Religiosity and Terrorism: Evidence from Ramadan Fasting*

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Abstract

This study examines the effect of religiosity on terrorism by focusing on one of the five pillars of Islam: Ramadan fasting. For identification, we exploit two facts: First, daily fasting from dawn to sunset during Ramadan is considered mandatory for most Muslims. Second, the Islamic calendar is not synchronized with the solar cycle. We find a robust negative effect of more intense Ramadan fasting on terrorist events within districts and country-years in predominantly Muslim countries. We argue that this effect partly operates through a decrease in public support for terrorism, which in turn reduces the operational capabilities of terrorist groups.

Keywords: Terrorism, economics of religion.

JEL classification: D74, H56, Z12

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1 Introduction

Long before al-Qaeda's attacks on U.S. soil on September 11, 2001, terrorist groups were using religion as a justification for their actions. While many terrorist groups' motives may be of political nature, religion often serves as a common denominator among members and is used as vehicle to gain public support. Prominent examples include Abu Sayyaf in the Philippines, Hezbollah in Lebanon, the Irish Republican Army, and the Ulster Volunteer Force in Northern Ireland. Since the September 11 attacks and the subsequent U.S.-led military interventions in Afghanistan and Iraq, terrorism has been on the rise. Most of the perpetrators in recent years have claimed links to Islam and many have (self-)legitimized their terrorist attacks on religious grounds, often referring to Islamist ideologies.[1]

Previous contributions on the economics of religion and terrorism have shed light on the organizational structure of religious groups and terrorist organizations (e.g., Iannaccone, 1992; Berman and Laitin, 2008; Berman, 2011), and on the importance of public support for terrorist organizations (e.g., Atran, 2003; Siqueira and Sandler, 2006; Bueno de Mesquita and Dickson, 2007; Tessler and Robbins, 2007; Krueger and Malečková, 2009; Malečková and Stanišić, 2011, 2013; Jaeger *et al.*, 2015; Toft and Zhukov, 2015; Polo and Gleditsch, 2016).[2] Public support includes monetary assistance, in-kind assistance (e.g., weapons, vehicles or food), shelter, or legitimization. We do, however, not yet understand how higher religiosity – that is, more intense religious feelings and beliefs – impacts upon terrorism and the public support for terrorist attacks. On the one hand, higher religiosity may increase the perceived gap between people of the same faith and others, which creates the potential for them to be depicted as enemies, thereby potentially increasing terrorism and public support for it. On the other hand, higher religiosity may induce people to see the killing of civilians as unacceptable, thereby decreasing terrorism and public support for it.

In this study we investigate the causal effect of religiosity induced by intense religious experience on terrorist events. The religious experience we focus on is one of the five pillars of Islam: Daily fasting during the month of Ramadan. For our analysis, Ramadan and Ramadan

[1] To be clear, most Muslims oppose terrorism and the ideology of Islamist groups. For example, the Pew Research Center conducted surveys asking more than 50,000 Muslims from 13 predominantly Muslim countries (including the countries listed in Table 1 below) during the years 2002–2015 whether they feel that "suicide bombings and other forms of violence against civilian targets are justified in order to defend Islam from its enemies." 78% responded that such violence is "never" or "rarely" justified (as opposed to "sometimes" or "often" justified).

[2] Other contributions to the economics of religion study the effects of religiosity on economic growth (e.g., Barro and McCleary, 2003; McCleary and Barro, 2006; Durlauf *et al.*, 2012; Campante and Yanagizawa-Drott, 2015) and happiness (e.g., Lim and Putnam, 2010; Campante and Yanagizawa-Drott, 2015). Many studies on the economics of terrorism document negative effects of terrorist attacks on economic activity (e.g., Abadie and Gardeazabal, 2003; Blomberg *et al.*, 2004; Tavares, 2004). Some other studies document that terrorist attacks reduce happiness (e.g., Frey *et al.*, 2009) and can change electoral outcomes (e.g., Gassebner *et al.*, 2008; Gould and Klor, 2010; Gassebner *et al.*, 2011).

fasting have three intriguing characteristics. First, Ramadan fasting is seen as mandatory for adult Muslims until they lose their good health or sanity in older age.[3] Table 1 presents survey data by the Pew Research Center from a diverse set of ten predominantly Muslim countries.

Table 1 around here

It shows that 86% of Muslim respondents fast on most or all days during Ramadan. Hence, Ramadan fasting is indeed practiced by the large majority of Muslims living in predominantly Muslim countries. Second, Ramadan fasting lasts from dawn to sunset every day during Ramadan. As a result, the fasting duration various across locations at different latitudes in any given year. Third, the Islamic calendar follows the lunar cycle and is therefore not synchronized with the solar cycle. As a result, Ramadan takes place in different seasons in different years. Over the years, therefore, the duration of daily Ramadan fasting oscillates around approximately 12 hours in any given location, with smaller amplitudes at locations closer to the equator.

We exploit the variation in Ramadan daylight hours following from differences in latitudes across districts within country-years and the changing seasons during which Ramadan takes place in order to estimate the causal effect of Ramadan daylight hours on terrorist events. For the interpretation of this effect it is important to know that most Muslims do not only fast during Ramadan. They also engage in increased prayers and charity, abstain from sinful behaviour, meet for pre-fast meals before dawn (called Suhur) and fast-breaking meals after sunset (called Iftar), and recite the Quran, which Sunni Muslims often do in extra prayers at night (called Tarawih). Hence, for most Muslims Ramadan is an intense religious experience that allows for reevaluating their lives in light of Islamic guidance. Moreover, Ramadan fasting and the religious experience are arguably more intense when the daily Ramadan fasting is longer. Consistent with these notions, Haruvy *et al.* (2018) find that alimentary abstention has positive effects on pro-social behavior during Ramadan, but not when it is unrelated to religion. Furthermore, Campante and Yanagizawa-Drott (2015) find that longer Ramadan daylight hours increase happiness despite leading to a decrease in GDP per capita.

Campante and Yanagizawa-Drott (2015) have also made an important methodological contribution, as they were the first to exploit differences in latitude and the changing seasons of Ramadan to identify a causal effect of the daily fasting duration in Ramadan and the accompanying religious experience. In this study we build on their identification strategy but take it to the subnational level by exploiting variation in Ramadan fasting hours across districts within country-years.

One reason for exploiting only variation within country-years is the existing literature on

[3]People who are sick, nursing or traveling are exempt from fasting during Ramadan, but must do so later.

determinants of terrorism, which proposes many potential economic and political determinants of terrorism at the level of countries. Gassebner and Luechinger (2011) review the literature and find 65 correlates of terrorism that had been proposed in earlier studies. Moreover, the effects of many of these potential determinants vary across countries, time periods and perpetrator groups (e.g., Meierrieks and Gries, 2013; Kis-Katos *et al.*, 2014; Enders *et al.*, 2016). The use of country-year fixed effects implies that we implicitly control for all these potential determinants and their heterogeneous effects across countries and over time. In addition, we study how the effects of religiosity on terrorism vary across country groups (based on the population share of Muslims), by the background and ideology of perpetrator groups, and over time.

We use data from the Global Terrorism Database (GTD) by the National Consortium for the Study of Terrorism and Responses to Terrorism (START, 2017), which contains the day and location of approximately 180,000 terrorist events since 1970. We build a panel dataset of administrative regions at the second subnational level (typically districts) and with annual frequency. A brief look at the data reveals the following global trends in terrorism: First, terrorist events are observed with higher frequency since the September 11 attacks. Second, Islamist perpetrators are mainly responsible for this increase. And third, civilians in predominantly Muslim countries are mainly suffering from this increase. These trends call for research aimed at understanding terrorism in these countries.

Our main finding is that the probability of the occurrence of a terrorist event (or a fatal terrorist event) in a given district and year decreases by 2–3 percentage points in predominantly Muslim countries when the duration of the daily Ramadan fasting increases by an additional hour. This decrease is exclusively driven by terrorist attacks by Muslim perpetrator groups, and we find no robust effect on countries with a Muslim population share below 75%.

We discuss three potential channels. First, Ramadan fasting is known to have physiological and psychological effects, such as body weight loss, sleep deprivation, tiredness, lassitude and irritability (e.g., Leiper and Molla, 2003). Hence, more intense Ramadan fasting may lower terrorism due to such short-term physiological and psychological effects. We show, however, that the negative effects of more intense Ramadan fasting on terrorist events persist over the entire year following a Ramadan with long fasting hours. Hence, our main findings cannot be driven by short-term physiological and psychological effects of Ramadan fasting. Second, we find no evidence that the negative effects of longer Ramadan fasting on terrorist events could operate through empathy and self-restraint of (potential) terrorists.

Instead, we argue that an important channel operates through a decrease in public support for terrorism, which in turn reduces the operational capabilities of terrorist groups. We provide evidence for both parts of this argument: First, based on survey data from the Pew Research

Center, we find that more intense Ramadan fasting leads to a decrease in the share of Muslim respondents who support terrorism or, more precisely, who feel that violence is justified "to defend Islam from its enemies."[4] Second, we provide indirect evidence for a reduction of the operational capabilities of terrorist groups. We hypothesize that terrorist groups with little public support and limited operational capabilities would find it particularly hard to attack armed targets (as opposed to unarmed civilian targets), and to commit terrorist attacks in which the perpetrators must survive. This argument is in line with Berman and Laitin (2008), who argue that suicide attacks are effective in circumstances in which other tactics may fail. We indeed find that the effect of longer Ramadan fasting hours on terrorist attacks against unarmed civilian targets is considerably less pronounced than the effect on terrorist attacks against armed targets; and that the effect on suicide attacks is considerably less pronounced than the effects on other assaults and bombings.

The finding that a decrease of public support for terrorism can effectively reduce terrorist attacks is consistent with the findings of previous studies. The major contributions of this study are the causal identification of the effect of religiosity on terrorism (and arguably of the effect of religiosity on public support for terrorism), and the finding that religiosity in society at large may reduce public support for terrorism rather than promote the conditions that allow for the spread of terrorism.

The remainder of the paper is structured as follows: Section 2 introduces the data and illustrates important global trends in terrorism. Section 3 discusses our empirical strategy. Section 4 presents our results. Section 5 discusses possible channels through which longer Ramadan fasting may affect the occurrence of terrorist events. Section 6 offers a brief conclusion.

2 Data

2.1 Our time scale: Ramadan years

In most of our analysis we use data with annual frequency. However, we deviate from the common practice of defining years based on the Georgian calender. Instead, we base our analysis on the Islamic Hijri calendar. The Islamic calculation of times starts in the Georgian year 622 AD, when the Prophet Muhammad established the first Muslim community. The Islamic year has 12 months. The duration of the Islamic months is based on the lunar cycle. In the Hijri calendar, the observation of the crescent marks the end of the previous lunar cycle

[4] Clingingsmith *et al.* (2009) look at the effect of another intense religious experience, the Hajj pilgrimage, which is another one of the five pillars of Islam. Consistent with our results, they find that participation in the Hajj lowered the respondents' beliefs that the goals for which Osama bin Laden was fighting and the methods he was using were correct.

and the beginning of a new month. The duration of each month varies between 29 and 30 days, depending on actual observations of the lunar crescent.[5] The Islamic year has 354 or 355 days. Accordingly, the Islamic year is 10-12 days shorter than the Georgian year, which is based on the solar cycle. Hence, the lunar cycle laps the solar cycle approximately every 33 years.

We construct a pseudo time scale which we label "Ramadan year." Ramadan is the ninth month of the Islamic year. A Ramadan year begins with Ramadan of the corresponding Islamic year and ends on the last day before Ramadan of the subsequent Islamic year. For example, Ramadan year 1390 begins on the 1st of Ramadan of the Islamic year 1390 (corresponding to the Georgian date November 1, 1970) and ends on the 30th of Shaban, which is the eight month of the Islamic Hijri calender, in the Islamic year 1391 (corresponding to the Georgian date October 20, 1971). Because some readers are more familiar with the Georgian time scale, we additionally report Georgian years whenever possible. To avoid ambiguity, we report the Georgian year that corresponds to the beginning of the respective Ramadan year. For example, we match the Georgian year 1970 to Ramadan year 1390. We restrict our sample to Ramadan years 1390 to 1436 (corresponding to the Georgian dates November 1, 1970, and June 5, 2016).

The reason for basing our analysis on Ramadan years is that we are interested in how the daily fasting duration during Ramadan affects terrorism over the next year. The underlying idea is that longer and more intense Ramadan fasting leads to higher religiosity in the entire year until the next Ramadan. The disadvantages of basing the analysis on Georgian years would be two-fold: First, Ramadan would be early in some Georgian years and late in others. Second, some Ramadans overlap two Georgian years. In these cases, Georgian years often contain parts of two Ramadans.

2.2 Data on Muslim population shares

Our final panel dataset introduced in Section 2.4 includes districts from 190 countries and territories from around the world. In most parts of our analysis, we stratify these countries and territories into three groups based on the share of the Muslim population in these countries. The reason for this stratification is that daylight hours during the month of Ramadan can be expected to have very different effects in countries with a predominantly Muslim population than in religiously divided countries or countries with a predominantly non-Muslim population.

We use data on the Muslim population share in 1990 from the Pew Research Center. The

[5]Some Muslims use a tabular calendar, which assigns 30 days to odd months and 29 days to even months. In Iran and Afghanistan, the solar calendar is common, but Ramadan is practiced following the lunar Hijri calendar.

data are based on national censuses, demographic and health surveys, and general population surveys and studies. We distinguish between 137 countries and territories with a Muslim population share below 25%, 18 countries and territories with a share between 25% and 75%, and 35 countries and territories with a share above 75%. The map in Figure 1 indicates the countries and territories belonging to these three different country groups.[6]

Figure 1 around here

2.3 Data on terrorist events and global trends in terrorism

We use the Global Terrorism Database (GTD) by the National Consortium for the Study of Terrorism and Responses to Terrorism (START, 2017), which is among the most comprehensive terrorist event datasets. The GTD defines a terrorist event as "the threatened or actual use of illegal force and violence by a non-state actor to attain a political, economic, religious, or social goal through fear, coercion, or intimidation" (START, 2018, p. 10). The GTD contains detailed information about the time and location of terrorist events and the number of deaths, which includes perpetrators and victims. The START assembles the GTD from three main data sources. First, the Pinkerton Global Intelligence Services identified terrorist events between 1970 and 1997 from wire services, government reports and major international newspapers. Second, the Center for Terrorism and Intelligence Studies, using archival sources, documented attacks until 2008. Third, the Institute for the Study of Violent Groups included data on terrorist events that occurred between 2008 and 2011. The START continuously integrated and updated the data sources. They improved machine learning and data mining techniques to pre-screen news articles that potentially include information about terrorist events. Currently, the GTD contains more than 180,000 terrorist events.[7]

A major advantage of the GTD is the daily temporal scale and the availability of the location of the terrorist events. This information enables us to exploit variation in those events within districts and country-years in our main analysis, and also to present additional results based on quarterly aggregates of terrorist events.

