Terrorist Signalling and the Value of Intelligence

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This article presents a model of terrorist attacks as signals where the government is uncertain as to whether it is facing a group that is politically motivated or militant. Pooling equilibriums result with two types of *ex post* regret: *P-regret*, where the government concedes to political types that would not subsequently attack; and *M-regret*, where the government does not concede to militant types that subsequently attack at greater levels. Avoidance of such regret defines a measure of the value of intelligence. Counter-terrorism policy can then be characterized in terms of whether a government should focus on increased intelligence versus increased security (hardening targets). The recommended use of asset freezing is also evaluated in terms of the resources required by terrorists to achieve the various equilibriums. Finally, this article supports the empirical finding of intertemporal substitution of resources by terrorists, concerned with the level of government response to their attacks.

Terrorism is the premeditated use, or threat of use, of violence by individuals or subnational groups to obtain a political or social objective through intimidation of a target audience, beyond that of the immediate victims. Terrorists try to impose sufficient costs on a target constituency so that its government is pressured into conceding to the terrorists' demands, when concessions are viewed as less costly than enduring future attacks. The immediate response to an attack is for the government to address the initial consequences, including clean-up and additional security measures. Thereafter, the government assesses the likely subsequent threat that the group poses in terms of its resources and proclivity for future attacks. Politically orientated groups are ultimately interested in change and will eventually channel resources into political activities. In contrast, militant groups are more vengeful and will focus on attacks until concessions are granted.

   Consider, for example, the Spanish government, which has had an armed struggle since 1968 with the Basque-separatist group *Euskadi ta Askatasuna* (ETA). Spain also suffered from the Madrid train station bombings on 11 March 2004 by Islamic terrorists seeking a withdrawal of Spanish troops from Iraq and Afghanistan. ETA can be characterized as a politically motivated group because the demands of its larger constituency may be met through the granting of more regional autonomy and self-determination (for example, responsibility for social services, taxation and policing). On occasion, ETA has agreed to a cease-fire. Moreover, ETA has been discriminate in its targeting, avoiding attacks with mass casualties. The Islamic terrorists in the Madrid bombing were more militant, intent on escalating attacks if their demands were not immediately met. They threatened to turn Spain into an 'inferno' should the withdrawal of Spanish troops from Iraq not take place.[1] Three days after the Madrid bombings, Spanish voters reversed their apparent course to re-elect the government of the popular party Aznar and elected the socialist

   [1] MSNBC.com, 'Group Threatens to Turn Spain into Inferno: Islamic Group Issues Warning after Alleged Plotters Kill Selves', 5 April 2004, accessed 3 June 2005.

Zapatero government, which had campaigned under the promise to withdraw Spanish troops in Iraq unless they came under United Nations' control.

In assessing the signalling content of an attack, the government must determine an appropriate response that hinges on its beliefs about the militancy of the terrorists. This decision is made under conditions of incomplete information, because the government is unlikely to be completely informed whether the terrorists' preferences are militant or political. This lack of information may stem from many causes. For example, multiple terrorist groups may be claiming responsibility for a series of attacks. Moreover, terrorist groups may have both political and militant elements that vie for dominance, so that the controlling wing may change and not be apparent at any point in time. This change in group orientation may arise when government concessions appease the moderates, thereby leaving the more extreme elements to carry on the terrorist campaign.[2] Following concessions of partial autonomy made to ETA in 1978, extremist elements in ETA waged a much more deadly campaign into the 1990s. Additionally, new and splinter groups may come on the scene. Splintering was especially true of the Palestine Liberation Organization (PLO), which gave rise to more militant groups such as Black September, Popular Front for the Liberation of Palestine, Abu Nidal Organization and others. During a group's initial attacks, the target government does not know the group's resolve or militancy. In still other instances, no group may claim responsibility, leaving the government unenlightened as to the perpetrator or its orientation.

The effect of incomplete information is twofold. First, there is a reputation incentive for politically motivated terrorists (*P*-types) to mimic militants (*M*-types) with a spectacular attack if it will quickly lead to concessions. Secondly, an incentive may exist for *M*-types to mimic *P*-types so that the government will be less compelled to harden targets, which would diminish the likelihood (or increase the cost) of the logistical success of future terrorist activity. This then feeds into a notion of intelligence consistent with that given in Cilluffo *et al.* by involving an understanding of the motivations, thoughts and future plans of one's enemies.[3] Multi-disciplinary intelligence, including insights into the cultures and mindsets of terrorist organizations, is crucial for counter-terrorism policy. In particular, there is the possibility of *ex post regret* where a government concedes to politically motivated terrorists to whom it would not have conceded under complete information. This type of regret may arise because the magnitude of the attacks leads the government to conclude falsely that it is facing militants who will escalate attacks if their demands are not met. Alternatively, a government may hold firm and face a second type of *ex post* regret when it is subsequently attacked by militant terrorists whom the government would have accommodated under complete information. Examples of the first type of *ex post* regret include concessions to groups such as the PLO, African National Congress (ANC), Irish Republican Army (IRA) and ETA, which each have a history of using diplomacy as well as sustaining a military wing, whose influence is not well understood.[4] Examples of the second type of regret include the Algerian revolt (1954–62) and Israel's conflict with Hezbollah and Hamas, where the government did not seek a

[2] Ethan Bueno de Mesquita, 'Conciliation, Counterterrorism, and Patterns of Terrorist Violence', *International Organization*, 59 (2005), 145–76; Todd Sandler and Daniel Arce, 'Terrorism and Game Theory', *Simulation and Gaming*, 34 (2003), 319–37.

[3] Frank L. Cilluffo, Ronald A. Marks and George C. Salmoiraghi, 'The Use and Limits of US Intelligence', *Washington Quarterly*, 25 (2002), 61–74.

