Transnational Terrorism: An Economic Analysis

by

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Abstract

Both theoretical and empirical techniques are used to put modern-day terrorism into perspective. This paper surveys past contributions, presents updated empirical findings, and suggests new directions for research. Because of strategic interactions among terrorists and targeted government, game theory and economic methods play an important role in identifying novel policy recommendations and behavioral insights. Transnational terrorism and efforts to curtail it involves externalities and market failures. The paper analyzes how terrorists alter tactics in reaction to government policies and how a no-negotiation hostage policy is difficult to institute.

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I. Introduction

On 11 September 2001 (henceforth, 9/11), the world watched aghast as two commercial airliners toppled the twin towers of the World Trade Center (WTC) and a third plowed into the Pentagon. Yet a fourth hijacked plane landed short of its intended Washington, DC target as passengers took matters into their own hands. Economic methods – both theoretical and empirical – have been applied by a small and growing group of economists to understand a host of issues associated with such terrorist events. These issues concern the policy effectiveness of alternative responses (e.g., toughening punishments, retaliatory raids, and installing technological barriers), negotiation responses in hostage incidents, the terrorists' choice of target, the economic impacts of terrorism, the provision of terrorism insurance, the curbing of interdependent risk, and others.

Terrorism is the premeditated use, or threat of use, of extranormal violence by an individual or a subnational group to obtain a political objective through intimidation or fear directed at a large audience usually beyond the immediate victims. An essential aspect of this definition concerns the presence of a political objective (e.g., getting the United States out of the Persian Gulf states) that the terrorist acts or campaigns are designed to achieve. Incidents that have no specific political demands are criminal rather than terrorist acts – e.g., extortion for profit. Another crucial ingredient is the use of extranormal violence or brutality to capture news headlines. As the public becomes numb to their acts of violence, terrorists respond with more heinous actions to recapture media attention. Thus, the escalation experienced on 9/11 was part of an ongoing process. Terrorists often direct their violence and threats toward a vulnerable target group, not immediately involved with the political decision-making process that they seek to influence. The two planes that crashed into the WTC fit this pattern, but the other two planes were targeted against decision makers. In a deliberate attempt to create a general atmosphere of

fear, terrorists strike at a variety of targets with alternative modes of operations (e.g., assassinations, bombings, and kidnappings), thus making it difficult for the authorities to anticipate the venue of the next incident. Such actions make attacks appear to be random, so that a targeted society must expend large amounts of resources to protect a wide range of vulnerabilities. This simulated randomness provides terrorists with a cost advantage over the stronger authorities who must defend against the threat that they pose. Because people tend to overrespond to unlikely catastrophic events while ignoring more likely daily dangers (e.g., dying in a car accident), terrorists succeed in achieving society-wide anxiety with minimal resources.

When a terrorist incident in one country involves victims, targets, institutions, governments, or citizens of another country, terrorism assumes a *transnational* character. In the WTC tragedy, citizens from over 80 countries lost their lives at the hands of foreign terrorists who crossed into the United States from abroad. Obviously, the four hijackings on 9/11 constitute transnational terrorist attacks. During the 1980s, the kidnappings of foreigners in Lebanon or the near-simultaneous suicide truck bombings at the US Marines barracks and apartment building housing French Paratroopers, as a protest against Western policies, also represent transnational terrorism. Transnational terrorist incidents are *transboundary externalities* insofar as actions conducted by terrorists or authorities in one country may impose uncompensated costs or benefits on people or property of another country. As such, myriad market failures are associated with collective actions to curb international terrorism.

The application of economic methods to the study of terrorism began with Landes (1978), who applied the economics of crime and punishment to the study of domestic skyjackings in the United States. Economic methodology is particularly well-suited to provide insights in studying terrorism. Economic analysis can account for the strategic interactions among opposing interests – e.g., among rival terrorists, the terrorists and the authorities, and among targeted countries.

Rational-choice models, based on microeconomic principles, can be applied to ascertain how terrorists are apt to respond to policy-induced changes to their constraints. The same methods can be used to analyze how governments react to terrorist-induced changes to their policymaking environment. Altruistic-based intergenerational rewards can even be shown to motivate the growing use of suicide bombings (Azam, forthcoming). Additionally, the theory of market failures can underscore how agents' independent optimization may be at odds with socially efficient outcomes, so that governmental failures may result from well-intentioned policies. In addition, various economic empirical methods can be applied to evaluate theoretical predictions and policy recommendations. Empirical techniques can evaluate the economic consequences of terrorism – e.g., the impact of terrorism on tourism (Enders, Sandler, and Parise, 1992), foreign direct investment, (Enders and Sandler, 1996), and per capita GDP (Abadie and Gardeazabal, 2003).

The primary purpose of this article is to survey some crucial insights gained from applying an economic perspective to the study of terrorism. A second purpose is to present an updated analysis of trends and cycles, policy-induced externalities, collective action responses, and hostage negotiation strategy. A third purpose is to identify some future research directions.

II. A Look at the Data

To provide a perspective on the nature of the transnational terrorist threat, we compile Table 1 based on data from the US Department of State (1988-2004). This table indicates the annual number of transnational terrorist events, the associated deaths, the number of wounded, and the number of attacks against US people and/or property for 1968-2003. During these 36 years, there were 14,857 transnational terrorist incidents in which 14,807 people (including those on 9/11) died. On average, there were 411 fatalities per year which is relatively few, especially

compared with the 41,000 or so people killed annually on US highways. Each terrorist incident

kills on average about one person. The casualties on 9/11 represent a clear outlier with deaths on

this single day approximately equal to all transnational terrorist-related deaths recorded during

the entire 1988-2000 period.

An examination of Table 1 suggests that transnational terrorism follows a cyclical pattern

with much of the 1990s being relatively calm compared to the earlier two decades.

Transnational terrorism is particularly low during 2002-2003, with incidents on par in number to

that of 1969 at the start of the era of transnational terrorism. Something that cannot be seen from

Table 1 is that a high proportion of total casualties for a given year is typically associated with a

couple of "spectacular" events – e.g., the simultaneous bombings of the US Embassies in

Nairobi, Kenya, and Dar es Salaam, Tanzania, accounted for 291 deaths and almost 5,000

injuries in 1998 (US Department of State, 1999). The right-hand column of Table 1 indicates

that approximately 40% of all transnational terrorist attacks are against US interests. This is

especially noteworthy from an externality viewpoint, because relatively few incidents take place

on US soil – i.e., during 1998-2003, only six incidents (including the four skyjackings on 9/11)

occurred in the United States (US Department of State, 2004).

By having relatively secure borders, the United States must rely on foreign governments

to protect US citizens and property while abroad. Terrorists that target US interests – e.g.,

Revolutionary Organization 17 November in Greece (known as 17 November) – may operate

with impunity if the risks to foreigners are of little concern to the local government. This leads

to underdeterrence of terrorism from a multi-country viewpoint (Lee, 1998). Until the summer

of 2002 when a 17 November terrorist injured himself in an attempted bombing, the group had

engaged in over 140 attacks and 22 assassinations since 1973 with no arrests (Wilkinson, 2001,

p. 54). If, instead, much of the threat is to a host country's interests, then overdeterrence may

result as the country does not account for the transference externality of causing the terrorists to switch their attacks to another less-protected country. In the overdeterrence scenario, each country engages in a Prisoners' Dilemma "arms race" to deflect the common terrorist threat to an alternative venue (Arce and Sandler, 2004; Sandler and Lapan, 1988; Sandler and Siqueira, 2003). Unless such actions decrease the overall level of attacks, each country expends resources without securing their citizens' safety, which is particularly relevant when these citizens are targeted in other countries. This is a real concern for the United States, which has deflected almost all attacks on its interests to foreign soil.

