AN ECONOMIC PERSPECTIVE ON TRANSNATIONAL TERRORISM

by

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On 11 September 2001, the world watched aghast as two commercial airliners toppled the twin towers of the World Trade Center and a third airliner 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 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, installing technological barriers), negotiation responses in hostage incidents, the terrorists' choice of target, the economic impacts of terrorism, and others.

Terrorism is the premeditated use, or threat of use, of extranormal violence to obtain a political objective through intimidation or fear directed at a large audience. 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 of terror are designed to achieve. Incidents that have no specific political demand 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 ghastly actions to recapture media attention. Thus, the escalation experienced on 11 September 2001 came as no surprise to those who study terrorism. Moreover, 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 were crashed into the World Trade Center fit this pattern, while the planes that were intended for targets in Washington, DC do not fit this pattern. 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, 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 (Hirshleifer, 1991). 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 a minimal amount of 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 World Trade Center tragedy, citizens from over 80 countries lost their lives at the hands of terrorists who crossed into the United States from abroad. Obviously, the four hijackings on 11 September constitute transnational terrorist attacks. The kidnappings of foreigners in Lebanon during the 1980s, as a protest against Israeli-occupied territory, 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 skyjackings in the United States. Economic methodology is particularly well-suited to provide insights over and beyond those from a political science approach, the latter of which has stressed definitions, institutional factors, and case studies in an inductive framework (see, e.g., Crenshaw, 1992; Hoffman, 1998; Wilkinson, 1986; Wilkinson and Stewart, 1987). First, economic analysis can account for the

strategic interactions among opposing interests – e.g., the terrorists and the authorities, between two targeted countries. Second, 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. Third, the theory of market failures can underscore how independent pursuits of well-being by the agents may be at odds with socially efficient outcomes. Thus, governmental failures may result from well-intentioned policies. Fourth, various economic empirical methods can be applied to evaluate theoretical predictions and policy recommendations.

The primary purpose of this article is to demonstrate novel insights already gained from applying an economic perspective to a political problem. A second purpose is to highlight the role of game theory and other modern economics tools in the study of transnational terrorism. A third purpose is to present some new applications of economic methods to this crucial problem area.

A Look at the Data

To provide a perspective of the nature of the transnational terrorist threat, we compile Table 1 based on data from the US Department of State (1988-2001). 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. A number of essential facts can be drawn from these numbers. First, transnational terrorism on average results in relatively few deaths, especially when compared with the annual 40,000 people killed on US highways, so that the events on 11 September are clear outliers. In fact, the deaths on this single day is approximately equal to all transnational terrorist-related deaths recorded during the entire 1988-

2000 period. Second, transnational terrorism appears to follow a cyclical pattern with much of the 1990s being a relatively calm era. 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 account for 291 deaths and almost 5,000 injuries in 1998 (US Department of State, 1999). Third, attacks against US interests account for a relatively high proportion of events. This is particularly noteworthy from an externality viewpoint, because relatively few incidents take place on US soil – in 1998 and 2000, there were no such events, while, in 1999, there was just one such event (US Department of State, 1999-2001).

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 – may operate with impunity if the risks to foreigners are of little concern to the local government.[1] This leads to underdeterrence of terrorism from a multi-country viewpoint (Lee, 1998). 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 (Sandler and Lapan, 1988). Unless such actions decrease the overall level of attacks, each country expends resources without reducing the overall threat or 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. RAND also maintains data on significant transnational terrorist incidents and has made it available to some researchers. Edward Mickolus (1980, 1982) developed a data set, *International Terrorism: Attributes of Terrorist Events* (ITERATE) for 1968-77. This incident-based data set was extended to cover 1978-87 and 1988-91 by Mickolus, Sandler, Murdock, and Fleming (1989, 1993). More recently, Fleming (2001) has updated some 40 variables for 1992-98, while Sandler has updated select variables for 1999-2000. 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, terrorists' actions during negotiations) than in recording those of the authorities. 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, 2001). ITERATE picks up *newsworthy* transnational terrorist incidents, so that there is some bias, which must be recognized. The bias is 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 newsworthy 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, number of hostages secured.

