Global terrorism: deterrence versus preemption

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Abstract

This paper analyzes two anti-terrorism policies when a targeted nation's people and property are in jeopardy at home and abroad. A country's deterrence decision involves both external benefits and costs as the terrorist threat is deflected, while its preemption decision typically gives external benefits when the threat is reduced for all potential targets. With damages limited to home interests, a country will overdeter, while, for globalized terror, a country will underdeter. Preemption is usually undersupplied. Leader-follower behavior is apt to lessen inefficiency for deterrence, but worsens inefficiency for preemption as compared with simultaneous-choice equilibrium allocations. Targeted nations can never achieve the proper counterterrorism policy through leadership. *JEL* Codes: H40, D62

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1. Introduction

Since the Israeli-Arab conflicts of the late 1960s and beyond, transnational terrorism (i.e., terrorist attacks involving victims, perpetrators, or audiences from two or more countries) have posed worldwide security concerns (Hoffman 1998) that are highlighted by the London subway bombing on 7 July 2005, the Madrid commuter train bombing on 11 March 2004, the Bali nightclub bombing on 12 October 2002, and the four hijackings on 11 September 2001 (henceforth, 9/11). Decentralized counterterrorism measures by autonomous national governments to deter attacks by hardening targets at home or to preempt future terrorist actions by annihilating the terrorists, their supporters, and resources result in transnational externalities with diverse outcomes. Although one may jump to the conclusion that underprovision of effort is likely to characterize such measures owing to an underlying provision of an international public good (e.g., Lee 1988; Lee and Sandler 1989; Rosendorff and Sandler 2004), the situation is more complex so that intuition may be misleading. The nature of externalities stemming from counterterrorism depends on the governments' payoff functions and how they account for repercussions at home and abroad. That is, homeland security may protect not only citizens but also foreign visitors, while such measures may jeopardize other countries' assets by deflecting a potential attack abroad. Recent empirical investigations demonstrate that defensive actions taken by some targeted countries have transferred the attacks abroad (Enders and Sandler 1993, 2004, 2006a, b).

The purpose of this paper is to gain an understanding of countermeasure externalities because, despite some examples of cooperation to freeze assets or to share information, homeland security budgets and preemptive responses are still decided independently by nations that cherish their autonomy (Sandler and Enders 2004). Consequently we may either end up in an unsafe world where too little of an international public good is provided, or else in an excessively defended one where too much is invested to shift attacks abroad. When decisions are simultaneous, deterrence may be too much or too little compared with the social optimum, depending on the relative magnitude of opposing deterrence-induced externalities. Preemption, in contrast, will typically be undersupplied as compared with the social optimum. The extent of overdeterrence or underdeterrence generally diminishes when a leader-follower equilibrium is compared with that of simultaneous moves. Although all targeted nations benefit from a leader's deterrence decisions, a nation is relatively better off moving second. We are interested in such leader-follower responses because spectacular attacks at home may necessitate that a targeted country (e.g., the United States following 9/11 or England following the subway bombings) assume the initiative. Under these circumstances, we investigate how such positions influence the internalization of counterterrorism externalities. Leadership typically exacerbates the inefficient level of preemption as decisive action by one targeted country can result in a reduced level of overall preemption when compared with the equilibrium allocation of simultaneous actions. Deterrence often represents strategic complements where actions by targeted countries move in unison, while preemption represents strategic substitutes where actions by targeted countries move in opposite directions.

2. Toy game representations

Terrorism is the premeditated use, or threat of use, of extra-normal violence by individuals or subnational organizations to obtain a political objective through intimidation or fear directed at an audience beyond the immediate victim. Generally, a terrorist act is transnational when its ramifications transcend the host country where the act is staged. Policies directed at thwarting such incidents are prone to generate uncompensated interdependencies among at-risk countries, because actions to address the exigency may either ameliorate the risks to all or deflect the attack elsewhere. Astute terrorists will not only exploit the failure of governments to cooperate by attacking the weakest link (e.g., the least-secure airport), but will also exacerbate this noncooperative inefficiency by playing alternative targets off against one another. Globalization heightens the risk of transnational terrorism owing to the greater mobility of terrorists, better communication networks among terrorists, enhanced means to publicize terrorist causes, and the greater dispersion of countries' assets and people.

If one were to display the deterrence and preemption games as 2×2 normal-form matrices, both games are apt to be a Prisoners' Dilemma (PD) for the targeted nations (Arce and Sandler 2005). This follows because the deterrence game is analogous to an arms race when external costs dominate, with each country best off when it deters and the other does not. For preemption, a PD is also likely owing to the public good nature of such action, where each nation is best off when it can free ride on the other nations' action. To illustrate, consider figure 1. In panel a, a 2×2 generic deterrence game is depicted where nation 1 is the row player and nation 2 is the column player. This representation is reflective of other defensive countermeasures. Deterrence by just nation i gives it a benefit of b at a cost of C, in which $b > C$ so that a country is motivated for self-defense. Moreover, passive country j endures a cost of C_j as it draws more attacks, since it becomes a relatively softer target in light of i's defensive measures. No action by either nation gives no net gain, while mutual action provides each nation a negative payoff of $b - (C + C_i)$, for $i = 1, 2$, as private and external costs overwhelm private gains. Obviously, the dominant strategy of this PD is to deter and a Nash equilibrium of mutual deterrence with negative payoffs results.

[Figure 1 near here]

Alternatively, panel b of figure 1 displays the generic preemption game, where each of two targeted nations can preempt or maintain the status quo. If, say, nation 1 preempts while nation 2 does not, then nation 1 gains a net benefit of $B - c$ as it deducts its private preemption costs of c from the public benefit of B that it receives along with nation 2. Thus, nation 2 obtains a free-rider benefit of B in the upper right-hand cell. A reversal of roles reverses payoffs. If both countries preempt, then each gains $2B$ from the cumulative action at an individual cost of c, so that net gains are $2B - c$ for both. Payoffs are zero from all-around inaction. The public good dilemma is aptly captured by assuming that $2B > c > B$ so that acting alone is not desirable but mutual activity is desirable. Again, a PD applies. Each country's dominant strategy is now to do nothing and the Nash equilibrium is mutual inaction.