We omit terrorist events that occurred outside our sample period from Ramadan year 1390 to Ramadan year 1436. In addition, we omit 12,991 terrorist events that we cannot

[6]Online Appendix A lists all countries and territories in these three country groups. Further, Figure A.1 shows a histogram of Muslim population shares. It shows that 70% of the countries and territories have a Muslim population share below 5% or above 95%. The exact thresholds used in the stratification of the countries and territories into three groups are therefore not particularly important (see also Section 4.3).

[7]According to the START (2018, p. 3), the GTD does not contain any terrorist events for 1993 "because they were lost prior to START's compilation of the GTD from multiple data collection efforts." As a result, we have too few terrorist events in Ramadan years 1412, which ended on the Georgian date February 22, 1993, and 1413, which started on February 23, 1993. Our results are robust to the exclusion of these Ramadan years (see Section 4.3).

match to any of the 39,530 districts in our final panel dataset (see Section 2.4 for details). The START only adds terrorist events from credible sources to the GTD. We drop 22,168 ambiguous events that the START classifies with high probability, but not certainty, as an act of terrorism. These ambiguous events could be insurgencies, guerrilla actions, conflicts between or within groups, or other crimes. Overall our data contains 126,346 terrorist events that caused 254,108 terror deaths.

Figure 2 shows the distribution of terrorist events and terror deaths over our sample period.

Figure 2 around here

It shows a steady increase in terrorism up to the end of the Cold War around Ramadan year 1411, followed by a slight decrease in terrorism until the September 11 attacks in Ramadan year 1421. Since then, terrorist events and terror deaths have increased dramatically. There is an important caveat when comparing terrorist events and terror deaths over long periods. The GTD combines different data sources and the data quality may vary over time. This has two implications: First, we should interpret Figure 2 and the subsequent figures as illustrations of the rough pattern rather than as a precise documentation of changes over time. Second, in our main analysis, the use of Ramadan year fixed effects or country-Ramadan year fixed effects will be important.

Figure 3 divides the aggregate development of terrorism into the development in predominantly Muslim countries and territories (with a Muslim population share above 75%), religiously divided countries (between 25% and 75%) and predominantly non-Muslim countries (below 25%).

Figure 3 around here

We can see that the pronounced increase in terrorism since the September 11 attacks has primarily occurred in predominantly Muslim countries. Among others, this group includes the three countries with the most terror deaths during our sample period: Iraq (with 21% of total terror deaths), Afghanistan (9%) and Pakistan (7%).[8] More generally, even though only 15% of the world's population lives in a country or territory with a Muslim population share above 75%, these countries and territories are the location of 43% of terrorist events and 52% of terror deaths during our sample period (see Table B.2 in Online Appendix B).

The GTD also provides the names of the perpetrator groups for the majority of terrorist events. We classify these perpetrator groups into Muslim and non-Muslim groups. Muslim perpetrator groups have some connection to Islam, e.g., many of their members and supporters

[8]Table B.1 in Online Appendix B lists the countries and territories with the most terrorist events and terror deaths.

being Muslim. We further classify Muslim perpetrator groups into groups with either an Islamist or secular ideology. Islamist perpetrator groups claim to have a connection to Islam and confess to terrorist attacks citing religious ideologies or religious motives. Examples include al-Qaeda, al-Shabaab, Boko Haram and Islamic State. Secular Muslim perpetrator groups are driven by other ideologies and motives. They include separatists (or freedom fighters), such as the Kurdistan Workers' Party or the Palestine Liberation Organization, and communist groups, such as Devrimci Sol.

For the years up to 2008, we follow the classification of Kis-Katos *et al.* (2014). We update the classification for more recent years.[9] In total, we identify 878 Muslim and 2,180 non-Muslim perpetrator groups. These groups are jointly responsible for 51% of terrorist events and 67% of terror deaths in our data. We are unable to classify the perpetrators of the remaining terrorist events because the perpetrators are unknown, multiple groups confessed to the attack, or the press reports were ambiguous. We assign Islamist ideologies to 367 classified Muslim perpetrator groups and secular ideologies to 207 of these groups. These groups are jointly responsible for 85% of terrorist events and 90% of terror deaths committed by the classified Muslim perpetrator groups. The remaining terrorist events by Muslim perpetrators are unclassified because of imprecise information about the perpetrators or their ideology. Therefore, it is important to interpret all results based on the classification of perpetrator groups with caution.

Figure 4 splits the development of terrorist events and terror deaths over time by Muslim and non-Muslim perpetrator groups. Figure 5 further splits Muslim perpetrator groups into Islamist and secular groups.

Figures 4 and 5 around here

The resulting pattern suggests that the pronounced increase in terrorism since the September 11 attacks is mostly due to Islamist perpetrator groups. Non-Muslim perpetrator groups committed terrorist attacks mainly in countries with a Muslim population share below 25%, and Muslim perpetrator groups, in particular those with an Islamist ideology, mainly committed attacks in countries with a Muslim population share above 75% (see Table B.2 in Online Appendix B).

For most terrorist events, the GTD contains information about the targets. We group the targets into armed targets (such as military, police and armed rivals), unarmed civilians and infrastructure. Figures 6 documents changes in the targets of terrorist attacks over time.

Figures 6 around here

[9]The classification of perpetrator groups is available upon request.

We see that most of the recent terrorist attacks targeted civilians, while a considerable share had armed targets and very few had infrastructure targets.

The GTD also provides information about (non-mutually exclusive) attack types, which may reflect the broad tactics used by the perpetrators. We focus on the two attack types that are the most common and cause the most deaths: Assaults and bombings. In addition, we look at suicide attacks, which were rare before the September 11 attacks, but have become more frequently used since.[10] Figure 7 shows that bombing is the most commonly employed attack type, followed by assaults.

Figure 7 around here

In addition, Figure 7 shows that suicide attacks are responsible for a much higher share of terror deaths than terrorist events, implying that they are disproportionally lethal.[11] In addition, suicide attacks occur disproportionally often in countries with a Muslim population share above 75% (see Table B.2 in Online Appendix B).

In summary, Figures 2–7 provide evidence for several general trends in terrorism: First, terrorism has been on the rise since the September 11 attacks. Second, this increase has mainly been driven by Islamist perpetrators, many of whom have been suicide attackers. Third, most victims have been civilians in predominantly Muslim countries.

Finally, we examine the dynamics of terrorism within years. In particular, we look at the share of terrorist events taking place during Ramadan. If terrorist events were uniformly distributed across the Islamic months, we would expect a share of 8.3% of terrorist events during Ramadan. Figure 8 shows that the actual shares of terrorist events and terror deaths occurring during Ramadan are indeed fluctuating (with a few outliers) around a share of approximately 8.3%.

Figure 8 around here

Averaged over the sample period, the actual shares of terrorist events and terror deaths during Ramadan are both 7.8%, with the differences to 8.3% not being statistically significant at conventional levels. Hence, we find no evidence that terrorism is particularly frequent or infrequent during Ramadan (as compared to other months).

[10] All other assault types (including assassinations, kidnapping and hijacking) were less common than assaults and bombings during our sample period, and led to fewer fatalities than assaults, bombings and suicide attacks.

[11] The average number of terror deaths per terrorist event is 3.4 for assaults, 1.7 for bombings, and 10.9 for suicide attacks (see Table B.2 in Online Appendix B).

2.4 Our panel dataset

Our main analysis is based on panel data. The time-series dimension is 47 Ramadan years. The cross-sectional units are administrative regions at the second subnational level (ADM2). These units correspond to counties or, more often, districts. Compared to cross-sectional units that do not coincide with administrative regions, the use of districts has the advantage that the START typically provides the geo-references for cities or districts in which terrorist events occurred. In total, our sample contains 39,886 such districts from 190 countries and territories from around the world. The sample contains 1,874,642 observations.

We transform the terrorism data from the GTD by aggregating the terrorist events and terror deaths by districts and Ramadan year, using the date and location information in the GTD and the administrative (ADM2) boundaries provided by GADM. In the resulting panel, the occurrence of terrorist events is highly right-skewed. There are terrorist events in only 27,866 (1.6%) of our observations. 25,147 of these observations have between one and four terrorist events, while there were 980 terrorist events in Baghdad in Ramadan year 1436. Similarly, there are deadly terror attacks only in 17,223 (0.9%) of our observations. 9,740 of these observations have between one and four terror deaths, but Baghdad suffered 3,348 terror deaths in Ramadan year 1427. By comparison, the terrorist attacks on the World Trade Center in New York on September 11, 2001, enter the data with 2,766 deaths. We transform our terrorism data to avoid the results being driven by extreme outliers. In the main analysis, we focus on the the extensive margin of terrorist events defined as $1\{N > 0\} \cdot 100$, where N stands for the number of terrorist events or terror deaths by district and Ramadan year.[12] The extensive margin of terrorist events indicates whether any terrorist event occurred in the given district and Ramadan year, and the extensive margin of terror deaths indicates whether any fatal terrorist event occurred. We provide additional results for the intensive margin based on the log-modulus transformation $\ln(N + 1) \cdot 100$.

In order to collect information on daylight hours during Ramadan, we first determine the centroid of each district.[13] We then use the centroid's geo-coordinates to collect the district's daylight hours during Ramadan from the Astronomical Application Department. Finally, we average the daylight hours in a district over all days of Ramadan in a given Ramadan year. Hence, the Ramadan daylight hours always refer to the latest Ramadan, i.e., the first month of a Ramadan year. This is the rationale for using the pseudo time scale "Ramadan year" in our analysis.

Table 2 presents the Ramadan daylight hours and the occurrence of terrorist events and terror deaths in our panel dataset, stratifying the countries and territories into three groups

[12] We multiply our dependent variables by 100 to ease the interpretation of the coefficient estimates.

[13] More specifically, we calculate the "representative" centroid (point) for each ADM2 polygon, which ensures that the point falls inside the polygon.

depending on their Muslim population share.

Table 2 around here

3 Empirical strategy

As highlighted in Section 1, our empirical strategy builds on Campante and Yanagizawa-Drott (2015) and exploits key characteristics of Ramadan fasting and the Islamic calender. Daily fasting from dawn to sunset during Ramadan is seen as mandatory and is practiced by many Muslims (see Table 1). Daylight hours, however, vary by latitude and seasons, and the season in which Ramadan takes place varies over time because the Islamic calender is not synchronized with the solar cycle. As a result, the daily Ramadan fasting duration typically varies across districts within a given country and year, and the difference in Ramadan fasting duration between districts varies over time.

Figure 9 shows the Ramadan daylight hours in the northernmost (solid lines) and southernmost (dashed lines) regions of Iraq, Pakistan, Somalia and Indonesia throughout our sample period.

Figure 9 around here

The Ramadan daylight hours oscillate around approximately 12 hours. The amplitude depends on the distance to the equator. The Ramadan daylight hours have larger amplitudes in districts farther away from the equator. Zakho is the northernmost district of Iraq and Al Faw the southernmost. The Ramadan daylight hours are longer in Zakho than in Al Faw when Ramadan is in the summer season. Conversely, Ramadan fasting is shorter in Zakho than in Al Faw when Ramadan is in the winter season. Ramadan daylight hours are similar for Iraq and Pakistan, in particular in their northernmost districts, which have similar latitudes. Ramadan daylight hours have smaller amplitudes in Somalia, which is much closer to the equator. They are almost time constant in the southernmost district of Somalia, Kismaayo, which is located almost on the equator. Ramaday daylight hours in the Indonesian district Banda Aceh and Rote Ndao oscillate in opposite directions. The reason is Banda Aceh is in the northern hemisphere and Rote Ndao in the southern.

Ramadan daylight hours are exogenous after controlling for the latitude and the seasonality of Ramadan. We can account for these two factors with district and Ramadan year fixed effects. The district fixed effects capture factors that are time constant within districts, such as geography, culture and historical heritage. The Ramadan year fixed effects capture the Gregorian month during which Ramadan takes place in a given Ramadan year, as well as yearly varying factors that affect all countries equally. Possible candidates for such factors

might be the global business cycle and tectonic shifts in geopolitics, such as the end of the Cold War, the September 11 attacks or the U.S.-led invasions in Afghanistan and Iraq. However, even such global factors are likely to affect different countries differently.

In addition, the literature has proposed a large number of potential determinants of terrorism that vary across countries and over time. For example, Gassebner and Luechinger (2011) perform an extreme bound analysis in which they consider 65 correlates of terrorism at the country-year level that had been proposed by previous studies. Moreover, Meierrieks and Gries (2013), Kis-Katos *et al.* (2014), and Enders *et al.* (2016) show that some of these determinants have heterogeneous effects across different types of perpetrators, countries and time periods. For these reasons, we use interacted country-Ramadan year fixed effects instead of Ramadan year fixed effects. These interacted fixed effects allow us, among others, to implicitly control for the many previously proposed determinants of terrorism and to account for their potentially heterogeneous effects. Furthermore, they also control for country-level GDP and average happiness, which by themselves are affected by Ramadan fasting (Campante and Yanagizawa-Drott, 2015).

Our main specification is

$$Terror_{ict} = \alpha_i + \beta_{ct} + \sum_{G=1}^{3} \gamma_g \left(RDH_{ict} \times 1_c\{c \in G\} \right) + \epsilon_{ict}, \tag{1}$$

where $Terror_{ict}$ is a terror outcome in district i of country c in Ramadan year t, e.g., the occurrence of at least one terrorist event. α_i and β_{ct} represent the region and country-Ramadan year fixed effects mentioned above. RDH_{ict} measures the average Ramadan daylight hours in region i of country c in Ramadan year t. $1_c\{c \in G\}$ represents indicator variables for the three mutually exclusive country groups $G = 1, 2, 3$, which we stratify by the Muslim population share using thresholds of 25% and 75%. The indicator function $1_c\{c \in G\}$ is equal to one if country c is part of group G, and zero otherwise. The parameters of interest are γ_1, γ_2 and γ_3. They measure the average effect of Ramadan daylight hours on terror outcomes within these three country groups. It is worth highlighting that we exploit only within country and Ramadan year variation to identify these parameters. That is, in Figure 9 we exploit only the vertical variation in the Ramadan fasting duration within country-years, but not the horizontal variation across Ramadan years or any cross-country variation. This choice makes it a conservative specification.

