Terrorism and Counter-terrorism:

A Game Theoretic Approach

by

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The research work presented in this thesis is original and has not been submitted elsewhere for a degree or a diploma.

This thesis is dedicated to the loving memory of my grandfather Late Shri Hari Narayan Bhan, and to the brave warriors of the Indian Army's Rashtriya Rifles in the forefront of India's counterterrorism effort, *always and every time*.

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Contents

Chapter 1

Chapter 1: Introduction

Microeconomic concepts are often applied to analyze the phenomenon of terrorism, and game-theoretic frameworks are commonly applied throughout the existing literature. This is unsurprising, since real-world scenarios involving strategic interactions are best formulated using game theory because such formulations not only provide deep insights into the web of incentives and disincentives within which each player operates and consequent predictive paradigms, but also enable the creation of policy architectures based on anticipation of players' actions and/or alteration of players' incentives/disincentives to encourage/discourage certain behavioural outcomes. This thesis also applies game-theoretic frameworks to analyze some issues within the domain of terrorism and CT.

1.1 Motivation and Approach

Terrorism is a menacing problem affecting large parts of the world. Terror events such as those of September 11, 2001 (United States), December 13, 2001 (New Delhi, India), October 12, 2002 (Bali, Indonesia), October 23, 2002 (Moscow, Russia), March 11, 2004 (Madrid, Spain), July 7, 2005 (London, United Kingdom), July 11, 2006 (Mumbai, India), November 26, 2008 (Mumbai, India), May 22, 2013 (London, United Kingdom), July 27, 2015 (Gurdaspur, India), January 2-5, 2016 (Pathankot, India), September 18, 2016 (Uri, India), February 14, 2019 (Pulwama, India) amongst many others; illustrate the magnitude of the threat posed by terror outfits such as al Qaeda, Lashkar-e-Taiba, Jaish-e-Mohammad, Jemaah Islamiyah, etc. Terrorists operate both within and across borders, attempting to leave a trail of death and destruction, in order to create fear among people. Given the extent of suffering caused by these actors on the global stage, it is the endeavor of policy-makers and governments all over the world, to restrict terrorism. And for this purpose, they need to choose suitable counter-terrorism (CT) policies given their financial and operational constraints.

CT measures are broadly classified as defensive measures, offensive measures and confidence-building measures (CBMs). *Defensive CT measures* include *hardening* of potential targets[1], deployment of governmental intelligence agencies against the outfit on a priority basis, covert tactical operations aimed at disrupting the operational capabilities of the terrorists and their handlers, etc. The construction of a double-row concertina wire fence about 700 meters from the Line of Control (LoC) separating the Indian State of Jammu and Kashmir from Pakistan Occupied Kashmir (POK), called the Anti-Infiltration Obstacle System (AIOS), by the Indian Army during 2003 to 2005, is an example of such efforts. Such CT efforts attempt to reduce terror strikes by rapidly increasing the terrorists' (ex-post) operational inefficiency.

The targeted country's government may alternatively take the more *offensive* approach of imposing financial and other sanctions, or even conducting strategic pre-emptive strikes to destroy the assets of terror outfits.[2] A case in point is that of American airstrikes conducted in 2001 in the aftermath of the 9/11 attacks, to topple the Taliban regime in Afghanistan through massive destruction of its resources and elimination of its leadership. Such measures are mostly strategic in scope, as opposed to the tactical nature of most defensive measures.

The government may also adopt the softer approach of winning the *hearts and minds* of the alienated population living in a terror-affected geographical area, in order to reduce support for the terror outfit(s) operating in that area and/or to reduce the outfit's motivation to maintain a

[1] That is, by increasing the security levels of potential targets or enhancing surveillance, etc., thereby rendering these targets more difficult or costly for a terror outfit to attack.
[2] On the other hand, localized or tactical pre-emptive actions do not usually create any major dent in the resources available with terror outfits, and fall under the category of the afore-discussed defensive CT measures.

very high level of terror activity. To this end, so-called *confidence-building measures* (CBMs) may be undertaken. In January, 2007, for instance, President Arroyo of the Phillippines credited the success in countering Abu Sayyaf partly to larger developmental initiatives involving trade and investment, targeted at increasing the security sphere while inhibiting that of "*terror and transnational crime*".

In reality, a government's CT strategy may involve a combination of different types of CT measures. For instance, governments often embark on and/or maintain "*back-channel*" negotiations with certain terror outfits, even as operations against those outfits continue on the ground. Moreover, the CT measures (as well as the CT strategy as a whole) chosen by the government to target an outfit may evolve over time, driven by changes in the outfit's nature. For example, an outfit that previously was not resource-constrained, may begin to suffer from paucity of resources over a period of time due to a decline in its operational efficiency. This change would necessitate a corresponding evolution of the CT strategy employed against that outfit.

Microeconomic concepts are often applied to analyze the phenomenon of terrorism, and game-theoretic frameworks are commonly applied throughout the existing literature. This is unsurprising, since real-world scenarios involving strategic interactions are best formulated using game theory because such formulations not only provide deep insights into the web of incentives and disincentives within which each player operates and consequent predictive paradigms, but also enable the creation of policy architectures based on anticipation of players' actions and/or alteration of players' incentives/disincentives to encourage/discourage certain behavioural outcomes. This thesis also applies game-theoretic frameworks to analyze some issues within the domain of terrorism and CT, which have either hardly been addressed in the existing literature, or have not been adequately formalized to obtain sufficiently deep insights into the problem. The analyses will help arrive at some interesting inferences.

1.2 Thesis Plan and Findings

The important issues addressed in this thesis relate to operational externalities, terror finance, terrorist intergroup cooperation, and countering terror cells. The thesis is structured as follows: The next chapter (Chapter 2) provides a review of literature on terrorism and CT, as well as on related topics which have an important bearing on this field of inquiry. Chapter 3 addresses the CT implications of operational externalities imposed by terror outfits on each other. Chapter 4 investigates the role of external sponsorship of terror outfits in increasing terror activity, while Chapter 5 analyses the ramifications of terrorist intergroup cooperation on terror activity. Chapter 6 provides some insights pertaining to tactical CT effort directed against a terror cell, and Chapter 7 provides some concluding remarks. All citations in the thesis are provided in the reference list.

Chapter 2 first discusses the early literature on terrorism and CT, and subsequently focuses on more contemporary (twenty-first century) literature addressing the respective areas of CT policy (including CT strategy, co-ordination issues, delegation of decision-making/policy, CT resource-allocation and the secrecy accompanying it, etc.), transnational terrorism and terror finance, cooperation between terror outfits, and other important contributions and related literature with major applications in the field of terrorism and CT. The review demonstrates that while the literature on terrorism has expanded at a very rapid pace over the last two decades, there still remain important questions regarding the circumstances under which radicalization causes terrorism, the application of terrorism as a means of waging proxy war, the effectiveness of international sanctions on regimes engaged in terrorist acts or their funding, the role of multilateral organizations in creating CT policy frameworks and their effectiveness compared to bilateral arrangements, etc.

Chapter 3 presents a structure involving two independent terror outfits operating in a country, to study possible implications for CT strategy in the presence and absence of operational externalities. *Inter alia*, the analysis suggests a possible explanation for the widespread application of defensive CT measures and the sparing use of offensive CT. CBMs are found to be ineffective against resource-constrained outfits, irrespective of the nature and magnitude of externalities.

Chapter 4 not only supports the findings of the previous chapter, both in the presence and absence of external terror finance, but also illustrates the potential of external sponsorship to incentivize increased terrorism by inducing strategic interaction between terror outfits. Curtailing external sponsorship, if present, is always effective in inhibiting terror activity. In fact, targeting external funding may be the most effective CT tool if terror activity is sufficiently low. Also, CBMs may not be as effective in the presence of external sponsorship, as in its absence.

Chapter 5 models terrorist intergroup strategic cooperation in a manner which reveals that the cooperating terror outfits may conduct more, less or the same number of attacks as in the absence of cooperation; based on whether they are resource-constrained or not *a priori*; and on the extent to which cooperation can serve to ease such a constraint through inter-outfit resource-transfer. It is demonstrated that while cooperation can neutralize the impact of strategic external sponsorship on terror activity and thereby remove the incentive for its provision, there are circumstances external sponsorship can enhance terror activity. In the analysis, cost-convexity in conducting attacks has been exploited to explain many results.

Chapter 6 provides insights regarding the suitability of offensive versus defensive measures in countering a terror cell. This issue has hardly been addressed in the literature. It is shown that the optimal resource allocation is more offensive when the cell is aware of which targets have been protected, but does not distinguish between the values of different targets; than the case where it neither distinguishes between target values nor is the protection conspicuous. Also, the ability of the terror cell to inflict damage is least when it neither distinguishes between target values nor is the target protection conspicuous, and most when it shares the counter-terrorists' target valuations and observes target protection.

1.3 Policy Relevance

The findings of this thesis lead to some salient CT policy implications. The research supports widespread application of defensive CT, combined with judicious application of CBMs and offensive CT. In particular, CBMs are shown to be ineffective against resource-constrained terror outfits, whereas offensive measures can be effectively used against such outfits unless the terror activities of the outfits impose strong enough negative operational externalities on those of other outfits. Most interestingly, the phenomenon of terrorist backlash can render offensive CT effective even against resource-abundant outfits, in the presence of sufficiently strong negative externalities.

Underscoring the limited applicability of CBMs, the present body of research demonstrates that governmental efforts at outreach via CBMs may not be as effective in the presence of external terror sponsorship, as in its absence. In fact, if defensive CT is more effective than CBMs in the absence of external funding, then it must be more effective even in its presence. Also, curtailing external sponsorship, if present, is always effective in reducing terror activity.

Further, the thesis demonstrates that inter-outfit strategic cooperation can serve to increase terror attacks under certain circumstances, while serving to inhibit terror activity under other situations. An example of the former is when a resource-constrained outfit cooperates with a resource-abundant outfit having sufficiently large resources, in the absence of external funding. On the other hand, multiple situations have been discussed where external sponsorship can be offered strategically to enhance terror activity by inhibiting inter-group cooperation. Hence, CT efforts targeted at disrupting cooperation under the former set of circumstances, while those aimed at curbing the leverage of the external sponsor over the terrorists by encouraging intergroup cooperation under the latter, would serve to decrease terror attacks. Therefore, a *one-size-fits-all* CT architecture is undesirable, and the existing CT policy framework must be reviewed in view of the implications of strategic cooperation between terror outfits.

In the context of tactical CT directed against a terror cell, there appears to be a rationale for suppressing target information from the terror cell, by making target protection wholly or partially inconspicuous for example. The deployment of inconspicuous target protection measures such as hidden cameras can serve the dual purpose of not only preventing the deflection of terror attacks to more vulnerable targets, but catching the terrorists ill-prepared by drawing them into a well-monitored and well-defended space. Also, if better intelligence for CT is available in respect of possible hideouts, then pre-emptive strikes become more attractive compared to target protection. Finally and most interestingly, it is shown that a more offensive CT resource allocation may be optimal if CT preferences over potential targets diverge from those of the terror cell.

Chapter 2

Chapter 2: Literature Review

For a field of study which gained prominence less than two decades ago, the literature on terrorism has expanded at a very rapid pace. This has greatly contributed to the global understanding of this phenomenon, and provided salient policy insights on how to combat it. However, it would be incorrect to assume that this understanding is complete. There still remain important questions regarding the circumstances under which radicalization causes terrorism, the application of terrorism as a means of waging proxy war, the effectiveness of international sanctions on regimes engaged in terrorist acts or their funding, the role of multilateral organizations in creating CT policy frameworks and their effectiveness compared to bilateral arrangements, etc.

2.1 Overview

Depending on which account one chooses to lend credence to, the menace of terrorism may have originated in the 19th century with the Fenian Brotherhood and the Narodnaya Volya, the 11th century with the Al-Hashshashin, or even as early as the 1st century CE with the insurrection of the Jewish Zealots. It is therefore most surprising that the bulk of the structured analysis of terrorism is fairly recent.

Albeit scant, there is a body of work which addresses some of the early instances of terrorism (Rapoport 1984, Zarakol 2011). It remains true however that the overall literature on terrorism and counter-terrorism (CT) has mushroomed especially after the terror attacks targeting the United States homeland on 11 September 2001, and it barely caters to the early history and evolution of terrorism in general, and religious fundamentalism driven terrorism in particular.

Notable works addressing religion and fundamentalism, and their linkages with terrorism include Gilling (1992), Pratt (2006) and Tibi (2002). Also, there is related literature on contests developed over decades, which finds widespread application in the field of terrorism and CT (Choi et al. 2016, Chowdhury and Sheremeta 2011, Dixit 1987).

Although the overwhelming literature is less than two decades old, there are a few pioneering contributions that were made by researchers such as Walter Enders and Todd Sandler, prior to the turn of the millennium. These include analyses of transnational terrorism (Sandler et al. 1983, Enders and Sandler 1999) and the effectiveness of anti-terrorism policies (Enders and Sandler 1993). Other notable works during that period include an interview of Kozo Okamoto, a former Japanese communist terrorist (Steinhoff 1976), and a detailed account of the evolution of terrorism in Western Europe and the policy response since the late 1960s (Chalk 1996).

Despite the substantial increase in the volume of literature since the turn of the millennium, a disproportionate fraction of analyses continued to focus on transnational terrorism, terror finance, and CT policy. Notable empirical contributions have attempted to identify or forecast the evolving trends and patterns associated with transnational terrorism (Braithwaite and Li 2007; Enders and Sandler 2005a, 2005b), while others have tried to explore the linkages between transnational terrorism and income class and geography (Enders and Sandler 2006), youth unemployment (Bagchi and Paul 2018), press freedom and publicity (Hoffman et al. 2013), economic globalization (Li and Schaub 2004), democracy (Li 2005), state failure (Piazza 2008), human rights (Piazza and Walsh 2009), etc. Then there are data-driven analyses which have tried to estimate the impact of transnational terrorism on foreign direct investment (FDI) in the United States (Enders et al. 2006), and to derive policy insights in the fight against transnational terror by applying economic methods (Sandler and Enders 2004).

Unlike that addressing transnational terrorism, a very small fraction of the literature on terror finance is empirical. Carter (2012) for instance, which investigates the relation between state sponsorship of a terror outfit and its longevity, is a notable exception. The paucity of such research is understandable, given the limited availability of data on the funds raised by terror outfits from various sources.

While there are books which focus on the dynamics of terror finance and the associated CT implications (Acharya 2009), others provide detailed accounts of state sponsorship of terrorism (Byman 2005). Then there are works which apply such conceptual frameworks to arrive at policy insights, with particular emphasis on the ground realities of the Indian subcontinent (Chadha 2015). In addition to these, there are notable articles and research papers addressing this area.

Levitt (2002) evaluates the evidence of Syrian state support to terror outfits such as the Islamic Jihad, thereby contextualizing American foreign policy in Syria. Myers (2005) argues that targeting terror finance is not sufficient to eliminate terrorism, while the motivation to commit terrorist violence is present. Siqueira and Sandler (2006), on the other hand, demonstrate that state sponsorship can enhance terrorist violence. Then there are works which evaluate the conditions under which state sponsorship of terrorism is likely to occur (Byman and Kreps 2010), and those which assess the possibility of an international anti-terror finance apparatus (Clunan 2007).

Similarly, the bulk of the literature addressing various aspects of CT policy is non-empirical, barring the exception of some frontier research such as in Perliger and Milton (2018). Many of these utilize game-theoretic frameworks to evaluate the suitability of defensive versus preemptive CT measures, and the associated international coordination problem in the provision of CT effort and its mitigation (Arce and Sandler 2005; Bandyopadhyay et al. 2020; Bandyopadhyay and Sandler 2011; Das and Roy Chowdhury 2014; Das and Lahiri 2006, 2019; Faria et al. 2013; Mesquita 2005a, 2005b; Sandler 2003, 2005; Sandler and Siqueira 2006; Lee 2010). Those analyses also involving the issue of delegation of decision-making or policy include Siqueira and Sandler (2007, 2008, 2010).

Also a critical aspect of any counter-terrorist's arithmetic, is the allocation of scarce CT resources and the maintenance of secrecy around the same. While the pioneering work of Bier et al. (2007) demonstrates conditions in which the defender prefers her allocation to be public, the bulk of the research rationalizes secrecy in defensive allocation (Dighe et al. 2009; Zhuang and Bier 2010, 2011; Zhuang et al. 2010).

Another area of research, which has gained traction over the past decade, is on cooperation between terror outfits. Alliances between terrorist groups however, are an exception rather than the rule, given that less than one percent (417 to be exact) of the 81,799 terror attacks conducted during 1970-2007 involved more than one terror outfit (Asal et al. 2016). This may be due to the inability of terror outfits, which are illegal organizations, to credibly overcome commitment issues in the absence of third-party enforcement (Bacon 2017).

In fact, a prominent reason proposed in the literature for inter-outfit cooperation, is the resultant enhancement of outfit longevity (Phillips 2014). Further, the abilities of terror outfits to address each other's organizational voids, forge a common discernibility and cultivate mutual trust are ubiquitous prerequisites for intergroup alliances (Bacon 2018a). The notion that alliances are a measure of vulnerability, however, is not empirically validated (Phillips 2019).

Other notable contributions on terrorist intergroup cooperation elucidate the vulnerabilities created by the merger of the Somali terrorist group al-Shabaab with the al Qaeda

(Thomas 2013), discuss the significant variation observed in the scope and depth of cooperation between terror outfits (Moghadam 2015), analyze the evolution of the symbiotic relationship between the al Qaeda and the Taliban spanning over two decades (Bacon 2018b), study the consequences of the training of Jemaah Islamiyah operatives by the al Qaeda (Horowitz and Potter 2014) and Boko Haram terrorists by al Qaeda in the Islamic Maghreb (AQIM) operatives (Aronson 2014), and identify the conditions which favour asymmetric alliances rather than bilateral cooperation (Bapat and Bond 2012).

While section 2.2 below, discusses the early literature on terrorism and CT, sections 2.3 through 2.6 focus on more contemporary (twenty-first century) literature addressing the respective areas of CT policy (including CT strategy, co-ordination issues, delegation of decision-making/policy, CT resource-allocation and the secrecy accompanying it, etc.), transnational terrorism and terror finance, cooperation between terror outfits, and other important contributions and related literature with major applications in the field of terrorism and CT. Section 2.7 concludes the chapter with summarizing comments.

2.2 Early Literature

The early literature in the field of terrorism and CT, as well as the literature on related topics finding application in this field, although limited, address fairly diverse areas. These range from contest strategy, fundamentalism (Gilling 1992), and the history of terrorism; to transnational terrorism and anti-terrorism policies. Some of the noteworthy contributions are discussed below.

Dixit (1987) shows how the favourite and underdog in a contest with effort pre-commitments, over-invest and under-invest effort directed at winning the contest respectively, relative to the Nash equilibrium without commitment. With symmetric players on the other hand, the paper finds no divergence in effort invested, relative to the Nash equilibrium without commitment. These results not only find application in sports, oligopoly and rent-seeking; as mentioned in the paper; but also in the field of terrorism and CT (see Chapter 4).

Enders and Sandler (1999) find a decline in transnational terrorism in the years following the end of the Cold War between the Soviet Union and the United States, compared to the Cold War era. The data spanning 1970 through mid-1996, shows a marked decline in bombings and hostage-taking episodes. A possible explanation, proposed by the authors for the observed reduction in terrorism, is the fall in state sponsorship of terror outfits which was widespread during the Cold War period.

Steinhoff (1976) is based on the interview of a former Japanese Red Army terrorist named Kozo Okamoto, the sole surviving attacker involved in the suicide attack on Lod Airport in Tel Aviv, Israel, in 1972. The work explores the motivation behind the Red Army's violent campaign. Okamoto justifies the violence on the grounds that "*the revolution is not fought in the name of any specific values*", and that the only "*focus is on the immediate need to overthrow the existing order by violence, not on the kind of society that should follow*".

Rapoport (1984) provides the first comparative analysis of terrorism in three different religious traditions – Thugs (Hinduism), Assassins (Islam) and the Zealots-Sicarii (Judaism) – and argues that these radical movements proved to be more enduring and dangerous than any of their contemporary secular counterparts. In doing so, the author provides a critique of analyses which claim that terrorism, although an age-old phenomenon, has achieved "*novel dimensions*" (Sandler et al. 1983) only in the recent past. The paper also draws important distinctions between religious and secular terror campaigns.

Enders and Sandler (1993) apply vector autoregression and intervention analysis on quarterly data spanning 1968 to 1988, to evaluate the effectiveness of different CT measures. An important observation was the substitution effect of policy, between certain modes of terror attacks such as skyjackings and hostage-taking incidents. Also, certain overseas retaliatory measures undertaken by the United States, in response to terror strikes, were found to have no lasting impact. Similarly, Chalk (1996) examines the evolution of terrorism in West Europe, and attempts to identify major trends. The author also provides a detailed analysis of the efficacy of different homeland security policies adopted by the member countries of the European Union (EU).

2.3 CT Policy: Strategy, Co-ordination, Delegation and Resource-allocation

There are notable works which try to derive CT policy insights by modeling the interaction between a targeted country's government and former terrorists. Mesquita (2005a), for instance, applies a repeated game-theoretic model to rationalize the increase in terrorist violence which often follows governmental concessions to terror outfits. The paper proposes that an increase in violence may follow if the moderate terrorists accept the concessions, and thereby leave the extremists in control. On the other hand, cooperation with the former terrorists may enhance the government's CT capabilities. Hence, the government must choose the timing and level of concessions offered to the terrorists keeping in mind the mentioned tradeoff. Mesquita (2005b), on the other hand, introduces uncertainty from the government's perspective, in terms of the capability of former terrorists to assist in CT endeavors. Also introduced in the structure, is the choice of the government to replace the former terrorists it is negotiating with, with a new negotiating partner. Given these, the author utilizes a two-period game-theoretic model to demonstrate that the threat of replacement as negotiating partner serves as a potent incentive for the former terrorists to exert CT effort.

Then there are works which dwell on issues relating to international cooperation in the provision of CT effort when faced with a common transnational terrorist threat, and the consequent proclivity of countries to oversupply certain types of CT measures while undersupplying others. While Sandler (2003) applies economic methods of analysis to show how well-networked transnational terrorists can exploit the lack of co-ordination between countries for conducting terror strikes; Arce and Sandler (2005) establish the prevalence of deterrence over preemption in the CT effort provided by countries, which leads to an equilibrium with inferior payoffs compared to that obtained under joint preemption.

Sandler (2005) models the collective action problem faced by countries when faced by a common transnational terrorist threat, and contrasts it with the absence of such a co-ordination problem in the context of domestic terrorism. The paper, therefore, argues that while resolute action is hard to achieve in the former scenario, such action is more straight-forward to achieve in the latter. Along similar lines, Sandler and Siqueira (2006) demonstrate that leader-follower behavior partially mitigates the oversupply of deterrence, while worsening the undersupply of preemption, compared to simultaneous-move equilibrium. However, these inefficiencies can never be completely eliminated through leadership.

There is some literature, however, which challenges the conventional wisdom of defensive and offensive measures being over-supplied and under-supplied, respectively. Lee (2010), for instance, models the repeated interaction between a terror outfit and the government to identify a dynamic inconsistency problem which forces the government to over-invest and under-invest in offence and defence, respectively. The author also demonstrates that the problem may be resolved via delegation to an independent agency. However, even experimental analyses such as Arce et al. (2011) have found evidence in support of defensive and proactive CT measures generating public "*bads*" and "*goods*", respectively.

Bandyopadhyay and Sandler (2011) and Bandhyopadhyay et al. (2020) also address the common-enemy problem of CT. The former analysis uses a two-stage game involving two countries, to identify the potential preemptor. The authors infer that preemption is likely by a country which is a high-cost defender with foreign interests or a prime-target country. Even in such cases, however, the optimal level of preemption will not be achieved because of incomplete internalization of the externalities generated by the country's CT policy. The latter work, on the other hand, infers that trade partners – one a developed country and the other a developing country – exert CT effort in a manner where the former exerts a higher effort while the latter exerts a lower effort in response to terms-of-trade externalities.

More recent literature on co-ordination failures in CT include Das and Roy Chowdhury (2014), who identify conditions under which increased preemption is the "*rational response to an increase in terrorism*"; and Faria et al. (2013), who infer that countries faced by a common-enemy problem with both inter-temporal and spatial dimensions tend to prioritize inter-temporal policy considerations in their CT calculus, and thereby decide whether to co-ordinate with other countries or to be spatially insensitive.

Also deserving a mention, are papers exploring the issue of delegation in the context of CT policy. Addressing the CT impact of domestic politics; Siqueira and Sandler (2007) apply a "*three-stage proactive game involving terrorists, elected policymakers and voters*"; to demonstrate the worsening of the undersupply of proactive CT measures against a common terrorist threat. However, Siqueira and Sandler (2008) demonstrate that such policy delegation by strategic voters to elected policymakers can limit the presumed oversupply of defensive CT measures. It is also possible, however, that a global terrorist outfit may also delegate responsibilities in different theatres to local affiliates. Providing a framework accommodating the possibility of delegation by both global (or general) terrorists as well as their targets, Siqueira and Sandler (2010) demonstrate that "*when both the GTO (general terrorist organization) and the government delegate to surrogates, the delegators are worse off if the government appears to be weak*".

Works which identify shortcomings and opportunities in specific cases of international CT cooperation are also important. According to Sharma (2012), the CT cooperation between the United States and India is suffering from unnecessary bureaucratic red-tape, and is not sufficiently sensitive to each other's core national security interests. In his view, the quality of partnership can be improved by leveraging "*the trust and confidence that they have built in their bilateral relationship*". The author also identifies the need to "*readjust their perspectives on the threat of terrorism" and to "make counterterrorism an important module in their 'strategic partnership' to tackle terrorism at the domestic, regional and global levels*".

Frontier research on CT strategy includes both theoretical and empirical works. An example of the former is Das and Lahiri (2019). This analysis utilizes a three-period game where the terrorists use terror as *a means to an end*, and neither the State nor the terrorists are completely aware of the other's preferences. The authors conclude that it is impossible for the State to triumph in the *war on terror* using preemption alone, if the marginal cost of preemption is rising. On the other hand, Perliger and Milton (2018) provide a data-driven analysis identifying conditions conducive to CT cooperation, in order to conceptualize different ways in which polities cooperate in the execution of CT policies.

Finally, analyses addressing the allocation of scarce CT resources must be discussed with particular emphasis on the aspect of secrecy, before concluding this section on CT policy. The pioneering work in this area is Bier et al. (2007), which allows for a divergence of preferences over targets between the defender and attacker such that the defender does not know the attacker's preferences, while the attacker observes the defender's resource allocation. Under these assumptions, the authors demonstrate that the defender prefers her allocation to be public rather than private. On the other hand, Hausken and Bier (2011) use a game involving two heterogeneous attackers and a single defender, to demonstrate that strategic leadership can be beneficial to a sufficiently strong defender. Further, Shan and Zhuang (2013) demonstrate the robustness and general desirability of defensive allocations based on game-theoretic models over other models, when the attacker may or may not be strategic.

Dighe et al. (2009) model strategic interaction between an attacker and a defender who is either centralized or decentralized, and identifies conditions under which centralization leads to greater cost-effectiveness in defence. The paper further demonstrates that partial secrecy in defence may deter the attacker if the cost of attacking is high. According to the authors, such partial secrecy may for instance be achieved by revealing the aggregate investment in defence while suppressing information about the spatial allocation of defensive assets.

Zhuang et al. (2010) model the strategic interaction between an attacker and a defender using a repeated game in which the defender can truthfully disclose her allocation, keep it private, or deceive the attacker. The attacker is assumed to learn through the defender's signals and periodic contest outcomes. The paper demonstrates that secrecy and deception can provide the most cost-effective means for the defender to achieve security, possibly spanning multiple periods. Similarly, Zhuang and Bier (2010) rationalize the choice of deception and secrecy by a defender, rather than truthful disclosure.

Zhuang and Bier (2011) characterize situations in which the defender is granted the first move. If the defender has private information, then the paper demonstrates that secrecy and deception may be the optimal defensive choice even if truthful disclosure is less costly. The analysis finds application in anti-terrorism as well as business competition.

2.4 Transnational Terrorism and Terror Finance

Post the attacks conducted by al Qaeda, in the United States in September 2001, the mushrooming of analyses of transnational terrorism is not surprising. Braithwaite and Li (2007) employ spatial statistics to identify terrorism hot spots at the disaggregated level, in order to forecast future attacks in countries located within these hot spots. The forecasts are arrived at using the ITERATE (International Terrorism: Attributes of Terrorist Events) database spanning 1975 to 1997, and including 143 countries. They infer that "*when a country is located within a terrorism hot spot neighborhood, it is highly likely to experience a large increase in its number of terrorist attacks in the next period*".

Enders and Sandler (2005a) investigate whether 11 September 2001, the date of al Qaeda's attacks on the United States' homeland, reflected a point of inflection in respect of transnational terrorism. Perhaps surprisingly, they find that when it comes to overall incidents, casualties, bombings, etc., little has changed since that date. However, within the overall incidents, the proportion of complex hostage-taking incidents has fallen while that of simple yet deadly bombings has increased, representing a change in the composition of terrorist events.

Similarly, Enders and Sandler (2005b) demonstrate the desirability of disaggregation of overall incidents, to obtain better forecasts. Moreover, segregation of countries into high-terrorism and low-terrorism regimes is shown to have an important bearing on the persistence levels of certain types of transnational terrorist events.

Enders and Sandler (2006) analyze time series data on transnational terrorism, spanning 1968 to 2003, to check whether there has been a shift in attacks between countries on the basis of income or geography. Contrary to expectations based on casual empiricism, the authors find no evidence of transference of attacks from high-income countries to low-income countries post the culmination of the Cold War, due to a rise in fundamentalism, or in the aftermath of the September 2001 attacks in the United States. There is however, some evidence in favour of such a shift, if focus is limited to events with American casualties. On the other hand, there seems to be evidence supporting a fundamentalism-related regional shift in terrorist incidents from the Western Hemisphere and Africa, to regions with large Islamic populations such as the Middle East and Asia.

Hoffman et al. (2013) discuss why most analyses of the linkages between press freedom and transnational terrorism are unable to find sufficient evidence of the same, despite press freedom being central to terrorism. The authors argue that whereas press attention is more important for transnational terror outfits with a wider and varied target audience, the same may not hold true for domestic terrorists with a narrower audience. Applying zero-inflated negative binomial (ZINB) regression on data on transnational terrorism spanning 1975 to 1995, the paper demonstrates that countries that limit press freedom are less than half as likely to be attacked by foreign terrorists, compared to states without such curbs.

Li and Schaub (2004) find that "*trade, FDI and financial flows of a country have no direct positive effect on the number of transnational terrorist incidents initiated within the country*", while Li (2005) uses a dataset covering 119 countries and the period from 1975 to 1997 to show that "*democratic participation reduces transnational terrorist incidents in a country, while government constraints increase the number of those incidents*". Also, Piazza (2008) establishes that "*states plagued by chronic state failures are statistically more likely to host terrorist groups that commit transnational attacks, have their nationals commit transnational attacks, and are more likely to be targeted by transnational terrorists themselves*", whereas Piazza and Walsh (2009) find an increase in the likelihood of state repression following transnational terrorist events. Then there are data-driven analyses which have tried to estimate the impact of transnational terrorism on foreign direct investment (FDI) in the United States (Enders et al. 2006), and to derive policy insights in the fight against transnational terror by applying economic methods (Sandler and Enders 2004).

Finally, whereas Rosendorff and Sandler (2005) make the general argument that a political economy based approach to the analysis of terrorism may involve many issues touched upon in this chapter including "*the practice of counterterrorism policy, the need for international cooperation, the interface of terrorism and democracy, and the collaboration of former terrorists and the government*", Downer (2004) focuses particularly on the case of Australia and articulates the need for international cooperation in combating transnational terrorism.

Unlike that addressing transnational terrorism, a very small fraction of the literature on terror finance is empirical. Carter (2012) for instance, which investigates the relation between state sponsorship of a terror outfit and its longevity, is a notable exception. The paucity of such research is understandable, given the limited availability of data on the funds raised by terror outfits from various sources.

Acharya (2009) argues that the blame for the failure to curb terrorist financing does not lie with the counter-finance institutions, but rather with countries that lack political will. The book also critically analyzes the role of international agreements and conventions on terror finance, created post the September 2001 attacks in the United States. Byman (2005) discusses specific cases of state-sponsorship of terrorists, covering the experiences of Iran, Pakistan, Afghanistan, Syria, Saudi Arabia and Libya. The book also discusses the histories of transnational terrorist organizations like the al Qaeda, Hizbullah and Hamas. Chadha (2015) discusses the various internal and external sources of terror finance, the patterns and trends observed in respect of such sponsorship, and demonstrational case studies.

Levitt (2002) discusses the overwhelming evidence of Syrian state support to Islamic Jihad, despite its repeated denials. The author also discusses the failure of U.S. foreign policy *carrots* as well as threats, in reigning in the Syrian regime's assistance to the terror outfit, and options available to the United States' policy-makers moving forward. Myers (2005), despite claiming that clamping down on terror finance is not sufficient to eliminate terrorism while the motivation for violence remains, suggests that the United States should focus on building infrastructure to gather financial intelligence - both domestically and abroad. Siqueira and Sandler (2006) model a terror outfit and a government that are competing for grassroots support, and show that the weaker side has an incentive to assume strategic leadership and thereby seize the initiative, to the benefit of both sides. External sponsorship, however, is shown to augment violence irrespective of whether the terror outfit has a committed support base or not.

Byman and Kreps (2010) treat state-sponsorship of terror outfits as a principal-agent issue. The authors argue that the relationship between the principal state and its agent terror group is often fragile and strained, given the trade-off between curbing the risk of exposure and limiting agency losses, faced by the former in deciding how much autonomy to grant the latter. This creates opportunities for counter-terrorists to exploit. On the other hand, Clunan (2007) emphasizes the importance of international cooperation in combating terror finance, and explores the possibility of an international anti-terror finance apparatus.

2.5 Cooperation between Terror Outfits

Just as governments of different countries may coalesce to combat terrorism, terrorist groups may join forces to overwhelm the State machinery. Consider, for instance, the merger in 2012 of the Somali terrorist group al-Shabaab, with the al Qaeda. Thomas (2013) discusses the CT opportunities arising from the vulnerabilities created as a result of this amalgamation because of clan-based Somalian power dynamics, disenchantment of the Somali populace with the brutal tactics and harsh governance regime promoted by the al Shabaab – al Qaeda combine, and disunity within the leadership of al Shabaab.

Alliances between terrorist groups, however, are an exception rather than the rule. Using the Big Allied and Dangerous (BAAD) dataset Version 1.0 or BAAD1, Asal et al., (2016) calculate that less than one percent (417 to be exact) of the 81,799 terror attacks conducted during 1970-2007 involved more than one terror outfit, and that intergroup alliances usually form between outfits "*that share motivation (especially if the potential partners are both Islamic or both ethnonationalist in their motivation), are relatively similar in age, seek to target the same country, are drawn from the same region, and are based in countries with small militaries*".

The observed rarity of intergroup alliances may be due to the inability of terror outfits, which are illegal organizations, to credibly overcome commitment issues in the absence of third-party enforcement (Bacon 2017). Further, Phillips (2019) finds that a significant fraction of outfits does not exist for more than a year, thereby making it difficult for them to reliably pledge to certain behavioral patterns for the long term. In particular, based on eight most extensive global datasets on the longevity of terror outfits, the author obtains that 25-74 percent of outfits do not last beyond a year.

Ackerman et al. (2017) explore the circumstances under which terror outfits with differing ideologies may align operationally, to achieve common goals. In fact, a prominent reason proposed in the literature for inter-outfit cooperation, is the resultant enhancement of outfit longevity. Using data spanning 1987 to 2005, Phillips (2014) shows that terror outfits having one ally are 38 percent less likely to discontinue in a given year, compared to terror outfits without any ally. Further, the abilities of terror outfits to address each other's organizational voids, forge a common discernibility and cultivate mutual trust are ubiquitous prerequisites for intergroup alliances (Bacon 2018a). The notion that alliances are a measure of vulnerability, however, is not empirically validated.[3] On the other hand, Phillips (2019) finds that "*alliances are associated with territorial control, intermediate membership size, and religious motivation*".

In addition to understanding the causes of inter-group terrorist cooperation, it is also important to dwell on the nature of cooperation between terror outfits. Moghadam (2015) observes that significant variation is observed in the scope and depth of cooperation between different terror outfits, from mergers and strategic cooperation at the upper end of the scale, to tactical and transactional cooperation at the lower end. When outfits merge, each outfit sacrifices

[3] See Phillips (2019), for instance.

its individual identity. Under transactional cooperation, at the other end of the spectrum, there is usually no noteworthy loss of independence for either outfit. Hence, the quality of cooperation holds salience for each outfit, and thereby for those seeking to counter them.

