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Communications Technology and Terrorism

Rafat Mahmood[1,2], and Michael Jetter[2,3]

Abstract

By facilitating the flow of information in society, communications technology (CT; e.g., newspapers, radio, television, the Internet) can help terrorists to (i) spread their message, (ii) recruit followers, and (iii) coordinate among group members. However, CT also facilitates monitoring and arresting terrorists. This article formulates the hypothesis that a society's level of CT is systematically related to terrorism. We introduce a simple theoretical framework, suggesting that terrorism first becomes more attractive with a rise in CT, but then decreases, following an inverted U shape. Accessing data for 199 countries from 1970 to 2014, we find evidence consistent with these predictions: terrorism peaks at intermediate ranges of CT and corresponding magnitudes are sizable. Our estimations control for a range of potentially confounding factors, as well as country fixed effects and year fixed effects. Results are robust to a battery of alternative specifications and placebo regressions. We find no evidence of a potential reporting bias explaining our findings.

Keywords

communications technology, GTD, information flows, terrorism, panel data

[1]Pakistan Institute of Development Economics, Islamabad, Pakistan
[2]The University of Western Australia, Crawley, Western Australia, Australia
[3]CESifo, Munich, Germany

Corresponding Author:
Rafat Mahmood, Pakistan Institute of Development Economics, Islamabad, Pakistan; The University of Western Australia, 35 Stirling Highway, Crawley, Western Australia 6009, Australia.
Email: rafat.mahmood@research.uwa.edu.au

> [U]nlike their predecessors, contemporary terrorists operate in a global information and communication environment with opportunities for mass self-communication that earlier terrorists could not have imagined.
>
> Nacos (2016, in mass-mediated terrorism)

In virtually every definition of terrorism, the communication of a message to a target audience plays a key role.[1] In most terrorist attacks, those who directly lose their lives are not the primary victims—they merely serve as a communication tool between the terrorists and an audience. Realizing this fundamental characteristic of terrorism carries a simple corollary: if information does not flow from the terrorist group to the target audience and is not distributed well among that audience, an attack fails its purpose of (i) spreading the group's message, (ii) creating fear in a target population, and (iii) recruiting followers (see Wilkinson [1997], Pries-Shimsh [2005], Frey, Luechinger, and Stutzer [2007], or Walsh [2010] for these goals of terrorist attacks). Beyond these goals, information flows also become important for a terrorist group's financing, planning, and execution of attacks (see Stenersen 2008; Jacobson 2010; Theohary 2011; Nacos 2016).

Over the past decades, the flow of information, that is, the ease and speed with which information travels through society, has been transformed in virtually every country as never before. This trend has been crucially driven by communications technology (CT) to facilitate and accelerate the free flow of information (see Harvey 1989; Castells 2008, 2011). By CT, we refer to the availability of means of communication, such as newspapers, radio, television, or the Internet, that enable the exchange of information and enhance the speed of that exchange. However, even though terrorism as an explicit communication tool has been employed as early as 2,000 years ago (e.g., see Malamat et al. 1976), we still have little empirical evidence on potential links between the degree of information flows in a society and terrorism. In the following pages, we propose the occurrence of terrorism to be intimately linked to the state of CT.

We begin by formulating a simple theoretical model to understand how the existing level of CT may influence a potential terrorist's decisions.[2] Our aim here is to provide the most basic framework that builds on few, but simple assumptions in framing a representative agent's choice between engaging in terrorism and participating in the labor market. The theoretical implications suggest that as CT improves, terrorism activity first increases because of increasing returns that an improvement in CT offers but later diminishes owing to an increased probability of apprehension, thereby following an inverted U shape. To check whether these propositions can be observed in reality, we study a sample of up to 199 countries from 1970 to 2014. Specifically, we connect the Konjunkturforschungsstelle (KOF) index of information flows to the number of terrorist attacks in a given country and year.[3] The corresponding results indeed document a bell-shaped relationship. Furthermore, this relationship holds (i) after considering a range of potentially confounding factors, as well as country fixed effects and year fixed effects, (ii) for domestic and transnational terrorism alike, and (iii) across a range of additional robustness checks.

We also show why, perhaps, previous empirical studies have focused less on information flows since a purely linear specification produces a coefficient that is not statistically significant at conventional levels. However, as soon as our suggested nonlinearity is accounted for, the relationship becomes statistically significant at the 1 percent level. Terrorism is suggested to peak in countries with moderate levels of information flows, everything else equal. In reality, this corresponds to countries with a KOF score in the range of .44 to .56, examples of which are India, Nigeria, Kenya, Bangladesh, or Yemen in 2014. To give an idea about the associated magnitudes, our results imply that improving a KOF score of .45 (e.g., Bhutan in 2014) to .55 (e.g., Sri Lanka in 2014) corresponds to a rise in terrorist attacks by 2.8 percent. However, raising CT by another ten percentage points, from .55 to .65 (e.g., to the level of the Dominican Republic in 2014), would relate to a *decrease* in the number of terrorist attacks by 5 percent. Thus, the implied magnitudes are sizable and, as we show in the article, larger than the suggested relationship between democracy and terrorism, for example (see Figure 4).

Overall, we aim to contribute to two distinct streams of research. First, our results speak to our understanding of what can drive terrorism. As CT has improved—from newspapers over the radio to television, the Internet, and now social media—our results suggest that these conditions may be intimately linked to terrorism, everything else equal. The closest existing research to our hypothesis considers the link between *press freedom* and terrorism (see Li 2005; Chenoweth 2010, 2012, 2013; R. Bakker, Hill, Jr., and Moore 2016). Although the regulatory freedom of the press can play an important role for terrorism in its own right, such characteristics form only a subset of our general concept of information flows presented here. Other related lines of scientific inquiry consider the link between *media coverage* of terrorism and subsequent attacks (e.g., see Nelson and Scott 1992; Scott 2001; Rohner and Frey 2007; Jetter 2014, 2017a, 2017b, 2017c), as well as the influence of *press attention* (A. M. Hoffman, Shelton, and Cleven 2013; Asal and Hoffman 2016). The underlying hypotheses here, also, consider a subset of our concept of information flows. Thus, we believe this article is the first to systematically formulate a general relationship between CT and terrorism with an empirical assessment of this hypothesis.

Second, this article speaks to the literature concerning consequences of technological improvements, in particular those related to CT. Although a number of works are proposing and documenting substantial gains in terms of productivity and output growth from improved CT (see Brynjolfsson and Hitt 2000; Schreyer 2000; Black and Lynch 2001; Radjou 2003; Timmer and Van Ark 2005), some studies suggest these developments also carry societal costs (Kiesler, Siegel, and McGuire 1984; Kraut et al. 1998; Silverstone 2017). Our findings imply that improved CT initially makes terrorism more attractive as a strategy to communicate grievances. However, once CT has crossed a threshold, further advancements are suggested to diminish terrorism.

The article proceeds with a brief section to motivate our analysis of CT and terrorism. We then introduce our theoretical intuition, followed by a description of our data and methodology in the Data and Empirical Methodology section. Empirical Findings section describes our main empirical findings with the associated robustness checks and extensions. Finally, Conclusion section concludes.

Background

Before introducing a formal model, we want to describe our underlying intuition about the link between information flows and terrorism. Our hypothesis is built on two mechanisms. First, improved CT can be conducive to the terrorists' goals of (i) spreading their message, (ii) creating fear in a target population, and (iii) recruiting followers. In addition, better CT facilitates coordination *between* members of a potential terror group. Second, we start from the premise that CT systematically improves the state's capabilities for countering terrorism, everything else equal, which in turn increases the likelihood of catching perpetrators. We now provide anecdotal evidence for both mechanisms.

CT as a Facilitator for Terrorism

While early terrorists had to rely on face-to-face communication or printed material that requires time and costly dissemination, modern terrorists have quick and reliable communication channels at their disposal that let them communicate instantaneously to thousands at negligible costs (Zanini and Edwards 2001; Weimann 2004). The introduction of satellite television and increased access of international media to a country have made both domestic and international terrorism more attractive (B. Hoffman 2006; Bell et al. 2014). CT developments have allowed the transition from a hierarchial to a network-based organizational structure that benefits nonstate actors and extends their reach internationally (Arquilla, Ronfeldt, and Zanini 2000; Deibert and Stein 2002).

