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The Trade-Offs of Counterterrorism Policies

Subhayu Bandyopadhyay and Todd Sandler

Abstract

This article provides a modern overview of counterterrorism tools and their trade-offs for curbing terrorist attacks and their consequences. Defensive and proactive countermeasures constitute two main classes of counterterror tools deployed by targeted governments. The primary drawback of defensive actions, which make terrorist attacks more costly and less apt to succeed, is attack transference that shifts the mode, venue, or target of attacks to those less protected. In contrast, offensive proactive measures, which confront the terrorists directly, may result in backlash as terrorist sympathizers, the public, and state sponsors augment their terrorist support resulting in more recruitment and attacks. Other essential trade-offs are identified and discussed. Additionally, we formulate a two-stage canonical game-theoretic model involving a targeted government and a terrorist group adversary. This model accounts for defensive and proactive policies but also myriad scenarios. As such, it serves as a foundation to explain the modern counterterrorism literature as illustrated by a discussion of iconic contributions to the study of counterterrorism.

JEL codes: C72, D62, D74, F13, F52, H41, H56

Federal Reserve Bank of St. Louis *Review*, Third Quarter 2023, *105*(3), pp. 177-97.
https://doi.org/10.20955/r.105.177-97

1. INTRODUCTION

Terrorism is the premeditated use or threat of violence by individuals or subnational groups to obtain one or more political objectives through the intimidation of a large audience beyond that of the immediate victims (Enders and Sandler, 2012, p. 4). The two key definitional ingredients are the associated violence and the necessary political objective. The terrorists employ attention-catching violence to threaten citizens as a means to circumvent elections, making their demands directly to government officials. Without some political goal, violence-backed extortion constitutes a crime but not terrorism. Terrorists' political aims may assume sundry forms including policy changes, regime alteration, territorial claims, political prisoner release, terrorist group political recognition, and income redistribution.

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The practice of terrorism involves at least three stakeholders: the terrorists or their group, the targeted government, and the impacted audience. Terrorists employ violence to induce at-risk citizens to pressure their government to grant terrorists' political concessions to end the violence.

Two decades have passed since the four al-Qaida skyjackings on September 11, 2001 (henceforth 9/11) killed almost 3,000 and injured over twice that number, and terrorism remains a significant global security threat. The public's apprehension is reinforced periodically by subsequent deadly and costly terror attacks worldwide, including the Madrid commuter trains and stations bombings on March 11, 2004, killing 193; the Beslan barricade hostage seizure of schoolchildren and parents on September 1, 2004, killing 333; the London underground and bus bombings on July 7, 2005, killing 56; the Mumbai bombings and armed attacks on November 26, 2008, killing 175; the Paris-coordinated bombings and armed attacks on November 13, 2015, killing 130; and so many others (see, e.g., Enders and Sandler, 2012, pp. 349-52).

In light of such threats, the authorities must allocate their scarce counterterrorism resources in an effective way to not only protect citizens and property but also curb terrorism-induced economic losses. The losses of venue countries, which host the terrorist attacks, involve foreign direct investment (Abadie and Gardeazabal, 2003, 2008; Bandyopadhyay, Sandler, and Younas, 2014; Enders, Sachsida, and Sandler, 2006; Enders and Sandler, 1996, 2004); economic growth, investment, and consumption (Blomberg, Hess, and Orphanides, 2004; Blomberg, Hess, and Weerapana, 2004; Eckstein and Tsiddon, 2004; Keefer and Loayza, 2008; Gaibulloev and Sandler, 2009, 2011, 2023); international trade (Bandyopadhyay, Sandler, and Younas, 2018, 2020; Mirza and Verdier, 2014; Nitsch and Schumacher, 2004); tourism (Drakos and Kutan, 2003; Enders, Sandler, and Parise, 1992); and stocks and bonds (Kollias, Papadamou, and Arvanitis, 2013).

In the case of economic growth and macroeconomic aggregates, the literature shows that terrorism-generated influences are greater in developing economies than in developed economies (Gaibulloev and Sandler, 2008). The average developed economy can generally withstand terrorism with little effect on macroeconomic growth, investment, or consumption except in the instance of sustained terrorist campaigns in smaller economies (Eckstein and Tsiddon, 2004; Gaibulloev, Sandler, and Sul, 2014; Sandler and Enders, 2008). However, Brodeur (2018) finds that large localized economic consequences can occur in close proximity to terrorist attacks by adversely affecting jobs and earnings (see also Abadie and Gardeazabal, 2003, for the Basque Country in Spain).

Modern-day theoretical studies of counterterrorism build game models where the targeted government takes defensive and/or offensive measures, followed by attack campaign choices by the terrorists in response to the government's policy choices.[1] Government actions take the form of policies that raise the cost of terrorist attacks, destroy the assets of terrorist groups, or reduce the cost of nonviolent acts (Gaibulloev and Sandler, 2019; Schneider, Brück, and Meierrieks, 2015). In particular, defensive or protective countermeasures intend to either raise the cost of terrorist attacks or limit their likelihood of success (Enders and Sandler, 1993; Landes, 1978). In contrast, proactive or offensive countermeasures are meant to capture or kill terrorists, punish their families or supporters, destroy groups' infrastructure (e.g., training camps or bomb factories), infiltrate groups, or gain intelligence.[2] Additionally, the government can engage in conciliatory measures that reward peaceful acts by the terrorists as a means of lowering the relative cost of nonviolent actions (Dugan and Chenoweth, 2012; Frey and Luechinger, 2003). Throughout the article, each type of counterterrorism action is tied to positive and negative trade-offs that must be weighed when being deployed.

1. The large game-theoretic literature includes articles by Bandyopadhyay and Sandler (2011, 2021, 2022), Bueno de Mesquita (2007), Bueno de Mesquita and Dickson (2007), Cárceles-Poveda and Tauman (2011), Rosendorff and Sandler (2004), and others.

2. On such proactive policies, see Bandyopadhyay and Sandler (2011, 2021), Benmelech, Berrebi, and Klor (2015), Brophy-Baermann and Conybeare (1994), Cárceles-Poveda and Tauman (2011), Enders and Jindapon (2010), Jacobson and Kaplan (2007), Jaeger et al. (2012), Sandler and Lapan (1988), and Sandler and Siqueira (2006).

Our study aims to provide an up-to-date overview of governments' rich array of counterterrorism actions in our quest to identify important trade-offs associated with the three main kinds of countermeasures, with a particular focus on defensive and proactive responses in our canonical model of counterterrorism. Knowing these trade-offs better allows targeted governments to compare alternative countermeasures when choosing to rely on diverse antiterrorism actions. Our canonical model is capable of forming a foundation for much of the modern counterterrorism literature as demonstrated by selected applications to the literature that follow the model's formulation. For instance, our model can allow a targeted government to tailor its foreign aid package to a developing country hosting a terrorist threat (Azam and Thelen, 2010; Bandyopadhyay, Sandler, and Younas, 2011; Bapat, 2011) or to permit a targeted government to determine its immigration policy for a developing country hosting a resident terrorist group, which poses a threat to the developed country (Bandyopadhyay and Sandler, 2014). Given the vast counterterrorism literature, our presentation is understandably eclectic by concentrating on primary concepts and influential contributions.

2. TRADE-OFFS OF COUNTERTERRORISM MEASURES

Defensive countermeasures dissuade terrorist attacks by making them more costly to a rational terrorist group, which weighs the cost and benefit from such actions.[3] By deploying defensive actions, threatened governments aim to limit the protected-against attacks as terrorists redirect resources to other less-guarded targets or activities. The same diversion of attacks may be achieved by policies that curb the terrorists' likelihood of a successful operation. Defensive actions assume many forms including installing metal detectors in airports starting in January 1973, hardening targets (e.g., the fortification of US embassies in October 1976 and October 1985), deploying sky marshals on select US flights, enacting harsher penalties for terrorist offenses (e.g., the Reagan "get tough" with terrorism laws), and ratifying international antiterrorism conventions (Enders and Sandler, 1993, 2012).