[4] Per Baltzer Overgaard, 'The Scale of Terrorist Attacks as a Signal of Resources', *Journal of Conflict Resolution*, 38 (1994), 452–78.

political solution and attacks subsequently escalated. We will discuss these cases in further detail in the body of the article. There is, thus, a value of intelligence that corresponds to eliminating or diminishing the likelihood of *ex post* regret.[5] Similarly, Hoffman has argued that because religious-based terrorists are generally more violent than secular ones, there exists a need for intelligence to identify terrorists' type/preferences.[6]

A suicide mission is a tactic of some militant groups to signal their resolve.[7] Such missions indicate that the group will gladly sacrifice even its human resources to raise the carnage of the campaign. This graphic signal was first employed by Hezbollah in its successful efforts to rid Lebanon of Israeli forces and then foreign peacekeepers in 1982 and 1983, respectively. Noteworthy suicide attacks included the 23 October 1983 suicide truck bombing of the US Marines barracks and the near-simultaneous suicide car bombing of the French paratroopers' apartment building. The effectiveness of these attacks in removing the peacekeepers led other militant groups – such as, Hamas, the Palestine Islamic Jihad (PIJ), the Al-Aqsa Martyrs Brigade and the Liberation Tigers Tamil Eelam (Tamil Tigers) – to adopt suicide missions. In some instances, these suicide campaigns resulted in concessions (for example, political concessions to Tamil Tigers) after an initial regret, once the extent of future attacks became understood by the targeted government.

In this article we examine a signalling model of terrorist attacks in which the government has incomplete information about terrorists' types. Past signalling models focused on attacks as signals of terrorist resource levels, where terrorists are (initially) able to stage an attack of sufficient magnitude to induce concessions, irrespective of whether they have high or low resources. Specifically, Lapan and Sandler examined the case where terrorists are *militant* and expend all remaining resources on attacks if concessions are not granted.[8] By contrast, Overgaard analysed *politically motivated* groups that allocate all remaining resources to (non-violent) political purposes if no accommodations are made.[9]

Our analysis is centred on the creation of a unifying model that simultaneously allows for both militant and political terrorist types. This facilitates a comparison of the value of intelligence for each case. No generality beyond the nexus of intelligence and uncertainty about terrorists' types/preferences is claimed. In addition, our model permits a fundamental extension whereby the government institutes defensive measures when attacks surpass a threshold, so that the value of intelligence depends not only on whether concessions occur, as is the case in the prior literature, but also on counter-terrorism policy. Specifically, the value of intelligence is broadened to include not only *ex post* regret following concessions, but also *ex post* regret following an escalation of terrorism in the absence of an accommodation. We characterize when a government should focus on increased

[5] The literature on the value of intelligence for terrorism has focused on the prevention of specific events, such as 9/11 or terrorists' use of weapons of mass destruction – see, e.g., Kevin Michael Derksen, 'Commentary: The Logistics of Actionable Intelligence leading to 9/11', *Studies in Conflict and Terrorism*, 28 (2005), 253–68; Francis H. Marlo, 'WMD Terrorism and US Intelligence Collection', *Terrorism and Political Violence*, 11 (1999), 53–71. In so doing, earlier articles indicated what type of intelligence (e.g., signal interception, human, or imagery) has the greatest effectiveness at each stage of a terrorist event. Unlike our exercise, the literature has not characterized the value of intelligence in terms of a signalling game of incomplete information, where the government is ill-informed about the nature of the terrorist group.

[6] Bruce Hoffman, *Inside Terrorism* (New York: Columbia University Press, 1998), pp. 185–205.

[7] Bruce Hoffman and Gordon H. McCormick, 'Terrorism, Signaling, and Suicide Attacks', *Studies in Conflict and Terrorism*, 27 (2004), 243–81.

[8] Harvey E. Lapan and Todd Sandler, 'Terrorism and Signalling', *European Journal of Political Economy*, 9 (1993), 383–97.

[9] Overgaard, 'The Scale of Terrorist Attacks as a Signal of Resources'.

intelligence versus increased security (hardening targets) to mitigate this possibility. Finally, the resulting equilibriums exhibit intertemporal substitution of terrorist resources where a militant group may restrain attacks for strategic advantage, thereby exhibiting varying patterns of terrorism, consistent with low-terrorism and high-terrorism periods as have been empirically identified.[10] The effects of proactive measures to freeze terrorist assets are also examined in this context.

The remainder of the article contains three sections. The next section presents a unifying signalling model where governments are uninformed about terrorist types. In the ensuing section, we indicate the value of intelligence. The final section contains concluding remarks.

TERRORIST SIGNALLING: A UNIFYING MODEL

In this section, we introduce a signalling model where the government has incomplete information about the type (preferences) of terrorists that it confronts. Information is asymmetric because terrorists can observe the outcomes of elections, implementation of proactive policies and the hardening of potential targets. As is standard, we consider a two-period model with dichotomous type set: $\{M, P\}$. Terrorists are M-types if they are *militant*; that is, they receive a *benefit* equal to the discounted sum of their attacks in the first and second period when the government holds firm. This is the case if terrorists perceive a positive value from attacking an obstinate government, or if they test a government's never-to-concede pledge by unleashing their military wing. In addition, fundamentalist terrorists often view violence as sanctified, so that they are less constrained in their carnage. Militant fundamentalists use violence to punish non-believers and seek maximum casualties even when attacks will not result in concessions. Similarly, Doran discussed militant (Arabic/Islamic) terrorists in terms of their predilection for escalation.[11] To summarize, militants are willing to escalate their attacks as a form of brinkmanship that challenges the interests of the opposing power to provoke the threat of intervention, if not actual intervention. For these militant terrorists, there exists a gap between the long-term goals set by their (religious/ideological) convictions and their immediate goals, constrained by unlikely successful political action. The terrorists' short-term goals are therefore aimed at foiling the targeted government, through escalated attacks, rather than the attainment of their long-term goals. For this reason, some argued that terrorist groups such as al-Qaeda are not susceptible to traditional international political pressures.[12]

