

THE PAST AND FUTURE OF TERRORISM RESEARCH

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This paper highlights five areas where economic analysis of terrorism has had the greatest policy relevance during the last 30 years. These areas involve evaluating the effectiveness of counterterrorism actions, identifying the causes of terrorism, measuring the economic ramification of terrorism, analyzing the time-series dynamics of terrorist events, and formulating game-theoretic representations of terrorism. The paper's primary novelty lies in synthesizing past research and in identifying the key policy-relevant issues that require additional analysis. These issues include understanding the operation of global terrorist networks, ascertaining the payback of counterterrorism strategies, evaluating the returns from alternative forms of international cooperation, and investigating the strategic aspects of suicide terrorism. A procedure for tackling each of these policy concerns is offered.

Key words: Terrorism, counterterrorism, benefit-cost analysis, game theory, policy effectiveness, economic consequences

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Since the four terrorist skyjackings on 11 September 2001 (hereafter, 9/11), economists have taken a strong interest in applying economic methods to the study of terrorism and counterterrorism. This post-9/11 effort has been, partly, supported by the Centers of Excellence, funded by the US Department of Homeland Security. Economic research on this topic dates back to Landes' (1978) study of the deterrent effects of US antiterrorism policies against skyjackings during 1961-1976. In particular, Landes was interested in the effectiveness of metal detectors used to screen passengers after detectors' installation on 5 January 1973. Economists' research efforts have greatly added to our understanding of terrorism by stressing a rational-choice model in which terrorists are viewed as optimizing an objective, subject to constraints. Terrorist rationality

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is not based on the “legitimacy” or desirability of their preferences or objectives, but rather on their appropriate (and predictable) response to changes in their constraints, which are determined by terrorist resources and the policy decisions of governments. For example, official steps that make skyjackings more costly should induce terrorists to shift to relatively less costly alternative modes of hostage taking (e.g., kidnappings). Similarly, terrorists’ choices affect governments’ objectives and constraints. Given this strategic interaction among targeted governments and terrorists, game theory has proven to be a useful tool in understanding interactive choices of these bitter adversaries. This game-theoretic interest has spilled over into political science (see, e.g., Bueno de Mesquita, 2005a, b; Powell, 2007).

Economists have also applied econometric methods to test alternative hypotheses – e.g., does poverty cause terrorism (Abadie, 2006; Krueger and Maleckova, 2003) and what is the impact of terrorism on tourism (Drakos and Kutan, 2003; Enders et al., 1992). Many terrorism-related questions have been investigated with a variety of techniques, which have included hazard (time-to-failure) models, discrete-choice models, panel estimations, time-series estimations, and simultaneous equations. The latter are particularly appropriate when the reduced-form equations derive from a game-theoretic foundation, since one agent’s choice is not independent of those of other agents. For example, two governments’ choices of defensive and proactive measures against a common terrorist threat result in best-response paths that have correlated errors. Simultaneous-equation estimations will become more prevalent as data on government actions are available. To date, most data sets primarily record the actions of the terrorists during incidents. With the help of empirical methods, economists have investigated the effectiveness of alternative counterterrorism policies – e.g., the impact of retaliatory raids on the prevalence of future incidents or the influence of UN conventions and resolutions on particular types of terrorist incidents.

This article has two main purposes: (i) to highlight significant economic research findings to date, and (ii) to indicate fruitful areas for future economic research on terrorism. The paper’s main novelty lies in identifying how economic methods can answer essential questions that have yet to be answered. Procedures for answering these questions are also indicated. To assist readers to understand unanswered issues, I must first indicate where economic analysis has had the greatest success in studying terrorism. These successes include evaluating counterterrorism policies (Section 1), measuring the economic consequences of terrorism (Section 2), investigating the causes of terrorism (Section 3), identifying time-series dynamics of terrorist events (Section 4), and building game-theoretic models (Section 5). Future directions then follow and include the study of networked terrorists (Section 6), the payback of alternative counterterrorism strategies (Section 7), the evaluation of international cooperation (Section 8), and the strategic analysis of suicide terrorism (Section 9). Section 10 concludes with additional future directions.

1. EFFECTIVENESS OF COUNTERTERRORISM POLICIES

The most important and useful contribution of economic analysis to the study of terrorism is its development of estimates for the effectiveness of counterterrorism measures. Prior to economic analysis, evaluation of alternative policies was based on casual empiricism with no quantification of policy effectiveness. In his seminal economic study, Landes (1978) used Gary Becker's crime and punishment model to derive an offense function, O , to ascertain the deterrent effect of explicit policy decisions on the number of US hijackings. The incidence of these skyjackings was related to the offender's estimate of the likelihood of apprehension (P_a), his or her estimate of the conditional probability of conviction and incarceration (P_c), the monetary value of the sentence (S), the cost of apprehension with sentencing (C), a vector of variables (Z) reflecting wealth differences between the destination country and the home country, and other variables (income) (X). Thus, the offense function is:

$$O = O(P_a, P_c, S, C, Z, X) \quad [1]$$

in which the probability of apprehension is influenced by metal detectors after January 1973. Offenses denote the quarterly number of skyjackings.

Landes (1978, p. 12) found that an increase in the probability of apprehension owing to metal detectors had a negative and highly significant influence on the incidence of skyjackings – a reduction of 1.1 to 2.2 US skyjackings per quarter. Other noteworthy deterrents included a higher probability of conviction and longer prison sentences. In a second set of regressions, Landes (1978) related the above deterrents to the length of time between skyjackings. Effective deterrents lengthened this time interval. He showed that a greater probability of apprehension, a greater chance of conviction, and longer prison sentences slowed the arrival rate of skyjackings, thereby serving as effective deterrents. Higher unemployment rates increased the frequency of skyjackings so that the opportunity costs in the home country made a difference.