Consider the Internet as the most recent example of a major CT innovation. The features of borderless communication, anonymity, and far-reaching transmission have made the Internet a key element in the mechanics of terrorism (Rogan 2006; Denning 2010). Al-Qaeda employed the Internet for "cyberplanning" (Thomas 2003), while the Islamic State of Iraq and Syria (ISIS) publishes online magazines (e.g., *Dabiq* and *Rumiyah*) that (i) provide volumes on their ideology, (ii) encourage readers to contribute financially, (iii) teach their followers how to conduct terrorist attacks, and (iv) provide links to assassination videos conducted by their members. The online dissemination of violent videos has been identified as one of the most powerful tools to promote radical extremism (e.g., see Alonso and Reinares 2006; Holt et al. 2015; Danzell and Montañez 2016). In one of the latest developments, communication applications enable live broadcasting of attacks; in an attack in

Pakistan on December 1, 2017, the perpetrators broadcasted live to their handlers via smartphones attached to their bodies (see Ali [2017] for details).

The power of the Internet to facilitate terrorism increases with the number of Internet users. For example, the counterterrorism strategy of the United Kingdom recognizes that the Internet "encourages interaction and facilitates recruitment. The way people use the internet also appears to be conducive to these processes" (Home Office 2011, p. 77). An increase in the number of Internet users, thus, increases the size of the audience for terrorist organizations, which likely raises the probability of interaction with like-minded people and, thus, facilitates mobilization and recruitment.

Although we generally know little about individual terrorists and their backgrounds, the few existing databases provide further reason to explore a systematic link to CT. For instance, in the *Profiles of Individuals Radicalized in the United States* data set (National Consortium for the Study of Terrorism and Responses to Terrorism [START] 2017), 252 of the 495 individuals (more than 50 percent) for whom data are available indicate that the Internet or other media played a substantial role in their radicalization; 44 percent of the 156 individuals for whom data are available used the Internet as a means for executing their respective plots. In another data set on *Profiles of Perpetrators of Terrorism in the United States* (Miller and Smarick 2012), 33 of the 48 groups for which this information is recorded use political pronouncements and exhortations through newspapers, radio, television, and the web as a medium of recruitment.

Studies on the cases of terrorism in the United Kingdom identify the Internet as a facilitator of radicalization (Gill et al. 2015) and a "key source of information, communication and of propaganda for... extremist beliefs" (Behr et al. 2013, p. xii). As a concrete example, consider the London bombings of July 7, 2005, in which a "self-starter" autonomous clique (Kirby 2007) motivated by Internet-based al-Qaeda propaganda followed "the recipe to make a bomb... as available on the [i]nternet as a recipe for meatloaf" (Savage 2005). The official report stated that the "London attacks were a modest, simple affair by four seemingly normal men using the internet" (Townsend 2006). Similarly, McCauley, Quiggins, and Moskalenko (2016) document that Momin Khawaja—a Canadian citizen sentenced for materially supporting terrorism—pledged allegiance to a radical group through their website and raised funds online for jihad. Before his arrest, Khawaja accessed a device for remote bomb detonation via a public computer in an Internet café. Although these anecdotes suggest that CT played an important role in a range of different terrorism settings, they of course remain descriptive.

CT and Counterterrorism Efforts

From a counterterrorism perspective, advances in CT have played crucial roles. We briefly discuss three broad types of CT-facilitated counterterrorism activities. First, governments use the agenda-setting function of the mass media to shape public opinion against antistate agents (Wanta and Kalyango, Jr. 2007). For example, the US media categorized 9/11 as "war" against the United States even before President

Bush mentioned the war on terror (Nacos 2002). This and the patriotic vein in which news agencies covered the post-9/11 events helped Bush gain overwhelming public support for the war on terror (Bennett, Lawrence, and Livingston 2008; Nacos, Bloch-Elkon, and Shapiro 2011). In Pakistan, when terrorists used religion to justify their brutalities, the government started the Paigham-e-Pakistan initiative, disseminating a joint declaration by clerics from all schools of thought that denounced the association of Islam with terrorism (*The Nation* 2018). Governments can even use mass media for propaganda that directly aims at demobilization of terrorists. For example, in 2013, the Colombian government hired an international agency for an advertisement campaign that invited antistate actors to disband (Leveille 2013).

Second, governments use CT tools creatively to thwart terror attacks. For instance, a planned suicide bombing in the Hudson river train tunnels in 2006 was averted by identifying the Lebanese planner, Assem Hammoud, in an Internet chatroom (Baker and Rashbaum 2006). In September 2009, a planned attack on the Dallas skyscraper in Texas was foiled when the police arrested Hosam Majer Husein Smadi, who was under surveillance since his identification as an extremist by his online conversations (Dahl 2011). In 2010, the Colombian government used state-owned radio channels to broadcast a coded song that helped rescue hostages held by terrorists (Maysh 2015). Reportedly, various interceptions in terrorists' communications have helped prevent terror attacks in the United States (Lister and Cruickshanck 2013).

Third, advances in CT help to improve policing capabilities. The dissemination of pictures and identification details of key terrorists through mass communication helps authorities collect useful information. The tracking of subscriber identity modules has helped states locate terrorists and conduct military operations against them (Gander 2014; Naughton 2016). The substantial improvement in aerial surveillance of terrorists (e.g., through spy drones) is made possible by CT developments that help collecting real-time data remotely and in relaying that data almost instantaneously to the ground-based intelligence agencies (Finn and Wright 2012; Howard 2013). Massive increases in data storage capacity enable the monitoring of a multitude of electronic communications which helps to identify and trace potential terrorists (Brown and Korff 2009; Lister and Cruickshanck 2013).

The Internet also enables intelligence agencies to passively attack the terrorists' computers (e.g., through viruses) to get access to their confidential data (Brown and Korff 2009). Further, by monitoring the public forums where senior terrorists participate, emerging terrorist leaders can be identified (Shahar 2007). The global reach of the Internet also allows governments to coordinate across borders. McCauley, Quiggins, and Moskalenko's (2016) case study referred to in the CT as a Facilitator for Terrorism section also discusses the role of CT in countering terrorism. British authorities identified Khawaja as a potential terrorist by tracking his Internet activity and "[w]ith a few quick calls to Canada, the investigation also became a national priority in Canada." Similarly, the identification of the London bombers was made possible by closed circuit television (CCTV); the investigators analyzed 2,500 pieces of CCTV footage to track the bombers (Wright and Singer 2014).

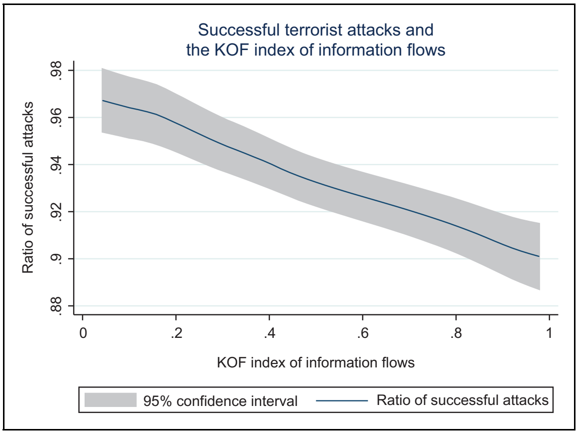

Figure 1. Displaying a kernel-weighted local polynomial smoothing of country-year observations from 1970 to 2014 for the ratio of successful terrorist attacks $\left(= \frac{\text{successful attacks}}{\text{successful} + \text{unsuccessful attacks}}\right)$ against the Konjunkturforschungsstelle index of information flows. The sample includes all 3,535 country-year observations that experienced at least one terror attack in the respective year.

To check for an empirical correlation between CT and the probability of apprehending terrorists, we access information from the Global Terrorism Database (GTD; see Data on terrorism section for a proper description of these data). Although exact data on the likelihood of getting caught are unavailable, the GTD data allow measuring the number of successful attacks as a fraction of all attacks in a given country and year. All failed attacks are listed as unsuccessful in the GTD, and we use data on those unsuccessful attacks that failed because of an intervention by law enforcement agencies.[4] The results are visualized in Figure 1 where we plot the ratio of successful attacks in a given country and year to the KOF index of information flows, which will form our primary measure for CT (see Data on information flows section). The negative and primarily linear relationship suggests that CT improvements are systematically correlated with the state's capacity of foiling a terrorist attack.

In sum, CT may not only facilitate terrorism but also the persecution and arrest of (potential) perpetrators (e.g., see Pattavina 2005), in addition to thwarting their plans. With these two basic mechanisms in mind, we now turn to formally modeling the link between CT and terrorism.