By contrast, P-types are politically motivated because an attack is a pure cost in terms of both resources and political capital. They consequently direct all second-period resources to political activity, from which they receive a benefit. In comparison to M-types, P-types have reached the point where the opportunity cost of escalation is unacceptably high. Elsewhere, we have analysed joint consideration of M-types and P-types in a bargaining context[13] and Siqueira has done so in terms of the incidence of

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[10] Such periods have been identified by Walter Enders and Todd Sandler, 'Patterns of Transnational Terrorism, 1970–1999: Alternative Time-Series Estimates', *International Studies Quarterly*, 46 (2002), 145–65; Walter Enders and Todd Sandler, "Transnational Terrorism 1968–2000: Thresholds, Persistence, and Forecasts', *Southern Economic Journal*, 71 (2005), 467–82.

[11] Michael Doran, 'The Pragmatic Fanaticism of al Qaeda: An Anatomy of Extremism in Middle Eastern Politics', *Political Science Quarterly*, 117 (2002), 177–90.

[12] Cilluffo, Marks and Salmoiraghi, 'The Use and Limits of US Intelligence', p. 65.

[13] Sandler and Arce, 'Terrorism and Game Theory'.

competing-faction violence.[14] Neither of the articles referred to above addressed the potential for inferring terrorists' type through past attack patterns.

Upon receiving a signal in terms of first-period attacks, the government either concedes (*C*) or does not concede (*D*). Governments often have a different response to spectacular attacks; consequently, we define an attack of at least (resource) level R^* to be such that a non-conceding government significantly increases its level of deterrence/defensive policies to limit successful future attacks.[15] An example is to harden targets through increased security, thereby decreasing the probability of a logistical success in a second-period attack. In this way, the discount factor for a second-period attack subsequent to a first-period attack of at least level R^* is given as δ. By comparison, the discount factor applied to all other second-period attacks is given by β, where $\beta > \delta$. Following 11 September 2001 (9/11), the United States created the Department of Homeland Security (DHS) to harden a wide range of targets (for example, airports, airplanes, public places, borders, ports and critical infrastructure), thereby greatly lowering δ. The US response is consistent with 9/11 attacks signalling the likely presence of a militant group, whereby defensive measures are prudent in the absence of concessions.

We assume that terrorists receive resource level R in each period, where $R \geq R^*$. In the first period, terrorists select their attack level from the dichotomous signal set $\{a, A\}$, where $a \in [0, R^*)$ and $A \in [R^*, R]$. An *A*-attack is considered large enough for the government to increase its defensive posture, thereby inducing discount factor δ if a second-period attack occurs.

The game is illustrated in Figure 1, with a *timeline* that is given as follows:

1. Nature (*N*) selects the terrorist's type from $\{M, P\}$.
2. In the first period, terrorists select their signal from the set $\{a, A\}$, where $A > a$ as defined above. The dotted lines connecting nodes in Figure 1 are the government's (*G*) information sets, which are labelled according to the signal the government receives: G_A or G_a.
3. Upon receiving this signal, the government either concedes (*C*) to the terrorists or holds firm (*D*).
4. If the government does not concede, terrorists combine the remainder of their first-period resources with their second-period resources. How these resources are put to use depends upon the terrorist's type/preferences, as specified by their payoffs. Militants (*M*-types) will expend all available resources in a second-period attack, while *P*-types will use them towards non-violent means.

Payoffs are expressed symbolically as Π_P for *P*-types, Π_M for *M*-types, and Π_G for the government. They are calculated as follows:

1. Each terrorist type receives resource level R in each period.
2. The government faces the costs of the attack levelled against it in the first period: *A* or *a*.

[14] Kevin Siqueira, 'Political and Militant Wings within Dissident Movements and Organizations', *Journal of Conflict Resolution*, 49 (2005), 218–36.

[15] Daniel G. Arce and Todd Sandler, 'Counterterrorism: A Game-Theoretic Analysis', *Journal of Conflict Resolution*, 49 (2005), 183–200; Todd Sandler and Kevin Siqueira, 'Global Terrorism: Deterrence versus Preemption', *Canadian Journal of Economics*, 39 (2006), 1370–87. In Overgaard, 'The Scale of Terrorist Attacks as a Signal of Resources', the act of not conceding is described as a response, which we interpret as an increased defensive posture.
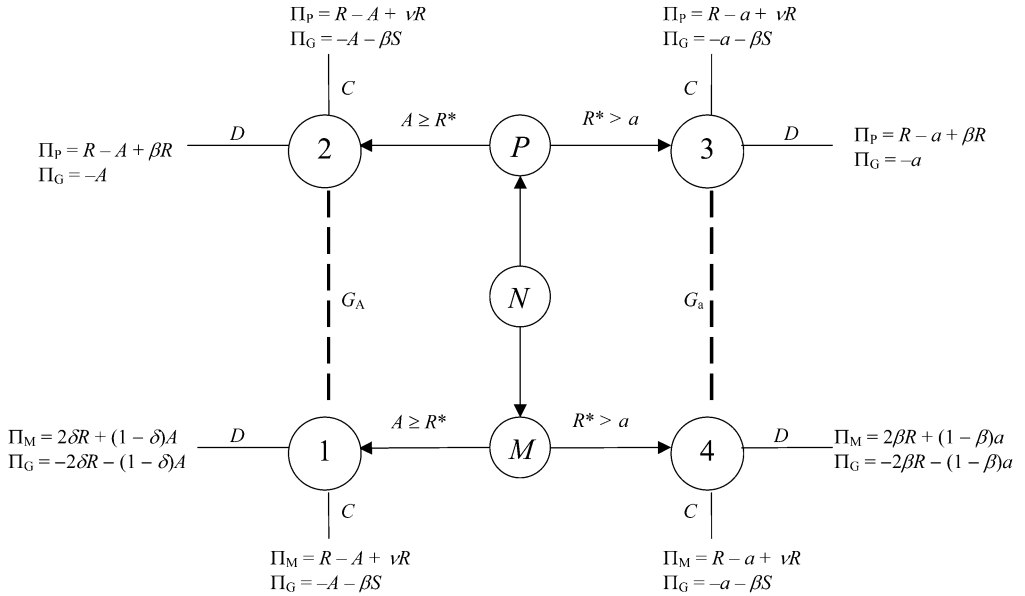
$\Pi_P = R - A + vR$
$\Pi_G = -A - \beta S$

