect, we drop one-by-one a Blitzmarathon date (Appendix Figure B11) or a state (Appendix Figure B12) from our main sample. Overall, the effect of the Blitzmarathons is stable, rebutting concerns that our results reflect the effect from a particular state or Blitzmarathon-date.

7 Mechanisms

The reduction in the number of accidents during the Blitzmarathons suggests that publicly announced driving speed enforcement is effective in increasing road safety. However, until now we do not know whether a change in driving speed, a change in traffic volume, or other driving behavior, e.g., following the right of way, drive the reduction in the number of accidents. In the following, we will therefore look at how the Blitzmarathons affect (1) traffic volume, (2) driving speed, and (3) several reported accident causes.

The Effect of the Blitzmarathons on Hourly Traffic Volume

We begin our analysis of mechanisms by examining the effect of the Blitzmarathons on traffic volume. Instead of driving more responsibly during a Blitzmarathon, risky drivers may leave their car in the garage and instead use public transport, ride a bicycle, or walk. If these risky drivers are more likely to cause traffic accidents, this might explain the constituted effect of the Blitzmarathons on traffic accidents. Table 7 presents the results of

[22]Note that the average number of accidents can be higher in low risk counties.

Table 7

The Effect of the Blitzmarathons on Hourly Traffic Volume

	(1)	(2)	(3)	(4)	(5)	(6)
(a) Freeways: number of passenger vehicles / 1,000						
[Mean: 0.921; N: 35,188,176]						
Blitzmarathon	-0.004^{*}	-0.001	-0.0001	-0.009^{***}	-0.009^{***}	-0.012^{***}
	(0.002)	(0.002)	(0.0021)	(0.001)	(0.001)	(0.001)
R^2	0.771	0.771	0.771	0.970	0.970	0.971
(b) Freeways: number of trucks / 1,000						
[Mean: 0.166; N: 35,188,176]						
Blitzmarathon	0.003^{***}	0.003^{***}	0.002^{**}	-0.001^{***}	-0.001^{***}	-0.002^{***}
	(0.001)	(0.001)	(0.001)	(0.000)	(0.000)	(0.000)
R^2	0.793	0.793	0.794	0.968	0.968	0.969
(c) Federal roads: number of passenger vehicles / 1,000						
[Mean: 0.252; N: 40,898,880]						
Blitzmarathon	-0.002	-0.001	-0.001	-0.002^{***}	-0.002^{***}	-0.003^{***}
	(0.001)	(0.001)	(0.001)	(0.000)	(0.000)	(0.000)
R^2	0.707	0.707	0.708	0.981	0.982	0.982
(d) Federal roads: number of trucks / 1,000						
[Mean: 0.023; N: 40,898,880]						
Blitzmarathon × 100	0.008	0.011	0.002	0.014^{*}	0.014^{**}	0.005
	(0.015)	(0.015)	(0.015)	(0.007)	(0.007)	(0.007)
R^2	0.693	0.693	0.693	0.962	0.962	0.962
Monitor FE	×	×	×	×	×	×
Time FE	×	×	×	×	×	×
Weather		×	×	×	×	×
Vacations			×	×	×	×
Monitor × Time FE				×	×	×
Monitor × Weather					×	×
Monitor × Vacation						×

Notes: The table shows the effect of the Blitzmarathons on the number of cars on freeways [Panel (a)] the number of trucks on freeways [Panel (b)], the number of passenger vehicles on federal roads [Panel (c)], and the number of trucks on federal roads [Panel (d)]. The sample includes 1,220 monitoring stations on freeways and 1,408 monitoring stations on federal roads. An overview of the stations is given in Appendix Figure B9. All regressions are run at the monitor-hour level. "Blitzmarathon" is as a dummy variable indicating the Blitzmarathon in each county. All regressions include monitor station and time fixed effects. Time fixed effects include hour-of-day, day-of-week, month-of-year, hour-of-day×day-of-week, and year fixed effects. Weather controls include atmospheric temperature, amount of precipitation, and a dummy for snow cover. Additionally, we include dummies indicating missing atmospheric temperature, missing amount of precipitation, and missing snow cover. Vacation controls include dummies for school vacation, the last school day before a school vacation, and the last day of a school vacation. Monitor × Time, Monitor × Weather, and Monitor × Vacation are interactions of monitor station indicators with all time fixed effects, weather controls, and vacation controls, respectively. We weight observations with probability weights of the inverse of the number of stations within each county. The reported R-squared is the adjusted R-squared. Standard errors (in parentheses) are clustered at the monitor level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

regressing the Blitzmarathon dummy on the hourly number of vehicles in units of 1,000 for different specifications of model 1. We present the results separately for freeways and federal roads; for passenger vehicles (cars and motorbikes) and trucks. Recall previous analyses revealed that accidents with cars and accidents on federal roads drive the reduction in the number of accidents during the Blitzmarathons. Despite some point estimates having a negative and statistically significant sign, the size of neither point estimate is economically meaningful. For example, the point estimates in Panel (c), number of passenger vehicles on federal roads, imply a reduction in the number of cars between 0.4 and 1.2 percent. Taking into account that we have hourly data, we can also study the evolution of the effect of the Blitzmarathon throughout the day. In these unreported results, we find no indication of a substantial change in traffic volume throughout a Blitzmarathon-day.

The Effect of the Blitzmarathons on Hourly Driving Speed

Anecdotal evidence suggests that driving speeds are substantially lower during a Blitzmarathon compared to regular days. The media cites police officials that report a generally more responsible driving behavior and an overall lower driving speed during a Blitzmarathon.[23] A descriptive study from the Institute of Highway Engineering in Aachen (Oeser et al., 2015) shows that driving speed in the city of Cologne was two to three km/h lower during the Blitzmarathon in April 2015 compared to the five weeks surrounding the Blitzmarathon.[24] Interestingly, the study reveals lower driving speed at locations where the police were enforcing speed limits and at locations where the police were not enforcing speed limits. Moreover, there is an indication that driving speed reduces especially at places where there are generally high violations of speed limits. The study also presents descriptive evidence that the driving speed reduction persists for some days after the Blitzmarathon.

We have detailed driving speed information about federal roads, the road type that drive the reduction in the number of accidents during a Blitzmarathon. Our driving speed data is not covering all counties in Germany but is representative for the total sample.[25] Table 8 now presents the effect of the Blitzmarathons on hourly driving speed for different specifications of model 1 and separately for passenger vehicles (cars and motorbikes) and trucks. The results show a systematic reduction in passenger vehicle driving speed of around two km/h during a Blitzmarathon compared to regular days. This effect translates into a reduction of 2.6 percent compared to the mean.

In Figure 6, we show that the effect on driving speed by hour of the day. In this exercise, we interact the Blitzmarathon dummy with each hour of the day. The resulting estimates give us the effect of the Blitzmarathon at a given hour compared to a regular

[23]See Appendix A for selected quotes of police officers.

[24]The April 2015 Blitzmarathon is not in our data, however, it is comparable to those that we study.

[25]Appendix Table B7 depicts the effect of the Blitzmarathons on traffic volume in the driving speed data (q/v–data) separately for passenger vehicles and trucks on federal roads. The results are very comparable to the previous analysis from Panels (c) and (d) in Table 7 and show again no systematic change in traffic volume during a Blitzmarathon.

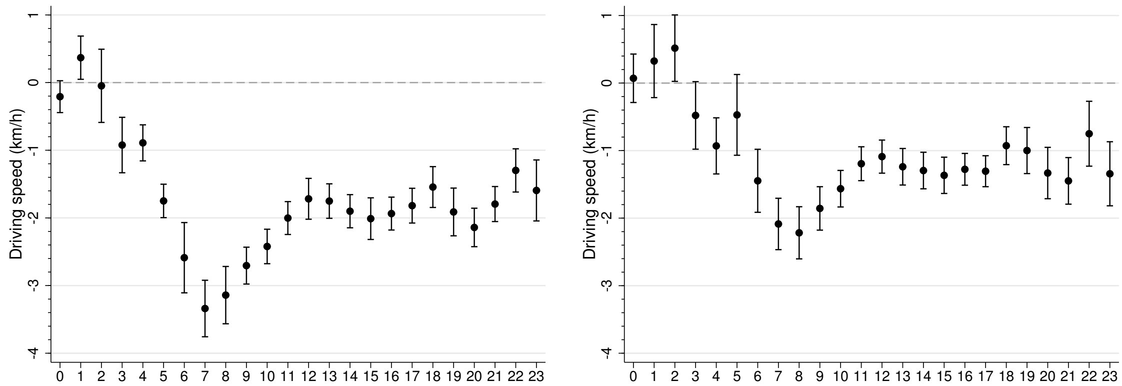
Table 8
The Effect of the Blitzmarathons on Hourly Driving Speed

	(1)	(2)	(3)	(4)	(5)	(6)
(a) Passenger vehicle driving speed [km/h]						
[Mean: 70.748; N: 20,244,303]						
Blitzmarathon	-1.816^{***}	-1.737^{***}	-1.586^{***}	-1.642^{***}	-1.730^{***}	-1.717^{***}
	(0.109)	(0.096)	(0.094)	(0.093)	(0.113)	(0.111)
R^2	0.872	0.873	0.873	0.921	0.922	0.922
(b) Truck driving speed [km/h]						
[Mean: 64.273; N: 17,501,447]						
Blitzmarathon	-0.945^{***}	-0.933^{***}	-0.812^{***}	-1.062^{***}	-1.117^{***}	-1.082^{***}
	(0.104)	(0.094)	(0.089)	(0.089)	(0.107)	(0.105)
R^2	0.716	0.717	0.717	0.787	0.788	0.791
Monitor FE	×	×	×	×	×	×
Time FE	×	×	×	×	×	×
Weather		×	×	×	×	×
Vacations			×	×	×	×
Monitor × Time FE				×	×	×
Monitor × Weather					×	×
Monitor × Vacation						×