The error term ϵ_{ict} absorbs unexplained variation of the terror outcome. We cluster the standard errors of the estimated coefficients at the country-level.

4 Results

4.1 Main results

Table 3 reports the effects of the daily fasting duration during Ramadan, measured by Ramadan daylight hours, on the extensive margin of terrorist events and terror deaths in panels A and B, respectively.

Table 3 around here

Column (1) looks at average effects and accounts separately for country and Ramadan year fixed effects. We find negative relations between Ramadan daylight hours and the two measures for the occurrence of terrorist events. These relations are not statistically significant at conventional levels. Column (2) includes district fixed effects as well as interacted country-Ramadan year fixed effects to account for constant region-specific characteristics and country-level changes of all sorts over time. The coefficient estimates and the standard errors remain similar. Hence, averaged across the globe, Ramadan daylight hours have no causal effect on the occurrence of terrorism.

Column (3) introduces an interaction term between Ramadan daylight hours and the Muslim population share. The coefficient estimates on this interaction term are negative, suggesting a negative relation between the Muslim population share and the effect of Ramadan daylight hours on the occurrence of terrorist events. This coefficient, however, is not statistically significant at conventional levels. Moreover, the model in column (3) would be misspecified if the relation between the Muslim population share and the effect of Ramadan daylight hours were non-linear.

We therefore turn to our preferred specification in column (4). There, we use three interaction terms between Ramadan daylight hours and indicator variables for whether the Muslim population share is below 25%, between 25% and 75%, or above 75%, respectively. The point estimates indeed hint at a non-linear relation. The effect of Ramadan daylight hours on the occurrence of terrorist events is negative, but small and not statistically significant in predominantly non-Muslim countries; positive, but imprecisely estimated in religiously divided countries; and negative, sizable and statistically significant at the 5%-level in predominantly Muslim countries. The point estimates suggest that an additional hour of daily fasting during Ramadan lowers the probability of a terrorist event in a predominantly Muslim country within 12 months after the beginning of Ramadan by 2.7 percentage points, and the probability of a fatal terrorist event by 2.4 percentage points.

These results imply that the geography of terrorism depends on the timing of Ramadan within the solar cycle. Suppose Ramadan daylight hours differ by 30 minutes between the northernmost and the southernmost district of a predominantly Muslim country when Ra-

madan is in summer (around late June) or winter (around late December), which is approximately true for Iraq and Pakistan (see Figure 9). Further suppose that these two districts have the same time-averaged propensity to terrorism, such that the probability of terrorist events is the same in these two districts if Ramadan is around late March or late September. Then, the probability of a terrorist event would be 1.35 percentage points lower in the northernmost (southernmost) than in the southernmost (northernmost) district if Ramadan were in summer (winter).

We now turn to the effect of Ramadan fasting on the intensity of terrorism across districts. Table 4 presents the results for the log-modulus transformation of the numbers of terrorist events and terror deaths per district (multiplied by 100).

Table 4 around here

The pattern is remarkably similar as the one seen in Table 3. Again, the effect of Ramadan daylight hours on terrorism is close to zero in predominantly non-Muslim countries, positive but imprecisely estimated in religiously divided countries, and negative, sizable and statistically significant in predominantly Muslim countries. We can interpret the coefficient estimates as approximations of semi-elasticities.[14] They suggest that an additional hour of daily fasting during Ramadan lowers terrorist events and terror deaths by approximately 3.3% and 4.6%, respectively.

4.2 Results for various time periods and perpetrator groups

In this section, we disaggregate terrorist events by different sample periods and perpetrator groups. Our motivation is twofold. First, a more disaggregated analysis is interesting in and of itself. Second, the disaggregation by perpetrator groups offers a falsification test.

We start by dividing the sample into three different time periods: The time prior to the end of the Cold War (Ramadan years 1390–1411); the time between the end of the Cold War and the September 11 terrorist attacks (Ramadan years 1412–1422); and the years after the September 11 attacks (Ramadan years 1422-1436). Table 5 presents the results.

Table 5 around here

Focusing on the first of these time periods, column (1) shows that longer Ramadan daylight hours had no effect on terrorist events, not even in predominantly Muslim countries. This

[14]The coefficient estimates could be interpreted as semi-elasticities if we did not add one before taking the logarithm of terrorist events or terror deaths. In that case, however, we would lose the majority of our observations.

finding is not surprising, given that terrorist events were rare in these countries prior to the end of the Cold War (see Figure 3). Columns (2) and (3) show that longer Ramadan daylight hours reduced the probability of terrorist events in predominantly Muslim countries after the end of the Cold War, and that this effect became slightly larger after the September 11 terrorist attacks. These latter columns also shed light on the effects of longer Ramadan daylight hours on the two other country groups seen in Table 3: First, the small negative average effect on the probability of terrorist events in predominantly non-Muslim countries is driven by the years since the September 2011 attacks. Second, the sizable, but imprecisely estimated positive average effect on the probability of terrorist events in religiously divided countries is driven by the entire time period since the end of the Cold War.

We turn to the split between Muslim and Non-Muslim perpetrator groups.[15] This split offers a falsification test: If Ramadan daylight hours matter for terrorism only for reasons related to Ramadan fasting and the associated religious experience, then we should find an effect on terrorist events committed by Muslim perpetrator groups, but no effect on terrorist events committed by non-Muslim perpetrator groups. That is exactly what we find in columns (1) and (2) of Table 6:

Table 6 around here

Longer Ramadan daylight hours have no effect on terrorist attacks by Non-Muslim perpetrators in any country group, but lead to a significantly lower probability of terrorist attacks by Muslim perpetrators in predominantly Muslim countries.

Columns (3) and (4) of Table 6 further split the Muslim perpetrator groups into groups with Islamist and secular ideologies, respectively. We find few statistically significant effects, possibly because we could not classify all the classified Muslim perpetrator groups as either Islamist or secular. The point estimates, however, suggest an interesting pattern in how these different Muslim perpetrator groups respond to longer Ramadan daylight hours: First, secular Muslim perpetrator groups tend to reduce terrorist attacks in predominantly non-Muslim countries. Second, Islamist perpetrator groups tend to increase terrorist attacks in religiously divided countries. Lastly, both groups tend to reduce terrorist attacks in predominantly Muslim countries.

4.3 Robustness checks

We present various robustness tests in Online Appendix C, thereby focusing on our main results reported in Table 3, column (4). In this section, we discuss these robustness tests.

First, Table C.1 replaces the continuous variable for Ramadan daylight hours with a set

[15] As discussed in Section 2.3, results based on our classification of perpetrator groups should be interpreted with caution, as we could not assign perpetrators to a large share of the terrorist events.

of indicator variables for different durations (and estimates separate models for each of the three country groups). Accordingly, the specifications are fully non-parametric, and there are no concerns about the limited support of the outcome variables. The reference category is 11.5–12.5 Ramadan daylight hours, capturing fasting durations close to the mean. We find that our main results are driven by particularly long Ramadan fasting. That is, there is a strong decrease in terrorist events in predominantly Muslim countries when Ramadan fasting is particularly long, but no corresponding increase when Ramadan fasting is particularly short. The positive (and often imprecisely estimated) effects of Ramadan daylight hours on terrorist events in religiously divided countries are also driven by particularly long Ramadan fasting.

Second, Table C.2 documents the robustness of the main results when using alternative thresholds of the Muslim population share to stratify the countries and territories into three groups. In particular, it replaces the thresholds of 25% and 75% by thresholds of 10% and 90%, 20% and 80%, and 30% and 70%, respectively. The estimated effects for predominantly Muslim and predominantly non-Muslim countries remain very similar, while the imprecisely estimated point estimates for the countries with an intermediate Muslim population share are quite sensitive to the chosen thresholds.[16]

Third, Table C.3 focuses on the population share of the largest Islamic sect rather than on the population share of all Muslims aggregated across sects. It is based on information by the Pew Research Center about the country-level population shares of Sunni and Shia Muslims. The estimated effects for countries where the larger of these two sects has a population share above 75% are very similar to the effects for countries with a total Muslim population share above 75% (reported in Table 3).

Fourth, Table C.4 adds time-varying district-level controls for economic activity and population size. Our measure of a district's economic activity is based on satellite data on the intensity of nighttime lights, provided by the National Oceanic and Atmospheric Administration (NOAA). Henderson *et al.* (2012) and Hodler and Raschky (2014) document a high correlation between changes in nighttime light intensity and GDP at the level of countries and subnational administrative regions, respectively.[17] The data come on a scale from 0 to 63 and in pixels of less than one square kilometer, which allows computing average nighttime light intensity within district boundaries. Our measure of a district's total population is based on population data from the Center for International Earth Science Information Network (CIESIN). Using these data, especially the nighttime lights, which are only available

[16]This pattern is not surprising as most countries have a Muslim population share close to either zero or one (see Figure A.1 in Online Appendix A). Therefore, the composition of the country groups with high or low Muslim population shares does not strongly depend on the exact thresholds, while the composition of the country group with an intermediate Muslim population share is fairly sensitive to the exact thresholds.

[17]Bruederle and Hodler (2018) show that nighttime lights are correlated with broad measures of local social development as well.

for the (Gregorian) years 1992–2013, reduces the sample size considerably. In this sample, we again find sizable and statistically significant negative effects of Ramadan daylight hours on the probability of terrorists events occurring in predominantly Muslim countries. More importantly, these effects remain almost unchanged when controlling for our measures of local economic activity and local population.

Fifth, Table C.5 uses administrative regions at the first subnational level as cross-sectional units. These administrative regions correspond to provinces (or states). An average province consists of 13 districts. The coefficient estimates again suggest a large negative effect of Ramadan daylight hours on terrorists events in predominantly Muslim countries, but the standard errors become considerably larger when basing the analysis on provinces rather than districts.

Sixth, Table C.6 reports results after dropping Ramadan year 1412, which ended on February 22, 1993, and Ramadan year 1413, which started on February 23, 1993. The coefficient estimates and standard errors are almost identical as in Table 3, column (4). Hence, our results are not an artefact of the missing data for the Georgian year 1993 in the GTD.

Lastly, Table C.7 reports results when re-estimating the main specification after dropping individual countries or country/territory-pairs. We sequentially drop the five countries with most terror deaths during the sample period, i.e., Afghanistan, India, Iraq, Nigeria and Pakistan, as well as Israel and Palestine, and the United States, which are other prominent countries/territories in public debates on terrorism.[18] The estimated effects for predominantly Muslim and predominantly non-Muslim countries remain the same in all cases. The imprecisely estimated positive effect for countries with an intermediate Muslim population share (see Table 3), however, disappears when dropping Nigeria, which has the most terrorist events and terror deaths of all the religiously divided countries.

The general pattern emerging is that Ramadan daylight hours have a robust negative effect on terrorist events in predominantly Muslim countries. By contrast, Ramadan daylight hours have no robust effect on terrorism in other countries.

5 Discussion

In this section, we discuss three potential channels through which longer Ramadan fasting may lead to a decrease in terrorist events in predominantly Muslim countries.

[18]The Muslim population share is below 25% in India, Israel and the United States; between 25% and 75% in Nigeria; and above 75% in Afghanistan, Iraq, Pakistan and Palestine (according to our data described in Section 2.2).

5.1 Short-term physiological and psychological effects of fasting

Medical studies have documented a plethora of physiological and psychological effects of Ramadan fasting, including body weight loss, sleep deprivation, tiredness, lassitude and irritability (e.g., Leiper and Molla, 2003). A first possibility is that longer Ramadan fasting could lower terrorism due to such short-term physiological and psychological effects. For example, long fasting hours could lead to (potential) terrorists who are too exhausted to commit terrorist attacks. On the other hand, military and police forces could also be exhausted from long Ramadan fasting hours, making terrorist attacks easier. Figure 8 already shows that terror events tend to be neither more, nor less common in Ramadan than in other months. But to properly test whether physiological and psychological effects are a likely channel through which longer Ramadan fasting decreases terrorist events, we make use of the fact that physiological and psychological consequences of fasting should be temporary. Hence, if we find that Ramadan fasting duration has an effect on terrorism beyond the month of Ramadan and the next one or two months, then that suggests that physiological and psychological effects are not a likely channel.

We therefore construct a new panel dataset with the same cross-sectional units but quarterly frequency instead of annual frequency. The first quarter of each Ramadan year starts with the month of Ramadan and also includes the two subsequent Islamic months Shawwa and Dhu al-Qidah. The second quarter contains the next three Islamic months: Dhu al-Hijjah, Muharram, and Safar. The third quarter and the fourth are constructed analogously. Table 7 reports the effects of Ramadan daylight hours on the probability that a (fatal) terrorist attack occurs in a given Ramadan year-quarter and district.[19]

Table 7 around here

Columns (1) and (4) present the results when rerunning our main specification on the quarterly panel dataset. The effects of Ramadan daylight hours are again negative and statistically significant in countries with a Muslim population share above 75%. In these countries, an additional hour of Ramadan fasting reduces the probability of a terrorist event in any given quarter and district by 1.2 percentage points and the probability of a fatal terrorist event by 0.9 percentage points.

Columns (2) and (5) introduce nine triple interaction terms by interacting Ramadan daylight hours with the (same) indicator variables for the three country groups as well as indicator variables for the second, third and fourth quarters of a Ramadan year. The double interaction term between Ramadan daylight hours and the indicator variable for predominantly Muslim

[19]Table D.1 in Online Appendix D provides descriptive statistics for the quarterly panel dataset.

countries now captures the effect of Ramadan daylight hours in the first quarter of any given Ramadan year in these countries (while it captures the average effect over all four quarters of a Ramadan year in these countries in columns (1) and (4)). We find that the coefficient estimates of this interaction term remains very similar. This is a first indication that the effect of longer Ramadan fasting on terrorist events in predominantly Muslim countries is not restricted to the first quarter of a Ramadan year. In addition, we find that the coefficient estimates of the three bottommost triple interaction terms are all very small in absolute value and typically not statistically significant. This is a second indication that the effect of Ramadan daylight hours outlasts the first quarter of a Ramadan year.[20] In columns (3) and (6), we replace the country-Ramadan year fixed effects by country-Ramadan year-quarter fixed effects and find qualitatively similar results.