Theoretical Framework

Assumptions

Our model is based on Becker's (1968) seminal work on crime.[5] Imagine one representative agent who is contemplating whether to invest their time in terrorism (denoted by β with $0 \leq \beta \leq 1$) or in the labor market $(1 - \beta)$. Without the loss of generality, we ignore leisure time. Further, τ (with $0 \leq \tau \leq 1$) represents the degree of CT in society, where $\tau = 0$ corresponds to a society without any type of communication, that is, not even talking to one's neighbor.[6] As τ rises, news travels faster and wider. For example, the invention and introduction of the newspaper, the radio, television, the Internet, and social media all constitute milestones that would be associated with a substantial rise in τ, so would their more widespread availability and usage.

The agent maximizes their profit function, π, which depends on their expected returns from terrorism and work. First, $F(\beta, \tau)$ constitutes the agent's production function for terrorism, which we assume to satisfy the Inada conditions, that is, $F(i, 0) = 0$, $\frac{\partial F}{\partial i} > 0$, $\frac{\partial^2 F}{\partial i^2} < 0$, $\lim_{i \to 0} \frac{\partial F}{\partial i} = \infty$, and $\lim_{i \to \infty} \frac{\partial F}{\partial i} = 0$, $\forall i \in \{\beta, \tau\}$. Intuitively, more investment in terrorism yields larger returns and so does better CT; however, returns from both are increasing at a decreasing rate. Thus, as investment in terrorism increases (i.e., one can imagine more and bigger attacks), the marginal benefit decreases, as less and less is gained from an additional attack. Similarly, the higher the level of technological advancements in communication, the smaller the marginal benefit from an additional innovation. For instance, when people watch the news on television about a terrorist attack, looking at the same news content on the Internet may increase the psychological impact, but the incremental increase in spreading information becomes smaller as CT improves. Put differently, receiving news for the first time carries a larger effect than getting the same story again via different (and perhaps better) means of communication. A similar intuition follows from the terrorist's perspective. In terms of communicating with fellow group members (e.g., to coordinate a strike), the returns from communicating at a faster pace with better technology are more than returns from communicating at a slower pace, but as CT improves, the marginal gains become smaller.

The overall returns from terrorism also depend on the success of the operation: if the agent gets caught by the policing authority, we assume they will not be able to reap the benefits from their terrorism investment.[7] We assume the likelihood of getting caught, p, to be proportional to changes in CT, consistent with the existing literature about the link between information technology and crime prevention (e.g., see Fazlollahi and Gordon 1993; Braga et al. 1999; Braga 2001; Pattavina 2005; Byrne and Marx 2011). Thus, a higher τ increases the probability of getting caught linearly, that is, $p = p(\tau)$, where $\frac{\partial p}{\partial \tau} > 0$ and $\frac{\partial^2 p}{\partial \tau^2} = 0$.

Lastly, we assume that the agent can earn an exogenously given nonnegative wage, w (with $w \geq 1$), in the formal labor market. Formally, we can then write the profit function of our representative agent as

$$\pi(\beta) = [1 - p(\tau)] \times F(\beta, \tau) + (1 - \beta)w. \tag{1}$$

With this description of profits in mind, we now turn to a specific functional form of $F(\cdot)$ to maximize π.

Maximizing Profits

What we are ultimately interested in is whether and, if so, how CT (τ) influences the agent's choice with respect to terrorism (β). In order to investigate that relationship, we now transform equation (1) to its simplest operable functional form:

$$\pi(\beta) = (1-\tau)(\beta\tau)^{\alpha} + (1-\beta)w, \tag{2}$$

where $0 < \alpha < 1$ satisfies our first-order and second-order conditions introduced above.[8] The agent then chooses β to maximize π, which leads to the equilibrium investment of

$$\beta^{*} = \left[\frac{\alpha\tau^{\alpha}(1-\tau)}{w}\right]^{\frac{1}{1-\alpha}}. \tag{3}$$

Because $0 \leq \tau \leq 1$ and $0 < \alpha < 1$, β^{*} is naturally bound between 0 and 1. Note that one can derive corner solutions of $\beta^{*} = 0$ for *both* extreme cases of $\tau = 0$ and $\tau = 1$. The latter case may be comparable to the "singularity" sometimes discussed among futurists (e.g., see Kurzweil 2005): any new piece of information becomes instantly available to everyone.

Equation (3) tells us that an increase in returns from the formal labor market (w) decreases the optimal time devoted to terrorism. Further, we can conduct comparative statics along the lines of τ—how does a change in CT affect the extent of terrorism? With a bit of algebra, we can show that finding the value of τ associated with the maximum point of β (i.e., β^{**}) via $\frac{\partial\beta^{*}}{\partial\tau} = 0$ produces[9]

$$\tau^{*} = \frac{\alpha}{1+\alpha}. \tag{4}$$

Since $0 < \alpha < 1$, τ^{*} constitutes a nonnegative value. Figure 2 visualizes the relationship between τ and β^{*}. Initially, with an improvement in CT, the agent devotes more time to terrorism, that is, better technology implies more terrorism, everything else equal. Intuitively, an attack earns more publicity and has therefore more impact when information flows better; in addition, internal coordination between the infinitesimal group members becomes easier. However, engaging in terrorism loses its relative profitability beyond τ^{*}, as the gains from earning w begin to outweigh the decreasing net returns to terrorism since the likelihood of apprehension gains strength.

In sum, our simple theoretical framework suggests a nonlinear relationship between the degree of information flows (i.e., the available CT) and the extent of terrorism. At low values of τ, we should expect a positive relationship, but after τ^{*} is reached, the link should turn negative. The quantification of τ^{*} remains an empirical question that we will investigate in the upcoming sections. Formally, we test the following hypotheses:

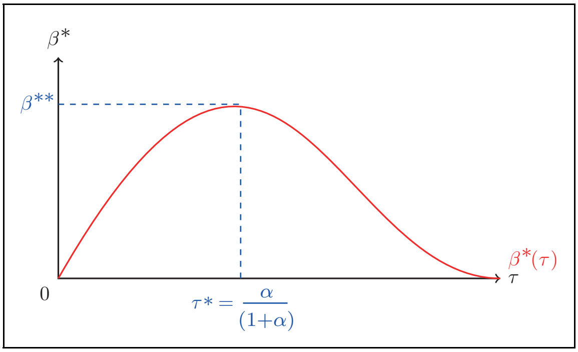

Figure 2. The impact of communications technology on the optimal fraction of time devoted to terrorism (β^*).

Hypothesis 1: Information flows are systematically associated with the degree of terrorism in a country.

Hypothesis 2: As information starts flowing better, terrorism first increases but then decreases leading to an inverted U-shaped relationship between information flows and terrorism.

Data and Empirical Methodology

We begin by describing our data sources for terrorism and information flows, the key variables in our empirical analysis. Our aim is to carefully relate our theoretical hypotheses to the existing empirical analyses that focus on related concepts. We then move to explaining our set of control variables, as suggested by the existing literature. All variables included in our study are summarized in Table 1 along with their corresponding sources and definitions. Finally, we introduce our econometric strategy.

Data

Data on terrorism. We access data on terrorist attacks from what has become the standard source for empirical research on terrorism: the GTD (START 2016).[10] The GTD is maintained and updated annually by the START, based at the University of Maryland. We employ the latest version of the GTD, covering over 170,000 incidents from 1970 to 2014.[11] The GTD offers a detailed list of variables related to each attack, such as the number of victims (dead and otherwise affected), the target, and whether the attack can be categorized as domestic or transnational terrorism.[12]

Our main outcome variable measures the number of terrorist attacks in a given country and year. Note that we include both successful and unsuccessful attacks here

Table 1. Summary Statistics of All Variables.