Other notable contributions on terrorist intergroup cooperation analyze the evolution of the symbiotic relationship between the al Qaeda and the Taliban spanning over two decades (Bacon 2018b), study the consequences of the training of Jemaah Islamiyah operatives by the al Qaeda (Horowitz and Potter 2014) and Boko Haram terrorists by al Qaeda in the Islamic Maghreb (AQIM) operatives (Aronson 2014), and identify the conditions which favour asymmetric alliances rather than bilateral cooperation (Bapat and Bond 2012).

2.6 Other Important Contributions and Related Literature

In the decade following the September 2001 attacks on the United States, there have been notable contributions dealing with terror network structures and network externalities. Enders and Jindapon (2010) compare alternative network structures of terror outfits – centralized and decentralized – and conclude that because the individual nodes in the latter structure may not make optimal decisions from the group's standpoint, "*the decentralized decision-making process is suboptimal from the overall perspective of the network*". However, with the increased surveillance of the activities of a terror outfit and the purposeful targeting of its leadership, survival may have to be prioritized by the outfit rather than organizational efficiency, thereby forcing it to rely on a decentralized network. Such a trade-off between outfit-safety and intra-outfit correspondence is modeled by Enders and Su (2007), to establish the rationale for the formation of terror cells, which are the smallest units of decentralized networks of terrorists. Such outfits often operate by establishing loosely-linked terror modules, each operating in multiple hubs through a network of largely independent terror cells. Each deployed al Qaeda cell, for example, is required to be financially independent (Medina and Hepner 2008). This minimizes money trails, thereby making the cell harder to detect.

The decade also saw the publication of thought-provoking accounts of fundamentalism and its linkages with terrorism. According to Pratt (2006), "*fundamentalism is both a specifically focused mindset and a certain kind of narrow worldview, a modus operandi, which can apply to just about any sphere of human activity, but especially so to religion and politics, for both are concerned with the context and aims of human existence*". In fact, religious fundamentalism may be described as a generic politicization of religion. Tibi (2002) does not identify religious fundamentalism as a spiritual faith. He describes it as a political doctrine grounded in the politicization of faith "*for sociopolitical and economic goals in the pursuit of establishing a divine order*". He describes this ideology as *exclusive* because it censures contrarian alternatives, mainly *secular* perspectives which counter the connection of religion to politics.

There is also related literature on contests, developed over decades, which finds widespread application in the field of terrorism and CT. Chowdhury and Sheremeta (2011) construct a generalized Tullock contest under complete information, which captures different contests in the preceding literature as special cases obtainable under different parametric specifications. And Choi et al. (2016) analyze the consequences of power dynamics in asymmetric contests characterized by both inter-group as well as intra-group rivalries, in terms of the allocation of effort expended by players in each type of rivalry, given their capabilities.

Other important theoretical works include Arce and Sandler (2007) which discusses terror threat assessment and the need for targeted countries to invest in their intelligence apparatus as an essential part of their CT efforts,[4] and Anderton and Carter (2006) which demonstrates the applicability of microeconomic concepts and principles to the study of terrorism. The latter work utilizes game theory to characterize strategic interdependencies among terrorists and governments. Byman (2017) provides an essay explaining the sources of al Qaeda's decline, Hoffman (2003) establishes the salience of handlers in the planning and execution of suicide terror attacks, Keohane and Zeckhauser (2003) demonstrate the deflection of terror attacks due to defensive/protective measures, and Zarakol (2011) classifies terrorists into nationalists and anarchists by linking terrorism to the evolution of the state.

Notable empirical analyses not included in the discussion above, address the economic impacts of terrorism. Based on the 2005 MIPT Terrorism knowledge database, Barth et al. (2006) find that terrorism adversely impacts overall economic activity. The authors, in particular, show that greater terrorist incidents per million of population is associated with lower real GDP per capita growth and lower capital formation as a percentage of GDP. Similarly, Crain and Crain (2006) find that terrorism has a sizeable impact on economic achievement. Finally, there are country-specific analyses of the economic effects of terrorism which apply techniques such as a geographically weighted regression (GWR). Consider Ocal and Yildirim (2010) for example, which applies GWR on data spanning 1987 to 2001, to obtain different local estimates of parameters and hence observe a significant "*variation in speeds of convergence of provinces, which cannot be captured by the traditional beta convergence analysis*".

Finally, Blomberg et al. (2010) provide an empirical analysis to identify the factors associated with the longevity and survivability of terror outfits. Based on the ITERATE dataset spanning 1968 to 2007, the authors find that younger organizations are likelier to perish, and that

[4] Also see Bagchi and Bandyopadhyay (2018) for similar insights in the specific context of cyber warfare and cyber-terrorism.

"*high-income countries are more likely to sustain attacks than lower-income countries and that current violent actions by terrorist organizations are a strong indicator that the organization will likely operate next period*".

2.7 A Perspective

The bulk of the structured analysis of terrorism is fairly recent. The overall literature on terrorism and CT has mushroomed especially after the terror attacks targeting the United States homeland on 11 September 2001, and it barely caters to the early history and evolution of terrorism in general, and religious fundamentalism driven terrorism in particular.

Despite the substantial increase in the volume of literature since the turn of the millennium, a disproportionate fraction of analyses continued to focus on transnational terrorism, terror finance, and CT policy. Notable empirical contributions have attempted to identify or forecast the evolving trends and patterns associated with transnational terrorism, while others have tried to explore the linkages between transnational terrorism and income class and geography, press freedom and publicity, economic globalization, democracy, state failure, human rights, etc.

Unlike that addressing transnational terrorism, a very small fraction of the literature on terror finance is empirical. While there are books which focus on the dynamics of terror finance and the associated CT implications, others provide detailed accounts of state sponsorship of terrorism. Then there are works which apply such conceptual frameworks to arrive at policy insights. In addition to these, there are notable articles and research papers addressing this area which evaluate the conditions under which state sponsorship of terrorism is likely to occur, and those which assess the possibility of an international anti-terror finance apparatus. However, more formal modeling of various terrorist sponsorship mechanisms, their comparison and analyses of the associated CT implications are required to create better policy mechanisms of targeting terror finance.

Similarly, the bulk of the literature addressing various aspects of CT policy is non-empirical. Many of these utilize game-theoretic frameworks to evaluate the suitability of defensive versus preemptive CT measures, and the associated international coordination problem in the provision of CT effort and its mitigation. There are also analyses involving the issue of delegation of decision-making or policy. On the other hand, analyses of the effects of operational externalities on CT policy, and the strategic aspects of tactical CT resource-allocation are conspicuous by their rarity.

Another area of research, which has gained traction over the past decade, is on cooperation between terror outfits. A prominent reason proposed in the literature for inter-outfit cooperation, is the resultant enhancement of outfit longevity. Further, the abilities of terror outfits to address each other's organizational voids, forge a common discernibility and cultivate mutual trust are ubiquitous prerequisites for intergroup alliances. An interesting area of inquiry would be to model the impact of terrorist intergroup cooperation on the provision of terror finance via different sponsorship mechanisms.

Finally, it must be stated that for a field of study which gained prominence less than two decades ago, the literature on terrorism has expanded at a very rapid pace. This has greatly contributed to the global understanding of this phenomenon, and provided salient policy insights on how to combat it. However, it would be incorrect to assume that this understanding is complete. There still remain important questions regarding the circumstances under which radicalization causes terrorism, the application of terrorism as a means of waging proxy war, the effectiveness of international sanctions on regimes engaged in terrorist acts or their funding, the role of multilateral organizations in creating CT policy frameworks and their effectiveness compared to bilateral arrangements, etc.

Chapter 3

Chapter 3: On Operational Externalities and Counter-terrorism

In a structure involving two independent terror outfits operating in a country, this chapter analyzes possible implications for counter-terrorism (CT) strategy in the presence and absence of operational externalities. Inter alia, the analysis suggests a possible explanation for the widespread application of defensive CT measures and the sparing use of offensive CT. But confidence building measures (CBMs) come to be ineffective against resource-constrained outfits, irrespective of the nature and magnitude of externalities. Offensive measures against resource-abundant outfits appear to be successful in reducing the total number of terror strikes only when strong negative externalities prevail.[5]

3.1 Overview

Arce and Sandler (2005) define terrorism as the "*premeditated use or threat of use of violence by individuals or sub-national groups to obtain political, religious, or ideological objectives through intimidation of a large audience usually beyond that of the immediate victims*". Because terrorists simulate randomness to generate fear and widespread panic, it is usually a daunting challenge for the targeted country's government to design a strategy that optimally utilizes its counter-terrorism (CT) resources. Achieving this involves assessing the threat that various terror outfits pose in terms of their resources and inclination for conducting attacks.[6] Moreover, as shall be demonstrated, the importance of understanding the magnitude and nature of operational

[5] The contents of this chapter are drawn largely from Bhan and Kabiraj (2019a).

[6] See Arce and Sandler (2007) for a similar discussion in the context of the need for targeted countries to invest in their intelligence apparatus as an essential part of their counter-terrorism efforts.

externalities generated by terror activities in framing the appropriate CT response cannot be overstated.

Consider a situation in which a terror outfit uses a particular route to transport terrorists and material into a conflict zone. If another outfit begins to use the same route for infiltration and/or exfiltration, the chances of the route being discovered by the security forces may increase, resulting in negative operational externalities between the outfits through the resulting increase in the expected cost of operations. There are numerous other such factors which can give rise to negative operational externalities when more than one outfit is active in the same theatre of operations. Some examples are discussed below.

In June 2014, for instance, the Islamic State of Iraq and Syria (ISIS)[7] conducted a rapid invasion of large parts of northern Iraq including Mosul. The media attention afforded to al-Qaeda declined ever since, while the focus on ISIS rose. This made recruitment more difficult and therefore more costly, for al-Qaeda. Al-Qaeda responded by escalating its rivalry with ISIS. Al-Qaeda in the Islamic Maghreb (AQIM) affiliates like Ansar Dine stepped up attacks, joining a series of efforts to regain support from the more popular ISIS.[8]

The predominantly Shiite outfit Hezbollah has for decades been one of the most intimate allies of the Gaza-based Palestinian Sunni group Hamas. However, their ties have suffered following the rebellion which began in March 2011 against the Syrian regime headed by President Bashar al-Assad, an Alawite Shia. The resultant overwhelmingly Sunni insurgency was supported by Hamas, while Hezbollah became deeply committed in fighting alongside Assad's

[7] Also called Islamic State of Iraq and the Levant (ISIL).
[8] See Hancock (2015) and Kronk (2015).

forces (Karam 2014). Since then, the total number of attacks conducted by these outfits more than doubled from a combined 34 in 2011 and 2012, to a combined 88 in 2013 and 2014.[9]

Consider, conversely, the presence of a sleeper cell of a terror outfit in a city. Left to itself, the cell may be unable to conduct successful attacks given the level of security preparedness. However, if another terror outfit enters the fray and conducts attacks – successful or otherwise – the terror cell may be activated to conduct attacks of its own in the resultant conducive environment of confusion. This provides a characterization of positive operational externalities between terror outfits. There are many other circumstances in which a group can benefit due to the presence of another in the same region.

Scrutinize, for instance, the relationship between Boko Haram and its 2012 offshoot Ansaru, and AQIM. When Boko Haram initially metamorphosed into a jihadist outfit post 2009, its affiliation with AQIM and the core of al-Qaeda was largely dismissed as rhetoric by observers and analysts. The notion that inexperienced domestic insurgents from northeast Nigeria would receive backing from transnational jihadist outfits was admonished as wishful at best. In 2010, however, AQIM leader Droukdel announced that AQIM would provide weapons, support and training to Boko Haram. This Boko Haram – AQIM alliance is validated by public statements from both outfits. Moreover, Boko Haram's suicide attack in 2011 targeting the United Nations office in Abuja, Nigeria, was tactically akin to bombings by AQIM (Aronson 2014).

The literature addressing the impact of externalities on the incidence of terrorism, and its implications on CT, is limited. Anderton and Carter (2006) demonstrate the applicability of microeconomic concepts and principles to the study of terrorism. They utilize game theory to

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[9] See Global Terrorism Database, Institute for Economics and Peace, (https://www.start.umd.edu/gtd/search/Results.aspx?start_yearonly=2007&end_yearonly=2014&start_year=&start_month=&start_day=&end_year=&end_month=&end_day=&asmSelect0=&asmSelect1=&perpetrator=399&perpetrator=407&dtp2=all&success=yes&casualties_type=b&casualties_max=).

characterize *strategic interdependencies* among terrorists and governments. Enders and Jindapon (2010) analyze the optimal network structure of centralized and decentralized terror outfits, and demonstrate the sub-optimality of decentralized decision-making resulting from its inability to internalize important network externalities.

A substantial part of the existing literature focuses on the externalities imposed on other countries, by the CT actions of one country against a common transnational terrorist threat. Arce and Sandler (2005) demonstrate the negative externalities imposed by a country's defensive measures on other countries, by deflecting attacks towards them. On the contrary, proactive measures are shown to generate positive externalities for all other countries by degrading the capabilities of the terrorists. This is what causes the international co-ordination failure problem characterized by the oversupply of defensive measures and undersupply of offensive measures relative to the optimum, as also discussed in Sandler and Siqueira (2006). Faria et al. (2013) formulate a structure with temporal and spatial externalities to demonstrate that in steady state, inter-temporal policy considerations outweigh concerns usually related to transnational CT policy. Siqueira and Sandler (2007) investigate the impact of domestic politics on the CT policy of two countries against a common terrorist threat. They demonstrate that the resulting delegation problem in which voters choose a policymaker with preferences different from their own, results in countries limiting the presumed oversupply of defensive CT measures. Similarly, Das and Roy Chowdhury (2014) apply a game-theoretic model to identify circumstances based on the impact of fear, which may render it logical to respond to increased terrorism with increased pre-emption.

This is the first formal analysis of the implications of the presence of operational externalities on the interactions between terror outfits. As opposed to the afore-mentioned literature on international externalities, this analysis focuses on the externalities imposed by the activities of one terror outfit, on those of another. The findings are compared with the "*benchmark*" case without externalities. The study then proceeds to analyze the counter-terrorism ramifications of the nature and magnitude of operational externalities, if present.

The analysis demonstrates that there is always scope for the effective employment of defensive CT, irrespective of whether or not operational externalities are present. This lends support to the "*oversupply of defensive CT*" hypothesis mentioned above. Moreover, *confidence-building measures* (CBM) are shown to be ineffective against resource-constrained outfits. In the presence of externalities, it is also demonstrated that the impact of offensive CT against a resource-abundant outfit is successful in reducing the total number of attacks of all outfits if and only if the magnitude of negative externalities on the other outfit is sufficiently high. This may explain the greater prudence with which countries, especially with strong democratic institutions, may employ offensive CT measures as compared to defensive measures.

The following section presents the basic model in the absence of operational externalities. The third section introduces externalities and analyzes the associated comparative statics. The fourth section addresses some aspects of counter-terrorism policy, both in the presence and absence of externalities. The salient findings of the chapter and their implications are summarized in the fifth and concluding section.

3.2 Model

Suppose there are two independent terror outfits,[10] T_1 and T_2, operating in a country. The outfits are assumed to be self-financed. Each terror outfit, T_i, $i = 1, 2,$ initially owns a resource endowment $R_i > 0$ and decides to allocate it between two activities, consumption and terror activity. Here, consumption refers to the resources spent on non-terror activities. Hence, it includes expenditure on housing, health, education, etc., over and above the usual consumption of goods and services by the families of the members of the outfits.

Therefore, it is assumed that a terror group draws utility from a basket of consumption goods and terror strikes. Let the utility function of the i^{th} terror group, T_i $(i = 1, 2)$ be[11]

$$U_i = X_i + \alpha_i v_i(A_i), \quad v_i'(A_i) > 0, \quad v_i''(A_i) \leq 0, \ \forall A_i \geq 0 \tag{1}$$

where X_i is the level of consumption as defined above, A_i is the level (or intensity) of its terror activity, and α_i (≥ 0) is the parameter representing its intrinsic propensity for violence. Therefore, $\alpha_i v_i(A_i)$ is the utility it derives from conducting A_i terror strikes,[12] A larger α_i implies that T_i is more hardline. Hence, α_i captures the fundamentalism which drives terrorism. On the other hand, a lower α_i may imply that the outfit is more practical and politically oriented.[13] In the extreme scenario where α_i is zero, the outfit would derive no utility from terrorism in the absence of external intervention, and would therefore abstain from terrorism. Note that in this formulation, it is assumed that the utility function is separable in its two

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[10] The present analysis can be extended to the case of more than two outfits, without affecting the results qualitatively.

[11] This specification treats terrorism as an end in itself for the terror outfit, rather than the means to achieving some other goal. The implications cannot be too divorced from reality in a world which is witnessing increasing instances of religious fundamentalist ideology driven terror incidents.

[12] To keep matters simple, I abstract away from the issue of the "success" or "failure" of a terror attack, because it is often hard to define "success" and "failure" in this context. The implicit assumption is that the cost of any terror attack is the same irrespective of whether it is successful or not.

[13] For instance, see Shan and Zhuang (2014). Given that X_i represents consumption, α_i may be interpreted as the outfit's willingness to give up current consumption in favor of terrorist activity.

arguments, X_i and A_i. This also means that the marginal utility with respect to either argument is independent of the other argument, which is reasonable to expect. There is, as such, no reason why consuming more of another good would yield a higher or lower marginal utility from conducting a terror strike, and vice versa. Both X_i and A_i are assumed to be continuous.

Suppose the cost to T_i of conducting A_i terror strikes is $\beta_i C_i(A_i)$ where $C_i(A_i)$ is increasing and strictly convex in A_i, and $\beta_i (> 0)$ is the cost-efficiency (or operational efficiency) parameter of T_i, such that lower (higher) β_i represents higher (lower) efficiency.[14] Note that the increasing and convex cost function reflects the increased difficulty in conducting each successive attack. This can be driven by the increased alertness and enhanced response of governmental authorities and security forces, after each successive terror strike.

Then, given R_i, T_i's budget constraint is

$$X_i + \beta_i C_i(A_i) = R_i \tag{2}$$

Therefore, T_i's optimization problem is to maximize its utility (1) subject to its budget constraint (2). Substituting X_i in (1) using (2), the utility maximization problem can be re-written as

$$Max_{A_i} U_i = R_i - \beta_i C_i(A_i) + \alpha_i v_i(A_i) \tag{3}$$

If an interior optimum exists,[15] the first order condition (FOC) is

$$-\beta_i C_i'(A_i^*) + \alpha_i v_i'(A_i^*) = 0 \tag{4}$$

The FOC represents the equality between the marginal benefit $(\alpha_i v_i'(A_i^*))$ and marginal cost $(\beta_i C_i'(A_i^*))$ of conducting an attack (to T_i) in equilibrium. From Equation (4), the optimal number of terror strikes conducted by each outfit in interior equilibrium, can be obtained. Note that the optimal number of terror attacks conducted by each outfit is independent of the other's attacks.

[14] For a similar cost function, see Siqueira and Sandler (2008).

[15] An interior optimum exists if and only if $R_i > \beta_i C_i(A_i), \forall i = 1, 2$, when A_i is chosen optimally.

Moreover, the second order condition (SOC) for utility maximization is satisfied since at the optimal number of terror strikes (A_i^*), $-\beta_i C_i^{''}(A_i^*) + \alpha_i v_i^{''}(A_i^*) < 0$.

When an outfit is resource constrained (i.e., the case of corner solution), the optimal number of attacks by this outfit can be solved from the budget constraint given by (2) by setting $X_i = 0$.[16]

The following comparative static results as given in Proposition 1 are easy to derive.

Proposition 1: *When an interior optimum exists, the optimal number of terror attacks that an outfit conducts varies directly with its intrinsic propensity for violence, α_i, varies inversely with its inefficiency, β_i, and is independent of the initial resource endowment of the terror outfit, R_i.*

If a group's members are inherently more (less) violent, then the group would tend to conduct more (less) attacks. An increase (decrease) in α_i, ceteris paribus, increases (decreases) the marginal benefit ($\alpha_i v_i^{'}(A_i^*)$) from terror attacks, thereby increasing (decreasing) the optimal number of attacks. Also, if a terror outfit is less (more) efficient, its marginal cost of conducting a terror strike ($= \beta_i C_i^{'}(A_i^*)$) is higher (lower). Hence, the less (more) efficient the outfit, the higher (lower) is its marginal cost. Consequently, the optimal number of terror strikes that the outfit conducts would be lower (higher). The interesting observation, in case of no resource constraint, is that the number of terror strikes conducted by an outfit does not depend on the size

[16] It is assumed that the marginal cost of conducting an infinitesimal amount of terror activity is not prohibitively high. Formally, I assume $-\beta_i C_i^{'}(0) + \alpha_i v_i^{'}(0) > 0$. If this is not so, then a corner solution shall result where all resources are optimally consumed and no attacks are conducted, thereby rendering the terrorism problem trivial. No "*counter-terrorism strategy*" would be required in this scenario.

of its initial resource endowment. The impact of variations in R_i are captured completely by corresponding equivalent variations in X_i.[17]

In contrast, if a terror outfit is resource-constrained, the optimal level of terror attacks varies directly with its initial resource endowment, R_i but is independent of its intrinsic propensity for violence, α_i. Such a case arises when a group does not have sufficient resources initially to conduct as many terror strikes as it would want to (given its inherent propensity for violence and efficiency). In this situation the level of terror strikes optimally conducted by the outfit would depend not on its inherent propensity for violence, but positively on the level of resources initially at its disposal. However, β_i continues to play a similar role.

3.3 Operational Externalities

This section examines the existence of possible externalities in between the activities of the outfits. It is conceivable that the level of terror activity of one outfit has implications for the marginal cost of terror activities of the other outfit. Suppose the cost to terror group $i(\neq j = 1,2)$ of conducting A_i terror strikes is $\beta_i C_i(A_i, A_j)$, where $C_i(A_i, A_j)$ is increasing and strictly convex in A_i (i.e., $\frac{\partial C_i(A_i,A_j)}{\partial A_i} > 0$ and $\frac{\partial^2 C_i(A_i,A_j)}{\partial A_i^2} > 0$). The fact that A_j features as an argument in T_i's cost function, captures the aspect of a terror outfit subjected to cost externalities due to the presence of another terror outfit in its theatre of operations. Therefore, existence of cost externalities implies that $\frac{\partial C_i(A_i,A_j)}{\partial A_j} \neq 0, i \neq j.$ The present chapter focuses on operational externalities to see how the action of one outfit is related to that of the other outfit. Therefore, cost interdependencies will induce operational externalities by means of affecting both the total

[17] This is clear from Equation (4), which does not involve R_i.

cost and marginal cost of an outfit. Positive operational externalities are said to prevail if $\frac{\partial C_i(A_i,A_j)}{\partial A_j} < 0$ and $\frac{\partial^2 C_i(A_i,A_j)}{\partial A_i \partial A_j} < 0$, and negative operational externalities if $\frac{\partial C_i(A_i,A_j)}{\partial A_j} > 0$ and $\frac{\partial^2 C_i(A_i,A_j)}{\partial A_i \partial A_j} > 0$.

With externalities, T_i's budget constraint is

$$X_i + \beta_i C_i(A_i, A_j) = R_i \tag{5}$$

Then T_i's problem is to maximize its utility (1) subject to its budget constraint (5). Substituting X_i in (1) using (5), the utility maximization problem can be re-written as

$$Max_{A_i} U_i = R_i - \beta_i C_i(A_i, A_j) + \alpha_i v_i(A_i) \tag{6}$$

When an interior optimum exists,[18] the FOC is

$$-\beta_i \frac{\partial C_i(A_i,A_j)}{\partial A_i} + \alpha_i v_i^{'}(A_i) = 0 \tag{7}$$

The second order condition (SOC) for maximization holds, since on differentiating the FOC with respect to A_i, one gets

$$-\beta_i \frac{\partial^2 C_i(A_i,A_j)}{\partial A_i^2} + \alpha_i v_i^{"}(A_i) < 0 \tag{8}$$

From Equation (7), the best-response (or reaction) function of each outfit $i\,(\neq j = 1, 2)$, $A_i = A_i(A_j)$, can be obtained. Also, along the reaction function,

$$\frac{dA_i}{dA_j} = \beta_i \frac{\frac{\partial^2 C_i}{\partial A_i \partial A_j}}{\alpha_i v_i^{''} - \beta_i \frac{\partial^2 C_i}{\partial A_i^2}} \tag{9}$$

The SOC in Equation (8) ensures that the denominator is negative. Therefore, the reaction functions are positively (negatively) sloped if and only if $\frac{\partial^2 C_i}{\partial A_i \partial A_j} < 0$ (> 0), i.e., if an outfits's

[18] An interior optimum exists if and only if in equilibrium neither outfit is resource-constrained, i.e., $R_i \geq \beta_i C_i(A_i, A_j), \forall i = 1, 2$.

terror activities impose a positive (negative) or cost-reducing (cost-increasing) externality on the marginal cost of the other outfit's terror activities. In this case, the numbers of attacks conducted by the outfits are strategic complements (substitutes). Further, the stability and uniqueness of the resultant equilibrium is guaranteed by assuming that the determinant of the Hessian matrix of second order partial derivatives of the utility functions is positive,[19] i.e.,

$$H \equiv \left(-\beta_i \frac{\partial^2 C_i}{\partial A_i^2} + \alpha_i v_i''\right)\left(-\beta_j \frac{\partial^2 C_j}{\partial A_j^2} + \alpha_j v_j''\right) - \beta_i \beta_j \frac{\partial^2 C_i}{\partial A_i \partial A_j} \frac{\partial^2 C_j}{\partial A_j \partial A_i} > 0 \tag{10}$$

When an outfit is resource-constrained, it uses all its resources to conduct attacks, its reaction function can be obtained from its budget constraint in Equation (5) as

$$\beta_i C_i(A_i, A_j) = R_i \tag{11}$$

Complete differentiation of (11) yields the slope as

$$\frac{dA_i}{dA_j} = -\frac{\partial C_i / \partial A_j}{\partial C_i / \partial A_i} \tag{12}$$

This is positive or negative according as $\frac{\partial C_i}{\partial A_j}$ is negative (positive externalities) or positive (negative externalities), respectively.

In order to ensure that the equilibrium is both stable and unique when both outfits are resource-constrained, it shall be assumed that

$$K \equiv \frac{\partial C_i}{\partial A_i}\frac{\partial C_j}{\partial A_j} - \frac{\partial C_i}{\partial A_j}\frac{\partial C_j}{\partial A_i} > 0 \tag{13}$$

The lemma below follows from the analysis above.

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[19] For instance, suppose $\beta_i = 1, i = 1, 2$; $v_i(A_i) = A_i, i = 1, 2$; and $C_i(A_i, A_j) = \frac{1}{\gamma} A_i^{\gamma} A_j^{\sigma}, , \gamma > 1$ and $, \gamma - 1 > |\sigma|$. Then all the relevant conditions are satisfied.

Lemma 1: *The reaction function of an outfit remains positively sloped under positive externalities, and negatively sloped under negative externalities, even if it is resource-constrained.*

From the solution to the optimization problem of any outfit $i = 1, 2$, it can be checked (from (9) and (12)) that the absolute slope of its reaction function (dA_i/dA_j) is less if it is resource-constrained (see Appendix A). Therefore, although externalities, if present, play a role even under resource-constraint, their ability to impact the level of terror activity is less.

It is important to mention, at this juncture that one could obtain similar reaction functions using a scenario of non-operational externalities. For example, higher terror activity levels of another outfit can lead to resentment in the ranks of the first. Alternatively, it could work as a morale booster. In such scenarios, even if there are no cost externalities, the outfits end up imposing externalities on each other via their ex-ante utilities. This issue is further discussed in Appendix B. Comparative static effects under operational externalities shall be discussed in the following two subsections:

3.3.1 *Positive Operational Externalities (i.e.,* $\frac{\partial C_i(A_i,A_j)}{\partial A_j} < 0, \frac{\partial^2 C_i}{\partial A_i \partial A_j} < 0$*)*

As already demonstrated, the presence of positive cost externalities ensures that the best-response functions of the terror outfits are sloped positively (Figure 1 is an illustration). Moreover, the SOCs and Equation (10) and (13) together ensure the uniqueness and stability of the equilibrium, as obtained by the intersection of the reaction curves.

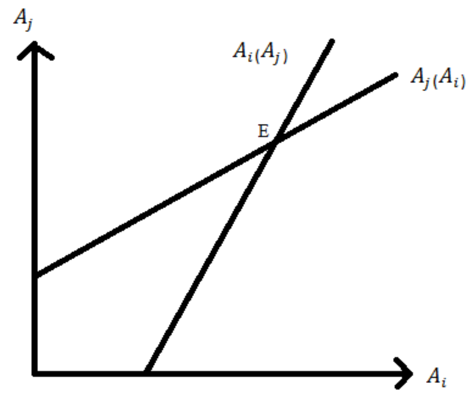

Figure 1: Reaction functions under positive externalities

Proposition 2: *Assume that neither outfit is resource-constrained. Then in the vicinity of the initial equilibrium the optimal number of terror attacks conducted by either outfit, and the total number of attacks:*

(i) Vary positively with their intrinsic propensities for violence, α_1 and α_2;

(ii) Vary negatively with their inefficiencies, β_1 and β_2; and

(iii) Are independent of the initial resource endowments of the terror outfits, R_1 and R_2.

The formal proof of the proposition is given in Appendix C. An increase (decrease) in α_i, ceteris paribus, raises (reduces) T_i's marginal benefit from attacking ($\alpha_i v_i'(A_i)$) while leaving its marginal cost of attacking ($\beta_i \frac{\partial C_i(A_i,A_j)}{\partial A_i}$) unchanged. Therefore it optimally conducts more (less) attacks given any A_j (rightward (leftward) shift of A_i's reaction function). This, in turn, reduces (raises) T_j's marginal cost of attacking ($\beta_j \frac{\partial C_j(A_i,A_j)}{\partial A_j}$) while leaving its marginal benefit from attacking ($\alpha_j v_j'(A_j)$) unchanged. Therefore, T_j too optimally conducts more (less) attacks. Thus, the total number of attacks also increases (decreases).

An increase (decrease) in β_i, ceteris paribus, leaves T_i's marginal benefit from attacking unchanged while raising (reducing) its marginal cost of attacking. Therefore it optimally conducts less (more) attacks given any A_j (leftward (rightward) shift of A_i's reaction function). This, in turn, raises (reduces) T_j's marginal cost of attacking while leaving its marginal benefit from attacking unchanged. Therefore, T_j too optimally conducts less (more) attacks. Thus, the total number of attacks also decreases (increases).

Finally, an increase (decrease) in R_i, ceteris paribus, leaves unaltered both T_i's marginal benefit and the marginal cost of conducting attacks. Therefore, it has no impact on the optimal number of attacks. It does, however, result in an equivalent increase (decrease) in X_i.

Given the assumptions, when both outfits are resource constrained, under positive externalities reaction functions will continue to be positively sloped (although these will be less steep). Then it is easy to understand that for $i = 1, 2$ in the vicinity of the initial equilibrium, A_1^*, A_2^* and $A_1^* + A_2^*$ all will vary positively with R_i and negatively with β_i, but are independent of α_i. But if only T_j is resource constrained, α_i will impact positively. The reason is that an increase (decrease) in α_i, ceteris paribus, causes a rightward (leftward) shift of T_i's reaction function. Therefore, it optimally conducts more (less) attacks. This, in turn, reduces (raises) T_j's cost of attacking ($\beta_j C_j(A_i, A_j)$) while leaving its initial resource endowment (R_j) unchanged. Therefore, T_j too optimally conducts more (less) attacks. Thus, the total number of attacks also increases (decreases).

3.3.2 *Negative Operational Externalities (i.e.,* $\frac{\partial C_i(A_i,A_j)}{\partial A_j} > 0, \frac{\partial^2 C_i}{\partial A_i \partial A_j} > 0$*)*

The presence of negative operational externalities ensures that the best-response functions of the terror outfits are sloped negatively (as illustrated in Figure 2).

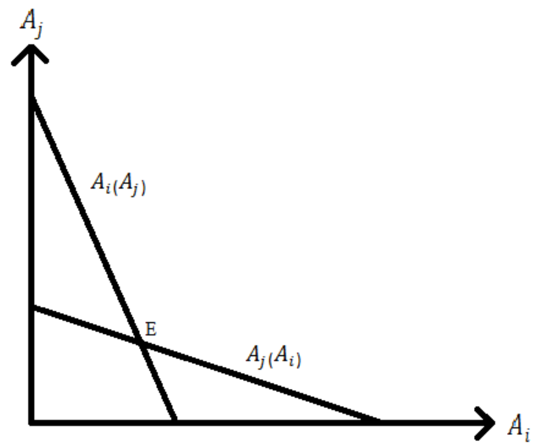

Figure 2: Reaction functions with negative externalities

Proposition 3: *If neither outfit is resource-constrained, then in the vicinity of the initial equilibrium for $i \neq j = 1, 2$:*

(i) An increase in β_i decreases A_i^*, increases A_j^*, but it decreases (increases) $A_1^* + A_2^*$ if and only if $\left|\frac{dA_j(A_i)}{dA_i}\right| < 1\ (> 1)$ *;*

(ii) An increase in α_i increases A_i^*, decreases A_j^*, but it increases (decreases) $A_1^* + A_2^*$ if and only if $\left|\frac{dA_j(A_i)}{dA_i}\right| < 1\ (> 1)$ *;*

(iii) Changes in R_i have no impact on the optimal number of attacks.

Note that contrary to the case of positive externalities, under negative externalities the effect on $A_1^* + A_2^*$ depends on whether the absolute slope of the corresponding reaction function is greater than or less than unity. Explanation of the results underlying Proposition 3 is not difficult. An increase (decrease) in β_i, ceteris paribus, leaves T_i's marginal benefit from attacking unchanged while raising (reducing) its marginal cost of attacking. Therefore it optimally conducts less (more) attacks given any A_j (leftward (rightward) shift of A_i's reaction function). This, in turn, reduces (raises) T_j's marginal cost of attacking while leaving its marginal benefit from attacking unchanged. Therefore, T_j optimally conducts more (less) attacks. If T_j's optimal number of attacks (best-response) is sufficiently sensitive to T_i's optimal decision,[20] then the rise (fall) in A_j dominates the fall (rise) in A_i, and the total number of attacks therefore increases (decreases). Conversely, if T_j's best-response is sufficiently insensitive, the total number of attacks declines (increases). Similar explanation follows for an increase or decrease of α_i.

Results for the case of resource constrained outfits can follow similarly because the reaction functions will still be downward sloping, The important difference from the above is that now R_i will impact on both A_i and A_j. However, still the impact on $(A_i + A_j)$ will depend on the absolute slope of the respective reaction functions. When both the outfits are resource constrained, α_i has no role to play, but it becomes active if only T_j is resource constrained.

To summarize the results of this section, note that in the absence of externalities the change of any of α_j, β_j and R_j has no effect on A_i, but given externalities (positive or negative), A_i depends on α_j and β_j but not on R_j (unless T_j becomes resource constrained). Further, the direction of the effect on A_i of a change of α_i or β_i is same irrespective of whether there are positive or negative externalities.

3.4 Counter-terrorism

[20] For this, T_j's reaction function must be steep enough, in particular, $\left|\frac{dA_j}{dA_i}\right| > 1$.

This section focuses attention on the implications of the above discussion and results, for the counter-terrorism policy of the targeted country's government. It must be noted, at the outset, that counter-terrorism measures seek to reduce the level of terror activity by impacting its determinants. A broad classification of CT measures is as follows:

1. Defensive measures,
2. Offensive measures, and
3. Confidence-building measures and others.

D*efensive CT measures* include "*hardening*" of potential targets[21], deployment of governmental intelligence agencies against the outfit on a priority basis, covert tactical operations aimed at disrupting the operational capabilities of the terrorists and their handlers, etc. The construction of a double-row concertina wire fence about 700 meters from the Line of Control (LoC) separating the Indian State of Jammu and Kashmir from Pakistan Occupied Kashmir (POK), called the Anti-Infiltration Obstacle System (AIOS), by the Indian Army during 2003 to 2005, is an example of such efforts. Such counter-terrorism efforts attempt to reduce the optimal number of terror strikes by rapidly *increasing the terrorists' (ex-post) operational inefficiency,* β_i. Even though such measures may sometimes occur *behind enemy lines* and involve an element of pre-emption, they are limited in size and scope, and aimed primarily at disrupting the terrorists' operational efficiencies rather than degrading their aggregate resources. The "surgical strikes" conducted by the Indian Army on 29 September, 2016, against multiple terrorist launch pads in POK, to thwart the efforts of terrorists seeking to "carry out infiltration

[21] That is, by increasing the security levels of potential targets or enhancing surveillance, etc., thereby rendering these targets more difficult or costly for a terror outfit to attack.

and conduct terrorist strikes inside Jammu and Kashmir and in various metros in other states", provides an example of such *cross-border* defensive measures.[22]

The targeted country's government may alternatively take the more *offensive* approach of imposing financial and other sanctions, or even conducting strategic pre-emptive strikes to destroy the assets of terror outfits.[23] A case in point is that of the American airstrikes conducted in 2001 in the aftermath of the 9/11 attacks, to topple the Taliban regime in Afghanistan through the massive destruction of its resources and the elimination of its leadership. Such measures are mostly strategic in scope, as opposed to the tactical nature of most defensive measures. This would result in a rapid *reduction of resources*, R_i, available with the terrorists. However, offensive measures may potentially alienate the larger civilian population in the area of operations and this, over a period of time, may make it easier for terror outfits to recruit and indoctrinate locals. This would be reflected in decreased ex-post operational inefficiencies, β_i. Also, in the aftermath of any major military offensive, there is often a "*terrorist backlash*"[24] (increased number of attacks) due to *increased intrinsic propensity of violence*, α_i.