To illustrate the key disadvantage of transference caused by antiterror defensive policies, we consider the January 1973 installation of metal detectors in US and other airports. In Figure 1, we display the time series of skyjackings (blue dashed line) and other hostage-taking incidents (red solid line) during 1968–1990, based on transnational terrorist events data drawn from *International Terrorism: Attributes of Terrorist Events (ITERATE)* (Mickolus et al., 2022). There are three varieties of other hostage-taking incidents: kidnappings, barricade and hostage taking, and nonaerial hijackings (buses, trains, or boats). International or transnational terrorist attacks involve victims, perpetrators, or institutions from more than a single country. If an incident commences in one country but concludes in another, then the attack is a transnational event as in the case of a US domestic flight diverted forcibly to Cuba for political purposes including asylum. Additionally, a terrorist attack in the United States that kills or injures foreigners or a terrorist event abroad that kills or injures US citizens constitutes a transnational terrorist incident.

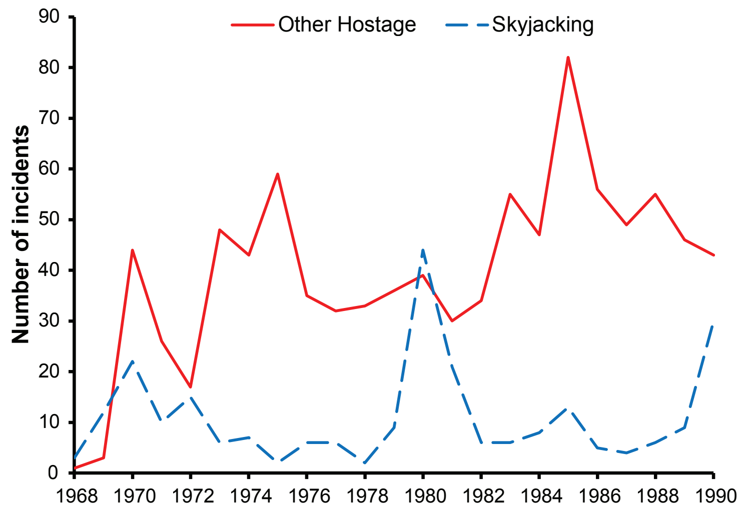
Returning to Figure 1, we see that metal-detector-related transference occurs during the three years following the January 1973 deployment of detectors in airports, at which time skyjackings took a precipitous drop while other hostage-taking incidents rose greatly. Thus, terrorists appeared to have substituted from skyjackings to other hostage attacks, not guarded by metal detectors. The apparent substitutability between skyjackings and other hostage-taking incidents makes sense since both generate possible ransom payments, prisoner releases, and large media exposure (Brandt and Sandler, 2009).

Other likely instances of defensive action transference are documented in the literature: For instance, Enders and Sandler (1993) show that heightened US embassy security in the 1970s and 1980s resulted

3. The origins of the rational depiction of terrorist groups trace back to Landes (1978), Sandler, Tschirhart, and Cauley (1983), and Selten (1977).

Figure 1

Substitutions between Skyjackings and Other Hostage-Taking Events, 1968–1990



in fewer attacks on embassy grounds and more attacks against US diplomats beyond embassy compounds.[4] In fact, security-stimulated transference seemed to raise attack casualties in some instances, as did airport metal detectors, as terrorists mainly switched to kidnappings that had more casualties than skyjackings in the 1970s (Enders and Sandler, 2012, pp. 90-91). Policy-induced transference may also be tied to terrorist groups shifting country attack venues away from more- to less-protected countries (Arce and Sandler, 2005; Enders and Sandler, 2006). Moreover, transference may alter the mode (e.g., bombings and armed attacks), target (i.e., government officials, military personnel, business assets, or private parties),[5] or location of attack (i.e., transportation facilities, malls, and infrastructures).

In Figure 1, another adverse trade-off of defensive actions is captured by the incidence of skyjackings during 1978-1981 after terrorists innovated to circumvent airport metal detectors. One innovation included plastic guns that, once smuggled onto planes, could gain the submission of passengers. During the start of the 1980s, there was a host of skyjackings of US domestic flights on the East Coast routes to Cuba as individuals sought asylum there. In many of those skyjackings, hijackers brandished bottles with allegedly inflammable liquids that they threatened to pour on themselves and others before igniting (Enders and Sandler, 2012). The lesson here is that defensive barriers must be constantly updated to stay ahead of terrorists. Another thing to note about the two hostage-taking time-series plots in Figure 1 is how they often move in opposing directions, indicative of substitute incidents (Brandt and Sandler, 2009, 2010).

In contrast to defensive efforts, proactive or offensive measures directly confront terrorist groups, their assets, finances, safe havens, or supporters in the hope of reducing the groups' threat. Quite simply, proactive measures reduce terrorist groups' resources so as to shift down their resource or budget constraint. Specific proactive operations may entail retaliatory raids against a state sponsor (e.g., the US raid on Libya in 1986 following Libya's alleged support of the bombing of the La Belle discotheque in West Berlin), assassinating terrorist leaders (Jacobson and Kaplan, 2007), uncovering intelligence on planned terrorist attacks, or apprehending terrorists. Arguably, the biggest drawback of proactive

4. On transference, see, e.g., Cárceles-Poveda and Tauman (2011), Das and Lahiri (2006), de Oliveira, Faria, and Silva (2018), Enders and Sandler (2004), Sandler and Lapan (1988), and Sandler and Siqueira (2006) for in-depth discussions.

5. See, in particular, Brandt and Sandler (2010).

measures stems from backlash by other terrorist groups, the sympathetic public, and state sponsors that perpetrate violence to protest the proactive operation.[6] At times, backlash results in terrorist groups attracting larger numbers of recruits to protest heavy-handed government operations—e.g., the recruitment of Palestinian terrorists following the capture and murder by German police of the hostage takers at the 1972 Munich Olympics (Hoffman, 2006).

A documented case of backlash occurred immediately after the US retaliatory raid on Muammar Qaddafi's compound in Libya in April 1986, motivated by the deaths and injuries of US service personnel in the discotheque bombing on April 5, 1986, allegedly supported by the Libyan regime. Enders and Sandler (1993) demonstrate that terrorist attacks against US and UK interests jumped sharply during the first three months following the retaliatory raid. The US reliance on UK airbases to launch its airstrikes linked the UK to the raid, leading to backlash terrorist attacks against both countries' interests. Notably, US-UK terrorist attacks returned to the preintervention mean in about a year, so the backlash was not long-lived. Similar backlash patterns are found by Brophy-Baermann and Conybeare (1994) after Israeli retaliatory raids to punish Palestinian groups for their Israel-directed terrorist attacks. Another aspect of backlash concerns regime instability stemming from a public outcry when a host developing terrorist country accepts counterterrorism assistance from a targeted developed country (Azam and Thelen, 2010; Bandyopadhyay, Sandler, and Younas, 2011; Carter, 2012).

When multiple countries are targeted by the same terrorist group, each country's proactive effort is viewed as a public good with nonexcludable and nonrival benefits by other targeted countries. This follows because proactive countermeasures reduce the threat from the terrorist group for all targeted countries, potentially leading them to a free (or easy) ride on the actions of other countries. The public-good-induced substitutability of proactive measures represents another negative trade-off that opposes the usual benefit for targeted countries stemming from the harm those measures inflict on the terrorist group.[7]

A final class of counterterrorism policies are conciliatory, which rewards the terrorists for nonviolent behavior (Dugan and Chenoweth, 2012; Frey and Luechinger, 2003). By so doing, conciliatory actions reduce the relative price of nonviolence, thereby making terrorist attacks less inviting. If conciliatory policies are to have the desired outcome of less terrorism, then the associated substitution effect must outweigh the income effect stemming from the relative price fall (Anderton and Carter, 2005). If the income effect dominates, then conciliatory efforts may be undesirable by increasing both terrorism and nonterrorism actions. Even with a negative income effect, conciliatory policy may present a negative trade-off: If terrorism appears to be effective in gaining political concessions from a government with little stomach for violence, conciliatory policy may encourage other terrorist groups to increase their attacks as a means of gaining their own concessions. Owing to the lack of data on governments' conciliatory actions, there is only a single empirical study of the effectiveness of conciliatory policy—a study on Israeli conciliatory actions (Dugan and Chenoweth, 2012).