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$\Pi_G = -a - \beta S$

C C

$\Pi_P = R - A + \beta R$ D ② $A \geq R^*$ Ⓟ $R^* > a$ ③ D $\Pi_P = R - a + \beta R$
$\Pi_G = -A$ $\Pi_G = -a$

G_A Ⓝ G_a

$\Pi_M = 2\delta R + (1 - \delta)A$ D ① $A \geq R^*$ Ⓜ $R^* > a$ ④ D $\Pi_M = 2\beta R + (1 - \beta)a$
$\Pi_G = -2\delta R - (1 - \delta)A$ $\Pi_G = -2\beta R - (1 - \beta)a$

C C

$\Pi_M = R - A + vR$ $\Pi_M = R - a + vR$
$\Pi_G = -A - \beta S$ $\Pi_G = -a - \beta S$

Fig. 1. Incomplete information about terrorists' preferences

3. If the government concedes, it incurs second-period costs of $S > 0$. Terrorists receive a payoff equal to their net remaining funds: $R - A$ or $R - a$, plus vR, where $v > \beta$ is the 'victory' parameter that increases the value of second-period resources relative to those discounted by β or δ. Essentially, v is a third discount factor.

4. If the government does not concede:

   i. *P*-types receive $R - A + \beta R$ or $R - a + \beta R$, the discounted present value of their remaining resources put to political use.

   ii. *M*-types receive a *benefit* equal to the discounted value of their remaining resources, which they expend in a second-period attack. Subsequent to an *A*-level attack, this payoff is discounted by $\delta < \beta$ because the government responds to such an attack with increased defensive policies. The discounted value of the two attacks is therefore $A + \delta(R - A) + \delta R = 2\delta R + (1 - \delta)A$. Similarly, after an *a*-attack, *M*-type terrorists gain $2\beta R + (1 - \beta)a$. In either case, the government's payoffs are defined by the zero-sum nature of attacks, so that they lose an amount equal to the terrorists' payoff.

The *critical levels of belief* in this model correspond to the conditional probabilities such that the government concedes at information sets G_A and/or G_a. This occurs when its belief that it is facing an *M*-type meets or exceeds a threshold level. Belief μ_i corresponds to nodes $i = 1, 2, 3, 4$, where $\mu_1 + \mu_2 = 1$, $\mu_3 + \mu_4 = 1$. *G* concedes at G_A if its expected payoff is such that:

$$E_G[C|G_A] = -A - \beta S \geq -A\mu_2 - [2\delta R + (1 - \delta)A]\mu_1 = E_G[D|G_A]; \text{ i.e., if}$$

$$\mu_1 \geq \beta S/\delta(2R - A) = L_A. \tag{1}$$

When the government *G* experiences an *A*-level attack, it will concede provided that its belief that it is facing an *M*-type exceeds the lower bound L_A given in Condition 1. The

lower is L_A, the more likely that a concession will occur. From Condition 1, we have $\partial L_A/\partial S > 0$. As the costs of concession increase, the government is less likely to concede.

Lapan and Sandler recognized that the value of S may be determined through a declaration or commitment by the government never to concede to terrorists' demands.[16] Such a commitment has the effect of reducing the government's options, because, as S increases, it becomes less likely that the government will concede regardless of the prior probability of M-types.[17] The beliefs embodied in Condition 1 also imply that $\partial L_A/\partial R < 0$, so that the government is more apt to concede as terrorists' resources increase. This follows because a larger R means that the government incurs greater damage from a militant group's second-period attacks if the government holds firm. Condition 1 also implies that $\partial L_A/\partial(\beta/\delta) > 0$. Recall that at G_A the D strategy corresponds to an increase in the government's defensive posture relative to that at G_a, leading to a greater discounting of second-period attacks where $\delta < \beta$. As defensive measures are more effective, β/δ increases; consequently, the government must be more certain that it is facing an M-type to concede. We denote the reverse of the inequality in Condition 1 as ~ 1, indicating the condition on beliefs such that the government does not concede at G_A.

Similarly, the government concedes at G_a if $E_G[C|G_a] = -a - \beta S \geq -a\mu_3 - [2\beta R + (1-\beta)a]\mu_4 = E_G[D|G_a]$, which indicates the following threshold:

$$\mu_4 \geq S/(2R - a) = L_a. \tag{2}$$

The signs on $\partial L_a/\partial S$ and $\partial L_a/\partial R$ are the same as those associated with L_A for identical reasons. Here, the comparative effect of β versus δ, which applied for L_A, does not come into play because it is only through an attack of level $A \geq R^*$ that the government increases its defensive posture (in relative terms), resulting in discount factor δ. Finally, Condition ~ 2 denotes the condition under which Condition 2 is reversed, in which case the government selects D at G_a.