In December 2014, in the aftermath of the carnage carried out by NDFB(S) militants killing over 80 people, a major offensive was allegedly planned in Assam, Nagaland and Bhutan. The Assam State Government had also increased the reward amount on information regarding the whereabouts of the NDFB(S) top brass by four times to Rs. 20 lakh (Acharya 2014).

The government may also adopt the softer approach of winning the "hearts and minds" of the alienated population living in a terror-affected geographical area, in order to reduce the support for the terror outfit(s) operating in that area and/or to reduce the outfit's motivation to

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[22] These details are as mentioned by the Indian Director General of Military Operations (DGMO), in the immediate aftermath of the surgical strikes.
[23] On the other hand, localized or tactical pre-emptive actions do not usually create any major dent in the resources available with terror outfits, and fall under the category of the afore-discussed defensive CT measures.
[24] See Mesquita (2005a) for a formal explanation of the causes of terrorist backlash.

maintain a very high level of terror activity. To this end, so-called *confidence-building measures* (CBMs) may be undertaken. Religious institutions of learning may be nudged to accept greater state regulation and to modify their curriculum and academic discourse, in exchange for greater State support. Public spending on social and economic infrastructure may be enhanced, along with special economic assistance for the affected region. All such measures are targeted at *reducing the intrinsic propensity of violence*, α_i, of an outfit active in that area.

In January, 2007, for instance, President Arroyo of the Phillippines credited the success in countering Abu Sayyaf partly to larger developmental initiatives involving trade and investment, targeted at increasing the security sphere while inhibiting that of "*terror and transnational crime*". She called on other countries combating terrorism to learn from the successful use of both "*soft and hard power*" in the Phillippines (Calica 2007).

The government's CT approach towards an outfit is contingent upon the specifics of that outfit such as its intrinsic propensity for violence, its operational efficiency, and the resources available to it. Therefore, if the specifics of two outfits vary, then the government's CT approach towards them may vary. In reality, a government's CT strategy may involve a combination of different types of CT measures. For instance, governments often embark on and/or maintain "*back-channel*" negotiations with certain terror outfits, even as operations against those outfits continue on the ground. Moreover, the CT measures (as well as the CT strategy as a whole) chosen by the government to target an outfit may evolve over time, driven by changes in the outfit's nature. For example, an outfit that previously was not resource-constrained, may begin to suffer from paucity of resources over a period of time due to a decline in its operational efficiency. This change would necessitate a corresponding evolution of the CT strategy employed against the outfit.

The choice of CT strategy also depends on the cost of each CT measure as well as the resources committed towards CT efforts. Finally, the overall nature of response to terrorist threats depends crucially on the nature of the government itself. Some governments, for instance, are more willing and/or able to commit to a sustained effort to counter terrorists than others. Therefore, although a similarity is often observed in the immediate response of various governments after a major terrorist incident, discrepancy between the approaches of different regimes may creep in with the passage of time. Hence, the chosen CT strategy may vary based on the extent of the government's bias towards immediate/short-term or ad hoc/piecemeal responses as opposed to a more sustained anti-terror campaign.

From the results presented in the second and third sections, it emerges that defensive measures can be effectively utilized against any terror outfit irrespective of the nature of externalities (if any) and the quantum of resources with the terrorists because under any scenario, as long as the equilibrium is stable, there is at least one outfit against which defensive measures can be used effectively to reduce the total number of terror attacks. This explains the universality of defensive measures. For instance, in the immediate aftermath of a terrorist event where the government is unaware or unsure about the perpetrator(s), a "*safe*" choice of an ad hoc CT strategy involves hardening of potential targets and increasing surveillance. It is another matter that given the extent of public outrage after a major terrorist event, the government may find it politically untenable to stick to defensive CT measures alone.

On the other hand, in the absence of externalities as well as in the presence of positive externalities or sufficiently weak negative externalities, offensive measures are effective if and only if the targeted outfit is resource-constrained. However, in the presence of sufficiently strong negative externalities the reduction in the targeted outfit's attacks would be more than compensated by the increase in the other outfit's attacks, due to a decline in its cost of operations. This would, therefore, result in an increase in the total number of attacks. Hence, defensive instead of offensive measures would be preferable in such cases. Further, although the application of offensive measures against resource-rich outfits generally leads to an increase in attacks due to a terrorist backlash in the absence of externalities, such measures can decrease the overall attacks in the presence of sufficiently strong negative externalities. Interestingly in such cases, the higher the terrorist backlash by the targeted outfit, the greater the decline in the other outfit's attacks due to higher operational costs. In the presence of externalities, therefore, a necessary and sufficient condition for offensive CT to be effective against an outfit that is resource-abundant is the presence of sufficiently strong negative externalities.

Finally, CBMs can be effectively utilized only if the targeted outfit is not resource-constrained, irrespective of whether externalities are present or not. In the vicinity of the interior equilibrium in the absence of externalities, the sensitivity of the outfit's optimal number of attacks to the outfit's inefficiency is greater or lesser than that to the outfit's intrinsic propensity for violence according as the intrinsic propensity for violence is greater or lesser than the outfit's inefficiency in interior equilibrium, since from Equation (4)

$$\left|\frac{\partial A_i^*}{\partial \beta_i}\right| = -\frac{C_i^{'}}{\alpha_i v_i^{''} - \beta_i C_i^{''}} \gtrless -\frac{v_i^{'}}{\alpha_i v_i^{''} - \beta_i C_i^{''}} = \frac{\partial A_i^*}{\partial \alpha_i} \leftrightarrow \alpha_i \gtrless \beta_i \tag{14}$$

Hence, the deployment of CBMs is optimal in the absence of externalities if and only if the targeted outfit is resource-rich and sufficiently inefficient. This is because the incentive of a resource-rich outfit to respond to CBMs is stronger (weaker), the lesser (greater) the impunity with which it can carry out terror attacks. Also, offensive measures against such an outfit would result in an increase in the number of attacks in the vicinity of the initial equilibrium via an increase in the outfit's intrinsic propensity of violence, as mentioned earlier.

In the presence of externalities, although CBMs would result in the reduction of attacks by the targeted outfit, the other outfit will overcompensate by increasing its attacks by an even greater magnitude in the presence of sufficiently strong negative externalities. Here, defensive measures would be optimal. In all other situations in the presence of externalities, CBMs are effective in the vicinity of the initial equilibrium.

3.5 Conclusion

Given the limited literature investigating the role of externalities in CT, a simple formalization of operational externalities has been presented in this chapter. The insights, however, are compelling. The analysis demonstrates that the policy ramifications of CT measures are directionally the same both in the absence of externalities, and under positive externalities. It is however demonstrated that the magnitude of the impact in the latter regime is never less than that under the former. In fact, the direction of impact of CT measures is also the same under negative externalities unless the optimal response of one outfit is sufficiently sensitive to changes in the parameters of the other. The magnitude of the impact, however, would never exceed that in the absence of externalities. This is because the response of one outfit to a CT measure runs contrary to that of the other under negative externalities.

The universality of defensive CT measures is also explained by the structure, thus lending credence to the possibility of oversupply of defensive CT. It is also argued that CBMs are ineffective against resource-constrained outfits. Moreover, the possible limitations of offensive CT in the vicinity of the initial equilibrium have been demonstrated. Offensive measures can be effectively used against resource-constrained outfits both in the absence of externalities and under positive externalities. This result also holds under negative externalities if the magnitude of externalities is sufficiently low. Most interestingly, the phenomenon of terrorist backlash can render offensive CT effective even against resource-abundant outfits, in the presence of sufficiently strong negative externalities. Examples including Phillippines use of both "*soft and hard power*" against Abu Sayyaf, American airstrikes targeting the Taliban in 2001, and the surgical strikes conducted by the Indian Army against multiple terror launch-pads in PoK in 2016 have been provided as evidence of the above findings.

3.6 Appendices

Appendix A:

T_i's optimization problem is to maximize its utility (1), with respect to its resource constraint (5), and non-negativity constraints $X_i \geq 0$ and $A_i \geq 0$. This is equivalent to the unconstrained maximization of the Lagrangean function

$$L = X_i + \alpha_i v_i(A_i) + \lambda\{R_i - X_i - \beta_i C_i(A_i, A_j)\} + \gamma X_i + \mu A_i \quad \text{(A1)}$$

where λ, γ and μ are non-negative Lagrangean multipliers.

Solving the FOCs, the slope for the reaction function can be obtained as

$$\frac{dA_i}{dA_j} = -\beta_i \frac{\frac{\partial^2 C_i}{\partial A_i \partial A_j}}{\beta_i \frac{\partial^2 C_i}{\partial A_i^2} - \frac{1}{1+\gamma}\alpha_i v_i''} \quad \text{(A2)}$$

where $\gamma = 0$ when the resource constraint (5) is not binding, and $\gamma > 0$ when (5) is binding. Invoking Equation (8), the result follows. Q.E.D.

Appendix B:

In this scenario, T_i's budget constraint is given by Equation (2). However, its utility is

$$U_i = X_i + \alpha_i v_i(A_{i,}A_j),\ \ \frac{\partial v_i(A_i,A_j)}{\partial A_i} > 0,\ \ \frac{\partial^2 v_i(A_i,A_j)}{\partial A_i^2} \leq 0,\ \ \forall A_{i,}A_j \geq 0 \tag{A3}$$

T_i's optimization problem is to maximize its utility (A3) subject to its budget constraint (2). Substituting X_i in (A3) using (2), the utility maximization problem can be rewritten as

$$Max_{A_i} U_i = R_i - \beta_i C_i(A_i) + \alpha_i v_i(A_i, A_j) \tag{A4}$$

If an interior optimum exists, the first order condition (FOC) is

$$-\beta_i C_i^{'}(A_i) + \alpha_i \frac{\partial v_i(A_i,A_j)}{\partial A_i} = 0 \tag{A5}$$

From (A3), the best-response (or reaction) function of each outfit $i(\neq j = 1,2)$, $A_i = A_i(A_j)$, can be obtained. Also, along the reaction function, $\frac{dA_i}{dA_j} = \alpha_i \frac{\frac{\partial^2 v_i}{\partial A_i \partial A_j}}{\beta_i C_i^{''} - \alpha_i \frac{\partial^2 v_i}{\partial A_i^2}}$. The SOC ensures that the denominator is positive. Therefore, the reaction functions are positively (negatively) sloped if $\frac{\partial^2 v_i}{\partial A_i \partial A_j} > 0$ (< 0), i.e., if an outfits's terror activities impose a positive (negative) externality on the utility of the other outfit's terror activities. In this case, the numbers of attacks conducted by the outfits are strategic complements (substitutes). Q.E.D.

<u>*Appendix C*</u>:

Differentiating the FOCs for T_i (given by Equation (7)) and T_j (obtained by interchanging subscripts i and j in Equation (7)) with respect to α_i ($i \neq j = 1,2$), and solving the resulting pair of Equations, one obtains

$$\frac{dA_i^*}{d\alpha_i} = -\frac{v_i^{'}\left(\alpha_j v_j^{"} - \beta_j \frac{\partial^2 C_j}{\partial A_j^2}\right)}{H} > 0 \tag{A6}$$

invoking the SOC, Equation (1) and Equation (9). Under positive externalities,

$$\frac{dA_j^*}{d\alpha_i} = -\beta_j v_i' \frac{\frac{\partial^2 C_j}{\partial A_j \partial A_i}}{H} > 0 \tag{A7}$$

Obviously, the total number of attacks also increases if α_i increases, since

$$\frac{d\left(A_i^* + A_j^*\right)}{d\alpha_i} = -\frac{v_i'\left(\alpha_j v_j'' - \beta_j \frac{\partial^2 C_j}{\partial A_j^2}\right) + \frac{\partial^2 C_j}{\partial A_j \partial A_i}}{H} > 0 \tag{A8}$$

In the context of β_i $(i \neq j = 1, 2)$, Equation (7) can similarly be utilized to obtain

$$\frac{dA_i^*}{d\beta_i} = -\frac{\left(\alpha_j v_j'' - \beta_j \frac{\partial^2 C_j}{\partial A_j^2}\right)\frac{\partial C_i}{\partial A_i}}{H} < 0 \tag{A9}$$

And under positive externalities,

$$\frac{dA_j^*}{d\beta_i} = \beta_j \frac{\frac{\partial^2 C_j}{\partial A_j \partial A_i}\frac{\partial C_i}{\partial A_i}}{H} < 0 \tag{A10}$$

Obviously, the total number of attacks also decreases if β_i increases, since

$$\frac{d\left(A_i^* + A_j^*\right)}{d\beta_i} = -\frac{\left(\alpha_j v_j'' - \beta_j \frac{\partial^2 C_j}{\partial A_j^2}\right)\frac{\partial C_i}{\partial A_i} + \frac{\partial^2 C_j}{\partial A_j \partial A_i}\frac{\partial C_i}{\partial A_i}}{H} > 0 \tag{A11}$$

Lastly, for $(i \neq j = 1, 2)$, $\frac{dA_i^*}{dR_i} = \frac{dA_j^*}{dR_i} = \frac{d\left(A_i^* + A_j^*\right)}{dR_i} = 0.$ Q.E.D.

Chapter 4

Chapter 4: External Sponsorship of Terrorism

This chapter considers the interaction of two terror outfits and studies possible counter-terrorism (CT) measures, both in the absence and presence of external terror finance. In the structure presented, external sponsorship with proportional allocation rule induces strategic interaction and incentivizes more attacks. A theoretical foundation for the ubiquity of defensive CT versus the limited applicability of offensive measures and confidence-building measures (CBMs) is provided. Curtailing external sponsorship is always effective in inhibiting terror activity. In fact, targeting external funding may be the most effective CT tool if terror activity is sufficiently low. While CBMs may be more effective in the absence of external sponsorship, defensive CT may be preferable in its presence. However, CBMs may not be as effective in the presence of external sponsorship, as in its absence.[25]

4.1 Overview

Terrorism is a menacing problem afflicting large parts of the world. Terror events such as those of September 11, 2001 (United States), December 13, 2001 (New Delhi, India), October 12, 2002 (Bali, Indonesia), October 23, 2002 (Moscow, Russia), March 11, 2004 (Madrid, Spain), July 7, 2005 (London, United Kingdom), July 11, 2006 (Mumbai, India), November 26, 2008 (Mumbai, India), May 22, 2013 (London, United Kingdom), July 27, 2015 (Gurdaspur, India), January 2-5, 2016 (Pathankot, India), September 18, 2016 (Uri, India), February 14, 2019 (Pulwama, India) amongst many others; illustrate the magnitude of the threat posed by different terrorist groups. This has been associated with a dramatic increase in the number of casualties

[25] The contents of this chapter are drawn mostly from Bhan and Kabiraj (2020a).

from terror strikes since the turn of the millennium. From 3,361 in 2000, the number of fatalities from terrorism has soared to 15,952 in 2018, at a compounded annual growth rate of 9%. The Global Terrorism Index (GTI) (2019) report states that the majority of claimed deaths from terrorist attacks – 57.8 per cent in 2018 - are claimed by only four terrorist organizations, namely the Taliban, ISIL, the Khorasan Chapter of the Islamic State, and Boko Haram. Radical doctrines rooted in Wahhabi Islam provide the crucial common denominator for all four groups, even though their strategic objectives may vary. It is evident that many of the terror attacks have been motivated by religious fundamentalist ideologies.[26]

Increasing terrorist activity, however, cannot solely be explained on the basis of rising religious fundamentalism. After all, terrorist activities need to be fed by the provision of funds, and without sufficient availability of finance such activities just cannot be planned and executed. Acharya (2009) clearly observes that "*if radical ideology and extremism are at the heart of terrorism today, finance is its lifeblood*" (p.7). So it is important to know the sources and channels of terror finance.

Broadly speaking, the fund sources of a terror outfit can be classified as internal or external, depending on whether the outfit generates funds from its own sources or it manages to source from outside. Internal sources primarily include extortion or taxation, outfit's involvement in business and criminal activities like counterfeiting currency, drug trafficking, manufacturing of opium and drugs, etc. On the other hand, external sources include, among others, charities, Non-Governmental Organizations (NGOs) and Designated Non-Financial Businesses and Professions (DNFBPs), donations from other terror organizations and state funding. External finance from charities and NGOs may be donation-based and non-strategic, but

[26] For detailed accounts on fundamentalism, see Gilling (1992) and Pratt (2006). Tibi (2002), on the other hand, views religious fundamentalism as a political doctrine rather than a spiritual faith.

such institutions also often act as conduits for countries and their deep states to fund internal disturbances in other countries via means including terrorism. Hence, a large part of external finance which relates to state funding of terror outfits, funds received from other terror outfits and criminal syndicates, etc. is strategic in nature, and aimed at inducing increased terrorism. So whereas non-strategic external finance supplements the outfit's internal resources from which it can spend on both terror and non-terror activities, strategic external finance serves to incentivize increased terror attacks. Attention shall henceforth be restricted only to the strategic component of external funding, and all subsequent references to external finance will allude only to strategic finance unless specified otherwise. In particular, the ability of an external sponsor to induce enhanced levels of terror activity through the strategic provision of funds to terror outfits shall be demonstrated.[27]

The purpose of the present chapter is to discuss and characterize the strategic interaction between two terror outfits both in the presence and absence of potential (strategic) external sponsorship of terrorism, and then derive in this context the implication of counter-terrorism (CT) policy measures of the government of the targeted country. Three types of policies are broadly considered - offensive, defensive and confidence building measures (CBMs). I establish and contrast the limited applicability of offensive CT and CBMs, with the widespread utility of defensive CT.[28] Offensive CT policy is meant to pre-empt strikes by imposing financial and other sanctions and destroying assets and resources of the outfits. Defensive policy targets to deter terror activities by increasing protection and security, and raising effective costs of terror

[27] Byman (2005) similarly argues that terrorist groups that enjoy state support have greater ability and inclination for large-scale bloodshed, than those without state support.
[28] Arce and Sandler (2005) think that governments tend to prefer deterrence over preemption, as a result of coordination failure in the provision of CT effort.

attacks. On the other hand, CBMs are meant to bring terrorists back to the mainstream by means of reducing their propensity of violence.[29]

This chapter will demonstrate how and when external sponsorship may induce larger terror attacks vis-à-vis absence of sponsorship. For any level of sponsorship, various allocation rules by which funds may be divided between the outfits are discussed. One interestingly finds that ex post proportional allocation mechanism acts as a strategic device to incentivize the terror attacks. The present chapter, therefore, focuses on this allocation rule.[30] The level of optimal sponsorship is also determined. Before proceeding to discuss the important results of this chapter, it is important to illustrate the extent and direction of external finance to various outfits, and briefly outline the literature related to sponsorship.

In India, a major part of external funding for terrorism comes through counterfeit currency, drug-trafficking, charities, NGOs, and finally due to alleged state sponsorship by Pakistan. In Pakistan, for instance, the government has limited control over charities and NGOs (Ghumman 2012). Terrorism finance is therefore generated from NGOs and charities such as *Jamaat-ud-Dawa* (JuD) and *Falah-e-Insaniyat* Foundation (FeF) within Pakistan. Saudi Arabia has also emerged as a large source of funds for terrorist groups like the Lashkar-e-Taiba (LeT), which functions on an approximate annual budget of US $5.25 million (Walsh 2010). Fake Indian currency is allegedly used by Pakistan to fund groups like LeT, Al-Badr, Harkat-ul-Jihad-e-Islami (HuJI), Khalistan Commando Force (KCF) and operations run by Dawood Ibrahim. Bangladesh and Nepal are amongst the most viable routes for inducting Fake Indian Currency Notes (FICN) (Chadha, 2015). Additionally, drugs are a major source of terrorism finance. Afghanistan emerged as the hub for the global production of opiates. In 2009, the Afghan

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[29] A comprehensive discussion of different categories of CT policies is already given in the previous chapter.

[30] This states that the share of allocation of an outfit will be proportional to its terror activities. The rule has been formally defined in subsection 3.1.

Taliban was estimated to have earned around US $150 million from the opiate trade, Afghan drug traffickers US $2.2 billion, and Afghan farmers US $440 million (see United Nations Office on Drugs and Crime 2011). Criminal and terrorist groups from Bangladesh have also allegedly exploited the drug trade to fund terrorism (Bhattacharya 2012). Lastly, the Pakistan Government is often accused of employing its intelligence agency (the Inter-Services Intelligence) to fund terrorist activities in India. Addressing the Hindustan Times Leadership Summit in 2014, Shri Rajnath Singh (then Home Minister, Govt. of India) said, "*Terrorism here is not home grown. It is externally aided. Pakistan blames non-state actors for it. I ask them whether the Inter-Services Intelligence (ISI) is a non-state actor. If anyone is fully helping terrorists, it is the ISI*".[31]

It must be noted at this juncture, however, that Pakistan is not the only state to sponsor terrorism. It is alleged, for instance, that Syrian sponsorship of the Palestinian Islamist group Hamas has greatly enhanced the outfit's operational capabilities. Since the mid-1990s, Syria and Syrian-occupied Lebanon had allegedly become prime conduits for channeling weapons and explosives to Hamas, and safe havens for training hundreds of its operatives. In addition to greatly augmenting the movement's ability to inflict casualties, alleged Syrian sponsorship had fueled its willingness to kill. The alleged weakening of the internal leadership of Hamas vis-à-vis the external leadership had allegedly made the group's military cells less sensitive to public disaffection with the costs of terror (Gambill 2002).

Similarly, consider the Abu Nidal Organisation (ANO), a terrorist organization which conducted deadly attacks on Western, Palestinian and Israeli targets in the 1980s. Since its inception in 1974, the ANO had allegedly received state support from Iraq, Syria and Libya during different stages of its existence. Since Syria expelled the ANO in 1987, probably under U.S. pressure, the supply of external sponsorship almost vanished completely in 1999 after local

[31] *The Hindu* (November 23, 2014).

authorities curbed the ANO’s operations in Libya. Since then, the organization is considered largely inactive (Council of Foreign Relations 2009).

It may be noted that most of the major external sources of terrorism finance are sufficiently autonomous to operate as separate entities from the terror outfits that they support. This, in turn, implies that the external sponsors are able to strategically manipulate the behavior of the recipient terror outfits. In contrast, most of the major internal sources of terrorism finance such as extortion or taxation, crime, diversion of the funds of NGOs, and money laundering from DNFBPs, are largely controlled and managed by the recipient terror outfits themselves.

Among the various works, Siqueira and Sandler (2006) have argued that state sponsorship and franchising of terrorists augment violence. Byman and Kreps (2010) discuss state-sponsored terrorism as an illicit principal-agent problem. Then it is potentially fruitful for counter-terrorism (CT) officials to exploit the information gap between states and the terrorists they support.

An important feature of the present study is to characterize the equilibria under two different scenarios - one where both the concerned terror outfits are resource-abundant, i.e., each has sufficient resources to achieve its desired level of terror activity, and the other where at least one terror outfit is resource-constrained and hence cannot achieve its desired activity level. This is the case of corner solution. Results and policy implications, to a large extent, hinge on whether the equilibrium is an interior equilibrium or a corner solution. It is demonstrated specifically that while offensive CT is effective only against resource-constrained outfits, CBMs are effective only against resource-abundant outfits. Also, if defensive CT is more effective than CBMs in the absence of external sponsorship, then it must be more effective even in its presence. In Sandler and Siqueira (2006), nations confronted by a common terrorist threat can rarely achieve a proper policy mix between deterrence and pre-emption through leadership.

This analysis sharply differs from Sandler and Siqueira (2006). Firstly, the scenario described here involves more than one terror outfit (specifically two), and is therefore able to capture inter-outfit strategic interaction. Secondly, the present analysis does not focus on co-ordination and externality-related issues between targeted countries when confronted by a common terrorist threat, and the structure is therefore limited to include only one targeted country. The present framework, in fact, explores the possibility and implications of externalities resulting from the terror activities of an outfit on another, induced via the introduction of strategic external sponsorship. Thirdly, in this analysis, all payoffs are derived endogenously from the respective utility functions of each group. And finally, this analysis addresses the possibility of external sponsorship, and is therefore able to derive additional and deeper insights in respect of CT policy.

The next section presents the basic model involving terror outfits and the targeted country's government. Section 4.3 introduces external sponsorship to the structure described in Section 4.2. Section 4.4 addresses the problem facing the targeted country, and discusses the ramifications of the results derived in Sections 4.2 and 4.3 on its CT policy. Section 4.5 concludes the chapter by summarizing the analysis, and providing potential directions for future research.

4.2 Model

In this section we provide, as a benchmark, a model of interaction between two terror outfits which internally finance their activities. We follow the same framework and notations as in the last chapter. However, in this chapter we have assumed specific forms of different functions so as to obtain closed form solutions.

Consider a country whose government aims to minimize the level of terror activity directed against it by two terror outfits. As in the previous chapter, each terror outfit, T_i, $i = 1, 2,$ initially owns a resource endowment $R_i > 0$ and decides to allocate it between two activities, consumption and terror activity. Let the payoff function of T_i $(i = 1, 2)$ be

$$U_i = X_i + \alpha_i A_i \tag{1}$$

where X_i is level of consumption, A_i is the level (or intensity) of its terror activity, and α_i (≥ 0) is the parameter representing its intrinsic propensity for violence. Both X_i and A_i are assumed to be continuous.

Let the associated cost to T_i of conducting A_i terror strikes be

$$C_i(A_i) = \frac{1}{2}\beta_i A_i^2 \tag{2}$$

where $\beta_i > 0$ is the cost-efficiency parameter of terror outfit T_i, such that lower (higher) β_i represents higher (lower) efficiency. The cost function is increasing and convex, reflecting the increased difficulty in conducting each successive attack.

Given R_i, T_i's budget constraint is,

$$X_i + \frac{1}{2}\beta_i A_i^2 = R_i \tag{3}$$

Therefore, T_i's optimization problem is to maximize its objective function (1), subject to the constraint (3). Hence, its maximization problem is

$$Max_{A_i} U_i = R_i - \frac{1}{2}\beta_i A_i^2 + \alpha_i A_i \tag{4}$$

When an interior optimum exists, the first order condition is given by

$$-\beta_i A_i + \alpha_i = 0 \tag{5}$$

This solves for

$$A_i = \frac{\alpha_i}{\beta_i} \equiv A_i^0 \text{ and } X_i = R_i - \frac{1}{2}\frac{\alpha_i^2}{\beta_i} \equiv X_i^0 \quad (6)$$

Therefore, greater terror attacks will occur when intrinsic propensity for violence is higher, and/or the efficiency of the organization is higher. It is also easy to see that the second order sufficient condition for utility maximization is satisfied, because $\frac{\partial^2 U_i}{\partial A_i^2} = -\beta_i < 0$. Hence, the interior equilibrium exists if and only if $R_i \geq \frac{1}{2}\beta_i \left(\frac{\alpha_i}{\beta_i}\right)^2 = \frac{1}{2}\frac{\alpha_i^2}{\beta_i}$. Further, note that each terror outfit's problem is solved independently of other's problem.

From (6), it is observed that a terror group which is more violent tends to conduct more attacks. On the other hand, if the government steps up its counter-terrorism efforts against a terror outfit, it increases the marginal cost of conducting a terror strike for that outfit. Consequently, it reduces the optimal number of terror strikes. But the number of terror strikes an outfit conducts is independent of the size of its initial resource endowment. So, in interior equilibrium, any variation in R_i will lead to a corresponding equivalent variation in X_i.

Now consider the case when a terror group is resource-constrained, and is therefore unable to conduct A_i^0 attacks.[32] In this situation, the marginal benefit from terrorism exceeds its marginal cost, i.e., $-\beta_i A_i + \alpha_i > 0$. Then the optimal number of attacks by an outfit will be solved from the budget constraint (3) subject to $X_i = 0$. This is called a *corner* solution. Under this case, the entire initial resource endowment is spent on terrorism, and hence the optimal number of attacks is given by

$$A_i = \sqrt{\frac{2R_i}{\beta_i}} \quad (7)$$

[32] This is the case when $R_i < \frac{1}{2}\beta_i \left(\frac{\alpha_i}{\beta_i}\right)^2$.

Note that in interior equilibrium, the level of terror strikes does not depend on the resources the outfit holds. Contrastingly, in corner equilibrium, the level of terror strikes optimally conducted by the outfit will depend positively on the level of resources it has initially, but is independent of its inherent propensity for violence.[33] However, the parameter β_i has a similar effect directionally in both the cases.

4.3 External Sponsorship

In this section, the role of external sponsorship in inducing terror activities is examined, and its optimal size is also determined.

Suppose there is an external sponsor (S) having an amount $F > 0$, in units of resources, to induce terror attacks by the outfits.[34] It distributes the funds between the terror outfits based on some pre-specified allocation mechanism. Having observed A_1 and A_2, S rewards terror outfits T_1 and T_2 with amounts F_1 and F_2 such that $F_1 + F_1 = F$. The whole structure of the game is assumed to be common knowledge.

The above structure captures the role of external sponsorship as an inducement for violence. Terror attacks by an outfit are restricted by the resources available to it, *a priori*. This is not to say that in reality, terror outfits are only provided external sponsorship as a reward or inducement. For example, external sponsorship may be provided to a terror outfit even before it has conducted any terror strike. In our analysis, such sponsorship would be captured by a higher initial resource endowment (R_i). However, as demonstrated earlier, if a terror outfit having an

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[33] It may be worth noting, however, that whether there will exist corner solution or not will depend, to some extent, on the propensity of violence (α_i). Specifically, the equilibrium will be characterized by a corner solution if $\alpha_i > \sqrt{2\beta_i R_i}$, ceteris paribus. Otherwise, an interior equilibrium shall result.

[34] It is entirely possible that instead of a single external sponsor, S may represent a conglomerate of external sponsors, provided each conglomerate member has the same objective viz., maximization of total terror activity. In sub-section 3.4 the size of F has been optimally determined.

interior solution in the absence of external sponsorship was initially provided with more resources, it would use these additional resources only for increased consumption of the numeraire good. This would leave the level of terror activity unchanged. Although, if there existed a corner solution for the terror outfit in the absence of external sponsorship, provision of more resources initially would raise the level of terror activity.

With sponsor money, the payoff function of the i^{th} terrorist group $(i = 1, 2)$ is modified to be

$$U_i = X_i + \alpha_i A_i + F_i \tag{8}$$

Correspondingly, T_i's payoff maximization problem becomes

$$Max_{A_i} U_i = R_i - \frac{1}{2}\beta_i A_i^2 + \alpha_i A_i + F_i \tag{9}$$

In accordance with the above-discussed optimization exercise of the terror outfits, S may decide a rule or mechanism to allocate funds between the outfits to maximize aggregate terror activity. In the present chapter, however, the analysis is restricted to the proportional allocation rule alone, because this leads to interesting interactions between terror outfits, as shall be subsequently shown. A discussion shall also be provided on alternative allocation rules in subsection 4.3.3.

4.3.1 Proportionate Rule and Terror Activity

Under this allocation mechanism, the external sponsor awards each terror outfit a fraction of F equal to the fraction of total terror strikes carried out by that outfit. So, the fraction is endogenous. Then terror outfit T_i $(i = 1, 2)$ receives[35]

[35] Alternatively, it may be assumed that T_i $(i = 1, 2)$ will receive the entire sponsorship fund F with probability $\frac{A_i}{A_i + A_j}$ $(i \neq j = 1, 2)$. This, then, becomes similar to the Tullock (1980) game, where the probability of winning

$$F_i = \frac{A_i}{A_i+A_j} F \tag{10}$$

Substituting Equation (10) in Equation (9), T_i's utility maximization problem can be rewritten as[36]

$$Max_{A_i} U_i = R_i - \frac{1}{2}\beta_i A_i^2 + \alpha_i A_i + \frac{A_i}{A_i+A_j} F \tag{11}$$

If an interior optimum exists, the first order condition for terror outfit T_i $(i = 1, 2)$ is

$$\alpha_i + \frac{A_j}{(A_i+A_j)^2} F - \beta_i A_i = 0 \tag{12}$$

Clearly, $\alpha_i + \frac{A_j}{(A_i+A_j)^2} F$ is the marginal benefit and $\beta_i A_i$ is the marginal cost of an additional attack. Comparing (12) with (5), it can be seen that the marginal benefit in the presence of sponsorship is larger than that in its absence. Hence, the optimal number of attacks under sponsorship exceeds that in the absence of external sponsorship. This is the inducement effect of sponsorship.

The second order condition for T_i's optimization problem under external sponsorship is

$$\frac{\partial^2 U_i}{\partial A_i^2} = -\beta_i - 2\frac{A_j}{(A_i+A_j)^3} F < 0 \tag{13}$$

which is satisfied. Further note that

$$D \equiv \frac{\partial^2 U_i}{\partial A_i^2}\frac{\partial^2 U_j}{\partial A_j^2} - \frac{\partial^2 U_i}{\partial A_i \partial A_j}\frac{\partial^2 U_i}{\partial A_j \partial A_i} = \left(\beta_i + 2\frac{A_j}{(A_i+A_j)^3} F\right)\left(\beta_j + 2\frac{A_i}{(A_i+A_j)^3} F\right) + \frac{\left(A_i - A_j\right)^2}{\left(A_i+A_j\right)^6} F^2 > 0 \tag{14}$$

Therefore, the equilibrium is unique and stable. Equation (12) generates T_i's $(i = 1, 2)$ best-response (reaction) function $A_i = A_i\left(A_j\right)$, with intercept $A_i(0) = \frac{\alpha_i}{\beta_i} \equiv \underline{A}_i > 0$, and slope

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depends on the relative investments or efforts of the players. I call this the probabilistic allocation mechanism. Note that the analysis will remain unchanged in this case, if both terror outfits are assumed to be risk-neutral.

[36] The problem formulated here closely resembles the generalized Tullock contest game of Chowdhury and Sheremeta (2011). But unlike them, I am implementing a quadratic cost function.

$$\frac{dA_i}{dA_j} = -\frac{\frac{\partial^2 U_i}{\partial A_i \partial A_j}}{\frac{\partial^2 U_i}{\partial A_i^2}} = \frac{(A_i - A_j)F}{\beta_i (A_i + A_j)^3 + 2A_j F} \gtreqless 0 \qquad (15)$$

The best-response function is initially increasing, since $\left(\frac{dA_i}{dA_j}\right)_{A_j=0} = \frac{F}{\beta_i A_i^2} > 0$, and reaches its maximum at $A_i = A_j = \overline{A}_i$ (say) at which it intersects the line of equality, $A_i = A_j$ (i.e., the 45^0 line from the origin). From the reaction function, $\overline{A}_i = \frac{\alpha_i + \sqrt{\alpha_i^2 + \beta_i F}}{2\beta_i}$. Then $\overline{A}_1 \gtreqless \overline{A}_2$ according as $\frac{\alpha_1 + \sqrt{\alpha_1^2 + \beta_1 F}}{\alpha_2 + \sqrt{\alpha_2^2 + \beta_2 F}} \gtreqless \frac{\beta_1}{\beta_2}$. In the presence of external sponsorship, the reaction function of each outfit is therefore positively sloped till it reaches its maximum at its intersection with the line of equality, and is thereafter negatively sloped.[37] Finally, the optimum number of terror strikes (A_1^*, A_2^*) in an interior equilibrium (where neither outfit is resource-constrained) can be obtained at the intersection of the reaction functions of the terror outfits.