The potential identity of the underlying 2×2 matrices may lead one to conclude that these countermeasures require the same policy corrections. As our continuous-choice analysis demonstrates, this conclusion could not be further from the truth – policy implications differ greatly for these terrorism-thwarting decisions. As the game is generalized, differences arise that not only apply to a simultaneous-move representation, but also to a leader-follower representation.

3. The deterrence decision

To highlight the similarities and differences between the deterrence and preemption decisions for two countries confronting a transnational terrorist threat, we construct a single game model that can be adapted by some parameters to represent either counterterrorism instrument. In so doing, we limit notation. We first focus on deterrence efforts to harden potential targets.

The model involves two governments (countries) that are targeted by the same terrorist group or network. Targeted governments are denoted by $i = 1, 2$. In any given period, the terrorists can stage their attack in just a single country, known as the *host* country. For example, al-Qaida may engage in simultaneous attacks but typically in the same country during the same period. This assumption agrees with how most groups operate owing to limited resources. Each country is vulnerable at home and abroad, insofar as an attack anywhere may involve residents or foreigners. Government *i* first chooses its policy instrument or effort to raise the probability of a terrorist failure at home, denoted by θ_i. Thus, $1-\theta_i$ represents the probability of a terrorist success in country *i*. Government *i* decides its expenditure level on deterrence $G(\theta_i)$, where $G'(\theta_i) > 0$ and $G''(\theta_i) > 0$. We treat the terrorist threat as exogenous and focus on the strategic interactions between the targeted governments. The probability that government *i* is attacked is given by $\pi_i(\theta_i, \theta_j)$, which for deterrence satisfy $\partial \pi_i / \partial \theta_i < 0$ and $\partial^2 \pi_i / \partial \theta_i^2 > 0$, so that defensive measures limit the likelihood of a home attack with diminishing returns to effort. However, greater deterrence by country *j* augments the probability of an attack on country *i*, but at a decreasing rate: $\partial \pi_i / \partial \theta_j > 0$ and $\partial^2 \pi_i / \partial \theta_j^2 < 0$. Finally, country *j*'s deterrence will reduce (increase) the marginal impact of country *i*'s action to limit the probability of being attacked when *j*'s efforts are greater (less) than that of *i*'s efforts so that $\partial^2 \pi_i / \partial \theta_i \partial \theta_j \gtreqless 0$ as $\theta_i \lesseqgtr \theta_j$. When each country's efforts are equal, the value of the cross partials is zero. The assumptions on π hold for *i*, *j* = 1, 2 and $i \neq j$. In today's world of fundamentalist terrorists, there is always a likelihood of attack even when both countries are heavily defended. The model, however, captures the real-world observation that terrorists favor softer targets (Enders and Sandler 1993). Unless otherwise indicated, we assume symmetry such that $\pi_i(\theta_i, \theta_j) = \pi_j(\theta_j, \theta_i)$.

The game has four alternative outcomes: the attack succeeds or fails in country *i* = 1, 2. In addition to the deterrence costs that each country pays in any of these eventualities, each country incurs costs from the attack at home or abroad as its people or property may be in harm's way. For simplicity, we have made payoffs symmetric, so that the costs of a failed (successful) attack in a *host* country are A (H), where $H > A$ as failure limits damage to the venue country. We use lower-case analogous symbols, a and h, for the costs to country i from a terrorist attack failure (success) abroad, where $h > a$.

3.1. Government costs functions

Country i's expected damage from a home attack is $l(\theta_i)$, while i's expected damage from an attack on its interests abroad is $v(\theta_j)$. This is captured in (1)-(2):

$$l(\theta_i) = \theta_i A + (1 - \theta_i) H \tag{1}$$

and

$$v(\theta_j) = \theta_j a + (1 - \theta_j) h. \tag{2}$$

Given the assumptions on the cost parameters, $l(\theta_i)$ decreases as θ_i increases and $v(\theta_j)$ decreases as θ_j increases, because expected damages fall as terrorist failure is more imminent. Given (1)-(2), the expected costs of terrorism for government i is:

$$C_i(\boldsymbol{\theta}) = G(\theta_i) + \pi_i l(\theta_i) + \pi_j v(\theta_j), \tag{3}$$

where $\boldsymbol{\theta} = (\theta_i, \theta_j)$ and an interchange of the i's and j's would give country j's costs. Country i's expected costs derive from three considerations: deterrence expenditure, attacks at home, and attacks on i's interests abroad.

The simultaneous-move equilibrium follows when country i chooses θ_i to minimize its expected costs, subject to the constancy of θ_j, while country j chooses θ_j, subject to the constancy of θ_i. For either country, the first-order condition requires that

$$\frac{\partial C_i}{\partial \theta_i} = G'(\theta_i) + \pi_i l'(\theta_i) + l(\theta_i)\frac{\partial \pi_i}{\partial \theta_i} + v(\theta_j)\frac{\partial \pi_j}{\partial \theta_i} = 0, \quad i,\ j = 1, 2, \text{ and } i \neq j. \tag{4}$$

On the right-hand side of (4), the first and fourth terms represent the costs of increasing θ_i (coming from greater deterrence expense and the expected damage of deflecting an attack abroad to i's *own interests*), while the second and third terms represent the benefits of increasing θ_i (arising from the reduced expected costs and the smaller likelihood associated with home attacks).[1] Second-order conditions require that $\partial^2 C_i / \partial \theta_i^2 > 0,$ which we assume holds.[2] Given the presence of externalities, independent behavior by the governments are unlikely to give a cost minimum for society at large, where $C^T = C_i + C_j$ is minimized, in which

$$C^T = G(\theta_i) + G(\theta_j) + \pi_i(\boldsymbol{\theta})\left[l(\theta_i) + v(\theta_i)\right] + \pi_j(\boldsymbol{\theta})\left[l(\theta_j) + v(\theta_j)\right]. \tag{5}$$