Variable	Variable Description	Observations	Mean	Standard Deviation	Minimum	Maximum	Data Source
Attacks	Total number of attacks in a country-year	8,046	17.27	100.28	0	3,925	Global Terrorism Database
Domestic attacks	Total number of domestic attacks in a country-year	6,239	7.32	39.96	0	881	Global Terrorism Database
Transnational attacks	Total number of transnational attacks in a country-year	7,055	3.61	17.13	0	453	Global Terrorism Database
KOF index of information flows	An index of information flows ranging from 0 to 1 with higher values associated with larger flow of information	8,046	0.51	0.23	0.01	0.99	Dreher (2006), Dreher et al. (2008)
Polity2	(Polity2 score + 10)/20	6,356	11.21	7.37	0	20	Polity IV data set (Marshall et al. 2017)
Duration of regime	Log(regime durability score)	5,793	2.66	1.17	0	5.32	Polity IV data set (Marshall et al. 2017)
Interstate armed conflict (yes/no)	Interstate armed conflict	8,046	0.018	0.13	0	1	Uppsala Conflict Data Program and International Peace Research Institute, Oslo (2017) Armed Conflict data set
Internal armed conflict (yes/no)	Internal armed conflict	8,046	0.12	0.32	0	1	Uppsala Conflict Data Program and International Peace Research Institute, Oslo (2017) Armed Conflict data set

(continued)

Table 1. (continued)

Variable	Variable Description	Observations	Mean	Standard Deviation	Minimum	Maximum	Data Source
Political instability index	Index of state failure	8,046	0.48	1.48	0	14	PITF
Ln(GDP/capita)	Log of GDP per capita at constant 2005 prices in US dollars	6,777	8.25	1.53	4.75	11.89	UN Statistics
Ln(population size)	Log of total population	8,001	15.16	2.22	9.12	21.03	World Development Indicators
Composite index of national capability	Composite index of national capability	6,897	0.005	0.02	0	0.22	National Material Capabilities (version 5.0; Singer et al. 1972; Singer 1988)

Note. GDP = gross domestic product; PITF = Political Instability Task Force; UN = United Nations; KOF = Konjunkturforschungsstelle.

since our theoretical framework models the decision of agents to conduct attacks. We begin by analyzing all attacks but then also split the sample into those categorized as domestic or transnational by the GTD and Enders, Sandler, and Gaibulloev (2011).[13]

One point of concern is that the GTD, as many other publicly available databases, collects information from open data sources. Thus, it is possible that some attacks remain undetected if they are never reported or documented anywhere, that is, when information flows are limited to begin with. For example, Drakos and Gofas (2006a, 2007) suggest an underreporting bias in countries where the media is not free. Although a concern for any empirical study of terrorism, this is of particular importance in our setting since our hypothesis states precisely that *information flows* can systematically influence terrorism. Although it remains difficult to completely dispel such concerns, we pursue several avenues to test for this possibility.

First, a range of studies argue that the likelihood of a systematic bias in media-based event count data becomes much smaller if the data (i) cover hard facts (Franzosi 1987), (ii) concern significant violent events (Schrodt 1994), or (iii) are gathered from a large number of sources (Woolley 2000). The first two criteria are intuitively satisfied with respect to terror attacks. To comply with these conditions more clearly, we conduct alternative estimations where we (i) only focus on attacks that produce fatalities, (ii) estimate the number of deaths, (iii) only consider binary outcome variables of *any* attack or deaths, and (iv) correct the data for reporting bias using Drakos's (2007) estimates. All corresponding results confirm our benchmark findings (see Accounting for Reporting Bias section). Second, related to the number of sources employed by the GTD, the database is put together using articles from more than 160 countries and over 80 languages, which leads to an initial pool of over one million articles (see GTD Codebook, p. 7). This makes it less likely that attacks (and especially those resulting in fatalities) remain entirely undetected. Third, several studies analyzing the relationship between regime type and terrorism find no evidence of an underreporting bias (e.g., see Walsh and Piazza 2010; Young and Dugan 2011; Piazza 2013). In sum, although we cannot completely eliminate the possibility that our results are influenced by a possible reporting bias, the above-mentioned reasons and the corresponding results of alternative estimations are reassuring, and it remains unlikely that they would be *completely* explainable by a possible reporting bias.

Data on information flows. To measure the degree of information flows and the available CT in a given country and year, we employ the KOF index of information flows. This index represents one of the subindices of the KOF index of globalization, developed annually for 207 countries from 1970 to 2014 (Dreher 2006; Dreher, Gaston, and Martens 2008). Published by the KOF Swiss Economic Institute, the index ranges from 0 to 100 and consists of three variables: the number of Internet users, the share of households with a television set, and trade in newspapers as a percentage of gross domestic product (GDP).[14] Thus, this index closely captures the concept of τ from our theoretical framework, assessing the degree of CT within a society that facilitates the flow of information. To facilitate the comparison of magnitudes in the upcoming regression analysis, we divide the index by 100, to let it range between 0 and 1.

At this point, it is useful to consider the closest related studies when it comes to analyzing the “publicity argument” with respect to terrorism. Several studies have employed binary indicators of press freedom to capture whether and how the existing media environment in a country can perhaps help terrorists gain publicity (Li 2005; Sawyer 2005; Chenoweth 2010; Asal and Hoffman 2016). This argument focuses on the regulatory environment of a country—intuitively, if the press is not free to report on potential terrorist attacks, terrorists may be deterred from attacking for the same reasons we build our hypothesis on. However, our concept is broader in that the general degree of information flows in society may be able to affect the terrorists’ decision. As such, the regulatory environment may well affect information flows, but the entire degree of information flows is not fully captured by press freedom alone. The corresponding measures of press freedom in this strand of research have been taken from the *Freedom of the Press* data (Freedom House 2011) or from Van Belle’s *Global Media Freedom* data set (Whitten-Woodring and Van Belle 2017). Indeed, these data sets either do not consider (Van Belle’s measure) or underrepresent (the *Freedom of the Press* data) modern channels of communication such as Internet usage.

Motivating our hypothesis, a large literature on communication studies has established that the availability of modern media channels not only improves communication and the flow of information but may also drive political awareness and participation more effectively than traditional channels (T. P. Bakker and De Vreese 2011; Valenzuela, Arriagada, and Scherman 2012; Enjolras, Steen-Johnsen, and Wollebæk 2013). For example, recognizing social media as an alternative to traditional media is necessary to understand the extent of mass mobilization, especially because social media targets different age groups and socioeconomic classes (Enjolras, Steen-Johnsen, and Wollebæk 2013). With respect to terrorism, Weimann (2006) documents that terrorists use the Internet for raising funds, winning support, and recruiting followers as well as planning and executing attacks. In short, our hypotheses here incorporate the comprehensive situation of a country when it comes to information flows via CT rather than focusing on the regulatory environment alone.

To get a preliminary idea of the empirical relationship between CT and terrorism, Figure 3 visualizes two basic descriptive relationships. Panel A plots the share of Internet users against the number of terrorist attacks in country-year observations, whereas panel B displays the number of terrorist attacks against the KOF index of information flows. We observe a bell-shaped relationship in both graphs, as suggested by our theoretical framework. Although only of a descriptive nature, these simple comparisons are suggestive of a systematic relationship between information flows and terrorism and motivate our econometric analysis.

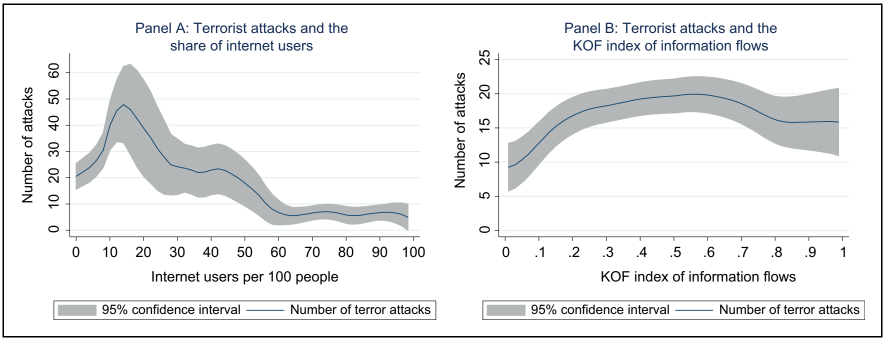

Figure 3. Information flows and terrorism. Both graphs employ a kernel-weighted local polynomial smoothing of country-year observations, displaying the corresponding 95 percent confidence interval.

Control variables. To ensure that other, potentially confounding factors are not driving our estimations, we include a comprehensive set of control variables based on the existing cross-country literature. First, we consider characteristics associated with the political regime, following Li (2005), Piazza (2008a), Chenoweth (2012, 2013), and Gaibulloev, Piazza, and Sandler (2017), among others. Specifically, we include the *polity*2 variable from the Polity IV data set to measure the degree of democracy (Marshall, Gurr, and Jaggers 2017). The index ranges from -10 to $+10$ with lower values indicating autocratic regimes and higher values referring to democracy. Since the literature suggests a nonlinear relationship between regime type and terrorism, we also include the square of *polity*2 (Gaibulloev, Piazza, and Sandler 2017). To properly construct the squared relationship, we therefore first rescale the *polity*2 indicator to range from 0 to 20. Next, we incorporate a measure for regime durability via the *durable* score from the Polity IV data set, since countries undergoing a regime change have been suggested to be more vulnerable to terrorism (Weinberg and Eubank 1998).