We conclude that short-term physiological and psychological effects cannot be the main channel through which longer Ramadan fasting reduces terrorist events in predominantly Muslim countries.

5.2 Religiosity and self-restraint by potential terrorists

A second possibility is that longer Ramadan fasting could increase the empathy and self-restraint of potential terrorists, such that they become reluctant to commit terrorist attacks. Even if we accept that longer Ramadan fasting implies a more intense religious experience for potential terrorists, it is unclear whether this increase in religiosity would lead to empathy and self-restraint. On the one hand, it seems possible given prominent Quran verses, such as verse 5:32, that condemn the use of force against innocent victims.[21] On the other hand, it is well-known that terrorist organizations, such as al-Qaeda or the Islamic State, focus in their propaganda on Quran verses that may justify violence, in particular violence against those who are perceived as enemies.[22] Therefore, it seems questionable whether intense religious experiences would lead to empathy and self-restraint among potential terrorists. However, if it did, then we would primarily expect an effect of longer Ramadan fasting on terrorist attacks

[20] The coefficient estimate on the bottommost triple interaction in column (2) is statistically significant at the 10%-level, but the point estimate is small, suggesting that only a minor share of the initial effect is undone until the fourth quarter of a Ramadan year.

[21] In its edict against terrorism in July 2005, the Fiqh Council of North America translated verse 5:32 as follows: "Whoever kills a person [unjustly] it is as though he has killed all mankind. And whoever saves a life, it is as though he had saved all mankind."

[22] Comerford and Bryson (2017) provide a text analysis of Salafi-Jihadi (and other) documents. They find that Salafi-Jihadi documents focus on "verses that have a backdrop of violence" (p. 19). Verse 8:60 is the top-quoted Quran verse in these documents: "And prepare against them whatever you are able of power and of steeds of war by which you may terrify the enemy of Allah and your enemy and others besides them whom you do not know [but] whom Allah knows. And whatever you spend in the cause of Allah will be fully repaid to you, and you will not be wronged."

targeted at unarmed civilians.

Table 8 reports the effects of Ramadan daylight hours on terrorist attacks on armed targets, unarmed civilian targets and infrastructure targets, respectively.

Table 8 around here

We see that longer Ramadan daylight hours tend to reduce terrorist attacks on all types of targets in predominantly Muslim countries. The effect on the probability of any terrorist attack on civilian targets, however, is not statistically significant (and the effect on the probability of a fatal terrorist attack on civilian targets is only statistically significant at the 10%-level). Comparing the point estimates and the sample means (reported in Table 2) further suggests that the relative change in terrorist attacks on civilian targets is smaller than the relative changes in terrorist attacks on armed or infrastructure targets. These results suggest that terrorist events do not decrease in response to longer Ramadan fasting because of empathy and self-restraint by (potential) terrorists.

5.3 Religiosity and public support for terrorism

We now turn to a third channel through which longer Ramadan fasting may lead to a decrease in terrorist events in predominantly Muslim countries. This channel has two parts: First, more intense Ramadan fasting increases the religiosity in the general public and lowers the public support for terrorism. Second, lower public support for terrorism reduces the operational capabilities of perpetrator groups. The first part is consistent with the observation that many Muslims are exposed to a different, more standard interpretation of the Quran than members of Islamist perpetrator groups. The second part is consistent with previous research showing that public support is an important determinant of the success of (planned) terrorist attacks. In what follows, we provide evidence for both parts of this third channel.

Our evidence for the effect of more intense Ramadan fasting on public support for terrorism is based on survey data from the Pew Research Center. The Pew Research Center has been running surveys since 2002 in which Muslims are asked whether they feel that violence is "justified in order to defend Islam from its enemies." We use data from Pew surveys in 13 countries and territories with a Muslim population share above 75%. We use the same empirical strategy as in previous tables, but the unit of observation here is a Muslim respondent from a particular province surveyed in a particular Ramadan year. The first (second) dependent variable is equal to 100 if the Muslim respondent feels that violence is "never" or "rarely" ("often" or "sometimes") justified "to defend Islam from its enemies," and zero otherwise.[23]

[23]These two indicator variables are both zero if a respondent refuses to answer or responds "do not know."

Table 9 reports the results.

Table 9 around here

We find that one additional Ramadan daylight hour increases the share of Muslims who feel that such violence is unjustified by 14% and decreases the share who feels that it is justified by 14%. Hence, more intense Ramadan fasting indeed lowers public support for terrorism. These findings recall the finding by Clingingsmith *et al.* (2009) that participation in the Hajj pilgrimage lowered the respondents' beliefs that the goals for which Osama bin Laden was fighting and the methods he was using were correct.

Our evidence for the second part of the proposed channel – the reduction in the operational capabilities of perpetrator groups – is indirect and based on the following two hypotheses: First, perpetrator groups with little public support and limited operational capabilities are relatively more likely to attack unarmed civilian targets as opposed to armed targets because the latter are harder to attack, especially when the perpetrators want to escape alive and thus need shelter or an escape route. Second, and along the same lines, perpetrator groups with little public support and limited operational capabilities are relatively more likely to commit suicide attacks as opposed to other types of terrorist attacks. This second hypothesis draws on Berman and Laitin (2008), who argue that suicide attacks remain effective in conditions in which other tactics would fail and are therefore chosen more often "when conditions disfavor" (p. 1948).[24]

The results reported in Table 8 and discussed in Section 5.2 are consistent with the first hypothesis. In addition, Table 10 reports the effects of Ramadan fasting hours on the most common and most lethal types of terrorist attacks.

Table 10 around here

Columns (1) and (2) show the effects of longer Ramadan daylight hours on the probability of assaults and bombings of any type (i.e., suicide attack or not). In predominantly Muslim countries, these effects are negative and statistically significant (with the exception of the effect on lethal bombings). However, when only focusing on suicide attacks in column (3), we find that the effect of longer Ramadan daylight hours becomes relatively small and far from statistically significant. This pattern is consistent with the second hypothesis.

Based on these different pieces of evidence, we can conclude that the following channel may

[24]Consistent with this notion, Benmelech *et al.* (2015) show that precautionary house demolitions in the Gaza Strip, which are intended to reduce the operational capabilities of perpetrator groups by preventing the launching of attacks from specific locations (but are unrelated to the owners and occupants of these houses), lead to an increase the number of suicide attacks. In contrast, they find that punitive house demolitions decrease the number of suicide attacks.

indeed be important: The intense religious experience of longer Ramadan fasting lowers public support for terrorism, and lower public support constrains perpetrator groups and reduces their operational capabilities. As a result, perpetrators groups commit fewer and operationally easier terrorist attacks, leading to a decrease in terrorist events and terror deaths.[25]

6 Concluding remarks

The long history of terrorist groups with a religious background and the recent surge of terrorist attacks by Islamist perpetrators in predominantly Muslim countries has motivated us to study the effect of religiosity on terrorism. We have focused on one of the five pillars of Islam: Daily fasting from dawn to sunset during the month of Ramadan. Building on Campante and Yanagizawa-Drott (2015), we have exploited the fact that the lunar Islamic calender is not synchronized with the solar cycle. We have identified causal effects by focusing on differences in Ramadan fasting duration across districts within country-years.

We have found a sizable and robust negative effect of more intense Ramadan fasting on terrorist events. This decrease is restricted to Muslim perpetrator groups and the time period in which such groups have been active. The evidence suggests that this effect is driven neither by short-term physiological and psychological consequences of alimentary abstention, nor by self-restraint of (potential) perpetrators. Instead, the evidence is consistent with a channel operating through a decrease in public support for terrorism and a reduction in the operational capabilities of perpetrator groups. Our results are thus consistent with previous research finding that a decrease of public support for terrorism can effectively reduce terrorist attacks. We add to the literature by showing that higher religiosity may reduce public support for terrorism among Muslims rather than being a breeding ground for terrorism.

One could interpret our findings as support for the promotion of peaceful interpretations of the Quran as counter-narratives to the interpretation and propaganda of Islamist groups. It is, however, questionable whether counter-narratives promoted by foreigners or a domestic elite can have similar effects as higher religiosity due to more intense Ramadan fasting. This question is related to the general concern – forcefully articulated by Sen (2007) – that counter-

[25]We reported in Section 4 that longer Ramadan daylight hours do not reduce (and may even increase) terrorist events in countries with a Muslim population share between 25% and 75%. The question arises as to why the proposed channel is not at work in these countries. A possible reason is related to the effect of Ramadan fasting duration on the views of Muslims on non-Muslims. Table E.1 in Online Appendix E presents results based on survey questions on the views on Christians and Jews in six predominately Muslim countries. It shows that longer Ramadan daylight hours increase the share of Muslim respondents with unfavorable views on Christians and Jews. Therefore, some Muslims seem to feel more at unease with both terrorism and non-Muslims after intense Ramadan fasting. It is conceivable that these countervailing effects are one of the reasons why longer Ramadan fasting does not lead to a reduction in terrorist events in religiously divided societies.

narratives may play into the hands of Islamist groups by focusing on religious identity rather than the plurality of identities each individual has.

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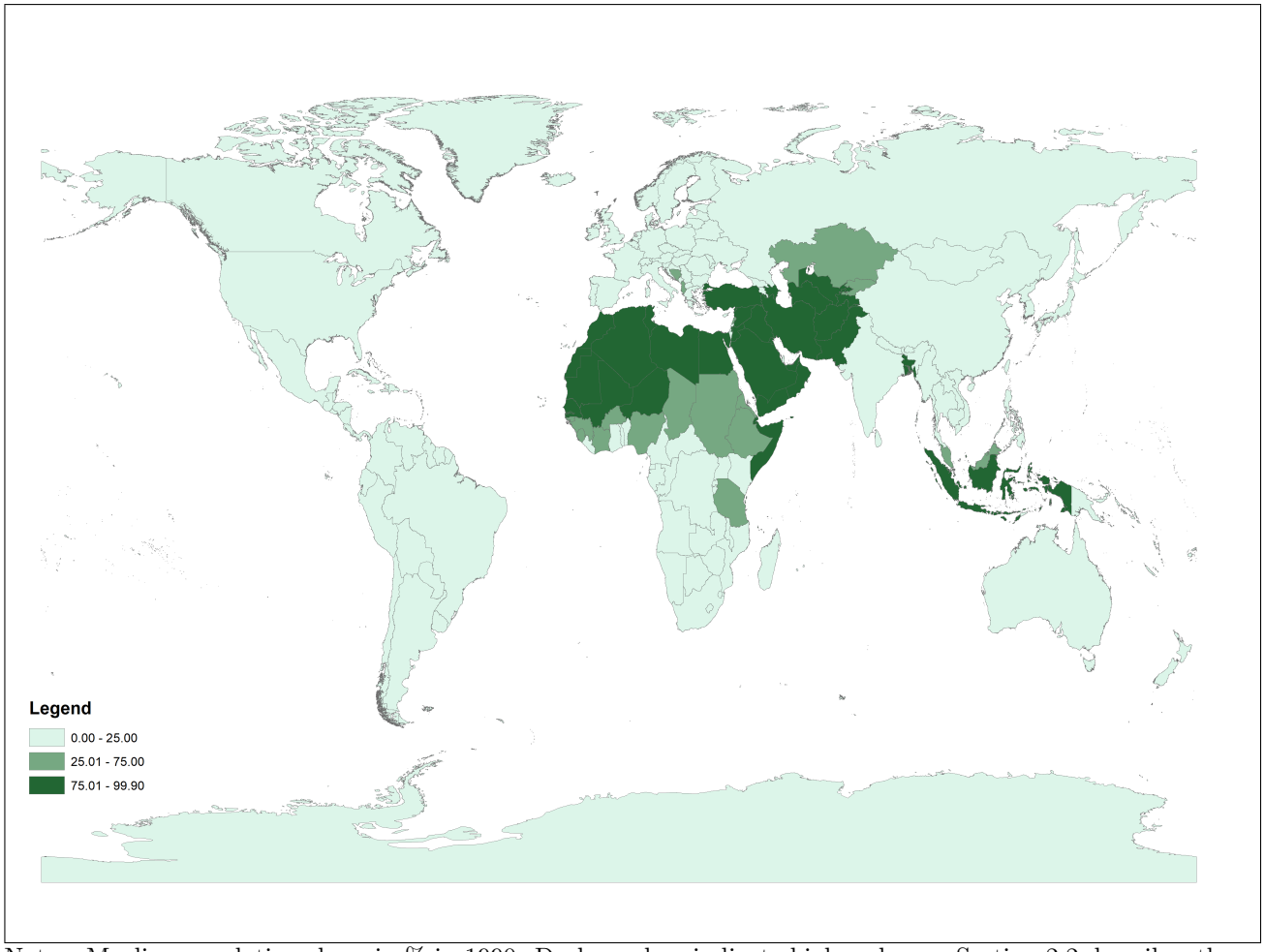
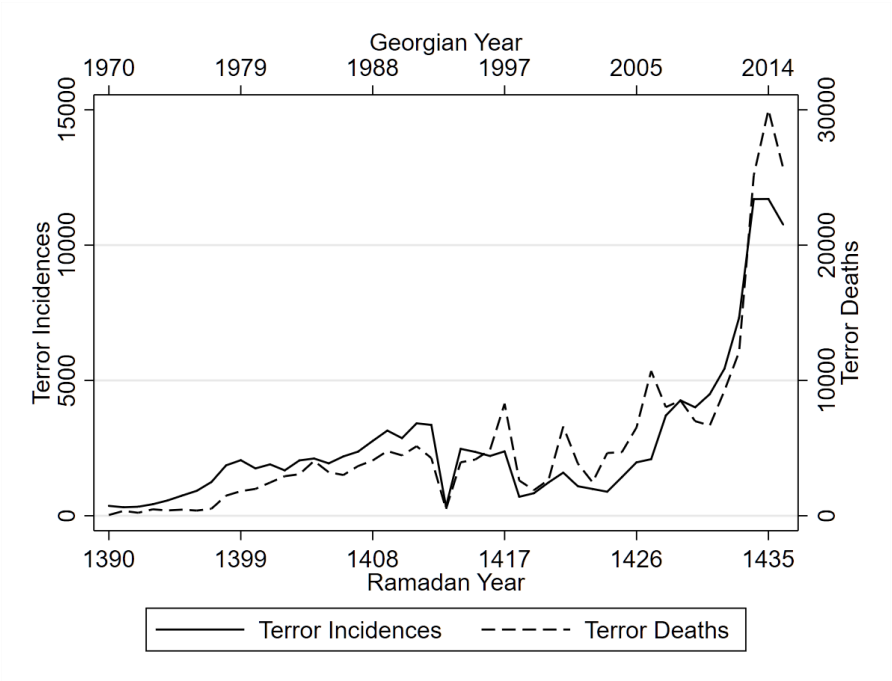
Figures and Tables

