Counterterrorism

A GAME-THEORETIC ANALYSIS

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This article establishes the prevalence of deterrence over preemption when targeted governments can choose between either policies or employ both. There is a similar proclivity to favor defensive counterterrorist measures over proactive policies. Unfortunately, this predisposition results in an equilibrium with socially inferior payoffs when compared with proactive responses. Proactive policies tend to provide purely public benefits to all potential targets and are usually undersupplied, whereas defensive policies tend to yield a strong share of provider-specific benefits and are often oversupplied. When terrorists direct a disproportionate number of attacks at one government, its reliance on defensive measures can disappear. Ironically, terrorists can assist governments in addressing coordination dilemmas associated with some antiterrorist policies by targeting some countries more often than others.

Keywords: *counterterrorism; deterrence; preemption; terrorism; noncooperative game; Nash equilibrium*

Terrorism is the premeditated use or threat of use of violence by individuals or subnational groups to obtain political, religious, or ideological objectives through intimidation of a large audience usually beyond that of the immediate victims.[1] By simulating randomness, terrorists create an atmosphere of fear where everyone feels vulnerable, thereby extending their sphere of influence as far as possible. Suicide missions can heighten this air of anxiety and place greater pressures on governments to capitulate to terrorist demands owing to the greater casualties, on average, associated with such events—thirteen deaths per suicide attack compared with less than one

1. This definition combines essential features of definitions in the literature; see Hoffman (1998, chap. 1) and Schmid and Jongman (1988).

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death per nonsuicide attack (Pape 2003). In this regards, the events of September 11, 2001 (henceforth 9/11), made the public and governments painfully aware of the risks posed by the new breed of suicide and fundamentalist terrorists bent on maximal casualties. Following 9/11, governments have spent tens of billions of dollars on a variety of antiterrorist policies. Since 2002, the budget supporting the newly created U.S. Department of Homeland Security grew by more than 60 percent to $36.2 billion for fiscal year 2004 (Office of Management and Budget 2003).

Counterterrorist policies may involve taking direct actions against terrorists or their sponsors. Such *proactive* policies may include destroying terrorist training camps, retaliating against a state sponsor, infiltrating terrorist groups, gathering intelligence, or freezing terrorist assets. Preemption is the quintessential proactive policy in which terrorists and their assets are attacked to curb subsequent terrorist campaigns. More defensive or passive counterterrorist measures include erecting technological barriers (e.g., metal detectors or bomb-sniffing equipment at airports), fortifying potential targets, and securing borders. These defensive policies are intended to *deter* an attack by either making success more difficult or increasing the likely negative consequences to the perpetrator.[2] Efforts to deter terrorist events often displace the attack to other venues, modes of attack (e.g., from a skyjacking to a kidnapping), countries, or regions, where targets are relatively softer (Drakos and Kutan 2003; Enders and Sandler 1993; Sandler and Enders 2004; Sandler 2003).

By protecting all potential targets, preemption provides public benefits; in contrast, by deflecting the attack to relatively less-guarded targets, deterrence and/or defensive measures impose public costs. The irony arises because nations have a pronounced proclivity to resort to deterrence rather than preemption despite the greater social gains usually associated with the latter. The primary purpose of this article is to apply elementary game theory to explain this tendency. Unlike a recent paper (Sandler and Siqueira 2003) that examines deterrence and preemption in isolation, the current exercise allows governments to choose between these policies or to employ them together. Although we allow alternative game forms to characterize both policies, deterrence is shown to have an unfortunate dominance over preemption, consistent with what is observed in the real world. A second major purpose is to investigate the game structure of other defensive and proactive counterterrorist policies. A variety of game forms are relevant, not only among different antiterrorist measures but also for the same measure under alternative scenarios. The analysis also identifies the circumstances when preemption may result owing to payoff asymmetries between targets or policies.

Game theory is an appropriate tool for investigating counterterrorism because it captures the strategic interactions between terrorists and targeted governments whose choices are interdependent.[3] In so doing, game theory permits a rich range of strategic

2. Our use of *deterrence* follows that in the terrorist literature (Sandler and Enders 2004), in which deterrence limits or restrains a particular action (e.g., metal detectors made hijackings more difficult and greatly reduced attempted hijackings). We do not use *deterrence* in the cold war sense of inhibiting an action necessarily through a threatened punishment.

3. Past articles have applied game theory to evaluate hostage negotiations (Atkinson, Sandler, and Tschirhart 1987; Lapan and Sandler 1988; Sandler, Tschirhart, and Cauley 1983; Selten 1988), terrorists' choice of targets (Sandler and Arce M. 2003; Sandler and Lapan 1988), and terrorists' allocation of resources under asymmetric information (Lapan and Sandler 1993; Overgaard 1994).