Minimization of C^T yields a Pareto optimum whose equilibrium choice variables are denoted by $\boldsymbol{\theta}^* = (\theta_i^*,\ \theta_j^*)$ in contrast to the simultaneous-action noncooperative solution indicated by $\boldsymbol{\theta}^{\mathrm{N}} = (\theta_i^{\mathrm{N}},\ \theta_j^{\mathrm{N}})$, which satisfies (4). The Pareto first-order conditions for minimizing C^T are:

$$\frac{\partial C^T}{\partial \theta_i} = G'(\theta_i) + \pi_i\left[l'(\theta_i) + v'(\theta_i)\right] + \left[l(\theta_i) + v(\theta_i)\right]\frac{\partial \pi_i}{\partial \theta_i} + \left[l(\theta_j) + v(\theta_j)\right]\frac{\partial \pi_j}{\partial \theta_i} = 0, \tag{6}$$

and a similar expression for $\partial C^T / \partial \theta_j$, where the i's and j's are switched as compared with (6).[3]

The nature of the opposing externalities is clear when the noncooperative first-order conditions are compared with those for the cooperative solution. Evaluation of the first-order conditions for the cooperative problem *at the simultaneous-move Nash equilibrium* yields:

$$\pi_i v'(\theta_i^{\mathrm{N}}) + v(\theta_i^{\mathrm{N}})\frac{\partial \pi_i}{\partial \theta_i} + l(\theta_j^{\mathrm{N}})\frac{\partial \pi_j}{\partial \theta_i} \gtreqless 0, \quad \text{for } i, j = 1, 2, \text{ and } i \neq j. \tag{7}$$

The first term on the left-hand side of (7) is a marginal external benefit, conferred by government i's deterrence on protecting j's citizens when they are in country i. Similarly, the second left-hand expression in (7) is a marginal external benefit conferred by *i*'s deterrence on country *j*'s interests by reducing terrorist attacks in *i*. In contrast, the third left-hand term in (7) is a marginal external cost that arises as *i*'s deterrence increases the likelihood of an attack in *j*, where *j*'s interests are in harm's way. Given the presence of opposing externalities, the net marginal externality in (7) cannot be signed without further structure. Marginal external benefits result in too little deterrence, whereas marginal external costs result in too much deterrence when the simultaneous-move equilibrium levels of deterrence are compared with social-optimizing levels.

For the simultaneous deterrence decision, the slope of the government's best-response (*BR*) path, which indicates the best choice of θ_i for alternative values of θ_j, proves instructive. This slope is derived by implicitly differentiating $\partial C_i/\partial\theta_i$ in (4) with respect to θ_j to give:

$$\frac{\partial BR_i}{\partial\theta_j}=\frac{-l'(\theta_i)\dfrac{\partial\pi_i}{\partial\theta_j}-v'(\theta_j)\dfrac{\partial\pi_j}{\partial\theta_i}-l(\theta_i)\dfrac{\partial^2\pi_i}{\partial\theta_i\partial\theta_j}-v(\theta_j)\dfrac{\partial^2\pi_j}{\partial\theta_i\partial\theta_j}}{\dfrac{\partial^2 C_i}{\partial\theta_i^2}}, \tag{8}$$

for *i*, *j* = 1, 2, and $i \neq$ j. The denominator of (8) is positive since the second-order conditions are satisfied by assumption, so that the sign of this slope hinges on the numerator. At the symmetric equilibrium, the numerator is positive and therefore the sign of the slope of these best-response paths are both positive.[4] As such, the countries' efforts at deterrence represent strategic complements (see Bulow, Geanakoplos, and Klemperer 1985).

4. Fully symmetric simultaneous-move case: alternative terrorist scenarios

To get some definitive results that possess some real-world analogues, we make some specific assumptions. The outcomes for our specialized scenario provide insights for less stark examples that may include aspects of both scenarios to varying degrees.

4.1. No collateral damage

In the first two scenarios, we assume that attacks are host-country specific with no collateral damage on foreign interests, so that $a = h = 0$ and, therefore, $v(\theta_i) = v'(\theta_i) = 0$ for $i = 1, 2$, owing to symmetry. The evaluation of C^T at the symmetric Nash equilibrium allocation implies:

$$\partial C^T(\boldsymbol{\theta}^{\mathbf{N}}) \big/ \partial\theta_i = l(\theta_i^{\mathrm{N}})(\partial\pi_j/\partial\theta_i) > 0, \quad i, j = 1, 2, \text{ and } i \neq j. \tag{9}$$

Eq. (9) indicates that a country overdeters as compared with the Pareto-optimal level, because the external costs imposed on the other country by deflecting the attack there are not taken into account. Consequently, a deterrence race applies as each nation tries to transfer the terrorist threat abroad where it has no interests.

Thus, the reaction of the United States to 9/11 or England to the London subway bombings may be excessive. The seemingly uncontrollable homeland security spending in the United States, when state and local spending is included, has this hallmark. Terrorists hurt their targeted countries' budgets in ways that transcend the carnage and destruction. Overdeterrence bolsters these economic consequences of terrorism. Even when there is some collateral damage, host-country losses motivate overdeterrence.

The best-response curves are displayed in figure 2 (ignoring point *S*) where θ_j is on the vertical axis and θ_i is on the horizontal axis. These best-response paths connect the optimums of the isocost curves (suppressed except for the dashed curve) for each country. These isocost curves are generally hill-shaped for government *i* (see the dashed curve) and an inverted C-shaped for government *j*. Country *i*'s welfare improves on lower isocost curves, while country *j*'s welfare improves on left-shifted isocost curves (closer to the vertical axis). This follows because each country then experiences a smaller deterrence level abroad for any level of its own deterrence, thereby making it relatively safer at home. In figure 2, the intersection of the two reaction paths at N denotes the simultaneous-move equilibrium, where country i's isocost curve has a zero slope and j's isocost curve has a vertical slope. The symmetric Pareto optimum is some point, P, along the 45° line that is closer to the origin than point N. This is a case of strategic complements where the deterrence choice of potential targets moves together.