Second, we control for GDP per capita and population size, accessing the World Development Indicators (see World Bank 2016). Consistent with the existing literature, we apply the natural logarithm to both variables. Intuitively, while economic development can alleviate grievances of an opposition group, more substantial resources also increase the "prize" of terrorism. With respect to transnational terrorism, higher economic development can also symbolize more attractive targets. Hence, a priori, the literature has produced somewhat mixed evidence as to *how* income levels are related to terrorism (e.g., see Blomberg and Hess 2008; Piazza 2013; M. C. Wilson and Piazza 2013). Further, everything else equal, a larger population may be associated with more terror attacks due to difficulties associated with policing or simple scale arguments (e.g., see Li 2005).

Third, we control for a country's involvement in conflicts by including data on interstate and internal armed conflicts, using data from Melander, Pettersson, and Themnér (2016) and Uppsala Conflict Data Program and International Peace Research Institute, Oslo (2017). While internal armed conflict is expected to increase terrorism because arms are easier to access and a potentially vulnerable security situation, interstate armed conflict is associated with increased security at home and, thus, may reduce terrorism by increasing its costs (Li 2005). In addition, following Piazza (2007, 2008b), Kis-Katos, Liebert, and Schulze (2011), and M. C. Wilson and Piazza (2013), we include a variable indicating state failure derived from the *Political Instability Task Force* (see Marshall, Gurr, and Harff 2017). Following Piazza (2008b), this variable is constructed as an aggregation of four types of state failures: adverse regime changes, ethnic wars, genocide/policide, and revolutionary wars. Further, we incorporate the Composite Index of National Capability (see Singer, Bremer, and Stuckey 1972; Singer 1988) to capture a state's capacity for counterterrorism, following suggestions from Li (2005) and Gaibulloev, Piazza, and Sandler (2017), among others.[15,16]

Finally, in order to account for unobserved characteristics along the country and time dimension, we employ country fixed effects and year fixed effects. Specifically, a number of time-invariant country-specific drivers of terrorism have been suggested, all of which can be accounted for in a fixed-effects setting when using panel data. For instance, Abadie (2006) suggests country area, elevation, and fraction of tropical area as relevant predictors of terrorism. Collier and Hoeffler (2004) suggest that mountainous terrain and forests can provide safe havens for rebels, decreasing their probability of being caught, while Fearon and Laitin (2003) propose that noncontiguous territories favor potential rebels. Further, with respect to time fixed effects, it is possible that large-scale global developments can influence both terrorism and the degree of information flows at the same time. For instance, the Cold War era or the post-9/11 period imply global shocks that could well affect terrorism and perhaps information flows simultaneously (see Li 2005; Gaibulloev, Piazza, and Sandler 2017). Fixed effects account for such developments.[17]

Methodology

Following the bulk of the literature, our empirical specification employs a negative binomial regression framework since the dependent variable represents a count variable (see Piazza 2008b; Chenoweth 2010; Walsh and Piazza 2010; Findley and Young 2011; see Cameron and Trivedi [2013] for a discussion about the underlying statistics). Alternatively, one could use a Poisson model that is specifically designed for predicting a nonnegative count variable. However, the data exhibit overdispersion and assuming independence between observations may not be valid, which generally speaks against a Poisson model (Cameron and Trivedi 1998; Brandt et al. 2000). Further, some terrorism studies use a zero-inflated negative binomial regression framework, motivated by employing the Vuong test (A. M. Hoffman, Shelton, and Cleven 2013; M. C. Wilson and Piazza 2013). However, both the zero-inflated negative binomial model and the Vuong test for testing its validity have recently been criticized (e.g., see Allison and Greene 2012; Xie et al. 2013; P. Wilson 2015; Fisher, Hartwell, and Deng 2017). Nevertheless, our findings are consistent with either specification, as will be discussed in Accounting for Reporting Bias section. Our main specification of a negative binomial regression framework for country i and year t becomes:

$$\text{Attacks}_{it} = \alpha_0 + \alpha_1(\text{Info flows})_{it} + \alpha_2(\text{Info flows})^2_{it} + \boldsymbol{X}_{it}\alpha_3 + \lambda_i\alpha_4 + \gamma_t\alpha_5 + \delta_{it}, \tag{5}$$

where we are interested in the coefficients α_1 and α_2. If our hypothesis was reflected in the empirical observations, we would expect α_1 to take on a positive and statistically meaningful value, whereas α_2 should turn negative but also statistically relevant.[18] Further, $\boldsymbol{X}_{it}$ constitutes the vector of control variables discussed in Control variables section, λ_i represents country fixed effects, γ_t includes year fixed effects, and δ_{it} corresponds to the conventional error term.

Although we allow for nonlinearity in the KOF index in our main specification, we also test for a more flexible approach via a semiparametric estimation. Figure A1 in the Online Appendix Section A.6 documents that the corresponding results support a quadratic relationship between the number of terrorist attacks and information flows, thereby reassuring us about the functional form employed here.

Empirical Findings

Main Results

Table 2 presents our main results. The first column displays results from a univariate estimation, where we only use the KOF index of information flows in its linear form to predict the number of terror attacks. Interestingly, the respective coefficient is not statistically significant on any conventional levels with a t value of 0.33 (equal to 0.329/1.002). However, as soon as we introduce a squared term in column (2) to account for the suggested nonlinearity, information flows become a strong predictor of terrorism. In particular, the linear term turns positive and the squared term negative, indicating that information flows are first associated with more terrorism but then decrease the number of attacks at higher levels of information flows. Toward the bottom of Table 2, we list the KOF value associated with the implied peak. In column (2), that peak corresponds to an intermediate KOF value of .54.

Columns (3) and (4) include our complete set of control variables, year fixed effects, and country fixed effects. Most importantly, the relationship between information flows and terrorism remains robust, and the most complete estimation in column (4) produces statistical significance at the 1 percent level for both the linear and the squared term. The relationship is suggested to peak at a KOF value of .53. To provide a better idea of that range of information flows, it may be useful to consider

Table 2. Predicting the Number of Terror Attacks, Employing a Negative Binomial Regression Framework.

	(1)	(2)	(3)	(4)	(5) Domestic Attacks Only	(6) Transnational Attacks Only
Dependent variable: Number of terror attacks in country *i* and year *t* (mean = 15.92)						
KOF index of information flows	.329 (1.002)	6.069*** (2.348)	9.288*** (1.228)	4.350*** (0.448)	5.436*** (0.696)	5.417*** (0.570)
(KOF index of information flows)^2		−5.604** (2.820)	−7.453*** (1.062)	−4.070*** (0.406)	−4.949*** (0.665)	−5.803*** (0.505)
Polity2			0.223*** (0.078)	0.119*** (0.022)	0.157*** (0.033)	0.096*** (0.029)
(Polity2)^2			−0.008** (0.004)	−0.004*** (0.001)	−0.005*** (0.001)	−0.002* (0.001)
Standard controls[a]			Yes	Yes	Yes	Yes
Year fixed effects			Yes	Yes	Yes	Yes
Country fixed effects				Yes	Yes	Yes
KOF score at maximum		0.54	0.62	0.53	0.54	0.46
Number of countries	199	199	158	155	105	140
Number of years	44	44	42	41	41	41
N	8,046	8,046	5,034	4,934	2,596	3,843

Note. Standard errors are displayed in parentheses and are clustered at the country level in columns (1)–(3). KOF = Konjunkturforschungsstelle; NBREG = negative binomial regression.

[a]Standard controls include variables measuring regime duration, interstate and internal armed conflict, the political instability index, the log of GDP per capita and population, as well as the Composite Index of National Capability.

*p < .10.