Although the Landes (1978) article is a landmark, he did not account for terrorists' abilities to substitute among modes of attacks in response to the higher metal-detector-related costs associated with skyjackings. Hence, his benefit estimate for metal detectors was solely based on the fewer skyjackings that ranged from 41 to 60 for 1973-76, and hence did not properly estimate these benefits (Landes, 1978, p. 21). Enders and Sandler (1993, 2006) used an alternative methodology for judging the benefits for metal detectors. In particular, they applied a vector autoregression (VAR) technique where multiple time series are investigated simultaneously to spot substitutions and complementarities among attack modes. For one set of runs, they used four time series: skyjackings, other hostage incidents (e.g., kidnappings, nonaerial hijackings, and building seizures), attacks against protected persons (i.e., nonhostage incidents against diplomats and other protected persons) and other incidents. Figure 1 from Enders and Sandler (2006) displays the four time series where actual series are in broken lines and predicted series are in solid lines. In each of the four panels, the first vertical line at the first quarter of 1973 denotes the introduction of metal detectors. As can be

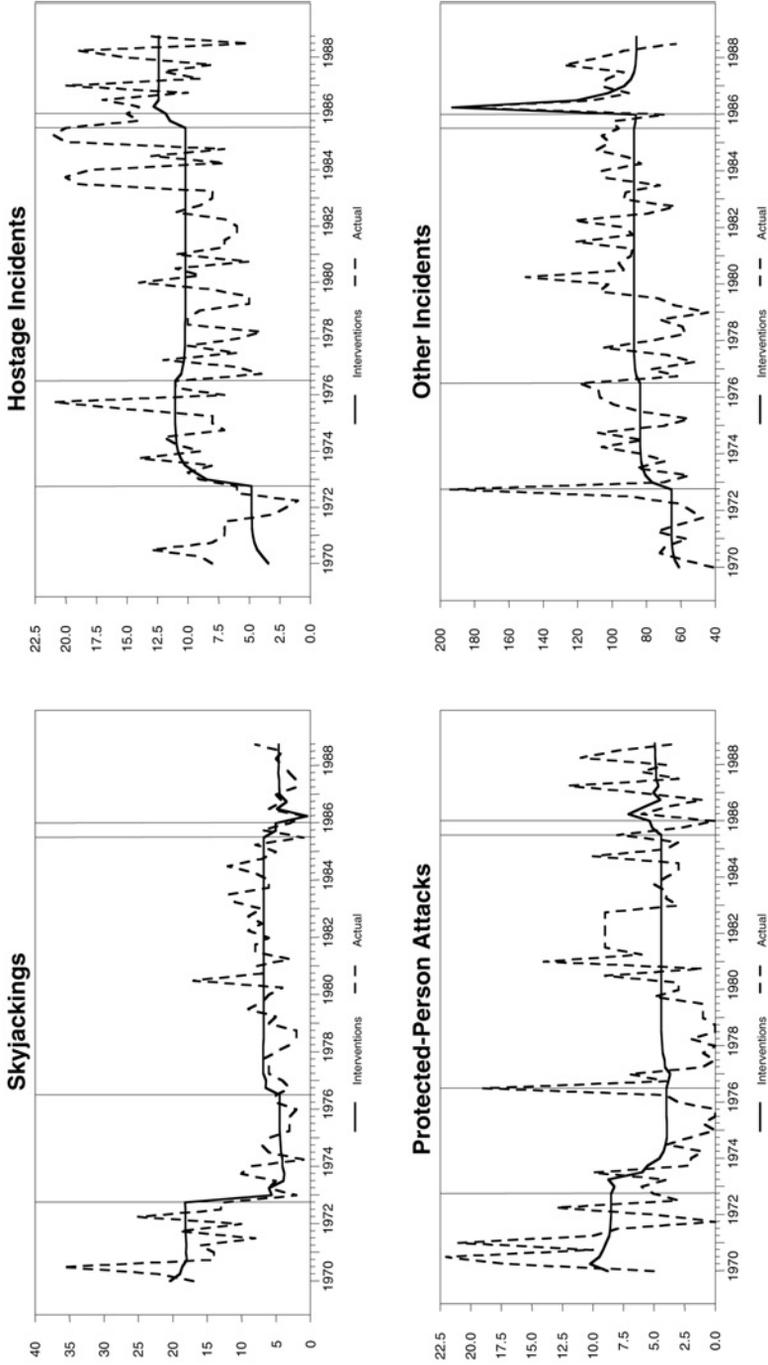
seen in the skyjacking panel, skyjackings dropped precipitously after metal detectors were installed, consistent with Landes' US findings; however, other kinds of hostage incidents rose greatly at the same time, limiting the gains from metal detectors. This reflects the transference of attacks, which also characterized other incidents. As metal detectors were placed in embassies and government buildings with a lag, there was a second benefit as crimes against protected persons fell. To truly judge the effectiveness of metal detectors, a researcher must account for negative and positive consequences of their installation.

Enders and Sandler (1993, 2006) also evaluated other policies with surprising findings. They examined the US retaliatory raid on Libya on 15 April 1986 for Libya's involvement in terrorist bombing of the La Belle discotheque in West Berlin on 4 April 1986, where 3 died and 231 were injured including 62 Americans. Enders and Sandler (1993) concluded that the Libyan bombing did not have the desired effect of reducing terrorist attacks. Instead, the US retaliatory raid raised terrorist attacks immediately, as terrorists showed their displeasure by moving planned future attacks into the present. Transnational terrorist attacks then dropped temporarily as terrorists needed to plan new attacks and recoup spent resources. Thus, terrorists displayed an intertemporal substitution of activities; however, the average number of attacks stayed unchanged. Identical findings characterized the Brophy-Baermann and Conybeare (1994) study of Israeli retaliatory raids.

Enders and Sandler (1993) also discovered that augmented mission security reduced embassy attacks, but increased assassinations of diplomatic officials off of embassy grounds. In addition, their study showed that UN conventions and resolutions outlawing hostage taking, sabotage against planes, and bombings had no effect: i.e., the relevant time series' post-intervention mean was not significantly different than its pre-intervention mean. This last finding casts doubts on recommendations by some terrorist experts (e.g., Wilkinson, 2001) that international conventions are the most effective way to fight terrorism. Finally, Enders *et al.* (1990) showed that some domestic laws – the so-called Reagan get-tough policy on terrorists – had no impact on transnational terrorist attacks against US interests. Terrorists presumably discounted greatly the ability of the US authorities to reach out and bring them to justice during the 1980s when these laws were enacted.