Notes: The table shows the effect of the Blitzmarathons on driving speed for passenger vehicles [Panel (a)] and trucks [Panel (b)]. The sample includes 1,017 monitoring stations on federal roads. An overview is given in Appendix Figure B10. All regressions are run at the monitor-hour level. "Blitzmarathon" is as a dummy variable indicating the Blitzmarathon in each county. All regressions include monitor station and time fixed effects. Time fixed effects include hour-of-day, day-of-week, month-of-year, hour-of-day×day-of-week, and year fixed effects. Weather controls include atmospheric temperature, amount of precipitation, and a dummy for snow cover. Additionally, we include dummies indicating missing atmospheric temperature, missing amount of precipitation, and missing snow cover. Vacation controls include dummies for school vacation, the last school day before a school vacation, and the last day of a school vacation. Monitor × Time, Monitor × Weather, and Monitor × Vacation are interactions of monitor station indicators with all time fixed effects, weather controls, and vacation controls, respectively. We weight observations with probability weights of the inverse of the number of stations within each county. The reported R-squared is the adjusted R-squared. Standard errors (in parentheses) are clustered at the monitor level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Figure 6

The Effect of the Blitzmarathons on Hourly Driving Speed by Hour of the Day



(a) Passenger vehicles

(b) Trucks

Notes: The table shows the effect of the Blitzmarathons on driving speed by hour of the day for passenger vehicles [Panel (a)] and trucks [Panel (b)]. The point markers indicate the point estimates of the variable Blitzmarathon interacted with dummies for hour of the day; the whiskers represent the 95 percent confidence intervals. All regressions include hour-of-day, day-of-week, month-of-year, hour-of-day$\times$day-of-week, and year fixed effects; weather and vacation controls; and interactions of monitor station indicators with all time fixed effects, weather controls, and vacation controls, respectively.

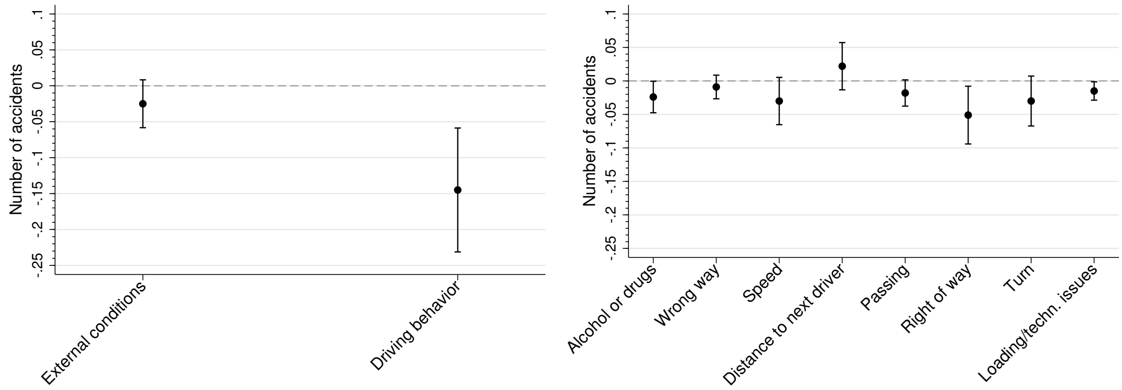
day at the same hour. Figure 6 (a) shows that passenger vehicle driving speed is lower throughout a Blitzmarathon–day, starting at 5:00 in the morning. The effect of truck driving speed is slightly smaller but evolves similar to the passenger vehicle results. In contrast to the results on traffic accidents, there is no indication that speed reduces already before a Blitzmarathon. Moreover, the effect vanishes immediately with the termination of a Blitzmarathon (see Appendix Figure B13).

Cause of Accident

Lower driving speed might not be the only mechanism that explains the reduction in the number of accidents during the Blitzmarathons. While the police are officially detecting speed violations during a Blitzmarathon, they fine drivers for other offenses as well, for instance, for wearing no helmet, using no seat belt, talking on the phone, driving under the influence of drugs and alcohol, or possessing no driver's license. To answer whether drivers behave overall more responsibly during a Blitzmarathon, we study the police-reported accident causes. The police differentiate between external causes (i.e., weather and road conditions) and driving behavior, where these two groups are not mutually exclusive. In addition, the police distinguish between different driving behaviors, for instance, driving under the influence of alcohol and drugs, speeding, or disregarding the right of way.

Figure 7

The Effect of the Blitzmarathons on Traffic Accidents by Cause of Accident



(a) External versus behavioral causes

(b) Behavioral causes

Notes: The figure shows the effect of the Blitzmarathons on the number of traffic accidents for different reported accident causes. The point markers indicate the point estimates of the variable Blitzmarathon; the whiskers represent the 95 percent confidence intervals. All regressions include county, day-of-week, month-of-year, year fixed effects; weather and vacation controls.

Figure 7 presents the effect of the Blitzmarathons on the number of traffic accidents for different reported accident causes.[26] The results in Panel (a) suggest that a more responsible driving behavior causes the reduction in the number of accidents during the Blitzmarathons. In terms of the specific characteristics of the driving behavior [Panel (b)], we find an indication that the change in driving behavior reflects not only a change in driving speed but also an overall more responsible behavior, i.e., following the right of way, no alcohol and drug use, and turning correctly left or right. However, while the point estimates for nearly all outcomes in Panel (b) are negative, they are also mostly imprecisely estimated.

Except for fatal accidents, where an external expert assesses the accident cause, the reporting of causes reflect subjective evaluations of the police officers. If these subjective evaluations induce measurement error in our dependent variables (which count the number of accidents for different causes) the precision of our estimates will fall. Even more importantly, if the reporting is different on Blitzmarathon-days compared to regular days, we might get biased estimates. For example, a negative effect of the Blitzmarathons on the number of accidents that are due to driving behavior may overstate the true reduction if the police report fewer driving behavior related causes during a Blitzmarathon in favor of the goals of the campaign. Contrary, the police may systematically report more driving behavior related causes and fewer external causes if the Blitzmarathons induce better reporting (i.e. the police pay more attention) and on regular days the police overreport

[26] Appendix Table B8 shows the point estimates and standard errors in a table. In addition to the division of the total number of accidents, the table also categorizes the number of slightly injured, severely injured, and fatally injured. Again, in order to not overfit the model, we estimate equation 1 without the pairwise interactions between the county indicators and the time fixed effects, weather and vacation controls.

external causes. Given the issues with respect to the reporting of accident causes, the results can only be indicative of the change in driving behavior.[27]

8 Conclusion

In this paper, we evaluate a traffic safety campaign in terms of its effectiveness in reducing the number and the severity of traffic accidents. The campaign features repeated massive one-day lasting speed limit monitoring (the so called Blitzmarathons) and a media campaign that informs the public in advance about each Blitzmarathon. Our results suggest that the Blitzmarathons cause a significant reduction in the number of traffic accidents and road casualties compared to regular days. The effect begins to emerge with the onset of the media reporting, one to three days before a Blitzmarathon. However, while the initiators of the campaign intended a permanent change in road safety, we do not find that the reduction in traffic accidents persists beyond a Blitzmarathon-day. In terms of mechanisms, we show that a substitution of traffic from motorized vehicles to other modes of transport not targeted by the Blitzmarathons does not drive our results, and we demonstrate that overall driving speed is lower during a Blitzmarathon compared to other days. There is suggestive evidence that drivers behave more responsibly during a Blitzmarathon also with respect to following the right of way, no alcohol and drug use, or turning correctly left or right.

Even though the reduction in traffic accidents is temporary, we see that speed limit enforcement can be effective in increasing road safety. Moreover, in comparison to a large pan-European traffic campaign, we demonstrate that the combination of massive driving speed monitoring with a media campaign that informs the public about the purpose of the intervention is more effective than a moderate driving speed monitoring without the inclusion of the media. In addition to the measured temporary effect, there could be a potential gradual effect in the sense that the awareness of speeding increases with every Blitzmarathon and the number of accidents falls step-by-step a little more. Yet, at least within our study period, we do not see that the more recent Blitzmarathons have a particularly pronounced effect. One potential extension of the campaign could be to combine the publicly announced speed limit enforcement with the introduction of stricter speed limits or higher fines.

To put the effect of the Blitzmarathons on traffic accidents even more into perspective, we would like to contrast benefits and costs. Besides material damage, accidents raise medical care costs and reduce productivity, household production, and life satisfaction for casualties, depending on the severity of the accident. Using monetized values of these

[27] According to the Peltzman-effect (Peltzman, 1976), a regulation induces drivers to become more risky in non-regulated domains of driving behavior. Given that the police can stop and fine drivers for all types of offenses, we find it unlikely that this type of offsetting behavior occurs for the Blitzmarathons. In fact, Figure 7 (b) provides no indication that non-speed related accidents increase during the Blitzmarathons. Moreover, if the Peltzman-effect covers non-regulated domains of driving behavior that are difficult to prove, e.g., inattention while driving, we should see an increase in the number of accidents with external causes which is not the case.

accident costs, we find that the seven Blitzmarathon-days between 2012 and 2014 saved economic costs in the order of 9.5 to 11.0 million euro (Appendix Table B9). The inclusion of the lower number of accidents and injured starting with the media announcement of the Blitzmarathons, raises the reduction in economic costs by an additional two million.

In contrast to the benefits, the costs of the Blitzmarathons are much more difficult to assess. From media reports, we calculate that around 47,000 police officers must have enforced speed limits during the seven Blitzmarathon-days, but we do not know exactly into how many working hours this effort translates. From the state of Lower Saxony, we have information that each counted police officer in a Blitzmarathon spends around four hours with speed limit monitoring. Generalizing this to Germany, this results in $47,000 \times 4$ hours $= 188,000$ hours and expenditures of roughly 9.6 million euros.[28] The upper limit in terms of hours spent monitoring speed during a Blitzmarathon is eight hours (length of a regular working day), summing to $47,000 \times 8$ hours $= 376,000$ hours and expenditures of 19.2 million euros. To justify the Blitzmarathons, the costs for the police should not exceed 11.0 million euro, taking the values from Appendix Table B9. However, in addition to the direct costs for the police, there may be indirect costs (or benefits) from an increased concentration of police officers on the road. On the one hand, the increased concentration of police officers on the road may cause non-traffic related crime rates to elevate. On the other hand, from a range of economics studies we know that an increase in the presence of the police on the streets (for whatever reason) causes violent and property crime rates to fall (see, for instance, Di Tella and Schargrodsky, 2004; Draca et al., 2011; Machin and Marie, 2011). So if there is a crowding out of overall crime prevention efforts, there needs to be a distinction between Blitzmarathon-days and regular days as well as consideration of potentially lower crime rates during a Blitzmarathon-day. These potential crime effects could be explored in future research.

