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Terrorist Factions*

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ABSTRACT

I study how a variety of structural and strategic factors affect terrorist mobilization, the likelihood of a splinter faction forming, and the positions adopted by terrorist leaders. The factors considered include the state of the economy, the viability of institutions for the nonviolent expression of grievance, the ability of the factional leaders to provide nonideological benefits, and the risks associated with splintering. The model highlights that, for strategic reasons, changes in the structural environment often entail trade-offs between decreasing terrorist mobilization and increasing extremism. For instance, strengthening the economy or institutions for the nonviolent expression of grievance is found to decrease terrorist mobilization, increase the extremism of terrorist factions, and decrease the likelihood of a splinter faction forming. These results suggest competing micro-level effects of such changes on the expected level of violence that, because they are offsetting, might not be observed in macro-level data analyses, which have been the mainstay of empirical studies of terrorism.

Terrorist organizations are not monolithic nor is their structure stable. Rather, they are made up of heterogeneous factions that frequently splinter from one another as the political and economic landscape shifts (Bell 1998, Zirakzadeh 2002). Consider a few examples.

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Republican militants in Northern Ireland have experienced a variety of splinterings. In the late 1960s, the Provisional Irish Republican Army (IRA) split from the Original IRA due to disagreements over military policy. In the mid-1980s, the extremist Continuity IRA splintered from the Provisionals when the Provisionals abandoned their policy of refusing to participate in parliament. Another radical splinter group, the Real IRA, broke from the Provisionals in the 1990s over the peace process that led to the Good Friday Agreement.

Militant Palestinian nationalism has been represented by a variety of terrorist groups that have also splintered a number of times. In the 1970s a group of radical, secular nationalist factions split from the Palestine Liberation Organization over the value of compromise. Similarly, two militant Islamic terrorist groups — Palestinian Islamic Jihad (in the 1970s) and Hamas (in the 1980s) — split from the Muslim Brotherhood over the value of violent versus nonviolent resistance. In recent years further divisions have occurred between factions in both secular nationalist and Islamic organizations as these various groups vie for power.

Basque separatists have divided into several factions throughout the history of the terrorist group Euskadi Ta Askatasuna (ETA). For instance, in the late-1970s ETA divided into the extremist ETA-militar and the more moderate ETA-politico militar over whether Basque separatists should participate in regular politics following the death of Franco, Spanish democratization, and the grant of partial autonomy to the Basque Country.

Such internal divisions within terrorist organizations have important affects on both patterns of terrorist violence and counterterrorism strategies.[1] For instance, factions often disagree over the relative value of negotiated settlement versus continued violence (Jaeger and Paserman 2006). As a result, when one faction accepts government concessions violence can increase, both because the remaining faction is more extreme than the faction that accepted concessions and because the extremists use violence to undercut peace negotiations (Stedman 1997, Kydd and Walter 2002, Bueno de Mesquita 2005a).

I model a variety of determinants of mobilization, extremism, and factionalization. The model explores how the risks of factionalization affect and are affected by the level of extremism of the original terrorist group. It also allows me to examine how the extremism of factions and the likelihood of factionalization are affected by the economy, institutions for the nonviolent expression of grievance, factional leaders' abilities to provide nonideological benefits, and the risks associated with forming a splinter faction.

A key theme is that many policies that are expected to decrease mobilization — e.g., economic aid or building institutions for the nonviolent expression of grievance — will also lead terrorist factions to become more extreme. These effects may be offsetting in their impact on the level of terrorist violence, implying a trade-off for governments. Moreover, this same observation suggests a challenge for empirical studies that focus on the relationship between structural features of a society and macro-level measures of the

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[1] For models of terrorism and/or counterterrorism with internally divided terrorist organizations, see, among others, Berrebi and Klor (2006), Bloom (2004, 2005), Bueno de Mesquita (2005a), de Figueiredo and Weingast (2001), Kydd and Walter (2002), and Siqueira (2005).

level of terrorism. Even if such studies find no statistical relationship between the level of terrorism and nonviolent institutions or the economy, one need not conclude that these features of the political-economic environment do not matter for understanding terrorism. Rather, changes in the political-economic environment may have important micro-level effects that, because they are offsetting, are not observed in the type of macro-level data that are the mainstay of empirical studies of terrorism.

THE MODEL

Consider a model with three sorts of players: the leader of the original terrorist faction (t), a potential splinter terrorist faction leader (s), and a continuum of potential terrorists. I adopt the convention of referring to the leader of the original terrorist faction as "she" and the leader of the potential splinter faction as "he."

In the first period, the original terrorist faction's leader chooses a position $x_t \in [\underline{x}, \infty) \subset \mathbb{R}$. Each member of the population then decides whether to join the original faction or remain unmobilized (i.e., take his outside option). In the second period, Nature determines (and makes public) the potential splinter leader's capacity for providing nonideological benefits (denoted β_s). The potential splinter leader then decides whether or not to splinter. If he splinters, he chooses a position $x_s \in [x_t, \infty)$. Finally, each member of the population of potential terrorists makes a new affiliation decision — choosing between the original faction, the splinter faction (should one exist), and the nonviolent outside option.