Based on ITERATE data, we display two quarterly time series – all transnational incidents and bombings – in Figure 1 for 1970-2000. 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 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 1970-2000. Cycles are again prevalent. 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). Insofar as terrorists must allocate scarce resources from a budget (resource) constraint to alternative tactics, choices among attack modes are interdependent.

In Figure 3, we display the quarterly percentage of incidents with casualties (i.e., deaths or injuries) for the 1970-2000 period. This time series is noteworthy because it indicates that since the early 1990s, transnational terrorist incidents, although down in number, are more likely to end in injuries or death for targeted individuals. 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 has 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. Thus, the events of 11 September with their massive casualties of innocent people of all ages came as no surprise to those of us who study terrorism and warned of an ominous changing nature of transnational terrorism. In a recent time-series-based study, 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, as speculated by Hoffman (1998). 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.

Trends and Cycles

Judging by the public's and media's reaction to 11 September, one might conclude that international terrorism is on the rise, but Figures 1 and 2 (displayed earlier) indicate just the opposite trend. 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 1968-2000, 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 and the political science literature.[2] 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 11 September 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. 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 graph 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.[3] We anticipate that the logistically complex incident types will have relatively large amounts of this proportion attributable to the low frequencies. The all-events series has a large variance of 1335.56 with just 25.2 percent corresponding to the relatively low frequencies. In marked contrast, the more complex events of assassinations and those involving casualties have smaller variances with more of this variance (41.1 and 52.7 percent, respectively) attributed to low frequencies. Threats and hoaxes display the greatest evidence of short cycles with just 24.7 percent of the variance explained by the longest cycles. The variance results for hostage taking and bombing events imply moderately short cycles. Only in the case of hostage taking are our priors not realized.

Game Theory and Hostage Taking

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" (Malvesti, 2001; US Department of State, 2001, p. iii).

The underlying game tree is displayed in Figure 4, 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 4. 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.[4] 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.[5] Even if the government's pledge is believed by the terrorists (i.e., $p = 0$), conditions on $\tilde{m}$ exists, so that the terrorists can derive a positive gain from securing hostages when getting no concessions.[6] 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 than in the case of a credible governmental pledge, and so an attack becomes more imminent.[7] 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)[8] 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' 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 4. Even when reputation cost is included, conceding may not be eliminated unless $h + R$ exceeds *n* for all realizations of *n*. 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.[9] 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.

Game Theory and Governmental Responses

We have already discussed the transference externality when terrorists target two different countries and each *independently* chooses a level of deterrence that fails to account for associated external cost/benefit. 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 Lapan, 1998). 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; Mavesti, 2001). Ironically, US efforts to induce other countries to secure their airports and

public places make the United States a more attractive target, as 11 September 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 are loathed to sacrifice 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; Wilkinson, 1987). 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 terrorism literature.

Building a Coalition against Terrorism

Actions to coordinate retaliation against either a terrorist organization or a state-sponsor of terrorism has typically been characterized as a Prisoners' Dilemma (e.g., Lee, 1988) with all countries playing their dominant strategy to sit back and do nothing. This representation follows because a country's own cost of retaliating is often greater than its perceived benefit (Sandler, 1997, p. 133). That is, the cost is private to the retaliator but the benefit is purely public – nonexcludable and nonrival – to potential targeted countries. Perceived retaliation cost may be higher than the retaliator's derived benefit, since the retaliator often attracts subsequent terrorist attacks as protests for its actions (Brophy-Baermann and Conybeare, 1994; Enders and Sandler, 1993). In the past, a targeted country responds to maintain its political legitimacy in a liberal democracy (Wilkinson, 1986) – i.e., to be viewed as trying to protect lives and property. For a targeted country, these political benefits may offset the net negative economic gains associated with retaliation,[10] so that it acts alone. Countries not directly in the terrorists' cross hairs will only weigh the *net* negative economic benefits and free ride.