The VAR methodology was recently applied by Jaeger and Paserman (2008) to investigate the cycle of violence during the Second Intifada from September 2000 through May 2007. These authors showed that the level of Israeli casualties Granger caused Palestinian deaths, but that the level of Palestinian casualties did not Granger cause Israeli deaths. Thus, the Israelis retaliated in a systematic fashion to attacks against its citizens, while the Palestinians did not retaliate in a systematic fashion to attacks against its people. Thus, a tit-for-tat cycle of violence was not present. Given the uni-directional response, Israeli retribution did not necessarily increase the violence. The authors also found that Israel tightened security (e.g., closing checkpoints) after its retribution attacks. This security measure was an effective countermeasure in controlling violence.

Figure 1: SUBSTITUTIONS BETWEEN ATTACK MODES



Source: Enders and Sandler (2006).

Zussman and Zussman (2006) eschewed a direct VAR approach when investigating the effectiveness of Israeli assassinations of Palestinian terrorists during the Second Intifada. Instead, these authors applied a clever indirect approach by studying the effects of Israeli targeted assassinations on the value of the Tel Aviv 25 index. In so doing, they used an event data analysis. If Israeli investors viewed the assassinations as reducing terrorism, then the market index should display a sustained rise. If, however, Israeli investors viewed the assassinations as counterproductive, then the market index should display a sustained fall. The authors distinguished three types of assassinations: junior military personnel, senior military leaders, and senior political leaders. As anticipated, the assassination of senior *military* leaders had a sustained positive effect on stock prices, while the assassination of senior *political* leaders had a sustained (counterproductive) negative effect on stock prices. The murder of junior military personnel had no effect. The study had many controls, including the murder of noncombatants which were counterproductive.

Many other interesting economic studies have applied various methodologies to investigate counterterrorism measures. The studies above are only representative.

2. ECONOMIC CONSEQUENCES OF TERRORISM

There are essential reasons for studying the economic consequences of terrorism. First, the ability of modern-day terrorists to cause hardship to a society must be assessed. This hardship may be in terms of casualties and/or economic losses. Al-Qaida training manuals, captured in caves in Afghanistan by US troops, direct its followers to attack “vital economic centers” as a means to carry on the fatwa against the infidels (WorldNetDaily, 2003). Euskadi Ta Askatasuna (ETA) targeted hotels and resorts in the 1980s in an effort to hurt tourism and the economy in Spain (Mickolus *et al.*, 1989). In an important paper, Abadie and Gardeazabal (2003) showed that a sustained ETA campaign lost the Basque Country about 10% of its gross domestic product (GDP). Second, losses in GDP from terrorism are a crucial component of what is saved by counterterrorism that reduces attacks, thereby raising growth. Any exercise to compute the benefit-cost ratios of alternative counterterrorism policy requires knowledge of these GDP losses worldwide (see section 6). Third, the economic consequences of terrorism must be calibrated if offsetting economic stimulus packages or foreign assistance to terrorism-plagued countries are to be determined. Many economies and economic structures are surprisingly resilient to terrorist attacks. Chen and Siems (2004) showed that terrorist attacks prior to 9/11 did not reduce the value of stock market indices for more than two or three days, even though specific impacted sectors – e.g., airline stocks – would suffer for much longer. The attacks of 9/11 reduced stock market indices for 30-40 days (Chen and Siems, 2004); nevertheless, financial markets rebounded surprisingly fast from 9/11.

There are four unifying principles regarding the economic impact of terrorism (Sandler and Enders, 2008). The immediate costs of most terrorist attacks are localized, not unlike crime. Next, terrorism-prone sectors may suffer substantial losses when attacked as investors and customers seek less risky sectors. Skyjack-

ings in the 1980s temporarily crippled the tourist industry in some countries – e.g., Greece – until airports were made more secure (Enders *et al.*, 2002). Moreover, large diversified economies are able to withstand some terrorism and display relatively little macroeconomic losses. Finally, small countries plagued by a sustained terrorist campaign can lose more than 10% of their GDP (Abadie and Gardeazabal, 2003; Eckstein and Tsiddon, 2004). Developing countries are similarly more susceptible to terrorism-induced economic consequences (Gaibullov and Sandler, 2009; Keefer and Loayza, 2008).

Why are rich diversified countries relatively immune from terrorism-induced economic hardships? Such countries have well-honed monetary and fiscal policy tools that can be applied to cushion the effects of a large-scale terrorist attack. After 9/11, the Federal Reserve (FED) slashed the federal funds rate to meet a 9/11-induced demand surge for liquidity. Liquidity was also increased by the FED encouraging banks to borrow from the FED, which more than doubled its bank loans on 12 September (Enders and Sandler, 2006, p. 211). Fiscal policy also played a role in speeding up the recovery after 9/11. Diversified economies facilitate between-sector reallocation of resources, so that resources can temporarily exit risky sectors until confidence is restored. Also, the mere size of rich economies means that even large-scale attacks cause losses that dwarf GDP. The \$80-90 billion loss attributed to 9/11 was less than 0.1% of the US GDP at the time. Rich countries can also afford large security upgrades – e.g., the creation of the US Department of Homeland Security – in order to regain confidence following a large terrorist attack. Developing and poor less-diversified countries possess more limited means to absorb and recover from terrorism shocks. Gaibullov and Sandler (2009) showed that developed countries in Asia did not display a significant impact of transnational terrorist attacks on income per capita growth, unlike their developing country counterparts. Developing countries lose income growth through three avenues: reduced investment, increased government spending, and smaller aid inflows.