Data

Except for some annual totals, government-collected data sets have not been made available to researchers. Mickolus (1982) developed a data set, *International Terrorism: Attributes of Terrorist Events* (ITERATE) for 1968-77. This event-based data set was extended to cover 1978-2003 by Mickolus et al. (2004). ITERATE uses a host of sources for its information, including the Associated Press, United Press International, Reuters tickers, the Foreign Broadcast Information Service (FBIS) *Daily Reports*, and major US newspapers (e.g., the *Washington Post*, *New York Times*).

ITERATE poses a number of shortcomings that researchers must take into account when testing theories. By relying on newspaper accounts, ITERATE is better at chronicling the actions of terrorists (e.g., number of terrorists in a hit squad or terrorists' actions during negotiations) than in recording those of the authorities (e.g., how many commandos were used to free a hostage). In select instances, government strategy is revealed by newspapers and is coded by ITERATE. Because ITERATE is an events data set, researchers must rely on event counts rather than on continuous measures of intensity unless casualty counts are used (Enders and

Sandler, 2000, 2002). ITERATE picks up *newsworthy* transnational terrorist incidents, so that there is some bias, which must be recognized. The bias has worsened since mid-1996 when the FBIS *Daily Reports* was no longer available to ITERATE coders.

Despite these difficulties, ITERATE is suited to a wide range of empirical tasks. For example, it can display trends and cycles for events for forecasting purposes (e.g., Cauley and Im, 1988; Enders, Parise, and Sandler, 1992). The data have even been used to investigate terrorist and government bargaining behavior in hostage-taking events – i.e., kidnapping, skyjackings, and takeover of facilities (barricade and hostage-taking events) – by Atkinson, Sandler, and Tschirhart (1987). This latter study applied a time-to-failure model, where the length of an incident is related to choice variables of the adversaries – e.g., sequential release of hostages, allowing deadlines to pass uneventfully, and the number of hostages secured.

Based on ITERATE data, we display two quarterly time series – all transnational incidents (All) and bombings – in Figure 1 for 1968-2003. From Figure 1, we can see that transnational terrorism displays peaks and troughs. Bombings are the favorite mode of operation of terrorists, accounting for about half of all transnational terrorist incidents on average in any given year. Additionally, the bombing time series tracks the all-incident series rather well. The latter half of the 1990s to the present represents a downturn in transnational terrorism due, in large part, to fewer states sponsoring terrorism in the post-Cold War era (Enders and Sandler, 1999). In Figure 2, the quarterly time series for assassinations and hostage-taking events are displayed for 1968-2003. Cycles are again apparent. The two time series display far fewer incidents per quarter than bombings. If terrorists are rational actors, as we suppose, then they should respond to risk and engage less frequently in those events that are more risky and logistically complex, such as assassinations and hostage taking (Sandler, Tschirhart, and Cauley, 1983). Assassinations and hostage missions fell just prior to 9/11 and have not returned to their

old levels. There are probably three explanations for these drops. First, today's terrorists are more interested in greater carnage than an assassinated individual. Second, extra precautions at airports have reduced skyjackings – one kind of hostage-taking mission. Third, the war on terror has compromised al-Qaida's leadership and its ability to execute logistically complex and costly attacks.

In Figure 3, we display the quarterly percentage of incidents with casualties (i.e., deaths or injuries) for the 1968-2003 period. This time series is noteworthy because it indicates that since the early 1990s, transnational terrorist incidents, although way down in number, are more likely to end in injuries or death for victims. Terrorist experts have documented a change in the makeup and motivation of the general perpetrators of terrorism since the takeover of the US Embassy in Tehran in November 1979 (Hoffman, 1998). From the late 1960s until the latter 1980s, transnational terrorism has been primarily motivated by nationalism, separatism, Marxist ideology, and nihilism (Wilkinson, 1986). In the 1990s, the motivation of terrorism changed with "the emergence of either obscure, idiosyncratic millennium movements" or religious-based fundamentalist groups (Hoffman, 1997, p. 2). Since the beginning of 1980, the number of religious-based groups has increased as a proportion of the active terrorist groups: 2 of 64 groups in 1980, 11 of 48 groups in 1992, 16 of 49 groups in 1994, and 25 of 58 groups in 1995 (Hoffman, 1997, p. 3).

With the earlier prevalence of leftist-based organizations that wanted to win the hearts and minds of the people, such terrorist groups avoided casualties except of individuals characterizing the establishment or the "enemy." Today, fundamentalist terrorist groups purposely seek out mass casualties, viewing anyone not with them as a legitimate target as 9/11 showed. Enders and Sandler (2000) show that a significant rise in casualties from transnational incidents can be traced back to the takeover of the US Embassy in Tehran. In recent years, an

incident is almost 17 percentage points more likely to result in death or injury compared with the earlier eras of leftist terrorism.

To highlight the changing patterns of transnational terrorism since 9/11, we display the proportion of bombing incidents and the proportion of hostage-taking events for 1968-2003 in Figure 4. Since 9/11, transnational terrorisms have decreased the proportion of hostage events and greatly increased the proportion of bombings. This pattern is consistent with today's fundamentalist terrorists going for greater carnage and avoiding costly and risky hostage events.

Trends and cycles

Judging by the public's and media's reaction to 9/11, one might conclude that international terrorism is on the rise, but the opposite is true as Figure 1 showed. This misperception may be due to the increasing likelihood of an incident resulting in casualties, making incidents on average more newsworthy. The standard procedure for ascertaining the form of a deterministic trend is by fitting a polynomial in time (t), where additional trend terms (i.e., t, t^2, t^3) are added until the associated coefficient is no longer statistically significant. For 1968-2003, we investigate trends for six time series extracted from ITERATE: hostage taking, bombings (of all types), threats and hoaxes (i.e., threatened future incidents or a false claim for a concurrent incident – a bomb aboard a plane, when there is no bomb), assassinations, incidents with casualties, and all transnational terrorist incidents. Table 2 indicates the polynomial trend estimates for these six series (where time = t), all of which are characterized by a nonlinear trend. The t-ratios associated with the coefficient estimates are indicated in parentheses beneath the constant and the time trend terms. Five of the six series are represented by a quadratic trend with a negative coefficient for the squared time term. This characterization reflects the fact that series tended to rise in the late 1960s and to decline in the late 1990s. Only the threats and hoaxes

series is represented by a more complicated cubic trend; nevertheless, this series also displays a similar inverted U-shaped pattern.

In Table 2, the next-to-the-last column on the right reports the *F*-statistics and their "prob" values in brackets, representing the statistical significance of the overall regression. These significance levels are all zero to three digits, which are strongly supportive of the fitted nonlinear trend equations. Such fitted trends are not useful for very long-term forecasting, because there is little reason to believe that the number of incidents will continue to decline. Instead, the fit of the nonlinear trend cautions against simple statements about a decidedly upward or downward trend to any form of international terrorism. Such proclamations are common in the media. The trend analysis suggests that there is persistence in each of the incident series – high and low levels of terrorism come in waves or cycles. Shocks to any incident series are not permanent, so that there is a reversion toward a long-run mean.

Cycles in terrorism data have been attributable to a number of factors. Alexander and Pluchinsky (1992) explain fluctuations in terrorism using demonstration and copycat effects. Heightened public sensitivity following a successful terrorist attack induces other terrorists to strike when media reaction is likely to be great. The anthrax attacks following the events of 9/11 appear to correspond to this pattern. Economies of scale in planning terrorist incidents by terrorist groups or networks may also lead to the bunching of attacks. Cycles may also stem from the attack-counterattack process between the terrorists and authorities (Faria, 2003). Public opinion following a spate of attacks can prompt governments' periodic crackdowns that temporarily create a lull in transnational terrorism. These downturns are subsequently followed by countermeasures and recruitment by the terrorists as they prepare for a new offensive. Chalk (1995) indicates that cycles based on public-opinion pressure swings are in the three to five year range, insofar as time is required for the public to unite and successfully make their demands on

officials to do something – a prediction borne out by time series investigations (Enders and Sandler, 1999).