		EU Preempt	EU Status quo	EU Deter
US	Preempt	2,2	−2,4	−6,6
US	Status quo	4,−2	0,0	−4,2
US	Deter	6,−6	2,−4	Nash −2,−2

Figure 1: Deterrence versus Preemption: Symmetric Benefits and Costs
NOTE: EU = European Union.

environments and policy choices in keeping with modern-day terrorist threats. Moreover, game theory assumes that each player is rational and must second-guess its adversaries; thus, a government must place itself in its opponents' position before deciding the appropriate strategic response. To decide the best strategy, a government must anticipate not only the actions of terrorists but also those of other governments that might work at cross-purposes or take advantage of another government's action. In today's world of networked terrorists where the threat is global, accounting for these reactions of other governments is essential to the formulation of effective counterterrorist policies.

PREEMPTION OR DETERRENCE: SPECIFIC EXAMPLE

Any strategic analysis of the choice between preemption or deterrence must account for preemption's purely public benefits to all potential targets: direct action against terrorists or their sponsors makes everyone safer.[4] In contrast, a strategic representation of deterrence must account for the costs imposed on the nation that deters an attack as well as the public costs incurred by others from the increased likelihood of having an attack deflected to their soil. The deterrer must not only expend resources to make its territory a less attractive venue but also suffers costs from having its people or property targeted abroad. Deterrence spending is analogous to an insurance policy that is paid regardless of the outcome, but in bad states (when an attack ensues), deterrence curbs the expected damage at home, which is the deterrer's private benefit.

4. Everyone is safer insofar as a weakened terrorist threat means that all potential targets have less to fear. There is, however, a qualification: heavy-handed preemption may create anger and new recruits, thereby jointly producing a public bad (Rosendorff and Sandler 2004). The analysis here holds, provided that the pure public benefit from preemption-induced threat reduction outweighs any associated public costs from new recruits to the terrorist cause. Inclusion of recruitment costs would reinforce our findings that deterrence is favored to preemption.

To illustrate the dilemma posed by counterterrorist policies, we use a specific example in which two targets—the United States and the European Union (EU)—must choose preemption *or* deterrence. Both players can also do nothing, denoted by the status quo. The *passive player is the terrorist group* that is bent on attacking the weaker of the two targets or flipping a coin if neither is weaker. For illustration, each preemptive action provides a public benefit of 4 for the United States and EU at a private cost of 6 to the preemptor. In Figure 1, the preemption game is captured by the northwest 2 × 2 bold-bordered matrix, in which each government can preempt or maintain the status quo. If, say, the United States preempts, then it gains a net benefit of –2 (= 4 – 6) while conferring a free-rider gain of 4 on the EU. These payoffs are reversed if the roles are switched. When both governments preempt, each receives a net gain of 2 as its preemption expense of 6 is deducted from gains of 8 (= 4 × 2) derived from both targets' efforts. Neither country acting gives zero net benefits to both players. This 2 × 2 preemption game is a prisoner's dilemma (PD) with inaction as the dominant strategy since 4 > 2 and 0 > –2. The resulting Nash equilibrium is mutual status quo—(Status Quo, Status Quo)—from which neither target would unilaterally move. This equilibrium is Pareto dominated by mutual action (preemption).

Next, we turn to the 2 × 2 deterrence game displayed by the southeast 2 × 2 bold-bordered matrix in Figure 1, in which the players have two strategies: do nothing or deter an attack at home. In this stylized symmetric example, we assume that deterrence is associated with a public cost of 4 experienced by the deterrer and the other country. The deterrer's costs arise from the action and its potential losses from a deflected attack (say, from its citizens residing abroad), while the nondeterrer suffers the deflection costs of being the target of choice. A deterrer is motivated by private gains of 6 prior to costs being deducted. If, say, the EU deters alone, then it nets 2 (= 6 – 4), while the United States loses 4 by becoming the target of choice. Payoffs are switched when the United States deters alone. Net benefits are zero if neither acts, while each receives a net payoff of –2 [= 6 – (4 × 2)] from mutual deterrence as costs of 8 are deducted from a private gain of 6. Once again, a PD game results. Now, the dominant strategy is action (Deter) rather than inaction, and the Nash equilibrium is (Deter, Deter).

The real issue is which counterterrorism policy dominates if each target can choose either policy or the status quo. This can be addressed by consulting the 3 × 3 matrix of Figure 1 with its two embedded PD games. If one player deters and the other preempts, then the deterrer gains 6 (= 6 + 4 – 4), while the preemptor receives –6 (= 4 – 6 – 4). The deterrer gets a private benefit of 6 from its deterrence and a public benefit of 4 from the other player's preemption but must cover its deterrence cost of 4. In contrast, the sole preemptor suffers a cost of 4 from the other player's deterrence and a cost of 6 from its own efforts but only receives a private benefit of 4 from preempting. The other payoffs in the matrix remain as before.