Recent studies showed that terrorism has a moderate influence on income per capita growth. Blomberg, Hess and Orphanides, (2004) examined a pooled cross-section of 177 countries from 1968 to 2000 and discovered that each year of transnational terrorism resulted in a drop of 0.048% in income per capita growth. To put things into perspective, Sandler *et al.* (2009) used the Blomberg, Hess and Orphanides, (2004) model to calculate the global GDP lost for 2005, given transnational terrorism attacks that year. This lost GDP was about \$17 billion, far less than what is spent on homeland security. In a study of terrorism and European growth, Gaibullov and Sandler (2008) distinguished between domestic and transnational terrorist events, and found that domestic terrorist incidents had a much smaller impact on growth. For Asia, Gaibullov and Sandler (2009) demonstrated that internal conflicts had a much greater impact on income per capita growth than terrorism. Moreover, more populated countries were better able to withstand terrorist attacks without displaying smaller growth.

3. CAUSES AND ROOTS OF TERRORISM

Political scientists have been interested in the causes or roots of terrorism since they started to study the topic (Hoffman, 2006; Wilkinson, 2001). With little systematic theoretical or empirical analysis, political scientists typically attributed the causes to grievances or political demands in myriad forms: e.g., ethnic concerns, economic discrimination, specific issues (i.e., abortions or animal rights), separatism, nihilism, or nationalism. After 9/11, economists engaged in important analytic work to evaluate the popular consensus that poverty is the root of terrorism.

To investigate this consensus, economists applied a variety of empirical tools. Using a terrorism risk index, Abadie (2006) showed that, *ceteris paribus*, poverty is *not* a significant determinant of terrorism risks. In his study, political freedoms are an important nonlinear determinant of terrorism risks. “Countries with intermediate levels of political freedom are shown to be more prone to terrorism than countries with high levels of political freedom or countries with highly authoritarian regimes.” (Abadie, 2006, p. 51). He also found that a country’s geophysical characteristics – larger area, higher elevation, and greater jungle cover – are associated with a higher risk of terrorism, presumably because terrorists have havens to hide from government forces. In a complementary study, Krueger and Laitin (2008) separated the terrorists’ country of origin and their venue country, and found that political repression, not economics, explained the transnational terrorists’ country of origin. Thus, the lack of political freedom is a prime motivator of terrorism. Based on statistical analysis, they also established that target countries tended to be rich. This finding agrees with Blomberg, Hess and Weerapana (2004), who showed that richer countries in their 127-country panel for 1968-1991 experienced more transnational terrorist attacks than poorer countries. These authors also established that democracies are more plagued than autocracies by transnational terrorism; however, they did not look for a quadratic relationship like Abadie (2006). Blomberg, Hess and Weerapana (2004) also indicated that transnational terrorism increased during economic downturns, consistent with an opportunity costs theory of terrorism (also, see Jaeger *et al.*, 2008).

Drakos and Gofas (2006) used a large panel – 139 countries for 1985-1998 – to identify the characteristics of an average transnational terrorist attack venue. These authors found that such venues had an elevated level of international disputes, low economic openness, and high demographic stress. They also uncovered a weak relationship between democracy and transnational terrorism, consistent with democratic freedoms (e.g., freedom of association, freedom of movement, and a target-rich environment) facilitating the practice of terrorism (Enders and Sandler, 2006).

In summary, the picture that is emerging is that political considerations, not poverty, are the main driver of terrorism. A redistribution of income from rich to poor countries will do little to cure transnational terrorism. Political repression does more to recruit terrorists than economic deprivation. Rich countries are a venue of choice for transnational terrorist attacks for a number of reasons: opportunity provided by democratic freedoms, media coverage, and political grievances (e.g., US foreign policy).

Although the studies above addressed transnational terrorism, economic methods can be readily applied to fathom the causes of homegrown and home-directed domestic terrorism. Jaeger *et al.* (2008) investigated how government or terrorist violence in Israel generated grievances that fueled new attacks. These authors showed that Israeli violence against Palestinians increased attacks in the short run. Public support of the terrorists grew after such violence, but dissipated within three months. In the context of insurgencies, Iyengar and Monten (2008) showed that public criticism of the Iraqi war in the United States emboldened insurgents, especially in areas of Iraq with access to such information. This effect led to more attacks against US forces, but disappeared in about a month. Berman *et al.* (2008) also examined factors affecting the intensity of the Iraqi insurgency, and established that the provision of public services curbed violence. I must, however, emphasize that insurgency differs from terrorism. An insurgency seeks to overthrow a government with guerrilla tactics, which may include terrorism. In contrast, terrorists may seek other political goals with much more limited violence.

4. TIME-SERIES DYNAMICS

Given the collection of event data sets with daily observations dating back to 1968, time-series analysis has been applied by many studies of terrorism and counterterrorism (Enders, 2007). A favorite tool is *intervention analysis*, in which an event or shock is indicated in a time-series equation as a one-period (pulse) influence or as a continual (level) influence. At other times, the intervention is allowed to have a gradual increasing or decreasing impact. Until recently, interventions were prespecified by the researcher to capture an explicit policy intervention or a major event (e.g., 9/11) (Enders and Sandler, 1993, 2005). This practice may add bias and is apt to miss other important changepoints, where the arrival rate of new incidents changes its slope. Thus, state-of-the-art methods now allow the data to identify the changepoints. Another issue concerns aggregation in time-series analysis. The initial studies on terrorist event dynamics used quarterly observations, which can hide cyclical components and hamper inferences about structural changes. This aggregation was used to abide by the normality assumption underlying autoregressive integrated moving average (ARIMA) models. A monthly time series of, say, kidnappings may have some zeros or near-zero observations, which violates the normality assumption of ARIMA, since negative values for incidents are not allowed. By using event count time-series methods based on Poisson or negative binomial distributions, a researcher can now analyze “thin” series with some zero values and investigate more disaggregated time series. Thus, recent time-series papers on terrorism used more disaggregated time series (e.g., Barros and Gil-Alana, 2006) and did not prespecify intervention points. Moreover, estimated models now include covariates (e.g., past concessions in hostage incidents) in order to calculate short-run and long-run multipliers tied to explicit actions of the authorities.