3. TRANSNATIONAL AND DOMESTIC TERRORISM

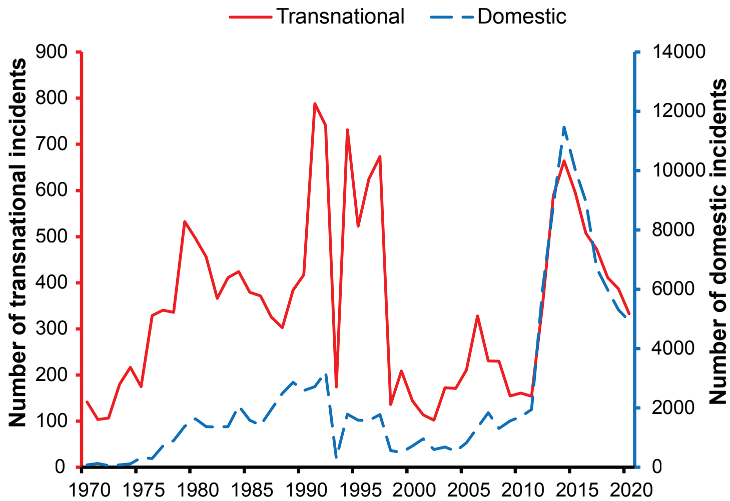
To fathom the threat posed by terrorism since 1970, the reader must consult the distinctions and trends of transnational and domestic terror attacks worldwide. Unlike transnational terrorism, domestic terrorism is homegrown and home directed with consequences for just that country, its citizens,

6. On backlash, consult Bloom (2005), Bueno de Mesquita and Dickson (2007), Das and Lahiri (2006), de Oliveira, Faria, and Silva (2018), Findley and Young (2012), Jaeger et al. (2012), and Rosendorff and Sandler (2004, 2010).

7. On the public substitutability of proactive responses, see Arce and Sandler (2005), Bandyopadhyay and Sandler (2011), Cárceles-Poveda and Tauman (2011), Sandler and Lapan (1988), and others.

Figure 2

Domestic and Transnational Terrorist Attacks, 1970–2020



property, institutions, and policies. There are also no international externalities (e.g., policy demands on a foreigner government) associated with them. On April 19, 1995, Timothy McVeigh's bombing of the Alfred P. Murrah Federal Building in Oklahoma City was a domestic terrorist attack. By contrast, the 9/11 skyjackings with their foreign victims and perpetrators were transnational terrorist incidents. Even though there were no foreign victims, the February 26, 1993, van bombing of the North Tower of the World Trade Center was a transnational terror attack given its foreign perpetrators.

The Global Terrorism Database (GTD) (National Consortium for the Study of Terrorism and Responses to Terrorism, 2021) provides open access terrorism event data on attacks for 1970-2020. We apply the Enders, Sandler, and Gaibulloev (2011) procedure to GTD data to distinguish between transnational and domestic terror attacks. Their procedure identifies any incident as transnational when the victims, perpetrators, and/or venue are associated with two or more countries. Incidents where the victims and perpetrators are citizens from the venue country are deemed domestic. If insufficient information in the GTD does not allow an attack to be unequivocally categorized as transnational or domestic, then we label the attack as uncertain. "Uncertain" incidents are included in empirical studies using the Enders, Sandler, and Gaibulloev (2011) divided data when total terrorist incidents are measured.

In Figure 2, for the years 1970-2020, transnational terror incidents are indicated by the solid red line on the left-side y-axis, while domestic terror incidents are indicated by the dashed blue line on the right-side y-axis. Given the much larger number of domestic, relative to transnational, attacks, the units on the domestic axis are much more compressed than those on the transnational axis. Our depiction shows that the two types of terrorist attacks follow similar trends, which is especially evident after 2011. There is a marked rise in domestic terrorism following 9/11 and heightened border security in the United States and other rich countries. The recent increase in populist regimes appears to be correlated with enhanced domestic terrorism.

The escalating threat of domestic terrorism is particularly noticeable in Figure 3, which plots the ratio of domestic to transnational terrorist incidents. This ratio shoots up after 2004. During 2005-2020, there were over 12 domestic attacks on average for every transnational attack, while during 1970-2000, there were just over 3 domestic attacks on average for every transnational attack. The current era of domestic terrorism cautions that counterterrorism policies must consider domestic attacks along with transnational ones.

Figure 3

Ratio of Domestic to Transnational Terrorist Attacks, 1970–2020

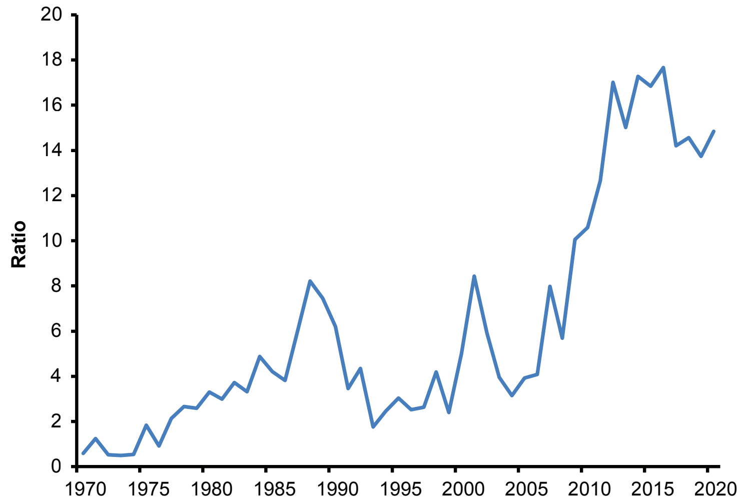


Figure 4

Transnational Terrorist Attacks by Type, 1968–2021

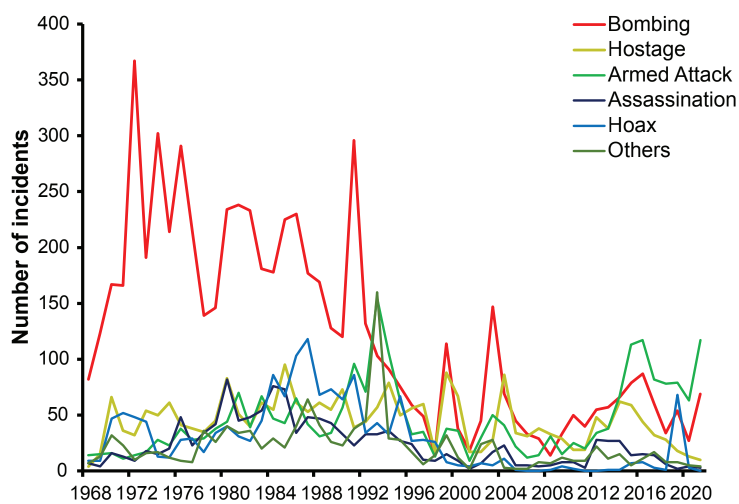


Figure 4 returns to transnational terrorist attacks by displaying the disaggregated time-series plots for terrorist bombings, armed attacks, hostage taking, hoaxes, and threats,[8] and other attack modes based on ITERATE data for 1968-2021. A breakdown of domestic terrorist incidents offers a similar picture (Gaibulloev and Sandler, 2019) but is not displayed here. In Figure 4, bombings (e.g., explosives, incendiary devices, grenades, and letter bombs) represent terrorists' preferred modes of attack, constituting over half of all terrorist attacks over the time period shown (Gaibulloev and Sandler, 2019, 2023). All of the displayed series show a great deal of variability. This is particularly true of hostage taking, which after 9/11 funded some terrorist groups' campaigns of terror as authorities cracked down on money laundering. Since 2000, hoaxes and threats have been generally down, with the exception of 2019.