The dominant strategy is for both players to deter since the payoffs are higher than the corresponding payoffs associated with the other two strategies. As both targets exercise their dominant strategy, the Nash equilibrium of (Deter, Deter) follows. This outcome is like a double PD game in which the smallest summed payoff results—every other strategic combination is socially preferred from an *aggregate* payoff viewpoint. Of the two Nash equilibria of the embedded and overlapping 2 × 2 PD games,

		EU		
		Preempt	Status quo	Deter
	Preempt	$2B-c, 2B-c$	$B-c, B$	$B-c-C, B+b-C$
US	Status quo	$B, B-c$	0,0	$-C, b-C$
	Deter	$B+b-C, B-c-C$	$b-C, -C$	Nash $b-2C, b-2C$

Figure 2: Generalized Deterrence-Preemption Game, 2*B* > *c* > *B* and 2*C* > *b* > *C*
NOTE: EU = European Union.

the Pareto-inferior equilibrium reigns. In the 3 × 3 game, the sum of the payoffs decreases when moving down the columns, but the strategy in the bottom row dominates; similarly, the sums of the payoffs decrease when moving rightward along a row, but the strategy in the right-most column dominates. This outcome is rather fascinating and disturbing; it implies that deterrence wins out over preemption when payoffs mirror one another in that the public versus private roles of benefits and costs are switched.[5] There is an implied resilience to deterrence in this stylized example. Is this example reflective of more generalized situations where benefits and costs do not merely switch roles in terms of values for the two policies, or alternative game forms apply, or players are asymmetric? We now analyze more general representations to address this question.

GENERALIZED DETERRENCE-PREEMPTION ANALYSIS

In this section, the generalized game no longer assumes that the public costs of deterrence equal the public benefits of preemption or that the private benefits of deterrence equal the private costs of preemption. In terms of notation, *B* denotes the public benefits of preemption, *c* represents the private costs of preemption; *C* denotes the public costs of deterrence, and *b* represents the private benefits of deterrence. The (re)actions of terrorists in this model are suppressed because they are consistent with the public aspects of deterrence and preemption produced in conjunction with terrorist activity, as explicitly derived by Sandler and Siqueira (2003) and Sandler and Arce (2003).[6] The generalized game is in Figure 2, where the overlapping 2 × 2 preemption and deterrence games are again highlighted by boldfaced borders. In the northwest 2 × 2 preemption game, the pure publicness of preemption is a key feature. If there is a sole preemptor, then that player affords a free ride worth *B* to the other nation and receives a

5. With an alternative solution concept, such as nonmyopic equilibria in the "theory of moves" (Brams 1994), the Pareto-efficient solution might be achieved. This investigation is left to our future work.

6. Heal and Kunreuther (2005 [this issue]) make a similar assumption in a study that focused only on defensive policies.

net benefit of $B - c$. We initially assume that the costs of preemption exceed the associated benefits so that $c > B$. If both countries preempt, then each receives $2B - c$ as costs are deducted from the benefits derived from the combined actions of the two governments (i.e., B from each preemption for a total of $2B$). To ensure that a PD game results, we must assume that $B > 2B - c$, which again implies that $c > B$. Also, we assume that the payoff from mutual preemption is greater than that from mutual inaction so that $2B - c > 0$.[7] Taken together, the inequality $2B > c > B$ is sufficient to ensure that a PD game characterizes the northwest 2×2 preemption game. The dominant strategy for this embedded game is to do nothing, which results in the Nash inactivity equilibrium with a payoff of (0, 0). The southeast 2×2 bold-bordered matrix indicates the deterrence game, in which payoffs are computed as before. To ensure a PD game, we assume that $2C > b > C$. The dominant strategy of this embedded game is to deter, and the Nash equilibrium is mutual deterrence.

For the 3×3 game, there are also the two strategic combinations in which one player deters and the other preempts. The deterrer then receives $B + b - C$ from the associated public gain from preempting, B, and the private gain from deterring, b, minus the public deterrence costs, C. The preemptor gains the public preemption benefit but must cover the private costs of preempting and the public costs of its counterpart's deterrence for a payoff of $B - c - C$. The two sets of inequalities ensure that the dominant strategy is to deter for both governments so that the Nash equilibrium of mutual deterrence results, which is Pareto inferior to doing nothing or mutual preemption. Thus, this first generalization of the game, denoted as the *baseline* game, does not eliminate the persistence of deterrence.[8]

Because targeted countries may face the same situation in each period, we examine when mutual preemption can be supported in an infinitely repeated game with a discount factor of δ. Suppose that a grim-trigger strategy is employed in which a player begins by preempting but will henceforth switch to deterrence if the other player ever fails to preempt, so that a "deterrence trigger" is employed. Preemption is then sustained if[9]

7. This last inequality also rules out any oscillatory supergame equilibrium in which alternating between the off-diagonal cells does better than mutual preemption. This means that $2B - c > .5B + .5(B - c)$, which implies that $2B > c$.

8. The same bias against proactive policy and reliance on defensive measures is not anticipated for domestic antiterrorist policy because the central government can internalize the public benefit from proactive responses. A weakened domestic terrorist group benefits just the host country, whose taxes can support a proactive campaign. Similarly, a central government can balance the external deflection costs from defensive actions. For transnational terrorism, there is no supranational government that can internalize external benefits and costs from proactive and defensive policies, respectively.