Each member of the population of potential terrorists, i, has an ideal point $x_i \in [\underline{x}, \infty)$. These ideal points are distributed according to an absolutely continuous, continuously differentiable distribution F (with density, f) which is nonincreasing on its support, $[\underline{x}, \infty)$.[2] I adopt the interpretation that positions further to the right are more extreme. One can think of a faction's choice of a position as its statement of demands, its marginal rate of substitution between pursuing total victory and accepting government concessions, the level of violence it intends to use, and so on.[3]

Members of the population are myopic, choosing their affiliation decisions in the first period without reference to the second period. In any period that a member of the population, i, joins the original terrorist faction her payoff is

$$U_i(t|x_t, \beta_t) = \beta_t - u(|x_t - x_i|),$$

[2] The assumption that the distribution of potential terrorists is nonincreasing on its support is consistent with a society with ideologies distributed according to a single-peaked distribution, with all potential terrorists on an extreme end of that distribution. Of course, there may be terrorist movements on the left and the right of a society, but each of those movements, analyzed separately, will satisfy the assumption here. There may be circumstances where this assumption does not hold (e.g., a cluster of public opinion located around each of two factions). Such considerations will affect the results in a fairly straightforward manner, but considerably complicate the analysis and, so, I abstract away from them.

[3] See de Figueiredo and Weingast (2001), Kydd and Walter (2002), and Bueno de Mesquita (2005a, 2005c) for models of how such positions translate into the use of violence or willingness to negotiate.

where $\beta_t > 0$ is a group-specific, nonideological payoff and $u(\cdot)$ is increasing, strictly convex, minimized at 0, and satisfies $\frac{u'}{u''}$ increasing and $\lim_{x\to\infty} u'(x) = \infty$.[4] A faction's nonideological payoffs may reflect the charisma of the leader, the level of private goods the faction can afford to provide, opportunities for graft and personal gain, and so on (Stern 2003).

In any period in which a member of the population, i, chooses the nonviolent outside option she receives a payoff of:

$$U_i(n|x_0, \gamma) = \gamma - u(|x_i - x_0|).$$

The parameter γ can be thought of as representing the underlying state of the economy and, consequently, the opportunity costs of mobilization. The term $u(|x_i - x_0|)$ represents the implicit ideological payoff associated with pursuing anti-government sentiments through nonviolent politics. I assume that $x_0 < \underline{x}$, so that there is an "ideological" cost to extremists of not joining the terrorist movement. This also implies that, as x_0 increases, nonviolent politics becomes a more viable option from the perspective of potential terrorists. I assume that $\gamma > \beta_t$, so that there are material costs to joining a terrorist organization.

In the second period, a member of the population of potential terrorists who joins the splinter faction receives a payoff of

$$U_i(s|x_s, \beta_s) = \beta_s - c - u(|x_s - x_i|),$$

where $c > 0$ is the cost associated with the risk of joining a splinter faction. It is common knowledge that β_s is distributed according to an absolutely continuous distribution G, with density g, and support $[0, \overline{\beta}_s]$. I assume that $\beta_t > \overline{\beta}_s - c$, so that the risk to members of the population associated with joining a new splinter faction makes doing so costly.

Both the original terrorist faction's leader and the splinter leader (conditional on splintering) seek to maximize his or her faction's support. The original faction's leader's payoffs are the sum of the proportion of potential supporters that join her faction in each period. If the splinter leader chooses not to form a faction, his payoffs are normalized to zero. If he does splinter, his payoffs are the proportion of potential supporters his faction attracts in the second period minus a cost associated with the risk of splintering, $k > 0$.

Two key assumptions of the model bear further comment. First, I assume that terrorist leaders seek to maximize the membership of their faction, but do not have direct preferences over the positions they adopt. Clearly, in reality, terrorist leaders are motivated by a range of factors including power, money, policy outcomes, religion, and so on. However, attracting adherents is a necessary condition for establishing a successful terrorist faction. Moreover, as Bueno de Mesquita (2005b) argues, terrorist organizations actively screen for high ability recruits. So, even if the largest terrorist organization is not always the most effective, terrorist leaders are still likely to want to attract as many potential

4 All of these assumptions are satisfied by, for example, any function of the form $-u(x) = -|x|^j$, for any $j > 1$.

recruits as possible, so they can select the cream of the crop. Thus, terrorist leaders' policy motivations and desire for power will, at least in part, induce the preferences over membership that I assume, though there may, of course, be offsetting effects in a model that also includes other types of motivations.

Second, I restrict attention to splinter factions that are more extreme than the original terrorist faction. I do so because, in many interesting empirical cases, the main concern of terrorist leaders is the formation of extremist, rather than moderate, splinter factions. For instance, Zirakzadeh (2002) describes a series of splinters within the ETA, as younger members formed ever more radical factions and older members moderated, accepted amnesties, and eventually joined non-violent political parties. Similarly, in Northern Ireland over the past two decades, new factions have consistently formed on the extreme in opposition to compromise with the British (English 2003). Of course, these examples may be equilibrium phenomena, resulting from terrorist leaders hedging against moderate splinters, which would present a serious challenge to the assumptions underlying this model. However, in many cases, the reason moderate splinters are uncommon is because the more moderate end of the ideological spectrum is already dense with political organizations. In such circumstances, terrorist leaders may fear defection by moderate members to existing organizations, but a moderate splinter is unlikely. That said, there are cases of factionalization where it is unclear whether the moderates or extremists should be viewed as the splinter faction. For instance, while Hamas was formed as a radical splinter group, as it has gained political power, it has experienced increased divisions between its more pragmatic and more radical members (Mishal and Sela 2000). These divisions seem to be leading to factionlization within Hamas, with competing factions staking out different positions simultaneously. These dynamics are clearly somewhat different from those described in my model. Hence, the assumption of one-sided splintering should be viewed as a simplification that is descriptive of many cases of interest but also limits the domain of cases to which the model can be applied.