Figure 1: Country-level population shares of Muslims



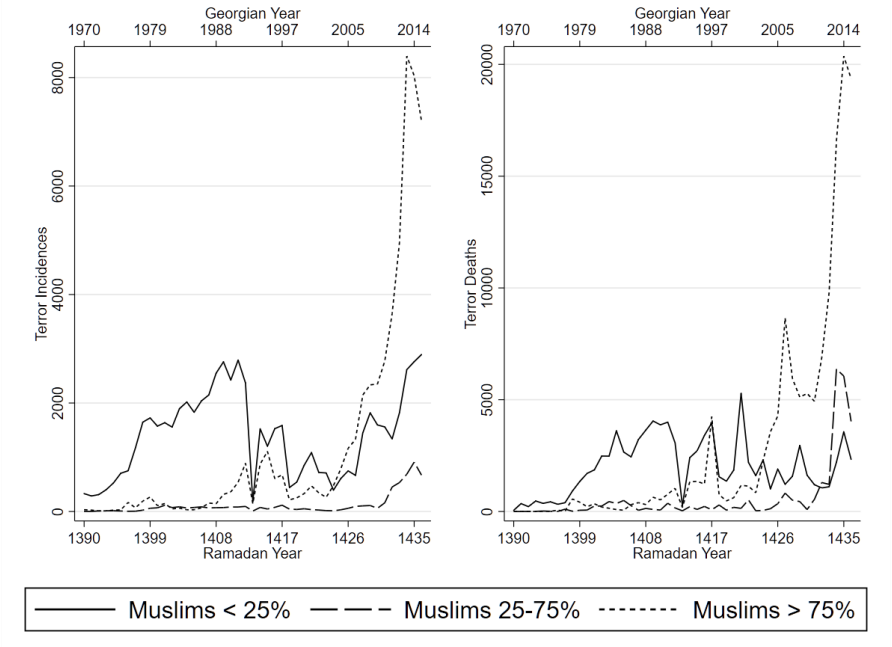
Notes: Muslim population share in % in 1990. Darker colors indicate higher shares. Section 2.2 describes the data.

Figure 2: Terrorist events and terror deaths by Ramadan year



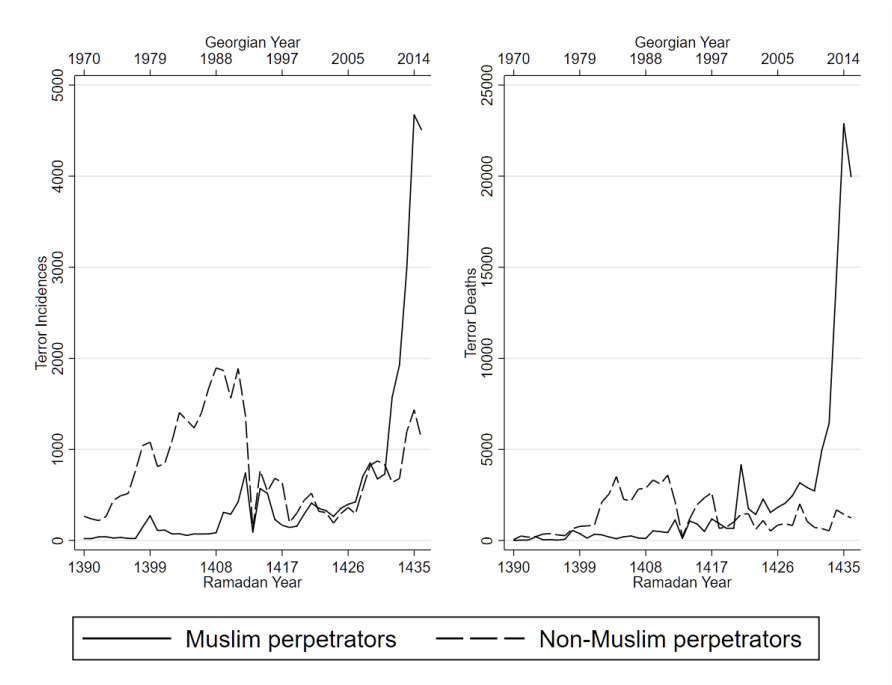
Notes: Section 2.1 introduces the time unit "Ramadan year," and Section 2.3 describes the terrorism data.

Figure 3: Terrorist events and terror deaths by Muslim population share



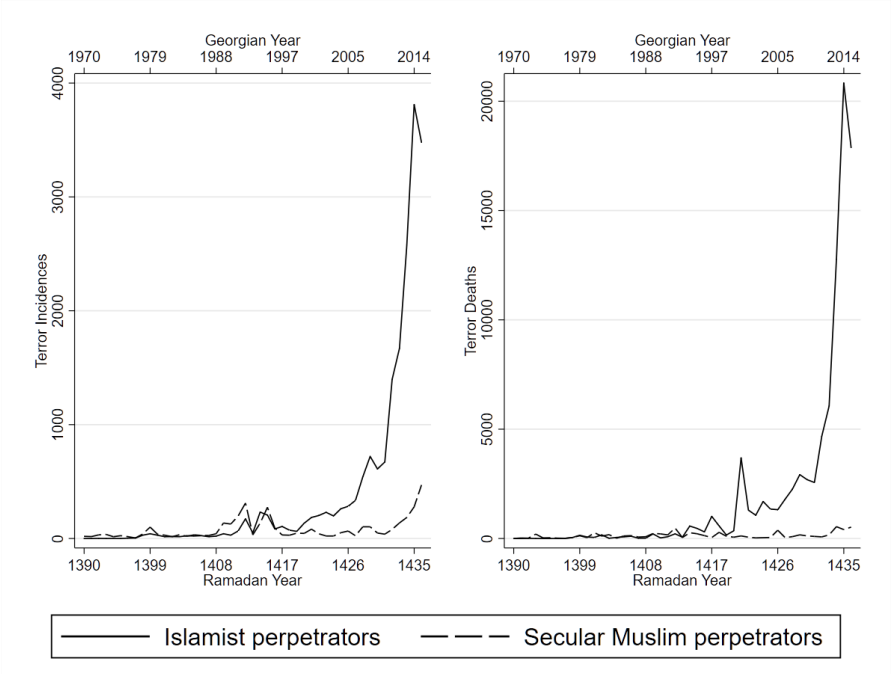
Notes: Section 2.1 introduces the time unit "Ramadan year," and Section 2.3 describes the terrorism data.

Figure 4: Terrorist events and terror deaths by Muslim vs Non-Muslim perpetrator groups



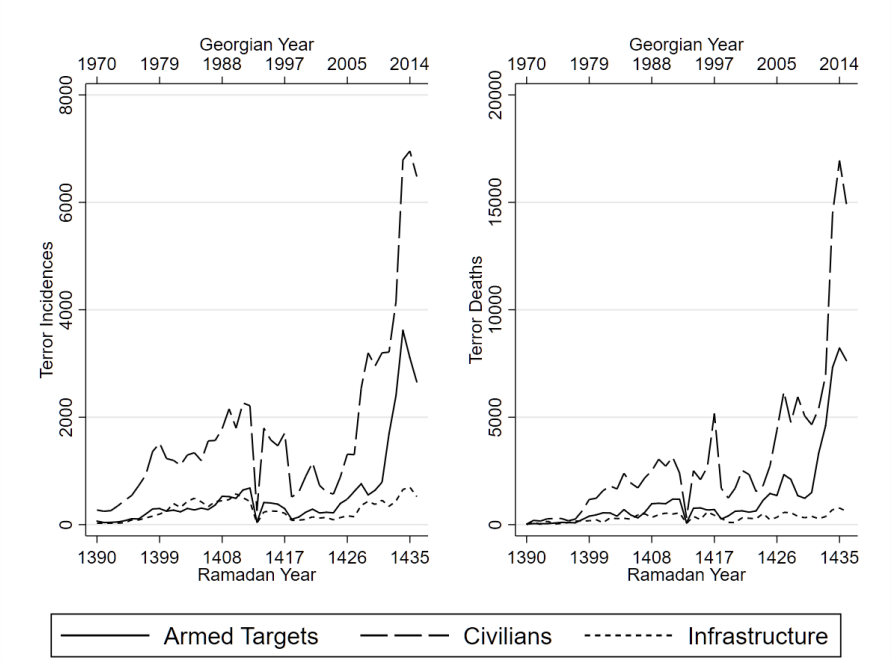
Notes: Section 2.1 introduces the time unit "Ramadan year," and Section 2.3 describes the terrorism data.

Figure 5: Terrorist events and terror deaths of Islamist and secular Muslim perpetrator groups



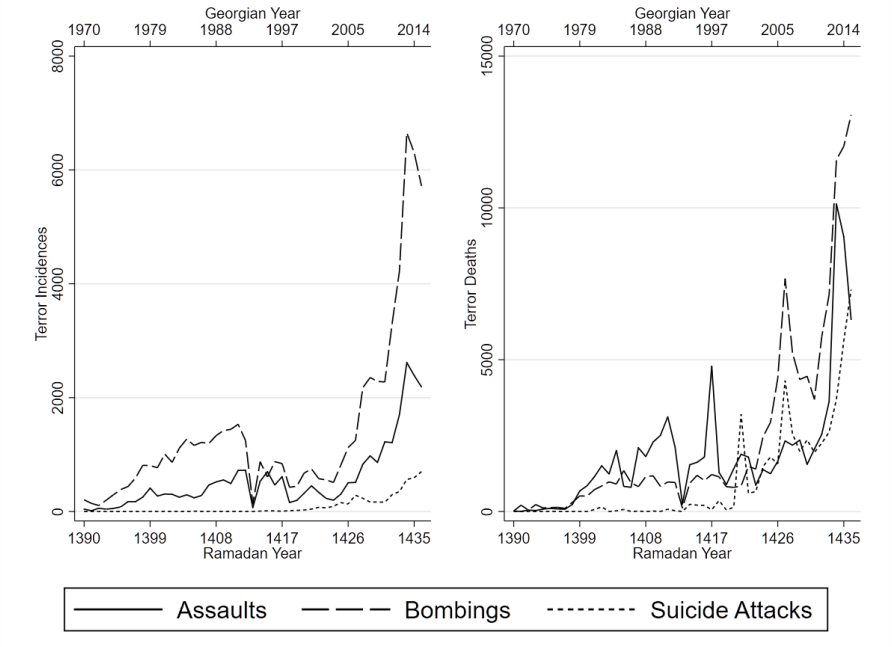
Notes: Section 2.1 introduces the time unit "Ramadan year," and Section 2.3 describes the terrorism data.

Figure 6: Terrorist events and terror deaths by targets



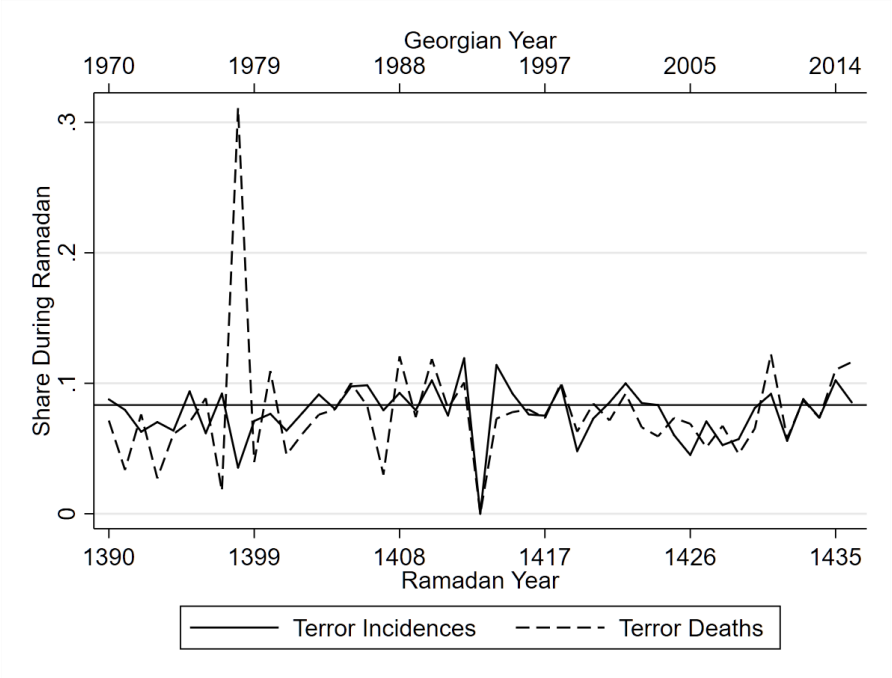
Notes: Section 2.1 introduces the time unit "Ramadan year," and Section 2.3 describes the terrorism data.