Therefore, if both terror outfits are characterized by interior optima, then $A_1^* \gtreqless A_2^*$ according as $\overline{A}_1 \gtreqless \overline{A}_2$.[38] When $\alpha_1 = \alpha_2$ and $\beta_1 = \beta_2$, one must have $A_1^* = A_2^* = \overline{A}_1 = \overline{A}_2$ in equilibrium. When $\alpha_i > \alpha_j$ but $\beta_i = \beta_j$, one gets $\overline{A}_i > \overline{A}_j$ and hence $A_i^* > A_j^*$. This is shown in *Figure 1* below. Note that a sufficient (but not necessary) condition for the existence of an interior optimum is $R_i \geq \frac{1}{2}\beta_i \overline{A}_i^2 \ \forall i = 1, 2$.

[37] For similar reaction functions in contexts other than external sponsorship of terror outfits, see Chowdhury and Sheremeta (2011) and Dixit (1987). In contrast, when there are operational externalities in the absence of external sponsorship, the reaction functions of the outfits may either slope upwards throughout or downwards throughout, depending on whether there are positive externalities or negative externalities respectively (see Chapter 3). Therefore, the CT policy implications under external sponsorship depend, to a large extent, on whether an initial equilibrium occurs at the rising portion or falling portion of the reaction functions.

[38] It is easy to understand the result. When $\overline{A}_1 > \overline{A}_2$, T_1's reaction function will be increasing and T_2's will be decreasing at the intersection point of two reaction functions, hence equilibrium will occur on the side of the 45^0 where $A_1 > A_2$.

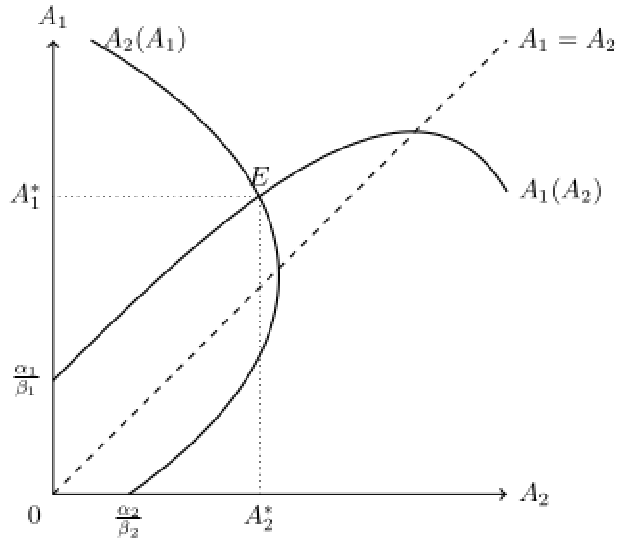

Figure 1: Interior optimum with external sponsorship if $\overline{A}_1 > \overline{A}_2$.

Now consider the scenario of corner solution. A necessary (though not sufficient) condition for the existence of a corner solution is $R_i < \frac{1}{2}\beta_i\overline{A}_i^2$ for some $i \in \{1, 2\}$. If terror outfit T_i's resource constraint binds, A_i^* satisfies $\frac{1}{2}\beta_i A_i^{*2} = R_i$. Clearly, if R_i is small enough, the optimal number of attacks may even go below $\underline{A}_i \left(= \frac{\alpha_i}{\beta_i}\right)$. *Figure 2* illustrates the case where T_1 alone is characterized by a corner solution. One interesting observation that follows in this case is that if only one terror outfit is resource-constrained, the other terror outfit may conduct a higher number of attacks compared to the interior optimum.[39] To write it more formally,

Proposition 1: *Under proportionate external sponsorship, if only T_i ($i = 1, 2$) is resource-constrained in the vicinity of the interior equilibrium, T_j's terror activity exceeds that in interior optimum whenever $\overline{A}_i > \overline{A}_j$.*

[39] It is easy to understand that if both terror outfits are resource-constrained, the terror activity conducted by each will be less than that in interior optimum.

The reason is that when $\overline{A}_i > \overline{A}_j$, $A_i^* > A_j^*$ holds in an interior equilibrium, and T_i's reaction function intersects T_j's reaction function in the latter's negatively sloping section. Now if T_i be resource-constrained in the vicinity of equilibrium, its reaction function becomes horizontal and will continue to intersect at the negatively sloped portion of the T_j's reaction function, but below the interior equilibrium. Hence, follows the result. In fact, if the resource-constrained outfit (T_i) is not too handicapped, that is, if the resource constraint is not too severe, then the resource-abundant outfit (T_j) would find it optimum to conduct more attacks than that under interior equilibrium. This is because at the number of attacks corresponding to the interior equilibrium, the resource-abundant outfit's marginal benefit from conducting more attacks would exceed the marginal cost of the same, thereby making it beneficial for this outfit to grab an even greater share of the external sponsorship on offer by conducting more attacks than in interior optimum. The result is portrayed in *Figure* 2.

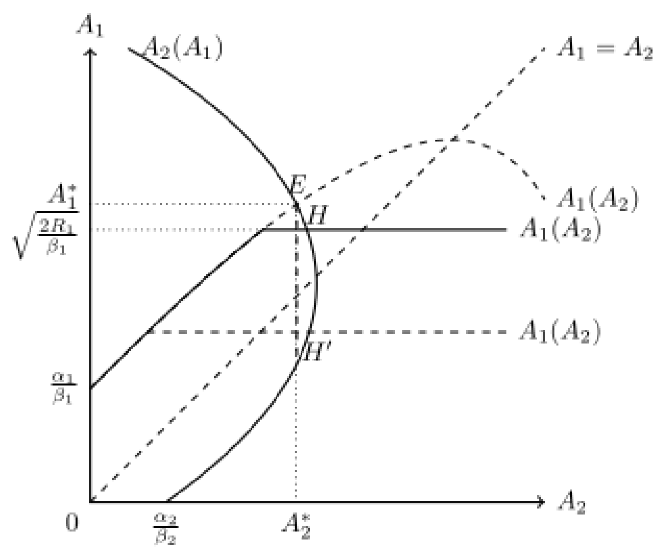

Figure 2: Equilibrium under external sponsorship when T_1 is resource-constrained, and T_2 is not.

If the resource-constrained outfit faces a sufficiently severe resource-crunch however, then at the level of attacks corresponding to the interior equilibrium, the resource-abundant outfit's marginal cost of conducting more attacks would exceed the marginal benefit from the same, thereby making it optimal for this outfit to conduct fewer attacks than in interior equilibrium.

The role of sponsorship can now be explained in the context of my model. It has already been observed that in the absence of sponsorship (i.e., $F = 0$) the optimal attacks conducted by T_i is $\frac{\alpha_i}{\beta_i}$ if it is not resource-constrained (i.e., $R_i \geq \frac{1}{2}\frac{\alpha_i^2}{\beta_i}$), and it is $\sqrt{\frac{2R_i}{\beta_i}}$ if T_i is resource constrained. Moreover, each outfit's decision is independent of the other. But when $F > 0$, each outfit's reaction function first rises, and then falls if it is not resource-constrained; and becomes a horizontal or vertical line (in the (A_i, A_j) space) at the terror activity level satisfying the budget with strict equality when the respective outfit becomes resource-constrained. This means, external sponsorship with the proportionate rule of allocation makes the outfits' decisions interdependent. Therefore, sponsorship via the proportionate allocation rule forces each outfit to behave strategically. The inter-outfit competition for a larger share of external sponsorship causes the outfits to conduct a higher number of terror attacks, exceeding that in the absence of such funding. This is the inducement effect of external finance. By committing to reward an outfit in proportion to its attack, the sponsor incentivizes each outfit to conduct more attacks. In subsection 4.3.4, the optimal level of sponsorship has been derived from the perspective of the sponsor who seeks to maximize the total number of attacks (i.e., $A = A_1 + A_2$). It may, however, be noted that in this structure an outfit's attacks are restricted by its initial resources, that is,

$A_i \leq \sqrt{\frac{2R_i}{\beta_i}}$. Therefore, the induced effect will work only up to that level. Hence, one arrives at the following proposition:

Proposition 2: *If at least one outfit is not resource-constrained, external sponsorship will induce more attacks.*

The comparative static effects of changes in different parameters are studied in the next section. It is shown that an external sponsor, by increasing sponsorship, can induce further attacks till both outfits become resource-constrained.

4.3.2 Comparative Static Results

In the present structure, CT policy will affect either one or the other parameter underlying the model. Therefore, to understand the impact of any CT policy, it is necessary to understand the effect of the change of a parameter in the model on A_i and A_j. The effect actually depends on the initial equilibrium, i.e., whether $\overline{A}_i \gtreqless \overline{A}_j$ and whether any outfit is resource-constrained or not. For the following analysis continues to assume the proportionate rule to allocate sponsorship, and discuss the effect of the change of a parameter in the vicinity of the initial equilibrium. Note that when $\overline{A}_i > \overline{A}_j$ and none of the outfits is resource constrained, then in the interior equilibrium one must have $A_i > A_j$.

An increase in the intrinsic propensity of violence

Consider an increase in T_i's intrinsic propensity of violence (α_i). One can see from (15) that the slope of its reaction function remains unchanged, but the intercept ($\frac{\alpha_i}{\beta_i}$) increases. Therefore, if T_i is not resource constrained, its reaction function will shift up by an equal amount corresponding to each level of terror strikes conducted by the other terror outfit. Hence, A_i^* will increase. But whether A_j^* will increase or decrease in the vicinity of the initial equilibrium, depends on whether $\overline{A}_i < \overline{A}_j$ or $\overline{A}_i > \overline{A}_j$. However, if T_i is resource-constrained, then both A_i^* and A_j^* will remain unchanged. On the other hand, if T_j is resource-constrained but T_i is not, then A_i^* will go up but A_j^* will remain unchanged. When both outfits are resource-constrained, there will be no effect on the number of attacks. To conclude, if there is an increase in propensity of violence of an outfit, generally it would tend to increase the total number of attacks. In particular, given the second order and stability conditions, if none or only T_j is resource-constrained, the total number of terror attacks ($A^* = A_i^* + A_j^*$) must increase if the intrinsic propensity of violence of any outfit increases. The formal proof of the result is given in Appendix A.

<u>An increase in cost inefficiency</u>

Consider an increase in β_i (i.e., the cost inefficiency of T_i). This will shift down the reaction function of T_i such that both the intercept and the absolute slope will fall. If T_i is resource-constrained, the horizontal segment of its reaction function will undergo a downward shift. Therefore, if β_i increases, T_i's equilibrium number of attacks (A_i^*) must fall irrespective of whether one or the other outfit is initially resource-constrained. If neither outfit is resource-constrained or T_i alone is resource-constrained, A_j^* will increase or decrease according as whether T_i's reaction function intersects the T_j's reaction function on the latter's falling or rising portion in the initial equilibrium (i.e., whether $A_i^* > A_j^*$ or $A_i^* < A_j^*$ initially). On the other hand, if T_j alone or both outfits are initially resource constrained, A_j^* will remain unchanged. However, even when A_j^* goes up, it will be dominated by the fall in A_i^*, hence the total number of attacks will fall. This happens because the direct effect of an increase in β_i, will dominate its indirect effect. To summarize, an increase in the inefficiency of any outfit will necessarily lead to a lower total attacks (see Appendix A).[40]

<u>An increase in external sponsorship</u>

An increase in sponsorship F, ceteris paribus, leaves the intercepts of the reaction functions unchanged, although the absolute slope of each reaction function increases (see Equation (15)). This will lead to an increase in the number of terror strikes conducted by each outfit such that Equation (12) is satisfied, provided that neither is resource-constrained. Hence, the new equilibrium lies to the north-east of the original equilibrium. If only one terror outfit is resource-constrained, it is unable to increase its number of attacks in response to a higher F. However, the other outfit increases its number of terror strikes. To summarize, if at least one outfit is resource-abundant, the total number of attacks must increase with an increase in F. The formal proof is provided in Appendix B.

<u>An increase in resources</u>

Suppose R_i increases. Then it will not affect the number of attacks conducted by either outfit if neither outfit, or only outfit T_j, is resource-constrained at the initial equilibrium. On the other hand, there will be an equivalent increase in X_i. However, if T_i alone is initially resource-

[40] Note that when T_i is resource-constrained and β_i increases, A_j^* will fall if $A_i^* < A_j^*$ in the initial equilibrium, although A_i^* must fall.

constrained and R_i increases, then it will enhance A_i^*. But whether A_j^* will increase or decrease depends on whether at the initial equilibrium, $A_i^* < A_j^*$ or $A_i^* > A_j^*$. If both outfits are resource-constrained initially, then an increase in the resources of one outfit will raise its number of attacks, although the other outfit's attacks will remain unchanged. Thus, an increase in the resources of an outfit may not necessarily increase the total number of attacks. For details, see Appendix C.

The comparative static results are summarized in Table 1, on page 79. To interpret these effects very briefly, note that an increase in propensity of violence of an outfit, say T_i, or increasing efficiency (i.e., lowering of β_i) will induce the outfit to enhance its terror activities, and the number of attacks will go up if it is not already resource-constrained. Now as A_i goes up, it will induce terror outfit T_j to change its optimal attacks A_j along its reaction function. If T_j was initially conducting more attacks (i.e., $A_j > A_i$), then in the vicinity of the initial equilibrium it would also optimally raise its optimal number of attacks. This captures the competition for external sponsorship F, which leads T_j to raise its terror attacks in order to neutralize the negative impact of the increase in T_i's terror attacks on its share of external sponsorship. If, on the other hand, T_j was conducting fewer attacks to begin with (i.e. $A_j < A_i$), then T_j optimally reduces its terror attacks in the vicinity of the initial equilibrium in response to an increase in the number of other outfit's attacks. This is because the benefit from cost-savings due to lower number of terror strikes dominates the loss from obtaining a reduced fraction of F. Similarly, a higher F implies a higher prize to be divided between the outfits on the basis of their fractions of the total number of terror strikes and, therefore, a fiercer competition between the outfits. This induces both outfits to conduct more attacks relative to the initial equilibrium. The effect of a change in resource-endowment can be similarly interpreted. The fundamental difference in the

Table 1: Comparative static results under sponsorship: [Here, "↑" denotes `increase', "↓" `decrease' and "↔" `remain unchanged'; $A = A_1 + A_2$.]

Parameter	Both T_i and T_j are Unconstrained	Only T_i is resource-constrained	Only T_j is resource-constrained	Both T_i and T_j are resource-constrained
α_i ↑	A_i ↑ A_j ↑, ↔, or ↓ acc. as $A_j \gtreqless A_i$. A ↑	A_i ↔ A_j ↔ A ↔	A_i ↑ A_j ↔ A ↑	A_i ↔ A_j ↔ A ↔
β_i ↑	A_i ↓ A_j ↑, ↔, or ↓ acc. as $A_j \underset{>}{\overset{<}{=}} A_i$ A ↓	A_i ↓ A_j ↑, ↔, or ↓ acc. as $A_j \underset{>}{\overset{<}{=}} A_i$ A ↓	A_i ↓ A_j ↔ A ↓	A_i ↓ A_j ↔ A ↓
F ↑	A_i ↑ A_j ↑ A ↑	A_i ↔ A_j ↑ A ↑	A_i ↑ A_j ↔ A ↑	A_i ↔ A_j ↔ A ↔
R_i ↑	A_i ↔ A_j ↔ A ↔	A_i ↑ A_j ↑, ↔, or ↓ acc. as $A_j \underset{>}{\overset{<}{=}} A_i$ A ↑	A_i ↔ A_j ↔ A ↔	A_i ↑ A_j ↔ A ↑

impacts of higher F and R_i is that a terrorist group must compete with the other for its fraction of F, which is not the case with R_i.

4.3.3 Alternative Sponsorship Mechanisms

In the present chapter, it is assumed that the total amount of external sponsorship F is fixed and committed before the game. Even if however, the external sponsorship amount is drawn from some probability distribution such that its expected value is F, the number of attacks optimally conducted by the terror outfits will be the same as before if the terror outfits are risk-neutral. If the outfits are risk-averse, however, then each will conduct fewer attacks. However, the number of attacks under risk-aversion would still exceed the number of attacks in the absence of external sponsorship. This is because the realized or *ex post* value of F can never be negative and hence, neither terror outfit can be worse off than in the absence of external sponsorship, despite being risk-averse.

It may also be possible that S grants a per-attack (constant) reward of $\gamma > 0$ to each terror outfit, that is, $F_i = \gamma A_i$ $(i = 1, 2)$. In this case, the total external sponsorship is not fixed but proportional to the total number of attacks, that is, $F = \gamma\left(A_i + A_j\right)$. In this case, the solution to the relevant first order condition yields the following optimum level of attacks for T_i $(i = 1, 2)$:

$$A_i = \frac{\alpha_i + \gamma}{\beta_i} > A_i^0 \tag{16}$$

It is easy to check that the second order condition for optimization holds. Hence, as in the case of proportionate or probabilistic allocation, external sponsorship in the form of per-attack reward once again results in a higher optimal number of attacks. This is due to the higher marginal benefit $\alpha_i + \gamma$ from each terror strike, compared to α_i in the absence of external sponsorship. There is, however, a marked similarity between this case and that without external sponsorship in that the optimal number of terror strikes conducted by one terror outfit is independent of the number of attacks conducted by the other outfit, hence there is no strategic interaction between the terror outfits in this case.

It is also possible that S may fix for T_i a sponsorship amount $\widetilde{F}_i > 0$ $(i = 1, 2)$ and some level of attacks $\widetilde{A}_i > A_i^0$ such that if $A_i \geq \widetilde{A}_i$, then $F_i = \widetilde{F}_i$; and if $A_i < \widetilde{A}_i$, then $F_i = 0$.[41] Note that such an inducement for additional terror strikes can only work if $\widetilde{A}_i$ is not too high. Specifically, $\widetilde{A}_i$ must satisfy $\frac{1}{2}\beta_i \widetilde{A}_i^{\,2} \leq R_i$, which can be interpreted as a participation constraint for T_i. A necessary condition for this is that T_i must not be resource-constrained initially.

For this sponsorship mechanism to successfully induce T_i to conduct $\widetilde{A}_i$ attacks instead of only A_i^0, however, it must also satisfy the '*acceptance*' condition, that is, the requirement that the outfits accept the contract.[42] The necessary and sufficient condition for this is $U_i(\widetilde{A}_i) \geq U_i(A_i^0)$, where $U_i(\widetilde{A}_i) = R_i - \frac{1}{2}\beta_i \widetilde{A}_i^{\,2} + \alpha_i \widetilde{A}_i + \widetilde{F}_i$ and $U_i(A_i^0) = R_i + \frac{1}{2}\frac{\alpha_i^2}{\beta_i}$. This condition entails that $\widetilde{F}_i$ be large enough to compensate for the marginal disutility to T_i, of conducting $(\widetilde{A}_i - A_i^0)$ additional attacks. Specifically, it can be shown that this translates to $\widetilde{F}_i \geq \frac{1}{2}\frac{\alpha_i^2}{\beta_i} - \left(\alpha_i \widetilde{A}_i - \frac{1}{2}\beta_i \widetilde{A}_i^{\,2}\right)$. The first and the second terms on the right-hand side represent the net benefits from conducting A_i^0 and $\widetilde{A}_i$ attacks respectively, in the absence of external sponsorship.[43] Hence, the right-hand side as a whole represents the marginal disutility of increasing the number of attacks from A_i^0 to $\widetilde{A}_i$. This is positive because A_i^0, being the optimal number of terror strikes conducted by T_i in the absence of external sponsorship, must necessarily generate a higher net benefit than

[41] It is also possible to consider the case of "winners take all". This is the case where the outfit conducting higher attacks wins all sponsor money.
[42] Note that T_i will not conduct more than $\widetilde{A}_i$ attacks because any additional attacks above this level would leave F_i unchanged, but would increase its cost incurred on terror strikes.
[43] The second term refers to the term within parentheses.

that achieved by conducting $\widetilde{A_i}$ attacks. Therefore, for such an acceptance condition to hold, the external sponsor must compensate T_i for the marginal disutility incurred by the latter in increasing its number of terror strikes above its interior optimum to the level desired by the former. Expectedly, it is easier to induce an inherently more violent group to conduct a given number of additional attacks, because the minimum compensation required for such inducement varies inversely with an outfit's intrinsic propensity for violence. Similarly, it is harder to induce a group to conduct a fixed number of additional terror strikes if the government's counter-terrorism efforts are more focused towards it (through a higher β_i).

In the sponsorship mechanism described above, one observes that because S commits F_1 and F_2 (and not F), there is once again no strategic interaction between the terror outfits, and A_1 and A_2 are thus mutually independent.

S may also subsidize the cost to the terror outfits of conducting attacks, by providing a per-attack subsidy to the terror outfits.[44] The outcome would be identical to that under per-attack reward, if the per-attack subsidy is set equal to the per-attack reward ($\gamma > 0$). This is because the budget constraint under per-attack subsidy is $X_i + \frac{1}{2}\beta_i A_i^2 = R_i + \gamma A_i$ and hence, the optimization problem of T_i is given by $Max_{A_i} U_i = R_i - \frac{1}{2}\beta_i A_i^2 + \gamma A_i + \alpha_i A_i$, the solution to which is $A_i = \frac{\alpha_i + \gamma}{\beta_i}$, $(i = 1, 2)$. This, of course, is identical to the number of terror strikes under an equivalent per-attack reward.

It must also be noted that if it was possible to provide external sponsorship to an outfit at the beginning of the game, then it would be equivalent to a higher initial resource endowment for

[44] Note that a lump-sum subsidy would fail to induce additional terror strikes if the outfit is not-resource constrained, because it would be equivalent to a higher R_i, and therefore leave the marginal cost of a terror strike unaltered. If however, the outfit is resource-constrained to begin with, then the optimal number of terror strikes would increase due to a lump-sum subsidy.

that outfit. Therefore, if the outfit is not resource-constrained, the external sponsorship would fail to induce additional terror strikes. The external sponsorship would only result in higher consumption. A resource-constrained outfit, however, would optimally conduct a higher number of terror strikes if provided with such sponsorship. Here, too, there is no strategic interaction between the outfits.

In this chapter, the focus is on external sponsorship which leads to strategic interaction between the outfits. Hence, I restrict myself to the proportionate allocation rule as given by Equation (10), for the remaining analysis.[45]

4.3.4 Optimal Sponsorship

In subsection 4.3.1, it is assumed that before the outfits choose non-cooperatively the number of the attacks they will conduct, the sponsors commit to pay a sum of money $F > 0$ to the outfits once the attacks take place, in proportion to their respective attacks, i.e., $F_i = \frac{A_i}{A_i + A_j} F;\ i \neq j$. It is further shown that an $F > 0$ will induce more terror activities compared to the no-sponsor case if and only if at least one outfit is not resource-constrained in the no-sponsor case i.e., $R_i \leq \frac{\alpha_i^2}{2\beta_i}$ at least for one i. On the other hand, if $R_i \leq \frac{\alpha_i^2}{2\beta_i}$ for both $i = 1, 2$, sponsorship cannot induce more terror attacks compared to no-sponsorship, but only causes consumption of the outfits to adjust. Under the proportionate rule, since sponsorship accrues to the outfits only after terror activities have taken place, each outfit's terror activity is restricted by the size of its resource endowment,

[45] When `optimal' sponsorship mechanism is the consideration of the sponsor, then one should study which sponsorship mechanism yields a higher benefit-cost ratio of the sponsor compared to feasible alternatives. If the sponsor does not value the cost of funds, as in this chapter, then the problem is to search for a mechanism which maximizes the total terror activity for a fixed F. This, however, is out of the purview of this analysis.

i.e., $A_i \leq \sqrt{\frac{2R_i}{\beta_i}}$, $i = 1, 2$. The implication is that under proportionate rule, sponsorship may induce terror attacks at most up to that level.

Let us assume that unlimited funds are available with the external sponsor, who wants to determine optimally how much funds to provide for sponsoring terror activities with the objective of maximizing the total number of terror attacks. I continue to assume that the sponsorship will be divided between the outfits as per the proportionate rule. The problem shall be discussed under the following assumptions:

Assumption (A1): $R_i > \frac{\alpha_i^2}{2\beta_i}$, $i = 1, 2$;

Assumption (A2): $R_1 > \frac{\alpha_1^2}{2\beta_1}$ *and* $R_2 \leq \frac{\alpha_2^2}{2\beta_2}$; and

Assumption (A3): $R_i \leq \frac{\alpha_i^2}{2\beta_i}$, $i = 1, 2$.

If external sponsorship is unavailable (i.e., $F = 0$), then the optimal number of attacks under assumption (A1) is $A_i = A_i^0$ $(= \frac{\alpha_i}{\beta_i})$, $i = 1, 2$. Then it follows from subsection 4.3.1 that for any $F > 0$, the optimal number of attacks will be given by the solution to the FOC (12), i.e., $\alpha_i + \frac{A_j}{(A_i+A_j)^2} F - \beta_i A_i = 0$, $i \neq j$ subject to $A_i \leq \sqrt{\frac{2R_i}{\beta_i}}$. Therefore, under proportionate external sponsorship, the optimal number of attacks under non-cooperative competition will be given by

$$A_i^*(F) = \min\{A_i(F), \sqrt{\frac{2R_i}{\beta_i}}\}, \; i = 1,2 \tag{17}$$

where $A_i(F)$ is obtained by simultaneously solving the FOCs, as given in Equation (12). Further, for any F, if $A_i(F) < \sqrt{\frac{2R_i}{\beta_i}}$, then as F is increased, $A_i(F)$ will go on increasing up to the level $\sqrt{\frac{2R_i}{\beta_i}}$. If F further increases, $A_i(F)$ will be pegged at $\sqrt{\frac{2R_i}{\beta_i}}$. Therefore, the maximum number of attacks that can be induced by sponsor money will be $A_i(F) = \sqrt{\frac{2R_i}{\beta_i}}$, $i = 1,2$. Then plugging $A_i(.) = \sqrt{\frac{2R_i}{\beta_i}}$ in the FOCs one obtains

$$\alpha_i + \frac{\sqrt{\frac{2R_j}{\beta_j}}}{(\sqrt{\frac{2R_i}{\beta_i}}+\sqrt{\frac{2R_j}{\beta_j}})^2} F - \beta_i\sqrt{\frac{2R_i}{\beta_i}} = 0; i \neq j$$

Summing over $i = 1,2$, one obtains the solution for optimal sponsorship $F = F^*$ as

$$F^*(R_1, R_2) = \left(\sqrt{\frac{2R_1}{\beta_1}} + \sqrt{\frac{2R_2}{\beta_2}}\right)\left(\beta_1\sqrt{\frac{2R_1}{\beta_1}} + \beta_2\sqrt{\frac{2R_2}{\beta_2}} - \alpha_1 - \alpha_2\right) \quad (18)$$

This simply states the optimal sponsorship amount required to enhance the number of attacks from $(\frac{\alpha_1}{\beta_1} + \frac{\alpha_2}{\beta_2})$ to $(\sqrt{\frac{2R_1}{\beta_1}} + \sqrt{\frac{2R_2}{\beta_2}})$.

Now consider assumption (A2). As shown in section 4.2, when $F = 0$, one must have $A_1^0 = \frac{\alpha_1}{\beta_1}$ and $A_2^0 = \sqrt{\frac{2R_2}{\beta_2}}$.[46] When $F > 0$, as follows from subsection 4.3.1, one has $A_2(F; R_2) = \sqrt{\frac{2R_2}{\beta_2}}$, and then $A_1 = A_1(F; A_2(F; R_2))$ is solved from the FOC: $\alpha_1 + \frac{A_2}{(A_1+A_2)^2}F - \beta_1 A_1 = 0$ subject to $A_1(F; A_2(F; R_2)) \leq \sqrt{\frac{2R_1}{\beta_1}}$. Therefore, given $F > 0$ the optimal number of attacks that T_1 will conduct is:

$$A_1^*(F) = \min\{A_1(F; A_2(F; R_2)), \sqrt{\frac{2R_1}{\beta_1}}\} \quad (19)$$

[46] Actually, if $R_2 = \frac{\alpha_2^2}{2\beta_2}$, then $A_2^0 = \frac{\alpha_2}{\beta_2} = \sqrt{\frac{2R_2}{\beta_2}}$.

Therefore, the maximum number of attacks by T_1 that can be induced by appropriate choice of F will be $A_1(F; A_2(F; R_2)) = \sqrt{\frac{2R_1}{\beta_1}}$. Finally, plugging $A_i(.) = \sqrt{\frac{2R_i}{\beta_i}}$, $i = 1,2$, in the FOC of T_1, I shall solve for optimal F under assumption (A2), i.e.,

$$\alpha_1 + \frac{\sqrt{\frac{2R_2}{\beta_2}}}{(\sqrt{\frac{2R_1}{\beta_1}} + \sqrt{\frac{2R_2}{\beta_2}})^2} F - \beta_1 \sqrt{\frac{2R_1}{\beta_1}} = 0$$

Therefore, the optimal $F = F^*$ under assumption (A2) is given by

$$F^*(R_1, R_2) = (\beta_1 \sqrt{\frac{2R_1}{\beta_1}} - \alpha_1) \frac{[\sqrt{\frac{2R_1}{\beta_1}} + \sqrt{\frac{2R_2}{\beta_2}}]^2}{\sqrt{\frac{2R_2}{\beta_2}}} \tag{20}$$

Here the optimal sponsorship is the amount required to enhance the number of attacks from $(\frac{\alpha_1}{\beta_1} + \sqrt{\frac{2R_2}{\beta_2}})$ to $(\sqrt{\frac{2R_1}{\beta_1}} + \sqrt{\frac{2R_2}{\beta_2}})$.

Finally, consider assumption (A3). It is already mentioned that if any $F > 0$ is committed before attacks are conducted, then F will have no impact on optimal A_i. This means if $R_i \leq \frac{\alpha_i^2}{2\beta_i}$ $\forall i = 1,2$, then F will fail to induce A_i using the proportionate rule. Summarizing the above analysis, the following proposition can be written:[47]

Proposition 3: *If the sponsor can provide unlimited finance, then given either of assumptions (A1) through (A3), the amount of sponsorship can always be determined optimally so as to maximize the total number of attacks using the proportionate rule. Under assumptions (A1) and*

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[47] The proportionate rule aside, one may consider the provision of sponsorship, *a priori*. Under Assumption (A3) such that $R_i < \frac{\alpha_i^2}{2\beta_i}$ for at least some i, a lump sum sponsorship F_i can be provided such that T_i conducts $\frac{\alpha_i}{\beta_i}$ $(i = 1, 2)$ attacks. In that case the optimal F_i will be solved from $\sqrt{\frac{2(R_i+F_i)}{\beta_i}} = \frac{\alpha_i}{\beta_i}$, hence $F_i = \frac{\alpha_i^2}{2\beta_i} - R_i$. Such F_i enables the outfit to conduct more attacks, but this is not via inducement.

(A2), F will provide an inducement for attacks whereas under assumption (A3), proportionate external sponsorship is ineffective and hence none is provided optimally.

To complete the analysis, consider the situation when the sponsor has limited funds in the sense that $F = \bar{F} < F^*$. In this case, one is back to the analysis of subsection 4.3.1 with $F = \bar{F}$, and so $A_1^* + A_2^* < \sqrt{\frac{2R_1}{\beta_1}} + \sqrt{\frac{2R_2}{\beta_2}}$ must hold (under assumption (A1) and (A2)). Note that the analysis has been restricted to the case of the proportionate rule, and demonstrates situations in which the sponsor may utilize external sponsorship to induce terror attacks. Naturally, CT policy will attempt to block this flow of money and thereby minimize incremental terror activity.

4.4 Counter-terrorism

Attention is now shifted toward the implications of the above discussion and results, for the counter-terrorism policy of the targeted country's government. Various categories of CT policies available to a country are discussed, with examples, in Chapter 3. In the present chapter the CT parameters that can be impacted by one or the other CT measure are β_is, α_is, R_is and F. For instance, an increase in β_i could be achieved through "*hardening*" of potential targets of T_i,[48] or by deploying governmental intelligence agencies against the outfit on a priority basis. Such CT efforts attempt to reduce the optimal number of terror strikes by reducing the (net) operational efficiency with which a terror outfit can attack certain targets.

If the targeted country's government takes the more pro-active/offensive approach of imposing financial and other sanctions or even conducting pre-emptive strikes to destroy the

[48] That is, by increasing the security levels of potential targets, thereby rendering them more difficult or costly for a terror outfit to attack.

assets of terror outfits, then this would result in lower R_is. Consider for example, the American campaign against the Afghan Taliban, post the attacks conducted by al Qaeda in the United States on 11 September, 2001. Sustained airstrikes, aimed at degrading the Taliban's assets and resources, were at the core of the war effort.

The government may alternatively attempt to win the *hearts and minds* of the alienated population living in a terror affected geographical area, in order to reduce the support for the terror outfit(s) operating in that area. Operation Sadbhavana, launched by the Indian Army in rural areas adjoining the LoC in 1998, is a case in point. Incentives may also be given to members/functionaries of a terror outfit in order to induce them to surrender. To this end, so-called *confidence-building measures* (CBMs) may be undertaken by the government. Further, the government may try to nudge religious institutions of learning to accept greater state regulation and to modify their curriculum and academic discourse. All such measures would tend to lower the intrinsic propensity of violence of an outfit active in that area.

Finally, economic sanctions may be imposed on institutions, individuals and countries sponsoring terrorism. The assets of such entities - financial and physical - may be frozen and confiscated, and the associated individuals jailed, thereby inhibiting their capacity to sponsor terror activities. All such measures would tend to reduce the external sponsorship available to terror outfits.

One of the most salient consequences of the analysis in Sections 4.2 and 4.3, is the effectiveness of defensive CT both in the absence and presence of external sponsorship, irrespective of whether the targeted terror outfit is resource-constrained or not. This is because as brought out by Equations (6), (7) and (12); the optimal number of terror attacks varies negatively with outfit-inefficiency β_i; which increases as a result of defensive CT. Equation (7), in fact, also has an important bearing on the applicability of offensive CT. Equation (7) gives the optimal number of terror attacks conducted by a resource-constrained terror outfit, both in the absence and presence of external sponsorship, and shows it to be an increasing function of resource-endowment R_i. Given that offensive CT causes R_i to decrease, it is effective against resource-constrained terror outfits. A similar result can be obtained for resource-abundant outfits, in terms of the applicability of CBMs, using Equations (6) and (12). This leads us to the proposition below.

Proposition 4: *Irrespective of the absence or presence of proportionate external sponsorship:*

a) *Defensive CT is effective against all terror outfits,*

b) *Offensive CT is effective against resource-constrained terror outfits, and*

c) *CBMs are effective against resource-abundant terror outfits*.

The comparative efficacy of different policy measures shall now be discussed. First consider absence of external sponsorship and that no outfit is resource-constrained. This means, both CBMs and defensive CT policy measures are effective. To compare the marginal impacts of these two policy measures in the vicinity of the initial interior equilibrium, it is easy to see from Eqn. (6) that

$$\left|\frac{\partial A_i}{\partial \beta_i}\right| = \frac{\alpha_i}{\beta_i^2} \gtrless \frac{1}{\beta_i} = \frac{\partial A_i}{\partial \alpha_i} \text{ according as } \alpha_i \gtrless \beta_i$$

This states that the choice between defensive CT policy and CBMs depends on whether the intrinsic propensity for violence is greater or lesser than the outfit's inefficiency in interior equilibrium. Since at the interior equilibrium, $A_i = \frac{\alpha_i}{\beta_i}$, therefore, the condition equivalently states that the defensive bias of an ad hoc CT response versus CBMs is positively associated with the level or intensity of terror activity of the concerned outfit(s). This explains why victim countries often deal with low-intensity conflicts (LICs) with *kid gloves*, unless and until they evolve over time into violent insurgencies that threaten the very political stability of the region and the government's administrative machinery. It is only under such situations, that the government feels compelled to suppress the terrorists with an *iron fist*.

Now considering the case of resource-constrained outfits, it is noteworthy that both defensive and offensive policies are effective. In the vicinity of corner equilibrium, the marginal impacts of the policy measures are obtained from Eqn. (7). This gives

$$\left|\frac{\partial A_i}{\partial \beta_i}\right| = \frac{1}{\beta_i^{3/2}}\sqrt{\frac{R_i}{2}} \gtrless \frac{1}{\sqrt{2\beta_i R_i}} = \frac{\partial A_i}{\partial \alpha_i} \text{ according as } R_i \gtrless \beta_i$$

Hence, in corner equilibrium, the offensive versus defensive bias of ad hoc CT response varies negatively with the outfit's resource base as well as the outfit's operational efficiency. This illustrates why even while dealing with resource-constrained outfits, the CT response in many countries prioritizes offense over defense if and only if the outfit's resources are sufficiently low (or existing surveillance measures and/or security of potential high-value targets are adequate to begin with). Hence, governments often act the toughest against those resource-constrained outfits which are the easiest to counter. The following proposition summarizes the above discussion on ad hoc CT:

Proposition 5: *In the absence of external sponsorship, the CT response in the vicinity of the initial equilibrium tends to prioritize:*

1. *CBMs, if and only if the terror outfit is resource-rich and sufficiently inefficient (or insufficiently violent),*

2. *Offensive measures, if and only if the terror outfit is sufficiently resource-constrained (or sufficiently inefficient), and*
3. *Defensive measures for all other outfits.*

The above proposition is logical. Firstly, a resource-rich outfit has a stronger (weaker) incentive to respond to CBMs if it is unable (able) to carry out attacks with sufficient impunity, say due to high-value targets being sufficiently secure (insecure); or if it is not too violent intrinsically, say because its objectives are political rather than ideological. Hence, follows the first statement. Secondly, an ad hoc CT response tends to be predominantly offensive if and only if governmental efforts to neutralize/squeeze the outfit's assets has an immediate impact on the ability of the outfit to conduct attacks, without threatening to draw the government into a long-drawn military campaign. This rationalizes the second statement. All other outfits are sufficiently efficient and are not highly resource-constrained. Hence, CBMs are not very effective and offensive measures threaten to snowball into a long-drawn and expensive military campaign, or are simply ineffective given that the outfit has sufficient resources at its disposal. Hence, the government tends to focus primarily on hardening potential targets. This justifies the third statement.