EQUILIBRIUM

The solution concept is subgame perfect Nash equilibrium (extended to games with moves by Nature).

Affiliation Decisions

A member of the population will join the original faction in the first round if and only if

$$\beta_t - u(|x_t - x_i|) \geq \gamma - u(|x_0 - x_i|). \tag{1}$$

This gives rise to the following result.

Lemma 1 *For any x_t, there is a point in the ideological space, $\underline{x}_t(x_t)$ such that, in the first period, members of the population join the original faction if and only if $x_i \geq \underline{x}_t(x_t)$. This cutpoint is increasing in x_t if $x_t > \underline{x}_t(x_t)$ and decreasing in x_t if $x_t < \underline{x}_t(x_t)$.*

If a splinter does not form, then no affiliation decisions change in the second period. If a splinter faction forms, a member of the population joins it if and only if:

$$\beta_s - c - u(|x_i - x_s|) \geq \max\{\gamma - u(|x_i - x_0|), \beta_t - u(|x_i - x_t|)\}. \qquad (2)$$

Since nothing changes between periods in the comparison between the outside option and the original faction, no one will switch between these two in the second period.

The Splinter Faction

Suppose a splinter faction emerges. Since $\beta_s - c < \beta_t$, if the splinter leader locates too close to the original leader, the splinter faction will attract no adherents. Consequently, the splinter leader must stake out a more extreme position to build a faction. Doing so appeals to more extreme members of the population, who may be willing to abandon the original faction, despite the cost, for a splinter faction pursuing an agenda they find more palatable.

Lemma 2 *If a splinter faction forms at $x_s \geq x_t$, and a person with ideal point x_i joins the splinter faction, then*

1. $x_i > x_t$.
2. *All people with $x_i' > x_i$ also join the splinter faction.*

Lemma 2 shows that the splinter leader's challenge is to identify the most moderate adherent he can hope to attract away from the original faction and the outside option. Define $\underline{x}_s^O(x_s, x_0, \beta_s, \gamma)$ as the point where, given a choice of x_s, a member of the population is indifferent between joining the splinter faction and the outside option. Define $\underline{x}_s^T(x_s, x_t, \beta_s, \beta_t)$ as the point where, given a choice of x_s, a member of the population is indifferent between the two factions. When no confusion will result, I will drop some of the functional notation. Finally, define $\underline{x}_s = \max\{\underline{x}_s^O, \underline{x}_s^T\}$.

Definition 1 *Say that the* outside option constraint binds *if $\underline{x}_s = \underline{x}_s^O$ and that the* factional competition constraint binds *if $\underline{x}_s = \underline{x}_s^T$.*

The splinter leader maximizes his membership by positioning his faction such that its most moderate member agrees exactly with the faction's position. Figure 1 illustrates the splinter leader's optimal location, which is formalized in the following lemma.

Lemma 3 *The splinter faction's optimal location, x_s^*, satisfies $x_s^* = \underline{x}_s(x_s^*) > x_t$.*

An implication of the optimal location for the splinter leader described in Lemma 3 is that as the original group becomes more extreme, it pushes the splinter faction to become more extreme as well by making the splinter faction less able to compete for moderate adherents.

Remark 1 *The splinter faction's optimal location (x_s^*) is weakly increasing in the ideological location of the original terrorist faction (x_t). Moreover, the relationship is strict if the factional competition constraint binds.*

The splinter leader will form a new faction only if he can attract enough adherents to justify the costs, which is only true if $1 - F(\underline{x}_s(x_s^*, x_t, \beta_s, \beta)) - k \geq 0$. Two strategic

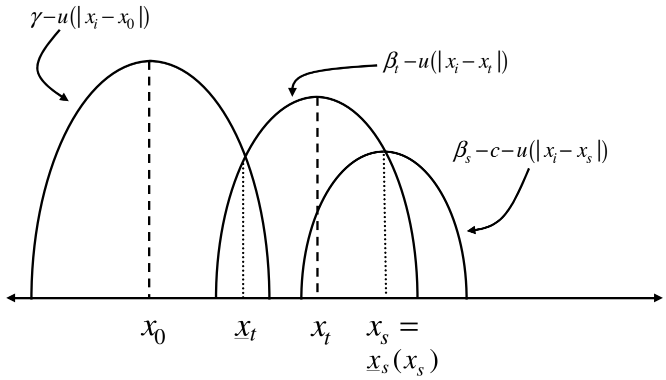

Figure 1. The splinter faction attracts all member's of the population to the right of $\underline{x}_s(x_s)$. The splinter leader's optimal location is where $x_s = \underline{x}_s(x_s)$. Were the splinter faction to move to the left (so that $x_s < \underline{x}_s(x_s)$) or the right (so that $x_s > \underline{x}_s$), the cutpoint $\underline{x}_s(x_s)$ would increase, implying fewer members of the splinter faction.

facts emerge from this decision rule. First, as demonstrated in Remark 1, as the original terrorist faction becomes more extreme, it pushes the splinter faction to the extremes as well. This reduces the splinter leader's payoff from splintering by reducing the number of adherents he attracts. Thus, the original faction's leader can reduce the risk of a splinter faction forming by becoming more extreme.