8. A hoax is a claimed *past* terrorist attack that did not happen (i.e., the claim of a bomb on a plane when no bomb is found aboard), while a threat is a claimed *future* action that may or may not eventually occur.

Moreover, after the end of the Cold War, transnational terrorist bombings declined with the fall in state-sponsored terrorism and transnational terrorism in general, while transnational-terrorist-armed attacks increased with the rise of religious fundamentalist terrorism (Enders and Sandler, 1999). Religious terrorists viewed armed attacks as better able to grab headlines and make the public feel at risk. In particular after 2009, armed attacks displayed a marked increase with the continued expansion of religious terrorism (Gaibulloev and Sandler, 2019). Variations between two time series of modes of attack allow for a distinction of substitute modes (skyjackings and kidnapping) that vary in opposing directions from complementary modes (bombings and bombing hoaxes) that vary in sync (see, e.g., Brandt and Sandler, 2009, 2010).

4. A CANONICAL MODEL OF COUNTERTERRORISM

To capture the results in the counterterrorism literature and to lay a foundation for more recent contributions, we put forward a simple canonical model that analyzes defensive and proactive measures in various scenarios. Given the thin empirical and theoretical literature on conciliatory measures, our concentration on proactive and defensive terrorist measures makes sense. Our goal is to present a simple game-theoretic model capable of accounting for two main types of counterterrorist policies in a scenario with two targeted countries and a single terrorist group, which resides in one of the two nations. This scenario agrees with real-world cases such as al-Qaida in Afghanistan targeting US and Afghani interests. The model can be readily extended to multiple targeted countries (e.g., Cárceles-Poveda and Tauman, 2011).

In game-theoretic parlance, there are three players in the game: the respective governments of the two targeted nations (*A* and *B*) and the terrorist organization residing in nation B. The game has two stages. In stage 1, the two governments move simultaneously and unilaterally to choose their desired policy levels. In stage 2, the terrorist organization chooses how to allocate its resources to optimally attack the two targeted nations.[9] With this sequence of moves, the policy variables chosen by the two governments are given for the terrorist group in stage 2. As in a Stackelberg leadership game, the governments' actions in stage 1 anticipate how their policy choices affect the terrorist organization's stage 2 choices. As is standard in solving such multistage games, we employ backward induction such that we first solve for the second-stage equilibrium and then use the second-stage solutions to obtain the equilibrium for the first-stage policy game. Accordingly, we first describe the terrorist organization's payoff and optimization problem and then turn to the description and analysis of the governments' policy problems.

4.1. Stage 2: The Terrorist Organization

Terror attacks in nation *A*, denoted by T^A, constitute transnational terrorism since they are perpetrated by *B*'s citizens. By contrast, terror attacks, T^B, are perpetrated by *B*'s own citizens, thereby constituting domestic terrorism.[10] The terrorist organization's reduced-form payoff function is

$$V = \theta^A T^A + \theta^B T^B, \tag{1}$$

where $\theta^j > 0$ is a target preference parameter indicating the marginal payoff from creating terror in nation j, $j = A,B$.

9. This sequence of moves is used by Bandyopadhyay and Sandler (2022), Cárceles-Poveda and Tauman (2011), Sandler and Lapan (1988), and others. Depending on the problem examined, the order of moves may be reversed, with the terrorist group going first and the targeted government(s) going second (see, e.g., Bier, Oliveros, and Samuelson, 2007). In some applications, the choice at each stage may be different; see the next-to-last section.

10. For simplicity, this assumes that attacks in *B* do not involve *A*'s interest there.

Terrorism in nation j is created when the terrorist group devotes resources l^j to attacking targets in j with production function[11]

(2) $$T^j = \gamma^j\left(e^j\right)f^j\left(l^j\right),\ f^j\left(0\right)=0, f^{j\prime} > 0, f^{j\prime\prime} < 0,$$

where e^j is the defensive policy choice of nation j with $\gamma^j(0) = 1$, $0 < \gamma^j(e^j > 0)$, and $\gamma^{j\prime} < 0$. Thus, greater defense reduces terrorism in nation j for any level of terrorist resource l^j directed at the assets of nation j. We also assume there are diminishing returns in defense such that $\gamma^{j\prime\prime} > 0$. Our representation is consistent with the notion expressed earlier that defensive measures limit the level of successful attacks.

The terrorist group in nation B possesses a given amount of resources L, which can be reduced by the aggregate proactive response of the two nations, given by $m = m^A + m^B$, where m^j is the proactive response employed by j's government. The overall proactive response m reduces the terrorist group's aggregate resources, L, but at a diminishing rate such that $L = L(m)$, $L'(m) < 0$, and $L''(m) > 0$. As mentioned earlier, either nation's proactive measures reduce the prowess of the common terror threat, thereby conferring nonrival and nonexcludable (pure public) benefits on the two targeted nations. Therefore, we can represent the terrorist organization's resource constraint as[12]

(3) $$l^A + l^B = L\left(m\right).$$

Substituting equation (2) into equation (1), we get the terrorist organization's payoff

(4) $$V = \theta^A\gamma^A\left(e^A\right)f^A\left(l^A\right)+\theta^B\gamma^B\left(e^B\right)f^B\left(l^B\right).$$

The terrorist group maximizes payoff V by optimally choosing l^A and l^B, subject to the resource constraint. Also, because (e^A, e^B, m) is chosen in stage 1, γ^A, γ^B, and $L(m)$ are given for the terrorist group in its optimization problem. At an interior optimum, the first-order conditions (FOCs) of this constrained optimization problem are[13]

(5a) $$\theta^A\gamma^A\left(e^A\right)f^{A\prime}\left(l^A\right) = \theta^B\gamma^B\left(e^B\right)f^{B\prime}\left(l^B\right) \text{ and}$$

(5b) $$l^A + l^B = L\left(m\right).$$

Equations (5a) and (5b) imply that the terrorist group allocates its resource L between home and foreign attacks so that the group's marginal payoffs are equated between attacking A's and B's assets.

To foster intuition, we use Figure 5 to provide a graphical representation of this allocation problem. The left vertical axis measures marginal value (MV) to the terrorist organization of raising l^A, $MV^A = V_{l^A} = \theta^A\gamma^A f^{A\prime}(l^A)$, and the right vertical axis measures the corresponding marginal benefit from raising

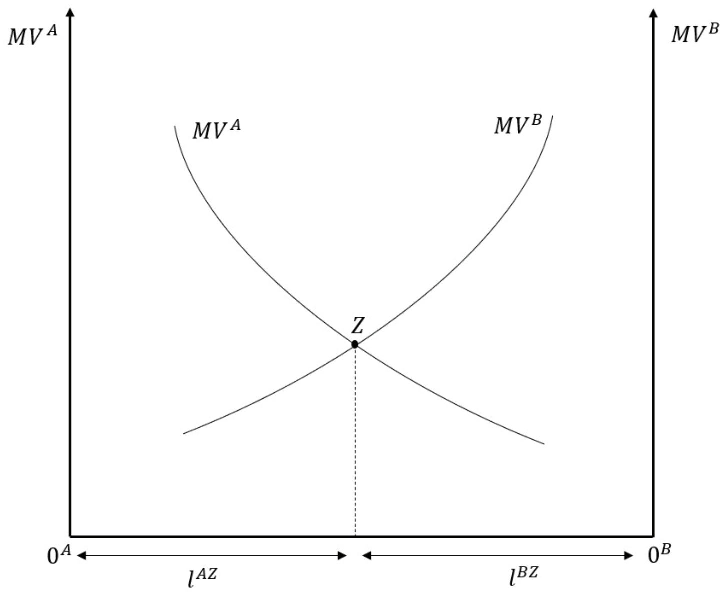
11. At this point, we clarify our notation: (a) superscripts refer to nations; (b) for a single-variable function, $\psi^j(x)$, $\psi^{j\prime}(x)$ and $\psi^{j\prime\prime}(x)$ denote first and second derivatives, respectively; and (c) for multivariable functions, subscripts refer to partial derivatives. For example, for $\phi^j(p,q)$, $\phi^j_p(p,q)$ refers to the partial with respect to p, while $\phi^j_{pp}(p,q)$ and $\phi^j_{pq}(p,q)$ denote partials of the function $\phi^j_p(p,q)$ with respect to p and q, respectively.