SIGNALLING EQUILIBRIUMS AND THE VALUE OF INTELLIGENCE

Once again, incomplete information raises the concerns that politically motivated terrorists may be seeking a quick resolution to their grievances by posing as militant types, and/or militant types have purposely avoided spectacular attacks to forestall a heightened focus on security by their targets. As an example of the latter phenomenon, Enders and Sandler presciently stated that authorities should focus on intelligence and prophylactic measures in anticipation of upturns in terrorist incidents involving casualties following fairly lengthy lulls of greater than two years.[18] By 9/11, the US was well beyond a two-year lull. In this way, the *value of intelligence* that we investigate corresponds to eliminating or reducing the occurrence of *ex post regret* associated with misreading terrorists' true intentions. One such occurrence is *ex post P-regret*, meaning that the government concedes to P-types, which, under complete information, the government would hold firm against. Another

[16] Lapan and Sandler, 'Terrorism and Signalling'. The Irangate hearing following the Reagan administration's arms-for-hostages negotiations was an effort by the US Congress to raise S to subsequent administrations.

[17] This is akin to a sense of government resolve – see Robert Powell, 'The Dynamics of Longer Brinkmanship Crises', in Peter C. Ordeshook, ed., *Models of Strategic Choice in Politics* (Ann Arbor: University of Michigan Press, 1989), pp. 151–75.

[18] Walter Enders and Todd Sandler, 'Is Transnational Terrorism Becoming More Threatening? A Time-Series Investigation', *Journal of Conflict Resolution*, 44 (2000), 307–32.

possibility is *ex post M-regret*, where, under complete information, the government would have preferred either concession or increased security in the face of escalated militant attacks. Clearly, either type of *ex post* regret is only possible in a pooling equilibrium where both types send the same signal. Consequently, we begin with an examination of the pooling equilibriums, followed by a characterization of the separating equilibrium where each type sends a different signal.

An A-pooling equilibrium occurs under Conditions 1 and ~ 2 so that the government's (local) strategy at G_A is C and at G_a it is D. Together, these strategies comprise the behavioural strategy CD. Henceforth, we adhere to the convention of listing the government's strategy at G_A first and its strategy at G_a second. Given Conditions 1 and ~ 2, P-types undertake an A-attack in period 1 if $\Pi_P[A, CD] = R - A + vR \geq R - a + \beta R = \Pi_P[a, CD]$. This simplifies to

$$R \geq (A - a)/(v - \beta), \tag{3}$$

thereby defining a resource constraint to be met for this equilibrium to hold. Furthermore, for M-types to engage in an A-attack, it must be the case that $\Pi_M[A, CD] = R - A + vR \geq 2\beta R + (1 - \beta)a = \Pi_M[a, CD]$; i.e.,

$$R \geq [A + (1 - \beta)a]/[(1 - \beta) + (v - \beta)]. \tag{4}$$

Information set G_a is not reached in an A-pooling equilibrium. Nevertheless, actions off-the-equilibrium path must be justified in terms of the consistency and rationality of the set of beliefs and actions specified there. A set of beliefs that supports D at G_a is that the government believes that it is more likely to be facing a P-type at G_a. This is consistent with the upper bound on μ_4 given in Condition ~ 2, implying that the government's belief that it is facing an M-type is low. Furthermore, P-types would send the out-of-equilibrium signal $a = 0$, implying that Condition 3 rather than Condition 4 is the binding constraint on R. Finally, the A-pooling equilibrium occurs with *ex post P-regret* because the government is potentially conceding to P-types to whom it would not have conceded under complete information. For purposes of comparison, all equilibrium conditions are summarized in Table 1.

An example of this pooling equilibrium is the internationalization of the Palestinian cause.[19] The premier example of a Palestinian-based spectacular (A-level attack) is the 1972 Munich Olympics hostage incident staged by the Black September PLO offshoot, resulting in the death of eleven Israeli Olympian competitors and five terrorists. What actually occurred in the aftermath of the ill-fated attempt to concede to the Black September terrorists is entirely consistent with the payoffs that follow information set G_A. The European reply to this security failure was immediately to establish special anti-terrorist units that successfully acquitted themselves in subsequent hostage incidents (for example, Grenzschutzgruppe Neun's rescue of a hijacked Lufthansa aeroplane at Mogadishu, Somalia on 18 October 1977),[20] thereby implying a discount factor of $\delta < \beta$ for future attacks. During the same time period, the PLO was granted special observer status in the United Nations, and, by the end of the 1970s, the PLO had formal diplomatic relations with more countries than did Israel, consistent with the vR component of payoffs.[21]

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[19] Hoffman, *Inside Terrorism*, pp. 67–86.
[20] Lufthansa flight 181, a Boeing 737, was hijacked en route from Mallorca to Frankfurt on 13 October 1977. The plane was stormed in Mogadishu, following stop-overs in Rome, Larnaca, Dubai and Aden.
[21] Hoffman, *Inside Terrorism*, p. 75.