Proposition 1 *The more extreme is the original terrorist faction, the less likely a splinter faction is to form.*

Second, when the splinter faction's capacity to provide nonideological benefits is large, the splinter faction competes more successfully for relatively moderate adherents, making it more likely that the splinter leader will find the benefits of splintering worth the costs.

Proposition 2 *The larger the level of nonideological benefits the splinter leader can provide* (β_s), *the more likely a splinter faction is to form.*

The Original Terrorist Faction

At the point where she chooses her location, the original faction's leader's first period payoffs are simply a function of the number of adherents she attracts away from the outside option, but her second period payoffs are uncertain. She does not know the splinter faction's leader's capacity for providing nonideological benefits and so does not know whether a splinter faction will form and, if one does, where it will locate.

If the original terrorist leader knew the level of nonideological benefits the splinter leader could provide, she could choose a location just extreme enough to dissuade splintering. Label this level of extremism $\tilde{x}_t(\beta_s)$, which is implicitly defined by

$1 - F(x_s^*(\tilde{x}_t, \beta_s, \beta_t)) - k = 0$ (where I make use of the fact, from Lemma 3, that $\underline{x}_s(x_s^*) = x_s^*$). Since the payoff from splintering is strictly increasing in β_s, $\tilde{x}_t$ is a random variable that is uniquely determined by the realization of β_s. Let $\tilde{\beta}_s(x_t)$ be the β_s such that $\tilde{x}_t(\beta_s) = x_t$.

It is worth noting that although, in the absence of uncertainty, the original faction's leader could deter splintering, the existence of a splinter faction is not dependent on the presence of uncertainty. Deterring a splinter requires the original faction leader to choose a sufficiently extreme position, foregoing many adherents on its left. The original faction's leader may not be willing to pay this price to prevent a splinter from forming.[5]

The original faction's leader also has to form beliefs about which constraint will bind, should a splinter faction form. As formalized in the next result, she chooses a sufficiently extreme position that, for any β_s, the factional competition constraint binds. Label the point where the factional competition constraint just binds $\hat{x}_t$ (formally defined in the proof of Lemma 4).

Lemma 4 *The optimal x_t is such that the factional competition constraint binds (i.e., $x_t^* \geq \hat{x}_t$).*

Given this result, the original terrorist leader chooses a location to solve:

$$\max_{x_t \geq \hat{x}_t} (1 - F(\underline{x}_t(x_t)))(1 + G(\tilde{\beta}_s(x_t))) + \int_{\tilde{\beta}_s(x_t)}^{\overline{\beta}_s} [F(\underline{x}_s^T(x_t, x_s^*(x_t, \beta_s), \beta_s)) - F(\underline{x}_t(x_t))] g(\beta_s) d\beta_s,$$

where, in order to minimize clutter, I only notate those functional dependencies that are relevant. This objective function reflects the original faction's leader's first period payoff of $(1 - F(\underline{x}_t(x_t)))$ and two contingencies for the second period. In the first contingency, no splinter faction forms (if $\beta_s \in [0, \tilde{\beta}_s(x_t))$) and the original faction's leader receives the same payoffs in the second period as in the first. In the second contingency, a splinter faction does form (if $\beta_s \in [\tilde{\beta}_s(x_t), \overline{\beta}_s]$) and the original faction loses all adherents to the right of $\underline{x}_s^T$.

Taking first-order conditions and rearranging shows that the optimal choice at an interior solution is characterized by

$$g(\tilde{\beta}_s(x_t^{**})) \frac{\partial \tilde{\beta}_s}{\partial x_t} (1 - F(\underline{x}_s^T(x_t^{**}, \tilde{\beta}_s))) + \int_{\tilde{\beta}_s(x_t^{**})}^{\overline{\beta}_s} f(\underline{x}_s^T(x_t^{**}, \beta_s)) \left(\frac{\partial \underline{x}_s^T}{\partial x_t} + \frac{\partial \underline{x}_s^T}{\partial x_s} \frac{\partial x_s^*}{\partial x_t} \right) g(\beta_s) d\beta_s$$
$$= 2f(\underline{x}_t(x_t^{**})) \frac{\partial \underline{x}_t}{\partial x_t}. \tag{3}$$

By increasing her faction's extremism, the original faction's leader decreases the probability that a splinter faction will form. If a splinter is deterred, the original faction gains those contested adherents who would have joined the splinter faction. This component of the marginal benefit can be seen in the first term of the left-hand side of Equation 3.

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5 Formally, there would be a splinter in a model with complete information if $1 - F(\underline{x}_t(\tilde{x}_t(\beta_s))) < F(x_s^*(x_t, \beta_s, \beta_t)) - F(\underline{x}_t(x_t))$ for some $x_t < \tilde{x}_t(\beta_s)$. This occurs if the extremists gained by deterring a splinter $(1 - F(x_s^*(x_t, \beta_s, \beta_t)))$ do not make up for the moderates lost $(F(\underline{x}_t(x_t)) - F(\underline{x}_t(\tilde{x}_t(\beta_s))))$.

In the event that a splinter faction forms, increasing the extremism of the original group adds members on the original group's right in the second period, for two reasons. First, for any given location of the splinter faction, a more extreme original faction is more attractive to more extreme members of the population. Second, by becoming more extreme, the original faction pushes the splinter faction to become more extreme and thereby cede more adherents to the original faction. This component of the marginal benefit is represented by the second term on the left-hand side of Equation 3.