[28] For the average cost of a police officer we take the value of 51 euros per hour from Krems (2016) that includes wages, social contributions, and future pensions.

A Media Quotes of Police Officers

Blitzmarathon February 10, 2012

- "Almost all were driving very responsibly." (WAZ Hattingen, 10-02-2012)
- "Because of the media reports, the drivers are especially attentive." (WAT Lethmathe, 10-02-2012)
- "Those who were on the road in Oberberg could see that many drivers were driving with less speed than on regular days, sometimes they were even going slower than what the maximum speed limit allows." (RP Hueckeswagen, 13-02-2012)

Blitzmarathon July 3, 2012

- He [chief inspector] knows that many drivers were driving especially careful because of the Blitzmarathon. "But that is the whole point of it". (RP Grevenbroich, 03-07-2012)
- "Many drivers were clearly much more disciplined than on other days which is not unexpected but a desirable effect, given the numerous announcements in advance." (Aachener Zeitung, 05-07-2012)
- "The announcements were effective: most drivers were going with less speed and more discipline." (General Anzeiger Bonn, 05-07-2012)

Blitzmarathon October 24, 2012

- "We noticed that many drivers adjusted to the announced police controls and followed traffic regulations." (Ruhr Nachrichten Luenen, 25-10-2012)
- The police confirm that drivers were behaving "pronouncedly disciplined." (Westfaelische Nachrichten Muenster, 25-10-2012)
- "Drivers were obviously warned and comply with the speed limits." (HNA Goettingen, 24-10-2012)

Blitzmarathon June 4, 2013

- On June 4, 2013, four percent of the controlled vehicles violated the speed limit. "Considering that on normal days eight percent of all [controlled] drivers are caught for driving too fast, the drivers obviously complied more with the speed limits.(...) Most drivers behaved very responsibly and complied with the traffic regulations." (DerWesten Siegen, 05-06-2013)
- "People adjust and drive more slowly." (Aachener Zeitung Heinsberg, 04-06-2013)
- Drivers were "altogether exceptionally disciplined." (Ruhr Nachrichten Steinfurt, 05-06-2013)

Blitzmarathon October 10, 2013

- "People are driving especially careful today. We notice that our campaign is successful.(...) That there is no result [referring to the low detection rate] is a result for us, a good one." (Suedwest Presse Ulm, 10-10-2013)

- “We observe a strikingly calm driving style. (...) In total, we observe a very careful driving.” The detection rate is much higher during announced speed controls, says the police spokeswoman. (Hamburger Abendblatt, 11-10-2013)
- ”We achieved the goals we had. (...) Most cars were forewarned and were driving considerably more slowly.” (Potsdamer Neueste Nachrichten, 11-10-2013)

Blitzmarathon April 8, 2014

- “Even if the number of detected traffic offenders is relatively low given the large number of controls, the police and the county are very satisfied with the result. It shows that the drivers complied with speed limits at least in the last 24 hours.” (Hamburger Abendblatt Winsen/Stade, 10-04-2014)
- “We notice that the behavior has changed. The driving speed has already clearly declined.” (RP Dinslaken, 09-04-2014)
- “When we usually conduct speed controls here, we have relatively many hits [offenders]. (...) Usually, only one percent of all trucks are driving at 60km/h [speed limit], most trucks are usually driving at 70 to 80 km/h.”(Allgmeine Zeitung Uelzen, 09-04-2014)

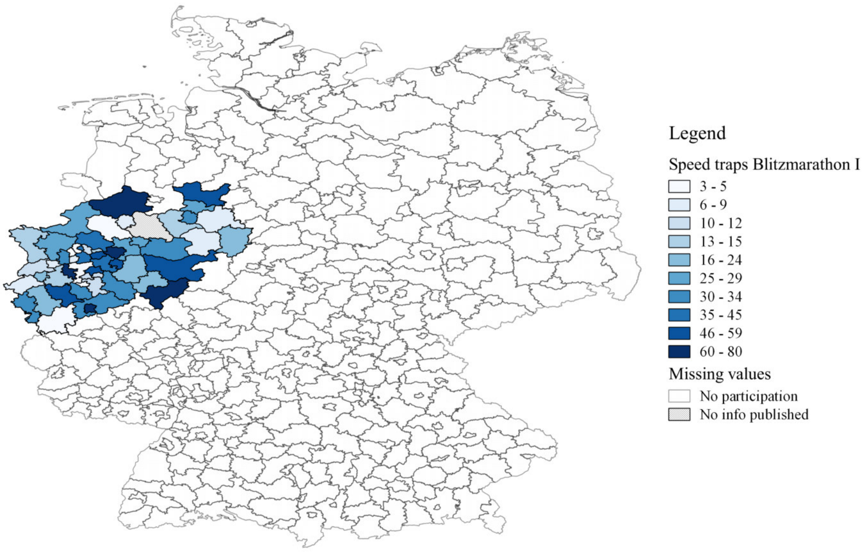
Blitzmarathon September 18, 2014

- “They were clearly driving with less speed than usually.” (NWZ Duesseldorf, 19-09-2014)
- The police note an “essentially more relaxed and responsible behavior” on Berlin’s roads. (Berliner Morgenpost, 19-09-2014)
- “The drivers were warned. This leads to slower driving. This is exactly our goal.” (Mitteldeutsche Zeitung Aschersleben, 18-09-2014)

(All quotes are translated from German)

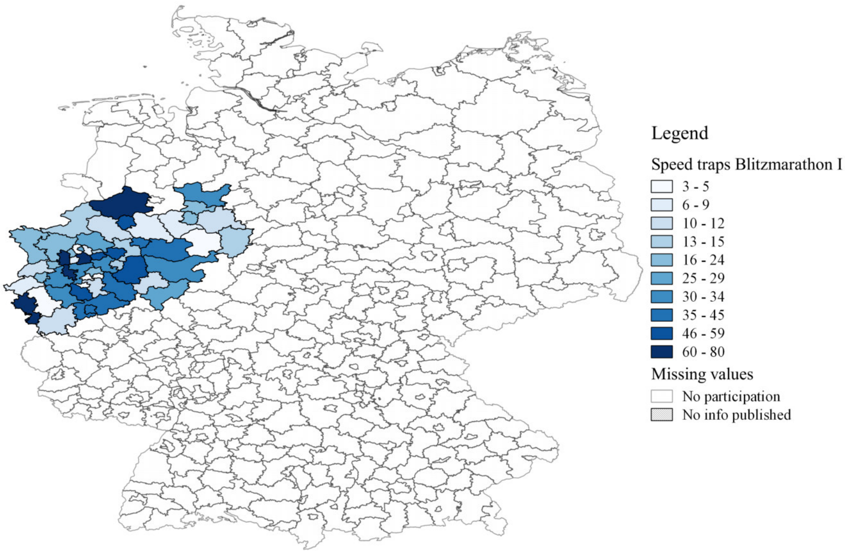
B Supplementary Figures and Tables

Figure B1
Number of Temporary Speed Traps per County Blitzmarathon I



Notes: The figure shows the number of temporary (mobile) speed traps per county during the first Blitzmarathon. Source: own data

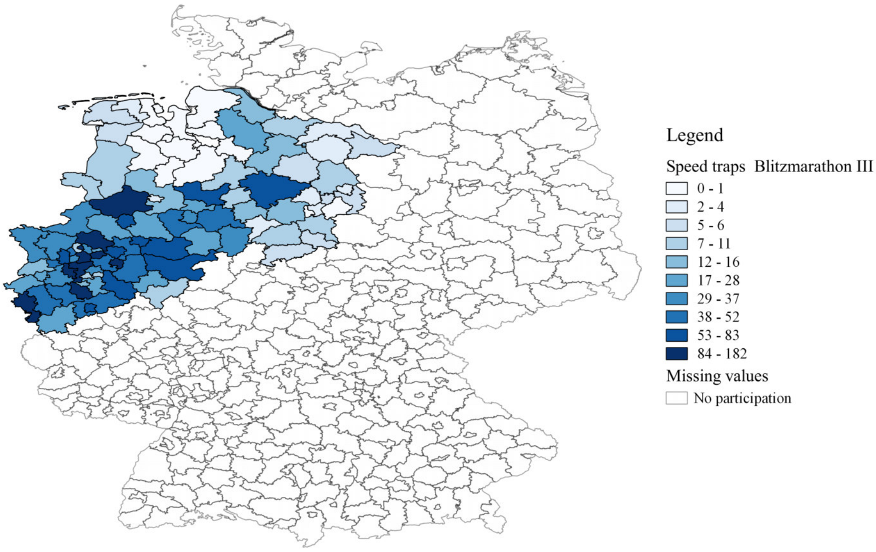
Figure B2
Number of Temporary Speed Traps per County Blitzmarathon II



Notes: The figure shows the number of temporary (mobile) speed traps per county during the second Blitzmarathon. Source: own data