The forging of an alliance to wage war on terrorism in Afghanistan after 11 September 2001 appears to abide by a different underlying game form than the Prisoners' Dilemma for select countries that have participated in the retaliatory response against the Taliban and Osama bin Laden. We shall focus on the two most ardent participants – the United States and the United Kingdom. In Figure 5, we represent an underlying retaliation game in ordinal form, where payoffs are rank ordered from highest (4) to lowest (1). The payoffs for the row player – the US – are listed first, followed by those of the column player – the UK – in each of the four strategic combinations. The ordinal payoffs displayed indicate that the highest payoffs come from these two countries jointly retaliating, followed by the next-largest payoff for free riding when the other country retaliates. The worst payoff corresponds to retaliating on one's own,

followed by the second-worst payoff when neither country retaliates. This game differs from the standard Prisoners' Dilemma by having the ordinal payoffs of the 3s and 4s switched. That is, the heinous nature of the 11 September attacks and its human toll on American and British citizens at the World Trade Center increased the ordinal payoff for joint retaliation and decrease this payoff from free riding, as compared with earlier terrorist incidents, including the downing of Pan Am Flight 103 over Lockerbie, Scotland on 21 December 1988.[11]

For the *assurance* game displayed in Figure 5, there is no dominant strategy that gives higher payoffs no matter what the other country does, but there are two pure-strategy Nash equilibria, where either both countries retaliate or both do nothing. In this scenario, an alliance can be forged provided that one country *leads* and begins to retaliate, which was the role that the United States assumed. Other countries that have come along once the retaliatory strikes were well underway were Japan, Germany, and Italy. US leadership, coupled with initially successful operations, brought these others into the alliance by more than name only. Still other alliance members would only go along with US actions through private inducements that made being an ally a dominant strategy.

Rational-Choice Representations

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 will 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 1961-76, 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 1973-76.

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 then 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 the activity's 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 is anticipated to differ based on security measures taken by the authorities, so that 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 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.[12]

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, its membership) if an overall decrease in terrorism is to follow. Efforts to infiltrate groups or to freeze terrorist 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. Thus, there is a dynamic strategic interaction present, where authorities must be ever vigilant to be improving the technology by anticipating 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 in practice 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 (2001) 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 on 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 percent annually, and it reduced net FDI in Greece by 11.9 percent 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 percent and 34.8 percent 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.

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. The cost side is much easier than the benefit side for measurement purposes since figures are available in, say, the United States as to what is paid to fortify our embassies and missions, or to guard US airports. Consider the cost associated with airport security. To the cost of guards and screening equipment must be added the value of lost time as travelers are screened at US airports.

On the benefit side, calculations are less transparent and more cleverness is needed on behalf of the researcher. 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 11 September 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 other intervening factors at work – e.g., air travel was already in a slump prior to 11 September.

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. Time-series techniques, engineered by Enders and Sandler 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.

Concluding Remarks

Although economic methods have enlightened the public on a number of issues concerning transnational terrorism, not addressed by the political science literature, 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, 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 has almost no clue about the size of al-Qaida,[13] 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.

Footnotes

1. Since 1973, the 17 November group has engaged in over 140 attacks and 22 assassinations yet no member has been brought to justice (Wilkinson, 2001, p. 54).

2. In fact, there is reasonable evidence to support the claim that each of the incident series is stationary. Using an augmented Dickey-Fuller unit-root test, we can reject the null hypothesis of a unit-root in all series, but that of threats and hoaxes, at the .05 level. For this latter series, we can reject the null of a unit-root at the .10 level.