In our past work, we find that each type of terrorist series has its own characteristic cycle that hinges on the logistical complexity of the attack mode. Enders and Sandler (1999) and Enders, Parise, and Sandler (1992) argue that logistically complex events such as skyjackings, large suicide car bombings, and assassinations will have longer cycles than less sophisticated events as the attack-counterattack interaction among adversaries takes longer. Such complex missions utilize relatively large amounts of resources as compared to small explosive bombings, threats, and hoaxes. Given their resource constraints, terrorists can more easily gear up for a campaign dominated by small bombs than one relying on more resource-intensive events.

The theory of Fourier series allows a wide class of functions to be expressed in terms of sine and cosine components. To uncover the underlying cycles in a series, a researcher must regress the detrended values of a series on all frequencies in the interval [1, T/2], where T is the number of observations. The frequency of a series indicates how fast the underlying cycle is completed – a low (high) frequency implies a long (short) cycle. A graphical depiction the proportionate variation explained by each frequency (called the periodogram) has large peaks representing the crucial underlying frequencies. Some series with obvious cycles, like sunspots or average daily temperatures, will display a periodogram with a single focal frequency. Given the stochastic behavior of terrorists and the measures applied to curb terrorism, there is unlikely to be one deterministic frequency that dominates the periodicity for any of the six series. Thus, we use a different approach than trying to identify one particular frequency. Series with long periods will have most of their variance explained by the low frequencies, whereas series with short periods will have most of their variance explained by high frequencies.

In accordance with spectral analysis, we detrended each series using the fitted polynomial

trends in Table 2. The last two columns of Table 2 report the total variance of each series and the proportion of this variance accounted for by the lowest 15 percent of the frequencies. In particular, we report the proportion of the variance explained by the frequencies in the interval $[1, 0.15 \times T/2]$. We anticipate that the logistically complex incidents types will have relatively large amounts of this proportion attributable to the low frequencies. The all-events series has a large variance of 1256.651 with just 22.2 percent corresponding to the relatively low frequencies. In marked contrast and in accordance with our priors, the more complex events of assassinations and those involving casualties have smaller variances with more of this variance (39.3 and 39.1 percent, respectively) attributed to low frequencies. As predicted, threats and hoaxes of bombings display the greatest evidence of short cycles with approximately 25 percent of their variance explained by the longest cycles. Hostage taking is in the intermediate range with 31.1 percent of the variance explained by the low frequencies. Some hostage-taking events (e.g., skyjackings) are complex, while others (e.g., kidnapping) are not so complex; hence this intermediate finding for all hostage-taking missions is sensible.

III. Game Theory and Hostage Taking

Despite the events of 9/11, hostage taking may still involve negotiations, because most such missions involve kidnappings, where the terrorists are not suicidal. Skyjackings in Turkey and Cuba during March 2003 demonstrate that not all such events include terrorists bent on mass destruction. Nevertheless, suicide skyjackings and the reactions of desperate passengers to fight back must be analyzed in the future along with a government's decision to destroy a hijacked plane.

To date, there have been seven economic analyses of hostage-taking events – i.e., Atkinson, Sandler, and Tschirhart (1987), Lapan and Sandler (1988), Selten (1988), Islam and

Shahin (1989), Sandler and Scott (1987), Scott (1991), and Shahin and Islam (1992). The first three studies stress game-theoretic aspects, while the latter four studies do not. We focus our remarks around the Lapan and Sandler (1988) study, which is the most general of these three game-theoretic studies. The question posed by their investigation is whether or not a stated policy by which a government precommits never to negotiate with hostage takers will have the intended consequence of keeping terrorists from ever taking hostages. The conventional wisdom states that if terrorists know ahead of time that they have nothing to gain that they will never abduct hostages. This belief has become one of the four pillars of US policy with respect to addressing transnational terrorism – i.e., "make no concessions to terrorists and strike no deals" (US Department of State, 2001, p. iii).

The underlying game tree is displayed in Figure 5, where the government goes first and chooses a level of deterrence, D, which then determines the likelihood, θ, of a logistical failure (i.e., failure to secure hostages). Because deterrence expenditure (equivalent to D) must be paid by the government in all states of the world, it is analogous to an insurance premium and is, hence, part of the *cost* to the government's payoff, listed above that of the terrorists, at the four endpoints to this simple game in Figure 5. More risk-averse governments choose higher deterrence levels and experience less hostage taking at home. Once deterrence is decided, the terrorists must then choose whether or not to attack. The probability of an attack, Ω, depends on whether the terrorists' expected payoffs from a hostage-taking attack are positive. If $c < c^* = [(1-\theta)/\theta] \times [pm + (1-p)\tilde{m}]$, then the terrorists are better off attacking even though they receive $-c\theta$ for a logistical failure and $(1-\theta)[pm + (1-p)\tilde{m}]$ for a logistical success. We have $c < c^*$ when the expected payoff from a logistical success, which accounts for negotiation success or failure, exceeds the expected payoff from a logistical failure. In Figure 5, Ω corresponds to

$\int_0^{c^*} f(c)dc$, where $f(c)$ is the probability density for c which reflects the unknown resolve of the

terrorists.

If hostages are apprehended (i.e., logistical success occurs), then the government must

decide whether or not to capitulate to terrorists' demands, where p is the likelihood of

government capitulation. The probability of a hostage-taking incident increases with the

likelihood of a logistical success, the probability of a government capitulation (if hostages are

secured), and the benefit of a successful operation, m. In contrast, the likelihood of an attack

decreases with smaller terrorist payoffs associated with logistical and negotiating failures – i.e.,

smaller $|c|$ and $\tilde{m}$.

The conventional wisdom for the never-to-capitulate policy hinges on at least four

implicit assumptions: (i) the government's deterrence is sufficient to stop all attacks; (ii) the

government's pledge is fully credible to all would-be hostage takers; (iii) the terrorists' gains

from hostage taking only derives from the fulfillment of their demands; and (iv) there is no

uncertainty concerning the payoffs. Each of these assumptions may not hold in practice.

Deterrence will not stop all attacks if the terrorists perceive that there is a positive expected

payoff from taking hostages – that $(1-\theta)\times\left[pm+(1-p)\tilde{m}-\theta c>0\right]$. Even if the government's

pledge is believed by the terrorists (i.e., $p=0$), conditions on $\tilde{m}$ exists [i.e., $(1-\theta)\tilde{m}>-c\theta$], so

that the terrorists can derive a positive gain from securing hostages when getting no concessions.

This may arise when media exposure from holding the hostages is sufficient reward in itself. If,

however, the government's pledge is not completely credible (i.e., $p>0$) owing to past

concessions, then the terrorists' expected payoff is greater by $(1-\theta)(pm-p\tilde{m})$ than in the case

of a credible governmental pledge, and so an attack becomes more imminent. When a terrorist

group is sufficiently fanatical that it views failure as having a positive payoff (i.e., $\tilde{m}>-c>0$),

then the expected payoff is always positive even when $\theta = 1$ and deterrence is insufficient to make failure a certainty.

At the endpoints of the game, the payoffs may themselves be uncertain. In this regard, we focus on the payoffs to government from the four possible outcomes to the game. With no attack, the government incurs only the cost of deterrence. If an attack ensues but fails (i.e., no hostages are taken), then the government incurs the cost of a (> 0) in addition to deterrence expense; if, however, an attack succeeds, then the government experiences an added cost of h for capitulating and n for not capitulating. The game is more interesting (and realistic) by allowing either h or n, or both to be uncertain. When, instead, h and n are known beforehand, the government's response would be to not capitulate provided that $h > n$. In the latter case, conventional wisdom applies. Next, suppose that n is a random variable, which may assume a large value for some hostages (e.g., a soldier or member of parliament). The government is now guided by comparing h with the *expected value* of n, and then choosing the smallest, which may involve conceding to terrorist demands (e.g., the Israeli release of 1,150 Arab prisoners in a negotiated swap for three Israeli soldiers in May 1985) when the expected value of n exceeds h.