Figure B3

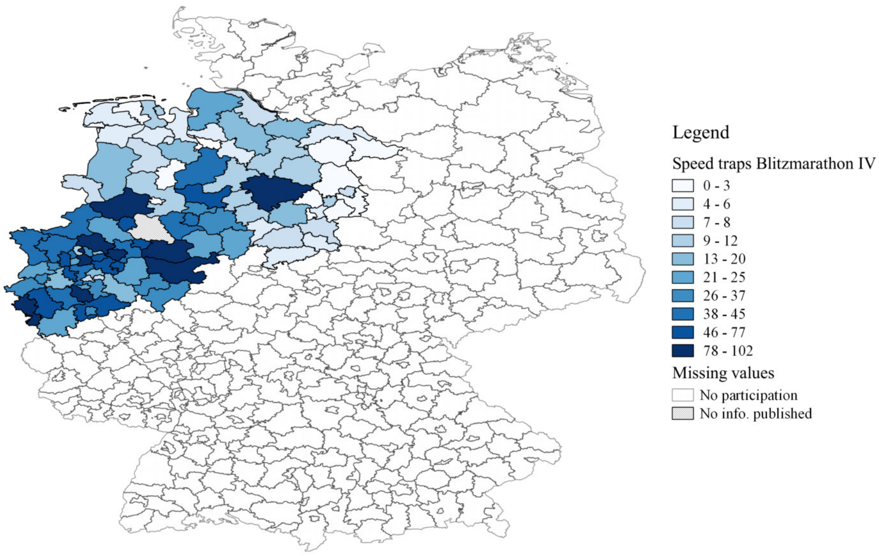
Number of Temporary Speed Traps per County Blitzmarathon III



Notes: The figure shows the number of temporary (mobile) speed traps per county during the third Blitzmarathon. Source: own data

Figure B4

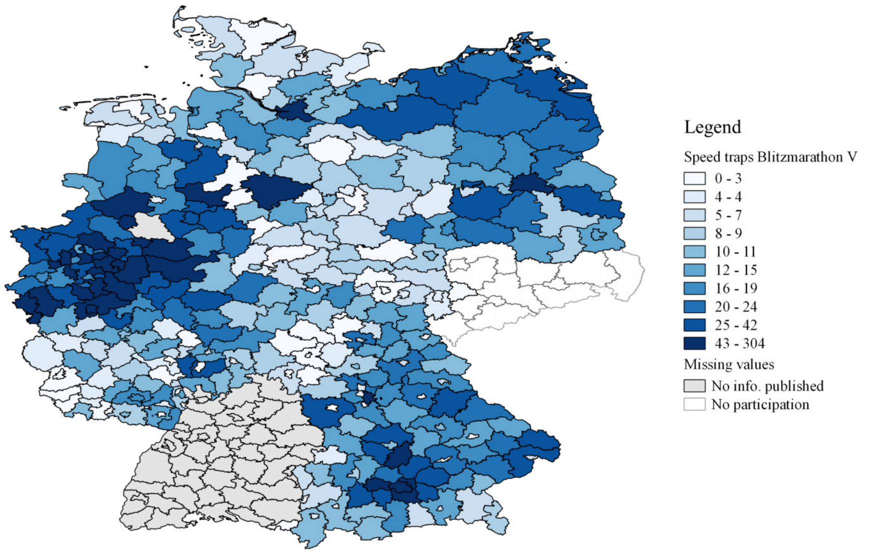
Number of Temporary Speed Traps per County Blitzmarathon IV



Notes: The figure shows the number of temporary (mobile) speed traps per county during the fourth Blitzmarathon. Source: own data

Figure B5

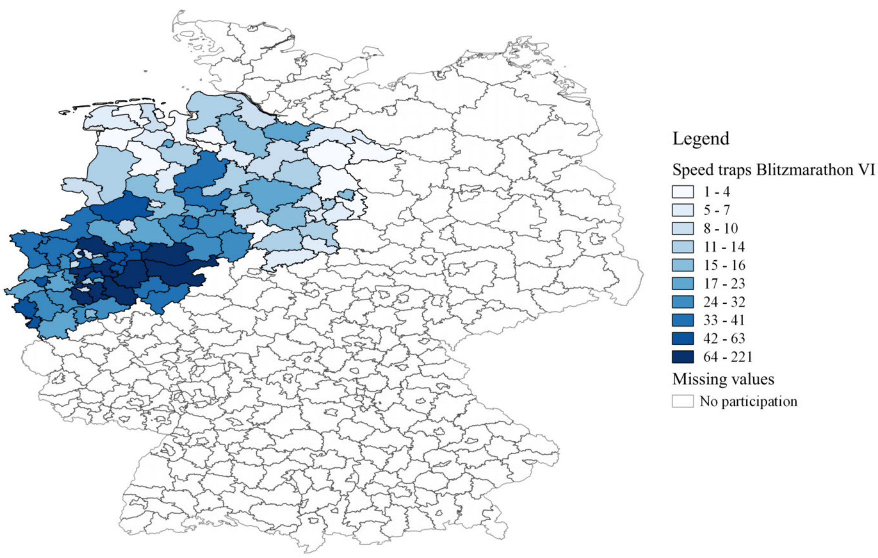
Number of Temporary Speed Traps per County Blitzmarathon V



Notes: The figure shows the number of temporary (mobile) speed traps per county during the fifth Blitzmarathon. Source: own data

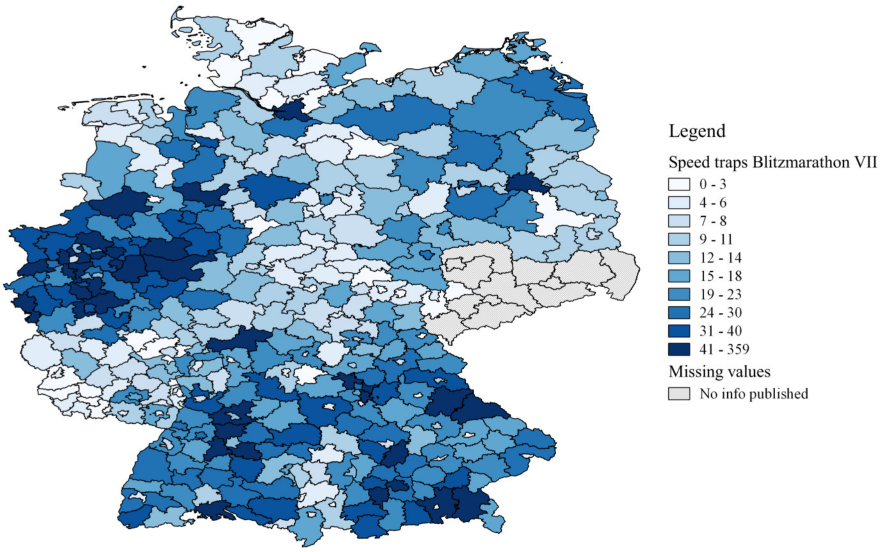
Figure B6

Number of Temporary Speed Traps per County Blitzmarathon VI



Notes: The figure shows the number of temporary (mobile) speed traps per county during the sixth Blitzmarathon. Source: own data

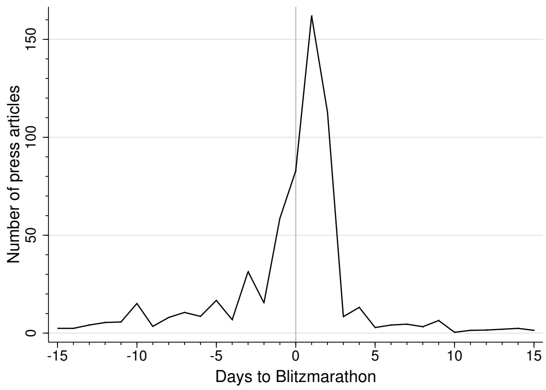
Figure B7
Number of Temporary Speed Traps per County Blitzmarathon VII



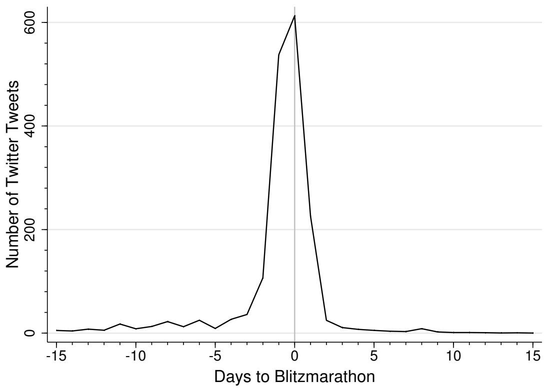
Notes: The figure shows the number of temporary (mobile) speed traps per county during the seventh Blitzmarathon. Source: own data

Figure B8

Press Articles and Twitter Tweets including “Blitzmarathon”, 15 Days before and after a Blitzmarathon



(a) Average number of press articles

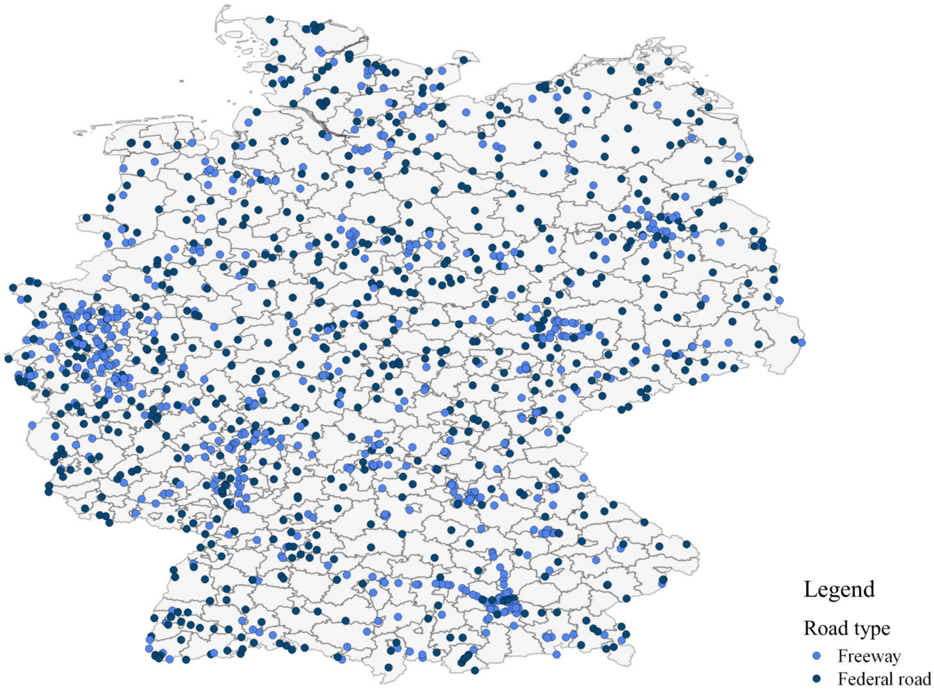


(b) Average number of Twitter Tweets

Notes: The Figure shows the average daily number of press articles [Panel (a)] and Twitter Tweets [Panel(b)] 15 days before and a after a Blitzmarathon. Source: WISO, Twitter.