Let us now address external sponsorship. In the context of an outfit that is not resource-constrained, there are some obvious CT implications that flow from the third section. As in the absence of external sponsorship, CBMs and defensive CT measures are effective in inhibiting the outfit's terror activities while offensive measures are ineffective. Moreover, measures effectively targeting the sponsor would inhibit the sponsorship available to the outfits, and thereby reduce the optimal number of attacks.[49] A prime example of such an outfit is Boko Haram which, despite its decline since 2015, continues to remain a potent regional threat (Thurston 2017). In fact, Boko Haram's decline can be attributed, at least partially, to that of one of its principal sponsors, al Qaeda.[50] There can, however, be additional *indirect* impacts of CT measures targeting the other outfit, due to the inter-outfit strategic interaction induced by proportionate external sponsorship.

If the other outfit T_j $(j \neq i = 1, 2)$ is resource-rich as well, then as a consequence of the nature of the reaction functions derived in subsection 4.3.4, the optimal number of attacks conducted by the outfit under consideration T_i $(i = 1, 2)$ will be indirectly impacted by CBMs and defensive measures targeting T_j. If T_j conducts more attacks in the initial equilibrium, then these measures tend to increase A_i in the vicinity of the initial equilibrium. The converse is true if the other outfit conducts fewer attacks in initial equilibrium. If T_j is resource-constrained on the other hand, the optimal number of attacks conducted by T_i will be indirectly impacted by both defensive as well as offensive measures targeted at T_j. If T_j conducts more attacks in the initial equilibrium, then these measures tend to increase A_i in the vicinity of the initial equilibrium. The converse is true if the other outfit conducts fewer attacks in initial equilibrium.

For resource-constrained outfits, as in the absence of external sponsorship, the optimal number of attacks can be inhibited only by defensive and offensive CT, e.g., the Jammu and Kashmir Liberation Front (JKLF) in the Indian State of Jammu and Kashmir, failed to resurrect itself as a terror outfit after outfit head Shabbir Siddiqui and the 37 remaining members of the

[49] This supports the hypothesis suggested by Enders and Sandler (1999), that the reduction in bombings and hostage-taking episodes after the conclusion of the Cold War, was a result of reduced state-sponsorship of terrorism.
[50] See the 2015 report by the United States Army for a discussion al Qaeda's declining influence over Boko Haram, and Byman (2017) for an overall discussion of al Qaeda's decline.

Amanullah Khan faction were eliminated in two separate encounters in Hazratbal, in March 1996.[51]

Note interestingly that under sponsorship also, the comparison between defensive CT measure and CBMs against a resource-rich outfit depends on a similar threshold in terms of the initial intensity of terror attacks, as in the absence of sponsorship. To be more formal, from comparative static results it follows that

$$\left|\frac{\partial A_i}{\partial \beta_i}\right|_S > \left(\frac{\partial A_i}{\partial \alpha_i}\right)_S \text{ iff } A_i^S > 1$$

where $A_i^S = \frac{\alpha_i}{\beta_i}\ (= A_i^{NS})$. Here superscripts S and NS denote sponsorship and no-sponsorship, respectively. Note that the threshold `unity' in the condition is an outcome of the specifications of the present model. The important consideration is whether initial terror activity level is above or below a critical level, which, in turn, depends on the propensity of violence and the efficiency of the outfit Since $\frac{\alpha_i}{\beta_i} \gtreqless 1$, comparing the sponsorship and no-sponsorship cases for a resource-rich outfit, one arrives at the following proposition:

<u>Proposition 6</u>: *If defensive CT is more effective than CBMs without external sponsorship, then it is also more effective in its presence; on the other hand, if CBMs are more effective in the presence of external sponsorship, then they are also more effective in its absence; and finally, it is possible that defensive CT is more effective in the presence of external sponsorship, while CBMs are more effective in its absence.*

[51] See Vembu (September, 8, 2011) and GlobalSecurity.org (November 7, 2011) for instances of the muscular approach adopted by the Indian State in countering the JKLF.

To explain, first note that the optimal number of attacks conducted by a targeted resource-rich outfit in the presence of external sponsorship exceeds the optimal number of attacks in its absence. Further, from Lemma 1, it is known that the threshold for comparing the effectiveness of defensive CT relative to CBMs is unity. So there are three possibilities. If the optimal number of attacks conducted by the targeted outfit under both regimes exceeds unity, defensive CT is more effective under both regimes. If the optimal number of attacks conducted by the targeted outfit under both regimes falls short of unity, CBMs are more effective under both regimes. However, if the optimal number of attacks in the absence of external sponsorship falls short of unity while that in the presence of external sponsorship exceeds unity, then CBMs are more effective under the former regime while defensive CT is more effective in the latter.

Finally, counter-terrorism policy must take into consideration the different impacts of given policy interventions under each of the two regimes of *sponsorship* and *no sponsorship*. Proposition 8 below compares the impact of CBMs under the two regimes.

Proposition 7: *If both terror outfits are resource-rich and equally efficient a priori, then CBMs are more effective in the absence of external sponsorship, than in its presence.*

Proof: If both outfits are resource-rich, the impact of CBMs in the absence of external sponsorship is $\left|\frac{dA}{d\alpha_i}\right|_{NS} = \frac{1}{\beta_i}$, and that in its presence is $\left|\frac{dA}{d\alpha_i}\right|_{S} = \frac{\beta_j + \frac{F}{A^2}}{D}$. Now supposing $\beta_i = \beta_j = \beta$, and then substituting for D using Equation (14), one gets $\left|\frac{dA}{d\alpha_i}\right|_{NS} \gtrless \left|\frac{dA}{d\alpha_i}\right|_{S}$ according as $\beta A^2 + F \gtrless 0$. Since $\beta A^2 + F > 0$, therefore $\left|\frac{dA}{d\alpha_i}\right|_{NS} > \left|\frac{dA}{d\alpha_i}\right|_{S}$. Hence the proof.

The logic appeals to intuition. An outfit, which is responsive to the government's overtures in the absence of external funding, may not display the same urgency towards a negotiated settlement once it becomes a recipient of external funding. In the latter situation, the balance of power to *pull strings* with the outfit would likely be tilted in favour of the external sponsor. This is similar to the results obtained by Siqueira and Sandler (2006).

4.5 Conclusion

The present work explores the role of external sponsorship of terror outfits in augmenting violence, its potential to alter the behavior of terrorists, and the consequent impact on CT dynamics. The very first result expectedly bears out the ability of proportionate and probabilistic external sponsorship to augment terror activity, by engendering competition between terror outfits for the reward of funds. Although this is in line with the arguments presented in Byman (2005), Siqueira and Sandler (2006) are only able to prove this result under the assumption that the terrorist's support base is strong. The present analysis is able to establish the robustness of this result by demonstrating that it holds true as long as at least one of the terror outfits is resource-rich. Hence, the result holds even if one of the outfits is resource-constrained, which would be likely if that outfit does not have a strong support base.

Also in line with Byman (2005) and Siqueira and Sandler (2006), it is shown that governmental efforts at outreach via CBMs may not be as effective in the presence of external sponsorship, as in its absence. This is because the negative impact of CBMs on the terrorists' intrinsic proclivity for violence is negated by the increased motivation for terror attacks due to increased sponsorship.

Another striking inference borne out of the present effort is that defensive measures are a ubiquitous constituent of CT. This is because such measures reduce the efficiency with which terror outfits can use their scarce resources, thereby making them a safe choice in the context of any CT effort. And in contrast to the ubiquity of defensive measures, one finds CBMs and offensive CT measures to have limited applicability, as these are demonstrated to only be of any use against a resource-rich and resource-constrained terror outfit respectively.

Further, it must be noted that since any terror outfit would conduct at least as many terror strikes in the presence of external sponsorship than in its absence, it is obvious that if an outfit is resource-abundant in the presence of external sponsorship, then it must be resource-abundant even in its absence. In fact, this chapter establishes that if CBMs are more effective than defensive CT under external sponsorship, than they must be more effective even in its absence. As a corollary, if defensive CT is more effective than CBMs in the absence of external funding, then it must be more effective even in its presence.

CBMs can inhibit the activity of resource-rich terrorists by reducing their inherent propensity for violence, while offensive measures can serve to curtail the activity of a resource-constrained terror group by causing the degradation of its resources. This contributes to the existing literature which only demonstrates the general *over-investment* in defensive measures and *under-investment* in offensive measures (eg., Sandler (2005)), the inability of countries to arrive at the optimal CT mix between offence and defence when faced with a common terrorist threat (eg., Sandler and Siqueira (2006)), and the inability of the State to win a *war-on-terror* using preemption alone as long as the marginal cost of preemptive measures is increasing (Das and Lahiri (2019)). The importance of my finding lies in its rationalization of the omnipresence of defensive CT on the basis of the above-mentioned *efficiency-of-resource-use* hypothesis, a novelty. This is demonstrated under constant marginal costs of preemption and defence, and both in the presence and absence of a strategic external sponsor, thereby establishing the inherent robustness of the result.

Finally, if finance is the *lifeblood* of terrorism (Acharya (2009)), curbing it must prove effectual in severing the terrorists' lifeline. The present work demonstrates that curtailing external sponsorship, if present, is always effective in reducing terror activity. Choking such funding is shown to successfully reduce the attacks conducted by each outfit. Moreover, the present analysis illustrates that targeting external finance if present, may be the most effective means to reduce terror attacks if terror activity is sufficiently low. The decline and eventual disappearance of the Abu Nidal Organisation (ANO), is a prime example of the efficacy of constraints on external finance. The impact of curbed external funding results in reduced size of the reward, which inhibits the incentive of the terror outfits to compete as aggressively by conducting more attacks.

A lot remains to be explored about the external sponsorship of terror outfits, however. It would be meaningful to compare the effectiveness of alternative mechanisms of terror finance, both as an incentivizing device (as in the present work), and as an enabler of terror activity. In fact, it would be particularly meaningful to explore the latter in the context of resource-constrained outfits. Moreover, it is also important to delve into the impact of inter-outfit cooperation between terrorists, on the effectiveness of external funding.

4.6 Appendices

Appendix A: Effect of change of α_i *and* β_i

Under external sponsorship, the problem of T_i is given by Eqn. (11). When interior optimum exists, A_i and A_j are solved from (12). The solutions are unique and stable, given (13) and (14) are satisfied. The equilibrium solutions are functions of the parameters in the model. One can further derive $\frac{\partial^2 U_i}{\partial A_i \partial A_j} = \frac{A_i - A_j}{(A_i+A_j)^3} F$. For any parameter, θ, the comparative static results in general are:

$\frac{dA_i}{d\theta} = \frac{1}{D}[-\frac{\partial^2 U_i}{\partial A_i \partial\theta}\frac{\partial^2 U_j}{\partial A_j^2} + \frac{\partial^2 U_j}{\partial A_j \partial\theta}\frac{\partial^2 U_i}{\partial A_i \partial A_j}]$ and $\frac{dA_j}{d\theta} = \frac{1}{D}[-\frac{\partial^2 U_j}{\partial A_j \partial\theta}\frac{\partial^2 U_i}{\partial A_i^2} + \frac{\partial^2 U_i}{\partial A_i \partial\theta}\frac{\partial^2 U_j}{\partial A_j \partial A_i}]$

Using the above, comparative static results can be obtained under each situation, as follows:

Situation 1: No outfit is resource-constrained.

Change of α_i:

$\frac{dA_i}{d\alpha_i} = \frac{1}{D}(\beta_j + 2\frac{A_i}{(A_i+A_j)^3}F) > 0$, and $\frac{dA_j}{d\alpha_i} = \frac{1}{D}\left(\frac{A_i - A_j}{(A_i+A_j)^3}\right)F$; hence $\frac{dA_j}{d\alpha_i} \gtrless 0 \Leftrightarrow A_j \gtrless A_i$.

Defining $A = A_i + A_j$, one has $\frac{dA}{d\alpha_i} = \frac{1}{D}(\beta_j + \frac{F}{(A_i+A_j)^2}) > 0$.

Change of β_i:

$\frac{dA_i}{d\beta_i} = -\frac{A_i}{D}\left(\beta_j + 2\frac{A_i}{(A_i+A_j)^3}F\right) < 0$ and $\frac{dA_j}{d\beta_i} = -\frac{A_i}{D}\left(\frac{A_j - A_i}{(A_i+A_j)^3}\right)F$; hence $\frac{dA_j}{d\beta_i} \gtrless 0 \Leftrightarrow A_j \lessgtr A_i$

So, $\frac{dA}{d\beta_i} = -\frac{A_i}{D}\left(\beta_j + \frac{F}{(A_i+A_j)^2}\right) < 0$; $\frac{dA}{d\beta_i} = -A_i\frac{dA}{d\alpha_i}$.

Situation 2: Only T_i is resource-constrained.

Here A_i is solved from $R_i = \frac{1}{2}\beta_i A_i^2$, hence $A_i = \sqrt{\frac{2R_i}{\beta_i}}$. But A_j is solved from the FOC: $\alpha_j + \frac{A_i}{(A_i+A_j)^2}F - \beta_j A_j = 0$.

Change of α_i:

Here, $\frac{dA_i}{d\alpha_i} = 0 = \frac{dA_j}{d\alpha_i}$, hence $\frac{dA}{d\alpha_i} = 0$.

Change of β_i:

$\frac{dA_i}{d\beta_i} = -\frac{1}{2\beta_i}\sqrt{\frac{2R_i}{\beta_i}} < 0$. From the FOC $\frac{dA_j}{d\beta_i} = \frac{(A_j - A_i)F}{\beta_j (A_i+A_j)^3 + 2A_i F}\frac{dA_i}{d\beta_i}$ can be derived.

Hence, $\frac{dA_j}{d\beta_i} \gtreqless 0 \iff A_j \lesseqgtr A_i$. Therefore, $\frac{dA}{d\beta_i} = \frac{\beta_j (A_i+A_j)^3 + (A_i+A_j)F}{\beta_j (A_i+A_j)^3 + 2A_i F}\frac{dA_i}{d\beta_i} < 0$.

Situation 3: Only T_j is resource-constrained

In this case A_j is solved from $R_j = \frac{1}{2}\beta_j A_j^2$, hence $A_j = \sqrt{\frac{2R_j}{\beta_j}}$. Now given A_j, A_i is solved from the FOC: $\alpha_i + \frac{A_j}{(A_i+A_j)^2}F - \beta_i A_i = 0$.

Change of α_i

$\frac{dA_j}{d\alpha_i} = 0$, and from FOC, $\frac{dA_i}{d\alpha_i} = \frac{1}{\beta_i + 2\frac{A_j}{(A_i+A_j)^3}F} > 0$, hence $\frac{dA}{d\alpha_i} = \frac{dA_i}{d\alpha_i} > 0$.

Change of β_i

$\frac{dA_j}{d\beta_i} = 0$, and using FOC, $\frac{dA_i}{d\beta_i} = -\frac{A_i}{\beta_i + 2\frac{A_j}{(A_i+A_j)^3}F} < 0$, hence $\frac{dA}{d\beta_i} = -A_i\frac{dA}{d\alpha_i} < 0$.

Appendix B: Effect of change of F

When neither outfit is resource-constrained, the optimal attacks are solved from the FOC, SOC and stability and uniqueness condition as given by (12), (13) and (14) respectively. Then one can derive

$$\frac{dA_i}{dF} = \frac{1}{D(A_i+A_j)^5}\left[A_i(A_i - A_j)F + A_j\left\{\beta_j\left(A_i + A_j\right)^3 + 2A_i F\right\}\right] > 0,$$

$$\frac{dA_j}{dF} = \frac{1}{\Delta(A_i+A_j)^5}\left[-A_j(A_i - A_j)F + A_i\left\{\beta_i(A_i + A_j)^3 + 2A_jF\right\}\right] > 0,$$

Therefore,

$$\frac{dA}{dF} = \frac{1}{D(A_i+A_j)^3}\left[F + (A_i + A_j)(\beta_i A_i + \beta_j A_j)\right] > 0.$$

Now, if T_j is resource constrained but T_i not, then $A_j(F; R_j) = \sqrt{\frac{2R_j}{\beta_j}}$, and A_i is finally solved from T_i's FOC, $\alpha_i + \frac{A_j}{(A_i+A_j)^2}F - \beta_i A_i = 0$, subject to $A_i \leq \sqrt{\frac{2R_i}{\beta_i}}$. Then clearly $\frac{dA_i}{dF} > 0$, hence $\frac{dA}{dF} > 0$ for all $A_i < \sqrt{\frac{2R_i}{\beta_i}}$.

Appendix C: Effect of change of R_i

When neither outfit or T_j alone is resource constrained, it is easy to understand that neither outfit's terror activity changes. When both are constrained, A_i rises because $A_i = \sqrt{\frac{2R_i}{\beta_i}}$. Therefore, when T_i alone is resource constrained, A_i goes up for the same reason, but in this case A_j is solved from the FOC: $\alpha_j + \frac{A_i}{(A_i+A_j)^2}F - \beta_j A_j = 0$. Using this, one can derive $\frac{dA_j}{dR_i} = \frac{(A_j - A_i)F}{\beta_j(A_i+A_j)^3 + 2A_iF}\frac{dA_i}{dR_i}$. Hence, $\frac{dA_j}{dR_i} \gtrless 0 \iff A_j \gtrless A_i$. Finally, $\frac{dA}{dR_i} = \frac{\beta_j(A_i+A_j)^3 + (A_i+A_j)F}{\beta_j(A_i+A_j)^3 + 2A_iF}\frac{dA_i}{dR_i} > 0.$

Chapter 5

Chapter 5: Terrorist Inter-Group Cooperation

This chapter presents the first formal model of inter-outfit strategic cooperation which reveals that the cooperating terror outfits may conduct more, less or the same number of attacks as in the absence of cooperation; based on whether they are resource-constrained or not a priori; and on the extent to which cooperation can serve to ease such a constraint through inter-outfit resource-transfer. In the absence of external sponsorship, the chapter shows that strategic cooperation between two outfits has no impact on terror activity if neither outfit is resource-constrained a priori. If only one outfit is resource-constrained a priori, on the other hand, then inter-group cooperation increases terror activity if and only if there is sufficient resource-asymmetry between the outfits. Further, if both outfits are resource-constrained a priori, then cooperation may increase or decrease terror activity depending on parametric asymmetries. Finally, it is demonstrated that while cooperation can neutralize the impact of strategic external sponsorship on terror activity and thereby remove the incentive for its provision, minor modifications to the sponsorship mechanism can often mitigate this phenomenon.[52]

5.1 Overview

Terrorists perpetrate violence to draw public attention to their objectives, and to pressurize ruling political dispensations into capitulating to their demands. Just as governments of different countries may coalesce to combat terrorism, terrorist groups may join forces to overwhelm the

[52] The contents of this chapter are drawn mostly from Bhan and Kabiraj (2020b).

State machinery.[53] For instance, consider the merger in 2012 of the Somali terrorist group al-Shabaab, with the al Qaeda.[54] Alliances between terrorist groups however, are an exception rather than the rule, given that less than one percent (417 to be exact) of the 81,799 terror attacks conducted during 1970-2007 involved more than one terror outfit (Asal et al., 2016). This may be due to the inability of terror outfits, which are illegal organizations, to credibly overcome commitment issues in the absence of third-party enforcement (Bacon, 2017).[55] Further, a significant fraction of outfits does not exist for more than a year, thereby making it difficult for them to reliably pledge to certain behavioral patterns for the long term.[56]

Ackerman et al. (2017) explore the circumstances under which terror outfits with differing ideologies may align operationally, to achieve common goals. The game-theoretic framework used by the authors for this purpose gives rise to multiple equilibria, with some characterized by cooperation. In fact, a prominent reason proposed in the literature for inter-outfit cooperation, is the resultant enhancement of outfit longevity. Using data spanning 1987 to 2005, Phillips (2014) shows that terror outfits having one ally are 38 percent less likely to discontinue in a given year, compared to terror outfits without any ally. Further, the abilities of terror outfits to address each other's organizational voids, forge a common discernibility and cultivate mutual trust are ubiquitous prerequisites for intergroup alliances (Bacon, 2018a). The notion that alliances are a measure of vulnerability, however, is not empirically validated.[57] On

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[53] See Sandler (2005) for a discussion on coordination problems which plague international cooperation against transnational terrorism, but do not hinder resolute effort against domestic terrorism; and Perliger and Milton (2018) for a data-driven identification of conditions under which countries may engage in counter-terrorism cooperation.

[54] See Thomas (2013) for a discussion on the counter-terrorism opportunities arising from vulnerabilities created as a result of this amalgamation.

[55] See Choi, Chowdhury and Kim (2016) for an insightful discussion on inter-group and intra-group dynamics, and possible feedback effects of inter-outfit rivalries. These can potentially negate any attempts at cooperation.

[56] Phillips (2019), based on eight most extensive global datasets on the longevity of terror outfits, obtains that 25-74 percent of outfits do not last beyond a year.

[57] See Phillips (2019), for instance.

the other hand, Phillips (2019) finds that "*alliances are associated with territorial control, intermediate membership size, and religious motivation*".

In addition to understanding the causes of inter-group terrorist cooperation, it is also important to dwell on the nature of cooperation between terror outfits. Significant variation is observed in the scope and depth of cooperation between different terror outfits, from mergers and strategic cooperation at the upper end of the scale, to tactical and transactional cooperation at the lower end (Moghadam, 2015). In fact, mergers and strategic cooperation become equivalent if payoffs are freely transferable between the outfits, under the latter regime. When outfits merge, each outfit sacrifices its individual identity. Under transactional cooperation, at the other end of the spectrum, there is usually no noteworthy loss of independence for either outfit. Hence, the quality of cooperation holds salience for each outfit, and thereby for those seeking to counter them.

The present work is the first to formally model inter-outfit strategic cooperation in a manner which reveals that the cooperating outfits may conduct more, less or the same number of attacks as in the absence of cooperation; based on whether they are resource-constrained or not *a priori*; and on the extent to which cooperation can serve to ease such a constraint through inter-outfit resource-transfer. The alleged provision of training facilities by the Hezbollah in southern Lebanon, for thousands of Hamas fighters, is a case in point.[58] Bacon (2018b) discusses how cooperation between the al Qaeda and the Taliban, provided the former with a safe haven in Afghanistan, while benefitting the latter in terms of superior training of its fighters by al Qaeda operatives. She points out that al Qaeda operatives have, in fact, been known to carry out special operations on Taliban's behalf. Bacon (2018b) also mentions how it was the al Qaeda, during the

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[58] See "Israel says Hamas working with Hezbollah to train 'thousands' in Lebanon", in Times of Israel (9 June, 2018), https://www.timesofisrael.com/israel-says-hamas-working-with-hezbollah-to-train-thousands-in-lebanon/.

1990s, which provided funds to the Taliban. This typifies successful cooperation spanning over two decades, in which resources have been transferred in both directions during different periods of time, based on changing circumstances and evolving requirements. Also consider the alliance with the Popular Front for the Liberation of Palestine (PFLP), initiated by Fusako Shigenobu of the Japanese Red Army, in 1971. The cooperation, driven by resource requirements needed to implement its chosen strategy, resulted in the provision of guerilla training facilities to Red Army members, by PFLP operatives in Lebanon (Steinhoff 1976; Bacon 2018a).

Based on Bhan and Kabiraj (2020a), the presented structure is able to illustrate clearly the distinction – if present - between the equilibria in the presence and absence of strategic cooperation, under different parametric restrictions. Further, the formulation demonstrates a natural barrier to the excessive use of any outfit channel for conducting attacks under cooperation, based on the diseconomies of scale associated with terror activity. This shows why such cost-convexities, by themselves, may provide a strong rationale for inter-outfit cooperation by providing the co-operating outfits multiple channels of terror activity.

Other benefits from strategic cooperation may flow from the internalization of operational externalities imposed by the activities of one group on the other, such as those discussed and modeled in Bhan and Kabiraj (2019a). As a consequence of such cooperation, the total number of attacks conducted by the terrorists would tend to increase under positive externalities, and decrease under negative externalities. The present analysis, on the other hand, rationalizes strategic cooperation even in the absence of externalities, thereby indicating the possibility of inter-outfit cooperation in a wider range of real-world situations.

Refer to the afore-mentioned example of cooperation between the Japanese Red Army and the PFLP, the former originating in the East Asian country of Japan, and the latter operating in West Asia. Despite the traditional theatres of operation of these outfits being separated by thousands of kilometers of land and sea, their alliance led to the deadly attack conducted by Red Army terrorists on Lod Airport near the Israeli city of Tel Aviv in 1972, resulting in 28 deaths (including two attackers) and nearly 80 injuries (including the third attacker), thereby highlighting the potential for deadly cooperation between outfits imposing no operational externalities on each other *a priori*.

Inter-outfit cooperation may also have grave consequences in terms of the lethality of terror outfits. For instance, consider the symbiotic relationship that emerged between the Southeast Asian outfit Jemaah Islamiyah and the al Qaeda, which enabled the training of the former's manpower by the latter's operatives, resulting in the deadly Bali bombing in 2002 (Horowitz and Potter 2014). Also, the then alleged and oft-ridiculed - and later proven - training of amateur Boko Haram personnel by al Qaeda in the Islamic Maghreb (AQIM) operatives beginning in 2009, resulted in suicide attacks conducted by the former in 2011 on the United Nations office in Abuja, Nigeria, using tactics similar to bombings conducted by the latter (Aronson 2014). These examples serve to illustrate how cooperation can serve to increase the killing capacity of the outfits involved.

Finally, the circumstances associated with cooperation between symmetric and asymmetric entities, is critical in obtaining a holistic understanding of inter-group terrorist cooperation. Utilizing the UCDP/PRIO Armed Conflict Dataset, Bapat and Bond (2012) conclude that whereas outfits less at risk of State suppression tend to favour two-sided alliances, "*vulnerable militants are more likely to form asymmetric alliances*" such as those involving state or external sponsors. The present chapter borrows from the formulation of Bhan and Kabiraj (2020a) to illustrate not only the potential of strategic external sponsorship to augment violence, but also to demonstrate how strategic intergroup cooperation between terrorists can impede the effectiveness of such sponsorship, thereby decreasing the appeal for any potential sponsor to finance the cooperating outfits. This also provides a logical basis for a potential external sponsor, to hinder any inter-outfit strategic cooperation, in order to increase its own ability to induce additional terror attacks.

Consider for instance, the impact of the emergence of al-Badr in the Indian State of Jammu and Kashmir, towards the close of the 20th century. Earlier operating under the banner of Hizb-ul-Mujahideen (HM), Al-Badr was allegedly encouraged by Pakistan's Inter-Services Intelligence (ISI) to operate independently in the year 1998, as mentioned in an ANI report (dated 23 August, 2017) titled '*J-K: Al-Badr terrorist killed in Budgam encounter*'.[59] Since then, the combined number of terror strikes conducted by both outfits dramatically increased, although HM still accounted for an overwhelming majority of the attacks. From 0 incidents in 1996 and 1997, the combined number of terror strikes jumped to 8 in 1999, 12 in 2000, and 11 in 2001. It is also noteworthy that Al-Badr was involved in only 1 terror incident (in 1999) out of the combined 31 in the period 1999-2001 (Global Terrorism Database). Hence, by engineering a split between HM and Al-Badr, the ISI was able to manipulate the former into conducting more attacks in order to maintain its (the HM's) pre-eminence.

In the present chapter it is shown that depending on the resources available with the outfits, their intrinsic propensities for violence and cost-efficiency parameters, cooperation may or may not increase the total number of attacks. Also, there are situations when cooperation reduces the total number of attacks. Further, the present work provides a theoretical foundation for strategic external sponsorship by internalizing the decision of terror outfits to cooperate strategically or not, and the external finance offered. Based on the *ex-ante* resources with the

[59] See https://www.aninews.in/news/national/politics/j-k-al-badr-terrorist-killed-in-budgam-encounter/.

outfits and the quantum of finance made available by the sponsor, situations are illustrated where strategic external sponsorship can optimally induce outfits to operate non-cooperatively, and conduct attacks at the behest of the strategic sponsor.

Counter-terrorism (CT) implications of inter-group strategic cooperation must be viewed in light of the specificities of each instance in terms of *ex ante* resources with the outfits, availability of external sponsorship, etc., in order to determine whether such cooperation would increase or decrease terror strikes. Circumstances encouraging cooperation must be created in the latter situation, while measures inhibiting cooperation must be pursued in the former. For example, if the presence of a potential external sponsor is likely to increase attacks by discouraging cooperation, then CT efforts must be directed at enabling and encouraging alliance-formation, and thereby keeping the external sponsor at bay. Consider conversely, for instance, that cooperation is likely to ease the resource-constraint of an outfit such that overall violence is augmented. Then all efforts must be made to disrupt such an alliance by sowing distrust between the outfit leaders by raising suspicions of the potential partner being infiltrated by enemy intelligence, emphasizing ideological distinctions and operational autonomy, etc. via surveillance of inter-group communications and covert messaging for example, along the lines suggested by Bacon (2017).

The next section presents the baseline model, utilizing it to characterize and compare the equilibria under cooperation and non-cooperation. The third section analyzes the impact of strategic cooperation in the presence of a potential external sponsor. The fourth section extends the analysis by endogenizing the outfits' decision to cooperate or not, in the presence of strategic external sponsorship. Finally, the fifth section briefly discusses the implications of the results obtained, and concludes.

5.2 Model

Consider the interaction of two terror outfits, T_1 and T_2, operating in a target country. It is assumed that initially, each outfit T_i $(i = 1, 2)$ possesses some resources R_i (> 0) of which a part is spent on terror activities and the remaining part on other non-terror activities, called consumption.[60] Hence, the utility or payoff of T_i comes from two sources: consumption (X_i), and the attacks (A_i) it conducts.[61] Assume the utility function to be linear, specifically,[62]

$$U_i = X_i + \alpha_i A_i; i = 1, 2$$

where the parameter α_i (≥ 0) represents intrinsic propensity for violence of T_i. The associated cost of conducting A_i attacks for T_i is

$$C_i(A_i) = \frac{1}{2}\beta_i A_i^2$$

where β_i (> 0) is a parameter representing cost-efficiency of T_i, such that a higher β_i represents a lower efficiency. The quadratic cost function reflects increasing difficulty in conducting successive attacks. Then, the budget constraint of T_i is given by:

$$X_i + \frac{1}{2}\beta_i A_i^2 = R_i$$

First, the equilibrium outcomes are noted when the outfits interact independently or non-cooperatively, that is, when each outfit maximizes its payoff subject to its budget constraint. Following the analysis of the previous chapter, the following outcomes are obtained:

5.2.1 Non-cooperative (NC) equilibrium outcomes

[60] This may include expenditure on housing, health, education, etc. of the families of the members of the terror groups.
[61] More generally, A_i can be considered as an index of terror activity. So A_i is assumed to be a continuous variable.
[62] The formulation is the same as in the previous chapter.

(NC1): When $R_i \geq \frac{1}{2}\beta_i\left(\frac{\alpha_i}{\beta_i}\right)^2$ holds for each i, that is, no outfit is resource-constrained, it is called an interior equilibrium. Then in equilibrium:

$$A_i^{NC} = \frac{\alpha_i}{\beta_i}, \text{ and } X_i = R_i - \frac{1}{2}\frac{\alpha_i^2}{\beta_i} \equiv X_i^{NC} \geq 0 \quad \forall\, i = 1,2 \tag{1a}$$

Hence, total number of attacks is:

$$A^{NC} = A_1^{NC} + A_2^{NC} = \frac{\alpha_1}{\beta_1} + \frac{\alpha_2}{\beta_2} \tag{1b}$$

(NC2): When $R_1 \geq \frac{1}{2}\beta_1\left(\frac{\alpha_1}{\beta_1}\right)^2$ but $R_2 < \frac{1}{2}\beta_2\left(\frac{\alpha_2}{\beta_2}\right)^2$, the equilibrium outcomes will be:

$$A_1^{NC} = \frac{\alpha_1}{\beta_1}, X_1^{NC} = R_1 - \frac{1}{2}\frac{\alpha_1^2}{\beta_1} \geq 0 \text{ , but } A_2^{NC} = \sqrt{\frac{2R_2}{\beta_2}} \text{ and } X_2^{NC} = 0 \tag{2a}$$

$$A^{NC} = A_1^{NC} + A_2^{NC} = \frac{\alpha_1}{\beta_1} + \sqrt{\frac{2R_2}{\beta_2}} \tag{2b}$$

(NC3): When $R_i < \frac{1}{2}\beta_i\left(\frac{\alpha_i}{\beta_i}\right)^2$ holds $\forall\, i = 1,2$, in equilibrium one has

$$A_i^{NC} = \sqrt{\frac{2R_i}{\beta_i}}, \text{ and } X_i^{NC} = 0 \;\; \forall\, i = 1,2 \tag{3a}$$

$$A^{NC} = A_1^{NC} + A_2^{NC} = \sqrt{\frac{2R_1}{\beta_1}} + \sqrt{\frac{2R_2}{\beta_2}} \tag{3b}$$

The equilibria in (NC2) and (NC3) are called corner solutions – these are cases where at least one outfit is resource-constrained. Given the above equilibria, I shall now study whether the outfits collectively enhance terror activity under cooperation.

5.2.2 Cooperation between terror outfits

It is assumed that under cooperation, payoffs are freely transferable between the outfits. This means that under cooperation, the outfits are concerned with the maximization of the sum of their payoffs, subject to the overall resource-constraint. Hence, strategic cooperation is equivalent to a merger of the outfits. The outfits will cooperatively decide the numbers of attacks to be conducted through each of the two outfit channels. After this allocation, all remaining resources will be consumed by the outfits. Note that the channel of consumption is irrelevant when maximizing joint utility.

As far as the incentive for cooperation is concerned, in the present analysis there is no problem of coordination or externalities, nor is there any increase in cost-efficiency though cooperation.[63] Hence, the joint payoff under cooperation always being at least as large as the sum of their non-cooperative payoffs, explains the incentive for cooperation. Moreover, if the ultimate objective of the terrorists is to overpower the targeted country and take control, then the outfits are likely to attempt increasing the total number of terror strikes. I identify situations where the total number of attacks increases under cooperation, and try to derive insights into the problem.

Denoting $X_1 + X_2 = X$, the optimization problem under cooperation is

$$Max_{X,A_1,A_2}(U_1 + U_2) = X + \alpha_1 A_1 + \alpha_2 A_2$$

subject to the following constraints:

Budget constraint: $R_1 + R_2 = X + \frac{1}{2}(\beta_1 A_1^2 + \beta_2 A_2^2)$

Non-negativity constraints: $X \geq 0$, $A_1 \geq 0$ and $A_2 \geq 0$.

Then the optimization problem can be restated as:

$$\max_{\{X,A_1,A_2,\lambda,\mu,\gamma_1,\gamma_2\}} L$$

where L is the Lagrangian, the expression for which is

$$L = X + \alpha_1 A_1 + \alpha_2 A_2 + \lambda\left[R_1 + R_2 - X - \frac{1}{2}(\beta_1 A_1^2 + \beta_2 A_2^2)\right] + \mu X + \gamma_1 A_1 + \gamma_2 A_2.$$

[63] Note that existence of coordination problems will tilt the choice towards non-cooperation, whereas the existence of synergies will favor cooperation.