**p < .05.

***p < .01.

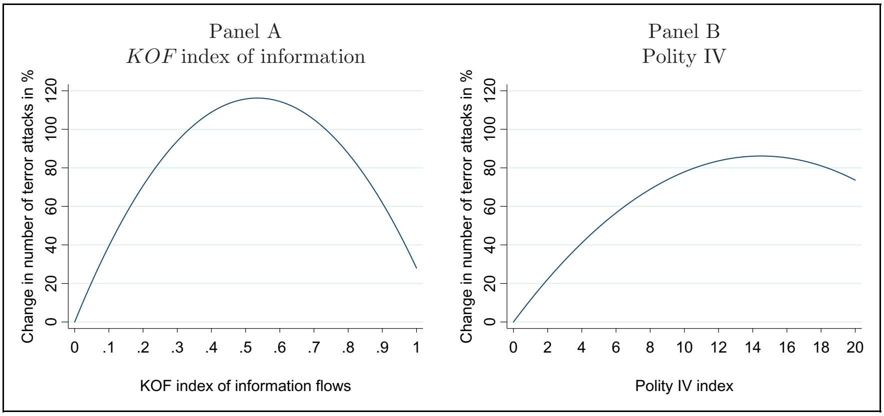

Figure 4. Visualizing regression results from column (4) in Table 2.

the most recent KOF data. For instance, from 2010 to 2015, six countries (Afghanistan, India, Nigeria, Pakistan, the Philippines, and Yemen) account for 46 percent of all terror attacks; in all those countries, the KOF score of information flows ranges between .43 and .53. Of course, we are not suggesting that these countries are particularly prone to terrorism *only* because of an intermediate range of information flows, but our results suggest that CT may indeed contribute.[19] In terms of magnitude, our results imply that if Sierra Leone in 2014 were to increase their KOF score by ten percentage points, from .32 to .42 (for example, to match that of Papua New Guinea), while keeping everything else constant, we would expect the number of terrorist attacks to increase by 14 percent. However, considering an example beyond the suggested peak, if Brazil were to increase its KOF score from .70 (in 2014) to the level of Sweden (KOF score of .80), we would expect the number of terror attacks to decrease by 16 percent.

Figure 4 visualizes the suggested relationship for the KOF index in panel A and, as a comparison, for the degree of democracy in panel B. Note that we use the same scale on the *y*-axis to facilitate comparing magnitudes. In panel A, terror attacks are increased by almost 120 percent at a value of KOF = .53, relative to a hypothetical KOF score of 0. Panel B then serves as a reference point, visualizing our predicted effect of democracy, as suggested by Chenoweth (2013) and Gaibulloev, Piazza, and Sandler (2017). Consistent with their findings, democracy is also suggested to follow an inverted U shape in its relationship with terrorism, but the underlying magnitudes are, in fact, smaller. Here, terrorism is suggested to be most severe for a *polity*2 score of 14.48—but at this peak, we should only expect an increase of 85 percent, relative to a complete autocracy (a *polity*2 score of 0). This comparison highlights that information flows may not only be a statistically relevant predictor of terrorism but also a quantitatively sizable one.

Finally, columns (5) and (6) replicate our most complete estimation, but separately consider domestic and transnational terrorism. It is interesting to see that the respective results are consistent with our benchmark finding from column (4).[20] The suggested peak value of information flows again occurs at intermediate ranges of the KOF index with values of .54 and .46. In the upcoming section, we now turn to alternative specifications, extensions, and placebo regressions to verify whether the derived results from Table 2 remain consistent. In all of these estimations, we will consider the results displayed in column (4) of Table 2 as our benchmark regression.

Robustness Checks

First, one concern with interpreting our results lies in the potential correlation between the state of CT in a country and its level of development.[21] Specifically, the inverted U-shaped relationship obtained in panel A of Figure 4 may be driven by development-related aspects. Although our main estimation controls for GDP per capita, we also analyze individual subsamples of poor, lower-middle income, upper-middle income, and rich countries by dividing our sample by quartiles of GDP per capita (while still controlling for income levels). In another estimation, we control for a squared term of GDP per capita, following the research developed by Enders and Hoover (2012) and Enders, Hoover, and Sandler (2016). The corresponding results confirm our baseline findings of a nonlinear and strongly statistically relevant link between the KOF index and the number of terror attacks (results are available in Table A6).

Second, Table 3 displays results from twelve alternative estimations. In columns (1) to (3), we consider other functional forms to predict terrorist attacks. Specifically, we display results from (i) calculating bootstrapped standard errors in our familiar negative binomial regression framework (using hundred replications), (ii) applying a Poisson regression framework, and (iii) employing a standard ordinary least squares regression. In columns (4) to (9), we further test whether government size, press freedom, political rights, civil liberties, democratic participation, executive constraints, or inequality can explain away the inverted U-shaped relationship between information flows and terrorism. All of these variables have been proposed as meaningful drivers of terrorism before.[22] In column (10), we control for past incidences of terrorism, following suggestions from A. M. Hoffman, Shelton, and Cleven (2013) and Young and Dugan (2011).[23] Next, we predict the number of fatalities in column (11) instead of the number of attacks. Finally, the regression results displayed in column (12) predict the *onset* of terrorism, following the spirit of the conflict literature, where incidence, that is, the intensity, is distinguished from a beginning conflict where no violence occurred in the year prior (e.g., see Collier and Hoeffer 1998; Fearon and Laitin 2003; Collier and Hoeffler 2004; Miguel, Satyanath, and Sergenti 2004; Blattman and Miguel 2010). Thus, onset is coded as equal to 1 if the country experienced *any* terrorism in the present year, but no terrorism in the previous year. Overall, the nonlinear influence of the KOF prevails throughout all additional estimations in Table 3.[24]

Table 3. Displaying Results from Various Robustness Checks, Building on the Main Specification of Column (4) in Table 2.

Estimation Method:	NBREG[a]	Poisson	OLS	NBREG								Logit
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Dependent variable:	Attacks										Deaths	Terrorism onset
KOF index	4.350*** (1.041)	2.231*** (0.125)	123.180*** (24.979)	4.735*** (0.465)	4.274*** (0.481)	3.976*** (0.459)	4.285*** (0.458)	4.483*** (0.446)	5.020*** (0.453)	4.309*** (0.453)	6.276*** (0.567)	6.833*** (2.152)
(KOF index)^2	−4.070*** (0.864)	−0.229** (0.113)	−59.016*** (21.883)	−4.299*** (0.421)	−3.805*** (0.424)	−3.690*** (0.416)	−3.855*** (0.419)	−4.322*** (0.404)	−4.772*** (0.410)	−3.850*** (0.391)	−6.358*** (0.549)	−7.613*** (1.854)
Additional control variable				Government size	Press freedom	Political rights	Civil liberties	Democratic participation; Executive constraints	Gini index	Attacks^{t-1}		
Standard controls[b]	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes[c]	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of countries	155	155	158	153	155	155	154	155	155	155	146	136
Number of years	41	42	41	41	32	38	38	41	41	39	41	40
N	4,934	4,934	5,034	4,676	4,123	4,634	4,619	4,933	4,934	4,725	4,688	2,516

Note. Standard errors are displayed in parentheses. OLS = ordinary least squares; GDP = gross domestic product; KOF = Konjunkturforschungsstelle.

[a]Specification (1) reports bootstrapped (100 rep) standard errors, while specification (2) reports results for Poisson regression.

[b]Standard controls include polity2 (rescaled to range from 0 to 20) and its square, regime duration, interstate and internal armed conflicts, the political instability index, the natural logarithm of GDP per capita and population size, as well as the Composite Index of National Capability.

[c]Specification (8) does not include Polity2 and its square, following Li (2005) and Chenoweth (2010).

*$p < .10$.

**$p < .05$.

***$p < .01$.

Accounting for Reporting Bias

Third, a potential reporting bias could confound our analysis. If terrorist attacks were systematically underreported in countries with little press freedom, our results could be biased in that the suggested relationship would not follow an inverted U shape but rather could be a linear negative relationship. To test for that possibility, we conduct a series of additional estimations with the results displayed in Table 4. In column (1), we display results from reestimating our main regression, but only employ those country-year observations where the press is rated to be free or partly free by the *Freedom of the Press* indicator. The corresponding results confirm a nonlinear relationship. Thus, those countries where we would be most concerned about a potential reporting bias are not driving our results.

In column (2), we return to the full sample and predict whether the country has experienced *any* terror attacks in the given year. Intuitively, although a regime may be able to hide *some* terror attacks, we propose that it would be difficult to hide if *any* terrorism was occurring. Estimating this binary outcome variable via a *logit* regression again confirms the suggested nonlinearity. Next, following Young and Dugan (2011), we count only those attacks in which at least one person was killed since it appears more difficult to completely censor news about fatal attacks, even in countries where information flows remain restricted.[25] In column (4), using the same logic, we construct a binary indicator that captures whether the country suffered any deaths from terrorism in the given year. In column (5), we employ a zero-inflated negative binomial regression framework, which has been suggested to alleviate concerns about reporting bias (Lai 2003; Drakos and Gofas 2006b). Finally, we use the estimates provided by Drakos (2007) in their calculation of underreporting biases. Specifically, Drakos suggest an underreporting bias of 18 percent for countries featuring a partially free press and 21 percent for countries that are rated as not enjoying a free press. Thus, in column (6), we consider only those observations with at least one attack and multiply the number of attacks by 1.18 and 1.21 for partly free and nonfree countries, respectively, following the *Freedom of the Press* data (Freedom House 2011).