[Figure 2 near here]

4.2. *Globalized terror scenario*

Our second polar case is globalized terror where a country's risk is equivalent at home and abroad, so that $A = a$ and $H = h$. This implies that a country's expected attack costs are such that $l(\theta_i) = v(\theta_j)$ at the symmetric equilibrium where $\theta_i = \theta_j = \theta$. Now, an evaluation of C^T at the simultaneous-move equilibrium gives:[5]

$$\partial C^T\left(\boldsymbol{\theta}^{\mathrm{N}}\right)/\partial\theta_i = \pi_i v'\left(\theta^{\mathrm{N}}\right) < 0, \qquad i = 1, 2. \tag{10}$$

Thus, the external benefits that a country's deterrence efforts provide to foreigners are not taken into account and this leads to underdeterrence – i.e., $\theta^* > \theta^{\mathrm{N}}$, where subscripts are suppressed.

Although this scenario is extreme to focus our thinking, it provides insight for other cases. In nonsymmetric cases for which a country's citizens are at greater risks abroad owing to excellent protection at home (e.g., the United States after 9/11), foreign-generated external benefits and, hence, foreign underdeterrence are anticipated to dominate. As such, the downside to successful efforts at home to deflect attacks is that a country's citizens are then more vulnerable abroad, where the country has little influence owing to sovereignty issues. Recent statistical analyses have uncovered a shift in transnational terrorist incidents from Western venues to the Middle East and Asia, where post-9/11 upgrades have not been instituted (Enders and Sandler 2006a). This shift is particularly strong for attacks against US interests. If the terrorists purposely limit the collateral damage to the host country from their attacks against, say, Americans, then the terrorists can *maximize the host country's underdeterrence*. This appears to have been the Greek scenario with respect to its ineffective efforts to curb 17-November terrorist activities for 22 years until a terrorist accidentally blew himself up during the summer of 2002 (Lee 1988; Wilkinson 2001). The US assistance to foreign governments – one of the four "pillars" of US antiterrorist policy (US Department of State 2002) – is a sensible action to address this foreign underdeterrence, but, of course, the United States can fortify only a limited number of potential target nations. If, however, the asymmetry involves dominant costs at home ($A > a$, $H > h$), then overdeterrence may characterize a less extreme degree of globalized terrorism. Thus, the richness of the deterrence game is brought out.

For the fully symmetric globalized scenario, the slope of the best-response curve is positive for both countries. Once again, we have strategic complements for the deterrence game, but the isocost curves are now U-shaped and C-shaped for country i and j, respectively. Moreover, the Pareto optimum (not displayed for this case) is on the 45° line above the simultaneous-move equilibrium N in figure 2. The discussion above establishes:

Proposition 1. In the case of no collateral damage, each noncooperative target government overdeters relative to the Pareto-optimal level; in the case of globalized terror, each noncooperative target government undeters relative to the Pareto-optimal level.

5. Preemption game

In the preemption game, the targeted government (i = 1, 2) must independently decide whether to launch an attack against a terrorist group or its sponsor. Although the preemption game bears great similarities to the deterrence game, the former displays some subtle but important differences. First, preemption confers public benefits on targeted countries, while deterrence confers public costs and benefits on targeted countries. Second, a corner solution may characterize preemption as only one government (i.e., the prime target) takes action. In contrast, *all* targeted governments will take deterrent measures so that a corner solution is not economically relevant. Third, with preemption, a fanatical terrorist group may be kept from attacking if the governments' actions sufficiently deplete a group's capabilities. Other differences will be noted in the ensuing analysis.

We utilize the same notation as before, but $G(\theta_i)$ now denotes preemption costs. All of the other parameters – e.g., $l(\theta_i), v(\theta_i)$, *A*, *H*, *a*, and *h* – have analogous interpretations as those in the deterrence game. The essential difference in parameters involves the probability that country *i* will be attacked, as given by $\pi_i(\boldsymbol{\theta})$. An increase in *i*'s preemption reduces this probability not only for country *i* but also for *j* – i.e., $\partial\pi_i/\partial\theta_i < 0$ and $\partial\pi_j/\partial\theta_i < 0$ – with diminishing returns to effort. This second inequality is a key difference between preemption and deterrence. A second associated difference is the unambiguous sign of the cross partial – i.e., $\partial^2\pi_i/\partial\theta_i\partial\theta_j > 0$ – which indicates that *j*'s preemption reduces the marginal impact of *i*'s preemptive efforts owing to diminishing returns. Collective preemption may be sufficient to eliminate all attacks, where $\pi_0 = 1-\pi_1-\pi_2$ is the governments' perceived likelihood of no attack.[6]

The first-order conditions characterizing the Nash equilibrium of the preemption game played between two targeted countries are identical in form to that in (4), and are not displayed here. Now, $G'(\theta_i)$ denotes the marginal preemption costs and the remaining three terms represent marginal benefits either conferred at home or abroad. Unlike deterrence with opposing externalities, preemption reduces vulnerabilities in all potential target countries by curbing terrorists' capabilities. Because all externalities are positive, best-response paths and outcomes are easier to sign.

In figure 3, government *i*'s isocost curves are U-shaped (see I_iI_i), while government *j*'s isocost curves (see I_jI_j) are translated through 90˚. For *i*, higher isocost curves indicate a greater well-being, since each level of *i*'s preemption is associated with a higher preemption by the other country. Similarly, isocost curves to the right represent greater well-being for country *j*. Based on the assumptions, the thickened best-response curves (BR_i and BR_j) are negatively sloped, indicative of the public good nature of preemption. BR_i joins the zero slopes of the isocost contours for *i*, while BR_j joins the vertical slopes of the isocost contours for *j*. These negatively sloped best-response paths are also consistent with the preemption decisions of the governments being strategic substitutes. The simultaneous-move equilibrium occurs at *N*.

[Figure 3 near here]

5.1. Noncooperative versus cooperative behavior: *alternative scenarios*

By evaluating the first-order conditions for minimizing C^T at the symmetric, Nash equilibrium allocation of the simultaneous-move preemption game, we find that $\partial C^T\left(\boldsymbol{\theta}^{\mathbf{N}}\right)/\partial\theta_i$ is negative in any scenario. This comparison leads to the following result:

Proposition 2. For all cases, the simultaneous-move equilibrium allocation results in a smaller level of preemption by both targeted governments, compared with the Pareto optimum.