Figure 7: Terrorist events and terror deaths by attack types



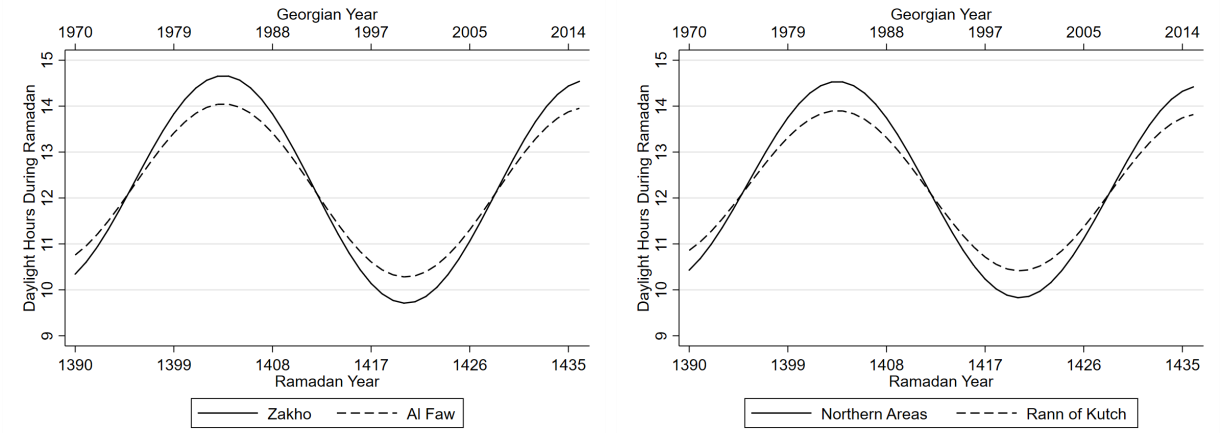
Notes: Section 2.1 introduces the time unit "Ramadan year," and Section 2.3 describes the terrorism data.

Figure 8: Share of terrorist events and terror deaths during the month of Ramadan



Notes: Section 2.1 introduces the time unit "Ramadan year," and Section 2.3 describes the terrorism data.

Figure 9: Average daylight hours during Ramadan



(a) Iraq

(b) Pakistan

(c) Somalia

(d) Indonesia

Table 1: Ramadan fasting in Muslim countries

Country	Ramadan fasting: most/all days	Obs.
	(1)	(2)
Egypt	94%	4,653
Indonesia	90%	2,769
Jordan	95%	2,890
Kuwait	99%	471
Mali	71%	622
Pakistan	78%	9,244
Palestine	93%	3,540
Senegal	85%	742
Tunisia	93%	981
Turkey	81%	5,524
Weighted average	86%	31,436

Notes: Results are based on Muslim respondents in surveys by the Pew Research Center from the years 2007–2013. Column (1) shows the share answering "During most or all days of Ramadan" or "During all of Ramadan and other religious holidays" as opposed to lower frequency when asked "How often, if at all, do you fast?" Column (2) provides the number of responses on which the share in column (1) is based.

Table 2: Descriptive statistics of the district-Ramadan-year panel data, by country group

	Muslim population share:					
	< 25%		25–75%		>75%	
	Mean	Std.Dev.	Mean	Std.Dev.	Mean	Std Dev.
	(1)	(2)	(3)	(4)	(5)	(6)
Ramadan daylight hours	12.24	1.81	12.18	0.93	12.26	1.37
Muslim pop. share (in %)	2.28	3.90	48.45	8.75	96.25	5.24
Terrorist events						
All events:						
Extensive margin	1.32	11.40	1.77	13.18	4.09	19.80
Log-modulus	1.94	20.29	2.71	24.32	7.80	53.10
By perpetrator groups (extensive margins):						
Muslim	0.11	3.33	0.74	8.55	2.60	15.91
Non-Muslim	0.79	8.86	0.25	4.96	0.30	5.46
Islamist	0.06	2.42	0.45	6.68	1.92	13.72
Secular Muslim	0.03	1.81	0.15	3.89	0.40	6.35
By targets (extensive margins):						
Armed targets	0.37	6.04	0.48	6.93	1.86	13.50
Civilians	1.01	9.99	1.46	11.99	3.19	17.57
Infrastructure	0.27	5.19	0.25	4.97	0.76	8.71
By attack types (extensive margins):						
Assault	0.46	6.75	0.78	8.78	1.91	13.68
Bombing	0.64	8.00	0.78	8.82	2.47	15.51
Suicide attack	0.01	1.22	0.11	3.28	0.62	7.83
Terror deaths						
All deaths:						
Extensive margin	0.67	8.15	1.15	10.66	3.03	17.15
Log-modulus	1.52	24.33	4.06	53.53	10.04	82.97
By perpetrator groups (extensive margins):						
Muslim	0.06	2.51	0.57	7.54	2.00	14.00
Non-Muslim	0.40	6.33	0.13	3.58	0.17	4.14
Islamist	0.04	1.87	0.37	6.11	1.55	12.37
Secular Muslim	0.01	1.18	0.08	2.83	0.25	5.04
By targets (extensive margins):						
Armed targets	0.23	4.75	0.35	5.87	1.49	12.11
Civilians	0.49	7.01	0.92	9.53	2.27	14.89
Infrastructure	0.06	2.52	0.08	2.88	0.33	5.76
By attack types (extensive margins):						
Assault	0.31	5.52	0.62	7.84	1.58	12.45
Bombing	0.20	4.43	0.41	6.41	1.64	12.69
Suicide attack	0.01	1.19	0.10	3.22	0.59	7.67
Observations	1,591,279		93,671		189,692	

Notes: Section 2 describes the data.

Table 3: Effects of longer Ramadan fasting on the occurrence of terrorist events and terror deaths

	(1)	(2)	(3)	(4)
A: Terrorist event (extensive margin)				
Ramadan daylight hours	-0.077	-0.069	0.019	
	(0.073)	(0.084)	(0.100)	
× Muslim pop. share			-1.686	
			(1.319)	
× Muslims <25%				-0.049
				(0.075)
× Muslims 25-75%				1.026
				(1.208)
× Muslims >75%				-2.704**
				(1.209)
B: Terror deaths (extensive margin)				
Ramadan daylight hours	-0.040	-0.033	0.046	
	(0.044)	(0.049)	(0.068)	
× Muslim pop. share			-1.504	
			(1.111)	
× Muslims <25%				-0.018
				(0.040)
× Muslims 25-75%				1.231
				(1.389)
× Muslims >75%				-2.359**
				(0.970)
Country fixed effects (FE)	Yes	No	No	No
Ramadan year FE	Yes	No	No	No
District FE	No	Yes	Yes	Yes
Country-Ramadan year FE	No	Yes	Yes	Yes
Observations	1,874,642	1,874,642	1,874,642	1,874,642

Notes: Panel fixed effects regressions. Dependent variables are the extensive margins for terrorist events in panel A and terror deaths in panel B. Section 2 introduces the time unit "Ramadan year" and all the variables used. Standard errors are clustered at the country-level and reported in parentheses. ***/**/* indicate statistical significance at the 1%/5%/10%-level.

Table 4: Effects of longer Ramadan fasting on the number of terrorist events and terror deaths

	(1)	(2)	(3)	(4)
A: Terrorist events (log-modulus)				
Ramadan daylight hours	-0.071	-0.075	0.026	
	(0.101)	(0.105)	(0.124)	
× Muslim pop. share			-1.931	
			(1.656)	
× Muslims <25%				-0.057
				(0.097)
× Muslims 25-75%				2.071
				(2.126)
× Muslims >75%				-3.286**
				(1.582)
B: Terror deaths (log-modulus)				
Ramadan daylight hours	-0.052	-0.024	0.105	
	(0.087)	(0.126)	(0.157)	
× Muslim pop. share			-2.474	
			(2.732)	
× Muslims <25%				-0.010
				(0.111)
× Muslims 25-75%				4.488
				(4.941)
× Muslims >75%				-4.646**
				(2.336)
Country fixed effects (FE)	Yes	No	No	No
Ramadan year FE	Yes	No	No	No
District FE	No	Yes	Yes	Yes
Country-Ramadan year FE	No	Yes	Yes	Yes
Observations	1,874,642	1,874,642	1,874,642	1,874,642

Notes: Panel fixed effects regressions. Dependent variables are the log modulus of terrorist events in panel A and for terror deaths in panel B, with the log-modulus being multiplied by 100. Section 2 introduces the time unit "Ramadan year" and all the variables used. Standard errors are clustered at the country-level and reported in parentheses. ***/**/* indicate statistical significance at the 1%/5%/10%-level.

Table 5: Effects of longer Ramadan fasting on terrorism in different time periods

	Ramadan years:		
	<1412	1412-1422	>1422
	(1)	(2)	(3)
A: Terrorist event (extensive margin)			
Ramadan daylight hours			
× Muslims <25%	0.008	0.091	-0.388**
	(0.046)	(0.141)	(0.179)
× Muslims 25-75%	-0.162	0.422	2.763
	(0.178)	(0.705)	(3.650)
× Muslims >75%	-0.142	-4.433*	-5.095**
	(0.177)	(2.650)	(2.344)
B: Terror deaths (extensive margin)			
Ramadan daylight hours			
× Muslims <25%	0.013	0.057	-0.195**
	(0.038)	(0.075)	(0.087)
× Muslims 25-75%	-0.094	1.270***	3.542
	(0.112)	(0.339)	(4.665)
× Muslims >75%	-0.142	-4.433*	-5.095**
	(0.145)	(2.268)	(1.837)
District fixed effects (FE)	Yes	Yes	Yes
Country-Ramadan year FE	Yes	Yes	Yes
Observations	877,492	398,860	598,290

Notes: Panel regressions with district and country-Ramadan year fixed effects. Sample is restricted to different time periods indicated in the top row. (Ramadan years 1412 and 1421 corresponds to Georgian years 1991 and 2000.) Dependent variables are the extensive margins for terrorist events in panel A and terror deaths in panel B. Section 2 introduces the time unit "Ramadan year" and all the variables used. Standard errors are clustered at the country-level and reported in parentheses. ***/**/* indicate statistical significance at the 1%/5%/10%-level.

Table 6: Effects of longer Ramadan fasting on terrorism by different perpetrator groups

	Perpetrator groups:			
	Non-Muslim	Muslim	Islamist	Secular M.
	(1)	(2)	(3)	(4)
A: Terrorist event (extensive margin)				
Ramadan daylight hours				
× Muslims <25%	-0.030	0.032	-0.012	-0.018*
	(0.031)	(0.046)	(0.011)	(0.011)
× Muslims 25-75%	-0.246	1.679	1.775	-0.014
	(0.308)	(1.589)	(1.739)	(0.092)
× Muslims >75%	0.041	-2.306**	-0.910	-0.852
	(0.179)	(0.929)	(0.893)	(0.664)
B: Terror deaths (extensive margin)				
Ramadan daylight hours				
× Muslims <25%	-0.007	0.027	-0.006	-0.011*
	(0.019)	(0.034)	(0.009)	(0.007)
× Muslims 25-75%	-0.102	1.640	1.631	0.029
	(0.157)	(1.572)	(1.610)	(0.050)
× Muslims >75%	-0.007	-1.719**	-0.751	-0.620
	(0.109)	(0.769)	(0.721)	(0.510)
District fixed effects (FE)	Yes	Yes	Yes	Yes
Country-Ramadan year FE	Yes	Yes	Yes	Yes
Observations	1,874,642	1,874,642	1,874,642	1,874,642

Notes: Panel regressions with district and country-Ramadan year fixed effects. Dependent variables are based on the extensive margins for terrorist events in panel A and terror deaths in panel B. In each column they are restricted to terrorist events by the type of perpetrator groups indicated in the top row. Section 2 introduces the time unit "Ramadan year," discusses the classification of perpetrator groups, and describes all the variables used. Standard errors are clustered at the country-level and reported in parentheses. ***/**/* indicate statistical significance at the 1%/5%/10%-level.

Table 7: Effect of longer Ramadan fasting on terrorism across quarters of Ramadan years

	(1)	(2)	(3)	(4)	(5)	(6)
	Terrorist event (ext. margin)			Terror deaths (ext. margin)		
Ramadan daylight hours						
× Muslims <25%	-0.022	-0.024	-0.039	-0.009	-0.010	-0.025
	(0.036)	(0.036)	(0.028)	(0.019)	(0.019)	(0.015)
× Quarter 2		0.001	0.014		-0.001	0.013
		(0.001)	(0.013)		(0.001)	(0.008)
× Quarter 3		0.003**	0.032		0.001	0.027
		(0.001)	(0.037)		(0.001)	(0.027)
× Quarter 4		0.003*	0.021		0.001	0.024*
		(0.002)	(0.019)		(0.001)	(0.013)
× Muslims 25-75%	0.512	0.506	0.522	0.595	0.593	0.675
	(0.609)	(0.607)	(0.740)	(0.655)	(0.654)	(0.774)
× Quarter 2		0.001	0.066		0.000	0.032
		(0.001)	(0.098)		(0.001)	(0.140)
× Quarter 3		0.011***	0.091		0.004*	-0.154
		(0.004)	(0.151)		(0.002)	(0.160)
× Quarter 4		0.013***	-0.195		0.006*	-0.197
		(0.005)	(0.411)		(0.003)	(0.348)
× Muslims >75%	-1.161**	-1.165**	-1.260**	-0.917*	-0.919*	-0.945*
	(0.531)	(0.530)	(0.487)	(0.504)	(0.503)	(0.491)
× Quarter 2		-0.012	0.267		-0.008	0.022
		(0.008)	(0.352)		(0.006)	(0.244)
× Quarter 3		0.008	0.057		0.004	0.022
		(0.006)	(0.291)		(0.005)	(0.256)
× Quarter 4		0.020*	0.071		0.015	0.069
		(0.011)	(0.218)		(0.009)	(0.135)
District fixed effects (FE)	Yes	Yes	Yes	Yes	Yes	Yes
Country-RY FE	Yes	Yes	No	Yes	Yes	No
Country-RY-quarter FE	No	No	Yes	No	No	Yes
Observations	7,498,568	7,498,568	7,498,568	7,498,568	7,498,568	7,498,568

Notes: Panel regressions with district fixed effects and either country-Ramadan year (RY) or country-Ramadan year-quarter fixed effects. Sample is based on the panel dataset with quarterly frequency explained in Section 5.1. Dependent variables the extensive margins for terrorist events in panel A and terror deaths in panel B. Section 2 introduces the time unit "Ramadan year" and the data. Standard errors are clustered at the country-level and reported in parentheses. ***/**/* indicate statistical significance at the 1%/5%/10%-level.