Overall, the results displayed in Table 4 are encouraging in that none of the corresponding robustness checks would give us an indication that our results are systematically explainable by a potential reporting bias. Nonetheless, we can of course not completely eliminate that possibility and all interpretations of our findings should keep this in mind.

Placebo Regressions

In our final set of estimations, we now turn to placebo regressions with the corresponding results displayed in Table 5. As our hypothesis related to CT is specific to terrorism and the underlying importance of information flows for terrorism, we should not observe a nonlinear relationship between information flows and other

Table 4. Displaying Results from Robustness Checks to Address Concerns about Reporting Bias.

	(1)	(2)	(3)	(4)	(5)	(6)
	Excluding Nonfree Press	Attack (Yes/No)	Deaths (Yes/No)	Excluding Nonfatal Attacks	Zero-inflated NBREG	Drakos and Gofa Correction
KOF index	4.580*** (0.628)	10.648*** (1.345)	11.652*** (1.413)	3.353*** (0.523)	7.737*** (0.629)	3.117*** (0.431)
(KOF index)^2	−3.730*** (0.518)	−10.692*** (1.174)	−11.189*** (1.272)	−2.790*** (0.492)	−5.741*** (0.586)	−2.594*** (0.389)
Standard controls[a]	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Country fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Number of countries	124	146	136	143	155	152
Number of years	33	41	41	41	41	41
N	2,663	4,653	4,622	1,619	5,034	2,435

Note. Standard errors are displayed in parentheses; KOF = Konjunkturforschungsstelle; NBREG = negative binomial regression.
[a]Standard controls include *polity2* (re-scaled to range from 0 to 20) and its square, regime duration, interstate and internal armed conflicts, the political instability index, the natural logarithm of GDP per capita and population size, as well as the Composite Index of National Capability. Specifications (2) and (3) employ a conditional logistic model, while specifications (2), (4), and (5) use a negative binomial regression framework.
*$p < .10$.
**$p < .05$.
***$p < .01$.

Table 5. Displaying Results from Placebo Regressions, Using the Full Sample in Columns (1)–(3), (6), and (7).

Estimation method:	Logit			OLS		NBREG	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Dependent Variable:	Internal Conflict	Internal War	Internal Conflict or War	Homicide Rate	Attacks		
KOF index	2.741 (1.861)	4.410 (4.559)	3.001 (2.381)	−8.142 (8.675)	248.163*** (89.420)	4.235*** (0.462)	3.879*** (0.599)
(KOF index)^2	−6.491*** (1.879)	−3.610 (5.446)	−6.473*** (2.401)	11.450* (6.827)	−202.751*** (70.374)	−4.122*** (0.421)	−3.796*** (0.592)
KOF index of political globalization						−0.237 (0.716)	
(KOF index of political globalization)^2						0.564 (0.581)	
KOF globalization index							1.762 (1.093)
(KOF globalization index)^2							−0.919 (0.938)
Standard controls[a]	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes

(continued)

Table 5. (continued)

Estimation method:	Logit			OLS		NBREG	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Dependent Variable:	Internal Conflict	Internal War	Internal Conflict or War	Homicide Rate		Attacks	
Number of countries	73	33	69	156	156	155	155
Number of years	43	43	43	18	18	42	42
N	2,464	1,114	2,302	1,627	1,627	4,934	4,934

Note. In columns (4) and (5), we use those country-year observations that show data for homicide rates. Standard errors are displayed in parentheses. KOF = Konjunkturforschungsstelle; OLS = ordinary least squares; NBREG = negative binomial regression.
[a]Standard controls include *polity2* (rescaled to range from 0 to 20) and its square, regime duration, interstate and internal armed conflicts, the political instability index, the natural logarithm of GDP per capita and population size, as well as the Composite Index of National Capability.
*$p < .10$.
**$p < .05$.
***$p < .01$.

types of organized violence. In columns (1) to (3), we predict whether the country experienced an internal (or internationalized internal) conflict or war.[26] (Note that sample sizes are decreased solely because many countries have not experienced statistical variation in the dependent variable.) However, we do not observe the same inverted U-shaped relationship between the KOF index of information flows and these forms of organized violence.

Further, in column (4), we predict the rate of intentional homicides (per 100,000 people), using data from the World Bank (2016). Here again, we do not observe a nonlinear link that would be consistent with our hypothesis. In column (5), we document that this finding is not driven by the substantially reduced sample size for which the homicide rate is available by reestimating our main estimation with only those observations where the homicide rate is available. These results further indicate that the nonlinear effect from information flows is specific to terrorism and does not emerge for other forms of major violence.

Finally, columns (6) and (7) focus on the KOF index of information flows. As our argument is specific to information flows, we would predict that other indices of globalization do not follow the nonlinear pattern in describing terrorism. Indeed, when including the KOF indices for political globalization and the overall KOF index of globalization, we derive statistically insignificant results; however, the KOF index of information flows remains a meaningful predictor in its original nonlinear form.

Conclusion

This article proposes a systematic relationship between the existing degree of CT and terrorism. We introduce a simple theoretical framework in the spirit of Becker (1968), where a representative profit-maximizing agent allocates their time between terrorism and participating in the labor market. The corresponding predictions suggest a nonlinear link between CT and terrorism: as CT improves, facilitating the flow of information in society, the optimal time devoted to terrorism first increases but then decreases. In particular, monitoring and apprehending potential terrorists becomes easier for law enforcement and, in turn, returns from the labor market become relatively more attractive.

We then test these predictions, studying up to 199 countries from 1970 to 2014. The suggested nonlinearity emerges throughout all our specifications, even after controlling for a comprehensive list of potentially confounding covariates, as well as country fixed effects and time fixed effects. A rise in information flows is systematically associated with an increase in terrorism at first, but after peaking at an intermediate range of information flows, the relationship turns negative. That peak corresponds to Afghanistan, India, Nigeria, Pakistan, the Philippines, and Yemen in 2014, for example, countries which were some of the most terror-prone nations at the time, accounting for 46 percent of all terrorist attacks worldwide. Alternative econometric specifications produce consistent findings, and it appears unlikely that a potential reporting bias in measuring terrorist attacks can fully explain our findings. Finally, although our empirical findings are consistent with our theoretical predictions modeling the potential terrorists' decision, we want to mention one alternative, perhaps complementary explanation: when CT is high, governments may be able to foil more terror plots early on, well before their execution. Even though our analysis does consider *all* attempted attacks documented in the GTD (rather than just successful attacks), we cannot completely rule out this alternative explanation as attacks foiled early on may well be missing from the GTD.

Overall, we hope this study helps to better explain when and why terrorism may arise. As a society develops communications technologies, such as currently the Internet and specifically social media, it may become vulnerable to terrorism at first. However, as information continues to flow better, terrorism may become less attractive. These results may also help us to predict what may happen after large shocks in terms of CT, such as the widespread distribution of television, smartphones, the Internet, or social media. At first, such shocks may indeed facilitate terrorism, and policy makers may benefit from understanding this possibility in advance. In particular, public decision makers may be able to direct resources toward counterterrorism as CT improves initially, both in terms of increasing policing capacity and investing in public awareness. Historically, however, efficient regulatory structures for CT have usually followed the introduction of these technologies after significant lags (Wadhwa 2014). Future research may be able to better distinguish between the introduction of different types of CT as well as more microfounded analyses. We hope that our article provides a starting point to inspire further inquiry into the systematic link between CT and terrorism.

Authors' Note

All remaining errors are our own.

Author Contribution

Rafat Mahmood and Michael Jetter contributed equally to the completion of this article.

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ORCID iD

Rafat Mahmood https://orcid.org/0000-0001-6332-8060
Michael Jetter https://orcid.org/0000-0001-7967-5200

Supplemental Material

Supplemental material for this article is available online.