For the scenario when both h and n are random, the choice then hinges on choosing the negotiation response that minimizes the expected cost. A precommitment strategy to never concede to hostage takers' demands may be *time inconsistent* when a government later discovers that the cost of holding firm is too high owing to cost randomness. Although the government has every intention to fulfill its pledge, its inability to deter all incidents and the terrorists' ability to capture the "right" hostage means that a government may, at times, renege on its pledge.

The game representation can be made more realistic by allowing multiple periods and reputation costs. A government concession in one period to hostage takers makes terrorists raise their belief about future concessions. As p increases for future periods, more hostages will be

taken, so that there is an added cost to conceding in any period. This cost is denoted by R for loss of reputation, and results in capitulation costs to the government, becoming $h + R + D(\theta)$ in Figure 5. Even when reputation cost is included, conceding may not be eliminated unless $h + R$ exceeds n for all its realizations. Such a scenario may be achieved through rules – e.g., a constitutional amendment that imposes sufficiently severe punishment to eliminate any discretion of government negotiators.

The game can be made still more realistic by including additional sources of uncertainty in terms of the terrorists' payoffs. Hostage-taking incidents involve asymmetric information and uncertainty on the part of both terrorists and governments (Lapan and Sandler, 1993; Overgaard, 1994). The beauty of game theory is that it permits the evaluation of policies while accounting for uncertainty and strategic interactions of opposing interests. In so doing, easy fixes may not be so straightforward.

IV. Game Theory and Governmental Responses

We have already discussed the transference externality when terrorists target two or more countries and each *independently* chooses a level of deterrence that fails to account for associated external costs/benefits. External costs are present when deterrence at home displaces the attack abroad, while external benefits are relevant when deterrence at home either protects foreigners or reduces the level of attacks globally. Depending on the opposing external effects, and there may be others not listed, there may result too much or too little deterrence (Sandler and Arce, 2003; Sandler and Lapan, 1988; Sandler and Siqueira, 2003). The overdeterrence/underdeterrence problem is heightened when a terrorist network (e.g., al-Qaida) operates in upwards of 60 countries and stages their attacks worldwide (US Department of State, 2001). Underdeterrence is particularly acute in countries sympathetic to a group's grievances when the group focuses

their attack on foreigners. As the number of potential targets increase, transference efforts may be especially large. By forming a global network, terrorists limit the effectiveness of countries' efforts to thwart terrorism *as externalities are maximized through countries' uncoordinated decisions*. Terrorists will naturally seek out the weakest link – i.e., the country with the least security – for the venue for their next attack. To address these weaknesses, prime targets, such as the United States, have instituted programs to assist such weakest-link countries in bolstering their counterterrorist capabilities. In fact, this assistance is another of the four pillars of US antiterrorism policy (US Department of State, 2001). Ironically, US efforts to induce other countries to secure their airports and public places make the United States a more attractive target, as 9/11 sadly demonstrated.

If the terrorist networking advantage is to be countered, then targeted nations must learn to coordinate their own efforts at counterterrorism. This poses a special problem because nations resist sacrificing their autonomy over security matters to a supranational collective. With this in mind, terrorist experts have often called for piecemeal policy where intelligence is shared but not deterrence decisions (e.g., Kupperman, 1987, p. 577). Such piecemeal responses may be inadvisable when the strategic incentives are taken into account. Suppose that a terrorist network targets three countries, each of which are engaged in overdeterrence to transfer the attack abroad. Further suppose that intelligence allows the targeted countries to better judge the marginal effectiveness of diverting attacks by revealing the terrorists' preference for alternative targets. As these nations acquire this information, they become better adept at diverting attacks, thereby augmenting the negative transference externality. The net impact of this information sharing may be to heighten the "transference race" without providing more security, so that the added deterrence cost simply makes the three countries worse off. This results in a second-best outcome in which the change in one policy parameter (i.e., increased information sharing) which

would, under full cooperation, improve efficiency, may worsen inefficiency when a second policy (i.e., coordination of deterrence) is not chosen optimally. A similar second-best scenario may characterize other partial responses – e.g., greater actions to apprehend terrorists without coordinating efforts to increase punishments. The failure to coordinate retaliatory responses until 7 October 2001 is another piecemeal response that may have led to inefficiencies. Thus, the application of game theory again raises policy concerns previously ignored in the literature.

V. Fighting Terrorists and Their Sponsors

Although governments are often confronted by the same terrorists who will target the countries' assets and people at home and abroad, countries nevertheless find it difficult to form coalitions to attack the terrorists on their sponsors directly. Actions to coordinate retaliation against terrorist camps are typically characterized as a Prisoners' Dilemma (e.g., Lee, 1988; Sandler, 1997; Sandler and Arce, 2003) where the dominant strategy, giving the greatest reward regardless of the other countries' action, is to do nothing. This representation follows because a country's own cost of attacking exceed its perceived benefits. Terrorists locate in out-of-the-way places that give them a strategic and cost advantage – e.g., al-Qaida located in the caves and mountains of Afghanistan. This locational advantage raises a retaliator's costs, thus limiting a nation's desire to assume this role. Perceived retaliation cost may also be high relative to derived benefits, because the retaliator often attracts subsequent terrorist attacks as a protest to its action (Brophy-Baermann and Conybeare, 1994; Enders and Sandler, 1993). Any retaliatory action, however, yields purely public benefits – nonexcludable and nonrival – to all potential target countries. For example, suppose that three countries confront a common terrorist threat. Further suppose that unilateral action by any nation costs it 6 but confers benefits of 4 on each of the targeted nations. Thus, the retaliator nets –2, while the other nations receive a free-rider

benefit of 4. From a social viewpoint, each retaliator gives more total benefits to society than its individual costs; however, from the nation's perspective, costs exceed benefits and it will do nothing.

Action may, however, occur if some nation is the prime target so that its actions provide *more* benefits to it than to other countries. When these nation-specific benefits begin to outweigh the associated costs, a prime-target nation acts and "privileges" other less-preferred targets with a free ride (Arce and Sandler, 2004; Sandler, forthcoming). After 9/11, the two countries – the United States and the United Kingdom – that lost the most were the main two participants in the attack of the Taliban and al-Qaida in Afghanistan. These targeted countries had to be seen by their people to be doing something to protect their lives and property against another devastating attack. Without action, the ruling government would lose legitimacy. This need to maintain legitimacy in the aftermath of 9/11 raised the benefits of retaliatory action sufficiently to warrant acting alone if required. This was particularly true for the United States.

A number of lessons in building a coalition to weaken a terrorist threat can be gleaned from the aftermath of 9/11. Asymmetric targets foster action. If some countries are the choice targets, then they may be sufficiently motivated to act. In addition, the terrorists encourage this coalition building by concentrating their attacks on relatively few nations and escalating the magnitude of spectacular attacks. If they were to spread their attacks more evenly over nations, no nation may derive sufficient benefits to privilege the rest of the group with a free ride from a retaliatory action. Terrorists will concentrate their attacks to satisfy a constituency. Terrorists' desire to capture the attention of the media means that they must kill lots of people with some attacks. As death tolls mount, nations become motivated to act as benefits start to outweigh costs.

VI. Rational-Choice Representations of Terrorists

Beginning with the Landes (1978) study of skyjackings, economists characterize terrorists as rational actors who maximize expected utility or net payoffs subject to constraints. Arguments in these constraints may consist of terrorists' resource endowments or actions taken by the authorities to thwart terrorism. In the Landes (1978) model, potential hijackers engage in a hijacking provided that the associated expected utility exceeds other nonskyjacking means of furthering their goals. Based on this utility comparison, Landes (1978) specifies an *offense* (i.e., number of skyjackings) *function*, whose independent variables include the hijackers' subjective estimate of the likelihood of apprehension, their estimate of the conditional probability of imprisonment (if apprehended), and other actions by the authorities (e.g., the presence of US sky marshals on flights). Using data on US hijackings for 1961-1976, Landes demonstrates that greater prison sentences and enhanced likelihood of apprehension are significant deterrents. He also indicates that the installation of metal detectors on 5 January 1973 led to between 41 and 50 fewer hijackings in the United States during 1973-1976.