To illustrate the applied power of these studies, I briefly consider the study of Brandt and Sandler (2009) on the dynamics of hostage taking. These authors

separated hostage-taking incidents into three time series: kidnappings, skyjackings, and others (i.e., nonaerial hijackings and the takeover of buildings with hostages). In kidnappings, hostages are secured in locations typically unknown to the authorities; in skyjackings and other hostage events, hostages are secured in location known to the authorities. Thus, hostage takers are less vulnerable in kidnappings, which may affect policy consequences.

Brandt and Sandler (2009) investigated whether concessions to hostage takers really generated new hostage incidents, as embodied in the conventional wisdom. The latter is based on the subgame perfect equilibrium notion that if would-be hostage takers truly believe a government's pledge never to concede to terrorist demands, then terrorists will never abduct hostages since there is no payoff from doing so (see section 5). With advanced time-series methods, Brandt and Sandler (2009) found that conceding to kidnappers' demands resulted in 2.62 additional abductions, lending strong support for the conventional wisdom. However, concessions generated fewer additional skyjackings – just 0.6 more incidents. Apparently, location makes a difference. Violent ends to incidents dissuaded future skyjackings but not future kidnappings. Kidnappers presumably reasoned that other groups' mistakes, leading authorities to storm their hideouts, did not necessarily apply to them if they did a better job in keeping their whereabouts unknown.

Brandt and Sandler (2009) used daily observations of incidents when ascertaining changepoints for the three hostage-taking time series. For each series, the data pointed to breaks previously unidentified in earlier studies. New changepoints were associated with hot spots (e.g., skyjacking in the Soviet Union prior to the fall of communism), policies previously unidentified (e.g., the deployment of the multinational force to Lebanon in 1983), and political events (e.g., Abu Ghraib abuses). In the case of Abu Ghraib, a wave of kidnappings throughout the Middle East followed the revelation of prisoner abuse by US soldiers. These authors also established that skyjackings and kidnappings are negatively correlated, while skyjackings and other hostage events are positively correlated. The negative correlation is indicative of substitutes, while the positive correlation is indicative of complements. Substitute and complement hostage-taking incidents imply policy insights: isolated actions to thwart skyjackings may result in more kidnappings, while isolated actions to curb skyjackings may also reduce other hostage incidents.

There are a wide range of policy issues that can be investigated with these advanced time-series methods. For example, policy-induced substitutions among terrorist targets – i.e., businessmen, officials, tourist, military personnel, and others – have never been studied. As governments and businesses heightened security around their personnel, the general public is increasingly targeted.

5. GAME-THEORETIC ANALYSIS

Game theory (i.e., the study of strategic rational choice) is an appropriate tool to capture the strategic interactions among various agent pairings: e.g., the terrorists and the government, two or more targeted countries, rival terrorist groups (e.g., Fatah and Hamas), the political and military wings of a terrorist

group, and terrorists and their supporters. Other strategic interactions may involve terrorists, the media, and a targeted government (Rohner and Frey, 2007), or a terrorist leader, suicide terrorists, and the general public. Since 9/11, there has been a great deal of interest in game analyses of terrorism, which has been the subject of recent surveys (Sandler and Arce, 2007; Sandler and Siqueira, 2009). Thus, my goal here is merely to highlight a few interesting nonobvious results.

When a government allocates its defensive resources among alternative potential targets, Bier *et al.* (2007) showed that some locations may be best left undefended. Moreover, a centralized allocation is preferable to decentralized one, thereby making a case for an entity such as the Department of Homeland Security. Centralized defense allows the government to internalize possible externalities that arise based on the relative hardness of targets, with softer targets attracting more attacks. If an attack is inevitable somewhere because the terrorists are determined and all targets cannot be guarded equally, then it stands to reason that attacks should be guided to low-value targets. This then implies that defensive allocations be made public rather than secret.

Another issue involves proactive and defensive measures against a transnational terrorist group that targets multiple countries. Proactive policies are offensive as a government confronts the terrorists or their supporters directly. Actions intended to destroy terrorist training camps, to freeze terrorists' funding, to retaliate against state-sponsors of terrorism, or to infiltrate a terrorist group are proactive. In contrast, defensive measures protect potential targets either by making attacks more costly for the terrorists or by reducing their likelihood of success. In light of an attack, defensive actions can also limit the losses. Defensive measures by one country to make entry into the country more difficult may result in the terrorists targeting that country's interests abroad. When countries independently make defensive decisions, there is a tendency to engage in a defense race with targeted countries overspending (Sandler and Lapan, 1988). This overspending is attenuated if each targeted nation has interests abroad.

Proactive measures are like pure public goods where actions against a common terrorist threat confer security benefits on all at-risk countries. There is consequently a desire to free ride on the proactive response of others. As targeted nations sit back and wait for others to confront the terrorists and their supporters, offensive measures are undersupplied (Sandler and Siqueira, 2006). If action is taken, then it is usually by the prime-target country that has the most to gain from a diminished threat. This free-riding concern does not apply to domestic terrorism since a targeted country cannot rely on other countries to act, since it is the sole target of the attacks.

Game theory has also enlightened policy in terms of negotiation responses in hostage incidents. Lapan and Sandler (1988) investigated whether a government's pledge never to concede to terrorists would keep terrorists from taking hostages, as presupposed by the alleged subgame perfect equilibrium. These authors first allowed the targeted government to choose a level of deterrence that determines the likelihood of a terrorist logistical failure when abducting hostages. Based on their perceived likelihood of logistical success or failure and also on their perceived likelihood of negotiated success or failure, the terrorists decide whether or not to

take hostages. The game has four endpoints: no attack; an attack that fails logistically; an attack that captures one or more hostages but results in no concessions; and an attack that captures one or more hostages and results in concessions. Lapan and Sandler (1988) showed that if the government's pledge not to concede is believed, then the terrorists may still abduct hostages. This occurs when the terrorists view there to be a net gain from holding hostages even in the absence of payment – say, from publicity. Terrorists may even view a logistical failure as having benefits if martyrdom is valued.