Notes

1. For example, Frey and Luechinger (2003) and Frey, Luechinger, and Stutzer (2007) suggest terrorists are seeking publicity "in order to make their cause widely known"; the Britannica Concise Encyclopaedia suggests that "[t]errorism's impact has been magnified by the . . . capability of the media to disseminate news of such attacks instantaneously throughout the world" (Encyclopaedia Britannica 2006, p. 1890); and section 2656f(d) of the US Code of Laws emphasizes terrorists' goal of "influencing an audience" (Nacos 2016, p. 5). We refer to B. Hoffman (2006) and Schmid and Jongman (2017) for a detailed analysis of various definitions of terrorism.
2. Conceptually, we follow the definition of terrorism provided in Schmid and Jongman (2017) with any individual or group participating in such activity being defined as a terrorist.
3. KOF stands for Konjunkturforschungsstelle (Zürich, Switzerland), the institute where this index of information flows has been developed and measured.
4. Note that some attacks listed in the Global Terrorism Database (GTD) were unsuccessful because (i) the bomb did not detonate, (ii) the target was missed, or (iii) hostage takers could not take control of the individual. We use the summaries of attacks in the GTD to track the reason for failure of the attack. After carefully reading a sample of summaries for individual attacks, we coded for filtering the unsuccessful attacks that failed for reasons other than the intervention by security forces (see Online Appendix A.1 for details on the respective code). We verify that variable's validity by manually cross-checking for a random selection of event records. Of a total of 15,111 unsuccessful attacks in our sample period, 4,253 attacks (28 percent) failed for reasons other than intervention by security forces; we exclude such attacks from the correlation displayed in Figure 1. As a robustness check, we also exclude those unsuccessful attacks for which attack summaries are not available and the relationship remains consistent.

5. The alternative theoretical models closest to the focus of our study can be found in Scott (2001), Rohner and Frey (2007), and Pfeiffer (2012b). However, these models concentrate only on the role of the traditional media in terrorism and, thus, are not well-suited to the broader context considered in our analysis.
6. In an extreme scenario, this would correspond to the Khmer Rouge's envisioned society (e.g., Kiernan 1972).
7. Without the loss of generality, one could change this assumption and assume nonnegative returns even after the terrorist is caught. Further, in reality, the punishment for engaging in terrorism may impose large *negative* returns on the terrorist. However, the essence of the model's conclusions would remain unaffected if we adjusted the payoff structure in either direction.
8. It is worth mentioning that by leaving β and τ to be governed by the same exponent α, we are forcing the two to behave similarly. Our results, however, do not change if we relax this assumption (see Online Appendix A.2 for this alternative specification).
9. The proof that τ^* constitutes a maximum, not a minimum, is referred to Section A.3 in the Online Appendix.
10. Recent papers employing the GTD come from Krieger and Meierrieks (2010), Berrebi and Ostwald (2011, 2013), Derin-Güre (2011), Dreher, Krieger, and Meierrieks (2011), Findley and Young (2011), Freytag et al. (2011) Gaibulloev and Sandler (2011), Pfeiffer (2012a), Chenoweth (2013), Choi and Salehyan (2013), Piazza (2013), M. C. Wilson and Piazza (2013), Kis-Katos, Liebert, and Schulze (2014), Brockhoff, Krieger, and Meierrieks (2015), R. Bakker, Hill, Jr., and Moore (2016), and Gaibulloev, Piazza, and Sandler (2017).
11. Note that, as is well-known in the literature and stated in the GTD codebook, the GTD does not include any information for the year 1993 (see Lafree and Dugan 2007; Lee 2008; LaFree 2010). Thus, we exclude 1993 from our analysis.
12. We employ the term transnational terrorism because international terrorism as defined in the GTD codebook comes closer to the definition of transnational terrorism given in Sandler and Enders (2004, p. 302): "[w]hen a terrorist incident in one country involves victims, targets, institutions, governments, or citizens of another country, terrorism assumes a transnational character."
13. An attack is categorized as transnational if the perpetrator group does not belong to the country attacked, the nationality of the targets or victims do not belong to the country attacked, or the nationality of the perpetrators is different from that of the targets or victims. In case none of these criteria are met, the attack is categorized as a domestic attack. Nevertheless, our results are consistent when considering the unclassified attacks as domestic or transnational attacks (see Online Appendix Table A1).
14. We use version 2.1 of the KOF Index of Globalization (KOFGI 2017). Details on data collection and methodology for computing the index are available under the Archive section on http://globalization.kof.ethz.ch/ in the folder "KOFGI 2017" (ZIP, 2.1 MB).
15. It could be argued that Composite Index of National Capability and gross domestic product (GDP) per capita are closely correlated, which may introduce multicollinearity issues. However, we find that correlation to be relatively low with a coefficient of .12.

Nevertheless, our results remain consistent to the inclusion of either of the two variables in the regression model.

16. A correlation matrix for these control variables is referred to Online Appendix A.5. In order to verify that multicollinearity is not driving our results, we also check by removing one control variable at a time in a series of regressions. Our results, reported in Table A3, remain intact.
17. In alternative specifications, we also employ binary indicators for the Cold War and the post-9/11 period (separately and in combination) while excluding year fixed effects. The results reported in Table A4 in Online Appendix A.7 remain consistent.
18. As pointed out by Young and Findley (2011) and Young (2016), the operationalization of terrorism can affect empirical results. We employ a variety of alternative specifications to verify our results are not driven by such particularities (see Robustness Checks section and Accounting for Reporting Bias section, as well as Online Appendix A.4).
19. These five countries are also victims of internal conflict, so it is interesting to mention that according to our results, if a country is experiencing internal armed conflict, it is likely to experience .7 additional attacks annually as compared to a country without internal armed conflict, keeping other factors constant.
20. Following Savun and Phillips (2009), we estimate an alternative specification for domestic attacks controlling for *fractionalization*, *economic discri*min*ation*, and *political discri*min*ation* as a robustness check. We obtain data for *fractionalization* from Fearon and Laitin (2003) which is available from 1970 to 1999, while we get data for *economic* and *political discri*min*ation* from the *Minorities at Risk* project which is available until 2000. Results reported in Table A5 in Online Appendix A.8 show that domestic terrorism exhibits an inverted U-shaped relationship with the KOF index in the alternative specifications as well.
21. The correlation coefficient between the KOF index and GDP per capita reaches a value of .76.
22. Government size has been suggested by several studies as a potential determinant of terrorism (e.g., see Kirk 1983; Freytag et al. 2011; Krieger and Meierrieks 2011). We use general government final consumption expenditure as a percentage of GDP from the *World Bank* as an indicator of government size. In column (5), we follow the existing literature on the importance of press freedom in explaining terrorism (A. M. Hoffman, Shelton, and Cleven 2013; Asal and Hoffman 2016; R. Bakker, Hill, Jr. and Moore 2016) and include a binary variable for countries that are categorized as free in the *Freedom of the Press* data (Freedom House 2011). In columns (6) to (8), we incorporate additional institutional controls that have been shown to matter for explaining terrorism (Li 2005; Young and Dugan 2011; A. M. Hoffman, Shelton, and Cleven 2013). Data on political rights and civil liberties are taken from Freedom House (2011), whereas we access Vanhanen and Lundell's (2014) polyarchy data set to measure democratic participation. Information about executive constraints is taken from the Polity IV data set (Marshall, Gurr, and Jaggers 2017). Information on the Gini index as a measure of income inequality comes from Solt (2016; see Li [2005] and Piazza [2013] on the importance of income distribution for terrorism).

23. In the results presented in Table 3, we use the lag of attacks to capture past incidents. However, as suggested in Li (2005), we also tested by calculating past incidents with the logarithm of the average annual number of terrorist incidents in each country and results remain consistent.
24. To demonstrate it is communications technology, rather than openness of states to foreign media, which is driving the change in terrorism, we use the external transparency measure from Bell et al. (2014) as an additional control in robustness checks. The measure assesses external transparency by the scale of presence of the *New York Times* within the borders of a country and the data are available for a period of 12 years (1982 to 1999). The inverted U-shaped relationship between the KOF index and the number of terrorist attacks remains robust to the inclusion of Bell et al.'s (2014) indicator. In addition, we conduct robustness check for subsamples for a period prior to the commercial use of the Internet (1970 to 1989) and the period thereafter (1990 to 2015). The inverted U-shaped relationship between the KOF index and terrorism persists in both the subsamples. These robustness checks are reported in Table A7 of Online Appendix A.10.
25. As it is argued in the literature that even low fatality attacks may go unnoticed by the press (Weidmann 2016), we conduct robustness checks with different thresholds of fatalities to count terrorist attacks. Specifically, we use counts of terrorist attacks with at least 5, 10, 15, and 20 fatalities as our dependent variables. However, our results remain consistent as shown in Table A8 in Online Appendix A.10.
26. In the corresponding literature, a civil conflict is defined as drawing at least 25 battle-related deaths in the given year, whereas a civil war would draw at least 1,000 battle-related deaths (see Blattman and Miguel 2010). We access data from Uppsala Conflict Data Program and International Peace Research Institute, Oslo (2017) to calculate the respective binary indicators on the country-year level.

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