Proof: See Appendix

Both polar scenarios now lead to the same outcome. The extent of underpreemption will be greater in the globalized terror instance because there are a couple sources of external benefits in contrast to the single source for no collateral damage. Less extreme cases would also result in too little preemption. The situation is displayed in figure 3, where the cross-hatched region, defined by the government's isocost curves through *N*, denotes Pareto-improvement allocations for preemption. The symmetric Pareto optimum, *P*, is located somewhere in this region on the 45˚ line.

These results generalize to *n* target countries. In an asymmetric world where some country's interests are the preferred targets of the terrorists, the country is motivated to preempt despite the free ride given to others. For example, US interests are the target of 40% of the transnational terrorist attacks; its "war on terror" embodies its preemptive effort (Sandler and Enders 2004).

6. Stackelberg leader-follower in the deterrence game

Although a leader-follower representation is often of interest because there is an issue of coordination, signaling, or commitment, we choose to use this framework to ascertain if there is a possibility for the externalities to be internalized by one nation moving first. There has been little evidence either before or after 9/11 that nations coordinate their deterrence or preemption decisions (Sandler 2003). In a world where some countries' interests are the preferred target of terrorists, these countries will heavily invest in intelligence and antiterrorist measures. With their greater risks, such targeted countries may have little political choice but to assume a leadership role by deciding their deterrence prior to other targeted countries. Since 9/11, the United States has been more aggressive than other countries in bolstering antiterrorist measures, as reflected in the tens of billions of dollars of extra security spending. Currently, the United States is considering installing defensive measures against surface-to-air missiles on commercial planes. Thus, we first investigate the allocative implications if a past attack forces a government to assume a leadership position in terms of defensive measures.

Country *i* is assumed to be the leader and country *j* the follower. As the leader, *i* minimizes its costs, taking into account the impact that its deterrence decision will have on *j*'s choice of deterrence. That is, country *i* will choose θ_i to minimize its deterrence costs, while treating θ_j as dependent on its θ_i according to *j*'s best-response path, so that $\theta_j = BR_j(\theta_i)$. The leader's cost function is:

$$C_i\left[\theta_i, BR_j\left(\theta_i\right)\right] = G\left(\theta_i\right) + \pi_i\left[\theta_i, BR_j\left(\theta_i\right)\right] l\left(\theta_i\right) + \pi_j\left[\theta_i, BR_j\left(\theta_i\right)\right] v\left[BR_j\left(\theta_i\right)\right]. \qquad (11)$$

Differentiating (11) with respect to θ_i, we derive the leader's first-order condition,

$$\frac{\partial C_i^{\mathrm{S}}}{\partial \theta_i} = \left[G'\left(\theta_i\right) + \pi_i l'\left(\theta_i\right) + l\left(\theta_i\right)\frac{\partial \pi_i}{\partial \theta_i} + v\left(\theta_j\right)\frac{\partial \pi_j}{\partial \theta_i}\right] + \left[l\left(\theta_i\right)\frac{\partial \pi_i}{\partial \theta_j} + v\left(\theta_j\right)\frac{\partial \pi_j}{\partial \theta_j} + v'\left(\theta_j\right)\pi_j\right]\frac{\partial BR_j}{\partial \theta_i} = 0, \qquad (12)$$

where the superscript S on C_i denotes Stackelberg or leader-follower equilibrium allocation. In (12), the first bracketed expression consists of the same terms as in the simultaneous-move first-order conditions, while the second bracketed expression, which is multiplied by the slope of country *j*'s reaction path, distinguishes the leader's behavior from that in a noncooperative (N) simultaneous-move game. That is, when (12) is evaluated at $\boldsymbol{\theta}^{\mathrm{N}} = \left(\theta_i^{\mathrm{N}},\ \theta_j^{\mathrm{N}}\right)$, the first bracketed term equals zero, leaving the second composite expression as the determinant of the relationship of the leader-follower equilibrium allocation to that in the Nash simultaneous-move game. The terms in the second bracketed expression are the marginal external benefits and costs that *j* imposes on *i* from not cooperating [see (7)]. Even if the slope of the best-response path is positive, the net influence of this expression cannot be evaluated unless additional structure is placed on the problem.

6.1. Alternative scenarios: simultaneous-move versus Stackelberg equilibrium allocation

If there is no collateral damage beyond the host country's interests, so that the *v* expressions are zero, then the evaluation of the leader's Stackelberg first-order condition at the symmetric simultaneous-move equilibrium gives:

$$\frac{\partial C_i^S\left(\boldsymbol{\theta}^N\right)}{\partial \theta_i} = \left[l\left(\theta_i^N\right) \frac{\partial \pi_i}{\partial \theta_j} \right] \frac{\partial BR_j}{\partial \theta_i} > 0. \tag{13}$$

This sign follows because $\partial \pi_i / \partial \theta_j > 0$ (from deflecting the attack abroad) and the positive slope of *j*'s reaction path. This inequality indicates that the leader *internalizes* some of the marginal external costs from deflecting the attack. This partial internalization arises as the leader accounts for the strategic complementarity, in which overdeterrence on its part leads the follower to overdeter in response. To reduce the reciprocal external costs, the leader curtails its deterrence, an action that induces a similar response by the follower. As a consequence, $\boldsymbol{\theta}^N \gg \boldsymbol{\theta}^S$ where $\boldsymbol{\theta}^S = \left(\theta_i^S,\ \theta_j^S\right)$. Leader-follower behavior limits overdeterrence when the Stackelberg outcome is compared with the simultaneous-move equilibrium. This can be seen in figure 2, presented earlier, where leader *i*'s dashed isocost curve is tangent to *j*'s best-response curve at the leader-follower equilibrium *S*.[7] The isocost curves associated with *S* imply that both countries are better off than at *N* owing to the curtailment of the deterrence race. Because the follower's isocost curve necessarily shifts left by more than the leader's isocost curve shifts down, there is a second-mover advantage that a prime-target country relinquishes out of political necessity to act first. The 9/11 attacks have imposed a strategic disadvantage on the United States by making it assume a deterrence leadership role; nevertheless, the United States makes some gain by seizing the initiative.