9. To derive this inequality, we must assume that the present value of the perpetual gain from mutual preemption, $(2B - c)/(1 - \delta)$, exceeds the gain from deterring in the first period and then suffering the punishment payoff of mutual deterrence thereafter. This implies that

$$\frac{2B - c}{1 - \delta} \geq B + b - C + (b - 2C)\delta + (b - 2C)\delta^2 + \ldots ,$$

or

$$\frac{2B - c}{1 - \delta} \geq B + b - C - (b - 2C) + \frac{(b - 2C)}{1 - \delta},$$

from which equation (1) follows with some algebra.

$$\delta \geq [(b - C) - (B - c)]/(B + C). \tag{1}$$

Based on equation (1), the smaller is the incentive for unilateral deterrence, $b - C$, and the smaller is the net cost of unilateral preemption, $B - c$, the more likely it is to sustain mutual preemption through a threat-based trigger. This inequality also holds if

$$\delta \geq [(b + c) - (B + C)]/(B + C). \tag{2}$$

which indicates that mutual preemption has a better chance when the sum of public costs and benefits is large compared with the sum of private costs and benefits. Equation (2) highlights that private motivation must be small compared with external influences for a threat-based trigger to induce cooperation. Of course, the sustainability of mutual preemption also hinges on the discount factor being large so that the future is valued sufficiently.

Two problems must be resolved to secure mutual preemption through a threat-based trigger. First, mutual deterrence remains an equilibrium; thus, parties must agree to coordinate and move from deterrence to preemption. Second, sustaining mutual preemption may conflict with the short-run viewpoint taken by governments owing to election periods that limit tenure. The results for the infinitely repeated version of Figure 2 are equivalent to those for a finite, but indefinitely, repeated version where δ is the probability that the current period is *not* the last.[10] If δ represents the probability of reelection, then this may be quite low owing to term limits or other considerations, which then work against sustaining preemption through threat-based triggers. Thus, we must look elsewhere for supporting preemption. Ironically, the lifetime tenure of terrorist leaders supports the widespread cooperation that characterizes terrorist groups since the 1960s.[11]

MUTUAL INACTION IS DISASTROUS

Next, we change one payoff combination in Figure 2—that of mutual status quo, where the two embedded 2×2 games overlap. In particular, we change this payoff to $(-D, -D)$ (not shown in Figure 2) so that mutual inaction is disastrous in the sense that this payoff is less than the sucker payoffs of the embedded preemption and deterrence games. Thus, the payoff, Π, from the mutual status quo must satisfy

$$-D = \Pi(\text{Status Quo, Status Quo}) < \min\{B - c, -C\}. \tag{3}$$

This inequality ensures that the 2×2 preemption game is now a chicken game with pure-strategy Nash equilibria of unilateral preemption. The dominant strategy for the associated 3×3 game is still deterrence with a single Nash equilibrium of (Deter, Deter) that makes at least one player worse off than the equilibria of the embedded 2×2 preemption chicken game.[12] The Nash equilibrium of the embedded deterrence

10. The expected length of such a game is $1/(1 - \delta)$.

11. On terrorist networks, see Alexander and Pluchinsky (1992), Arquilla and Ronfeldt (2001), Hoffman (1998), and Sandler (2003).

12. This equilibrium could make both players worse off than the equilibria of the chicken game if $B - c > b - 2C$, both of which are negative by assumption.

		EU Preempt	Status quo	Deter
	Preempt	$2B-c, 2B-c$	$-c, 0$	$-c-C, b-C$
US	Status quo	$0, -c$	0,0	$-C, b-C$
	Deter	$b-C, -c-C$	$b-C, -C$	$b-2C, b-2C$

Figure 3: Deterrence and Threshold Preemption Game, $2B > c > B$ and $2C > b > C$
NOTE: EU = European Union.

game wins out over those of the embedded preemption game. Thus, the persistence of deterrence is again demonstrated.

DETERRENCE AND THRESHOLD PREEMPTION GAME

To further study the resilience of the mutual deterrence equilibrium, we now tie the countries' interests for preemption closer together by assuming a threshold preemption game in which benefits of B per preemption effort are only realized once there are two preemptors. This suggests that a sufficient effort must be expended or else nothing is achieved. Thus, a token operation such as the U.S. retaliatory raid on Libya in April 1986 may have no lasting impact—an outcome later demonstrated by empirical analysis (Enders and Sandler 1993). In Figure 3, two payoffs change in the northwest 2×2 matrix as compared with Figure 2—a sole preemptor only incurs costs of c, and there are no free-rider benefits. This embedded preemption matrix is an assurance or stag hunt game in which players will match actions at the Nash equilibria: either both preempt or both maintain the status quo. Strategy choices must be coordinated. The 2×2 embedded deterrence game remains unchanged.