Whether or not there is a splinter group, an increase in the original group's extremism costs it adherents from its moderate wing in both periods. This marginal cost can be seen on the right-hand side of Equation 3.

At an interior optimum, the ideological position of the original faction balances these costs and benefits. If the marginal costs are always larger than the marginal benefits, there is a corner solution at $x_t = \hat{x}_t$. Moreover, there is clearly an upper bound on how extreme the original terrorist faction is willing to become because at $x_t > \tilde{x}_t(\overline{\beta}_s)$ there is certain to be no splinter and so becoming more extreme involves costs but not benefits. The original faction's play is summarized in the following result, whose proof is the argument in the text.

Lemma 5 *The optimal ideological position of the original terrorist faction is given by*

$$x_t^* = \begin{cases} \hat{x}_t & \text{if Equation 3 does not hold for any } x_t \in [\hat{x}_t, \tilde{x}_t(\overline{\beta}_s)] \\ x_t^{**} & \text{else,} \end{cases}$$

where x_t^{**} is implicitly defined by Equation 3.

The next result, whose proof follows from the argument in the text, characterizes the equilibrium of the game.

Proposition 3 *There is a unique equilibrium of the game. In that equilibrium, each member of the population behaves according to the strategy implied by Equations 1 and 2, the splinter leader (should he splinter) chooses an ideological location as specified in Lemma 3 and splinters if $1 - F(\underline{x}_s^T(x_s^*, x_t, x_+0, \beta_s, \beta_t, \gamma)) - k > 0$, and the original terrorist leader chooses an ideological location as specified in Lemma 5.*

THE DETERMINANTS OF IDEOLOGY AND SPLINTERING

In this section, I explore how changes in some key parameters affect the likelihood of a splinter faction forming and the positions adopted by the factions.

The Economy

Changes in the economic opportunity costs of terrorism (γ) have no direct effect on the splinter faction, since the outside option constraint does not bind in equilibrium. Such changes can, however, affect the original faction's position, which, in turn, affects the splinter leader's choices.

When the economy improves, the original terrorist faction is less attractive to relative moderates, which diminishes the marginal cost of extremism leading the original terrorist faction to adopt a more extreme position. As shown in Proposition 1, when the original faction becomes more extreme, the probability of a splinter decreases. Thus, an improvement in the economy indirectly makes a splinter less likely. As shown in Remark 1, if a splinter faction does emerge, it will locate in a more extreme position as a result of the original faction's increased extremism.

Proposition 4 *An improvement in the economy (i.e., higher γ) increases the extremism of the original faction, decreases the probability of a splinter faction forming, and, conditional on a splinter forming, increases the extremism of the splinter faction.*

This result speaks to recent debates about the effects of the economy on terrorism.[6] Empirical findings on terrorism and the economy are mixed. Some scholars (e.g., Bloomberg *et al.* (2004)) find the intuitive negative correlation between the economy and terrorism. Others argue that, controlling for political freedom and/or correcting for endogeneity, there is essentially no correlation (e.g., Abadie (2006), Krueger and Laitin (Forthcoming)). Further complicating the debate, Krueger and Maleckova (2003) and Berrebi (2003) find that terrorist operatives do not tend to be from low socio-economic classes, which they interpret to mean that there is little link between the economy and terrorism. Bueno de Mesquita (2005b), however, argues that these individual-level findings are consistent with an economic model of terrorist mobilization, if terrorist organizations screen potential recruits on an ability dimension that is positively correlated with socio-economic status. Benmelech and Berrebi (2007) show empirically that high socio-economic status terrorist operatives are in fact more effective.

The model presented here suggests a framework in which to think about these contradictory empirical results. Positive economic shocks have at least three micro-level effects on the politics of terrorism in the model. First, terrorist mobilization decreases both because opportunity costs increase and because the factions become more extreme. Second, the original faction and the splinter faction (should it exist) become more extreme. Third, an extremist splinter is less likely to form.

These micro-level changes may have competing effects on the total level of terrorist violence. Decreased mobilization is likely to diminish terrorism. Increased ideological extremism is likely to increase terrorism. A decreased likelihood of a splinter forming has ambiguous effects. On the one hand, splinters can spoil peace negotiations (Stedman 1997, Kydd and Walter 2002). On the other hand, internal divisions can be exploited to drive a wedge in terrorist organizations (Bueno de Mesquita 2005a, 2005c).

While the model yields predictions about the effects of the economy on terrorist organizations, it suggests that there is no simple prediction of the effect of the economy on the expected level of violence. Thus, the fact that some macro-level studies of terrorism and the economy find little correlation should not be interpreted to mean that there is

[6] For empirical studies of the relationship between the economy and terrorism, see, for example, Abadie (2006), Abadie and Gardeazabal (2003), Berrebi (2003), Blomberg *et al.* (2004), Enders and Sandler (1996), Krueger and Maleckova (2003), and Sandler and Enders (2005).

no relationship. Rather, the economy may have a variety of effects on terrorism at the micro level that, because they are offsetting, are not observable at the macro level.

Institutions for the Nonviolent Expression of Grievance

When potential terrorists view nonviolent politics as a more viable alternative (i.e., x_0 increases) the effect is similar to an improvement in the economy. It becomes more difficult to recruit relative moderates, leading the original terrorist faction (and, consequently the splinter faction) to become more extreme.