3. We report the proportion of the variance explained by the frequencies in the interval [1, 0.15•T/2]. Since we are somewhat skeptical of the fitted polynomial trends, we also obtained results using only demeaned data. These results are very similar to those discussed below.

4. If $c < c^* = [(1-\theta)/\theta] \bullet [pm + (1-p)\tilde{m}]$, 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 4, 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.

5. The terrorists' perceived net expected payoff equals: $(1-\theta) \bullet [pm + (1-p)\tilde{m}] - \theta c$.

6. The condition is that $(1-\theta)\tilde{m} > -c\theta$.

7. When $p > 0$, expected benefits increase by $(1-\theta)(pm - p\tilde{m})$ compared with the $p = 0$ case. A reasonable assumption is that $m > \tilde{m}$, so that winning concessions is better than not gaining concessions.

8. The Arab prisoners released included Kozo Okomato, a Japanese Red Army Faction member, who was the sole surviving terrorist in the Lod Airport massacre of 1972, which left 27

people dead and 78 injured.

9. On asymmetric information models of terrorism, see Lapan and Sandler (1993) and Overgaard (1994).

10. Economic benefit refers to the direct benefit derived from retaliation, while economic cost refers to the expenditure of resources to carry out the retaliation and other subsequent losses associated with the retaliation. We use the term *economic benefit* to distinguish it from *political benefit* stemming from maintaining legitimacy.

11. Britain lost the second greatest number of citizens of any country at the World Trade Center. Despite Pan Am 103 flying out of Heathrow Airport and crashing in the United Kingdom (Lockerbie, Scotland), Britain lost relatively few of its citizens in this incident.

12. Analogous results are found in Brophy-Baermann and Conybeare (1994) for retaliations by Israel against Palestinian terrorists.

13. In the latest *Patterns of Global Terrorism*, al-Qaida strengths is given as “may have several hundred to several thousand members” (US Department of State, 2001, p. 69).

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Table 1

Transnational Terrorism: Events 1968-2000

Year	Number of Events	Deaths	Wounded	Attacks on US Interests
2000	423	405	791	200
1999	392	233	706	169
1998	273	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* (1988-2001) and tables provided to Todd Sandler in 1988 by the US Department of State, Office of the Ambassador at Large for Counterterrorism.

Table 2

Trend and Other Statistical Properties of Transnational Terrorist Incidents

Incident Type	Constant[a]	Time	(Time)^2	(Time)^3	*F*–stat[b]	Variance	Percent[c]
Hostage taking	5.901	0.219	–0.001		13.11	32.223	0.278
	(3.832)	(4.093)	(–3.202)		[0.000]		
Bombings	34.449	1.139	–0.010		15.87	842.470	0.314
	(4.442)	(4.230)	(–5.021)		[0.000]		
Threats & Hoaxes	8.595	–0.276	0.010	–0.000	11.34	87.170	0.247
	(2.540)	(–1.256)	(2.572)	(–3.340)	[0.000]		
Assassinations	–1.521	0.400	–0.003		43.49	21.472	0.411
	(–1.229)	(9.299)	(–8.830)		[0.000]		
Casualties	9.726	0.579	–0.004		10.74	119.479	0.527
	(2.441)	(4.497)	(–4.635)		[0.000]		
All Events	41.689	2.435	–0.019		30.79	1335.560	0.252
	(4.270)	(7.185)	(–7.743)		[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 1