For the 3×3 game, we must also alter the payoffs associated with (Deter, Preempt) and (Preempt, Deter) in Figure 3. If the United States deters and the EU preempts, then the United States gains $b - C$, and the EU endures the public costs of U.S. deterrence and the private costs of its own preemption. The EU receives no benefits from its preemption because the threshold has not been attained. In the upper right-hand cell of the matrix, the roles and payoffs are reversed. Deter still dominates over the status quo but may not dominate over preempt. The strategic combination (Deter, Deter) *remains* a Nash equilibrium. If $2B - c \geq b - C$, then (Preempt, Preempt) is a second Nash equilibrium. This inequality requires that mutual preemption provides payoffs at least as large as those from deterring alone. It also implies that the sum of public benefits and costs of preemption and deterrence, $2B + C$, exceeds the corresponding sum of private benefits and costs, $b + c$. If we use the benefits and costs underlying Figure 1, we get

		EU Preempt	Status quo	Deter
	Preempt	$3B-c, 2B-c$	$2B-c, B$	$2B-c-C, B+b-C$
US	Status quo	$B, B-c$	0,0	$-C, b-C$
	Deter	$B+b-C, B-c-C$	$b-C, -C$	$b-2C, b-2C$

Figure 4: Asymmetric Deterrence-Preemption Game, $2B > c > B$ and $2C > b > C$
NOTE: EU = European Union.

$2B - c = 2 = b - C$, so that deter weakly dominates preempt, and the likely equilibrium is (Deter, Deter), which is Pareto inferior to (Preempt, Preempt). Unless payoffs really favor preemption, mutual deterrence is anticipated.

ASYMMETRIC PREEMPTION

Countries that have engaged in preemption have one major commonality: they have attracted the lion's share of terrorist attacks. Thus, Israel is known for attacking terrorist groups and their infrastructure in the hopes of weakening them. Since 9/11, the United States has also greatly increased its preemptive actions against terrorists. U.S. action is understandable given that approximately 40% of transnational terrorist attacks are directed at U.S. people and property (Sandler 2003, Table 1). For *domestic* terrorism, countries engage in preemption because limiting such attacks solely benefits them. For transnational terrorism on home soil, governments have been more aggressive at pursuing groups that pose a significant threat to domestic interests (e.g., Red Brigades in Italy, Direct Action in France, and Red Army Faction in West Germany) and have done little to crush groups with little risk to domestic concerns (e.g., November 17 in Greece).

To model asymmetric gains from preemption, we alter the baseline game so that the United States receives greater benefits from its own preemption than it confers on the EU. In particular, U.S. preemption yields a benefit of $2B$ to itself and a spillover benefit of B to the EU at a cost of c to the United States. EU preemption still provides a public benefit of B at a preemption cost of c. Deterrence remains as before: each deterrer receives private benefits of b and confers a public cost of C to both countries. We again assume the same two sets of inequalities indicated in the caption to Figure 4.

In Figure 4, the 2×2 deterrence PD game has the same payoffs as in the baseline game of Figure 2. If the United States preempts alone, it now receives $2B - c$ while still conferring a free-rider benefit of B on the EU. Compared with the baseline game, the asymmetry adds B to each of the U.S. payoffs in the top row—all other payoffs remain unchanged. The EU still has a dominant strategy to deter, so that the only possible

Nash equilibria must be (Preempt, Deter) or (Deter, Deter) in the right-hand column. The former is the equilibrium if $2B - c > b - C$, so that the United States gains more from preempting alone than from deterring alone. In fact, satisfaction of this inequality makes preempt the dominant strategy for the United States. After 9/11, this inequality likely held for a preferred-target country such as the United States since deterring alone merely transfers the attack abroad where its people and property are still attacked, thus greatly limiting U.S. gains from relying on deterrence alone. Target asymmetry can explain the current state of affairs with the United States using preemption and deterrence, while less-preferred targets engage in just deterrence. As terrorists display less bias for a single target, there is less apt to be a preemptive response. It is asymmetric targeting by terrorists that induces countries to resort to preemption. The relevant asymmetry involves whose assets are targeted and not where they are targeted—an attack against Israelis in Kenya will be viewed by the Israeli government as an attack against Israel.

DOING BOTH

Next, we allow for a fourth strategic choice of doing both preemption and deterrence. The payoffs for preempting and deterring are those of the baseline game. The relevant 4×4 game matrix is displayed in Figure 5, in which the northwest bold-bordered 3×3 matrix is that of the baseline game. There are four new payoff combinations. If, for example, a government does both policies unilaterally, then it receives $B - c + b - C$ and provides the other government with a net payoff of $B - C$. When one government does both and the other just preempts, the first receives $2B - c + b - C$, and the preemptor gets $2B - c - C$. The other two payoff combinations are computed similarly.