12. Since $f^{j\prime}(l^j) > 0$, this resource constraint is binding at an optimum; otherwise the terrorist organization could always use some more of the resources to raise attacks on one or both nations to increase V.

13. For simplicity of exposition, we focus only on interior solutions for the entire analysis except for the discussion of proactive policy. The reason is the following. For both the terrorist organization's problem and the defense policy problem, the players' payoffs are best thought of in the context of private goods. Accordingly, while corner solutions are possible, interior solutions constitute standard representation. In contrast, the proaction problem has marked public good features because terror reduction applies to both nations in a nonexcludable and nonrival manner. In such public good provision problems, free-riding corner solutions naturally arise. Therefore, we consider both interior and corner solutions in the proaction game. Finally, we assume that functional forms and model parameters yield unique and stable two-stage equilibrium for each type of counterterror policy.

Figure 5

The Terrorist Organization's Optimal Effort Allocation



l^B, $MV^B = V_{l^B} = \theta^B\gamma^B f^{B\prime}(l^B)$ Effort l^A is measured on the horizontal axis with respect to origin O^A moving to the right, while l^B is measured on the horizontal axis starting from origin O^B but moving to the left. The length of the horizontal axis between O^A and O^B is $L(m)$. Strictly positive and diminishing marginal productivity in creating terror ensure both marginal value curves are downward sloping given their respective axes and that they never touch the horizontal axes. Furthermore, if $\theta^A\gamma^A f^{A\prime}(l^A = 0) > \theta^B\gamma^B f^{B\prime}[l^B = L(m)]$, then MV^A exceeds MV^B at $l^A = 0$, implying that V can be increased by raising l^A at the expense of l^B. Thus, the terrorists' optimum is to the right of point O^A. Similarly, if $\theta^A\gamma^A f^{A\prime}[l^A = L(m)] < \theta^B\gamma^B f^{B\prime}[l^B = 0]$, then MV^B exceeds MV^A at $l^B = 0$ so that the terrorist organization will want to increase l^B at the expense of l^A, indicating that the optimum has to be to the left of O^B. Therefore, assuming the aforementioned boundary conditions are satisfied, we have the optimum allocation at point Z in the figure, where $MV^A = MV^B$, $l^A = l^{AZ}$, $l^B = l^{BZ}$, and $l^{AZ} + l^{BZ} = L(m)$.[14]

With target parameters, θ^j, suppressed from the functional forms, simultaneous solution of equations (5a) and (5b) yields $l^j = l^j(e^A, e^B, m)$, where

$$\text{(6a)} \qquad l^j_{e^j} = -\frac{\theta^j\gamma^{j\prime}(e^j)f^{j\prime}(l^j)}{D} < 0 \text{ with } D = \theta^A\gamma^A f^{A\prime\prime} + \theta^B\gamma^B f^{B\prime\prime} < 0$$

so that an increase in targeted nation j's defense reduces terror effort directed at j. As a consequence, nation j's terrorism, $T^j = \gamma^j(e^j)f^j(l^j)$, must be lower. By contrast, we get

$$\text{(6b)} \qquad l^j_{e^i} = \frac{\theta^i\gamma^{i\prime}(e^i)f^{i\prime}(l^i)}{D} > 0,\ i \neq j$$

such that an increase in one targeted nation's defense augments the terrorist attacks directed at the other nation. The qualitative conclusions drawn from equations (6a) and (6b) can be seen by using Figure 5. When e^A increases, γ^A is reduced because $\gamma^{A\prime} < 0$. Thus, the MV^A curve shifts to the left without affecting the MV^B curve. The new equilibrium will have a lower l^A and a higher l^B compared with the

14. Note that $f^{j\prime}(l^j \to 0) \to \infty$ is a sufficient condition for the boundary conditions to hold assuming that $f^{j\prime}[l^j = L(m)]$ is finite.

initial equilibrium. The analysis of the effect of an increase in e^B is similar. Thus, an increase in either nation's defense incentivizes the terrorist group to transfer some attacks to the other targeted nation. This transference represents a negative trade-off noted earlier in our general discussion, as empirically documented in the literature—e.g., the shift in terrorism from rich to poorer countries following 9/11-induced security upgrades (Enders and Sandler, 2006, 2012). Being a negative international externality, attack transference is typically associated with a misallocation of resources from the perspective of global welfare.

Finally, we turn to the effect of proactive policy on the terror group's effort, where

$$l_m^j = \frac{\theta^i \gamma^i f^{i''} L'(m)}{D} < 0,\ i \neq j \tag{6c}$$

such that an increase in aggregate proaction m reduces terror attacks directed at each targeted nation. Since an increase in m reduces $L(m)$, the distance between the two origins in Figure 5 must be smaller after an increase in m. One way to capture this is to keep the origin O^A unchanged but move the other origin leftward from O^B to $O^{\tilde{B}}$ such that the distance between O^A and $O^{\tilde{B}}$ reflects a lower value of $L(m)$. This change in axis will not affect the MV^A curve but will shift the MV^B leftward by the amount of the shift of the origin. The new equilibrium has to be at a point that is higher on the MV^A curve, which implies a lower equilibrium level of l^A. At the new equilibrium, MV^B has to increase to match the higher MV^A. Given diminishing returns, this is achieved at a lower l^B at the new equilibrium (not shown) in Figure 5. Thus, at given defense levels, proaction reduces terror incidence $T^j = \gamma^j(e^j)f^j(l^j)$ in each nation.

There are four policy variables (e^A, e^B, m^A, m^B) that affect the last stage of the game. To keep the exposition simple and to develop the necessary intuition, we first consider the defense game with proactive measures held constant and then consider a proactive game with defense levels held constant. Although these assumptions simplify the presentation, we obtain insights that align with more general treatments of proactive and defensive counterterrorism policies analyzed using multistage games (e.g., Bandyopadhyay and Sandler, 2011).

4.2. Stage 1: The Defense Policy Game

Given the current assumed constancy of proactive measures, we drop m from the functional forms. Each nation chooses a defense level, assuming that the other nation's defense choice is given, to minimize its loss, Ω^j, from terrorism inclusive of defense provision cost, c^j,

$$\Omega^j\left(e^A, e^B\right) = T^j + c^j\left(e^j\right) = \gamma^j\left(e^j\right) f^j\left[l^j\left(e^A, e^B\right)\right] + c^j\left(e^j\right) \tag{7}$$

in which $c^j(e^j)$ is an increasing and weakly convex function. The FOC for nation j's defense choice is[15]

$$\Omega^j_{e^j}\left(e^A, e^B\right) = \gamma^j\left(e^j\right) f^{j\prime}\left[l^j(\cdot)\right] l^j_{e^j}(\cdot) + \gamma^{j\prime}\left(e^j\right) f^j\left[l^j(\cdot)\right] + c^{j\prime}\left(e^j\right) = 0. \tag{8}$$

Next, we consider the defense Nash reaction function of nation A implicitly defined by equation (8) as a function of nation B's defense level as

$$e^A = R^A\left(e^B\right). \tag{9a}$$

Using the implicit function theorem and equation (8), the reaction function's slope is

15. We assume that the diminishing returns in defense (i.e., $\gamma^{j''} > 0$) are sufficiently strong to ensure that the second-order conditions for a minimum hold.