Figure B9

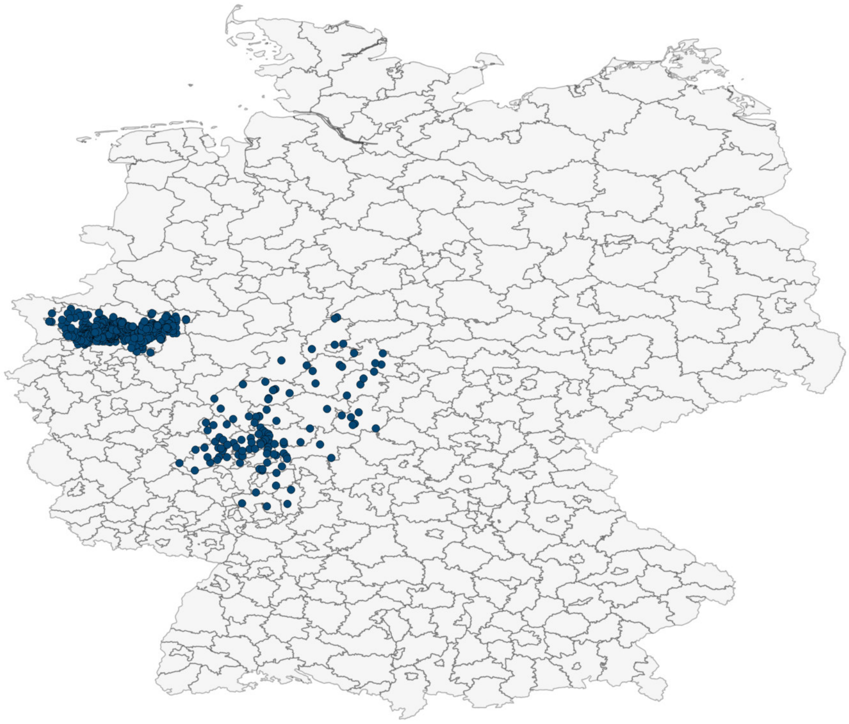
Locations of Traffic Volume Monitoring Stations



Notes: The figure shows the locations of the monitoring stations for the data on the number of passenger vehicles and trucks per hour. The sample includes 1,220 monitoring stations on freeways and 1,408 monitoring stations on federal roads, measuring the hourly number of vehicles on the road. Source: Federal Highway Research Institute (Bundesanstalt für Straßenwesen, BASt).

Figure B10

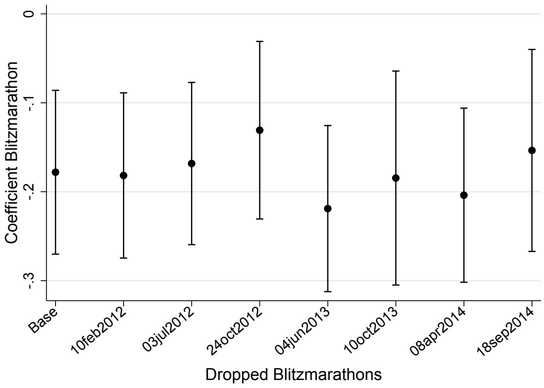
Locations of Driving Speed Monitoring Stations



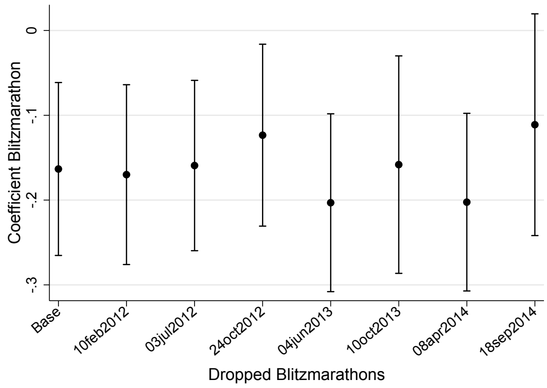
Notes: The figure shows the locations of the monitoring stations for the data on hourly driving speed for passenger vehicles and trucks. The sample includes 1,017 monitoring stations on federal roads, measuring the hourly number of vehicles on the road and their average driving speed. Source: Federal State of Hesse (Hessen Mobil) and North Rhine-Westphalia (Landesbetrieb Straßenbau NRW).

Figure B11

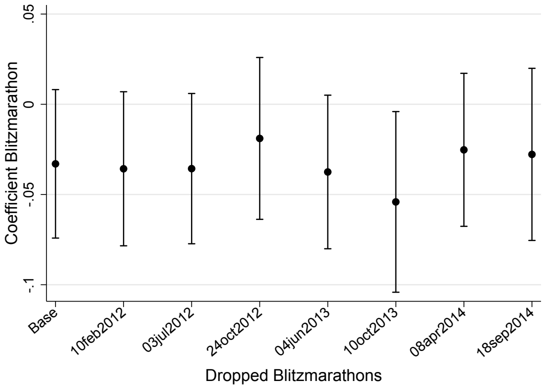
Dropping Blitzmarathon Dates One-by-One



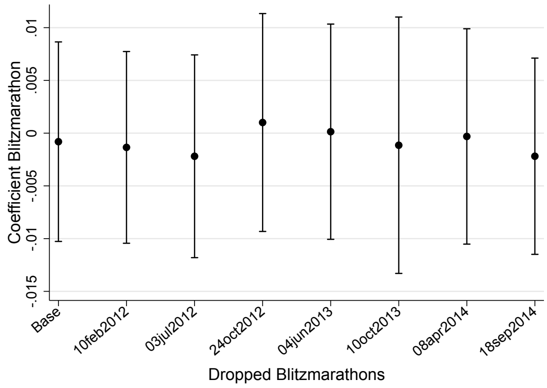
(a) Number of accidents



(b) Number of slightly injured



(c) Number of severely injured

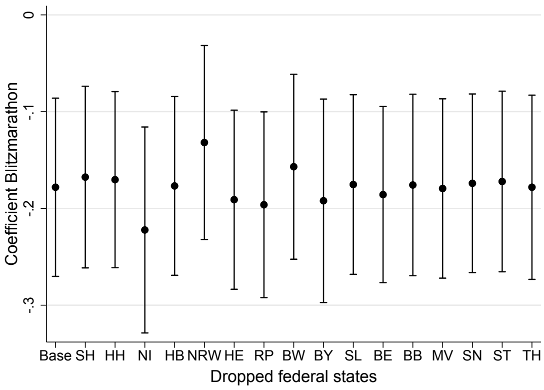


(d) Number of fatally injured

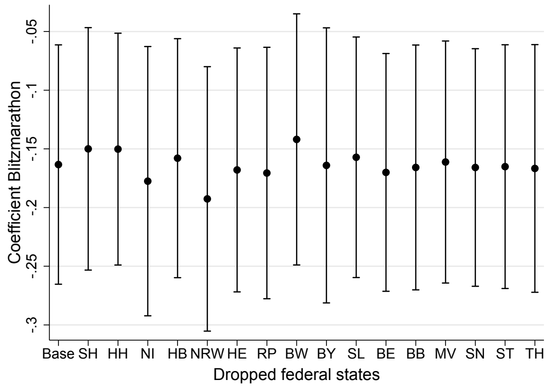
Notes: The figure shows the effect of the Blitzmarathons on the number of traffic accidents [Panel (a)], slightly injured [Panel (b)], severely injured [Panel (c)], and fatally injured [Panel (d)], sequentially dropping a particular Blitzmarathon date one by one. The point markers denote the point estimates of the variable Blitzmarathon, using a sample that deviates from Table 2 by dropping a particular Blitzmarathon date; the exception is “Base” which denotes the effect of the Blitzmarathons when all dates are included and corresponds to the estimates in Column (6) in Table 3. The whiskers represent the 95 percent confidence intervals. All regressions include county and time fixed effects, weather controls, vacation controls, and interactions of county indicators with all time fixed effects, weather controls, and vacation controls, respectively. Time fixed effects include day-of-week, month-of-year, and year fixed effects. Weather controls include atmospheric temperature, amount of precipitation, and a snow cover dummy. Additionally, we include dummies indicating missing atmospheric temperature, missing amount of precipitation, and missing snow cover. Vacation controls include a dummy for school vacation, the last school day before a school vacation, and the last day of a school vacation.