In the globalized scenario, a similar internalization occurs. An evaluation of the leader's

Stackelberg first-order conditions at the symmetric simultaneous-move equilibrium allocation implies that the leader internalizes some of the marginal external benefits that stem from the strategic complementarity. In particular, the leader increases its level of deterrence, because such efforts induce a greater deterrence by the follower, which safeguards the leader's interests on the latter's soil. As compared with the underdeterrence associated with simultaneous moves, both the leader's and follower's deterrence levels are greater, so that $\boldsymbol{\theta}^{S} \gg \boldsymbol{\theta}^{N}$. In figure 2, the leader-follower solution is up along BR_j to the right of N at S' where one of the leader's U-shaped isocost curves (not shown) is tangent to j's best-response path. Once again, both governments gain from leadership by one of the targeted countries, but the follower has a second-mover advantage. In summary, we have:

Proposition 3. For either no collateral damage or globalized terrorism, the equilibrium allocation in the leader-follower game results in deterrence levels that are closer to the social optimum, compared with those of the simultaneous-move outcome. The follower, however, gains relative to the leader.

6.2. Leader-follower and preemption

Given the unidirectional externalities in the preemption situation, the evaluation of the impact of leader-follower behavior is simple to ascertain. An evaluation of the leader-follower first-order condition at the simultaneous-move equilibrium of the preemption game gives:

Proposition 4. The leader decreases its preemption efforts relative to the simultaneous-move equilibrium. Moreover, total preemption for the leader-follower allocation is less than that for a unique (interior) simultaneous-move equilibrium.

Proof: See Appendix

At an interior solution, the leader reduces its preemption because it foresees that this reduction will induce the follower to provide more. This action improves the leader's well-being at the expense of the follower. Unlike deterrence, taking the initiative is not Pareto improving.

In figure 3 (displayed earlier), the leader-follower equilibrium at *S* will be northwest along the follower's best-response path. The aggregate leader-follower level of preemption must decrease as compared with the unique simultaneous-move equilibrium *N*, given that the slope of BR_j is greater than –1. All terrorist scenarios – no collateral damage, globalized terror, or some combination – give this outcome. If there is a corner solution where BR_i is everywhere above BR_j, then the leader-follower solution is at the θ_i intercept of the BR_i reaction path where *i* does all of the preemption and *j* free rides. In this case, leadership has no influence on the outcome. With an attack like 9/11, the host country's best-response curve may shift sufficiently to the northeast that a corner solution results where one or two most impacted countries do virtually all of the preempting – e.g., post-9/11 actions of the United States and the United Kingdom in Afghanistan.

7. Policy implications and concluding remarks

Although deterrence and preemption games are almost identical in structure, they possess some essential differences that influence the conduct of sensible and effective counterterrorism policy. For the deterrence game, the mix of home and abroad risks imply both external benefits and costs, which, in turn, can yield a wide variety of outcomes. Thus, noncooperating nations may overdeter if host-country risks outweigh threats to a country's citizens while abroad. If, however, terrorism is globalized, placing citizens equally in harm's way everywhere, then underdeterrence is the outcome. Because only external benefits are typically generated for preemption, too little action is the norm so that policy must bolster this measure.

In the absence of a corner solution, less global preemption will result from leadership so that the Bush doctrine of 2002 will limit the overall level of preemption, opposite to the doctrine's intention. This result follows because preemption is purely public to potential targets of transnational terrorism, thus allowing the leader to reduce its efforts by more than the follower increases its efforts. After 9/11, there were some countries – most notably, the United Kingdom – that followed the US invasion of Afghanistan, so that a corner solution did not apply. For these follower countries, US leadership is anticipated to have increased their participation level, consistent with the administration's wishes. Prime-target countries confront a real policy dilemma because preemption leadership shows its citizens that it is decisive, but at the risk of reducing *overall* efforts. As such, political realities lead to the wrong policy choice. When, however, deterrence decisions are considered, leadership is apt to limit the inefficiency – whether there is underdeterrence or overdeterrence. Thus, *leadership is apt to be helpful for deterrence but not for preemption*. This policy insight does not fully concur with the Bush administration's current actions.

As fundamentalist terrorist drive for ever-greater atrocities, they motivate leadership in a small set of prime-target nations – e.g., the United States, the United Kingdom, Israel, and Spain. What our analysis highlights is that leadership, without true cooperation, is a two-edged sword for the practice of counterterrorism: leadership *curbs* inappropriate deterrence levels but *exacerbates* inappropriate preemption levels. Given the diverse strategic character of deterrence and preemption decisions, nations can never get the mix correct through leadership, induced by large-scale terrorist attacks. The only solution is the creation of a cooperative network of nations with integrated counterterrorist measures. We are nowhere near this goal (Enders and Sandler 2006b).

Our models abstract by assuming just two targeted nations. This abstraction is appropriate because an individual nation views its actions vis-à-vis the collective target of the rest of the world. In the case of the United States, the rest of the world (in terms of targeted countries) is a collective player roughly of similar size. For a small country, the rest of the world overshadows it, so that a corner solution where it does no preemption of transnational terrorism is likely. In our future work, we are examining the mix between deterrence and preemption. This mix greatly complicates the analysis, which is best understood by first having these policies examined in isolation, as done here.

Appendix

Proof of Proposition 2.

We evaluate the first-order conditions for minimizing C^T at the symmetric Nash equilibrium of the simultaneous-move preemption game. This gives

$$\frac{\partial C^T\left(\boldsymbol{\theta}^{\mathbf{N}}\right)}{\partial\theta_i} = \pi_i v'\left(\theta_i^{\mathrm{N}}\right) + v\left(\theta_i^{\mathrm{N}}\right)\frac{\partial\pi_i}{\partial\theta_i} + l\left(\theta_i^{\mathrm{N}}\right)\frac{\partial\pi_j}{\partial\theta_i} < 0 \text{ for } i, j = 1, 2, \text{ and } i \neq j. \tag{A1}$$

For the no collateral damage case where $v = v' = 0$ and for the globalized terror case where $v(\cdot) = l(\cdot)$, there is too little preemption at the Nash equilibrium allocation compared with the Pareto optimum, so that all terms to the left of inequality are negative.

Proof of Proposition 4.