TABLE 1   *Summary of Equilibriums*

Equilibrium	Conditions on beliefs	Forms of regret	Value of intelligence
A-pooling C at G_A; D at G_a	$\mu_1 \geq \beta S/\delta(2R - A)$ $\mu_4 \leq S/(2R - a)$	*Ex post P*-regret: potential concessions to *P*-types	βS
a-pooling C at G_A; C at G_a	$\mu_1 \geq \beta S/\delta(2R - A)$ $\mu_4 \geq S/(2R - a)$	*Ex post P*-regret: potential concessions to *P*-types	βS
a-pooling D at G_A; D at G_a $R \geq [(1 - \delta)A - (1 - \beta)a]/2(\beta - \delta)$	$\mu_1 \leq \beta S/\delta(2R - A)$ $\mu_4 \leq S/(2R - a)$	*Ex post M*-regret: *M*-types escalate	$\beta(2R - a - S)$
Separating D at G_A; D at G_a $R \leq [(1 - \delta)A - (1 - \beta)a]/2(\beta - \delta)$	$\mu_1 = 1$ $\mu_3 = 1$	None	Equilibrium actions make information complete.

Next, consider an *a*-pooling equilibrium with concession. When Conditions 1 and 2 hold, the government's strategy is CC.[22] It follows that $\Pi_P[a, CC] \geq \Pi_P[A, CC]$ and $\Pi_M[a, CC] \geq \Pi_M[A, CC]$ because $A > a$. For example, instead of increasing counterterrorism measures (inducing δ), governments may accommodate terrorists.[23] Indeed, several European nations (France and Greece in particular) have allegedly accommodated *M*-types in order to tacitly obtain immunity from attacks.[24] Furthermore, Overgaard argued that at times concessions made to the ANC, IRA and PLO can be understood in terms of *ex post P*-regret, because these organizations' commitment to their military wings is not well understood.[25]

In the prior literature on signalling and terrorism, *ex post* regret occurred under an *A*-pooling equilibrium in Lapan and Sandler and an *a*-pooling equilibrium in Overgaard.[26] Neither type of pooling equilibrium took place in the other model, owing to differences in preferences posited for terrorists in each case. As either type of pooling equilibrium can result in our model, we are able to measure and compare the value of intelligence in a unified framework. Specifically, the value of intelligence under *P*-regret is the difference

[22] Beliefs consistent with Condition 1 do not violate forward induction as *M*-types have the greater incentive to send an out-of-equilibrium signal of *A*.

[23] See the discussion in Dwight R. Lee, 'Free Riding and Paid Riding in the Fight against Terrorism', *American Economic Association Papers and Proceedings*, 78 (1988), 22–6.

[24] For example, a revolutionary organization, known as the 17 November, had an alleged arrangement with the Greek government, whereby the terrorists directed attacks against non-Greek targets in return for sanctuary, see *The Economist*, issue no. 1831 (London: *The Economist*, 1984). From 1975 until the summer of 2002, the 17 November operated with impunity, carrying out 146 attacks and twenty-two assassinations. A failed bombing attempt on 22 June 2002 at the Port of Piraeus in Athens led to the first-ever arrest for the group.

[25] Overgaard, 'The Scale of Terrorist Attacks as a Signal of Resources'.

[26] Lapan and Sandler, 'Terrorism and Signalling'; Overgaard, 'The Scale of Terrorist Attacks as a Signal of Resources'. In the former study, *ex post* regret occurred when conceding to a low-resource type that initially attacks at a high (*A*) level.

between the government's payoff for conceding to a *P*-type, as occurs in equilibrium, and its payoff for not conceding, as happens under complete information.

RESULT 1. *The value of intelligence under P-regret is βS, regardless of whether an A-pooling or a-pooling equilibrium occurs.*

This result holds because the difference between not conceding or conceding to a *P*-type is $βS$ in either pooling equilibrium. As *S* is partially determined by the government's public stance towards concessions, it follows that a hard-line government is going to place greater value on intelligence because concessions implicitly increase the cost of *P*-regret. This also holds for terrorists bent on the annihilation of their targets, as *S* is commensurately high. This justifies US investments in intelligence and the creation of the DHS after 9/11. It is also consistent with Israeli investment in intelligence because of its perpetual dealings with militant terrorists who deny Israel's right to existence.

Our model also identifies a new type of regret: *ex post M-regret*, where the government holds firm at either information set and is subsequently attacked in the second period by *M*-types. In this equilibrium, Conditions ~1 and ~2 hold, implying that the prior probability of an *M*-type must be low.[27] It is clear that $Π_P[a, DD] ≥ Π_P[A, DD]$ because $A > a$. In addition, $Π_M[a, DD] = 2βR + (1 − β)a ≥ 2δR + (1 − δ)A = Π_M[A, DD]$ requires that

$$R ≥ [(1 − δ)A − (1 − β)a]/2(β − δ). \tag{5}$$

This condition increasingly holds as the expected level of deterrence after an *A*-level attack increases (*δ* decreases), implying that if *M*-types expect a large response to a first-period attack, then they will rationally make an intertemporal substitution favouring a second-period attack. This is a novel unintended consequence of terrorist deterrence (hardening targets). For example, elsewhere we have examined the public aspects of counter-terrorism policy and found that deterrence creates a public cost for those who do not harden targets, resulting in inefficiencies akin to the tragedy of the commons.[28] Here, (anticipated) deterrence does not actually eliminate attacks, but instead leads to strategic intertemporal substitution of attacks, so that terrorists can catch the government less prepared when launching their offensive.

The film, *The Battle of Algiers*, poignantly depicts this escalating pattern of tactics, which does not occur in prior signalling models. The Front de Libération Nationale (FLN) began with a policy of weeding marginal revolutionary elements – drunks and prostitutes – out of the Casbah district, something the imperial French probably did not even interpret as terrorism; i.e., $a = 0$. Indeed, Hoffman argued that prior to the French execution (by guillotine) of two FLN members, the terror campaign had been non-lethal by design – directed against inanimate symbols of French rule such as government offices and buildings, military cantonments and police stations, but not deliberately against people.[29] This was followed by escalating tactics such as shooting police, bombing civilian locales and conducting a general strike.[30]

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[27] As *P*-type have a payoff off the equilibrium path, $R − A − vR$, that is greater than its equilibrium payoff, these beliefs do not violate forward induction.