Deterrence dominates if it provides a player a higher payoff than doing both when the other player does both, that is, $B + b - 2C \geq 2B - c + b - 2C$. This inequality reduces to $c \geq B$, which is clearly true for our example because $c > B$ by assumption. The persistence of deterrence is again displayed. Thus we are led back to the realization of the last section that asymmetric preemption benefits are often essential to stem this tendency. In short, preemption benefits must outweigh associated costs if targeted government such as the United States is to engage in both deterrence and preemption against a terrorist threat. Only those countries experiencing a disproportionate number of attacks may fall into this category. All others will rely on deterrence and hope that some prime target will privilege them to some purely public preemption benefits.

OTHER PROACTIVE AND DEFENSIVE COUNTERTERRORIST POLICIES

Thus far, we have shown that for the choice between preemption and deterrence, there is a marked tendency to rely on Pareto-inferior deterrence. Preemption abides by a variety of game forms—PD, chicken, assurance (threshold), asymmetric domi-

US \ EU	Preempt	Status quo	Deter	Both
Preempt	$2B-c, 2B-c$	$B-c, B$	$B-c-C, B+b-C$	$2B-c-C, 2B-c+b-C$
Status quo	$B, B-c$	$0, 0$	$-C, b-C$	$B-C, B-c+b-C$
Deter	$B+b-C, B-c-C$	$b-C, -C$	$b-2C, b-2C$	$B+b-2C, B-c+b-2C$
Both	$2B-c+b-C, 2B-c-C$	$B-c+b-C, B-C$	$B-c+b-2C, B+b-2C$	$2B-c+b-2C, 2B-c+b-2C$

Figure 5: Four-Strategy Deterrence-Preemption Game, $2B > c > B$ and $2C > b > C$
NOTE: EU = European Union.

nance, and others indicated below—while deterrence typically adheres to a PD game. The issue here is whether these tendencies also characterize other proactive and defensive counterterrorism policies.

PROACTIVE POLICIES

In Figure 6, we display the game-theoretic aspects of four additional proactive policies. Each two-player, normal-form game is in ordinal (rank-ordered) form, where the largest number (i.e., 4) in the cells is the best payoff, and the smallest (i.e., 1) is the worst payoff. Consider two governments contemplating freezing terrorist assets, shown in panel *a*. Each government has two choices: to freeze assets or not to freeze assets. If a weakest-link situation (Hirshleifer 1983) applies, then nothing is accomplished unless both players take action—sole action merely induces the terrorists to put assets in the other country. The best payoff for each government arises when both freeze assets, thus eliminating a safe haven for the terrorist assets. The worst payoff is received by the government that freezes assets unilaterally since it suffers an economic loss without any safety gain. The government that does nothing then gets the second-greatest ordinal payoff of 3 from the banking profits derived from doing business with the terrorists. This latter government does not get a free ride because no safety is achieved—the lowest level of action determines the safety of everyone in a weakest-link scenario. The second-lowest payoffs are associated with mutual inaction. There are then two Nash equilibria—mutual freeze and mutual inaction—indicated by the cells with boldfaced payoffs. With a weakest-link situation, leadership by one country can coordinate efforts. If, therefore, the United States freezes assets, the EU is better off matching U.S. resolve because the EU prefers a payoff of 4 over 3.

When the noncooperating country is not worried about terrorist attacks and can gain greatly by sequestrating terrorist funds, then its ordinal payoffs in the off-diagonal cells change from 3 to 4—the temptation payoff—and the mutual action payoffs change from 4 to 3. A PD game results with a no-action equilibrium. Like preemption, freezing assets can be associated with numerous game structures such as PD, chicken, assurance, and asymmetric dominance. Asymmetric dominance applies when one country confronts a greater terrorist threat and achieves some protection from unilateral action. Given the strategic similarity between preemption and freezing assets, a country that must choose between freezing assets and deterrence will favor deterrence unless there is a significant asymmetry or a weakest-link consideration motivates cooperation.

Next, consider the proactive policy of retaliating against a state sponsor of terrorism. This policy has virtually the same strategic structure as preemption and is often a PD game. It is a chicken game if mutual inaction results in a spate of terrorist attacks in which the status quo is the worst outcome. In panel *b* of Figure 6, we characterize the United States as the prime target of a state sponsor, so that it has a dominant strategy to retaliate (4 > 3 and 2 > 1), while the EU has a dominant strategy not to retaliate. When both targets exercise their dominant strategy, the Nash equilibrium (whose payoffs are boldfaced) results, with the United States retaliating unilaterally. Retaliation may also abide by a threshold assurance game. Once again, a policy choice between retaliation

		EU: Freeze	EU: Does not
US	Freeze	**4,4**	1,3
	Does not	3,1	**2,2**

a. Freezing assets: weakest link

		EU: Retaliate	EU: Does not
US	Retaliate	4,3	**2,4**
	Does not	3,1	1,2

b. Retaliation: asymmetric dominance

		EU: Gather	EU: Does not
US	Gather	2,2	**4,3**
	Does not	**3,4**	1,1

c. Intelligence: hero

		EU: Infiltrate	EU: Does not
US	Infiltrate	2,2	**3,4**
	Does not	**4,3**	1,1

d. Infiltration: leader

Figure 6: Some Alternative Proactive Policies and Their Ordinal Game Forms
NOTE: EU = European Union.

and deterrence is apt to favor deterrence. After 9/11, the U.S.-led attack against the Taliban, who harbored al-Qaida, follows this pattern, with most European countries responding by tightening security to deter attacks.