(9b) $$\frac{de^A}{de^B} = -\frac{\Omega^A_{e^A e^B}}{\Omega^A_{e^A e^A}},$$

where the second-order condition (SOC) of a minimum ensures that $\Omega^A_{e^A e^A} > 0$. Thus, *A*'s defense reaction function is positively sloped if and only if $\Omega^A_{e^A e^B} < 0$. In the appendix, we show that if the nations are symmetric or if they confront terror production functions that are not too asymmetric, then the defense reaction functions are upward sloping.

The defensive policy game highlights two features that characterize the extant literature on counterterrorism. First, as seen in equation (6b), greater hardening of targets by one nation makes the terrorists allocate their effort toward softer targets in other nations. This transference is also true within a nation as terrorists shift their attacks from hardened targets to softer ones (Bier, Oliveros, and Samuelson, 2007; Brandt and Sandler, 2010). Thus, there are negative international and national terror spillovers or trade-offs associated with defensive actions. Second, when the other nation raises its defense, the terrorism that spills over to the home nation raises its marginal benefit of defense, captured by the first two terms on the right-hand side of equation (8), which makes the home nation respond by raising its defense. The strategic complementarity of defense choices characterizes many important game-theoretic contributions to the counterterrorism policy literature.

4.3. Stage 1: The Proactive Policy Game

Now, we assume that defense levels are given such that $\gamma^j = \bar{\gamma}^j$ is a parameter and the defense levels (e^A, e^B) are suppressed in the relevant functional forms. Each nation chooses a proactive response, m^j, assuming that the other nation's proactive choice is given, to minimize its loss from terrorism inclusive of its proactive provision cost,

(10) $$\Omega^j\left(m^A, m^B\right) = T^j + c^j\left(m^j\right) = \bar{\gamma}^j f^j\left[l^j\left(m = m^A + m^B\right)\right] + c^j\left(m^j\right),$$

where $c^j(m^j)$ is an increasing and weakly convex function. The FOC for nation j's proactive choice is[16]

(11) $$\Omega^j_{m^j}\left(m^A, m^B\right) = \bar{\gamma}^j f^{j\prime}\left[l^j(\cdot)\right] l^j_m(\cdot) + c^{j\prime}\left(m^j\right) \geq 0.$$

We write equation (11) to allow for a free-riding corner solution for reasons outlined in footnote 13. We also note that while proactive benefits are public, proactive provision costs are private, the latter leading to the possibility of an interior solution where each nation provides a positive proaction level. Accordingly, we turn next to consider an interior policy equilibrium and then consider the case of free riding.

4.4. Case 1: Interior Solutions

When equation (11) holds as an equality for both nations, the equation defines the proactive reaction function of nation *j* as

(12a) $$m^j = \rho^j\left(m^i\right),\ i \neq j,\ \text{and}\ i, j = A, B.$$

Following the method outlined in the appendix, we find that the slope of this reaction function is negative if and only if $\Omega^j_{m^j m^i} > 0$, where differentiating equation (11) and noting that $l^j_m < 0$ gives

16. We assume that the diminishing returns in proaction are sufficiently strong to ensure that the SOC for a minimum is satisfied.

(12b) $$\Omega^j_{m^j m^i}\left(m^A, m^B\right) = \bar{\gamma}^j \frac{\partial\left\{f^{j\prime}\left[l^j(m)\right]l^j_m(m)\right\}}{\partial m} = -\bar{\gamma}^j \frac{\partial\left|f^{j\prime}\left[l^j(m)\right]l^j_m(m)\right|}{\partial m}.$$

Based on equation (11), the term $\bar{\gamma}^j\left|f^{j\prime}\left[l^j(m)\right]l^j_m(m)\right|$ reflects nation *j*'s marginal proactive benefit. We assume that diminishing returns to proaction, $L''(m) > 0$, are sufficiently strong to ensure that this marginal benefit curve is downward sloping with respect to m, which implies that the derivative in the last term in equation (12b) is strictly negative. Thus, $\Omega^j_{m^j m^i} > 0$ establishes that the two nations' proactive reaction functions are negatively sloped at a Nash equilibrium so that each targeted nation's proactive measures are substitutable to some extent, which promotes free riding and underprovision (Bandyopadhyay and Sandler, 2011; Sandler and Lapan, 1988).

4.5. Case 2: Corner Solution and Free Riding

Assume that the cost functions for proactive measures are $c^j(m^j) = cm^j$, where $c > 0$ is a constant. Without loss of generality, assume that nation *A* has an interior solution such that, using equation (11), we get

(13a) $$\bar{\gamma}^A f^{A\prime}\left[l^A(m)\right]l^A_m(m) + c = 0.$$

Now suppose that nation *B* has a smaller marginal proactive benefit than that of nation *A* such that $\left|\bar{\gamma}^B f^{B\prime}\left[l^B(m)\right]l^B_m(m)\right| < \left|\bar{\gamma}^A f^{A\prime}\left[l^A(m)\right]l^A_m(m)\right|$. Given $l^j_m < 0$, we have

(13b) $$\bar{\gamma}^B f^{B\prime}\left[l^B(m)\right]l^B_m(m) + c > \bar{\gamma}^A f^{A\prime}\left[l^A(m)\right]l^A_m(m) + c = 0.$$

Equations (13b) and (11) indicate that *B* provides no proactive measures in response to *A*'s proactive provision, which is the classic free-riding corner solution case often characterizing pure public goods provision. The free-riding equilibrium can be visualized by using a reaction function diagram (not drawn). Let us measure m^A and m^B on the horizontal and vertical axes, respectively. Notice that for given $\bar{\gamma}^A$ and *c*, equation (13a) implicitly defines $m = \bar{m}^A$, which is the aggregate desired proactive effort of nation *A* when it contributes nonzero effort. Using $m = m^A + m^B$, we get nation *A*'s reaction function as $m^A = \bar{m}^A - m^B$ when $0 \le m^B \le \bar{m}^A$. If $m^B > \bar{m}^A$, then *A*'s FOC is a strict inequality yielding a corner solution of $m^A = 0$. Thus, *A*'s proactive reaction function is a negatively sloped 45-degree line in (m^A, m^B) space until the vertical intercept at $m^B = \bar{m}^A$, at which point *A*'s reaction path coincides with the vertical axis.

Now consider *B*'s FOC as a strict equality such that $\bar{\gamma}^B f^{B\prime}\left[l^B(m)\right]l^B_m(m) + c = 0$, which implicitly defines $m = \bar{m}^B$. Following steps similar to those above, we get *B*'s proactive reaction function as $m^B = \bar{m}^B - m^A$ if $m^A \le \bar{m}^B$ and get $m^B = 0$ if $m^A > \bar{m}^B$. Thus, *B*'s reaction function is also a negatively sloped 45-degree line until the horizontal intercept at $m^A = \bar{m}^B$, at which point *B*'s reaction path coincides with the horizontal axis. Now, $\bar{m}^A > \bar{m}^B$ because the two nations have identical marginal costs, but *A* has a higher marginal benefit from proaction. This means that the negatively sloped part of *A*'s proactive reaction path is parallel to, and lies to the right of, the negatively sloped part of *B*'s proactive reaction path. Thus, no interior Nash equilibrium ($m^A > 0$, $m^B > 0$) exists for the proactive policy problem. Turning to possible corner solutions, we find that the proactive reaction paths intersect at the point ($m^A = \bar{m}^A$, $m^B = 0$), which is the unique free-riding Nash proactive equilibrium, where *A* provides all of the proactive effort while *B* free rides on *A*'s effort.