Proposition 5 *When potential terrorists view nonviolent politics as more viable* (x_0 *increases*), *the extremism of the original faction increases*, *the probability of the splinter group forming decreases*, *and*, *conditional on a splinter group forming, the extremism of the splinter faction increases.*

Just as the discussion of the economy highlighted trade-offs associated with economic improvement as a counterterrorism tactic, this result raises questions about attempts to build institutions for the legitimate, nonviolent expression of grievance as a counterterrorism strategy. The construction of such institutions is a common recommendation for societies plagued by violent conflict. But this model suggests that such institutions may involve costs, as well as benefits, in terms of the level of violence. As institutions for the nonviolent expression of grievance become stronger, terrorist mobilization decreases but terrorist organizations become more extreme.

The Costs of Splintering

Given an ideological position for the original terrorist faction, the higher the expected cost of splintering (k), the less likely a splinter group is to emerge. Intuitively, one might think, then, that an increase in the cost of splintering would lead the original terrorist faction to be less extreme, since it does not need to try as hard to deter a splinter faction. This need not be the case.

Implicit differentiation shows that the effect of an increase in the costs of splintering on the extremism of the original faction has the same sign as:

$$-g(\tilde{\beta}_s)\frac{\partial\tilde{\beta}_s}{\partial k}f(\underline{x}_s^T)\left(\frac{\partial\underline{x}_s^T}{\partial x_t}+\frac{\partial\underline{x}_s^T}{\partial x_s}\frac{\partial x_s^*}{\partial x_t}\right)+\left(1-F\left(\underline{x}_s^T\right)\right)\left(g(\tilde{\beta}_s)\frac{\partial^2\tilde{\beta}_s}{\partial x_t\partial k}+g'(\tilde{\beta}_s)\frac{\partial\tilde{\beta}_s}{\partial x_t}\frac{\partial\tilde{\beta}_s}{\partial k}\right). \tag{4}$$

Raising the costs of splintering has two effects on the original faction's marginal benefit from extremism. First, the original faction adds adherents by becoming more extreme *only* when there is a splinter faction competing for extremist adherents. Hence, when the probability of a splinter decreases, this component of the marginal benefit of extremism decreases. This effect, which is represented in the first term of Equation 4, unambiguously drives the original faction to become more moderate.

The second effect, however, is ambiguous. By becoming more extreme, the original faction decreases the likelihood of a splinter forming. The question is whether the magnitude of this decrease becomes larger or smaller when the costs of splintering increase. If it becomes smaller, then the marginal benefit of extremism is reduced. If it becomes bigger, then the marginal benefit of extremism is increased.

To see the ambiguity most clearly, focus on the term $g'(\tilde{\beta}_s)\frac{\partial\tilde{\beta}_s}{\partial x_t}\frac{\partial\tilde{\beta}_s}{\partial k}$ in Equation 4. Since $\frac{\partial\tilde{\beta}_s}{\partial x_t}\frac{\partial\tilde{\beta}_s}{\partial k} > 0$, this component tends to increase (resp. decrease) the marginal benefit of extremism if $g'(\tilde{\beta}_s)$ is positive (resp. negative). Recall that g is the density of the splinter leader's ability to provide nonideological benefits. Suppose that it is some single-peaked density (e.g., a truncated normal). If $\tilde{\beta}_s$ happens to lie to the left of the mode, then $g'(\tilde{\beta}_s) > 0$, and a small increase in the cost of splintering tends to increase the likelihood that a small increase in the extremism of the original group deters a splinter. If $\tilde{\beta}_s$ is on the other side of the mode, the effect is reversed. Since the exact shape of g and the exact magnitude of $\tilde{\beta}_s$ are arbitrary, it is not possible to determine, in general, whether this component of the marginal benefit of extremism is increasing or decreasing in the costs of splintering.

The preceding arguments shows that the effect of the costliness of splintering on the original terrorist group is ambiguous. Moreover, this discussion highlights a more fundamental, and perhaps counterintuitive, implication of the model. Deterring the creation of a splinter faction is one of the benefits of extremism for the original faction. Nonetheless, any factor that exogenously increases the probability of a splinter emerging can lead to an increase or a decrease in the extremism of the original terrorist faction, depending on specific functional form and distributional assumptions.

Nonideological Benefits and Costs of Disloyalty

As discussed in Proposition 2, a splinter leader who is able to provide a high level of nonideological benefits competes more successfully for moderate adherents. This means that the splinter leader can afford to adopt a more moderate position and can attract more adherents, making it more likely that the potential leader will find splintering worth the risk.

Proposition 6 *When the splinter leader is better able to provide nonideological benefits, a splinter is more likely to form and, if it does, it will be more moderate.*

In addition to gaining nonideological benefits from joining the splinter faction, members of the population also bear costs associated with possible retaliation from the original faction. These costs operate as the exact opposite of the splinter group's nonideological benefits. Thus, the following is immediate from Proposition 6.

Corollary 1 *If it becomes more costly to join a potential splinter group (i.e., c increases), a splinter is less likely to form and, if it does form, it will be more extreme.*

The effects of an increase in the original faction's ability to provide nonideological benefits are less clear. Like with the splinter group, an increase in the original group's capacity for providing nonideological benefits increases the number of adherents it can recruit. However, for a fixed ideological position on the part of the original faction, an increase in the nonideological benefits the original faction can provide decreases the probability that a splinter faction will emerge at all. And, as was discussed in the previous section, the effect of such a change on the ideological position of the original faction is ambiguous.