To compare the interior of Stackelberg equilibrium allocation to that of the simultaneous-move preemption game, we evaluate the first-order conditions charactering leader-follower behavior at $\boldsymbol{\theta}^{\mathbf{N}}$:

$$\frac{\partial C_i^S\left(\boldsymbol{\theta}^{\mathbf{N}}\right)}{\partial\theta_i} = \left[l\left(\theta_i^{\mathrm{N}}\right)\frac{\partial\pi_i}{\partial\theta_j} + \pi_j v'\left(\theta_j^{\mathrm{N}}\right) + v\left(\theta_j^{\mathrm{N}}\right)\frac{\partial\pi_j}{\partial\theta_j}\right]\frac{\partial BR_j}{\partial\theta_i} > 0. \tag{A2}$$

In (A2), all terms in the brackets are negative and the slope of the followers' best-response path is also negative; hence, the product of these expressions is positive for all scenarios. The sign in (A2) indicates that the leader will preempt to a smaller extent than at the simultaneous-move equilibrium. The follower will then increase its preemption, but since the slope of BR_j is less than one in absolute value to ensure uniqueness and existence of equilibrium (Cornes, Hartley, and Sandler 1999), the overall value of preemption falls relative to the simultaneous-choice equilibrium.

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Footnotes

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1. Although a corner solution is technically interesting, it is not economically meaningful. Terrorism-prone countries do not choose zero deterrence levels; every country with airports have installed metal detectors.

2. The second-order condition requires that

$$\frac{\partial^2 C_i}{\partial \theta_i^2} = G''(\theta_i) + 2l'(\theta_i)\frac{\partial \pi_i}{\partial \theta_i} + l(\theta_i)\frac{\partial^2 \pi_i}{\partial \theta_i^2} + v(\theta_j)\frac{\partial^2 \pi_j}{\partial \theta_i^2} > 0.$$

This condition will hold if the probability function consistent with our assumption on π_i is of the following specific form:

$$\pi_i = \frac{\theta_j}{\theta_i + \theta_j}, \; i, j = 1, 2, \text{ and } i \neq j.$$

A country's perceived likelihood of a terrorist attack hinges on the *other* target's relative deterrent measures. This attack probability function is similar but different than contest success functions in the conflict literature, where success hinges on the ratio of own effort to total effort (Hirshleifer 1989, 2000).

3. We assume that the second-order condition for the cooperative minimization problem is satisfied. A sufficient condition for this to hold is that the principal minors of the Hessian matrix are strictly positive:

$$\frac{\partial^2 C^T}{\partial \theta_i^2} > 0 \text{ and } \frac{\partial^2 C^T}{\partial \theta_i^2}\frac{\partial^2 C^T}{\partial \theta_j^2} - \left(\frac{\partial^2 C^T}{\partial \theta_i \partial \theta_j}\right)^2 > 0 .$$

For the specific probability function assumed in footnote 2, this condition holds.

4. In (8), the first two terms in the numerator are positive, while the last two terms will be of differing signs. The sum of these last two terms will, however, be zero when $\theta_i = \theta_j$ because cross partials are then zero.

5. This follows since $\partial \pi_i / \partial \theta_i = -\partial \pi_j / \partial \theta_i$.

6. The following specific forms for the attack probabilities would give such results:

$$\pi_i = \frac{\theta_{j0}}{\theta_i + \theta_j + \theta_{i0} + \theta_{j0}}, \quad \text{for } i, j = 1, 2, \quad i \neq j$$

and

$$\pi_0 = \frac{\theta_i + \theta_j}{\theta_i + \theta_j + \theta_{i0} + \theta_{j0}}.$$

In these equations, θ_{i0} and θ_{j0} are proxies for some kind of obstacle that protects country *i* and *j*, respectively. An increase in θ_{i0} reduces the likelihood of *i* being attacked, but increases the likelihood that country *j* is targeted. The need for a different underlying specific probability function is another difference between the two models.

7. Our problems are similar to some of the social dilemmas analyzed in the excellent article by Eaton (2004). Some important differences exist because deterrence has opposing externalities.

		nation 2	
		Status quo	Deter
nation 1	Status quo	$0, 0$	$-C_1, b - C$
	Deter	$b - C, -C_2$	$b - C - C_1, b - C - C_2$

$(C + C_i > b > C), i = 1, 2$

a. 2 × 2 Generic deterrence game

		nation 2	
		Preempt	Status quo
nation 1	Preempt	$2B - c, 2B - c$	$B - c, B$
	Status quo	$B, B - c$	$0, 0$