Table 8: Effects of longer Ramadan fasting on terrorism across targets

	Targets:		
	Armed targets	Civilians	Infrastructure
	(1)	(2)	(3)
A: Terrorist event (extensive margin)			
Ramadan daylight hours			
× Muslims <25%	-0.016	-0.044	0.011
	(0.028)	(0.061)	(0.028)
× Muslims 25-75%	0.727	1.116	-0.063
	(0.771)	(1.068)	(0.273)
× Muslims >75%	-1.798***	-1.496	-0.613**
	(0.538)	(0.916)	(0.279)
B: Terror deaths (extensive margin)			
Ramadan daylight hours			
× Muslims <25%	-0.000	-0.027	0.007
	(0.015)	(0.031)	(0.011)
× Muslims 25-75%	0.613	1.062	0.128
	(0.607)	(1.178)	(0.191)
× Muslims >75%	-1.515***	-1.407*	-0.325**
	(0.453)	(0.782)	(0.148)
District fixed effects (FE)	Yes	Yes	Yes
Country-Ramadan year FE	Yes	Yes	Yes
Observations	1,874,642	1,874,642	1,874,642

Notes: Panel regressions with district and country-Ramadan year fixed effects. Dependent variables are based on the extensive margins for terrorist events in panel A and terror deaths in panel B. In each column they are restricted to terrorist events with the type of target indicated in the top row. Section 2 introduces the time unit "Ramadan year" and all the variables used. Standard errors are clustered at the country-level and reported in parentheses. ***/**/* indicate statistical significance at the 1%/5%/10%-level.

Table 9: Effects of longer Ramadan fasting on public support for terrorism

	Violence against "enemies" of Islam:	
	Never/rarely justified	Often/sometimes justified
	(1)	(2)
Ramadan daylight hours	14.091*	-14.391***
	(8.209)	(4.916)
Province fixed effects (FE)	Yes	Yes
Country-Ramadan year FE	Yes	Yes
Observations	52,452	52,452

Notes: Panel regressions with province and country-Ramadan year fixed effects. The sample is based on Pew surveys conducted by the Pew Research Center in the years 2002–2015. The dependent variable in column (1) [column (2)] is equal to 100 if the Muslim respondent answers "never justified" or "rarely justified" ["often justified" or "sometimes justified"] when asked whether they personally feel that "suicide bombing and other forms of violence against civilian targets are justified in order to defend Islam from its enemies," and zero otherwise. This question was asked in Pew surveys in 13 predominantly Muslim countries (the ten countries and territories listed in Table 1 plus Bangladesh, Morocco and Uzbekistan). Standard errors in parentheses are clustered at the level of provinces. ***/**/* indicate statistical significance at the 1%/5%/10%-level.

Table 10: Effects of longer Ramadan fasting on terrorism by attack types

	Attack type:		
	Assault	Bombing	Suicide attack
	(1)	(2)	(3)
A: Terrorist event (extensive margin)			
Ramadan daylight hours			
× Muslims <25%	-0.048	-0.017	0.002
	(0.032)	(0.057)	(0.003)
× Muslims 25-75%	1.172	0.664	0.474
	(1.244)	(0.799)	(0.489)
× Muslims >75%	-1.327**	-1.775**	-0.220
	(0.607)	(0.688)	(0.519)
B: Terror deaths (extensive margin)			
Ramadan daylight hours			
× Muslims <25%	-0.041	0.004	-0.000
	(0.025)	(0.037)	(0.002)
× Muslims 25-75%	1.054	0.792	0.462
	(1.148)	(0.822)	(0.477)
× Muslims >75%	-1.224**	-1.325	-0.236
	(0.517)	(0.804)	(0.524)
District fixed effects (FE)	Yes	Yes	Yes
Country-Ramadan year FE	Yes	Yes	Yes
Observations	1,874,642	1,874,642	1,874,642

Notes: Panel regressions with district and country-Ramadan year fixed effects. Dependent variables are based on the extensive margins for terrorist events in panel A and terror deaths in panel B. In each column they are restricted to terrorist attacks of the type indicated in the top row. Section 2 introduces the time unit "Ramadan year" and all the variables used. Standard errors are clustered at the country-level and reported in parentheses. ***/**/* indicate statistical significance at the 1%/5%/10%-level.

Online Appendix to "Religiosity and Terrorism: Evidence from Ramadan Fasting"

Roland Hodler, Paul A. Raschky and Anthony Strittmatter[1]

Sections:

A. List of countries and territories, stratified by Muslim population shares

B. Additional descriptive statistics based on the Global Terror Database

C. Robustness tests

D. Descriptive statistics for quarterly panel

E. Ramadan fasting and views on Christians and Jews

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A. List of all countries and territories, stratified by Muslim population shares

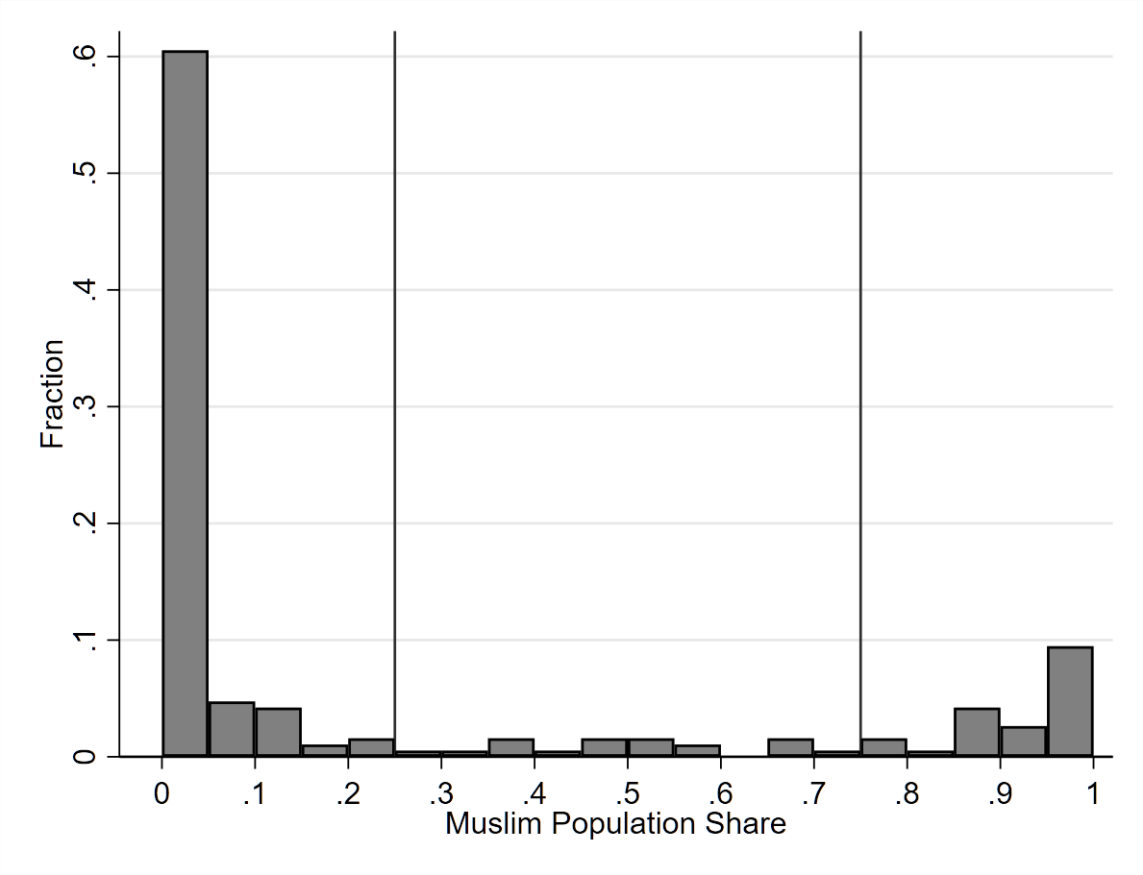
This appendix lists all countries and territories in our sample and stratifies them into three groups based on their Muslim population share (see Section 2.2).

Countries and territories with a Muslim population share below 25%: American Samoa, Angola, Antigua and Barbuda, Argentina, Armenia, Australia, Austria, Barbados, Belarus, Belgium, Belize, Benin, Bermuda, Bhutan, Bolivia, Botswana, Brazil, Bulgaria, Burundi, Cambodia, Cameroon, Canada, Cape Verde, Cayman Islands, Central African Republic, Chile, China, Colombia, Costa Rica, Croatia, Cuba, Cyprus, Czech Republic, Dem. Rep. of Congo, Denmark, Dominica, Dominican Republic, East Timor, Ecuador, El Salvador, Equatorial Guinea, Estonia, Faroe Islands, Fiji, Finland, France, French Guiana, Gabon, Georgia, Germany, Ghana, Greece, Greenland, Grenada, Guam, Guatemala, Guyana, Haiti, Honduras, Hungary, Hong Kong, Iceland, India, Ireland, Israel, Italy, Jamaica, Japan, Kenya, Laos, Latvia, Lesotho, Liberia, Lithuania, Luxembourg, Macedonia, Madagascar, Malawi, Martinique, Mauritius, Mexico, Micronesia, Moldova, Mongolia, Mozambique, Myanmar, Namibia, Netherlands Antilles, Nepal, Netherlands, New Caledonia, New Zealand, Nicaragua, North Korea, Norway, Panama, Papua New Guinea, Paraguay, Peru, Philippines, Poland, Portugal, Puerto Rico, Rep. of Congo, Reunion, Romania, Russia, Rwanda, Samoa, Sao Tome and Principe, Serbia, Slovakia, Slovenia, Solomon Islands, South Africa, South Korea, Spain, Sri Lanka, Suriname, Swaziland, Sweden, Switzerland, Taiwan, Thailand, Togo, Tonga, Trinidad and Tobago, Uganda, Ukraine, United Kingdom, United States, Uruguay, Venezuela, Vietnam, Wallis and Futuna, Zambia, Zimbabwe.

Countries and territories with a Muslim population share between 25% and 75%: Albania, Bosnia-Herzegovina, Brunei, Burkina Faso, Chad, Côte d'Ivoire, Eritrea, Ethiopia, Guinea, Guinea-Bissau, Kazakhstan, Kyrgyzstan, Lebanon, Malaysia, Nigeria, Sierra Leone, Sudan, Tanzania.

Countries and territories with a Muslim population share above 75%: Afghanistan, Algeria, Azerbaijan, Bahrain, Bangladesh, Comoros, Djibouti, Egypt, Gambia, Indonesia, Iran, Iraq, Jordan, Kosovo, Kuwait, Libya, Mali, Mauritania, Morocco, Niger, Oman, Pakistan, Palestine, Saudi Arabia, Senegal, Somalia, Syria, Tajikistan, Tunisia, Turkmenistan, Turkey, United Arab Emirates, Uzbekistan, Western Sahara, Yemen.

Figure 10: Histogram of Muslim population shares across countries and territories



Notes: Section 2.2 describes the data on Muslim population shares.

B. Additional descriptive statistics based on the Global Terror Database

Table B.1: Terrorist events and terror deaths in countries and territories with more than 1,000 events during sample period

Rank	Country	Terrorist events	Terror deaths	Death rate
1.	Iraq	17,610	54,305	3.08
2.	Pakistan	11,304	17,876	1.58
3.	India	8,735	14,498	1.66
4.	Afghanistan	7,995	22,946	2.87
5.	Colombia	6,082	8,909	1.46
6.	Peru	5,247	7,682	1.46
7.	United Kingdom	3,933	2,475	0.63
8.	Philippines	3,735	4,114	1.10
9.	El Salvador	3,052	3,731	1.22
10.	Spain	2,854	1,117	0.39
11.	Turkey	2,729	3,131	1.15
12.	Nigeria	2,663	17,730	6.66
13.	Thailand	2,464	1,722	0.70
14.	Chile	2,222	215	0.10
15.	Sri Lanka	2,071	9,464	4.57
16.	France	2,057	397	0.19
17.	Somalia	1,993	4,045	2.03
18.	Algeria	1,990	8,287	4.16
19.	Russia	1,773	3,555	2.01
20.	United States	1,743	3,447	1.98
21.	Yemen	1,644	3,638	2.21
22.	Israel	1,629	1,388	0.85
23.	South Africa	1,613	1,886	1.17
24.	Lebanon	1,541	2,681	1.74
25.	Palestina	1,523	1,111	0.73
26.	Egypt	1,468	2,010	1.37
27.	Italy	1,458	399	0.27
28.	Libya	1,441	1,278	0.89
29.	Bangladesh	1,370	867	0.63
30.	Guatemala	1,292	2,006	1.55
31.	Syria	1,181	7,491	6.34
32.	Greece	1,134	237	0.21
33.	Germany	1,052	129	0.12

Notes: Sample period covers Ramadan years 1390–1436 (corresponding to Georgian years 1970–2015). Death rate is the average number of terror deaths per terrorist event.

Table B.2: Terrorist events and terror deaths worldwide, by Muslim population shares

	Muslim population share						All
	<25%		25–75%		>75%		
	Freq.	Perc.	Freq.	Perc.	Freq.	Perc.	Freq.
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Population							
Population (in mio.)	4,314	79%	313	6%	835	15%	5,462
Terrorist events							
Total	66,103	52%	5,611	4%	54,632	43%	126,346
By perpetrators:							
Non-Muslim	36,154	96%	373	1%	1,307	3%	37,834
Muslim	4,524	17%	2,759	10%	19,193	72%	26,476
Islamist	2,287	12%	1,888	10%	14,523	78%	18,698
Secular Muslim	1,053	28%	417	11%	2,308	61%	3,778
By targets:							
Armed targets	11,493	42%	808	3%	14,792	55%	27,093
Civilians	44,169	54%	4,211	5%	33,830	41%	82,210
Infrastructure	8,854	70%	349	3%	3,532	28%	12,735
By attack type:							
Assault	13,176	50%	1,851	7%	11,282	43%	26,309
Bombing	31,574	48%	2,097	3%	31,639	48%	65,310
Suicide attack	385	9%	269	6%	3,542	84%	4,196
Terror deaths							
Total	94,603	37%	26,997	11%	132,508	52%	254,108
By perpetrators:							
Non-Muslim	58,255	92%	3,131	5%	1,941	3%	63,327
Muslim	15,502	15%	18,713	18%	72,478	68%	106,693
Islamist	10,634	12%	14,642	16%	64,367	72%	89,643
Secular Muslim	1,605	24%	1,636	25%	3,388	51%	6,629
By targets:							
Armed targets	18,371	31%	3,071	5%	38,672	64%	60,114
Civilians	53,294	36%	19,613	13%	76,890	51%	149,797
Infrastructure	8,781	59%	864	6%	5,277	35%	14,922
By attack type:							
Assault	42,534	48%	14,675	17%	30,990	35%	88,199
Bombing	24,153	22%	7,574	7%	77,938	71%	109,665
Suicide attack	6,910	15%	2,924	6%	35,836	78%	45,670

Notes: Sample period covers Ramadan years 1390–1436 (corresponding to Georgian years 1970–2015). Population size is from the World Bank Development Indicator (WBDI) data and averaged over the sample period, but excludes countries and years with missing information. The WBDI does not provide population data for French Guiana, Martinique, Netherlands Antilles, Reunion, Taiwan, Wallis and Futuna, and Western Sahara. Section 2.3 describes the terrorism data.