We now turn to two proactive policies that can be associated with a quite different strategic structure than the proactive policies considered thus far. In the case of gathering intelligence, the ordinal-payoff matrix for a two-government scenario may correspond to panel *c* of Figure 6. Each government must decide whether to gather intelligence on a terrorist threat or group. The intelligence game gives the greatest advantage to the government that gathers the information and the second-greatest payoff to the free rider. The gatherer achieves some additional benefit from being in control of the information that is not obtained by the free rider. In a world of globalized terror, the informed government will want to share much of its intelligence to protect its country's citizens and assets abroad. If both governments gather the same intelligence, there is wasted effort, and each may jeopardize the other's covert operation. Thus mutual action may result in the second-lowest payoff. Finally, mutual inaction leaves both governments vulnerable, and this gives the lowest payoff. In panel *c*, the resulting equilibria are the two off-diagonal cells in which just one country gathers the intelligence. This game structure is known as "hero" (Coleman 1999) because the player who unilaterally moves away from the maximin solution of mutual gathering is a hero by taking a lower return while conferring a higher return on the other player. Hero is a coordination game in which players must coordinate their choices or else be saddled with undesirable outcomes. This coordination requires a loss in autonomy that nations have often been unwilling to display on security matters except in the direst of circumstances. Furthermore, there is no room for two heroes as two heroes result in the smallest payoffs.

If payoffs from intelligence are asymmetric because terrorists' targeting decisions focus on some governments, then an asymmetric-dominance scenario may arise. In this case, the coordination dilemma is solved by the likely target providing intelligence for itself and others. Ironically, the terrorists can greatly assist governments in addressing the coordination dilemma by having favorite targets that attract a disproportionate share of attacks. As for other proactive policies, asymmetries may be essential if governments are to engage in intelligence gathering *and* deterrence and not rely on deterrence. Another asymmetry may arise from capacity when one country is better equipped than the other for the mission. The latter may then be willing to let its counterpart gather the intelligence. For choices involving intelligence and deterrence, the relatively high payoffs for both players mean that intelligence may win out when a decision between them must be made. In situations where doing both is an option, one or more players may do both, which again brings up a coordination problem.

In panel *d* of Figure 6, strategic aspects of infiltrating a terrorist group are indicated in a 2×2 game representation. Taking the action outweighs the costs but not relative to the net gain of free riding, which is associated with the greatest ordinal payoff. The second-smallest payoff arises when both governments infiltrate a terrorist group because mutual action may jeopardize the other government's operation. Agents may be killed if governments do not know of their counterpart's action. Moreover, resources are wasted since nothing is gained from duplicating the mission. The smallest payoffs arise from mutual inaction. The game is known as "leader," in which the player who moves away from the maximin solution of mutual action receives the greatest gain (Coleman 1999). The two Nash equilibria are again the off-diagonal cells with the boldfaced payoffs, in which one government infiltrates and the other free rides. As in the case of hero, coordination is required or else low-paying diagonal cells will be reached. The coordination can be provided de facto if one target has insufficient capacity or expertise to provide infiltration. Coordination is also not an issue when one country perceives a much greater threat from the group, so that an asymmetric dominance applies as in panel *b*. If infiltration abides by a leader game, then extending the analysis to allow infiltration to be chosen along with deterrence may lead to equilibria with both being chosen, as in the case of intelligence.

A final proactive policy concerns the development of new counterterrorism technologies (e.g., bomb-sniffing devices, plastic explosive tags, and new databases). Such actions are "best-shot" public goods for which the greatest effort determines the provision level (Hirshleifer 1983). Suppose that each of two governments can discover the new technology. Further suppose that the technology gives 6 in benefits to everyone once discovered but provides no additional benefits for a redundant discovery. The cost of discovery is, say, 4. If one computes the cardinal payoffs, they are (2, 6) and (6, 2) in the off-diagonal cells and (2, 2) and (0, 0) along the main diagonal. The greatest payoff is gained by the free-riding government when the other government achieves the technological breakthrough. In ordinal form, the game is that of panel *c* in Figure 6, provided that the 4s are changed to 2s. The Nash equilibria are the off-diagonal cells in which only one government acts; coordination is required to avoid duplication, not unlike intelligence or group infiltration.