Lapan and Sandler (1988) concluded that the pledged never-concede policy hinges on at least five implicit assumptions: (i) the government's deterrence is sufficient to stop all attacks; (ii) the government's pledge is fully credible to all potential hostage takers; (iii) the terrorists' gain from hostage taking derives only from fulfillment of their demands; (iv) there is no uncertainty concerning the costs from having hostages abducted; and (v) the government's costs from making concessions always exceed those of holding firm. Each of these assumptions is suspect in practice. Since there are so many potential hostages to take and a government cannot guard everyone, no deterrent effort can stop all hostage taking. A government's pledge is never fully credible because of past transgressions by earlier governments. The terrorists reason that if they capture the right hostage – e.g., the daughter of a prime minister – then the government will make an exception. If terrorists value publicity and martyrdom, then their failures may have perceived positive returns so that formidable deterrence and maintained pledges will not end all hostage seizures. Moreover, uncertainty is always present because the government does not know beforehand who will be abducted. If a sufficiently valued hostage is seized, then breaking its pledge may be less costly to the government. Thus, time-inconsistent decisions are a real concern. To limit this time inconsistency, a constitutional amendment must eliminate a government's discretion to break its pledge owing to unforeseen circumstances. Policies that make a government value its reputation will also reduce time-inconsistent pledges. Terrorists may try to circumvent these countermoves by abducting a targeted country's hostage abroad, where the venue country is seen as conducting the negotiations.

6. FUTURE DIRECTIONS 1: NETWORKED TERRORISTS

Since 9/11, transnational terrorists are understood to operate in loosely tied networks that include terrorist groups from many countries. In particular, al-Qaida has assembled a global network of Islamic fundamentalist terrorists that includes terrorist groups in Africa, the Middle East, Eurasia, Asia, and elsewhere (Hoffman, 2006, pp. 285-9). The al-Qaida network has been described as a global brand name, a franchise, an umbrella group, or a venture-capital firm (Cronin, 2006; Hoffman, 2006; Sageman, 2004).

Because the main terrorist threat confronting the world is a network, terrorism and counterterrorism research needs to do more to include the network in its theoretical and empirical constructs. One approach to addressing networks has been mathematical, based on graph theory (see, e.g., Farley, 2003). This approach identifies where efforts by the authorities can do the maximal damage to the in-

tegrity of an existing terrorist network. Although this approach is in principle interesting, it begs some key questions. First, the government must discover the network's structure, which the terrorists will try to keep secret. Second, terrorist networks are surely not static, but are continually evolving over time. If the network structure is discovered from seized computers or intercepted communications, then the terrorists have a strong incentive to alter the structure. Even in the absence of such seizures or intelligence, the structure is changing as missions are created and new groups join the network. Third, the terrorists realize that their network is vulnerable and, hence, will keep connectivity loose to limit the importance of linkages (Enders and Su, 2006). The creation of parallel structures and redundancies augments the reliability of the network. Terrorists will compose cells based on long-term friendships and family relationships to inhibit infiltration. Fourth, the terrorists can release false information about their network to direct the authority's efforts to nonexistent or inessential linkages.

As terrorists adjust the connectivity of their network, they face a trade-off between their ability to conduct missions (the benefits of connectivity) and their vulnerability from counterterrorism (the costs of connectivity). These marginal benefits and costs of connectivity have been examined by Enders and Su (2006) in an effort to describe an optimized network that equates these margins. In more recent work, Enders and Jindapon (2008) have included network externalities where cell members gain benefits from friends and family members in tightly knit cells. These benefits are in addition to those from terrorist operations. Enders and Jindapon (2008) also investigated the impact that government countermeasures have on the evolving optimized network. Bringing such strategic aspects into the study of networks is a promising avenue.

In a different approach that does not stress linkage connectivity, Siqueira and Sandler (2008) introduced strategic influences in a study of a global network with four distinct agents: a general terrorist organization (GTO), a local terrorist group in each country, local supporters of the groups, and a targeted government in each country. To include so many agents, the authors devise a three-stage game where there are no more than two active agents at any given stage. In stage 1, the GTO chooses its n representative groups to engage in terrorist activities in n countries. The GTO attempts not only to maximize its global net gains from the terrorist campaign, but also the benefits from its supporters. Stage 2 concerns the terrorism-counterterrorism decisions of the local terrorist group and the targeted government in each country. Each local terrorist group maximizes its net benefits from terrorism, while ignoring local supporters. The host government has its citizen's welfare at heart and minimizes aggregate losses from terrorism and expenses from counterterrorism. Finally, terrorist supporters decide their participation in stage 3 as they maximize their utility while accounting for budget and time constraints.

When the GTO approves local groups, it makes a delegation decision and may choose groups that are more or less bloodthirsty than it. This decision reflects the orientation of the targeted government and the GTO's perceptions of the fervor of the local supporters. If, for example, the GTO views the targeted government to be weak (i.e., reducing counterterrorism efforts in response to added at-

tacks) and supporters to be enthusiastic, then the GTO will dispatch a local group that is more violent than itself. Changes in local government orientation may make the GTO come to regret its choice. Once deployed in the field, the GTO has little ability to recall a local group. Siqueira and Sandler (2008) also showed that when both the GTO and the host government delegate responsibility to surrogates, the delegators may be worse off. Much more work on networks in a strategic framework is needed.

7. FUTURE DIRECTION 2: EVALUATING COUNTERTERRORISM STRATEGIES

Since 9/11, many at-risk governments have allocated increasing funds to counterterrorism without necessarily determining the net payback on their growing expenditures. Between 2003 and 2005, the US Department of Homeland Security budget rose from \$31.18 billion in 2003 to \$40.17 billion in 2005 (Enders and Sandler, 2006, p. 232). The department's request for 2009 is \$50.5 billion. Over 60% of this budget goes to homeland security. No matter what year is consulted, US homeland security spending displays a common trend: expenditures increasing at greater than the inflation rate. Even larger US spending increases are associated with proactive action in terms of spending on intelligence and operations in Afghanistan against the Taliban and al-Qaida. Similar scenarios are true for some other countries confronted by threats from transnational terrorism.