In a subsequent analysis, Enders and Sandler (1993) examine a wide range of policy interventions, including metal detectors, fortification of embassies, retaliatory raids, and the Reagan "get-tough-on-terrorists" laws. The theoretical model for the terrorists that underlies their study is analogous to the consumer-choice model. Terrorists maximize utility or expected utility derived from the consumption of basic commodities, produced from terrorist and nonterrorist activities. For example, al-Qaida terrorists may gain utility from a reduced political resolve on the part of the United States to remain in the Persian Gulf as Americans lose their lives in terrorist attacks (e.g., the destruction of the Al Khubar Towers housing US airmen and others on 25 June 1996 near Dhahran, Saudi Arabia). This weakening of US resolve is the basic commodity that can be produced with a number of alternative attack modes. Substitution

possibilities among terrorist tactics arise when alternative modes of operations produce the same

basic commodities (e.g., political instability, media attention) in varying amounts. Substitution

is enhanced when attack modes possess closely related outcomes and are logistically similar.

This is clearly the case for hijackings and other kinds of hostage events. Complementarity

results when combinations of attack modes are required to produce one or more basic

commodities. When threats follow real attacks, both actions assume a heightened effectiveness

and are thus complementary.

To produce these basic commodities, a terrorist group must choose between nonterrorist

and terrorist activities, while being constrained by resources. In the latter choice, terrorists must

further choose between different modes of terrorist attacks based on the perceived "prices"

associated with alternative operations. Choices are many and include the intended lethality of

the act, its country of location, and whom or what to target. The expenditure on any activity

consists of its per-unit price times the activity's level. Each mode of operation has a per-unit

price that includes the value of time, resources, and anticipated risk to accomplish the act. The

securing and maintenance of a kidnapping victim in a hidden location is logistically more

complex and requires more resources than leaving a small bomb in a trash bin in a railroad

station, so that the former has a greater per-unit price. In choosing a venue, the price differs

based on security measures taken by the authorities; a country with more porous borders will be

the staging ground for attacks against targets from other more secure countries. The prices

confronting the terrorists for each tactic are determined, in large part, by the government's

allocation of resources to thwart various acts of terrorism. If, for example, embassies are

fortified, then attacks against embassy personnel and property *within* the mission's ground

become more costly for the terrorists – i.e., there is a rise in the relative price of such attacks.

Similarly, metal detectors in airports increase the relative price of skyjackings as compared with

other kinds of terrorist acts, including kidnappings.

Government policies aimed at a single type of terrorist event (e.g., the installation of bomb-sniffing equipment in airports) adversely changes its relative price and results in a *substitution* into now less expense modes of attack. Thus, Landes' (1978) measure of the success of metal detectors, in terms of fewer skyjackings, does not go far enough, because the application of this technology may have induced a large number of other kinds of events. Similarly, to judge the success of embassy fortification, a researcher must also examine assassinations and other attacks against embassy personnel, once outside of the compound.

To account for these substitutions, Enders and Sandler (1993) apply vector autoregression (VAR) analysis to allow for the potential interactions among various terrorist time series (e.g., skyjackings and other hostage events) in response to government policies. They find that metal detectors decreased skyjackings and threats, but increased other kinds of hostage incidents, not protected by detectors. The trade-off between events were about one for one (also see Enders, Sandler, and Cauley, 1990; Im, Cauley, and Sandler, 1987). Both substitutions and complementarities are uncovered. Fortification of US embassies and missions reduced attacks against such installations, but were tied to a disturbing increase in assassinations of officials and military personnel outside of protected compounds. In addition, Enders and Sandler (1993) establish that the US retaliatory raid against Libya on April 1986 (for its suspected involvement in La Belle Discothèque in West Berlin on 4 April 1986) was associated with an immediate increase in terrorist attacks against US and UK interests. This increase was shortly followed by a temporary lull as terrorists built up depleted resources. Apparently, the raid caused terrorists to *intertemporally* substitute attacks planned for the future into the present to protest the retaliation. Within a relatively few quarters, terrorist attacks resumed the same mean number of events.

There are a number of ways to institute antiterrorist policies that address these likely

substitutions and complementarities. First, the government must make the terrorists substitute into less harmful events. Second, the government must go after the terrorists' resource endowment (i.e., its finances, its leadership, and its membership) if an overall decrease in terrorism is to follow. Efforts to infiltrate groups or to freeze terrorists' finances have this consequence. Third, the government must simultaneously target a wide range of terrorist attack modes, so that the *overall* rise in the prices of terrorist attacks becomes analogous to a decrease in resources. Success in raising the price of all modes of terrorist attacks would induce terrorists to shift into legal protests and other nonterrorist actions to air grievances. Based on the above, we can conclude that a reliance on technological barriers merely causes a substitution into other attack modes in the short run. In the long term, terrorists will develop ingenuous countermeasures (i.e., plastic guns, bottles of flammable liquid) to circumvent the technology. This terrorist response is an *innovation* effect, which gives rise to a dynamic strategic interaction. Consequently, authorities must be ever vigilant to improve the technology by anticipating terrorists' ways of circumventing such barriers. This vigilance must lead to periodic upgrades in the technology *prior* to the terrorists exposing the technology's weakness through a successful attack. Unfortunately, authorities have been reactive by only responding after a technological barrier's weakness has been exploited, so that the public remains vulnerable until a new technological fix is found and installed.

Other kinds of substitutions

Substitution effects abound in the study of terrorism and involve not only actions of the terrorists, as described above, but also actions of the targets. For targets, the economic literature addresses two kinds of substitutions. First, there are studies that examine the tourists' choice of vacation spot based on the perceived threat of terrorism and other costs. An alteration in travel

risks, arising from increased terrorist incidents in a country, raises the price of a holiday there in comparison to other vacation venues, not confronted with terrorism. In a study of Spain, Enders and Sandler (1991) employ VAR analysis to demonstrate that a typical transnational terrorist incident is estimated as scaring away just over 140,000 tourists when all monthly impacts are combined. Companion studies by Enders, Sandler, and Parise (1992) and Drakos and Kutan (2003) establish and quantify terrorism-induced substitutions in tourism for Greece, Austria, Italy, Turkey, Israel, and other terrorism-ridden countries. Countries, like Greece, that have not addressed transnational terrorist attacks directed at foreigners lose significant foreign-exchange earnings as a consequence. The cost of terrorism comes in many forms.

Second, target-based substitutions involve foreign direct investment (FDI). Investors decide where to invest based on their perceived economic risks, political risks, and monetary returns. An increase in transnational terrorism directed at FDI (e.g., attacks by Euskadi ta Askatasuna (ETA) in the Basque region of Spain) is sure to divert such investment. Enders and Sandler (1996) show that an "average" year's worth of terrorism reduced net FDI in Spain by 13.5% annually, and it reduced net FDI in Greece by 11.9% annually. These reductions translated into declines in real net FDI of $488.9 million and $383.5 million, respectively, or the equivalent of 7.6% and 34.8% of annual gross fixed capital formation in Spain and Greece. Transnational terrorism displayed significant economic cost, not counting the billions spent on barriers and deterrence. In a more recent study of the Basque region, Abadie and Gardeazal (2003) establish that terrorism reduced per capita GDP by ten percentage points in relation to the terrorism-free synthetic control region.