CONCLUSION

I have presented a model that yields a number of results concerning factors that affect the extremism of terrorist factions, the likelihood of a splinter emerging, and the level of mobilization. The model illuminates a critical trade-off for governments. Policies such as strengthening the economy or outlets for nonviolent expression of grievances reduce mobilization but also make terrorist factions more extreme. Moreover, these competing micro-level effects of economic growth or increased opportunities for the expression of grievance on the expected level of violence might be missed in, and confound the interpretation of, the sort of macro-level data analysis that is the mainstay of empirical studies of terrorism.

The model is only one step in the ongoing project of analyzing the internal politics of terrorist organizations. Clearly, it is incomplete in a variety of important ways. The model is silent on how levels of extremism translate into violence (Bueno de Mesquita 2005a, Berrebi and Klor 2006), willingness to negotiate and compromise (Lapan and Sandler 1988, Kydd and Walter 2002, Bueno de Mesquita 2005a), the types of tactics terrorists choose (Rosendorff and Sandler 2004), or the level of commitment within a terrorist organization (Berman 2003, Azam 2005, Shapiro and Siegel 2007). Moreover, the model does not address how counterterrorism policy might affect affiliation decisions (Rosendorff and Sandler 2004, Buendo de Mesquita 2005b, Bueno de Mesquita and Dickson 2007) or the positions taken by the terrorist factions (de Figueiredo and Weingast 2001). Finally, the model assumes that terrorist leaders are motivated by a desire to attract adherents. Although recruitment is likely to be one of leaders' motivations, several other factors influence their behavior, such as true ideological motivations, rent-seeking, and signaling to donors or the government (Lapan and Sandler 1993, Overgaard 1994).

The limited objective of this paper was to focus on mobilization, extremism, and factionalization. The resulting model helps provide micro-foundations for the ideological heterogeneity of terrorist groups, suggests testable implications, offers new interpretations of and challenges for existing empirical findings, and identifies previously unexplored trade-offs in potential counterterrorism policies.

APPENDIX

Proof of Lemma 1

Condition 1, which describes when a person will join the original faction, can be rewritten:

$$u(|x_0 - x_i|) - u(|x_t - x_i|) \geq \gamma - \beta_t. \tag{5}$$

Notice, first, that the right-hand side of Condition 5 is constant in x_i. Now I argue that the left-hand side goes to infinity as x_i goes to infinity. To see this, define $y = x_i - x_t$ and $z = x_t - x_0$. Now we have:

$$\begin{aligned}\lim_{x_i \to \infty} u(|x_0 - x_i|) - u(|x_t - x_i|) &= \lim_{y \to \infty} u(y + z) - u(y) \\ &> \lim_{y \to \infty} u'(y)z \\ &= \infty,\end{aligned}$$

where the first equality is a simple change of variables, the first inequality follows from the convexity of u, and the final equality follows from $\lim_{x\to\infty} u'(x) = \infty$.

Given this argument, there is a single cutpoint if the left-hand side is monotonically increasing in x_i. Consider, then, the derivative of the left-hand side with respect to x_i. If $x_i < x_0 < x_t$, the derivative is $-u'(x_0 - x_i) + u'(x_t - x_i)$ which is positive since $x_t - x_i > x_0 - x_i$ and u is convex. If $x_0 < x_i < x_t$ the derivative is $u'(x_i - x_0) + u'(x_t - x_i) > 0$. If $x_0 < x_t < x_i$, the derivative is $u'(x_i - x_0) - u'(x_i - x_t)$ which is positive since $x_i - x_0 > x_i - x_t$ and u is convex. Thus, the left-hand side of Condition 5 is monotonically increasing in x_i.

At the cutpoint, we have $u(|x_0 - \underline{x}_t|) - u(|x_t - \underline{x}_t|) = \gamma - \beta_t$. To see that the cutpoint is increasing in x_t for $x_t > \underline{x}_t$ and decreasing in x_t for $x_t < \underline{x}_t$ consider the derivative of the cutpoint with respect to x_t. If $\underline{x}_t < x_0 < x_t$, implicitly differentiating gives $\frac{\partial \underline{x}_t}{\partial x_t} = \frac{u'(x_t - \underline{x}_t)}{u'(x_t - \underline{x}_t) - u'(x_0 - \underline{x}_t)} > 0$, where the inequality follows from the fact that the numerator is clearly positive and the denominator is positive because $x_t - \underline{x}_t > x_0 - \underline{x}_t$ and u is convex. If $x_0 \leq \underline{x}_t < x_t$, $\frac{\partial \underline{x}_t}{\partial x_t} = \frac{u'(x_t - \underline{x}_t)}{u'(x_t - \underline{x}_t) + u'(x_0 - \underline{x}_t)} > 0$, where the inequality follows from the fact that the numerator and denominator are both clearly positive. If $x_0 < x_t \leq \underline{x}_t$, $\frac{\partial \underline{x}_t}{\partial x_t} = \frac{-u'(\underline{x}_t - x_t)}{u'(\underline{x}_t - x_0) - u'(\underline{x}_t - x_t)} < 0$, where the inequality follows from the fact that the numerator is clearly negative and the denominator is positive because $\underline{x}_t - x_0 > \underline{x}_t - x_t$ and u is convex. □

Proof of Lemma 2

Point 1 is immediate from the fact that $x_s \geq x_t$ and $\beta_s - c < \beta_t$.