$(2B > c > B)$

b. 2 × 2 Generic preemption game

Figure 1. Preemption and deterrence games in normal form

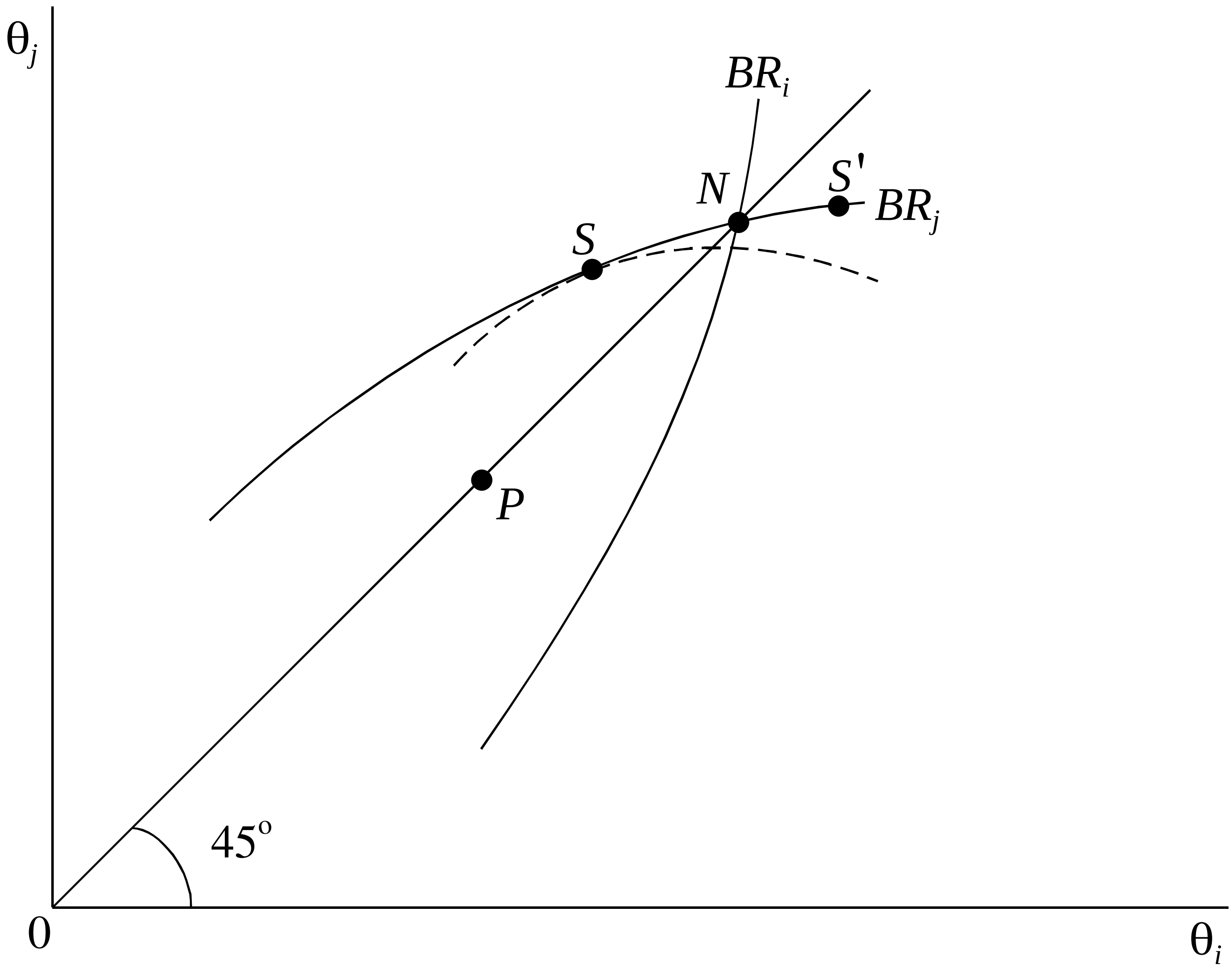

Figure 2. Best-response paths for symmetric deterrence game

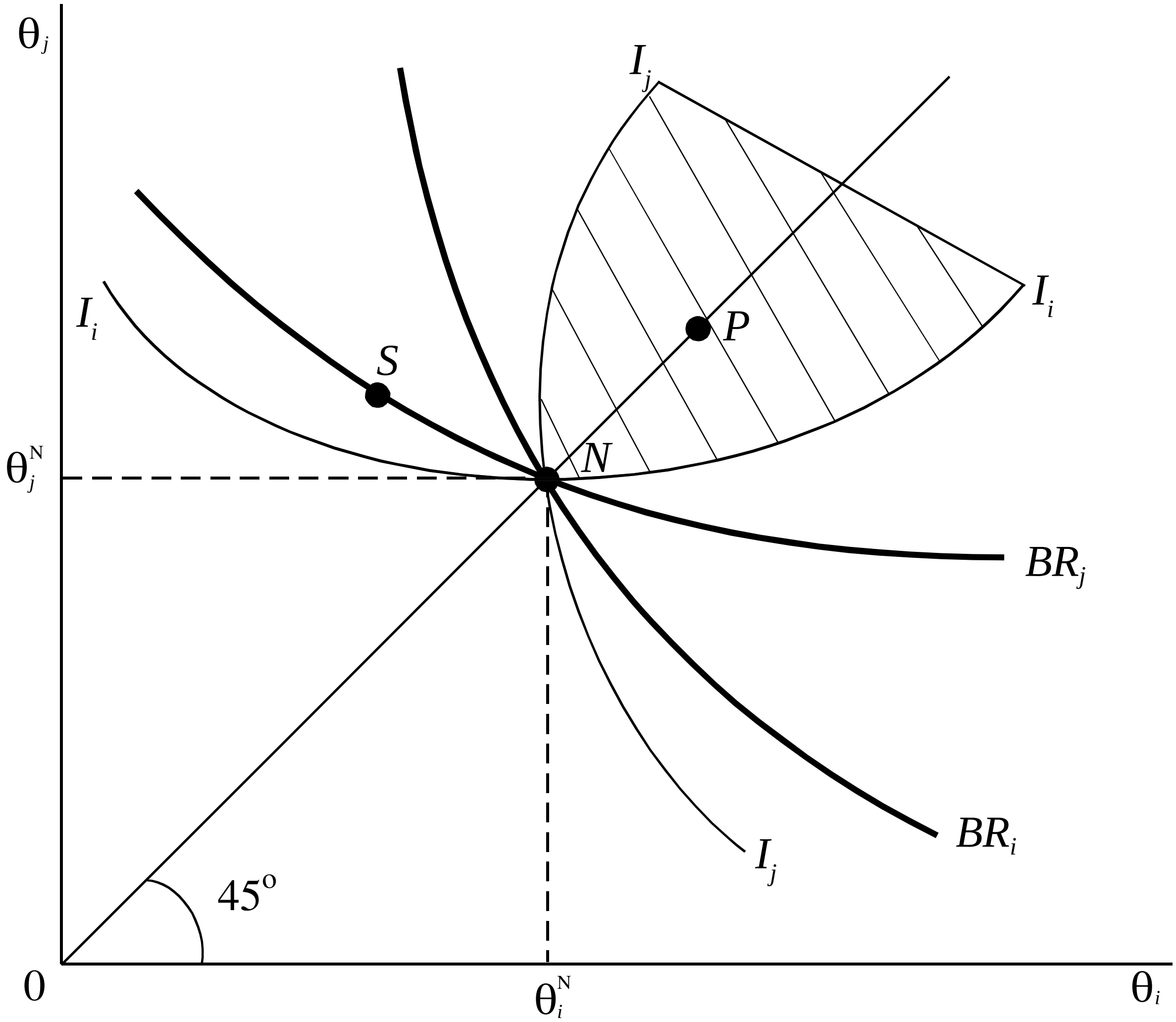

Figure 3. Symmetric preemption best-response paths