Studies of risks

After 9/11, there is greater interest in applying economic methods to study antiterrorism

policy choices. One useful line of study examines interdependent security (IDS) risks where the effectiveness of the protective actions by one agent is highly dependent on those of other agents (Heal and Kunreuther, 2004; Kunreuther and Heal, 2003). If, e.g., luggage in the cargo hold of a commercial plane is not rechecked during transfer, then airlines' incentives to invest in screening their own luggage are diminished because the safety of the flight is dependent on exogenous factors. These authors show that a variety of game forms may apply. They also make policy recommendations to create tipping and cascading equilibriums, whereby firms become more motivated to augment their own security as transferred luggage of key carriers (i.e., those with the greatest number of feeder flights) become safely screened. To achieve these equilibriums, government must target airline subsidies to key carriers. There are many IDS concerns associated with protective measures against terrorist attacks in a globalized world.

Economists are also interested in the insurance implications of terrorism, since extreme events such as 9/11 are very costly – about $90 billion in losses (Kunreuther, Michel-Kerjan, and Porter, 2003) – and virtually impossible to predict. Following 9/11, most insurers dropped their terrorism coverage or made it prohibitively expensive. Terrorism coverage raises public policy issues – e.g., should the government provide coverage and, if so, how should public and private coverage interface? Clearly, economics can be fruitfully applied to such problems.

VII. Toward a Benefit-Cost Analysis of Terrorist-Thwarting Policies

As a future research project, economists should assess the benefits and cost of specific policies to thwart terrorism. Such an exercise has not been adequately done and poses some real challenges. Costs are fairly straightforward since figures are available in, say, the United States as to what is paid to fortify embassies and missions, or to guard US airports. Consider the cost

associated with airport security. The value of lost time as travelers are screened must be added to the cost of guards and screening equipment.

On the benefit side, calculations are less transparent. One way to estimate a portion of this benefit would be to compute the reduced loss of life attributable to airport security measures – i.e., fewer people killed in skyjackings. If the net number of such lives saved, *after adjusting for substitutions* into other life-threatening terrorist actions, can be measured, then the average "value of a statistical life" can be applied to translate these lives into a monetary figure. To this figure, a researcher must also compute and add the reduced losses in property values (i.e., from destroyed planes) attributable to the fewer hijackings. In addition, a portion of the value of net air travel revenues must be considered as a benefit arising from a heightened sense of security stemming from security upgrades. The events of 9/11 clearly underscore that there is a cost to a breach in airport security as the public loses its confidence in air travel. Any of these components are fraught with measurement difficulties, because there may be intervening factors at work – e.g., air travel was already in a slump prior to 9/11.

Every policy to thwart terrorism would entail its own stream of benefits and costs. Invariably, the benefit calculations are problematic. The US-led retaliation against al-Qaida and the Taliban in Afghanistan has well-defined costs in terms of deployed soldiers, ordnance, diplomacy, and side payments to "allies." But the true savings or benefits from fewer future acts of terrorism, in terms of lives and property saved, is so much more difficult to calculate as they require counterfactual information. Time-series techniques, engineered by Enders and Sandler (1991, 1996) to measure losses to tourism or to FDI from terrorism, can be utilized following the retaliation to roughly estimate the decline in terrorist incidents and their economic value.

VIII. Concluding Remarks

Although economic methods have enlightened the public on a number of issues concerning transnational terrorism, there are many other issues to analyze. For instance, there is a need for applying more dynamic game methods – i.e., differential game theory – if the waxing and waning of terrorist organizations (e.g., Red Brigades and Red Army Faction) are to be understood. Clearly, past successes and failures determine the size of these groups over time. The terrorists try to increase their organization's size through enhanced resources, successful operations, and recruitment, while the government tries to limit the group's size through raids, intelligence, group infiltration, and actions to thwart successes. This dynamic strategic interaction needs to be modeled and empirically tested. In addition, researchers must better assess the role of information and intelligence on behalf of the terrorists and the authorities. Given how little governments really know about the strength of the terrorists that they confront – e.g., the US government had almost no clue about the size of al-Qaida (US Department of State, 2001, p. 69) prior to 9/11 – asymmetric information characterizes efforts to thwart terrorism. Similarly, the terrorists are ill-informed about the resolve of the government and the amount of resources that it is willing to assign to curbing terrorism. Additionally, there is a need to model terrorist campaigns – i.e., the choice of the sequence and composition of attacks used by terrorists. As researchers better understand these choices, more effective policy responses can be devised that adjust for the strategic interaction. Another unresearched issue is the optimal choice between proactive and defensive antiterrorism policies. Arce and Sandler (2004) show that governments have a proclivity to favor defensive policies when confronting transnational terrorism, but these authors do not indicate the optimal mix.

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TABLE 1: Transnational Terrorism: Events 1968-2003

Year	Number of Events	Deaths	Wounded	Attacks on US Interests
2003	208	625	3,646	84
2002	202	725	2,013	77
2001	355	3,296	2,283	219
2000	426	405	791	200
1999	395	233	706	169
1998	274	741	5,952	111
1997	304	221	693	123
1996	296	314	2,652	73
1995	440	163	6,291	90
1994	322	314	663	66
1993	431	109	1,393	88
1992	363	93	636	142
1991	565	102	233	308
1990	437	200	675	197
1989	375	193	397	193
1988	605	407	1,131	185
1987	665	612	2,272	149
1986	612	604	1,717	204
1985	635	825	1,217	170
1984	565	312	967	133
1983	497	637	1,267	199
1982	487	128	755	208
1981	489	168	804	159
1980	499	507	1,062	169
1979	434	697	542	157
1978	530	435	629	215
1977	419	230	404	158
1976	457	409	806	164
1975	382	266	516	139
1974	394	311	879	151
1973	345	121	199	152
1972	558	151	390	177
1971	264	36	225	190
1970	309	127	209	202
1969	193	56	190	110
1968	125	34	207	57

Source: US Department of State, *Patterns of Global Terrorism* (1988-2003) and tables provided to Todd Sandler in 1988 by the US Department of State, Office of the Ambassador at Large for Counterterrorism.
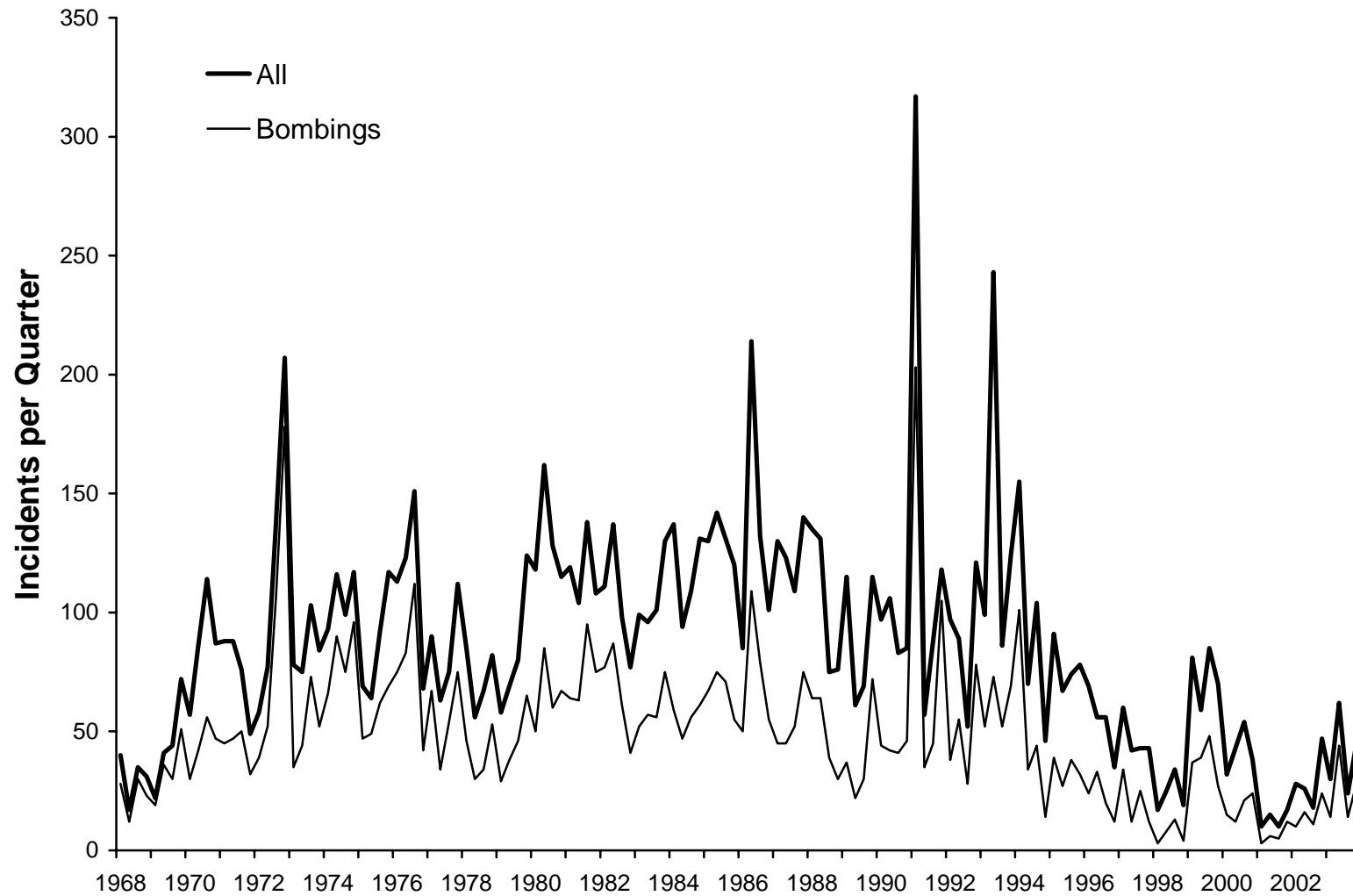
FIGURE 1: All Incidents and Bombings, 1968-2003