Cases 1 and 2 highlight the public good aspects of proactive countermeasures in two ways. First, greater proaction by the other nation confers a positive spillover in terms of terror reduction in the home nation equal to $\left|\bar{\gamma}^{j} f^{j\prime}\left[l^{j}(\cdot)\right] l_{m}^{j}(\cdot)\right|$. Second, at a higher provision level by the other nation, the marginal benefit of the home nation's proaction declines, which reduces the home nation's incentive to provide proactive measures. Therefore, the proactive reaction paths are negatively sloped at a Nash equilibrium, which results in an underprovision of the proactive response. This strategic substitutability takes an extreme form in the free-riding case discussed in case 2, where only one nation provides proactive effort at a Nash equilibrium. As with defensive actions, proactive response results in a negative trade-off owing to the substitutability of response among commonly targeted nations.

5. SOME APPLICATIONS OF THE CANONICAL MODEL OF COUNTERTERRORISM

This section discusses several important counterterrorism policy articles whose central results may, in some instances, be interpreted through suitable alterations and extensions of the canonical model. To avoid further technicalities, we present a verbal discussion. We start with articles whose primary focus is deterrence of terrorism through defensive and proactive measures. Although counterterrorism is our primary focus, some articles involve related counterterrorism benefits such as enhancing the solidity of an existing regime.

Bandyopadhyay and Sandler (2011) consider a transnational terrorist group that targets two nations. Proactive measures chosen by targeted governments in the first stage of a two-stage game reduce the terrorist group's ability to create terror, conferring benefits to both at-risk nations. However, defensive measures chosen by either nation in stage 2 divert some terror attacks to the other targeted nation. Although the terrorist group is assumed to be passive, the negative externalities of defense and the positive spillovers of proactive measures are consistent with our canonical model. As anticipated earlier, one nation free rides on another's proactive efforts when their respective proaction marginal costs are constant. The novelty of their study lies in the identification of the sole provider of proactive efforts on the basis of international comparisons of both proactive and defensive marginal costs. For example, a nation could be less efficient than the other nation in providing proactive effort but yet be the sole provider of such actions if it is even less efficient in defensive measures. This insight accords with the pattern of specialization in Ricardian models of trade where relative efficiency is what determines the pattern of comparative advantage. The authors show that the central result is unaltered in the presence of targeted nations' foreign interests, terrorists' target preferences, or reversal of stages when proaction is chosen in stage 2 of the game.

A similar exercise is developed independently by Cárceles-Poveda and Tauman (2011) in which proaction is chosen in stage 1 and defense in stage 2. As in our model, terrorist resources are depleted by proactive effort. However, Cárceles-Poveda and Tauman assume that the terrorist group also moves in stage 2 such that targeted governments' defensive policy and the terrorist group's effort are simultaneously chosen. Also, unlike Bandyopadhyay and Sandler (2011), Cárceles-Poveda and Tauman allow for multiple targeted countries that can potentially benefit in political/economic dimensions through cooperation in proactive counterterror provision. A major contribution of their work is to characterize the endogenous determination of a coalition of nations that cooperates in providing proactive measures while the remaining nations free ride on the coalition's efforts. The free riding results in a negative externality as the level of offensive action is reduced.

In a defensive policy investigation, Bier, Oliveros, and Samuelson (2007) develop a two-agent defender(s)-attacker model in which the attacker (i.e., a terrorist group) chooses to hit only one of two potential targeted locations. The defender affects the success probability of an attack at any given location with a suitable allocation of defensive measures. The attacker, who observes defense allocations, then decides on the location to hit. While the defender does not know which location will be attacked, it anticipates the optimal behavior of the attacker in response to its defense choices. An increase in defense at one location raises the probability of an attack (distinct from the probability of success) at the other location. If a location has little value for the defender, it is apt to leave that location less or even unguarded. This type of defense choice, which shifts the attack probability between locations, is analogous to the terror transference externalities (trade-offs) of our canonical model. Accordingly, the authors find that a centralized defender who internalizes the negative externalities of defending a particular location chooses lower defense levels compared with decentralized defenders who engage in a defense "arms" race. Moreover, they show that defensive efforts should be made public so that terrorists are guided to lower-valued targets, which is a clever response to counterterrorism trade-offs.

In an interesting exercise, de Oliveira, Faria, and Silva (2018) offer a three-targeted nation model where the terrorist organization attacks after observing the nations' counterterrorism choices (defensive or proactive). The nations may choose policies noncooperatively or cooperatively or by forming a two-nation coalition. Distinct from our canonical model, the authors use parametric representations of the international externalities associated with a nation's choice of counterterror policy. Among other findings in line with the existing literature, they show that the size and sign of externalities are critical in ascertaining the incidence of terrorism in a counterterrorism equilibrium. They also analyze how the size of the externalities affects coalitional stability. Again, our basic message comes through that trade-offs exist with any form of counterterrorism policies.

In the political economy literature, efficiency problems often arise when a government's objectives differ from its constituents' objectives (e.g., Bandyopadhyay and Sandler, 2023). In a similar vein, Bueno de Mesquita (2007) explores how a government, which has a payoff from diverting part of the counterterror budget to other uses, interacts with its voters. There is a nonobservable part of the counterterror budget whose role in fighting terror is similar to proactive measures of our model. In a political equilibrium, the voters' reelection rule incentivizes the government to overspend on *publicly observable* counterterror measures at the cost of the nonobservable actions. In this context, the moral hazard problem is manifested as an inefficient mix of counterterror policies. Once again, counterterrorism implies efficiency trade-offs.

In a novel exercise, Rosendorff and Sandler (2004) consider backlash to counterterrorism policies, which our canonical model currently does not address but could with a small adjustment by allowing proactive measures to have a negative side effect. These authors point out that aggressive proactive policies can increase sympathy for terrorists and swell their ranks through recruitment, constituting a clear negative trade-off of proactive measures. Rosendorff and Sandler assume that the government moves first and chooses its proactive effort, while terrorists move second and choose either a "normal" or a "spectacular" attack. A government trying to deter spectacular attacks may inadvertently encourage them through aggressive proactive measures, while a government that recognizes this unintended recruitment effect from overzealous proaction will moderate such efforts. Additionally, when a government, such as the United States, takes a strong proactive response, it might provoke attacks on its foreign interests with attending collateral damage in the foreign venue nation. To the extent that foreign collateral damage is not internalized in a nation's policy choice, proaction may be excessive from a global efficiency perspective. Jacobson and Kaplan (2007) also consider backlash effects within the context of a two-period model where government "hits" on terrorist resources in period 1 (similar to proactive effort of our canonical model) reduce attacks in that period but improve terrorist recruitment for subsequent attacks in period 2. A rational government may then willingly endure a greater terror-related loss in period 1 by moderating hits because that moderation might constrain recruitment and, in turn, limit terrorism in the ensuing period. In their analysis, they identify a clear intertemporal trade-off of counterterrorism.

Counterterrorism policies, besides reducing terror in a nation, may convey other benefits or costs on that nation. Bandyopadhyay, Sandler, and Younas (2020) show that the oversupply of defensive counterterrorism effort may be aggravated by terms-of-trade considerations, where the exporting nation of manufactured goods may raise its demand for defense above the level guided by terrorism considerations alone. This follows because counterterrorism competes for resources with manufacturing, reducing the latter's global supply and raising the relative price of manufactured goods. As a consequence, the exporting nation gains at the expense of the nation importing manufactured goods. The authors' model abides by the sequence of moves of our canonical model but casts counterterrorism policy within the context of a neoclassical trade paradigm with national welfare-maximizing governments.