Figure B12

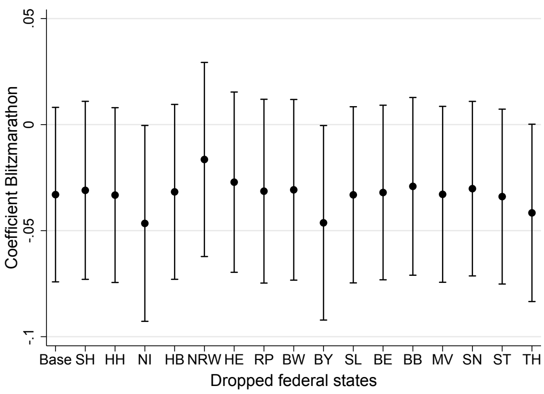
Dropping Federal States One-by-One



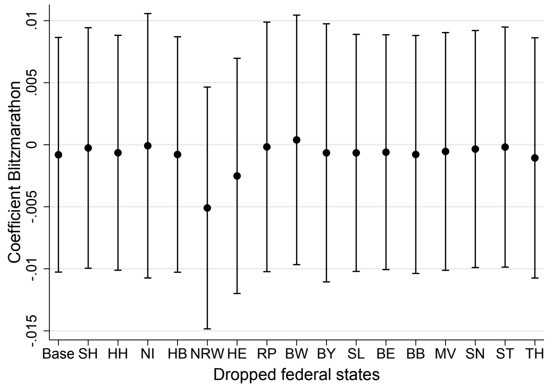
(a) Number of accidents



(b) Number of slightly injured



(c) Number of severely injured

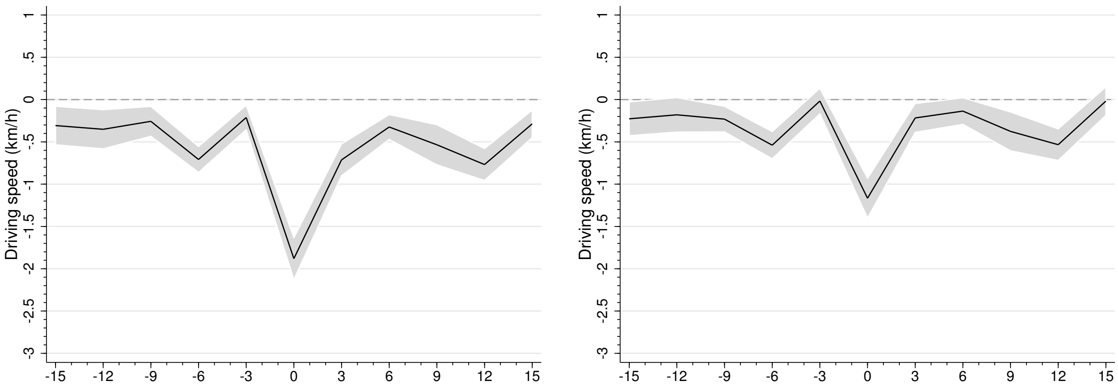


(d) Number of fatally injured

Notes: The figure shows the effect of the Blitzmarathon on the number of traffic accidents [Panel (a)], slightly injured [Panel (b)], severely injured [Panel (c)], and fatally injured [Panel d)], sequentially dropping a particular federal state one by one. The point markers denote the point estimates of the variable Blitzmarathon, using a sample that deviates from Table 2 by dropping all observations from a particular state; the exception is "Base" which denotes the effect of the Blitzmarathons when all states are included and corresponds to the estimates in Column (6) in Table 3. The whiskers represent the 95 percent confidence intervals. All regressions include county and time fixed effects, weather controls, vacation controls, and interactions of county indicators with all time fixed effects, weather controls, and vacation controls, respectively. Time fixed effects include day-of-week, month-of-year, and year fixed effects. Weather controls include atmospheric temperature, amount of precipitation, and a snow cover dummy. Additionally, we include dummies indicating missing atmospheric temperature, missing amount of precipitation, and missing snow cover. Vacation controls include a dummy for school vacation, the last school day before a school vacation, and the last day of a school vacation.

Figure B13

The Effect of the Blitzmarathons on Hourly Driving Speed over Time



(a) Passenger vehicles **(b)** Trucks

Notes: The table shows the effect of the Blitzmarathons on driving speed +/− 15 days for passenger vehicles [Panel (a)] and trucks [Panel (b)]. We group the 15 days before and after a Blitzmarathon in three-day intervals. The point markers indicate the point estimates of the variable Blitzmarathon and the ten time dummies for the 15 days before and after a Blitzmarathon; the whiskers represent the 95 percent confidence intervals. All regressions include hour-of-day, day-of-week, month-of-year, hour-of-day×day-of-week, and year fixed effects; weather and vacation controls; and interactions of monitor station indicators with all time fixed effects, weather controls, and vacation controls, respectively.

Table B1

Overview of the Blitzmarathons in Germany, 2012 to 2014

Date	Day of the week	Federal State	Duration
February, 10 2012	Friday	North Rhine-Westphalia	one day
July 3, 2012	Tuesday	North Rhine-Westphalia	one day
October 24, 2012	Wednesday	North Rhine-Westphalia & Lower Saxony	one day
June 4, 2013	Tuesday	North Rhine-Westphalia & Lower Saxony	one day
October 10, 2013	Thursday	nation-wide (excl. Saxony)	one day
October 11 to 17, 2013	Friday to Thursday	Bavaria	seven days
April 8, 2014	Tuesday	North Rhine-Westphalia & Lower Saxony	one day
September 18, 2014	Thursday	nation-wide	one day
September 19 to 25, 2014	Friday to Thursday	Bavaria	seven days

Notes: The table shows the dates, the participating federal states, and the duration of the Blitzmarathons between 2012 and 2014. Saxony did not participate in the first nation-wide Blitzmarathon (October 10, 2013).

Table B2

The Effect of the Blitzmarathons on Traffic Accidents by Accident Category

	(1)	(2)	(3)	(4)	(5)	(6)
(a) Number of accidents with material damage						
[Mean: 0.618; N: 493,518]						
Blitzmarathon	−0.034	−0.062**	−0.065***	−0.060**	−0.058**	−0.064**
	(0.025)	(0.025)	(0.025)	(0.025)	(0.025)	(0.025)
R^2	0.292	0.300	0.300	0.311	0.316	0.315
(b) Number of accidents with slightly injured						
[Mean: 1.414; N: 493,518]						
Blitzmarathon	−0.049	−0.052	−0.070*	−0.082**	−0.073*	−0.080**
	(0.038)	(0.038)	(0.038)	(0.038)	(0.037)	(0.038)
R^2	0.645	0.646	0.648	0.700	0.703	0.704
(c) Number of accidents with severely injured						
[Mean: 0.312; N: 493,518]						
Blitzmarathon	−0.034**	−0.030*	−0.032*	−0.029*	−0.028	−0.031*
	(0.017)	(0.017)	(0.017)	(0.018)	(0.018)	(0.018)
R^2	0.153	0.154	0.155	0.164	0.163	0.162
(d) Number of accidents with fatally injured						
[Mean: 0.019; N: 493,518]						
Blitzmarathon	−0.003	−0.003	−0.003	−0.003	−0.003	−0.002
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
R^2	0.008	0.008	0.008	0.006	0.005	0.002
County FE	×	×	×	×	×	×
Time FE	×	×	×	×	×	×
Weather		×	×	×	×	×
Vacation			×	×	×	×
County × Time FE				×	×	×
County × Weather					×	×
County × Vacation						×

Notes: The table shows the effect of the Blitzmarathons on the number of traffic accidents with material damage [Panel (a)], with slightly injured [Panel (b)], with severely injured [Panel (c)], and with fatally injured [Panel (d)]. Each column in each panel presents a separate regression. All regressions are run at the county-day level. "Blitzmarathon" is as a dummy variable indicating the Blitzmarathon in each county. All regressions include county and time fixed effects. Time fixed effects include day-of-week, month-of-year, and year fixed effects. Weather controls include atmospheric temperature, amount of precipitation, and a dummy for snow cover. Additionally, we include dummies indicating missing atmospheric temperature, missing amount of precipitation, and missing snow cover. Vacation controls include dummies for school vacation, the last school day before a school vacation, and the last day of a school vacation. County × Time, County × Weather, and County × Vacation are interactions of county indicators with all time fixed effects, weather controls, and vacation controls, respectively. The reported R-squared is the adjusted R-squared. Standard errors (in parentheses) are clustered at the county level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table B3

The Effect of the Blitzmarathons on Traffic Accidents over Time by Accident Category

	Number of accidents with			
	material damage	slightly injured	severely injured	fatally injured
	(1)	(2)	(3)	(4)
13–15 days before	−0.029**	−0.034	0.002	0.001
	(0.013)	(0.024)	(0.013)	(0.003)
10–12 days before	−0.003	−0.020	0.011	−0.000
	(0.014)	(0.021)	(0.011)	(0.002)
7–9 days before	−0.015	−0.007	−0.011	0.002
	(0.015)	(0.026)	(0.010)	(0.003)
4–6 days before	0.035*	0.017	−0.004	0.001
	(0.021)	(0.035)	(0.014)	(0.003)
1–3 days before	−0.019	−0.082***	−0.011	−0.001
	(0.015)	(0.027)	(0.012)	(0.002)
Blitzmarathon	−0.066***	−0.088**	−0.031*	−0.002
	(0.025)	(0.037)	(0.018)	(0.004)
1–3 days after	−0.011	0.017	−0.002	0.001
	(0.015)	(0.024)	(0.012)	(0.003)
4–6 days after	−0.021	−0.047*	0.007	0.003
	(0.016)	(0.027)	(0.013)	(0.003)
7–9 days after	−0.002	−0.015	0.012	−0.001
	(0.016)	(0.024)	(0.012)	(0.003)
10–12 days after	0.021	−0.042	−0.002	0.005
	(0.015)	(0.028)	(0.012)	(0.003)
13–15 days after	0.017	−0.022	0.004	−0.002
	(0.017)	(0.028)	(0.012)	(0.003)
Mean	2.362	1.916	0.367	0.021
R^2	0.710	0.624	0.128	0.002

Notes: The table shows the effect of the Blitzmarathons +/− 15 days on the number of traffic accidents with material damage [Column (1)], with slightly injured [Column (2)], with severely injured [Column (3)], and with fatally injured [Column (4)] The 15 days before and after a Blitzmarathon are grouped in three-day intervals. Each column presents a separate regression. All regressions are run at the county-day level (N: 493,518). "Blitzmarathon" is as a dummy variable indicating the Blitzmarathon in each county. All regressions include county and time fixed effects, weather controls, vacation controls, and interactions of county indicators with all time fixed effects, weather controls, and vacation controls, respectively. Time fixed effects include day-of-week, month-of-year, and year fixed effects. Weather controls include atmospheric temperature, amount of precipitation, and a dummy for snow cover. Additionally, we include dummies indicating missing atmospheric temperature, missing amount of precipitation, and missing snow cover. Vacation controls include dummies for school vacation, the last school day before a school vacation, and the last day of a school vacation. The reported R-squared is the adjusted R-squared. Standard errors (in parentheses) are clustered at the county level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table B4

The Effect of the Blitzmarathons on Traffic Accidents by Driver and Accident Scene Characteristics