All Incidents and Bombings

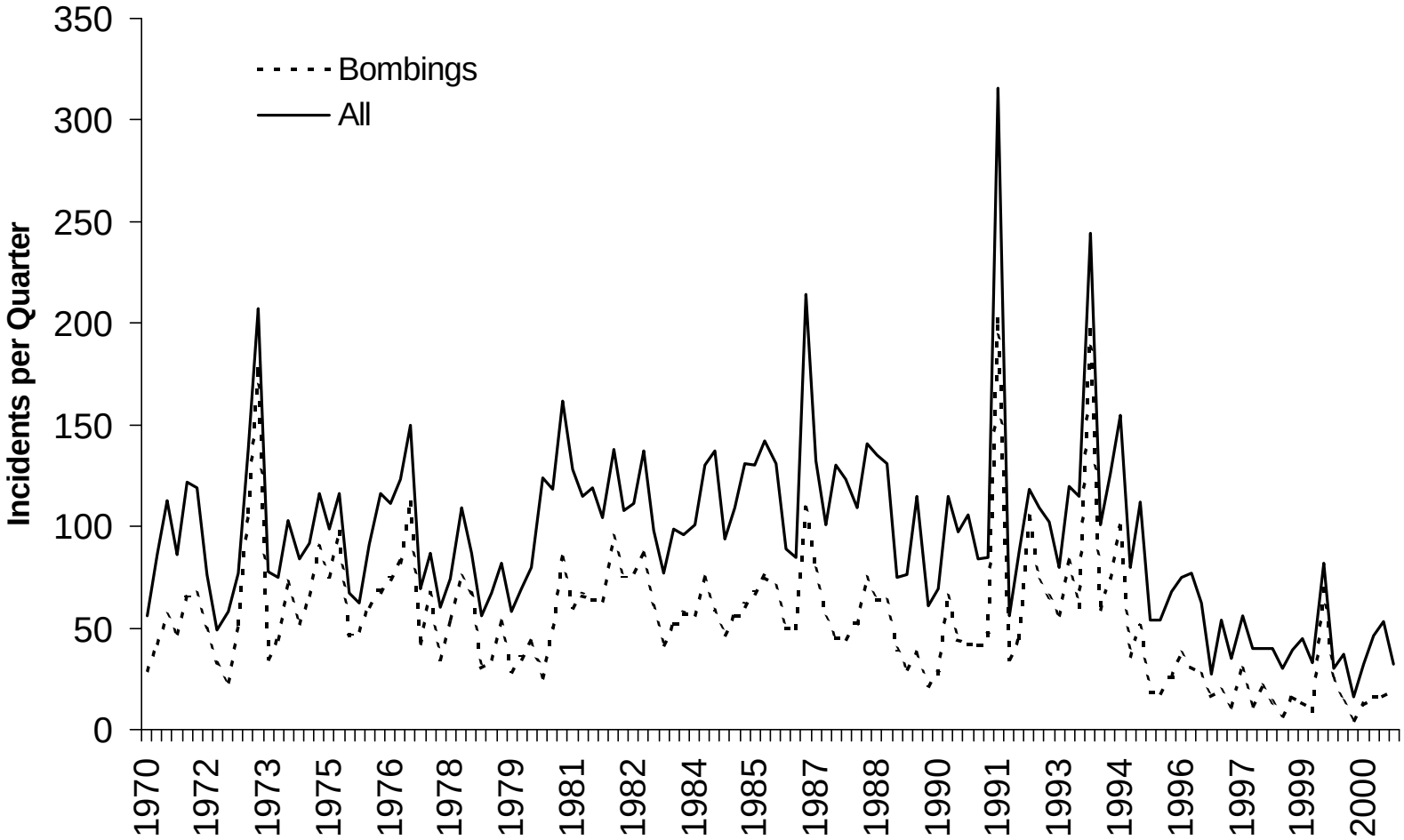

Figure 2

Assassinations and Hostage Incidents