In a similar vein, Bandyopadhyay and Sandler (2021) analyze the dual benefits of proactive counterterrorism policy in reducing terrorism and bolstering regime solidity. Such solidity benefits stem from intelligence gathered from covert counterterrorism measures, which may improve the existing regime's ability to thwart hostile political opponents. The terrorist group targets the host developing nation and a targeted developed nation, which has no regime solidity concerns. At an interior equilibrium where both nations contribute to the global proactive effort, a stronger preference for regime solidity simply shifts some of the proactive burden to the developing nation without any change in the global proactive effort or in the incidence of terrorism in the two nations. The authors also show that the developed nation has an incentive to transfer some of the proactive response burden to the developing nation through a tax-subsidy policy package.

In a context that differs from our canonical model, Bandyopadhyay and Sandler (2022) examine strategic counterterrorism policy by focusing on a single nation hosting multiple terrorist groups with no scope for causing international externalities through attacks on foreign interests. Each terrorist group cares about both hurting the government through terrorist attacks and maintaining their share of such attacks. The terrorist groups are "selfish" in the sense that they worry more about their share of terror attacks than the aggregate damages inflicted. Among other results, the authors find that the government's defensive measures protecting the common targets of these groups should be complemented by proactive measures that target the larger terrorist group more aggressively.

Last, we discuss optimal counterterrorism policy in the context of foreign aid and immigration policy, respectively. Bandyopadhyay, Sandler, and Younas (2011) investigate a situation where a developed nation sustains terrorist attacks that come from a developing nation, which is also a victim of terrorism created by its resident terrorist group. Foreign aid given by the developed nation in stage 1 comes in two forms: targeted aid subsidizing the developing nation's proactive efforts and general aid supporting the recipient nation's development. Targeted aid spurs the developing nation's proactive effort in stage 2 and, under regime continuity, reduces terrorism. However, that aid angers some of that recipient's citizenry, who perceive their government as acting as an agent of the developed nation to the detriment of national interest. Such sentiments raise the possibility of a hostile regime change, which can fuel more terrorism. The developed nation has a first-mover advantage where the developing nation moves in stage 2 and the terrorists take action in stage 3. Accordingly, the various trade-offs of targeted and developmental aid are reflected in the developed nation's design of an optimal foreign-aid package.

Turning to the interface of immigration and counterterrorism policy, Bandyopadhyay and Sandler (2014) analyze a world where transnational terrorism directed against a developed nation requires skilled labor, while terrorism directed against a host developing nation necessitates unskilled labor. These authors show that it is to the advantage of the developed nation to combine counterterrorism choices with an immigration policy that favors skilled workers. With fewer potential recruits from the skilled worker pool, the terrorist group is forced to scale back attacks on the developed nation.

The game-theoretic literature on counterterrorism is vast and rapidly expanding. By necessity, the discussion here focuses on only a small subset of influential articles.

6. CONCLUSIONS

We study the extant counterterrorism literature with a focus on understanding the interdependence of different nations' proactive and defensive measures in a multination world. Counterterror policies are associated with many intranational and international externalities, thus presenting challenges for efficient allocation of global counterterrorism resources. In a canonical game-theoretic framework, our presentation highlights myriad interactions among allies (e.g., commonly targeted nations) and adversaries (e.g., a terrorist group and targeted nation(s)). Our unifying message is that counterterrorism policies often involve unintended consequences such as the transference of attacks stemming from defensive measures of targeted nations or locations or terrorism backlash arising from overly zealous proactive measures of targeted nations. Backlash is especially disconcerting because it can result in terrorist group recruitment and funding, which heighten the terrorist threat. Even foreign aid given by a targeted developed country to a developing country hosting a terrorist group can jeopardize the aid recipient's regime stability. Once such counterterrorism trade-offs are recognized, policies can be redesigned to ameliorate these negative consequences. For instance, attack transference can be taken into account so as to guide terrorist groups to redirect attacks to less-valued targets. Moreover, proactive measures can be less heavy-handed and combined with some concessionary actions to reward terrorist groups' nonviolent actions. Foreign aid can be reengineered to be less objectionable to the host developed country's constituency.

One important dimension of future work on counterterrorism policy is to consider how different types of related policies—e.g., immigration and tariff policies—may complement or substitute for counterterrorism measures and how one should think about efficiency issues that may arise in the absence of perfect coordination of the different agencies of a government. Better coordination among commonly targeted countries is also needed. Currently, nations are loath to coordinate their security policies, thereby providing an advantage to terrorist groups that can exploit this reluctance. There are also macroeconomic consequences of counterterrorism policies that can be calibrated if targeted nations became more forthright about their counterterrorism expenditures. Without such calibration, commonly at-risk nations cannot truly know what their noncooperation really costs them.

MATHEMATICAL APPENDIX

Differentiating equation (8) and noting from equation (6b) that $l^A_{e^B} > 0$, we have

(A1) $$\Omega^A_{e^A e^B} = \frac{\theta^B \gamma^B \gamma^{A\prime} f^{A\prime} f^{B\prime\prime} l^A_{e^B}}{D} + \gamma^A f^{A\prime} l^A_{e^A e^B} < 0, \text{ if } l^A_{e^A e^B} \le 0,$$

where $D < 0$ from equation (6a). Ignoring third-order derivatives of the $f^j\left(l^j\right)$ function, we can differentiate equation (6a) to give

(A2) $$l^A_{e^A e^B} = l^A_{e^A} l^A_{e^B} \left(\frac{f^{A\prime\prime}}{f^{A\prime}} - \frac{f^{B\prime\prime}}{f^{B\prime}} \right) \le 0 \text{ if and only if } \frac{f^{A\prime\prime}}{f^{A\prime}} \ge \frac{f^{B\prime\prime}}{f^{B\prime}}.$$

Similarly, equation (8) defines B's reaction function and the other relationships corresponding to equations (9a), (9b), (A1), and (A2) as

(A3) $$e^B = R^B\left(e^A\right),$$

(A4) $$\frac{de^B}{de^A} = -\frac{\Omega^B_{e^B e^A}}{\Omega^B_{e^B e^B}} \ge 0 \text{ if and only if } \Omega^B_{e^B e^A} \le 0,$$

(A5) $$\Omega^B_{e^Be^A} = \frac{\theta^A\gamma^A\gamma^{B\prime}f^{B\prime}f^{A\prime\prime}l^B_{e^A}}{D} + \gamma^B f^{B\prime} l^B_{e^Be^A} < 0, \text{ if } l^B_{e^Be^A} \leq 0, \text{ and}$$

(A6) $$l^B_{e^Be^A} = l^B_{e^B} l^B_{e^A}\left(\frac{f^{B\prime\prime}}{f^{B\prime}} - \frac{f^{A\prime\prime}}{f^{A\prime}}\right) \leq 0 \text{ if and only if } \frac{f^{B\prime\prime}}{f^{B\prime}} \geq \frac{f^{A\prime\prime}}{f^{A\prime}}.$$

When nations *A* and *B* are symmetric, we have $\frac{f^{A\prime\prime}}{f^{A\prime}} = \frac{f^{B\prime\prime}}{f^{B\prime}}$ such that equations (A2) and (A6) imply that $l^A_{e^Ae^B} = l^B_{e^Be^A} = 0$. In turn, equations (A1) and (A5) imply that $\Omega^A_{e^Ae^B} = \Omega^B_{e^Be^A} < 0$ so that using equations (9b) and (A4), we have that the defense reaction functions are upward sloping at a symmetric Nash equilibrium. In the asymmetric case, suppose that $\frac{f^{A\prime\prime}}{f^{A\prime}} > \frac{f^{B\prime\prime}}{f^{B\prime}}$, where equations (9b), (A1), and (A2) ensure that *A*'s defensive reaction function is upward sloping. However, now equation (A6) suggests that $l^B_{e^Be^A} > 0$. The latter inequality, together with equations (A4) and (A5), implies that the sign of the slope of *B*'s reaction function is ambiguous. When the nations are not too asymmetric in the sense that the difference between $f^{A\prime\prime}/f^{A\prime}$ and $f^{B\prime\prime}/f^{B\prime}$ is small, *B*'s defensive reaction function will also be upward sloping.

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