One must wonder how much counterterrorism is enough. At what point, should the share of GDP devoted to counterterrorism stop increasing or even decline? Surprisingly, there have been few studies to investigate this question. As part of the Copenhagen Consensus 2008, Sandler *et al.* (2009) attempted to come up with benefit-cost ratios for various scenarios: (i) business as usual (the post-9/11 actions), (ii) greater international cooperation; (iii) increased proactive measures, and (iv) augmented defensive measures. For each scenario, the authors constructed informed counterfactuals on how many fewer attacks and casualties (deaths and injured) would have resulted. There are three basic drivers for these authors' benefit-cost calculations. On the benefit side, there are the reduced losses in GDP and the fewer casualties from the proposed action; on the cost side, there is the expense of the contemplated action. For business as usual, increase proactive measures, and augmented defensive actions, the payback on extra spending is quite adverse because proactive and/or defensive costs dwarf the tens of billions of US dollars of saved GDP and the mere millions of US dollars gained from fewer casualties. For an average year, only 420 people died in transnational terrorist events and another 1249 were injured; thus, the money saved from reduced casualties are rather modest compared with lost GDP and security spending.

For alternative assumptions, each dollar spent on business as usual returned from 4 to 9.5 cents on a dollar. An increased proactive campaign against al-Qaida had an estimated return of 5 to 12 cents on a dollar, while augmented defensive measures had a better anticipated return of 28 to 30 cents on a dollar. In all three cases, the payback was very disappointing, thus making one think about resource allocation in the "war on terror." The only favorable scenario is international cooperation. The Sandler *et al.* (2009) study needs to be greatly fine-tuned. There

are many ways – e.g., the counterfactuals, the alternative scenarios, and the basic drivers – to improve the calculations. This initial study offers a methodology that can be improved.

8. FUTURE DIRECTION 3: EVALUATING INTERNATIONAL COOPERATION

Another important benefit-cost calculation involves various forms of international cooperation in counterterrorism activity. When nations address the common threat of transnational terrorism, there is a proclivity to spend too little on proactive measures and too much on defensive efforts. As a consequence, we live in an overly defended but unsafe world. These spending tendencies are bolstered by nations that place a high value on their autonomy in regards to security and defense matters. This cooperation failure provides terrorists with safe havens and the means to fund their operations through money transfers in less vigilant nations (Sandler, 2005). International cooperation comes from the International Monetary Fund and related institutions in their efforts to track suspicious money transfers. It also stems from activities of the United Nations to coordinate members' antiterrorism activities. Informal linkages among police forces and intelligence agencies in two or more countries also represent this cooperation. I shall briefly focus on how to evaluate the benefit-cost ratios of coordination actions of INTERPOL.¹

After 9/11, INTERPOL focused some of its crime-fighting efforts in helping countries in their counterterrorism activities. In particular, INTERPOL issues arrest notices and diffusions for suspected terrorists and shares information about terrorist threats and innovations. I-24/7 connects INTERPOL's 187 countries continually to its databases. The Command and Coordination Center of INTERPOL is staffed by analysts who respond to member countries' requests for information. Recently, INTERPOL created Fusion Task Forces to track and assist countries in their capture of suspected terrorists in six defined geographical regions. INTERPOL has gathered an extensive and growing database on stolen and lost travel documents (SLTD) that can be accessed instantaneously by border officials in member countries in order to stop potential terrorists from crossing borders. Other counterterrorism measures of INTERPOL include incident response teams, a weapons and explosives tracking system, a suspected terrorist database, and bioterrorism program. INTERPOL facilitates the antiterrorism activities of member countries through its database, training programs, and best practices workshops. INTERPOL does not arrest terrorists; rather, it facilitates efforts in some of these arrests. Countries' police make the arrests.

In 2008, the INTERPOL budget was 48 million Euros, over 80% of which came from member nations' assessments. The remainder was from voluntary contributions. To uncover the costs of INTERPOL's counterterrorism activities, a researcher must identify the share of the budget going to such efforts. INTERPOL

(1) The work on INTERPOL describes an ongoing project with Daniel Arce and Walter Enders, based on data supplied by INTERPOL.

has six priority areas: (i) public safety and terrorism; (ii) financial and high-tech crime; (iii) trafficking in human beings; (iv) drugs and organized crime; (v) bringing fugitives to justice; and (vi) anti-corruption. Relevant expenditures by INTERPOL on counterterrorism include the budgets of public safety and terrorism division (which pays for the fusion task forces), I-24/7, incident response teams, the Command and Coordination Center, SLTD, and counterterrorism workshops. Since much of this counterterrorism activity is only in the last few years, a benefit-cost analysis is best done for 2006 on.

Benefits are much more difficult than costs to calculate because the former depends on counterfactuals as to the number of incidents and casualties in the *absence* of INTERPOL. One way to proceed is to acquire terrorist arrest data stemming from INTERPOL arrest notices. Each terrorist arrest may, conservatively, result in one less terrorist incident. One can then use databases on transnational terrorist events to ascertain how many people are killed or injured in an average reduced incident. Thus, value of life and injuries calculations can then translate these reduced casualties from arrests (and fewer incidents) into a component benefit figure.

Another benefit is associated with saved GDP losses from fewer incidents. The Blomberg, Hess and Orphanides (2004) empirical model, relating transnational terrorist attack to reduced growth worldwide, can be used to translate fewer incidents from arrests into saved GDP. The sum of the benefit components from reduced casualties and saved GDP must be divided by INTERPOL's counterterrorism costs to produce the sought-after figure. If this ratio is much greater than one, then budget increases for such activities in INTERPOL antiterrorism actions are warranted. Initial calculations have given huge benefit-cost ratios for even the most conservative estimates.

These kinds of counterfactual exercises – though tedious – should be applied to other kinds of joint efforts to address transnational terrorism. Economists have much to offer in guiding policy to high payback activities.