C. Robustness tests

Table C.1: Non-linear effects of Ramadan daylight hours, by country groups

	Muslim population shares:					
	<25%	25-75%	>75%	<25%	25-75%	>75%
	(1)	(2)	(3)	(4)	(5)	(6)
	Terrorist event (ext. margin)			Terror deaths (ext. margin)		
Ramadan daylight <10.5h	0.251	0.006	-0.115	0.259	-0.093	-0.234
	(0.223)	(0.578)	(1.402)	(0.174)	(0.569)	(1.272)
Ramadan daylight 10.5-11.5h	0.119	-0.064	-0.442	0.095	0.046	-0.430
	(0.198)	(0.409)	(1.041)	(0.166)	(0.349)	(0.976)
Ramadan daylight 12.5-13.5h	-0.525	2.221***	-2.195**	-0.261	2.386***	-1.972**
	(0.393)	(0.725)	(1.039)	(0.194)	(0.737)	(0.888)
Ramadan daylight >13.5	-0.706	2.389***	-2.983**	-0.342	2.588***	-2.668**
	(0.435)	(0.743)	(1.346)	(0.227)	(0.750)	(1.208)
District fixed effects (FE)	Yes	Yes	Yes	Yes	Yes	Yes
Country-Ramadan year FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1,591,279	93,671	189,692	1,591,279	93,671	189,692

Notes: Panel regressions with district and country-Ramadan year fixed effects. Sample is restricted to countries with a Muslim population share below 25% in columns (1) and (4); between 25% and 75% in columns (2) and (5); and above 75% in columns (3) and (6). Dependent variables are the extensive margins for terrorist events in columns (1)–(3) and terror deaths in columns (4)–(6). The explanatory variable are indicator variables for the Ramadan daylight hours. The omitted category are Ramadan daylight hours between 11.5h and 12.5h. Section 2 introduces the time unit "Ramadan year" and all the variables used. Standard errors are clustered at the country-level and reported in parentheses. ***/**/* indicate statistical significance at the 1%/5%/10%-level.

Table C.2: Different thresholds for the Muslim population share

	Terrorist event (extensive margin)			Terror deaths (extensive margin)		
	(1)	(2)	(3)	(4)	(5)	(6)
Ramadan daylight hours						
× Muslims <10%	-0.036			-0.008		
	(0.071)			(0.036)		
× Muslims 10-90%	-0.569			-0.254		
	(0.751)			(0.754)		
× Muslims >90%	-2.729*			-2.412**		
	(1.500)			(1.196)		
× Muslims <20%		-0.051			-0.019	
		(0.076)			(0.040)	
× Muslims 20-80%		1.163			1.316	
		(1.202)			(1.360)	
× Muslims >80%		-2.733**			-2.377**	
		(1.214)			(0.976)	
× Muslims <30%			-0.049			-0.018
			(0.075)			(0.040)
× Muslims 30-70%			1.450			1.651
			(1.307)			(1.518)
× Muslims >70%			-2.942**			-2.557***
			(1.170)			(0.939)
District fixed effects (FE)	Yes	Yes	Yes	Yes	Yes	Yes
Country-Ramadan year FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1,874,642	1,874,642	1,874,642	1,874,642	1,874,642	1,874,642

Notes: Panel regressions with district and country-Ramadan year fixed effects. Dependent variables are the extensive margins for terrorist events in columns (1)–(3) and terror deaths in columns (4)–(6). Section 2 introduces the time unit "Ramadan year" and all the variables used. Standard errors are clustered at the country-level and reported in parentheses. ***/**/* indicate statistical significance at the 1%/5%/10%-level.

Table C.3: Country classification according to population share of largest Islamic sect

	Terrorist event (extensive margin)	Terror deaths (extensive margin)
	(1)	(2)
Ramadan daylight hours		
× Largest sect <25%	-0.049	-0.018
	(0.075)	(0.040)
× Largest sect 25-75%	0.666	0.869
	(1.148)	(1.305)
× Largest sect >75%	-2.612**	-2.258**
	(1.278)	(1.030)
District fixed effects (FE)	Yes	Yes
Country-Ramadan year FE	Yes	Yes
Observations	1,874,642	1,874,642

Notes: Panel regressions with district and country-Ramadan year fixed effects. Dependent variables are the extensive margins for terrorist events in column (1) and terror deaths in column (2). Section 2 describes the time unit "Ramadan year," the dependent variables and the Ramadan daylight hours. Section 4.3 describes the indicator variables that stratify the countries into three groups based on the population share of the largest Islamic sect in any given country. Standard errors are clustered at the country-level and reported in parentheses. ***/**/* indicate statistical significance at the 1%/5%/10%-level.

Table C.4: Controls for local population and local economic activity

	Terrorist event (ext. margin)			Terror deaths (ext. margin)		
	(1)	(2)	(3)	(4)	(5)	(6)
Ramadan daylight hours						
× Muslims <25%	-0.456***	-0.458***	-0.459***	-0.277**	-0.278**	-0.278**
	(0.175)	(0.175)	(0.175)	(0.115)	(0.115)	(0.115)
× Muslims 25-75%	1.799	1.813	1.713	2.922	2.932	2.877
	(2.552)	(2.564)	(2.455)	(3.440)	(3.448)	(3.376)
× Muslims >75%	-5.604**	-5.599**	-5.569**	-5.742**	-5.738**	-5.686**
	(2.233)	(2.234)	(2.249)	(2.420)	(2.422)	(2.437)
Population (in logs)		0.119*			0.090	
		(0.071)			(0.056)	
× Muslims <25%			0.102			0.071
			(0.069)			(0.048)
× Muslims 25-75%			0.534			-0.598
			(1.027)			(0.965)
× Muslims >75%			0.663			0.976
			(0.542)			(0.690)
Nighttime lights (in logs)		0.135			0.093	
		(0.105)			(0.091)	
× Muslims <25%			0.158***			0.094**
			(0.052)			(0.045)
× Muslims 25-75%			-0.598*			-0.441**
			(0.322)			(0.208)
× Muslims >75%			0.444			0.452
			(0.806)			(0.714)
District fixed effects (FE)	Yes	Yes	Yes	Yes	Yes	Yes
Country-Ramadan year FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	915,763	915,763	915,763	915,763	915,763	915,763

Notes: Panel regressions with district and country-Ramadan year fixed effects. Dependent variables are the extensive margins for terrorist events in columns (1)–(3) and terror deaths in columns (4)–(6). Section 2 introduces the time unit "Ramadan year" and most of the variables used. Population (in logs) is based on the population data from the Center for International Earth Science Information Network (CIESIN). Nighttime lights (in logs) is based on the intensity of nighttime lights measured by weather satellites and provided by the National Oceanic and Atmospheric Administration (NOAA). We add a small constant (0.01) before taking the logarithm of a district's average nighttime light intensity. The sample is restricted to all observations for which the population and nighttime lights data are available. Standard errors are clustered at the country-level and reported in parentheses. ***/**/* indicate statistical significance at the 1%/5%/10%-level.

Table C.5: Provinces, i.e., administrative regions at the first subnational level (ADM1)

	Terrorist event (extensive margin)	Terror deaths (extensive margin)
	(1)	(2)
Ramadan daylight hours		
× Muslims <25%	0.302	0.194
	(0.537)	(0.481)
× Muslims 25-75%	1.389	1.119
	(3.743)	(3.283)
× Muslims >75%	-6.112	-5.538
	(6.326)	(6.283)
Province fixed effects (FE)	Yes	Yes
Country-Ramadan year FE	Yes	Yes
Observations	147,486	147,486

Notes: Panel regressions with province and country-Ramadan year fixed effects. The sample is based on the aggregation of our standard panel dataset at the province level. Dependent variables are the extensive margins for terrorist events in column (1) and terror deaths in column (2). Section 2 introduces the time unit "Ramadan year" and the dependent variables. In our province-level panel dataset, the means [standard deviations] of the dependent variables in columns (1) and (2) are 10.121 [30.161] and 6.048 [23.838], respectively. Standard errors are clustered at the country-level and reported in parentheses. ***/**/* indicate statistical significance at the 1%/5%/10%-level.

Table C.6: Dropping Ramadan years due to missing data in the GTD

	Omitted Ramadan years:	
	1413	1412 & 1413
	(1)	(2)
A: Terrorist event (extensive margin)		
Ramadan daylight hours		
× Muslims <25%	-0.047	-0.046
	(0.076)	(0.076)
× Muslims 25-75%	1.025	1.028
	(1.205)	(1.205)
× Muslims >75%	-2.716**	-2.710**
	(1.215)	(1.212)
B: Terror deaths (extensive margin)		
Ramadan daylight hours		
× Muslims <25%	-0.017	-0.016
	(0.041)	(0.041)
× Muslims 25-75%	1.233	1.238
	(1.382)	(1.379)
× Muslims >75%	-2.360**	-2.359**
	(0.974)	(0.969)
District fixed effects (FE)	Yes	Yes
Country-Ramadan year FE	Yes	Yes
Observations	1,834,756	1,794,870

Notes: Panel regressions with district and country-Ramadan year fixed effects. Column (1) omits Ramadan year 1413, which started on the Georgian date February 23, 1993. Column (2) omits Ramadan years 1412 and 1413. The rationale is that the GTD contains no terrorist events for the Georgian year 1993 "because they were lost prior to START's compilation of the GTD from multiple data collection efforts" (START, 2018, p. 3). Dependent variables are the extensive margins for terrorist events in panel A and terror deaths in panel B. Section 2 introduces the time unit "Ramadan year" and all the variables used. Standard errors are clustered at the country-level and reported in parentheses. ***/**/* indicate statistical significance at the 1%/5%/10%-level.

Table C.7: Dropping individual countries

	Omitted countries:						
	Afghanistan	India	Iraq	Israel and Palestine	Nigeria	Pakistan	United States
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
A: Terrorist event (extensive margin)							
Ramadan daylight hours							
× Muslims <25%	-0.049	-0.037	-0.049	-0.049	-0.049	-0.049	-0.047
	(0.075)	(0.071)	(0.075)	(0.075)	(0.075)	(0.075)	(0.084)
× Muslims 25-75%	1.026	1.026	1.026	1.026	-0.203	1.026	1.026
	(1.208)	(1.208)	(1.208)	(1.208)	(0.566)	(1.208)	(1.208)
× Muslims >75%	-2.947**	-2.704**	-2.733**	-2.721**	-2.704**	-2.883**	-2.704**
	(1.213)	(1.209)	(1.237)	(1.205)	(1.209)	(1.180)	(1.209)
B: Terror deaths (extensive margin)							
Ramadan daylight hours							
× Muslims <25%	-0.018	-0.009	-0.018	-0.017	-0.018	-0.018	-0.018
	(0.040)	(0.037)	(0.040)	(0.040)	(0.040)	(0.040)	(0.045)
× Muslims 25-75%	1.231	1.231	1.231	1.231	-0.245	1.231	1.231
	(1.389)	(1.389)	(1.389)	(1.389)	(0.517)	(1.389)	(1.389)
× Muslims >75%	-2.357**	-2.359**	-2.363**	-2.361**	-2.359**	-2.564***	-2.359**
	(1.036)	(0.970)	(0.997)	(0.970)	(0.970)	(0.924)	(0.970)
District fixed effects (FE)	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country-Ramadan year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1,859,226	1,846,724	1,869,848	1,873,561	1,838,217	1,873,138	1,727,344

Notes: Panel regressions with district and country-Ramadan year fixed effects. In each column, the omitted countries are indicated in the top row. Dependent variables are the extensive margins for terrorist events in panel A and terror deaths in panel B. Section 2 introduces the time unit "Ramadan year" and all the variables used. Standard errors are clustered at the country-level and reported in parentheses. ***/**/* indicate statistical significance at the 1%/5%/10%-level.

D. Descriptive statistics for quarterly panel

Table D.1: Descriptive statistics for quarterly panel, by country group

	Muslim population share:					
	< 25%		25–75%		>75%	
	Mean	Std.Dev.	Mean	Std.Dev.	Mean	Std.Dev.
	(1)	(2)	(3)	(4)	(5)	(6)
Terrorist events (ext. margin)	0.48	6.91	0.65	8.02	1.83	13.41
Terror deaths (ext. margin)	0.22	4.73	0.40	6.34	1.30	11.33
Observations	6,365,116		374,684		758,768	

Notes: Section 5.1 describes the construction of the quarterly panel and Section 2.3 the terrorism data.

E. Ramadan fasting and views on Christians and Jews

Table E.1: Effects of longer Ramadan fasting on views on Christians and Jews

	Views on Christians:		Views on Jews:	
	Favorable	Unfavorable	Favorable	Unfavorable
	(1)	(2)	(3)	(4)
Ramadan daylight hours	-22.351***	35.747***	-11.294**	23.750**
	(7.495)	(10.347)	(5.138)	(11.915)
Province fixed effects (FE)	Yes	Yes	Yes	Yes
Country-Ramadan year FE	Yes	Yes	Yes	Yes
Observations	22,129	22,129	22,928	22,928

Notes: Panel regressions with province and country-Ramadan year fixed effects. The sample is based on Pew surveys by the Pew Research Center. The dependent variable in column (1) [column (2)] is equal to 100 if the Muslim respondent answers "very favorable" or "somewhat favorable" ["very unfavorable" or "somewhat unfavorable"] when asked about their views on Christians, and zero otherwise. The dependent variable in column (3) [column (4)] is defined accordingly, but based on views on Jews. These questions were asked in Pew surveys in Egypt, Indonesia, Jordan, Pakistan, Palestine and Turkey in the years 2004–2011. Section 2 introduces the time unit "Ramadan year" and the Ramadan daylight hours. Standard errors in parentheses are clustered at the level of provinces. ***/**/* indicate statistical significance at the 1%/5%/10%-level.