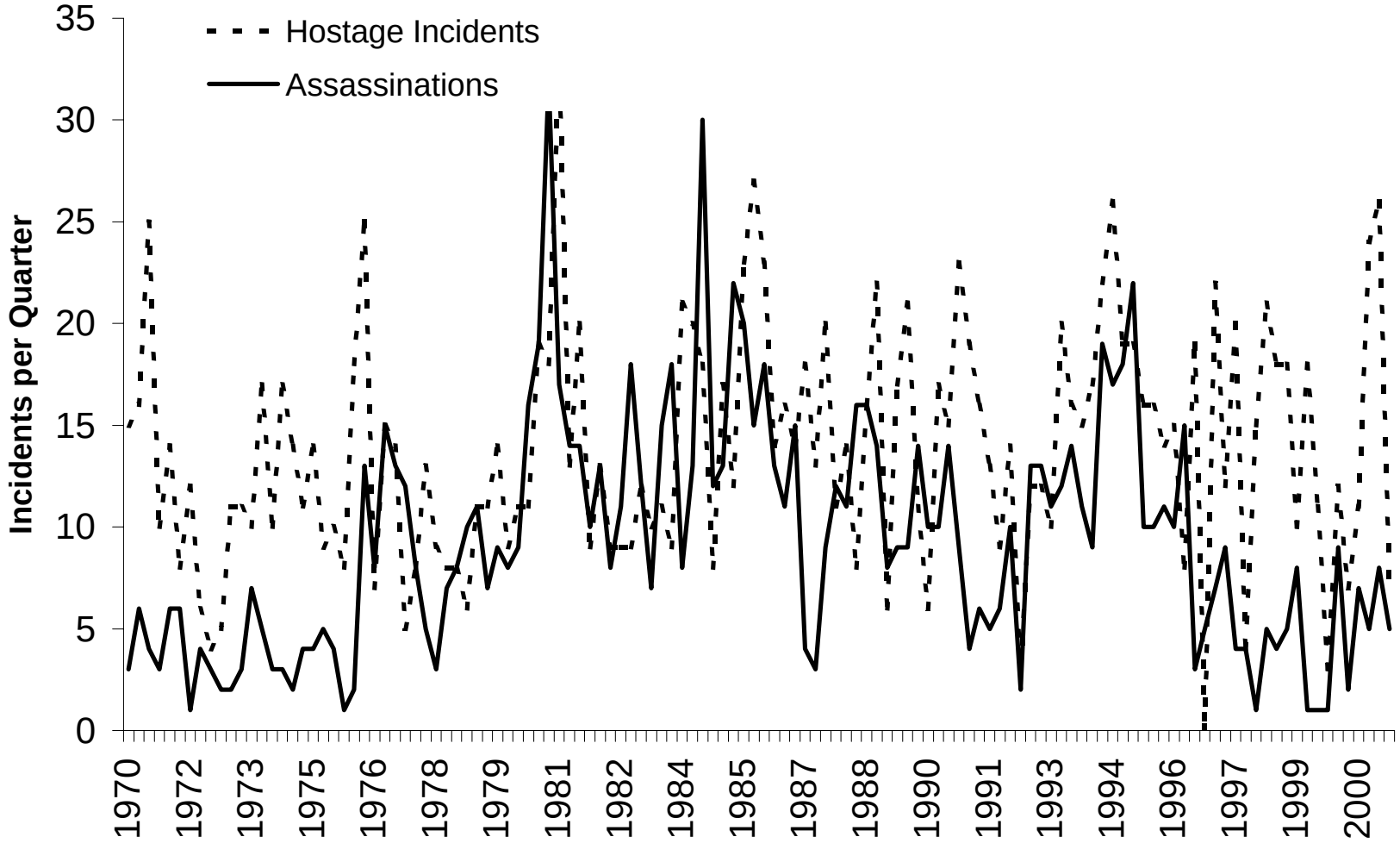

Figure 3

Proportion of Incidents with Casualties