[28] Arce and Sandler, 'Counterterrorism'.

[29] Hoffman, *Inside Terrorism*, p. 62.

[30] The film is historically accurate since European civilians were only targeted after a bomb exploded in the predominately Arab Casbah district (presumably by rogue French officials) in response to FLN activities against French *gendarmes*.

A novel aspect of this pooling equilibrium is that Condition ~ 2 places an upper-bound restriction on terrorists' resources for actions on the equilibrium path.[31] Given limited resources, M-types may rationally choose to attack at level a rather than A, and attack with greater force (amassed resources) in the second period. The larger second-period attack is also preferred because it does not induce the government to initially harden targets the way an A-level attack would. This outcome is consistent with empirical evidence of intertemporal substitution of attacks.

When Condition 5 holds, M-regret occurs under the auspices of an a-pooling equilibrium. In contrast to P-regret, M-regret is defined in terms of the opportunity cost of one of *two* forgone alternatives. First, under complete information the government prefers to concede at node 4, rather than not concede. This is an intelligence concern regarding incomplete information about the type of terrorists the government is facing; here, the value of intelligence is the difference in the government's payoffs for conceding (C) versus not conceding (D) at node 4; i.e., $\beta(2R - a - S)$. Under this form of M-regret, the value of intelligence is now a decreasing function of S. A tough public stance against terrorists is tantamount to a commitment to weather subsequent attacks by M-types. Because R now enters into the value of intelligence, a policy of freezing assets (limiting R) reduces this value of M-regret. For example, a great deal of ETA assets were frozen following 9/11, thereby decreasing both the Spanish government's willingness to concede to ETA and ETA attacks themselves. Any proactive counter-terrorism policy that curbs terrorist resources (such as, destroying terrorist training camps, capturing terrorists or infiltrating groups) will also reduce the value of M-regret. Conversely, terrorists with less restricted access to a large amount of assets require a commensurately larger amount of intelligence (for example, Abu Nidal Organization in the 1980s). Thus, the Tamil Tigers run a commercial shipping network, 95 per cent of which is estimated to be the transport of legitimate commercial materials.[32] An inability to freeze this source of income raises the value of intelligence about the Tamil Tigers in lieu of M-regret. Insufficient international proactive measures mean that R is high, so that M-regret leads to a higher value of intelligence.[33]

Alternatively, a government might prefer to harden its targets at node 4, rather than concede.[34] This is a *security concern*. Hardening targets at node 4 results in a payoff of $\Pi_G = -2\delta R - (1 - \delta)a$, where discount factor δ replaces β for hardened targets. The difference between the δ-based payoff and original β-based payoff at node 4 is $(\beta - \delta)(2R - a)$, which establishes the degree of security concern. Determining which form of regret is the greater forgone alternative is crucial for formulating counterterrorism policy. To wit:

RESULT 2. *M-regret is more of a security than an intelligence concern if $\beta S > \delta(2R - a)$.*

This result is novel because it gives a prescription for counter-terrorism policy to avoid M-regret. If the inequality in Result 2 holds, then policy should be focused on hardening

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[31] Condition ~ 2 holds for the A-pooling equilibrium with P-regret, but Condition ~ 2 constrains the government's belief at G_a, which is off the equilibrium path, and therefore met by $\mu_4 = 0$, where no restriction on R results.

[32] Peter Chalk, 'Liberation Tigers of Tamil: EELAM's (LTTE) International Organization – A Preliminary Analysis', Commentary No. 77, Canadian Intelligence Service, Ottawa, Canada, 2000.

[33] Such insufficient measures are identified by Todd Sandler, 'Collective versus Unilateral Responses to Terrorism', *Public Choice*, 124 (2005), 75–93.

[34] We thank an anonymous referee for this suggested extension.

targets – a security concern. For example, if the government's resolve is high, thereby increasing S, then security should be commensurately raised regardless of the size of past terrorist attacks (i.e., even in the absence of a spectacular). If, by contrast, the inequality is reversed, then security is less of a policy concern than intelligence. Moreover, intelligence should be focused on a judicious assessment of *militant* terrorists' demands to induce them to abandon violence. Indeed, as the left-hand side of the inequality in Result 2 is the value of information under P-regret, βS, this result shows that such a focus runs the risk of P-regret. Result 2 recognizes the trade-off between P-regret and M-regret at information set G_a.

Finally, when Condition 5 is reversed, a *separating* equilibrium is possible where M-types engage in an A-attack, P-types execute an a-attack, and the government does not concede to either type. This corresponds to the Conditions ~ 1, ~ 2 and ~ 5. In this scenario, there is no regret because the government recognizes that M-types are making the A-attack so that signalling acts as a perfect substitute for intelligence. Indeed, following Bayes's rule, we have $\mu_1 = 1$ and $\mu_3 = 1$.

Thus far, we have interpreted a policy of asset freezing as reducing R, for which the Condition ~ 5 for a separating equilibrium is increasingly met. Militants will attack more heavily in the first period, anticipating that their resources may be frozen thereafter. Moreover, P-types will set $a = 0$ so as to avoid having their assets frozen and maximize political benefits. If, in addition, $\Pi_M(A, DD) > \Pi_P(a, DD)$, then this separating equilibrium captures the publicity rationale for terrorism. Many organizations (for example, PLO, Hezbollah and Hamas) have turned militant because of difficulty in creating recognition of their cause through traditional political channels. If the government is not going to concede, terrorism has the effect of greatly increasing public awareness.