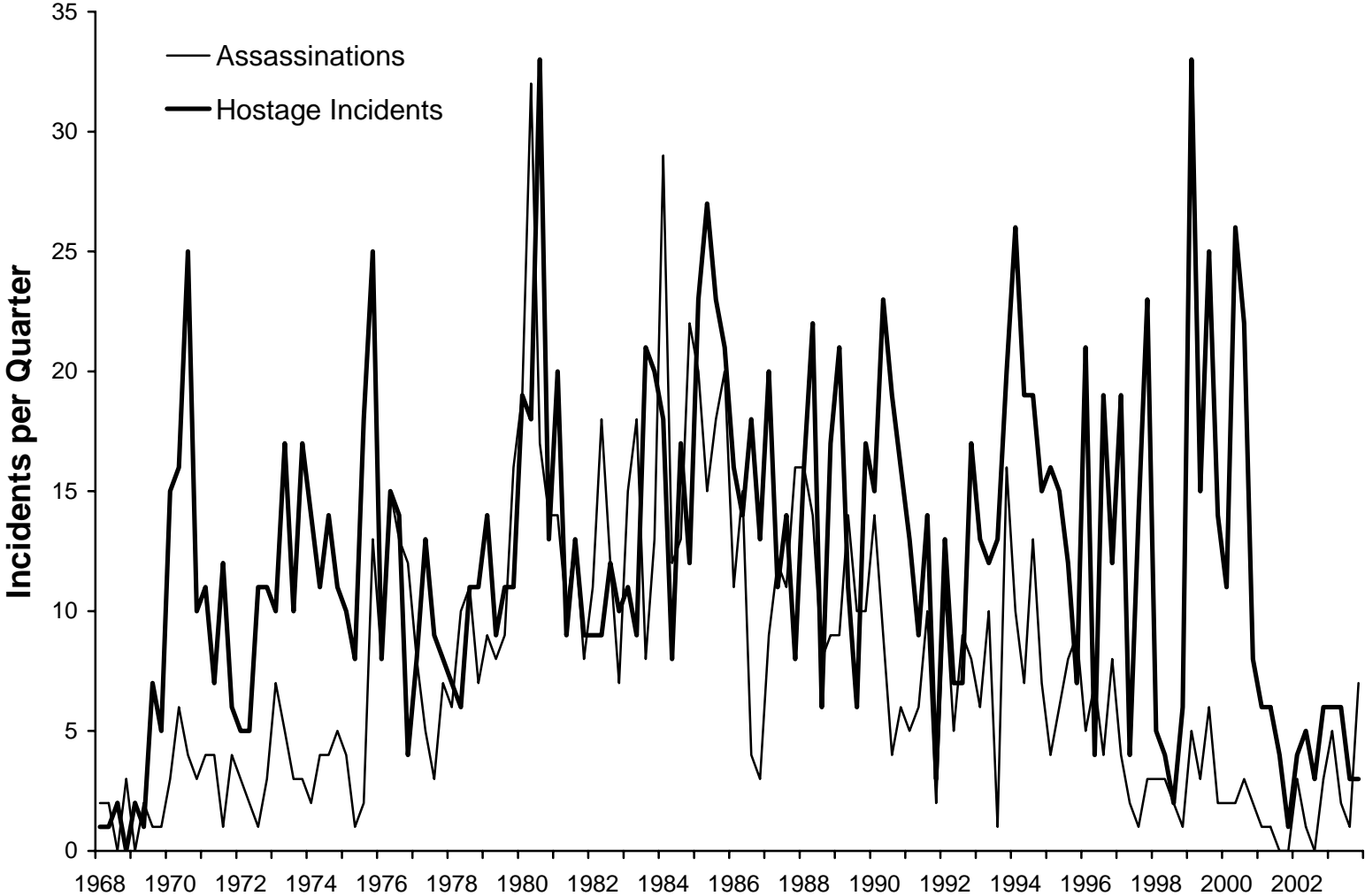FIGURE 2: Assassinations and Hostage Incidents, 1968-2003