By solving the Kuhn-Tucker conditions to the above problem, one obtains the following characterization of equilibrium under cooperation (C) (see Appendix A):

(C1): If $R_1 + R_2 \geq \frac{1}{2}\frac{\alpha_1^2}{\beta_1} + \frac{1}{2}\frac{\alpha_2^2}{\beta_2}$, the cooperative equilibrium outcome is

$$A_i^C = \frac{\alpha_i}{\beta_i}, \text{ i=1, 2, and } X^C = R_1 + R_2 - \frac{1}{2}(\frac{\alpha_1^2}{\beta_1} + \frac{\alpha_2^2}{\beta_2}) \geq 0 \quad (4a)$$

Then total number of attacks under this situation is

$$A^C = A_1^C + A_2^C = \frac{\alpha_1}{\beta_1} + \frac{\alpha_2}{\beta_2} \quad (4b)$$

(C2): If $R_1 + R_2 < \frac{1}{2}\frac{\alpha_1^2}{\beta_1} + \frac{1}{2}\frac{\alpha_2^2}{\beta_2}$, the cooperative equilibrium outcome is:

$$A_i^C = \sqrt{\frac{2(R_i+R_j)\beta_i\beta_j}{\alpha_i^2\beta_j + \alpha_j^2\beta_i}}(\frac{\alpha_i}{\beta_i}), \; i \neq j, \text{ and } X^C = 0 \quad (5a)$$

$$A^C = A_1^C + A_2^C = \sqrt{\frac{2(R_1+R_2)\beta_1\beta_2}{\alpha_1^2\beta_2+\alpha_2^2\beta_1}} [\frac{\alpha_1}{\beta_1} + \frac{\alpha_2}{\beta_2}] \quad (5b)$$

5.2.3 Cooperative vs. Non-cooperative outcomes

It can now be examined whether under cooperation, the total number of attacks will increase compared to non-cooperation. This issue is studied under four possible assumptions.

Assumption (A1): $R_1 + R_2 \geq \frac{1}{2}\frac{\alpha_1^2}{\beta_1} + \frac{1}{2}\frac{\alpha_2^2}{\beta_2}$ *along with* $R_1 \geq \frac{1}{2}\frac{\alpha_1^2}{\beta_1}$ *and* $R_2 \geq \frac{1}{2}\frac{\alpha_2^2}{\beta_2}$

Given assumption (A1), under non-cooperative equilibrium none of the outfits are resource-constrained, and hence the equilibrium outcome is given by (NC1). The corresponding equilibrium under cooperation is given by (C1). Then comparing (1) and (4) one has

$$A_i^C = A_i^{NC}; i = 1, 2, \text{ and } A^C = A^{NC}$$

Therefore, when none of the outfits are resource-constrained, cooperation will have no effect on the number of attacks.

Proposition 1: *When neither outfit is resource-constrained, cooperation will have no impact on terror activity.*

Assumption (A2): $R_1 + R_2 \geq \frac{1}{2}\frac{\alpha_1^2}{\beta_1} + \frac{1}{2}\frac{\alpha_2^2}{\beta_2}$ *along with* $R_1 > \frac{1}{2}\frac{\alpha_1^2}{\beta_1}$ *and* $R_2 < \frac{1}{2}\frac{\alpha_2^2}{\beta_2}$

Under this assumption, the equilibrium under non-cooperation is given by (NC2). This is the scenario when only one outfit (here T_2) is resource-constrained under competition, but the outfit cooperation does not face any resource-constraint. Hence, the cooperative equilibrium is once again given by (C1). So, to see the effect of cooperation on the number of attacks, one must compare (2) and (4). This yields

$$A_1^C = A_1^{NC}, A_2^C > A_2^{NC} \text{ and } A^C > A^{NC}$$

The inequality in the second term arises because $R_2 < \frac{1}{2}\frac{\alpha_2^2}{\beta_2}$. Thus, when only one outfit is resource-constrained under non-cooperation, at least some surplus resource from the resource-rich outfit (here T_1) is funneled to conduct more attacks through the resource-constrained outfit channel (T_2). Hence, the total number of attacks increases under cooperation.

Proposition 2: *When only one outfit is resource-constrained while the other outfit has sufficiently large resources, cooperation enhances terror activity.*

Assumption (A3): $R_1 + R_2 < \frac{1}{2}\frac{\alpha_1^2}{\beta_1} + \frac{1}{2}\frac{\alpha_2^2}{\beta_2}$ *along with* $R_1 \geq \frac{1}{2}\frac{\alpha_1^2}{\beta_1}$ *and* $R_2 < \frac{1}{2}\frac{\alpha_2^2}{\beta_2}$

Consider assumption (A3). This is the scenario when under non-cooperation, outfit T_2 is resource-constrained while T_1 is not. Moreover, the merged outfit faces a resource-constraint, meaning that it cannot conduct as many attacks it wants. Hence, non-cooperative equilibrium is given by (NC2) while the cooperative equilibrium is given by (C2). Then comparing (2) and (5) one obtains the following results: First, since under this scenario, $\sqrt{\frac{2(R_1+R_2)\beta_1\beta_2}{\alpha_1^2\beta_2+\alpha_2^2\beta_1}} < 1$, so one must have $A_1^C < A_1^{NC}$, that is, the number of attacks through the unconstrained outfit channel (T_1) falls under cooperation. Further, under the given conditions, one obtains $A_2^C > A_2^{NC}$. This follows from the fact that

$$\sqrt{\frac{2(R_1+R_2)\beta_1\beta_2}{\alpha_1^2\beta_2+\alpha_2^2\beta_1}}\,\frac{\alpha_2}{\beta_2} > \sqrt{\frac{2R_2}{\beta_2}} \Leftrightarrow R_1\alpha_2^2\beta_1 > \; R_2\alpha_1^2\beta_2 \Leftrightarrow \frac{R_1}{\frac{1\alpha_1^2}{2\beta_1}} > \frac{R_2}{\frac{1\alpha_2^2}{2\beta_2}}$$

which holds, given (A3). Finally, total number of attacks will go up (i.e., $A^C > A^{NC}$) if and only if the following holds, that is,

$$\sqrt{\frac{2(R_1+R_2)\beta_1\beta_2}{\alpha_1^2\beta_2+\alpha_2^2\beta_1}}\left[\frac{\alpha_1}{\beta_1}+\frac{\alpha_2}{\beta_2}\right] > \frac{\alpha_1}{\beta_1}+\sqrt{\frac{2R_2}{\beta_2}} \tag{6}$$

The following results can therefore be written:

Proposition 3: *Under assumption (A3), cooperation between the two outfits enhances the total number of attacks if and only if the outfit which is resource-constrained a priori, is sufficiently small compared to the other outfit in terms of resources.*

Proof: I prove the result in a special case, when both the outfits are equally efficient at conducing attacks, and have the same intrinsic propensity for violence. Suppose $\alpha_1 = \alpha_2 = \alpha$ and $\beta_1 = \beta_2 = \beta$. Then the condition (6) reduces to

$$2\sqrt{\frac{(R_1+R_2)}{\beta}} > \frac{\alpha}{\beta}+\sqrt{\frac{2R_2}{\beta}} \tag{7}$$

Then there always exists (R_1, R_2) satisfying $R_1 + R_2 < \frac{\alpha^2}{\beta}$ and $R_1 \geq \frac{1}{2}\frac{\alpha^2}{\beta} > R_2$ such that the above inequality holds.[64] This proves the result. QED

Proposition 3 must be understood in the context of transferring resources from the resource-abundant outfit (or channel of attack) to the resource-constrained outfit. In the vicinity of the initial equilibrium, this would leave the former's attacks unchanged, while easing the latter's resource-constraint and thereby enabling it to optimally conduct additional attacks. This would lead to higher overall attacks in the vicinity of the initial equilibrium. Further resource-transfer in the same direction, however, is optimal under cooperation, as demonstrated earlier.[65] Beyond a point, such a transfer would cause the former outfit's resource-constraint to bind, thereby causing its attacks to decline. However, this would be more (less) than proportionately compensated by the increase in the latter outfit's attacks, if and only if the latter outfit is sufficiently (insufficiently) small compared to the former, because of diseconomies in conducting attacks driven by the convex cost functions.

Assumption (A4): $R_1 + R_2 < \frac{1}{2}\frac{\alpha_1^2}{\beta_1} + \frac{1}{2}\frac{\alpha_2^2}{\beta_2}$ *along with* $R_1 < \frac{1}{2}\frac{\alpha_1^2}{\beta_1}$ *and* $R_2 < \frac{1}{2}\frac{\alpha_2^2}{\beta_2}$

Finally, consider assumption (A4). This is the scenario when not only is the outfit cooperation as a whole resource-constrained, but both outfits are also individually resource-constrained *a priori*. Therefore, the non-cooperative equilibrium is given by (NC3), and the cooperative equilibrium by (C2). Hence, comparing equations (3) and (5), it can be seen that

$$A_i^C > A_i^{NC} \text{ iff } R_j \alpha_i^2 \beta_j > R_i \alpha_j^2 \beta_i, \; i \neq j \tag{8}$$

[64] One can simply fix $R_1 + R_2$, then increase R_1 and decrease R_2 to satisfy the inequality (7).
[65] Refer to the resource-allocation derived earlier, under the cooperative equilibrium given by (C2).

and hence

$$A^C > A^{NC} \text{ iff } \sqrt{\frac{2(R_1+R_2)\beta_1\beta_2}{\alpha_1^2\beta_2+\alpha_2^2\beta_1}}\left[\frac{\alpha_1}{\beta_1}+\frac{\alpha_2}{\beta_2}\right] > \sqrt{\frac{2R_1}{\beta_1}}+\sqrt{\frac{2R_2}{\beta_2}} \quad (9)$$

Given the parametric restrictions under this case, the inequalities (8) and (9) may or may not hold, meaning that inter-outfit cooperation may increase or decrease the number of attacks by each outfit channel as well as the total number of attacks. I check the results in the following special cases:

Case (i): $\alpha_1 = \alpha_2$, $\beta_1 = \beta_2$ and $R_1 = R_2$. One expectedly obtains $A_i^C = A_i^{NC} \forall i = 1, 2$, and $A^C = A^{NC}$, that is, if the outfits are identical in respect of all parameters, cooperation will have no effect. Since both the outfits are identical in every respect, there is nothing additional to share under cooperation.

Case (ii): $\alpha_1 = \alpha_2$, $\beta_1 = \beta_2$ but $R_1 \neq R_2$. Here, one obtains $A^C > A^{NC}$.[66] Without any loss of generality, suppose $R_1 > R_2$. Then $A_1^C < A_1^{NC}$ and $A_2^C > A_2^{NC}$. So when the outfits differ only in respect of the size of their resources, cooperation will lead to a higher number of total attacks, such that the number of attacks through the outfit channel which has lesser resources will increase. The result is intuitive. Since $R_1 > R_2$, therefore under non-cooperation, $A_1^{NC} > A_2^{NC}$. Now given that the cost of conducting attacks is increasing and convex, the marginal cost of attacking through T_1 under non-cooperative competition is larger than that through T_2. So under cooperation, reallocation of resources from channel T_1 to channel T_2 will be mutually rewarding, that is, A_1 will fall and A_2 will rise. Reducing A_1 by one unit will release resources for increasing A_2 by more than one unit. Therefore, the total number of attacks (A) will increase.

[66] Under Case (ii), $A^C = 2\sqrt{\frac{(R_1+R_2)}{\beta}}$ and $A^{NC} = \sqrt{\frac{2R_1}{\beta}} + \sqrt{\frac{2R_2}{\beta}}$. Therefore, $A^C > A^N$ because $\frac{(R_1+R_2)}{2} > \sqrt{R_1R_2}$, that is, $A.M. > G.M.$, where the abbreviations refer to the arithmetic and geometric means of R_1 and R_2 respectively.

Case (iii): $\beta_1 = \beta_2,\ R_1 = R_2$ but $\alpha_1 \neq \alpha_2$. Here, one obtains $A^C < A^{NC}$.[67] If $\alpha_1 > \alpha_2$, then $A_1^C > A_1^{NC}$ and $A_2^C < A_2^{NC}$, that is, the number of attacks through the outfit channel having a higher intrinsic propensity for violence increases while that through the other channel falls. The total number of attacks also falls, given that the outfits differ in respect of their violence propensities. The intuition of this result also hinges on cost-convexities. Because the attacks conducted by each outfit in the non-cooperative equilibrium are equal and independent of the intrinsic propensity for violence, resource-reallocation from one outfit to the other leads to efficiency loss at the margin, due to the increasing and strictly convex cost of conducting attacks. But given $\alpha_1 > \alpha_2$, since resources are drawn from outfit channel T_2 to conduct additional attack through T_1, payoff of the outfit cooperation will increase at the margin. This explains why the number of attacks through T_1 increases, while that through T_2 falls. But given the strictly convex cost function, the fall of attacks in equilibrium must dominate the increase, thereby leading to a lower total number of attacks under cooperation.

Case (iv): $\alpha_1 = \alpha_2,\ R_1 = R_2$ but $\beta_1 \neq \beta_2$. Here, one unambiguously obtain $A^C > A^{NC}$, that is, cooperation will enhance the total number of attacks.[68] Without any loss of generality when $\beta_1 > \beta_2$, one obtains $A_1^C < A_1^{NC}$ and $A_2^C > A_2^{NC}$, implying that the inefficient outfit channel will conduct less attacks under cooperation. Since more and more attacks are conducted through efficient channel, the total number of attacks will go up.

Therefore, given assumption (A4), one arrives at the following proposition:

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[67] Under Case (iii), $A^C = 2\sqrt{\frac{2R}{\beta}}\frac{(\alpha_1+\alpha_2)}{\sqrt{2(\alpha_1^2+\alpha_2^2)}}$ and $A^{NC} = 2\sqrt{\frac{2R}{\beta}}$. Hence, $A^C < A^{NC}$ because $\frac{(\alpha_1+\alpha_2)}{\sqrt{2(\alpha_1^2+\alpha_2^2)}} < 1$.

[68] Here $A^C = \sqrt{\frac{2R}{\beta_1\beta_2}}\sqrt{2(\beta_1+\beta_2)}$ and $A^{NC} = \sqrt{\frac{2R}{\beta_1\beta_2}}(\sqrt{\beta_1}+\sqrt{\beta_2})$, hence $A^C > A^{NC}$ because $A.M. > G.M.$, where the abbreviations refer to the arithmetic and geometric means of β_1 and β_2 respectively.

Proposition 4: *When both outfits are resource-constrained a priori, and the outfits differ in respect of at least one parameter, cooperation will affect the number of attacks to be conducted by each outfit as well as the total number of attacks. In particular, if the outfits have different levels of resources or if they differ in respect of their efficiency in conducting attacks, the total number of attacks under cooperation must increase. On the other hand, if the outfits have different intrinsic propensities of violence, cooperation will reduce the total number of attacks.*

To summarize the results of this section, it has been shown that the effect of cooperation on terror activity depends on available resources, intrinsic propensities for violence and cost-efficiency parameters of the outfits. Cooperation will increase the total number of attacks under assumption (A2), under assumption (A3) if condition (6) holds, and under assumption (A4) if condition (9) holds. However, cooperation may sometimes also reduce the total number of attacks (see assumption (A3) when condition (6) does not hold, and assumption (A4) if the inequality in condition (9) is reversed). Under assumption (A1), however, cooperation has no effect.

Finally, as far as the choice between cooperation and non-cooperation is concerned, since it has been assumed that the outfit cooperation maximizes the sum of utility of the outfits and that payoffs are transferable between the outfits, cooperation will weakly dominate non-cooperation from the perspective of the outfits. When the cooperative and non-cooperative outcomes (i.e., terror activities) are the same (for example, this is the case under assumption (A1)), the outfits will be indifferent about its choice (given that there are no coordination or externalities problems). However, when the cooperative and non-cooperative outcomes are different, cooperation will be strictly preferred to non-cooperation. In the following section, I shall introduce the possibility of external sponsorship and study the consequences.

5.3 Cooperation under Sponsorship

There is ample evidence of terror outfits receiving funds from different agencies such as charities and NGOs.[69] A part of this sponsorship is provided strategically, to induce more attacks.

Consider the availability of external sponsorship $F > 0$ (measured in units of consumption). Further, assume that the sponsor commits to distribute this fund *ex post* between the outfits, in proportion to the number of terror attacks conducted by each.[70] Thus, T_i receives $F_i = \frac{A_i}{A_i + A_j} F$. In the presence of such sponsorship, the payoff function of T_i $(i = 1, 2)$ becomes

$$U_i = X_i + \alpha_i A_i + F_i \tag{10}$$

After incorporating the budget constraint, the payoff maximization problem of T_i $(i = 1, 2)$ under non-cooperation becomes

$$Max_{A_i} U_i = R_i - \frac{1}{2}\beta_i A_i^2 + \alpha_i A_i + F_i \tag{11}$$

Bhan and Kabiraj (2020a) have shown that the equilibrium solution to the above problem is stable and unique, and I denote this by (A_1^*, A_2^*). A brief outline of the solution is provided in Appendix B. It is shown that when resources are sufficiently large (i.e., $R_i > \frac{1}{2}\frac{\alpha_i^2}{\beta_i}; i = 1, 2$), the reaction functions are initially upward sloping, intersect the 45^0-line, and then slope downwards. In this case, given that each outfit T_i $(i = 1, 2)$ is competing for a larger share of external sponsorship, T_i will conduct more than $\frac{\alpha_i}{\beta_i}$ attacks. This illustrates the possibility that external

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[69] See Chadha (2015) for a comprehensive discussion on the sources of terror finance, and also the discussion in Chapter 4.
[70] This is the proportionate sponsorship mechanism discussed in the previous chapter.

sponsorship can induce more attacks when the outfits compete non-cooperatively. In fact, if the outfits play non-cooperatively and not all outfits are resource-constrained initially, the total number of attacks will increase under external sponsorship.

Now suppose that given the commitment of the sponsor, the outfits decide to act cooperatively and hence maximize the sum of their payoffs. Hence the problem is:

$$Max_{X_1,X_2,A_1,A_2}(U_1 + U_2) = X_1 + X_2 + \alpha_1 A_1 + \alpha_2 A_2 + F \quad (12)$$

subject to the budget constraint

$$X_1 + X_2 + \frac{1}{2}(\beta_1 A_1^2 + \beta_2 A_2^2) = R_1 + R_2$$

One can see that if $R_1 + R_2 \geq \frac{1}{2}\left(\frac{\alpha_1^2}{\beta_1} + \frac{\alpha_2^2}{\beta_2}\right)$, then an interior optimum exists. Otherwise, there is a corner solution. In either case, the solution to the above optimization problem is independent of F, and hence identical to the solution to the optimization problem of subsection 5.2.2 (absence of sponsorship). One therefore arrives at Proposition 5.

Proposition 5: *If terror outfits play cooperatively, then the number of terror strikes conducted by each group in the presence of ex post proportionate external sponsorship will be identical to that in the absence of external sponsorship.*

The intuition for this result rests on the fact that external sponsorship loses its ability to induce terror strikes because, irrespective of the values of A_1 and A_2, the groups together would receive $F_1 + F_2 = F$. Hence, the number of terror strikes each outfit conducts will depend only on those factors which determine the equilibrium levels in the absence of external sponsorship, thereby ensuring a solution identical to that in the absence of external sponsorship. Then the following is a straight-forward corollary.

Corollary: *If terror outfits co-operate strategically, there is no incentive for providing ex post proportionate external sponsorship.*

It seems intuitive that in an environment characterized by the presence of multiple terror outfits and a common potential external sponsor, greater strategic cooperation between the terror outfits would impede the ability of the sponsor to manipulate the behavior of the outfits. This, in turn, would weaken the incentive for the external sponsor to provide sponsorship. The sponsor would therefore have an incentive to hinder strategic co-operation or engineer a split between the terror outfits, in order to increase its own influence on their actions. This is allegedly what happened in the case of Hizb-ul-Mujahideen (HM) in 1998, as discussed earlier.

Finally, note that given the structure of the game, to the question of whether the outfits will decide their terror activities cooperatively or non-cooperatively, it follows from the mathematical formulation of the problem that cooperation will dominate non-cooperation from the perspective of the outfits.

5.4 Further Extension

In this section, the circumstances in which an external sponsor would provide funds to induce increased terror attacks are explored. Since the joint payoff of the outfits under cooperation is never less than the sum of their non-cooperative payoffs, the outfits may optimally decide to cooperate if possible, irrespective of whether any sponsorship (under the proportionate allocation rule) is available or not. Then, from the corollary to Proposition 5, it follows that the scope for inducing increased terror activity by providing proportionate external sponsorship is limited since cooperation is never less beneficial than non-cooperation from the perspective of the outfits. Hence, the model thus far, fails to adequately rationalize *ex post* proportionate external sponsorship. In the analysis below, the structure of the game is slightly modified and restricted to the assumption that external sponsorship is offered if and only if it increases the total number of attacks. Then it follows from the analysis of Section 5.3 that external sponsorship is offered only if the outfits behave non-cooperatively. Thus, the main idea of the present section is to show that the external sponsor can choose the sponsorship amount F to incentivize the outfits to behave non-cooperatively and increase the total number of attacks.

Suppose that initially, an external sponsor commits not to pay $F > 0$ unless the outfits play a non-cooperative game to determine the levels of their terror activities. In the following analysis, if the external sponsor offers any positive level of funding to the outfits, such a regime shall be called F. If no sponsorship is offered initially (i.e., $F = 0$) however, and then the outfits decide optimally whether to play the game cooperatively or non-cooperatively, this regime shall be called $\emptyset$. It has already been noted in Section 5.2, that under this situation playing the game cooperatively will weakly dominate playing non-cooperatively. The reason is that the outfits are never worse off under cooperation compared to non-cooperation, that is, $U^C(\emptyset) \geq U^{NC}(\emptyset)$, where $U^\tau = U_1^\tau + U_2^\tau$, $\tau \in \{NC, C\}$. So, it may be presumed that the outfits under regime $\emptyset$ will play the game cooperatively.[71] Then $F > 0$ will be committed only if $A^{NC}(F) > A^C(\emptyset)$,[72] that is, if the total number of terror attacks under F regime is larger than that under $\emptyset$ regime. But such an offer will be rejected by the outfits unless $U^{NC}(F) \geq U^C(\emptyset)$, that is, the outfits are not worse

[71] Note that the inferences pertaining to optimal external sponsorship, obtained in this section, remain unaffected even without this assumption.

[72] It must be borne in mind that in the absence of cooperation, the terror activity level under proportionate external sponsorship is never less than that in its absence. That is, $A^{NC}(F) \geq A^{NC}(\emptyset)$.

off by accepting the F contract. The problem shall now be discussed under the various assumptions made in subsection 5.2.2 (i.e., Assumptions (A1) - (A4)).

Assumption (A1): $R_1 \geq \frac{1}{2}\frac{\alpha_1^2}{\beta_1}$, $R_2 \geq \frac{1}{2}\frac{\alpha_2^2}{\beta_2}$, so $R_1 + R_2 \geq \frac{1}{2}\frac{\alpha_1^2}{\beta_1} + \frac{1}{2}\frac{\alpha_2^2}{\beta_2}$

Sub-case (i): $R_i > \frac{1}{2}\frac{\alpha_i^2}{\beta_i}$, $R_j \geq \frac{1}{2}\frac{\alpha_j^2}{\beta_j}$ and $R_1 + R_2 > \frac{1}{2}\frac{\alpha_1^2}{\beta_1} + \frac{1}{2}\frac{\alpha_2^2}{\beta_2}$. From subsection 5.2.3, $A^C(\emptyset) = A^{NC}(\emptyset) = \frac{\alpha_i}{\beta_i} + \frac{\alpha_j}{\beta_j} < \sqrt{\frac{2R_i}{\beta_i}} + \sqrt{\frac{2R_2}{\beta_2}}$, i.e., when $F = 0$, while cooperation is no worse for the outfits than non-cooperation, the former does not increase the number of attacks. On the other hand, when $F > 0$ is offered, it will be accepted by the outfits because $U^{NC}(F) > U^C(\emptyset)(= U^{NC}(\emptyset))$, and given Assumption (A1), one must have $A^{NC}(F) > A^C(\emptyset)$, because $A_i^{NC}(F) > \frac{\alpha_i}{\beta_i}$ but $A_j^{NC}(F) \geq \frac{\alpha_j}{\beta_j}$. Therefore, under this sub-case, sponsorship will occur and the number of attacks will increase. Since the maximum number of attacks that T_1 and T_2 can conduct cannot exceed $\sqrt{\frac{2R_1}{\beta_1}}$ and $\sqrt{\frac{2R_2}{\beta_2}}$ respectively, the sponsor can choose F strategically such that the outfits conduct these many attacks.[73]

Sub-case (ii): $R_i = \frac{1}{2}\frac{\alpha_i^2}{\beta_i}$ for $i = 1, 2$, and $R_1 + R_2 = \frac{1}{2}\frac{\alpha_1^2}{\beta_1} + \frac{1}{2}\frac{\alpha_2^2}{\beta_2}$. In this case $A^C(\emptyset) = A^{NC}(\emptyset) = \frac{\alpha_i}{\beta_i} + \frac{\alpha_j}{\beta_j} = \sqrt{\frac{2R_i}{\beta_i}} + \sqrt{\frac{2R_2}{\beta_2}}$. But since under sponsorship ($F > 0$) total number of attacks will be $A^{NC}(F) = A^C(\emptyset)$, therefore under this Sub-case, no sponsorship will be available.

Assumption (A2): $R_1 > \frac{1}{2}\frac{\alpha_1^2}{\beta_1}$, $R_2 < \frac{1}{2}\frac{\alpha_2^2}{\beta_2}$ but $R_1 + R_2 \geq \frac{1}{2}\frac{\alpha_1^2}{\beta_1} + \frac{1}{2}\frac{\alpha_2^2}{\beta_2}$.

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[73] As long as $A_i \leq \sqrt{\frac{2R_i}{\beta_i}}$, $i = 1, 2$, for any $F > 0$, A_i's are solved from the first order conditions (FOCs) of the utility maximization problem under non-cooperative situation, i.e., $\alpha_i + \frac{A_j}{(A_i+A_j)^2}F - \beta_i A_i = 0$; $i = 1, 2$. Now setting $A_i = \sqrt{\frac{2R_i}{\beta_i}}$ for $i = 1, 2$ from the FOCs, one shall get the optimal level of sponsorship which maximizes the total number of attacks to be $F = (\beta_1 A_1 + \beta_2 A_2) - (\beta_1 + \beta_2)$.

From subsections 5.2.1 and 5.2.2, $A_1^{NC}(\emptyset) = \frac{\alpha_1}{\beta_1}$, $A_2^{NC}(\emptyset) = \sqrt{\frac{2R_2}{\beta_2}} < \frac{\alpha_2}{\beta_2}$, $A_1^C(\emptyset) = \frac{\alpha_1}{\beta_1}$ and $A_2^C(\emptyset) = \frac{\alpha_2}{\beta_2}$, so that $A^C(\emptyset) > A^{NC}(\emptyset)$. Further, $U^C(\emptyset) > U^{NC}(\emptyset)$, that is, the outfits will be strictly better off choosing their terror activities cooperatively when no sponsorship is available, and under this situation it so happens that the number of attacks is higher than that under non-cooperation. Hence, under regime $\emptyset$, $A^C(\emptyset) = \frac{\alpha_1}{\beta_1} + \frac{\alpha_2}{\beta_2}$. Correspondingly, the joint profits of the outfits are,

$$U^C(\emptyset) = \alpha_1\left(\frac{\alpha_1}{\beta_1}\right) + \alpha_2\left(\frac{\alpha_2}{\beta_2}\right) + R_1 + R_2 - \frac{1}{2}\left(\frac{\alpha_1^2}{\beta_1} + \frac{\alpha_2^2}{\beta_2}\right) = \frac{1}{2}\left[\frac{\alpha_1^2}{\beta_1} + \frac{\alpha_2^2}{\beta_2}\right] + R_1 + R_2 \qquad (13)$$

The question then remains whether by committing an appropriate amount of funds, conditional on the terror outfits playing the game non-cooperatively, the sponsor can induce the outfits to further increase the total number of attacks. I show that if R_1 is sufficiently large, the sponsor can appropriately choose an $F > 0$ to maximize the total number of attacks.

If any $F > 0$ is offered by the sponsor and accepted by the terror outfits, then given Assumption (A2), the optimal number of terror attacks chosen by T_2 will be $A_2^{NC}(R_2) = \sqrt{\frac{2R_2}{\beta_2}}$, and the optimal number of terror attacks to be chosen by T_1 will be

$$A_1^{NC}(F; R_1, R_2) = \min\{A_1\left(F; A_2^{NC}(R_2)\right), \sqrt{\frac{2R_1}{\beta_1}}\} \qquad (14)$$

where $A_1\left(F; A_2^{NC}(R_2)\right)$ is the solution obtained from the first order condition (FOC) of the problem: $Max_{A_1} U_1 = R_1 - \frac{1}{2}\beta_1 A_1^2 + \alpha_1 A_1 + F_1$, where $F_1 = \frac{A_1}{A_1 + A_2}F$ and $A_2 = A_2^{NC}(R_2)$. The FOC is:

$$\alpha_1 + \frac{A_2}{(A_1 + A_2)^2}F - \beta_1 A_1 = 0 \qquad (15)$$

Given that the second order condition (SOC) is satisfied, $A_1\left(F; A_2^{NC}(R_2)\right)$ is solved from the above. Now, as long as $A_1\left(F; A_2^{NC}(R_2)\right) < \sqrt{\frac{2R_1}{\beta_1}}$, F can be increased to raise $A_1^{NC}(.)$ to $\sqrt{\frac{2R_1}{\beta_1}}$. Hence, the optimal F maximizing the total number of attacks in this situation is given by $F^* = F(R_1;\ R_2)$, solved from $A_1^{NC}(F; R_1, R_2) = \sqrt{\frac{2R_1}{\beta_1}}$.[74] Therefore, $F(R_1;\ R_2)$ will be offered by the sponsor provided the total number of terror attacks under $F > 0$ (non-cooperative competition) is larger than that under $F = 0$ (cooperative situation), i.e., $A^{NC}(F) > A^C(\emptyset)$, or, $\sqrt{\frac{2R_1}{\beta_1}} + \sqrt{\frac{2R_2}{\beta_2}} \geq \frac{\alpha_1}{\beta_1} + \frac{\alpha_2}{\beta_2}$. This can also be expressed as

$$R_1 > \frac{\beta_1}{2}\left[\frac{\alpha_1}{\beta_1} + \frac{\alpha_2}{\beta_2} - \sqrt{\frac{2R_2}{\beta_2}}\right]^2 \equiv R_1^* \tag{16}$$

So the sponsor will want to induce (A_1^{NC}, A_2^{NC}) terror attacks when condition (16) holds, and the optimal sponsorship $F(R_1;\ R_2)$ is obtained from the FOC $\alpha_1 + \frac{A_2}{(A_1+A_2)^2}F - \beta_1 A_1 = 0$ as

$$F(R_1;\ R_2) = (\beta_1 A_1 - \alpha_1)\frac{(A_1+A_2)^2}{A_2} \tag{17}$$

Finally, given $R_1 > R_1^*$, offer $F(R_1;\ R_2)$ will be acceptable to the outfits if and only if $U^{NC}(F) \geq U^C(\emptyset)$. One has

$$U^{NC}(F) = \alpha_1(A_1^{NC}) + \alpha_2(A_2^{NC}) + R_1 + R_2 - \frac{1}{2}\beta_1(A_1^{NC})^2 - \frac{1}{2}\beta_2(A_2^{NC})^2 + F$$

$$= \alpha_1\left(\sqrt{\frac{2R_1}{\beta_1}}\right) + \alpha_2\left(\sqrt{\frac{2R_2}{\beta_2}}\right) + R_1 + R_2 - \frac{1}{2}[\beta_1\left(\sqrt{\frac{2R_1}{\beta_1}}\right)^2 + \beta_2\left(\sqrt{\frac{2R_2}{\beta_2}}\right)^2 + F(R_1;\ R_2)$$

On simplification,

$$U^{NC}(F) = \alpha_1\left(\sqrt{\frac{2R_1}{\beta_1}}\right) + \alpha_2\left(\sqrt{\frac{2R_2}{\beta_2}}\right) + F(R_1;\ R_2) \tag{18}$$

[74] For all $F \geq F(R_1, R_2)$, A_1^{NC} will remain fixed at $\sqrt{\frac{2R_1}{\beta_1}}$.

Therefore, $U^{NC}(F)) \geq U^{C}(\emptyset)$ if and only if (comparing equations (13) and (18)),

$$\alpha_1\left[\left(\sqrt{\frac{2R_1}{\beta_1}}\right)-\frac{1}{2}\left(\frac{\alpha_1}{\beta_1}\right)\right]+F(R_1;\ R_2)\geq\alpha_2[\frac{1}{2}\left(\frac{\alpha_2}{\beta_2}\right)-\sqrt{\frac{2R_2}{\beta_2}}] \quad (19)$$

The left-hand side of Equation (19) is strictly positive, but the right-hand side can be positive or negative or zero. Hence, a sufficient condition to satisfy equation (19) is $\frac{\alpha_2}{\beta_2} \leq 2\sqrt{\frac{2R_2}{\beta_2}}$, that is, R_2 is sufficiently large. In general, condition (19) will be satisfied if R_1 is sufficiently large. Both conditions (16) and (19) must hold, for any $F > 0$ to be offered by the sponsor, and accepted by the outfits.

Assumption (A3): $R_1 \geq \frac{1}{2}\frac{\alpha_1^2}{\beta_1}$, $R_2 < \frac{1}{2}\frac{\alpha_2^2}{\beta_2}$, but $R_1 + R_2 < \frac{1}{2}\frac{\alpha_1^2}{\beta_1} + \frac{1}{2}\frac{\alpha_2^2}{\beta_2}$.

Sub-case (i): $R_1 > \frac{1}{2}\frac{\alpha_1^2}{\beta_1}$ and $R_2 < \frac{1}{2}\frac{\alpha_2^2}{\beta_2}$, and $R_1 + R_2 < \frac{1}{2}\frac{\alpha_1^2}{\beta_1} + \frac{1}{2}\frac{\alpha_2^2}{\beta_2}$. In this case $A^C(\emptyset) = \sqrt{\frac{2(R_1+R_2)\beta_1\beta_2}{\alpha_1^2\beta_2+\alpha_2^2\beta_1}}\left[\frac{\alpha_1}{\beta_1}+\frac{\alpha_2}{\beta_2}\right] < \frac{\alpha_1}{\beta_1}+\frac{\alpha_2}{\beta_2}$ because $\sqrt{\frac{2(R_1+R_2)\beta_1\beta_2}{\alpha_1^2\beta_2+\alpha_2^2\beta_1}} < 1$. The analysis in this case will be similar to the previous case. Here, however, there is limited flexibility to increase R_1 to satisfy a condition like equation (16).[75]

Sub-case (ii): $R_1 = \frac{1}{2}\frac{\alpha_1^2}{\beta_1}$ and $R_2 < \frac{1}{2}\frac{\alpha_2^2}{\beta_2}$, but $R_1 + R_2 < \frac{1}{2}\frac{\alpha_1^2}{\beta_1} + \frac{1}{2}\frac{\alpha_2^2}{\beta_2}$. From subsections 5.2.2 and 5.2.3 it is known that in the absence of external sponsorship, the outfits will play cooperatively, and the total number of attacks under this situation will be $A^C(\emptyset) = \sqrt{\frac{2(R_1+R_2)\beta_1\beta_2}{\alpha_1^2\beta_2+\alpha_2^2\beta_1}}\,[\frac{\alpha_1}{\beta_1}+\frac{\alpha_2}{\beta_2}]$ where $\frac{\alpha_1}{\beta_1} = \sqrt{\frac{2R_1}{\beta_1}}$ and $\frac{\alpha_2}{\beta_2} > \sqrt{\frac{2R_2}{\beta_2}}$ Then, from section 5.3 it follows that if $F > 0$ be offered by

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75 Here, $A^{NC}(F) > A^C(\emptyset)$ iff $R_1 > \frac{\beta_1}{2}\left[\sqrt{\frac{2(R_1+R_2)\beta_1\beta_2}{\alpha_1^2\beta_2+\alpha_2^2\beta_1}}(\frac{\alpha_1}{\beta_1}+\frac{\alpha_2}{\beta_2})-\sqrt{\frac{2R_2}{\beta_2}}\right]^2$. By implicitly solving this inequality, there exists some R_1^{**} such that $A^{NC}(F) > A^C(\emptyset)$ iff $R_1 > R_1^{**}$. Since $\sqrt{\frac{2(R_1+R_2)\beta_1\beta_2}{\alpha_1^2\beta_2+\alpha_2^2\beta_1}} < 1$, one must have $R_1^{**} < R_1^*$, where R_1^* is as defined in the discussion of Assumption (A2). Hence, the condition required for external sponsorship to be provided in the present case is $R_1^{**} < R_1 < R_1^*$.

the sponsor, the total number of attacks would be $A^{NC}(F) = A^{NC}(\emptyset) = \frac{\alpha_1}{\beta_1} + \sqrt{\frac{2R_2}{\beta_2}}$ under non-cooperation. Hence under the assumption of this Sub-case, sponsorship will be provided if and only if condition (6) holds with reverse inequality.