A number of findings are associated with proactive policies. First, most proactive policies are purely public goods. If governments' proactive policies are cumulative (i.e., actions add to the total level achieved rather than weakest link, threshold, or best shot), then a PD game applies, and inaction is the dominant strategy. Second, a variety of game forms can characterize the same proactive policy owing to alternative ways that effort levels of the governments are aggregated. Third, coordination games figure prominently, meaning that some communication and joint efforts are necessary to avoid wasteful duplication. Fourth, asymmetric targeting by terrorists can motivate action by a government to privilege the rest of the governments with benefits from its response.

DEFENSIVE POLICIES

Defensive policies include deterrence in which a PD game applies and the dominant strategy is to deter. Deterrence can result in a "deterrence race" whereby action by one potential target induces another target to take similar steps to reduce the terrorists' likelihood of success or their payoffs. A race occurs because failure to act makes a government a soft target that will draw an attack. Another defensive policy is to harden a target (e.g., fortifying embassies and diplomatic missions). Such security upgrades again deflect an attack to other less fortified targets, thereby inducing potential targets to compete in terms of fortification. Once again, a PD game applies. Both deterrence

TABLE 1
Policy Choices and Underlying Games

Policy Type	*Alternative Game Forms*
Proactive policies	
Preemption	Prisoner's dilemma, chicken, assurance (threshold), coordination (best shot), asymmetric dominance
Freezing assets	Prisoner's dilemma, chicken, asymmetric dominance, assurance (weakest link)
Retaliation	Prisoner's dilemma, chicken, assurance (threshold), coordination (best shot), asymmetric dominance
Group infiltration	Leader, asymmetric dominance
Intelligence	Hero, asymmetric dominance
New technological barriers	Coordination (best shot)
Defensive policies	
Deterrence	Prisoner's dilemma (deterrence race)
Hardening targets	Prisoner's dilemma (fortification race)
Shoring up weakest link	Prisoner's dilemma, chicken, asymmetric dominance

and security enhancement are instances of "strategic complements" whereby action by one government encourages similar actions by another government.

A somewhat different defensive scenario characterizes efforts to shore up a weakest-link or vulnerable country. Countries have an interest in bolstering such countries' defensive measures because foreign residents are in harm's way as terrorists use "soft" venues to hit other countries' assets. Thus, one of the four pillars of U.S. counterterrorism policy is to offer assistance to countries whose capacity is inadequate to counter terrorism (U.S. Department of State 2003). Shoring up vulnerable targets abroad is a pure public good in which inaction is a dominant strategy unless a country's assets are the targets of choice. Thus, shoring up the weakest link gives rise to a PD game, chicken game (if doing nothing is disastrous), or asymmetric dominance. In contrast to the other two defensive actions, efforts to achieve an acceptable security standard abroad yield purely public benefits. As such, this defensive policy has much in common with proactive policies of preemption, freezing assets, and retaliating against state sponsors.

CONCLUDING REMARKS

By way of summary, Table 1 lists six proactive and three defensive counterterrorism policies along with their corresponding game forms. Counterterrorism policies fall in four classes: PD scenarios with public benefits in which too little action follows, PD scenarios with public costs in which too much action follows, coordination games (e.g., assurance, best shot, leader, and hero) in which bad outcomes must be avoided, and asymmetric dominance in which a prime target provides protection for all. When compared to defensive measures, proactive counterterrorist policies display the greater variety of underlying game forms, which implies a richer set of policy responses. Efforts to facilitate more appropriate responses must be tailored to the associated strategic structure (e.g., with asymmetric dominance, no policy intervention may be needed if the acting country responds sufficiently for all, while for a chicken game, responses must be coordinated to avoid a disastrous outcome).

Earlier, we examined the choices between preemption and deterrence and demonstrated the resilience of deterrence even though the associated Nash equilibrium was the worse of the two embedded PD games. When a proactive policy such as retaliation is combined with a defensive policy such as hardening targets, the associated 3×3 game has target hardening being the dominant strategy, analogous to the preemption-deterrence choice. For the pattern of benefits and costs examined here, defensive policies of deterrence and hardening targets generally dominate many proactive policies, except for intelligence and infiltration. For the latter two policies, equilibria involve a coordination of efforts to avoid wasteful duplication or nations working at cross purposes. This coordination requires better communications between intelligence organizations or some type of signaling mechanism to indicate whose turn it is to act.

Many proactive policies yield purely public benefits in which free riding is a problem. In contrast, most defensive policies give private benefits and public costs, with countries competing to match one another's actions to not draw the attack. Governments are predisposed to engage in too little proactive effort and too much defensive effort—thus the general prevalence of the latter. Proactive policies are encouraged primarily by asymmetric targeting, in which a few nations draw a larger share of the attacks. This asymmetry raises these countries' net benefits from proactive measures that can potentially reduce the terrorist threat for everyone. Thus, asymmetric targeting works against terrorists' interests. *When asymmetries are sufficiently great, a nation will engage in both proactive and defensive actions*. A more optimal response may ensue if the international community fosters the prime target's proactive responses through subsidies or other support. Too much reliance on a prime target may lead to either fatigue or the pursuit of an agenda not in keeping with other countries' interest; thus, free riding has its own costs.

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