This separating equilibrium and the a-pooling equilibrium with M-regret are essentially two sides of the same coin. In anticipating a response, militants will either attack more heavily in the first period, as is the case in the separating equilibrium, or they will bide their time and attack more heavily in the second period. Which side of the coin comes up depends upon whether Condition 5 or ~ 5 holds. As either condition is independent of the government's public stance towards conceding (S), all that matters is the (anticipated) reaction to an attack (δ) and the ability to reduce assets (R). The greater the level of deterrence and, thus, the lower is δ, the more likely that Condition 5 holds, implying a pooling equilibrium with *ex post* M-regret and escalating attacks. More successful terrorist organizations are able to determine an effective level of violence that is at once 'tolerable' for the local populace, tacitly acceptable to international opinion and sufficiently modulated not to provoke massive government crackdown and reaction.[35] In contrast, the Tupamaros in Uruguay was a terrorist group whose level of violence was unacceptable for the local populace and a government offensive destroyed them. The Italian Red Brigades met a similar fate following the 17 December 1981 kidnapping of General James Lee Dozier, the senior US officer at NATO's southern European command. Callous acts, such as the 6 May 1978 murder of the former premier Aldo Moro, turned public opinion against the Red Brigades. The trade-off inherent in Conditions 5 and ~ 5 endogenously defines the edge of brinkmanship as it relates to the escalating behaviour of militant terrorists.

If, moreover, δ is time-variant, then our result is indicative of Faria's terror cycles, where there is an inverse relationship between government deterrence (via law enforcement in Faria) and terrorist activities.[36] We offer no formal repeated-game analysis, but, by

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[35] See Hoffman, *Inside Terrorism*, p. 162.

[36] Joao Ricardo Faria, 'Terror Cycles', *Studies in Nonlinear Dynamics and Econometrics*, 7 (2003), article 3.

extension, a non-stationary δ suggests two types of cycles through a state-dependent determination of whether Condition 5 or $\sim$5 holds. This is consistent with the empirical results that identified two cyclical components of terrorism: a high-activity and a low-activity series which are likely by-products of intertemporal substitution of resources.[37] Terrorists' high-activity series cannot be sustained, akin to the separating equilibrium in our model. In contrast, the low-activity series can be escalated, again consistent with an *a*-pooling equilibrium with *M*-regret. Previous signalling models were not indicative of such empirical findings.

The *M*-regret and separating equilibrium also share an important message about the difference between successful counter-insurgency tactics and the resolution of terrorism. In either case, military tactics reduce δ, but may buttress the equilibrium conditions under which *M*-types attack in the second period. Defensive postures affect the magnitude, but not the occurrence of signalling equilibriums with second-period attacks. This reinforces the definition of terrorism in the opening of this article, particularly when terrorists' goals are religious/ideological. Tactical counter-terrorism policies that are orthogonal to these goals do not temper terrorist actions, but instead encourage intertemporal substitution, which then places a further premium on intelligence.

CONCLUDING REMARKS

In a recent paper, Hoffman and McCormick characterized terrorism as a signalling game where target governments are ill-informed about terrorist groups' 'objectives, resources, and commitment'.[38] Given the short-term nature of most terrorist groups, with new groups appearing each year and others splintering, governments are faced with the never-ending chore of trying to assess the threat of terrorist groups under incomplete information. A miscalculation of this threat can either mean that a government underestimates a group's militancy and comes to regret its own resolve to hold firm, or else that a government fails to recognize a group's political intent and comes to regret its concessions. The rise of fundamentalist terrorism means that both militant and political groups are prevalent in the post-Cold War era.[39] This diversity in intent and resolve of terrorist groups means that regret (i.e., responding inappropriately to terrorist demands) may have greater consequences for governments now than in the 1970s and 1980s when groups were more homogeneous and less militant on average. Thus, the value of intelligence, which limits regret, has increased in recent time.

By introducing a model that unifies the existing signalling analyses of terrorism, our article offers a framework that is more descriptive of the complex world of post-9/11 terrorism with militant and political terrorist groups co-existing. An important innovation is to allow for defensive and proactive policies. Defensive actions can motivate intertemporal substitutions by militant groups that strategically hold back on attacks to catch a target government less aware. Proactive measures can reduce *R* and, thereby, influence the pooling and separating equilibriums. Government resolve, as reflected by high concession costs, also affects these equilibriums. We also give a characterization of

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[37] Enders and Sandler, 'Patterns of Transnational Terrorism, 1970–1999'; Enders and Sandler, 'Transnational Terrorism 1968–2000'.

[38] Hoffman and McCormick, 'Terrorism, Signaling, and Suicide Attacks', p. 244.

[39] Hoffman, *Inside Terrorism*.

optimal (regret-minimizing) counter-terrorism policy that is based on the relationship between terrorist resources and government resolve.

Our article demonstrates the trade-off between hardening of targets and intelligence. Recent game-theoretic work showed that international co-operation to shore up weak links (i.e., attractive soft targets) will be woefully inadequate owing to free-riding incentives.[40] As a consequence, the value of intelligence remains high in the face of al-Qaeda's global network. Moreover, other recent work highlighted the inadequacy of proactive policies by the international community to destroy terrorist assets with respect to global terrorist networks.[41] This, in turn, keeps terrorists' resources high, thereby raising the value of intelligence in a world besieged by heterogeneous terrorist threats. The inadequacy of international co-operation in terms of defensive and proactive counter-terrorism elevates the value of intelligence, given insufficient knowledge on the nature of the terrorist threat.

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[40] Sandler, 'Collective versus Unilateral Response to Terrorism'.
[41] Arce and Sandler, 'Counterterrorism'.