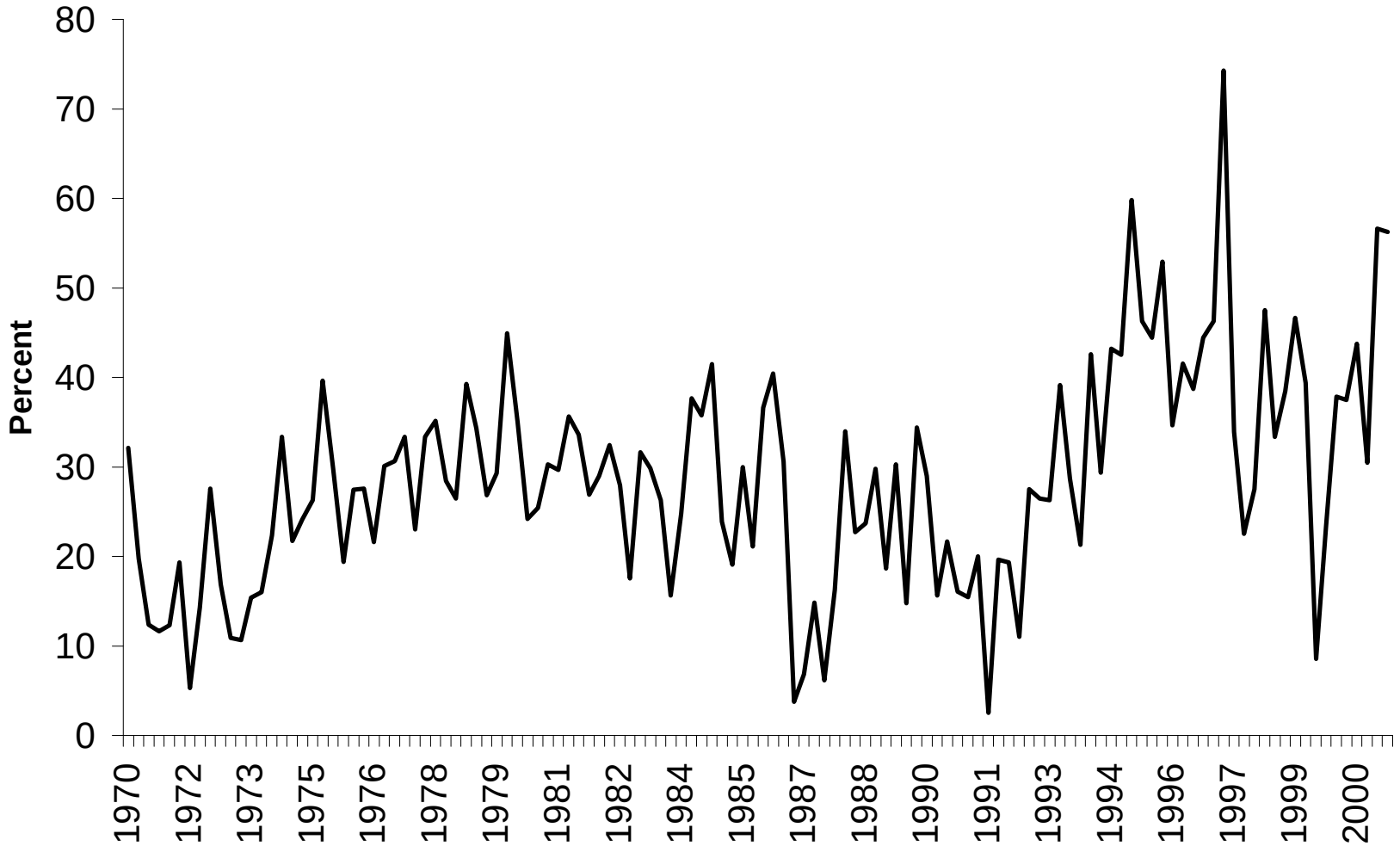

Figure 4

Game Theory for Hostage Event

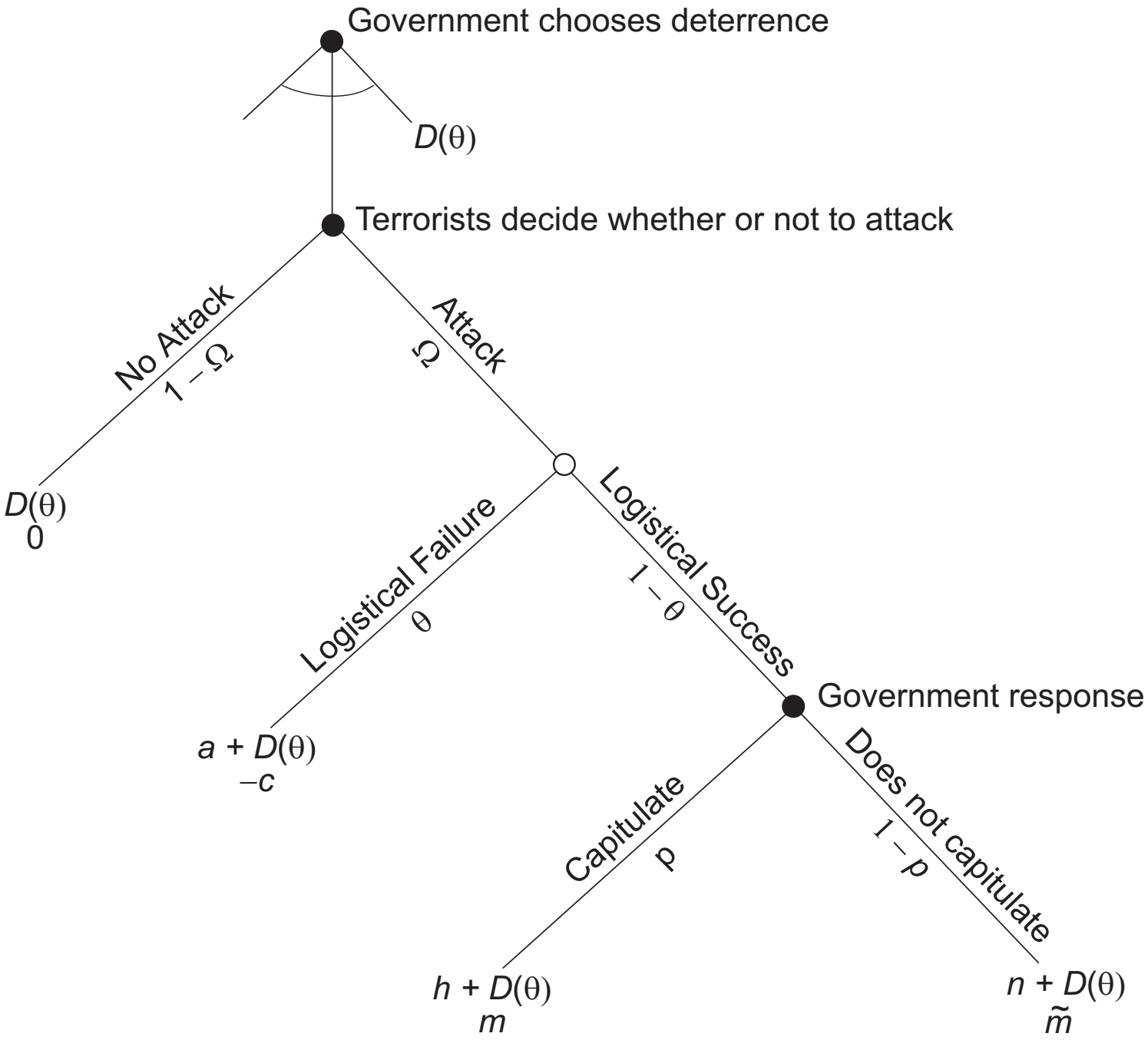

Figure 5
Ordinal Game Matrix for Retaliation

		UK	
		Retaliate	Do Nothing
US	Retaliate	4, 4	1, 3
	Do Nothing	3, 1	2, 2