9. FUTURE DIRECTION 4: STRATEGIC ANALYSIS OF SUICIDE TERRORISM

Since the 1983 suicide car bombings of the US Marine barracks and French Paratroopers headquarters in Beirut, suicide bombings have been increasingly used by terrorists to kill and terrorize target populations. The Hezbollah bombings in 1983 demonstrated the effectiveness of such heinous attacks to other terrorists worldwide. Suicide terrorist attacks have been used in Sri Lanka, Israel, Russia, Indonesia, Afghanistan, England, Iraq, and elsewhere. On average, suicide attacks kill eleven times more people than conventional terrorist attacks. (Pape, 2005)

Economists view suicide terrorists as rational agents, provided that their missions further the group's goals. Moreover, perpetrators must view the expected utility of their sacrifice to exceed the expected utility of living. This, in turn, requires the terrorists to value consequences after death. The attacker's expected utility of self-sacrifice can be increased by some of the following: rewards in the afterlife accorded to a martyr (Berman and Laitin, 2005), the prestige and friendship given to the bomber prior to his or her mission (Wintrobe, 2005), the public

good passed to future generations (Azam, 2005), and any payment granted to the bomber's family (Berman and Laitin, 2005).

To date, various player combinations – e.g., terrorist operatives (Azam, 2005), suicide bomber and terrorist group's leader (Berman and Laitin, 2005), the government and the terrorist group (Jacobson and Kaplan, 2007), and the government, the terrorist operatives, and the terrorist group (Bueno de Mesquita, 2005b) – have been included in game-theoretic representations of suicide terrorists. Many crucial ingredients are missing in particular investigations. To succeed, a strategic model of suicide terrorism must possess some key ingredients. First, it must contain a rich set of players that includes the suicide bomber, the group's decision maker, the targeted government, and the public. Given the need for three to four strategic players, at least two stages to the game are needed. Second, the model needs to account for the presence of both suicide and conventional attacks, because no terrorist group relies solely on suicide attacks. How government actions can affect the mix between suicide and conventional terrorist attacks would enlighten policymaking. Third, the analysis must allow for corner solutions with respect to the perpetrator, who is willing to give up life itself. The presence of a corner solution means that governmental policy changes that marginally alter the price of terrorists' actions may have no impact on the suicide bomber; thus, small changes in deterrence that make suicide bombings more difficult may achieve little. Effective policies must either involve large deterrents or else get at the terrorists' motivation. Fourth, targeted countries confront a trade-off between aggressive counterterrorism policies that harden targets but further terrorist group solidarity, and concessions that reduce support for terrorist groups, but leave targets more exposed. If the government applies very harsh measures, then this can result in a backlash and further recruitment of suicide terrorists.

On the empirical side, some notable papers investigated the demand and supply side of suicide terrorists. For example, Benmelech and Berrebi (2007, p. 236) showed that Palestinian terrorist leaders matched “older and more-educated suicide bombers to more important Israeli targets.” In addition, such bombers were less apt to fail logistically, compared with their younger and less-educated counterparts. These interesting findings demonstrate that terrorist leaders are indeed rational when choosing their operatives (Krueger, 2008). In a subsequent study, Benmelech *et al.* (2009) showed that opportunity cost is an essential factor determining the “quality” of terror or the outcome of suicide bombings. During depressed times, Palestinian terrorist leaders were able to recruit better educated individuals to carry out suicide attacks. These studies highlight the importance of the interaction between the suicide bombers and their handlers. They also underscore the importance of the rationality assumption even applied to suicide terrorism.

10. OTHER DIRECTIONS AND CONCLUDING REMARKS

This paper has identified some of the most important economic research findings to date. In deciding the five areas to highlight, I have focused on the most policy-relevant areas. Few would quibble over the importance of studies that have engineered methods for measuring counterterrorism policy effectiveness. A sec-

ond crucial contribution involves studies identifying the economic ramifications of terrorism. Here, disagreement is more likely to concern which particular studies to discuss, since there have been many excellent articles in this study area. Recent studies have enlightened us about the causes of terrorism. Time-series dynamics continue to add to our understanding of terrorism and will continue to do so as this method is refined. Finally, game-theoretic studies have investigated a wide range of policy-oriented topics.

The last half of the paper selectively indicated four areas that deserve further study because of their importance in the current era of fundamentalist terrorists. Many other directions are worth pursuing. For example, experimental economics can enlighten policy choices by governments, confronted by a common terrorist threat. Since proactive and defensive policy choices are analogous to a public good contribution and commons game, respectively, past experiments on these game forms can be modified to study counterterrorism. There are many questions with respect to foreign aid and terrorism. For example, can foreign aid be used effectively by a donor nation to curb a global terrorism threat, as the United States tried to do in its support of Pakistan? In the past, defensive and proactive countermeasures have been examined in isolation. An analysis of the interplay of these two kinds of policies is required, insofar proactive measures affect the need for defensive actions and vice versa (Bandyopadhyay and Sandler, 2008). A rich agenda for future research on terrorism and counterterrorism exists.



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RESUMEN

Este artículo destaca cinco áreas donde el análisis económico del terrorismo ha tenido mayor relevancia en las políticas de los últimos 30 años. Estas áreas son la evaluación de la efectividad de las acciones contra el terrorismo, la identificación de las causas del terrorismo, la medición de las consecuencias económicas del terrorismo, el análisis de la dinámica de las series temporales de actos terroristas y la formulación de representaciones del terrorismo basadas en la teoría de juegos. La principal novedad del artículo es que sintetiza investigaciones anteriores e identifica las cuestiones más importantes en las políticas que requieren un análisis adicional. Estas cuestiones permiten entender cómo operan las redes globales de terrorismo, evaluar los resultados de las estrategias antiterroristas y de formas alternativas de cooperación internacional e investigar los aspectos estratégicos del terrorismo de suicidas. Se ofrece un procedimiento para tratar cada una de estas políticas.

Palabras clave: terrorismo, contraterrorismo, análisis coste beneficio, teoría de juegos, efectividad de las políticas, consecuencias económicas.

JEL classification: D74, H41, H56.