		Number of accidents (1)	Number of slightly injured (2)	Number of severely injured (3)	Number of fatally injured (4)
(a) Age of the driver					
Age < 21	Blitzmarathon	−0.021	−0.028	−0.016***	−0.000
		(0.016)	(0.019)	(0.006)	(0.001)
	Mean	0.267	0.236	0.049	0.002
	R^2	0.104	0.061	0.014	0.001
Age 21–25	Blitzmarathon	−0.034**	−0.035**	0.005	0.001
		(0.016)	(0.018)	(0.008)	(0.002)
	Mean	0.304	0.253	0.049	0.003
	R^2	0.196	0.130	0.016	0.001
Age 26–30	Blitzmarathon	0.014	0.021	0.007	−0.001
		(0.014)	(0.018)	(0.007)	(0.001)
	Mean	0.223	0.180	0.033	0.002
	R^2	0.228	0.156	0.016	0.001
Age 31–35	Blitzmarathon	−0.016	−0.009	−0.006	−0.0016***
		(0.014)	(0.016)	(0.006)	(0.0002)
	Mean	0.190	0.155	0.027	0.002
	R^2	0.238	0.166	0.015	0.001
Age 36–40	Blitzmarathon	−0.020*	−0.014	0.0003	0.001
		(0.012)	(0.014)	(0.0052)	(0.002)
	Mean	0.171	0.142	0.024	0.001
	R^2	0.228	0.158	0.012	0.000
Age 41–45	Blitzmarathon	−0.021*	−0.017	−0.012**	−0.0016***
		(0.012)	(0.015)	(0.005)	(0.0002)
	Mean	0.202	0.165	0.029	0.002
	R^2	0.245	0.167	0.015	0.000
Age 46–50	Blitzmarathon	0.006	−0.011	−0.003	0.001
		(0.015)	(0.015)	(0.006)	(0.002)
	Mean	0.216	0.171	0.033	0.002
	R^2	0.241	0.174	0.016	0.001
Age 51–55	Blitzmarathon	−0.044***	−0.039***	−0.0004	0.000
		(0.012)	(0.012)	(0.0070)	(0.001)
	Mean	0.183	0.143	0.029	0.002
	R^2	0.193	0.134	0.015	0.000
Age 56-60	Blitzmarathon	−0.005	−0.008	0.001	0.000
		(0.012)	(0.014)	(0.007)	(0.001)
	Mean	0.142	0.111	0.023	0.001
	R^2	0.151	0.105	0.010	0.001
Age 61–65	Blitzmarathon	0.012	0.016	0.002	−0.0011***
		(0.010)	(0.010)	(0.005)	(0.0001)
	Mean	0.101	0.079	0.016	0.001
	R^2	0.118	0.079	0.009	0.000

Table B4 continued

Age 66–70	Blitzmarathon	−0.002	−0.005	−0.00002	0.002
		(0.009)	(0.009)	(0.00358)	(0.001)
	Mean	0.075	0.060	0.012	0.001
	R^2	0.097	0.063	0.006	0.000
Age > 70	Blitzmarathon	-0.035^{***}	−0.023	−0.010	-0.002^{**}
		(0.013)	(0.016)	(0.006)	(0.001)
	Mean	0.193	0.157	0.037	0.003
	R^2	0.139	0.089	0.013	0.001
(b) Gender of the driver					
Male	Blitzmarathon	-0.127^{***}	-0.123^{***}	−0.017	0.001
		(0.037)	(0.039)	(0.017)	(0.005)
	Mean	1.562	1.224	0.255	0.017
	R^2	0.612	0.508	0.094	0.006
Female	Blitzmarathon	−0.042	−0.034	−0.015	-0.003^{**}
		(0.027)	(0.032)	(0.010)	(0.001)
	Mean	0.727	0.644	0.106	0.004
	R^2	0.393	0.300	0.037	0.001
(c) Time of accident					
Before 6:00	Blitzmarathon	−0.015	−0.002	−0.001	−0.000
		(0.010)	(0.010)	(0.005)	(0.001)
	Mean	0.175	0.093	0.027	0.003
	R^2	0.164	0.067	0.015	0.001
6:00–11:00	Blitzmarathon	0.002	0.009	−0.010	-0.004^{**}
		(0.025)	(0.029)	(0.010)	(0.002)
	Mean	0.690	0.558	0.099	0.005
	R^2	0.398	0.319	0.042	0.002
12:00–17:00	Blitzmarathon	-0.109^{***}	-0.134^{***}	−0.015	0.002
		(0.030)	(0.034)	(0.012)	(0.004)
	Mean	1.009	0.890	0.160	0.008
	R^2	0.495	0.401	0.056	0.003
After 17:00	Blitzmarathon	-0.047^{**}	−0.026	−0.008	0.000
		(0.019)	(0.024)	(0.009)	(0.002)
	Mean	0.488	0.375	0.081	0.004
	R^2	0.376	0.271	0.035	0.002
(d) Type of road					
Freeway	Blitzmarathon	−0.002	−0.011	−0.002	0.002
		(0.014)	(0.015)	(0.007)	(0.003)
	Mean	0.200	0.157	0.035	0.003
	R^2	0.167	0.091	0.018	0.002
Federal road	Blitzmarathon	-0.169^{***}	-0.143^{***}	-0.033^{*}	−0.004
		(0.043)	(0.050)	(0.019)	(0.004)
	Mean	2.162	1.759	0.332	0.018
	R^2	0.674	0.588	0.123	0.007

Table B4 continued

(e) **Speed limit**					
30 km/h	Blitzmarathon	0.032*	0.023	0.003	0.000
		(0.017)	(0.015)	(0.006)	(0.000)
	Mean	0.211	0.146	0.022	0.001
	R^2	0.324	0.226	0.026	0.000
50 km/h	Blitzmarathon	−0.112***	−0.089**	−0.015	−0.002
		(0.036)	(0.041)	(0.013)	(0.002)
	Mean	1.342	1.102	0.154	0.005
	R^2	0.710	0.639	0.173	0.005
70 km/h	Blitzmarathon	−0.043***	−0.034**	−0.012	−0.001
		(0.012)	(0.015)	(0.008)	(0.002)
	Mean	0.197	0.180	0.044	0.003
	R^2	0.132	0.073	0.022	0.002
100 km/h	Blitzmarathon	−0.046***	−0.044**	−0.013	−0.002
		(0.018)	(0.021)	(0.011)	(0.003)
	Mean	0.454	0.366	0.118	0.010
	R^2	0.146	0.085	0.040	0.006
130 km/h	Blitzmarathon	−0.003	−0.005	−0.002	−0.0004***
		(0.005)	(0.005)	(0.002)	(0.0001)
	Mean	0.028	0.023	0.005	0.0004
	R^2	0.064	0.027	0.009	0.001
No speed limit	Blitzmarathon	0.001	−0.004	0.005	0.003
		(0.011)	(0.012)	(0.007)	(0.003)
	Mean	0.132	0.099	0.025	0.002
	R^2	0.115	0.059	0.013	0.002

Notes: The table shows the effect of the Blitzmarathons on the number of traffic accidents [Column (1)], slightly injured [Column (2)], severely injured [Column (3)], and fatally injured [Column (4)] for different characteristics of the driver and the scene of the accident. Each column in each panel presents a separate regression. All regressions are run at the county-day level (N: 493,518). "Blitzmarathon" is as a dummy variable, indicating the Blitzmarathon in each county All regressions include county, day-of-week, month-of-year, year fixed effects, weather controls, and vacation controls. Weather controls include atmospheric temperature, amount of precipitation, and a dummy for snow cover. Additionally, we include dummies indicating missing atmospheric temperature, missing amount of precipitation, and missing snow cover. Vacation controls include dummies for school vacation, the last school day before a school vacation, and the last day of a school vacation. The reported R-squared is the adjusted R-squared. Standard error clustered at the county level are in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table B5

The Effect of the Blitzmarathons on Traffic Accidents by Traffic Participation

		Number of accidents (1)	Number of slightly injured (2)	Number of severely injured (3)	Number of fatally injured (4)
Car	Blitzmarathon	-0.184^{***}	-0.162^{***}	-0.031^{*}	-0.005
		(0.041)	(0.046)	(0.018)	(0.004)
	Mean	1.989	1.634	0.283	0.015
	R^2	0.648	0.550	0.095	0.005
Motorbike	Blitzmarathon	-0.0001	0.006	-0.009	0.001
		(0.0131)	(0.012)	(0.007)	(0.002)
	Mean	0.160	0.118	0.052	0.003
	R^2	0.159	0.126	0.045	0.003
Truck	Blitzmarathon	0.011	0.001	0.005	0.002
		(0.014)	(0.015)	(0.008)	(0.002)
	Mean	0.211	0.163	0.032	0.003
	R^2	0.222	0.151	0.017	0.002
Bicycle	Blitzmarathon	0.034^{*}	0.033^{*}	0.010	-0.000
		(0.018)	(0.017)	(0.007)	(0.001)
	Mean	0.243	0.197	0.060	0.002
	R^2	0.365	0.331	0.084	0.002
Pedestrian	Blitzmarathon	0.001	0.003	-0.001	-0.001
		(0.007)	(0.007)	(0.005)	(0.001)
	Mean	0.067	0.050	0.022	0.001
	R^2	0.317	0.253	0.112	0.006

Notes: The table shows the effect of the Blitzmarathon on the number of traffic accidents [Column (1)], slightly injured [Column (2)], severely injured [Column (3)], and fatally injured [Column (4)] for different types of road users. Each column in each row presents a separate regression. All regressions are run at the county-day level (N: 493,518). The sample deviates from Table 2 by including also accidents where the person who caused the accident was a pedestrian or a bicyclist. "Blitzmarathon" is as a dummy variable indicating the Blitzmarathon in each county. All regressions include county and time fixed effects, weather controls, vacation controls. Time fixed effects include day-of-week, month-of-year, and year fixed effects. Weather controls include atmospheric temperature, amount of precipitation, and a dummy for snow cover. Additionally, we include dummies indicating missing atmospheric temperature, missing amount of precipitation, and missing snow cover. Vacation controls include dummies for school vacation, the last school day before a school vacation, and the last day of a school vacation. The reported R-squared is the adjusted R-squared. Standard errors (in parentheses) are clustered at the county level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table B6