Assumption (A4): $R_1 < \frac{1}{2}\frac{\alpha_1^2}{\beta_1}$, $R_2 < \frac{1}{2}\frac{\alpha_2^2}{\beta_2}$, so $R_1 + R_2 < \frac{1}{2}\frac{\alpha_1^2}{\beta_1} + \frac{1}{2}\frac{\alpha_2^2}{\beta_2}$

Here, inter-outfit cooperation will occur under regime $\emptyset$, and the outfits will conduct a total of $A^C(\emptyset)$ attacks. Now if condition (9) holds so that $A^C(\emptyset) > A^{NC}(\emptyset)$, then for any $F > 0$ which induces non-cooperation, the outfits would together conduct $A^{NC}(F)$ attacks where $A^{NC}(F) = A^{NC}(\emptyset) < A^C(\emptyset)$. So no external sponsorship will be provided, since it is counterproductive from the perspective of the sponsor because it reduces terror activity.[76] On the other hand, if condition (9) holds with reverse inequality so that $A^{NC}(\emptyset) > A^C(\emptyset)$, there exists $F > 0$ such that $U^{NC}(F) \geq U^C(\emptyset)$ which would induce the outfits to play non-cooperatively and thereby conduct $A^{NC}(F) = \sqrt{\frac{2R_1}{\beta_1}} + \sqrt{\frac{2R_2}{\beta_2}}$ attacks, where $A^{NC}(F) = A^{NC}(\emptyset) > A^C(\emptyset)$. Hence, given Assumption (A4), external sponsorship can induce additional terror strikes if and only if condition (9) holds with reverse inequality.

To summarize this section, there are scenarios under each of Assumptions (A1) through (A4) where the external sponsor can choose *ex post* proportionate sponsorship appropriately to induce higher terror activity. Of most interest appears to be Assumption (A4), where it may be possible for such sponsorship to induce higher terror activity despite both outfits being resource-constrained *a priori*.

So the amount of resources available to the outfits initially, plays a crucial role in the present analysis. There are, in fact, other alternative sponsorship mechanisms observed in the

[76] In fact, no external sponsorship will be provided even if condition (9) holds with equality, because the number of attacks under sponsorship will be equal to that in its absence, i.e., $A^{NC}(F) = A^{NC}(\emptyset) = A^C(\emptyset)$.

real world. Such mechanisms may act both as an incentivizing device and as an enabler of terror activity. For instance, when the outfits are resource-constrained, some funds may be provided before the terror activity has taken place. Then such a fund will relax, at least to some extent, the resource-constraints of the outfits, thereby enabling them to conduct more attacks. Hence, one arrives at the following proposition:

Proposition 6: *There are circumstances where external sponsorship increases terror activity*.

5.5 Conclusion

The present chapter shows that when terror outfits differ from each other in some aspect or the other, there are situations in which the outfits may gain through cooperation via inter-outfit resource-reallocation and the consequent increase in the total number of attacks. Generally, a terror outfit prefers to work independently in order to preserve its identity and autonomy. But there is evidence of inter-outfit strategic cooperation in certain situations. When outfits are not too distant ideologically, for instance, they may be willing to coordinate their activities. Coordinated transfer of resources and terror technology can enable terror outfits to enhance the number of attacks, and thereby reap benefits via the exploitation of loopholes in the state's security apparatus.

It is shown that benefits of strategic cooperation accrue to the cooperating outfits, when at least one outfit is resource-constrained. Through cooperation, the outfits can reallocate resources to conduct attacks more efficiently, or in favor of the more aggressive outlet. Inter-outfit cooperation can also derive benefits from cost-convexities. However, if an external sponsor commits to provide funds to the outfits in proportion to their attacks, cooperation will reduce the total number of attacks compared to non-cooperation. Hence, no strategic external sponsor will commit any funds to the outfits in this scenario. I have, however, subsequently modified the game and demonstrated situations rationalizing the existence of external sponsorship.

This chapter seeks to provide insights to policy makers, to enable better designing of counter-terrorism (CT) policies. Defensive CT policies generally increase the cost of terrorist operations. The present analysis also underscores the importance of preventing the transfer of resources from one terror outfit to another. To this end, offensive policies aimed at destroying terrorist infrastructure or confiscating resources, may appear effective. However, such a policy may sometimes be very expensive to implement, both in pecuniary and non-pecuniary terms. Confidence building measures, that target one or the other outfit to restore normalcy, may not be very effective in view of the possible funneling of resources from one outfit to the other.

Finally, and more generally, this analysis demonstrates that inter-outfit strategic cooperation can serve to increase terror attacks under certain circumstances, while serving to inhibit terror activity under other situations. An example of the former is when a resource-constrained outfit cooperates with a resource-abundant outfit having sufficiently large resources, in the absence of external funding. On the other hand, I have discussed multiple situations where external sponsorship can be offered strategically to enhance terror activity by inhibiting inter-group cooperation. Hence, CT efforts targeted at disrupting cooperation under the former set of circumstances, while those aimed at curbing the leverage of the external sponsor over the terrorists by encouraging intergroup cooperation under the latter, would serve to decrease terror attacks. Therefore, the present work amply demonstrates that a *one-size-fits-all* CT architecture is undesirable, and calls for reviewing the existing CT policy framework in view of the implications of strategic cooperation between terror outfits.

5.6 Appendices

Appendix A.

The Lagrangian problem is given by:

$$\max_{\{X, A_1, A_2, \lambda, \mu, \gamma_1, \gamma_2\}} L$$

where

$$L = X + \alpha_1 A_1 + \alpha_2 A_2 + \lambda\left[R_1 + R_2 - X - \frac{1}{2}(\beta_1 A_1^2 + \beta_2 A_2^2)\right] + \mu X + \gamma_1 A_1 + \gamma_2 A_2$$

The relevant K-T conditions for solving the above problem are:

(i) $\frac{\partial L}{\partial X} = 1 - \lambda + \mu = 0$

(ii) $\frac{\partial L}{\partial A_i} = \alpha_i - \lambda \beta_i A_i + \gamma_i = 0; i = 1, 2$

(iii) $\lambda \geq 0, \mu \geq 0, \gamma_i \geq 0 \ (i = 1, 2)$

(iv) $X \geq 0,\ A_i \geq 0 \ (i = 1, 2),\ \ R_1 + R_2 \geq X + \frac{1}{2}(\beta_1 A_1^2 + \beta_2 A_2^2)$

(v) $\mu X = 0, \gamma_i A_i = 0 \ (i = 1, 2)$ and $\lambda\left[R_i + R_j - X - \frac{1}{2}\left(\beta_i A_i^2 + \beta_j A_j^2\right)\right] = 0$

In the present formulation, $A_i > 0$, and so $\gamma_i = 0 \ \forall \, i = 1, 2$ (from (v)). Now consider the following cases:

Case (a): Consider equilibrium with $X > 0$; this means $\mu = 0$ (see (v)), hence $\lambda = 1$ (from (i)). This leads to cooperative equilibrium (from (ii)):

$$A_i = \frac{\alpha_i}{\beta_i} \equiv A_i^C \ \forall \, i = 1, 2 \ \text{ with } R_1 + R_2 > \frac{1}{2}\frac{\alpha_1^2}{\beta_1} + \frac{1}{2}\frac{\alpha_2^2}{\beta_2}.$$

Case (b): Consider equilibrium with $X = 0$. This means $\mu \geq 0$, and hence $\lambda = 1 + \mu \geq 1$ (see (v) and (i)). When $\mu = 0$, $\lambda = 1$, and the cooperative equilibrium is given by

$$A_i^C = \frac{\alpha_i}{\beta_i} \ \forall\, i = 1, 2 \ \text{ and } R_1 + R_2 = \frac{1}{2}\frac{\alpha_1^2}{\beta_1} + \frac{1}{2}\frac{\alpha_2^2}{\beta_2}.$$

If $\mu > 0$, then $\lambda > 1$. Hence, $A_i = \frac{\alpha_i}{\lambda\beta_i} < \frac{\alpha_i}{\beta_i}$ $\forall\, i = 1, 2$ from (ii), and $R_1 + R_2 = \frac{1}{2}(\beta_1 A_1^2 + \beta_2 A_2^2)$ (from (iv)). Then plugging the values of A_1 and A_2 into this expression, one obtains $\frac{1}{\lambda^2} = \frac{2(R_i+R_j)\beta_i\beta_j}{\alpha_i^2\beta_j + \alpha_j^2\beta_i}$.

Therefore, one obtains the cooperative solution as

$$A_i^C = \sqrt{\frac{2(R_i+R_j)\beta_i\beta_j}{\alpha_i^2\beta_j + \alpha_j^2\beta_i}} . \frac{\alpha_i}{\beta_i} \ \text{ for } i \neq j$$

This solves the cooperative game.

Appendix B.

The first order conditions (FOCs) to the maximization problem given in Equation (11) are $\frac{dU_i}{dA_i} = \alpha_i + \frac{A_j}{(A_i+A_j)^2}F - \beta_i A_i = 0$, for $i = 1, 2$; while the second order conditions (SOCs) are $\frac{\partial^2 U_i}{\partial A_i^2} = -\beta_i - 2\frac{A_j}{(A_i+A_j)^3}F < 0$. It is easy to see that the SOCs hold. And finally, the stability and uniqueness condition is $\frac{\partial^2 U_i}{\partial A_i^2}\frac{\partial^2 U_j}{\partial A_j^2} - \frac{\partial^2 U_i}{\partial A_i \partial A_j}\frac{\partial^2 U_i}{\partial A_j \partial A_i} = \left(\beta_i + 2\frac{A_j}{(A_i+A_j)^3}F\right)\left(\beta_j + 2\frac{A_i}{(A_i+A_j)^3}F\right) + \frac{(A_i-A_j)^2}{(A_i+A_j)^6}F^2 > 0$, which also holds. Therefore, if $R_i > \frac{1}{2}\frac{\alpha_i^2}{\beta_i}, i = 1, 2$; the slope of T_i's reaction function as obtained from the FOCs is $\frac{dA_i}{dA_j} = -\frac{\frac{\partial^2 U_i}{\partial A_i \partial A_j}}{\frac{\partial^2 U_i}{\partial A_i^2}} = \frac{(A_i-A_j)F}{\beta_i(A_i+A_j)^3 + 2A_j F} \gtrless 0$ according as $A_i \gtrless A_j$, $j \neq i = 1, 2$. This means that the reaction functions are initially sloped positively until they intersect the line of equality ($A_i = A_j$), and thereafter sloped negatively. On the other hand, if for any outfit $T_i, i = 1, 2$ one has $R_i \leq \frac{1}{2}\frac{\alpha_i^2}{\beta_i}$, T_i's reaction function becomes $A_i = \sqrt{\frac{2R_i}{\beta_i}}$, which is independent of $A_j, j \neq i = 1, 2$.

Chapter 6

Chapter 6: Countering Terror Cells

The analysis provides insights regarding the suitability of offensive versus defensive measures in countering a terror cell. It is shown that the optimal resource allocation is more offensive when the cell is aware of which targets have been protected, but does not distinguish between the values of different targets; than the case where it neither distinguishes between target values nor is the protection conspicuous. Also, the ability of the terror cell to inflict damage is least when it neither distinguishes between target values nor is the target protection conspicuous, and most when it shares the counter-terrorists' target valuations and observes target protection. Hence, from the counter-terrorism (CT) point of view, there seems to be a rationale in making CT target valuations and target protection inconspicuous to the extent possible. The chapter finally deals with the possibility of diverging target valuations from the CT standpoint and that of the terror cell, and shows that if target protection is conspicuous to the cell and these are common knowledge, then the optimal CT allocation is at least as offensive as the case with identical valuation rankings.[77]

6.1 Overview

Terrorism presents a menacing challenge across large parts of the world. Terrorists operate both within and across borders, attempting to leave a trail of death and destruction, in order to create fear among people. Given the extent of suffering caused by these actors on the global stage, it is the endeavor of policy-makers and governments all over the world, to restrict terrorism. For this

[77] The contents of this chapter are drawn largely from Bhan and Kabiraj (2019b).

purpose, they need to choose suitable counter-terrorism (CT) policies given their financial and operational constraints.

The linkages of global terrorism with income and geography on the one hand, and with politico-economic structures and frameworks on the other, have been analyzed at some length. In the former category, Enders and Sandler (2006) apply an autoregressive intervention model on data spanning 1968-2003 and surprisingly find a lack of evidence of income-based relocation of terror strikes to low-income countries after 9/11, while Bagchi and Paul (2018) find no evidence of youth unemployment impacting transnational terror activity in the MENAP (Middle East, North Africa, Afghanistan, and Pakistan) region, based on data from the Global Terrorism Database (GTD).[78] On the other hand, Barth et al. (2006) find that terrorism adversely impacts overall economic activity. In the latter category, Li (2005) shows that democratic involvement inhibits transnational terrorism, while Sandler and Siqueira (2007)[79] demonstrate that in light of the delegation problem arising in domestic politics where voters strategically choose a representative with preferences potentially different from their own, the *presumed oversupply* of defensive counter-terrorism measures by countries is curtailed.[80]

There have also been numerous works dealing with the co-ordination problem encountered by countries, when faced with a common terrorist threat. Arce and Sandler (2005) and Sandler (2005) demonstrate the rationale behind each country favoring defensive measures over offensive ones, relying on the nature of externalities generated on others by the type of measures implemented by a country. Das and Roy Chowdhury (2014) apply a game-theoretic model to identify circumstances which may render it logical to respond to increased terrorism

[78] However, this study finds that unlike transnational terrorism, domestic terrorism increases with youth unemployment in MENAP countries.
[79] Siqueira and Sandler (2007) also model the delegation problem arising in domestic politics, to derive similar results.
[80] See Mesquita (2005b) for a model which incorporates moral hazard and learning, to illustrate the dynamics between the government and former terrorists.

with increased pre-emption. Analyzing a framework where the targeted country has interests both at home and abroad, Sandler and Siqueira (2006) show that leader-follower behavior reduces the inefficiency in deterrence while worsening the inefficiency in pre-emption, compared with the choices in the equilibrium with simultaneous moves. Bandyopadhyay and Sandler (2011) use a two-stage game involving two commonly targeted countries to demonstrate that market failures related to preemption and defence may be collectively mitigated by a handicapped defender.

Countering the scourge of terrorism effectively necessitates an understanding of the organizational structure of terror outfits, and its evolution in the face of increased adversity. The American *war on terror* launched in the aftermath of the terror attacks conducted by al Qaeda on 11 September, 2001, resulted in the outfit adapting to ensure survivability in the face of intelligence-driven targeted attacks on its leadership. The result of this malleability was a more resilient global amalgamation of loosely-connected regional terror networks affiliated to al Qaeda which - albeit driven by a shared radical Islamic ideology and common larger goals - were less hierarchical, less operationally predictable, and more financially and tactically independent.[81] Similarly, with the severe disintegration of its hierarchical C3 (command, control and communications) structure in Iraq and Syria over the last few years, the Islamic State of Iraq and Syria (ISIS) has reorganized itself into a decentralized outfit and shifted its operational focus eastwards, especially towards South Asia and Southeast Asia. The group's recruitment of Abu Sayyaf operatives in the Philippines and large sections of Taliban echelons in Afghanistan, as brought out in an article by Callimachi and Schmitt (2019), is symptomatic of this shift.

[81] See Pace (2014) for an extensive discussion on the decentralization of al Qaeda, its consequences, and insights applicable to the war against the ISIS.

Enders and Jindapon (2010) compare alternative network structures of terror outfits – centralized and decentralized – and conclude that because the individual nodes in the latter structure may not make optimal decisions from the group's standpoint, "*the decentralized decision-making process is suboptimal from the overall perspective of the network*". However, with the increased surveillance of the activities of a terror outfit and the purposeful targeting of its leadership, survival may have to be prioritized by the outfit rather than organizational efficiency, thereby forcing it to rely on a decentralized network. Such a trade-off between outfit-safety and intra-outfit correspondence is modeled by Enders and Su (2007), to establish the rationale for the formation of terror cells, which are the smallest units of decentralized networks of terrorists. Such outfits often operate by establishing loosely-linked terror modules, each operating in multiple hubs through a network of largely independent terror cells, each cell comprising of a small and cohesive group of usually three to five members. Terrorists responsible for terror strikes in Western Europe, for instance, mostly depended on the wages and investments of the members of the cell for finance (Oftedal 2015). Similarly, each deployed al Qaeda cell is required to be financially independent (Medina and Hepner 2009). This minimizes money trails, thereby making the cell harder to detect. Further, according to The Free Dictionary by Farlex, ensuring operational safety generally requires that adjoining terror cells be unaware of one another or the headship's identity.[82] This, however, also means that an individual terror cell has limited resources and consequently, its existence is generally very task-specific. It is therefore uncommon for a terror cell to be allocated multiple assignments. Rather, the focus is on ensuring the efficient execution of a particular assignment by a given cell. Hence, the majority of terror cells are created to conduct a single attack (Oftedal 2015).

[82] Visit www.thefreedictionary.com/terrorist+cell.

Different terror cells operating in a hub may be assigned specialized roles in enabling the smooth execution of a terror attack. *Planning* or *support* or *logistics* cells are responsible for fund-raising and provision of logistical support to *execution* cells. *Sleeper* or *submarine* or *dormant* cells may have resided in the target country for years, living like normal residents until activated by their respective handlers.[83] *Execution* cells enter the fray right towards the end, utilizing the resources and intelligence provided by other cells to conduct attacks.[84]

To summarize, the cohesion of the terror cell as an operational unit mitigates intra-cell co-ordination issues, whereas the specialized nature of the task assigned to it ensures that inter-cell co-ordination issues are minimized.

Taking cognizance of the above, the present work investigates the nature of the interplay between preemption and defence in CT within a single-defender framework, by focusing on the role of information available with the terrorists and counter-terrorists, and potential divergences in target preferences between the two sides. This is a major departure from the existent literature which, in its focus on multi-country/multi-defender frameworks and the associated issue of co-ordination against a common terrorist threat, largely ignores the salient impacts of information and varying perceptions about target-values even in the absence of co-ordination related dynamics.

The focus of the following bottom-up analysis is on the role of the first-responder, the city police for example, in local (or tactical) CT. It is often the decision-making by the first-responder at the local level, given the limited availability of resources and time, which decides the success or failure of an intended terrorist operation. Therefore, the scenario discussed is

[83] Hoffman (2003) establishes the salience of handlers in the planning and execution of suicide terror attacks.
[84] See 'How Do Terrorist "Cells" Work?' (*Slate*, 17 September, 2001), https://slate.com/news-and-politics/2001/09/how-do-terrorist-cells-work.html.

likely to describe a situation in which the planning and support cells have already played their part, all concerned sleeper cells have been activated, and the execution cells have entered the fray. Hence to prevent the attack, it would be necessary for the first-responder - with its limited resources - to either apprehend or eliminate the execution cells before they conduct the attack, or to correctly predict the intended target and provide it protection. The present study intends to compare the optimal resource allocation between attacking the possible hideouts of the terror cell and protecting its potential targets, under different scenarios in respect of the observability of protection afforded to the potential targets,[85] and whether terror cells distinguish between the values of different targets.

It must be emphasized that at the level of the terror cell and the first-responder, the decision to conduct a terror attack is a fait accompli. Hence, the decision to conduct an attack is taken at a higher level within the terror outfit, and communicated to a terror cell by its handler. To illustrate, an India Today Television report[86] (dated 21 January, 2016) titled "*Operation Sleeper Cell: How Pakistani handlers guide terrorists in India*" reveals details of how the Pakistan-located handlers of terror cells based in India, passed on orders related to the execution of attacks, etc. According to the report, "*terrorists in India talk to their handlers not just about movement of personnel across the border and the shipment of weapons and ammunition, the conversations can sometimes be as basic as the handler telling his operative where to get hold of a second SIM card from, without giving any proof of identity*". In fact, as discussed in an article on the ISIS by Callimachi (2017), it is often the handler located in an ISIS-controlled territory that conceives of an attack and guides terror cells in their execution via the internet.

[85] A government residential complex may, for instance, be protected using bollards or through the deployment of concealed closed-circuit televisions (CCTV). The former would be conspicuous to terrorists, while they may be unable to detect the latter before a potential terror strike.

[86] See https://www.google.com/amp/s/www.indiatoday.in/amp/india/story/operation-sleeper-cell-how-pakistani-handlers-guide-terrorists-in-india-304946-2016-01-21.

Given that the present work focuses on last-gasp tactical CT from the point-of-view of the first-responder, whose direct adversary is the terror cell, the decision to conduct a terror strike is clearly beyond the scope of this analysis. As discussed above, neither is the decision to attack for the cell to make, nor can this decision be influenced by the first-responder.

According to Mueller et al. (2006), preemption is the probable choice of the first-responder if adequate intelligence about the terrorists' names, whereabouts, or designs is obtainable. It is, however, important to note that not only is the quantum of intelligence *per se*, important in determining its *actionability* (whether preemption or protection is optimal), but also the quality and nature of inputs. For example, more specific intelligence about the potential whereabouts of the cell drastically reduces the number of potential hideouts which would need to be raided if preemption is chosen, thereby making preemption more likely *ceteris paribus*. Conversely, if the inputs are more specific about potential targets of the outfit, then defence becomes more attractive *ceteris paribus*. This aspect is captured in the present framework, and is usually critical in determining the equilibrium allocation of CT resources between offence and defence.

A retired Commander from the Los Angeles Sheriff's Department, Sid Heal classifies defensive actions such as vigilance instillation, threat identification, target protection, attack forecasting and damage control under the head of *anti-terrorism* (AT), and the endeavors applied to resist terrorists and determinedly prevent terror strikes under the head of *counter-terrorism* (Heal 2011). He concludes that effectively tackling terrorism necessitates the application of both AT and CT. However, my findings suggest that while some amount of allocation to defense is usually optimal, pre-emptive measures may or may not be employed.

In similar vein, Das and Lahiri (2019) construct a three-period game where the terrorists use terror as *a means to an end*, and neither the State nor the terrorists are completely aware of the other's preferences. They conclude that it is impossible for the State to triumph in the *war on terror* using preemption alone, if the marginal cost of preemption is rising. Although the present framework focuses on countering the threat posed by a terror cell, and not on a full-blown war on terror, its robustness lies in its ability to demonstrate the strong rationale underlying the above-stated *impossibility theorem* under different scenarios in respect of the conspicuity of CT target valuations and defensive allocation to the terror cell.

Bier et al. (2007) allow for a divergence of preferences over targets between the defender and attacker such that the defender does not know the attacker's preferences, while the attacker observes the defender's resource allocation. Under these assumptions, they demonstrate that the defender prefers her allocation to be public rather than private. The present study considers a similar scenario with diverging preferences, but with two key differences. Firstly, my structure allows for pre-emptive strikes against the terror cell (attacker) and secondly, the cell's preferences are common knowledge. Under these assumptions, it is shown that the optimal CT allocation under diverging preferences is at least as offensive as that under identical preferences, and the expected damage that the terrorists can cause (from the CT standpoint) under diverging preferences does not exceed that under identical preferences.

The present chapter, under different assumptions relating to target valuation and protection (defensive allocation), attempts to study and compare the nature of optimal resource allocations between offence and defence. It demonstrates that if the cell does not value different targets differently, then the optimal allocation is at least as offensive if the terror cell can observe which targets are protected, than if it cannot. Moreover, it is shown that the terror cell's ability to inflict damage is least when it neither distinguishes between target values nor observes target protection, and most when it shares the counter-terrorists' target valuations and observes target protection.

Section 6.2 provides the basic model and results, given the valuations of the targets. Section 6.3 addresses the possibility of the terror cell having different target valuations than those from the CT perspective. Section 6.4 allows for the possibility of target protection being overwhelmed by the terrorists, and demonstrates the robustness of the propositions derived under this alternative assumption. Finally, Section 6.5 summarizes and discusses the implications of the results. All proofs and calculations are relegated to the appendices.

6.2 Model

Consider a terror cell located in a specified geographic area, having M possible hideouts and N potential targets T_1, T_2,…., T_N. Let the values of these targets be v_1, v_2,…., v_N respectively from the CT standpoint, such that $v_1 > v_2 > \cdots > v_N$. These valuations may or may not be known to the cell. Suppose the cell requires only one hideout, and has the capability to attack only a single target. Let R be the CT resource endowment, the cost of pre-emptively attacking any hideout be unity (numeraire), and α be the cost of defending any potential target.[87] It is assumed that $R < M$ and $R < \alpha N$, so that the CT resource endowment is such that neither can all possible hideouts be attacked, nor can all potential targets be defended.[88] Then, if m and n denote the number of

[87] Thus α, in effect, is the CT cost of defence relative to the CT cost of attack.

[88] If the cost of defending different targets is varying, v_is can be interpreted as the net CT valuations. To explain, for target T_i $(i = 1,..,n)$ let the (gross) CT valuation be u_i, the cost of defence be α_i, and the net CT valuation be $v_i = u_i - \alpha_i$, such that $v_1 > v_2 > \cdots > v_N$. Further assume that $R < M$ and $R < \sum_{i=1}^{N} \alpha_i$, so that the CT resource endowment is such that neither can all possible hideouts be attacked, nor can all potential targets be defended. Then if the remaining formulation is left unchanged, all results in the analysis continue to hold with the caveat that v_is represent the CT valuations of the targets, net of the cost of defence.

possible hideouts pre-emptively attacked and the number of potential targets defended respectively, the CT budget constraint is

$$R = m + n\alpha \quad (1)$$

The CT objective is to minimize the expected damage inflicted by the terror cell, by choosing m and n subject to (1). The terror cell's objective is just the converse, which is to inflict the maximum possible damage by choosing an appropriate target. It is assumed that if the correct hideout is attacked pre-emptively, the terror cell is neutralized before it can carry out an attack, and the game ends. Otherwise, the cell conducts an attack on its chosen target. If the designated target is protected, the attack is foiled. If not, the attack succeeds.[89] Moreover, the structure of the strategic interaction is assumed to be common knowledge. The following scenarios are considered:

1. Cell does not distinguish between the values of different targets, nor is it able to observe target protection,
2. Cell can observe target protection, but does not distinguish between target values, and
3. Cell shares the counter-terrorists' target valuations, and observes target protection.

Proposition 1: *The optimal CT allocation is at least as offensive in Scenario 2, as it is in Scenario 1.*

The proof of the proposition is given in Appendix A. Proposition 1 is a direct consequence of the fact that when target valuation is irrelevant to the terrorists, if target protection can be observed by the cell (Scenario 2), then the ability to defend against a terror

[89] The assumption of defended targets being impregnable is a simplifying one, and relaxing it leaves the chapter's results qualitatively unchanged. See Section 4 for further details.

strike effectively is compromised compared to the case where target protection is inconspicuous (Scenario 1). This is because if target protection is conspicuous to the cell, it will not attack a protected target if it survives the pre-emptive strikes. This ensures a successful terror attack if the cell survives the pre-emptive strikes because, by assumption, the CT resource endowment is not large enough to protect all targets. It is for this reason that pre-emptively attacking hideouts has greater appeal in Scenario 2.

Proposition 2: *Expected damage is highest in Scenario 3, and lowest in Scenario 1.*

The proof is outlined in Appendix B. In Scenario 1, even if the outfit survives pre-emptive CT strikes, it may end up attacking a defended target due to lack of information on target protection. In Scenarios 2 and 3, such an outfit (which has survived pre-emptive CT strikes) would successfully carry out an attack because target protection is conspicuous. Moreover, in Scenario 3, the outfit would successfully attack the most valuable unprotected target, because it shares the counter-terrorist's valuations of different targets in addition to observing the protection afforded to each of them. Proposition 2 follows as a consequence.

This result is in sharp contrast to Bier et al. (2007), who argue that making the defensive allocation public may be in the *defender*'s interests. Their result, however, is obtained by assuming that the *attacker* (the terror cell, in the present framework) has a non-trivial *outside option*. If there is no such alternative avenue which can yield higher utility to the terrorists, as in the present model, then Proposition 2 holds. The absence of such an *outside option* is in fact a reasonable assumption under the circumstances considered here, given that terror cells can seldom be deactivated at such an advanced stage of a terrorist operation, such as one where the *execution cells* have already entered the picture.

The proposition below rationalizes the ubiquity of defensive CT allocation in real-world scenarios.

Proposition 3: *Let* $\tilde{n}(\leq \left\lfloor \frac{R}{\alpha} \right\rfloor)$ *be a finite number of targets (from the set of all valuable targets arranged in descending order by value, starting from the most valuable) with cumulative value* $\tilde{v}$*, and* m^* *be the optimal number of potential hideouts to be pre-emptively attacked from the CT standpoint. Let the cumulative value of the remaining targets be* $\hat{v}$*, so that* $\sum_{i=1}^{N} v_i = \sum_{i=1}^{\tilde{n}} v_i + \sum_{i=\tilde{n}+1}^{N} v_i = \tilde{v} + \hat{v}$*. If* $\frac{\tilde{v}}{\hat{v}}$ *is high enough, then* $m^* < R$ *in Scenarios 1 and 2. Also, if* $\frac{v_1}{v_{\tilde{n}+1}}$ *is high enough, then* $m^* < R$ *in Scenario 3.*

The proof of the proposition is given in Appendix C. In scenarios where target values are inconspicuous to the cell, if the targets in a particular subset of targets of value (arranged in descending order, starting from the most valuable) can be protected given the CT resources available, then if the subset is valuable enough compared to its complement, allocating at least some part of the CT resources to defense is optimal. This is because the opportunity cost of not protecting targets which are very valuable compared to other targets, and which can be protected, is very high. To understand this, note that even given a higher CT allocation to offence at the cost of leaving some of such high-value targets unprotected, the cost that the terror cell can inflict if it survives the pre-emptive strikes is prohibitively high, thereby making such an allocation very risky. This ensures the absence of all-out offence in equilibrium. In Scenario 3, a similar result intuitively follows if the value of the most valuable target is sufficiently higher than the value of the most valuable target in the complement of the subset, since target values are conspicuous to the cell in addition to target protection. To understand this, note that if T_1 and other targets of very high value compared to $T_{\tilde{n}+1}$ are not protected for example, then once again there is the possibility of the terror cell inflicting prohibitively high damage if it escapes the pre-emptive strikes. In fact, the opportunity cost here is even higher than that in Scenarios 1 and 2 because target protection is conspicuous to the cell and it also shares the counter-terrorists' target valuations, thereby ensuring that it will attack the most valuable unprotected target on surviving the pre-emptive strikes.[90]

The omnipresence of defensive measures in combating terrorists, indicated by Proposition 3, is in similar flavor to a significant body of existing literature on terrorism. Although under different frameworks and assumptions than the present, the anecdotal evidence in Heal (2011), the three-stage game characterization of a country's *war on terror* in Das and Lahiri (2019), etc., all point towards the critical role of defensive CT.

I now illustrate the above-stated propositions by constructing numerical examples. We fix the values of various parameters to check the results. Detailed calculations are relegated to Appendix D.

Example 1: Let $N = 4$, $\alpha = 2$, $R = 4$ and $M = 5$ with $(v_1, v_2, v_3, v_4) = (40, 7, 6, 5)$, then a unique interior solution is obtained in Cases 1 and 3 with $n^* = 1$ and $m^* = 2$, whereas a unique corner solution is obtained in Case 2, where resources are only spent on pre-emptively striking the potential terror hideouts, i.e., $n^* = 0$ and $m^* = 4$. Also, the expected damage caused by the terror cell in Cases 1, 2 and 3 are 2.7, 2.9 and 4.2 respectively. It is immediately evident, therefore, that the results are in conformity with Propositions 1 and 2. Moreover, if $v_1 = 200$ instead of the earlier $v_1 = 40$, then the optimal values of n and m remain unchanged in Cases 1

[90] This is in accordance with Proposition 2.

and 3, but $n^* = 1$ and $m^* = 2$ in Case 2, instead of $n^* = 0$ and $m^* = 4$. The results, therefore, are also in conformity with Proposition 3.

Example 2: Now consider the case where $N = 3$, $\alpha = 2$, $R = 4$ and $M = 5$ with $(v_1, v_2, v_3) = (40, 7, 6)$. A corner solution is obtained in Case 1, where all CT resources are used for defense, i.e., $n^* = 2$ and $m^* = 0$. The other corner solution is obtained in Case 2, with all CT resources used for offence, i.e., $n^* = 0$ and $m^* = 4$. Finally, a unique interior solution is obtained in Case 3, with $n^* = 1$ and $m^* = 2$. Also, the expected damage caused by the terror cell in Cases 1, 2 and 3 are 2, 3.5 and 4.2 respectively. It is immediately evident, therefore, that the results are in conformity with Propositions 1 and 2. Moreover, if $v_1 = 200$ instead of the earlier $v_1 = 40$, then the optimal values of n and m remain unchanged in Cases 1 and 3, but $n^* = 1$ and $m^* = 2$ in Case 2, instead of $n^* = 0$ and $m^* = 4$. The results, therefore, are also in compliance with Proposition 3.

6.3 Differing Valuations – Further Possibilities

In this situation, the possibility that the terror cell's target valuations may differ from those of the CT authorities is considered. However, the valuations of the terror cell are assumed to be common knowledge. It is also assumed that the protection afforded to the targets is common knowledge.

For the targets T_1, T_2,…., T_N; let the cell's valuations be V_1, V_2,…., V_N where $V_1 > V_2 > \cdots > V_N$. Let v_1, v_2,…., v_N be the CT authority's valuations. If all CT resources are allocated to defence, then let S_0 be the set of targets defended if defensive allocation is granted in descending order of the terror cell's target valuations. It is reasonable to defend targets in descending order of valuation, since the cost of defending each target is the same and equal to α, and therefore the

CT focus will be on defending more valuable targets first. So, $S_0 = \left\{T_1, T_2, \ldots, T_{\left[\frac{R}{\alpha}\right]}\right\}$, where $\left[\frac{R}{\alpha}\right]$ is the largest integer in $\frac{R}{\alpha}$. Given the CT budget if S_0 is protected, the cell will attack $T_{\left[\frac{R}{\alpha}\right]+1}$, inflicting damage worth $v_{\left[\frac{R}{\alpha}\right]+1}$. Let $T_{min}^{S_0}$ be the least valuable target in S from a CT standpoint, i.e., $v_{min}^{S_0} = min\, v_i$, for all $T_i \in S_0$. Now construct the set $S_1 \subseteq S_0$, with targets in descending order of the terror cell's valuations up to the target $T_{min-1}^{S_0}$. So, $S_1 = \{T_1, T_2, \ldots, T_{min-1}^{S_0}\}$. Let $T_{min}^{S_1}$ be the least valuable target in S_1 from a CT standpoint, i.e., $v_{min}^{S_1} = min\, v_i$, for all $T_i \in S_1$. Let the cardinality of S_1 be n_1, that is, $T_{min-1}^{S_0} = T_{n_1}$. In this way, one can define S_r, $r = 0, 1, 2, \ldots$

There are the following two possibilities:

Case 1: $v_{min}^{S_0} < v_{\left[\frac{R}{\alpha}\right]+1}$.

This ensures that defending S_0 is not optimal from a CT standpoint because if S_1 is protected instead, the expected damage will be $\left(\frac{M-R+\alpha n_1}{M}\right) v_{min}^{S_0} < v_{\left[\frac{R}{\alpha}\right]+1}$. Construct $S_2 = \{T_1, T_2, \ldots, T_{min-1}^{S_1}\}$, where the cardinality of S_2 is n_2, that is, $T_{min-1}^{S_1} = T_{n_2}$. Compared to defending S_1, $(n_1 - n_2)$ additional targets are left undefended if S_2 is defended. This leads to an incremental CT resource-saving of $\alpha(n_1 - n_2)$, which can be utilized to preemptively attack $\alpha(n_1 - n_2)$ additional potential hideouts. Since it is optimal to defend fewer than the $\left[\frac{R}{\alpha}\right]$ targets in S_0, the optimal number of targets to defend must be a subset of S_1. This is because the best way to defend fewer targets than in S_0, must begin with leaving $T_{min}^{S_0}$ unprotected. This would therefore become the most valuable undefended target from the cell's perspective.[91] However, all targets in S_0 following $T_{min}^{S_0}$, that is, $T_{min+1}^{S_0}, T_{min+2}^{S_0}, \ldots, T_{\left[\frac{R}{\alpha}\right]}$, are less valuable for the cell than

[91] For more on the deflection of terror attacks due to defensive/protective measures, see Keohane and Zeckhauser (2003).