FIGURE 3: Proportion of Incidents with Casualities, 1968-2003
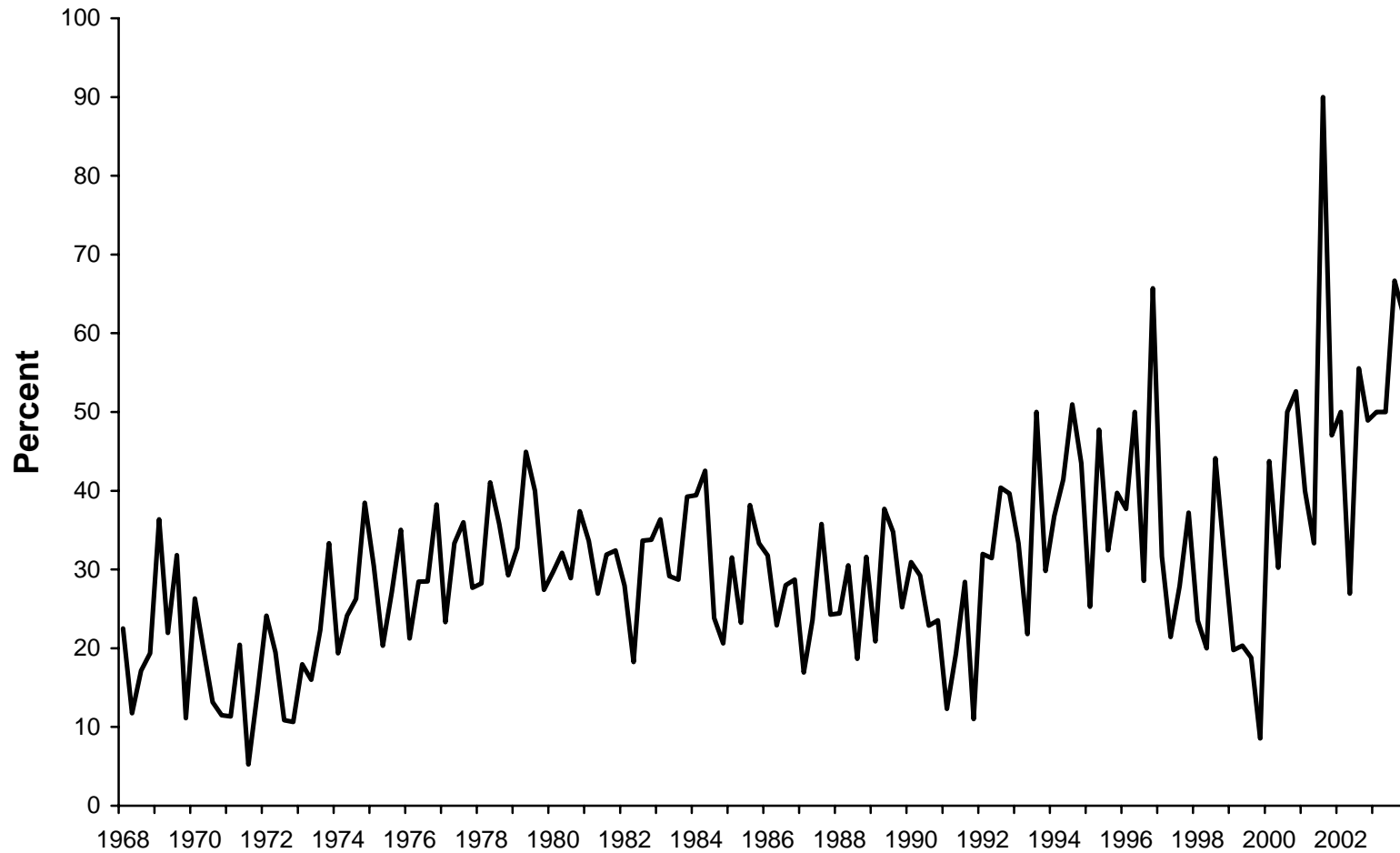
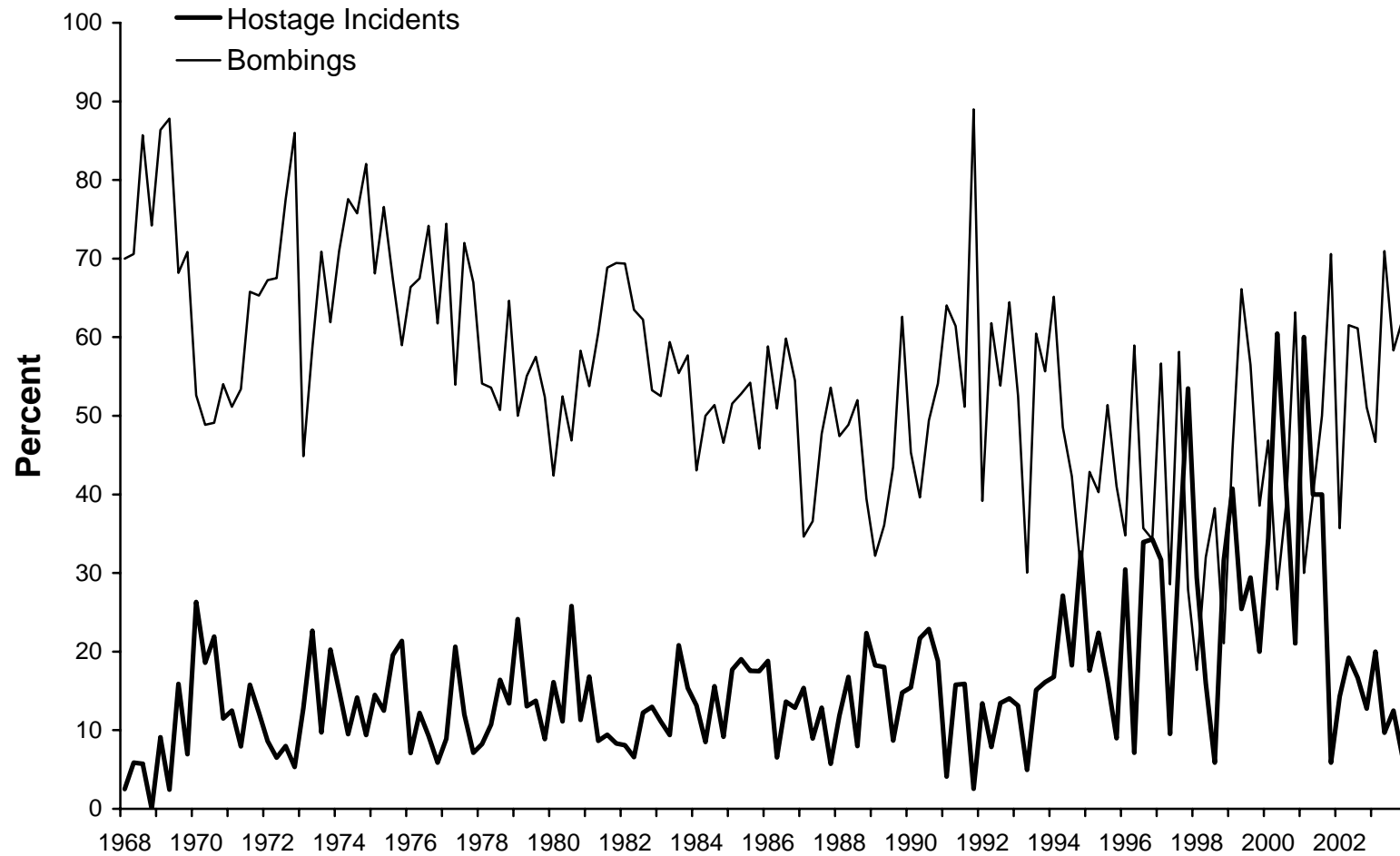FIGURE 4: Proportions of Bombings and Hostage Incidents, 1968-2003

TABLE 2: Trend and Other Statistical Properties of Transnational Terrorist Incidents, 1968-2003

Incident Type	Constant[a]	Time	(Time)^2	(Time)^3	F–stat[b]	Variance	Percent[c]
Hostage taking	2.916	0.244	–0.002		13.83	31.837	0.311
	(2.009)	(5.120)	(–4.839)		[0.000]		
Bombings	37.710	0.954	–0.008		30.296	624.310	0.241
	(5.916)	(4.637)	(–6.040)		[0.000]		
Threats & Hoaxes	6.024	–0.061	0.006	–0.000	15.011	79.431	0.263
	(1.940)	(–0.326)	(1.811)	(–2.854)	[0.000]		
Assassinations	–1.069	0.379	–0.003		65.367	18.126	0.393
	(–0.976	(10.716)	(–11.371)		[0.000]		
Casualties	5.112	0.810	–0.006		58.444	86.454	0.391
	(2.138)	(10.494)	(–10.811)		[0.000]		
All Events	43.075	2.293	–0.018		44.240	1256.651	0.222
	(4.725)	(7.790)	(–8.855)		[0.000]		

[a] t-ratios are in parentheses.
[b] Prob values are in brackets under the F-statistics.
[c] Proportion of variance of the detrended, fitted-polynomial series that is accounted for by the lowest 15 percent of the frequencies (i.e., the longest cycles).

FIGURE 5: Game Theory for Hostage Event

Government chooses deterrence

$D(\theta)$

Terrorists decide whether or not to attack

No Attack
$1 - \Omega$

Attack
Ω

$D(\theta)$
0

Logistical Failure
θ

Logistical Success
$1 - \theta$

$a + D(\theta)$
$-c$

Government response

Capitulate
p

Does not capitulate
$1 - p$

$h + D(\theta)$
m

$n + D(\theta)$
$\tilde{m}$