The Effect of the Blitzmarathons on Traffic Accidents by County Characteristics

		Number of accidents	Number of slightly injured	Number of severely injured	Number of fatally injured
		(1)	(2)	(3)	(4)
(a) Rural versus urban counties					
	Blitzmarathon	−0.224***	−0.193***	−0.037	0.002
Rural		(0.049)	(0.058)	(0.025)	(0.007)
[N: 362,151]	Mean	2.175	1.719	0.393	0.025
	R^2	0.412	0.304	0.060	0.000
	Blitzmarathon	−0.064	−0.088	−0.021	−0.006**
Urban		(0.112)	(0.110)	(0.040)	(0.003)
[N: 131,367]	Mean	2.878	2.461	0.294	0.009
	R^2	0.853	0.798	0.328	0.009
(b) High risk versus low risk counties					
	Blitzmarathon	−0.142	−0.223**	−0.069	−0.005
High risk		(0.108)	(0.096)	(0.043)	(0.008)
[N: 147,146]	Mean	2.003	1.633	0.292	0.017
	R^2	0.544	0.413	0.085	0.003
	Blitzmarathon	−0.189***	−0.144**	−0.022	0.001
Low risk		(0.052)	(0.061)	(0.024)	(0.006)
[N: 346,372]	Mean	2.515	2.036	0.399	0.022
	R^2	0.738	0.663	0.137	0.002

Notes: The table shows the effect of the Blitzmarathons on the number of traffic accidents [Column (1)], slightly injured [Column (2)], severely injured [Column (3)], and fatally injured [Column (4)] for different county characteristics. High risk counties are counties where the total number of accidents in 2011 per 100,000 population is above the 70th percentile; low risk counties are all other counties. Each column in each row presents a separate regression. All regressions are run at the county-day level. Number of observations are in squared brackets. "Blitzmarathon" is as a dummy variable indicating the Blitzmarathon in each county. All regressions include county and time fixed effects, weather controls, vacation controls, and interactions of county indicators with all time fixed effects, weather controls, and vacation controls, respectively. Time fixed effects include day-of-week, month-of-year, and year fixed effects. Weather controls include atmospheric temperature, amount of precipitation, and a dummy for snow cover. Additionally, we include dummies indicating missing atmospheric temperature, missing amount of precipitation, and missing snow cover. Vacation controls include dummies for school vacation, the last school day before a school vacation, and the last day of a school vacation. The reported R-squared is the adjusted R-squared. Standard errors (in parentheses) are clustered at the county level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table B7

The Effect of the Blitzmarathons on Hourly Traffic Volume (q/v–data)

	(1)	(2)	(3)	(4)	(5)	(6)
(a) Number of passenger vehicles / 1,000 (q/v–data)						
[Mean: 0.265; N: 20,462,014]						
Blitzmarathon	0.002^{**}	0.003^{***}	-0.003^{**}	-0.003^{***}	-0.003^{***}	-0.004^{***}
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
R^2	0.718	0.718	0.719	0.955	0.955	0.956
(b) Number of trucks / 1,000 (q/v–data)						
[Mean: 0.021; N: 20,433,158]						
Blitzmarathon×100	0.075^{**}	0.074^{**}	0.032	0.075^{***}	0.070^{***}	0.071^{***}
	(0.037)	(0.037)	(0.038)	(0.023)	(0.023)	(0.022)
R^2	0.57	0.57	0.57	0.81	0.81	0.81
Monitor FE	×	×	×	×	×	×
Time FE	×	×	×	×	×	×
Weather		×	×	×	×	×
Vacations			×	×	×	×
Monitor × Time FE				×	×	×
Monitor × Weather					×	×
Monitor × Vacation						×

Notes: The table shows the effect of the Blitzmarathons on the number of cars [Panel (a)] the number of trucks [Panel (b)] on federal roads in the q/v–data. The sample includes 1,017 monitoring stations on federal roads. An overview of the stations is given in Appendix Figure B10. All regressions are run at the monitor-hour level. "Blitzmarathon" is as a dummy variable indicating the Blitzmarathon in each county. All regressions include monitor station and time fixed effects. Time fixed effects include hour-of-day, day-of-week, month-of-year, hour-of-day×day-of-week, and year fixed effects. Weather controls include atmospheric temperature, amount of precipitation, and a dummy for snow cover. Additionally, we include dummies indicating missing atmospheric temperature, missing amount of precipitation, and missing snow cover. Vacation controls include dummies for school vacation, the last school day before a school vacation, and the last day of a school vacation. Monitor × Time, Monitor × Weather, and Monitor × Vacation are interaction of monitor station indicators with all time fixed effects, weather controls, and vacation controls, respectively. We weight observations with probability weights of the inverse of the number of stations within each county. The reported R-squared is the adjusted R-squared. Standard errors (in parentheses) are clustered at the monitor level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table B8

The Effect of the Blitzmarathons on Traffic Accidents by Cause of Accident

		Number of accidents (1)	Number of slightly injured (2)	Number of severely injured (3)	Number of fatally injured (4)
External Causes	Blitzmarathon	−0.025	−0.035**	−0.004	−0.002**
		(0.017)	(0.017)	(0.007)	(0.001)
	Mean	0.307	0.223	0.049	0.003
	R^2	0.136	0.089	0.019	0.002
Driving Behavior	Blitzmarathon	−0.145***	−0.119**	−0.031	0.000
		(0.044)	(0.050)	(0.019)	(0.004)
	Mean	2.055	1.637	0.318	0.018
	R^2	0.730	0.597	0.129	0.007
Alcohol or drugs	Blitzmarathon	−0.024*	−0.007	0.001	0.000
		(0.012)	(0.010)	(0.008)	(0.002)
	Mean	0.246	0.071	0.037	0.002
	R^2	0.215	0.021	0.014	0.001
Wrong way	Blitzmarathon	−0.009	−0.006	−0.014***	−0.002**
		(0.009)	(0.010)	(0.004)	(0.001)
	Mean	0.089	0.071	0.024	0.003
	R^2	0.044	0.018	0.008	0.002
Speed	Blitzmarathon	−0.030*	−0.028	−0.004	0.001
		(0.018)	(0.018)	(0.008)	(0.003)
	Mean	0.332	0.238	0.072	0.006
	R^2	0.156	0.106	0.025	0.003
Distance to next driver	Blitzmarathon	0.022	0.005	0.012*	−0.0005***
		(0.018)	(0.026)	(0.006)	(0.0001)
	Mean	0.268	0.339	0.021	0.001
	R^2	0.396	0.300	0.018	0.001
Passing	Blitzmarathon	−0.018*	−0.020*	−0.004	−0.0019***
		(0.010)	(0.011)	(0.005)	(0.0002)
	Mean	0.126	0.105	0.022	0.001
	R^2	0.192	0.137	0.012	0.001
Right of way	Blitzmarathon	−0.051**	−0.055**	0.001	0.001
		(0.022)	(0.023)	(0.009)	(0.002)
	Mean	0.489	0.375	0.061	0.002
	R^2	0.308	0.198	0.028	0.001
Turn	Blitzmarathon	−0.030	−0.029	−0.013*	0.000
		(0.019)	(0.022)	(0.007)	(0.001)
	Mean	0.407	0.348	0.055	0.002
	R^2	0.507	0.424	0.075	0.003
Loading/ technical issues	Blitzmarathon	−0.015**	−0.013**	−0.0003***	−0.0002***
		(0.007)	(0.006)	(0.002)	(0.0001)
	Mean	0.044	0.033	0.006	0.0002
	R^2	0.169	0.147	0.008	0.0009

Table B8 continued

Notes: The table shows the effect of the Blitzmarathons on the number of traffic accidents [Column (1)], slightly injured [Column (2)], severely injured [Column (3)], and fatally injured [Column (4)] for different reported accident causes. Each column in each row presents a separate regression. All regressions are run at the county-day level (N: 493,518). "Blitzmarathon" is as a dummy variable indicating the Blitzmarathon in each county. All regressions include county and time fixed effects, weather controls, and vacation controls. Time fixed effects include day-of-week, month-of-year, and year fixed effects. Weather controls include atmospheric temperature, amount of precipitation, and a dummy for snow cover. Additionally, we include dummies indicating missing atmospheric temperature, missing amount of precipitation, and missing snow cover. Vacation controls include dummies for school vacation, the last school day before a school vacation, and the last day of a school vacation. The reported R-squared is the adjusted R-squared. Standard errors (in parentheses) are clustered at the county level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table B9

Benefits of the Reduction in Accidents

Variable		Point estimate	Prevented cases	Unit costs in 2014 prices	Total
		(1)	(2)	(3)	(4)
Costs per casualty					
Number	of slightly injured	0.163	195	5,014€	977,730€
	of severely injured	0.033^{+}	39	120,921€	4,715,919€
	fatally injured	0.001^{+}	1	1,191,397€	1,191,397€
Material damage					
Accidents	with material damage	0.064	76	21,484€	1,632,784€
	with slightly injured	0.080	96	14,190€	1,632,240€
	with severely injured	0.031	37	21,883€	809,671€
	with fatalities	0.002^{+}	2	48,003€	96,006€
Total (lower bound)					9,498,344€
Total (upper bound)					10,785,747€

Notes: The Table shows the number of prevented accidents and the corresponding cost reduction for the seven one-day Blitzmarathons between 2012 and 2014. In Column (2), we multiply the coefficient of the variable Blitzmarathon (Column (1)) with the 1,194 Blitzmarathon-county-days to get the prevented accident cases. Column (3) lists the unit costs for each accident case. Unit costs stem from calculations from the German Federal Highway Research Institute (BASt, 2010) with updates for the year 2014. Column (4) returns the total costs for each accident case given the prevented cases in Column (2). The upper bound for the reduction in costs includes the number of fatally injured and material damage for accidents with fatalities. $^{+}$ indicates not statistically significant at the ten percent level.

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