$T_{min}^{S_0}$. Hence, these can be left undefended without any additional risk, since the terror cell's optimal target choice would remain $T_{min}^{S_0}$. Moreover, it costs α to defend each of these targets. Therefore, the resources saved can be utilized for preemptively striking potential hideouts. Hence, if defending S_0 is not optimal, then the set of optimally defended targets should either be S_1, or a proper subset of S_1. Similarly, it can be shown that if it is optimal to defend any fewer than the n_1 targets in S_1, then the optimal number of targets to defend must be a subset of S_2, and so on. So the change in expected damage at the margin, on defending S_2 instead of S_1, is $D_2 = \left(\frac{M-R+\alpha n_2}{M}\right) v_{n_2+1} - \left(\frac{M-R+\alpha n_1}{M}\right) v_{n_1+1}$.[92] If $D_2 \geq 0$, then it is optimal to defend S_1. Otherwise, $S_3 = \{T_1, T_2, \dots, T_{min-1}^{S_2}\}$ is constructed, where the cardinality of S_3 is n_3, that is, $T_{min-1}^{S_2} = T_{n_3}$. Then it is checked whether $D_3 = \left(\frac{M-R+\alpha n_3}{M}\right) v_{n_3+1} - \left(\frac{M-R+\alpha n_2}{M}\right) v_{n_2+1}$, is non-negative or not, and so on. For some integer r, if $D_1,\dots, D_r$ are negative but $D_{r+1} \geq 0$, then it is optimal to defend S_r. Here, $D_{r+1} = \left(\frac{M-R+\alpha n_{r+1}}{M}\right) v_{n_{r+1}+1} - \left(\frac{M-R+\alpha n_r}{M}\right) v_{n_r+1}$, $\forall r: 0 < r < \left[\frac{R}{\alpha}\right]$. If $D_1,\dots, D_{\left[\frac{R}{\alpha}\right]}$ are all negative, however, then it is optimal to allocate all resources towards offence.

Case 2: $v_{min}^{S_0} > v_{\left[\frac{R}{\alpha}\right]+1}$.

In this case, from the CT perspective, the least valuable target in S_0 is more valuable than the most valuable target outside S_0 from the terror cell's perspective. Hence, if defending all targets in S_0 is suboptimal from a CT standpoint, then the set of optimally defended targets should either be S_1, or a proper subset of S_1.[93] The change in expected damage at the margin, on defending S_1 instead of S_0, is $D_1 = \left(\frac{M-R+\alpha n_1}{M}\right) v_{n_1+1} - \left(\frac{M-R+\alpha [R/\alpha]}{M}\right) v_{\left[\frac{R}{\alpha}\right]+1}$. If $D_1 \geq 0$, then S_0 is the set of

[92] The expression for D_1, the marginal expected damage on defending S_1 instead of S_0, is given in Case 2.
[93] This is as discussed in Case 1.

optimally defended targets. Else, one checks the sign of D_2, and so on. In general, for some integer $r \epsilon [0, \left\lfloor \frac{R}{\alpha} \right\rfloor)$, if $D_0, \ldots, D_r$ are negative but $D_{r+1} \geq 0$, then it is optimal to defend S_r. If $D_1, \ldots, D_{\left\lfloor \frac{R}{\alpha} \right\rfloor}$ are all negative, then as in Case 1, it is optimal to allocate all resources towards offence.

Special Cases:

1. Suppose all targets are valued identically from a CT perspective, that is, $v_1 = v_2 = \cdots = v_N = v$ (say). Then if the terror cell is able to conduct a successful attack on any undefended target, the damage would be the same, that is v. Hence, defending any particular subset of targets is suboptimal, since the cell can observe the CT defensive allocation. Therefore, the optimal allocation is to allocate all CT resources to preemptively striking potential hideouts of the terror cell, that is $(m^*, n^*) = (R, 0)$. This is because: a) there are not enough resources to defend all of the equally valuable targets, and b) the damage is limited to v if the cell manages to survive the preemptive strikes.
2. Suppose the valuation-ranking of the targets from the CT standpoint is the same as that from the cell's perspective, that is, $v_1 > v_2 > \cdots > v_N$. If an interior solution exists (where some targets are defended as well as some potential hideouts are preemptively attacked), then the defensive CT allocation is afforded in descending order of value to targets starting from the most valuable, till the marginal utility from defense continues to exceed that from preemptive strikes.
3. Suppose the target valuation ranking from the CT perspective, is diametrically opposite to that of the terror cell, that is, $v_1 < v_2 < \cdots < v_N$. If the cell survives the preemptive strikes, then it would optimally attack the least valuable target from the CT perspective (T_1), since this is the most valuable target from the cell's perspective. So limited CT

resources need not be spent protecting other targets. Moreover, there is no CT incentive in changing the cell's target choice by protecting its most valuable target (T_N), since this is the least valuable target from the CT standpoint. Hence the optimal CT allocation, as when all targets are equally valuable from a CT standpoint, is to use all CT resources for preemptively attacking potential terror hideouts. So, $(m^*, n^*) = (R, 0)$.

In addition to the above extreme cases, this section concludes with a stronger assertion comparing the cases of identical valuations and differing valuations of potential targets, stated in the proposition below.

Proposition 4: *Suppose the target valuation ranking of the terror cell is different from the CT ranking, target protection is conspicuous to the terror cell, and these are common knowledge. Then the optimal CT allocation is at least as offensive as the case with identical valuation rankings. Moreover, the expected damage from the CT perspective does not exceed that in the case with identical valuation rankings.*

If the target valuation rankings differ, the CT authorities may not have to defend certain targets which they would have to under identical preferences (given their own preferences across targets), because the opportunity cost of defending these targets would be higher under diverging preferences. This is because these targets may not be valuable enough any longer, from a CT perspective. The other side of the coin is that the opportunity cost of preemption is now lower, because the potential damage from a successful attack on certain targets is lower under diverging preferences. So any resources saved as a result of defending fewer targets can now be optimally utilized for pre-emptive strikes on potential hideouts, thereby entailing a CT allocation which is at least as offensive as that under identical valuation rankings, and with expected damage that is no greater than that under identical rankings. The formal proof of Proposition 4 is in Appendix E.

6.4 Formulation under Alternative Assumptions

In this section, the problem is first formulated under alternative assumptions, and it is then verified whether the results derived in the previous two sections hold or not. In particular, the possibility of potential targets being successfully attacked despite being defended is allowed for. The analysis is then extended further.

Suppose that either of two levels of defence - high (H) or low (L) - can be provided to any potential target, with the respective per target cost of defence being α_H and α_L, such that $\alpha_H > \alpha_L$ without any loss of generality. If n^H and n^L be the number of potential targets provided H and L defence, respectively, then the CT budget constraint is $m + n^H\alpha_H + n^L\alpha_L = R$. In order to avoid trivial corner solutions, it is assumed that $R < \min\{M, \alpha_H N\}$, so that the CT resources are neither sufficient for raiding all possible terror hideouts preemptively, nor sufficient for providing all potential targets with a high level of defence.

Suppose further that the terror cell can be of either of two efficiency levels - high (H) or low (L), such that an H-type cell can overwhelm targets with L-defences, but not those with H-defences, while an L-type cell can only successfully attack undefended targets. Here, H-type terrorists may be *fidayeen* or suicide terrorists for example, while L-types may refer to other less dangerous terrorists. Further, it would not be unreasonable to expect the terror cell's efficiency to be its private information.

Assume that from the CT perspective the cell's efficiency is H and L, with probability q and $1-q$ respectively, $q \epsilon [0,1]$. Then the following lemma follows as a straightforward consequence.

Lemma 1: *If* $q=0$, *then* $n^{H*}=0$ *and if* $q=1$, *then* $n^{L*}=0$.

Proof: $q=0$ implies that from the CT perspective, it is known *a priori* that the terror cell is of L-type. In order to thwart an attack from such a cell, L-defence suffices and hence, there is no need for the CT to spend on the more expensive H-defence. Hence, $n^{H*}=0$. If $q=1$ on the other hand, then it is known *a priori* from the CT perspective that the terror cell is of H-type. Since an attack from such a terror cell can only be thwarted if the attacked target has been provided H-defence, therefore $n^{L*}=0$. This completes the proof. QED.

Now, if the counter-terrorist is assumed to be risk-neutral, it is easy to demonstrate that Propositions 1 through 4 continue to hold for all $q \in [0,1]$. See Appendix F. Hence, the results in Propositions 1 through 4 are not specific to the simplifying assumptions made in Sections 6.2 and 6.3.

To extend the analysis further, consider the scenario where L-defence is inconspicuous, while H-defence is conspicuous. Further, assume that it is common knowledge that counter-terrorism (CT) is risk-neutral. The analysis, however, shall be restricted to the scenario in which target valuations are inconspicuous to the terror cell. Let us call this Scenario 4, as compared to the three scenarios defined in Section 6.2.

If the cell is of H-type ($q = 1$), then Lemma 1 implies that $n^{L*} = 0$. Hence, as in Scenario 2, all target protection in equilibrium is conspicuous to the terror cell. Let the equilibrium vector, therefore, be $(n_2^H, 0, m_2^H)$. If the cell is of L-type ($q = 0$), on the other hand, then the lemma implies that $n^{H*} = 0$. Hence, as in Scenario 1, all target protection in equilibrium is inconspicuous to the terror cell. Let the equilibrium vector, therefore, be $(0, n_1^L, m_1^L)$. Then, for any $q \epsilon [0,1]$, the equilibrium vector will be $[qn_2^H, (1-q)n_1^L, qm_2^H + (1-q)m_1^L]$. The following proposition compares the CT allocation in Scenario 4, with those in Scenarios 1 and 2:

Proposition 5: *Under Scenario 4:*

- *The number of targets provided H-defence would equal that under Scenario 2, but not exceed that under Scenario 1;*
- *The number of targets provided L-defence would equal that under Scenario 1, but be no less than that under Scenario 2; and*
- *The number of potential hideouts preemptively attacked would be no less than that under Scenario 1, and no greater than that under Scenario 2.*

The proof to Proposition 5 follows from Proposition 1, recalling that the equilibrium CT allocations under Scenarios 1 and 2 are $[qn_1^H, (1-q)n_1^L, qm_1^H + (1-q)m_1^L]$ and $[qn_2^H, (1-$ *qn2L,qm2H+1−qm2L*, respectively. The result demonstrates that the offensive orientation of CT under Scenario 4 is no less than that under Scenario 1, and no greater than that under Scenario 2. This is along expected lines since the efficiency with which potential targets can be defended is greatest in Scenario 1 and least in Scenario 2, given the increasing conspicuity of target protection on moving from Scenario 1 to Scenario 4, and Scenario 2.

6.5 Conclusion

The present analysis attempts to derive insights regarding the optimal utilization of limited CT resources, to counter a terror cell, in scenarios where time is of the essence in being able to thwart a successful attack by the terrorist(s). Since the decision to conduct an attack has been taken at an earlier stage, which is not within the scope of this study, it is taken as a *fait accompli*. Consequently, it is observed that in scenarios where the cell is better informed about the targets, the cell is at least as lethal as in scenarios where it has less information about the targets.[94] Hence, there appears to be a CT rationale for suppressing target information from the terror cell, by making target protection wholly or partially inconspicuous for example.[95] In reality however, the ability to suppress target information may be costly, and therefore not achievable to the desired extent. In fact, the deployment of inconspicuous target protection measures such as hidden cameras can serve the dual purpose of not only preventing the deflection of terror attacks to more vulnerable targets, but catching the terrorists ill-prepared by drawing them into a well-defended space. Also, if better intelligence for CT is available in respect of the possible hideouts, as characterized by a lower number of possible hideouts (M) for example, then pre-emptive strikes become more attractive. This is along the lines of Mueller et al. (2006), as alluded to in the introduction.[96]

[94] This chapter therefore illustrates the importance of intelligence regarding the potential targets, in determining the lethality of the terror cell.

[95] For more on the desirability and logic of secrecy in the deployment of CT resources, see Dighe, Zhuang and Bier (2009); Zhuang, Bier and Alagoz (2010); and Zhuang and Bier (2010, 2011).

[96] For a framework which determines intelligence endogenously, see Arce and Sandler (2007). The study characterizes terrorist attacks as signals, where the government is uncertain whether it is confronted by a politically motivated or a militant outfit, in order to illustrate the possibility of ex-post regret and the consequent value of intelligence in CT.

The findings of this chapter must be viewed in the backdrop of the lack of analyses of counter-terrorism frameworks in general, and terror cells in particular, with specific focus on comparison of different scenarios in terms of the conspicuity of target information. This is despite the existence of a sizeable literature on the broad topic of terrorism, addressing a myriad of issues ranging from the linkages of terrorism to income, geography and politico-economic structures, to the problem of co-ordination failure encountered by countries in the provision of counter-terrorism effort when faced with a common terrorist threat. For instance, the third proposition must be viewed in context of the widespread finding that in the event of almost any terrorist threat, protection is afforded to at least a few potential targets of high enough value. This result provides a theoretical foundation for the ubiquity of defensive measures in countering terror cells, under different assumptions relating to the conspicuity of target information. This is along the lines of Das and Lahiri (2019), who demonstrate a similar result in the context of a State-waged anti-terror campaign.

Finally, and most interestingly, the present work provides the rationale for and demonstrates the greater offensive orientation of CT policy, when the CT preferences over the potential targets diverge from those of the terror cell. The framework improves upon that applied by Bier et al. (2007) by providing an additional CT policy lever. This is achieved by allowing for the possibility of conducting pre-emptive strikes on the potential hideouts of the terror cell. This is, in fact, the crucial feature which enables the current structure to demonstrate the increased effectiveness of offensive counter-terrorism under diverging target preferences. An interesting extension would be to check the robustness of this result in a scenario where the preferences of the terrorists are their private information.

6.6 Appendices

Appendix A: Proof of Proposition 1

In order to prove the first two propositions I characterize a strictly decreasing and differentiable target valuation function $v(.)$, $v^{'}(.) < 0$, defined over the interval $[0, N]$. Let n_1^* and n_2^* be the optimal CT choices in Scenarios 1 and 2, respectively. In Scenario 1, the terror cell neither distinguishes between the targets, nor can it observe which targets are protected. So it randomly selects a target. Hence, in order to minimize the expected damage, the authorities will protect the highest-value targets – 1 to n. If the cell attacks any of these n protected targets, then there is no damage because the attack will be thwarted. So the expected damage when the cell randomly chooses a target from the set of all N targets, is $\left(\frac{M-R+\alpha n}{M}\right)\frac{1}{N}\int_n^N v(t)dt$, where $\left(\frac{M-R+\alpha n}{M}\right)$ is the probability that the cell survives the pre-emptive CT strike on hideouts, and $\frac{1}{N}\int_n^N v(t)dt$ is the expected damage from a terror strike if the cell randomizes over all targets of value. The derivative of the expected damage with respect to n is $\frac{1}{N}\left\{\frac{\alpha}{M}\int_n^N v(t)dt - \left(\frac{M-R+\alpha n}{M}\right)v(n)\right\} \equiv C_1$. To ensure that the second order condition (SOC) for convexity holds over the interval of feasible n, it is assumed that $\frac{1}{NM}[-2\alpha v(n) - (M - R + \alpha n)v^{'}(n)] > 0$ for all $n \in [0, R/\alpha]$.

In Scenario 2, since the terror cell can observe target protection but again does not distinguish between their values, the authorities once again optimally protect the highest-value targets – 1 to n. However, unlike in Scenario 1, the cell randomizes only over the remaining $N - n$ unprotected targets. Hence, the expected damage is $\left(\frac{M-R+\alpha n}{M}\right)\frac{1}{N-n}\int_n^N v(t)dt$, where $\frac{1}{N-n}\int_n^N v(t)dt$ is the expected damage from a terror strike if the cell randomizes over all unprotected targets of value. The derivative of the expected damage with respect to n is $\frac{N}{N-n}C_1 + \frac{N}{(N-n)^2}\left(\frac{M-R+\alpha n}{M}\right)\frac{1}{N}\int_n^N v(t)dt \equiv C_2 > C_1$. The SOC here is $\frac{1}{M}\left[\frac{2\alpha}{(N-n)^2}\int_n^N v(t)dt - \frac{2\alpha}{N-n}v(n) + \frac{M-R+\alpha n}{(N-n)^3}\int_n^N v(t)dt - 2\frac{M-R+\alpha n}{(N-n)^2}v(n) - \frac{M-R+\alpha n}{N-n}v'(n)\right] > 0$ for all $n \,\varepsilon\, [0, R/\alpha]$. If either $C_1 = 0$ or $C_2 = 0$ in $(0, R/\alpha)$, then $n_1^* > n_2^*$. If $C_1 > 0$ at $n = 0$, then $C_2 > C_1 > 0$ at $n = 0$ and hence $n_1^* = n_2^* = 0$. If $C_2 < 0$ at $n = R/\alpha$, then $C_1 < C_2 < 0$ at $n = R/\alpha$ and hence $n_1^* = n_2^* = R/\alpha$. Finally, if $C_2 > 0$ at $n = 0$ and $C_1 < 0$ at $n = R/\alpha$, then $n_2^* = 0 < R/\alpha = n_1^*$. Hence the proof.

QED.

Appendix B: Proof of Proposition 2

The expected damage in Scenario 3 is $\left(\frac{M-R+\alpha n}{M}\right)v(n)$. Then comparing the expected damage under different scenarios, one obtains $\left(\frac{M-R+\alpha n}{M}\right)v(n) > \left(\frac{M-R+\alpha n}{M}\right)\frac{1}{N-n}\int_n^N v(t)dt > \left(\frac{M-R+\alpha n}{M}\right)\frac{1}{N}\int_n^N v(t)dt$, the latter two terms being the expected damages in Scenarios 2 and 1, respectively. Hence the proof. QED.

Appendix C: Proof of Proposition 3

Let $\bar{v}$ be the average value of all targets. Then $\bar{v} = \frac{\tilde{v}+\hat{v}}{N}$. If the CT allocation is purely offensive, the expected damage is $\left(\frac{M-R}{M}\right)\bar{v} = \left(\frac{M-R}{M}\right)\frac{\tilde{v}+\hat{v}}{N}$ in Scenarios 1 and 2, and $\left(\frac{M-R}{M}\right)v_1$ in Scenario 3. If, however, $\tilde{n}$ targets are protected, then the expected damage is $\left(\frac{M-R+\alpha\tilde{n}}{M}\right)\frac{1}{N}\sum_{i=\tilde{n}+1}^{N} v_i = \left(\frac{M-R+\alpha\tilde{n}}{M}\right)\frac{\hat{v}}{N}$ and $\left(\frac{M-R+\alpha\tilde{n}}{M}\right)\frac{1}{N-\tilde{n}}\sum_{i=\tilde{n}+1}^{N} v_i = \left(\frac{M-R+\alpha\tilde{n}}{M}\right)\frac{\hat{v}}{N-\tilde{n}}$ in Scenarios 1 and 2, respectively. Also, the expected damage is $\left(\frac{M-R+\alpha\tilde{n}}{M}\right)v_{\tilde{n}+1}$ in Scenario 3. From the above, it is follows that the necessary and sufficient conditions for $m^* < R$ to hold are $\frac{\tilde{v}}{\hat{v}} > \frac{\alpha\tilde{n}}{M-R}$, $\frac{\tilde{v}}{\hat{v}} > \frac{1+\frac{\alpha N}{M-R}}{\frac{N}{\tilde{n}}-1}$ and $\frac{v_1}{v_{\tilde{n}+1}} > 1 + \frac{\alpha\tilde{n}}{M-R}$ in Scenarios 1, 2 and 3 respectively. QED.

Appendix D: Calculations of the solutions of the examples in Section 6.3

The expected damage in Case 1 is given by $\left(\frac{M-R+\alpha n}{M}\right)\frac{1}{N}\sum_{i=n+1}^{N} v_i$. Substituting $N = 4$, $\alpha = 2$, $R = 4$ and $M = 5$ with $(v_1, v_2, v_3, v_4) = (40, 7, 6, 5)$, the expected damage is:

- $\frac{1}{5}.\frac{1}{4}.58 = 2.9$, when $n = 0$,
- $\frac{3}{5}.\frac{1}{4}.18 = 2.7$, when $n = 1$, and
- $1.\frac{1}{4}.11 = 2.75$, when $n = 2$.

Since the expected damage is lowest when $n = 1$, it is the optimal choice.

The expected damage in Case 2 is given by $\left(\frac{M-R+\alpha n}{M}\right)\frac{1}{N-n}\sum_{i=n+1}^{N} v_i$. Substituting $N = 4$, $\alpha = 2$, $R = 4$ and $M = 5$ with $(v_1, v_2, v_3, v_4) = (40, 7, 6, 5)$, the expected damage is:

- $\frac{1}{5}.\frac{1}{4}.58 = 2.9$, when $n = 0$,
- $\frac{3}{5}.\frac{1}{3}.18 = 3.6$, when $n = 1$, and
- $\frac{1}{2}.11 = 5.5$, when $n = 2$.

Since the expected damage is lowest when $n = 0$, it is the optimal choice.

The expected damage in Case 3 is given by $\left(\frac{M-R+\alpha n}{M}\right)\frac{1}{N}\sum_{i=n+1}^{N} v_i$. Substituting $N = 4$, $\alpha = 2$, $R = 4$ and $M = 5$ with $(v_1, v_2, v_3, v_4) = (40, 7, 6, 5)$, the expected damage is:

- $\frac{1}{5}.40 = 8$, when $n = 0$,

- $\frac{3}{5}.7 = 4.2$, when $n = 1$, and
- 6, when $n = 2$.

Since the expected damage is lowest when $n = 1$, it is the optimal choice. The above results conform to Propositions 1 and 2.

On replacing $v_1 = 40$ with $v_1 = 200$, the expected damage in Case 1 is:

- $\frac{1}{5}.\frac{1}{4}.218 = 10.9$, when $n = 0$,
- $\frac{3}{5}.\frac{1}{4}.18 = 2.7$, when $n = 1$, and
- $1.\frac{1}{4}.11 = 2.75$, when $n = 2$.

Since the expected damage is lowest when $n = 1$, it is still the optimal choice.

On replacing $v_1 = 40$ with $v_1 = 200$, the expected damage in Case 2 is:

- $\frac{1}{5}.\frac{1}{4}.218 = 10.9$, when $n = 0$,
- $\frac{3}{5}.\frac{1}{3}.18 = 3.6$, when $n = 1$, and
- $\frac{1}{2}.11 = 5.5$, when $n = 2$.

Since the expected damage is lowest when $n = 1$, it is the optimal choice, instead of $n = 0$ when $v_1 = 40$. It can also be easily verified that the optimal choice remains unchanged in Case 3, just as in Case 1. Hence, the results conform with Proposition 3.

The calculations for the case where $N = 3$, $\alpha = 2$, $R = 4$ and $M = 5$ with $(v_1, v_2, v_3) = (40, 7, 6)$ is similar, and left to the interested reader.

Appendix E: Proof of Proposition 4

For the targets T_1, T_2,…., T_N; let the cell's valuations be V_1, V_2,…., V_N where $V_1 > V_2 > \cdots > V_N$. Let v_1, v_2,…., v_N be the CT authority's valuations.

Claim: $S_r \subseteq P_r \equiv \left\{T_1, T_2, \dots, T_{\left[\frac{R}{\alpha}\right]-r}\right\}$, $\forall r \in [0, \left[\frac{R}{\alpha}\right])$, where r is an integer.

Proof: The claim obviously holds for $r = 0$, since $S_0 \subseteq S_0 = P_0$, because every set is a subset of itself. And by construction, for any $r \in (0, \left[\frac{R}{\alpha}\right])$, $T_{\left[\frac{R}{\alpha}\right]-r+1}, T_{\left[\frac{R}{\alpha}\right]-r+2}, \dots, T_{\left[\frac{R}{\alpha}\right]}$ must be excluded from S_0 to obtain S_r. And hence follows the claim.

Suppose the CT valuations share the same ranking as the cell's valuations, that is, $v_1 > v_2 > \cdots > v_N$. Then $S_r = P_r$ $\forall r \in [0, \left[\frac{R}{\alpha}\right])$, since no target other than $T_{\left[\frac{R}{\alpha}\right]-r+1}, T_{\left[\frac{R}{\alpha}\right]-r+2}, \dots, T_{\left[\frac{R}{\alpha}\right]}$ shall be excluded in order to obtain S_r from S_0. For some $r \in [0, \left[\frac{R}{\alpha}\right])$, if P_r is optimally defended under identical rankings, then differing valuation rankings may enable additional targets belonging from P_r to be left undefended if their CT value does not exceed $v_{\left[\frac{R}{\alpha}\right]-r+1}$. In other words, these targets are being left undefended without any increase in the damage that the cell can inflict if it survives pre-emptive strikes. This, in fact, is how one arrives at S_r from P_r. And any resources saved in this manner will be optimally utilized offensively. So the set of optimally defended targets under differing rankings must be a subset of S_r, which itself is a subset of P_r. Since $r \in [0, \left[\frac{R}{\alpha}\right])$ was chosen arbitrarily, it follows from the claim that the set of optimally defended targets under differing valuation rankings is a subset of the set of optimally defended targets under identical rankings, and therefore the optimal CT allocation under differing valuation rankings is at least as offensive as that under identical rankings.

Finally, it can easily be demonstrated that if all-out offence is optimal under $v_1 > v_2 > \cdots > v_N$, then it must also be optimal under all other CT valuation orderings. This is left to the interested reader.

Attention is now shifted toward the expected damage. Suppose for some $r \epsilon \left[0, \left[\frac{R}{\alpha}\right]\right)$, defending P_r is optimal under identical valuation rankings. Now consider the possibility of an arbitrary change in the CT valuation ranking. Now since S_r (a subset of P_r) can be defended without risking higher damage if the cell survives pre-emptive strikes, and any resources so saved can be used for additional pre-emptive strikes, the probability of the outfit surviving the pre-emptive strikes shall be no greater than that when P_r is defended. This ensures that the expected damage the terror cell can cause on defending S_r does not exceed that on defending P_r. And as argued above, because the optimally defended set under differing allocations is a subset of S_r, the expected damage associated with this set does not exceed that associated with defending S_r. Since $r \epsilon \left[0, \left[\frac{R}{\alpha}\right]\right)$ was chosen arbitrarily, it follows that the expected damage under differing rankings does not exceed that under identical rankings. This completes the proof. QED.

Appendix F: Propositions 1 through 4 under alternative assumptions

Consider the assumptions stated in Section 6.4, and further assume that the counter-terrorists are risk-neutral. The results underlying Propositions 1 through 4 are now examined.

To check Proposition 1, let $\left(n_j^H, 0, m_j^H\right)$ be the solution to the CT resource-allocation problem in Scenario j $(= 1,2,3)$ if it is common knowledge that $q = 1$, and $\left(0, n_j^L, m_j^L\right)$ be the corresponding solution if it is common knowledge that $q = 0$. Then $n_1^H \geq n_2^H$ and $n_1^L \geq n_2^L$, since Proposition 1 holds for $q = 1$ and $q = 0$. Assuming risk-neutral CT, it follows that the equilibrium configuration is $\left[qn_j^H,(1-q)n_j^L,qm_j^H+(1-q)m_j^L\right]$ under Scenario j. Notice that $qn_1^H \geq qn_2^H\ \forall q\ \epsilon\ [0,1]$, since $n_1^H \geq n_2^H$. Similarly, $(1-q)n_1^L \geq (1-q)n_2^L\ \forall q\ \epsilon\ [0,1]$, since $n_1^L \geq n_2^L$. Also, $qm_1^H+(1-q)m_1^L \leq qm_2^H+(1-q)m_2^L\ \forall q\ \epsilon\ [0,1]$, since $m_1^H \leq m_2^H$ and $m_1^L \leq m_2^L$, follows from Proposition 1. Hence, Proposition 1 holds true for all $q\ \epsilon\ [0,1]$.

To check Proposition 2, let the expected damage under Scenario $j\ (=1,2,3)$ be D_j^H and D_j^L, if $q=1$ and $q=0$, respectively. Then, since Proposition 2 holds for $q=1$ and $q=0$, one has $D_3^H > D_2^H > D_1^H$ and $D_3^L > D_2^L > D_1^L$. So for any $q\ \epsilon\ [0,1]$, the expected damage in Scenario j under private information is $qD_j^H+(1-q)D_j^L$, such that $qD_3^H+(1-q)D_3^L > qD_2^H+(1-q)D_2^L > qD_1^H+(1-q)D_1^L$. Hence, Proposition 2 holds true for all $q\ \epsilon\ [0,1]$.

For Proposition 3 to hold, a sufficient condition must exist under which not all CT resources are allocated to offence, that is, a sufficient condition for $qm_j^H+(1-q)m_j^L < R\ \forall q\ \epsilon\ [0,1]$, and $j\ (=1,2,3)$. Such sufficient conditions needed are:

- $\frac{\tilde{v}}{\hat{v}} > \frac{\alpha_H \tilde{n}}{M-R}$ if $j=1$,
- $\frac{\tilde{v}}{\hat{v}} > \frac{1+\frac{\alpha_H N}{M-R}}{\frac{N}{\tilde{n}}-1}$ if $j=2$,
- $\frac{v_1}{v_{\tilde{n}+1}} > 1+\frac{\alpha_H \tilde{n}}{M-R}$ if $j=3$.

Under those conditions, Proposition 3 holds for all $q\ \epsilon\ [0,1]$.

To check Proposition 4, let m_I^H and m_D^H be the optimal offensive CT allocations under identical and differing target valuations respectively, if $q=1$. Similarly, let m_I^L and m_D^L be the optimal offensive CT allocations under identical and differing target valuations respectively, if $q=0$. Then, since Proposition 4 holds for $q=1$ and $q=0$, one has $m_D^H > m_I^H$ and $m_D^L > m_I^L$. The optimal offensive CT allocations under identical and differing target valuations are $qm_I^H +$

$(1-q)m_I^L$ and $qm_D^H + (1-q)m_D^L$, respectively, for any $q \in [0,1]$. Now, $qm_D^H + (1-q)m_D^L > qm_I^H + (1-q)m_I^L \; \forall q \in [0,1]$, since $m_D^H > m_I^H$ and $m_D^L > m_I^L$. Hence for all $q \in [0,1]$, the CT allocation is more offensive under differing valuations, than under identical valuations.

Chapter 7

Chapter 7: Conclusion

The present thesis contributes to the literature on pertinent strategic and tactical issues in the domain of terrorism and counter-terrorism (CT) through rigorous formalization of less-addressed areas within the field, generalization of stylized facts by proving them under fewer assumptions, theoretical rationalization of certain real-world CT practices, and provision of novel policy insights in areas including those explored in frontier research within the domain.

This thesis addresses pertinent strategic and tactical issues in the domain of terrorism and counter-terrorism (CT). It contributes to the existing literature on the field through rigorous formalization of less-addressed areas within the field, generalization of stylized facts by proving them under fewer assumptions, theoretical rationalization of certain *real-world* CT practices, and provision of novel policy insights in areas including those explored in frontier research within the domain.

Considering the limited literature investigating the role of externalities in CT, for instance, the thesis provides a simple formalization of operational externalities which demonstrates that the policy ramifications of CT measures are directionally the same both in the absence of externalities, and under positive externalities. However, the magnitude of the impact in the latter regime is never less than that under the former. In fact, the direction of impact of CT measures is also the same under negative externalities unless the optimal response of one outfit is sufficiently sensitive to changes in the parameters of the other. The magnitude of the impact, however, would never exceed that in the absence of externalities. This is because the response of one outfit to a CT measure runs contrary to that of the other under negative externalities.

The universality of defensive CT measures is also explained, thus lending credence to the possibility of oversupply of defensive CT. Confidence-building measures (CBMs) are ineffective against resource-constrained outfits, while offensive measures can be effectively used against such outfits except in the presence of sufficiently strong negative externalities. Most interestingly, the phenomenon of terrorist backlash can render offensive CT effective even against resource-abundant outfits, in the presence of sufficiently strong negative externalities.

A limitation of the formulation applied for obtaining the above results, is that for the sake of simplicity, it abstracts away from the issue of *success* or *failure* of a terror attack. Therefore, the implicit assumption is that given a terror outfit's intrinsic propensity for violence, conducting a terror attack yields to it the same level of utility irrespective of whether or not it is successful. This is obviously unrealistic. By not taking cognizance of this issue, the model fails to obtain the optimal number of terror strikes as a function of the probability of success, which is most definitely the case in reality.

While the existing literature is able to establish the ability of external sponsorship to augment terror activity only under the assumption of a strong terrorist support base (Byman 2005, Siqueira and Sandler 2006), the fourth chapter of this thesis demonstrates this result even if one of the outfits is resource-constrained, which would be likely if that outfit does not have a strong support base. In particular, the result holds true as long as at least one of the terror outfits is resource-rich. Further, CBMs may not be as effective in the presence of external sponsorship, as in its absence. This is because the negative impact of CBMs on the terrorists' intrinsic proclivity for violence is negated by the increased motivation for terror attacks due to increased sponsorship.

The robustness of the earlier findings on the ubiquity of defensive CT versus the limited applicability of CBMs and offensive CT, is established in the presence of external terror finance. In fact, if CBMs are more effective than defensive CT under external sponsorship, then they must be more effective even in its absence. As a corollary, if defensive CT is more effective than CBMs in the absence of external funding, then it must be more effective even in its presence. Expectedly, if external terror funding is present, curtailing it is always effective in reducing terror activity. Finally, as with the formulation of operational externalities, it would be worthwhile to extend the analysis of external terror funding to incorporate the issue of success/failure of terror strikes in order to obtain optimal terror finance as a function of the probability of success of a terror attack.

A lot more remains to be explored about the external sponsorship of terror outfits, however. It would be meaningful to compare the effectiveness of alternative mechanisms of terror finance, both as an incentivizing device, and as an enabler of terror activity. In fact, it would be particularly meaningful to explore the latter in the context of resource-constrained outfits. The thesis contributes to this line of enquiry by establishing that benefits of strategic cooperation accrue to the cooperating outfits (or entities, in general), when at least one outfit is resource-constrained.[97] Through cooperation, the outfits can reallocate resources to conduct attacks more efficiently, to mitigate the adverse impact of convex costs, or in favor of the more aggressive outlet.

Inter-outfit strategic cooperation can serve to increase terror attacks under certain circumstances, while serving to inhibit terror activity under others. An example of the former is when a resource-constrained outfit cooperates with a resource-abundant outfit having sufficiently large resources, in the absence of external funding. On the other hand, multiple situations have

[97] One can think of the resource-rich entity as the external sponsor of the resource-constrained terror outfit.

been discussed where external sponsorship can be offered strategically to enhance terror activity by inhibiting inter-group cooperation. Hence, CT efforts targeted at disrupting cooperation under the former set of circumstances, while those aimed at curbing the leverage of the external sponsor over the terrorists by encouraging intergroup cooperation under the latter, would serve to decrease terror attacks. Therefore, a *one-size-fits-all* CT architecture is undesirable, and the existing CT policy framework must be reviewed in view of the implications of strategic cooperation between terror outfits.

Although cooperation in the present thesis has been modeled as simply a joint utility maximization problem, it misses many interesting features of cooperation. For example, terrorist groups may enjoy several kinds of synergies when they cooperate (say, one group has better knowledge of the terrain while the other is better equipped in terms of arms and ammunition). This, certainly, is different from what has been captured here via cost convexities. Also, depending on the severity of inter-outfit coordination issues due to differences in ideology, theatre of operations, etc., one can try to compare the likelihood of formation of symmetric versus asymmetric alliances. Further, terrorist groups may compete for the same kind of inputs, such as recruits or donors. In such situations, cooperation may allow them to mitigate these kinds of competition by avoiding effort-replication. Issues like these may be explored in future research.

In the context of tactical CT, the thesis derives that in scenarios where a terror cell is better informed about the targets, it is at least as lethal as in scenarios where it has less information about the targets. Hence, there appears to be a CT rationale for suppressing target information from terror cells, by making target protection wholly or partially inconspicuous for example. In fact, the deployment of inconspicuous target protection measures such as hidden cameras can serve the dual purpose of not only preventing the deflection of terror attacks to more vulnerable targets, but catching the terrorists ill-prepared by drawing them into a well-defended space. Also, if better intelligence for CT is available in respect of the possible terrorist hideouts, then pre-emptive strikes become more attractive. In fact, a worthwhile endeavor for future research would be to model tactical intelligence endogenously, to compare the optimal CT investment to be incurred on the intelligence apparatus under different scenarios pertaining to the target information available to the terror cell.

These findings on tactical CT must be viewed in the backdrop of the lack of analyses of CT frameworks in general, and terror cells in particular, with specific focus on comparison of different scenarios in terms of the conspicuity of target information. This is despite the existence of a sizeable literature on the broad topic of terrorism, addressing a myriad of issues. For instance, a theoretical foundation is provided for the widespread real-world application of defensive measures in countering terror cells. Finally, and most interestingly, the greater offensive orientation of CT policy is rationalized and demonstrated when the CT preferences over the potential targets diverge from those of the terror cell. An interesting extension would be to check the robustness of this result in a scenario where the preferences of the terrorists are their private information.

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