To establish point 2 it suffices to show that for all $x_i' \geq x_i$:

$$\begin{aligned}&\text{If } \beta_s - c - u(|x_i - x_s|) \geq \max\{\gamma - u(x_i - x_0), \beta_t - u(x_i - x_t)\}, \quad \text{then} \\ &\quad \beta_s - c - u(|x_i' - x_s|) \geq \max\{\gamma - u(x_i' - x_0), \beta_t - u(x_i' - x_t)\}. \qquad (6)\end{aligned}$$

First notice that if $\max\{\gamma - u(x_i - x_0), \beta_t - u(x_i - x_t)\} = \beta_t - u(x_i - x_t)$, then $\max\{\gamma - u(x_i' - x_0), \beta_t - u(x_i' - x_t)\} = \beta_t - u(x_i' - x_t)$. To see this, note that a sufficient condition for the former to imply the latter is $u(x_i' - x_0) - u(x_i' - x_t) > u(x_i - x_0) - u(x_i - x_t)$, which follows directly from the convexity of u. Now there are three cases to consider.

Case 1: $\max\{\gamma - u(x_i - x_0), \beta_t - u(x_i - x_t)\} = \gamma - u(x_i - x_0)$ and $\max\{\gamma - u(x_i' - x_0), \beta_t - u(x_i' - x_t)\} = \gamma - u(x_i' - x_0)$.

Condition 6 holds if $\beta_s - c - u(|x_i - x_s|) \geq \gamma - u(x_i - x_0)$ implies that $\beta_s - c - u(|x_i' - x_s|) > \gamma - u(x_i' - x_0)$. If $x_i < x_i' < x_s$, then it suffices to show that $u(x_i' - x_0) - u(x_s - x_i') > u(x_i - x_0) - u(x_s - x_i)$, which follows from the facts that $x_i' - x_0 > x_i - x_0$ and $x_s - x_i' < x_s - x_i$. If $x_i < x_s < x_i'$ it suffices to show that $u(x_i' - x_0) - u(x_i' - x_s) > u(x_i - x_0) - u(x_s - x_i)$. This condition obviously holds when $x_i' - x_s \leq x_s - x_i$. Now, to show that it holds for $x_i' - x_s > x_s - x_i$ it suffices to show that $u(x_i' - x_0) - u(x_i' - x_s)$ is increasing in x_i'. Taking derivatives, we have $\frac{\partial[u(x_i' - x_0) - u(x_i' - x_s)]}{\partial x_i'} = u'(x_i' - x_0) - u'(x_i' - x_s)$, which is positive since u' is increasing and $x_i' - x_0 > x_i' - x_s$. Finally, if $x_s < x_i < x_i'$, then it suffices to show that $u(x_i' - x_0) - u(x_i' - x_s) > u(x_i - x_0) - u(x_i - x_s)$, which follows from the convexity of u.

Case 2: $\max\{\gamma - u(x_i - x_0), \beta_t - u(x_i - x_t)\} = \gamma - u(x_i - x_0)$ and $\max\{\gamma - u(x_i' - x_0), \beta_t - u(x_i' - x_t)\} = \beta_t - u(x_i' - x_t)$.

To show that Condition 6 holds, it suffices to show that if $\beta_s - c - u(|x_i - x_s|) \geq \gamma - u(x_i - x_0)$, then $\beta_s - c - u(|x_i' - x_s|) > \beta_t - u(x_i' - x_t)$. Moreover, since we have that $\gamma - u(x_i - x_0) > \beta_t - u(x_i - x_t)$, it is also sufficient to show the stronger condition that if $\beta_s - c - u(|x_i - x_s|) \geq \beta_t - u(x_i - x_t)$, then $\beta_s - c - u(|x_i' - x_s|) > \beta_t - u(x_i' - x_t)$. Now the proof is identical to Case 1, substituting x_t for x_0.

Case 3: $\max\{\gamma - u(x_i - x_0), \beta_t - u(x_i - x_t)\} = \beta_t - u(x_i - x_t)$ and $\max\{\gamma - u(x_i' - x_0), \beta_t - u(x_i' - x_t)\} = \beta_t - u(x_i' - x_t)$.

To show that Condition 6 holds, it suffices to show that if $\beta_s - c - u(|x_i - x_s|) \geq \beta_t - u(x_i - x_t)$, then $\beta_s - c - u(|x_i' - x_s|) > \beta_t - u(x_i' - x_t)$. Now the proof is identical to Case 2. □

Proof of Lemma 3

To see that $x_s^* > x_t$, suppose not. Since $\beta_s - c < \beta_t$, if $x_s^* = x_t$, then no one joins the splinter faction, which cannot be optimal.

The point $\underline{x}_s^O$ is implicitly defined by $\beta_s - c - u(|x_s - \underline{x}_s^O|) = \gamma - u(\underline{x}_s^O - x_0)$ and the point $\underline{x}_S^T$ is implicitly defined by $\beta_s - c - u(|x_s - \underline{x}_s^T|) = \beta_t - u(\underline{x}_s^T - x_t)$. There are two cases:

1. $\underline{x}_s^O > \underline{x}_s^T$: Suppose $x_s < \underline{x}_s = \underline{x}_s^O$. Then $\underline{x}_s$ is given by $\beta_s - c - u(\underline{x}_s - x_s) = \gamma - u(\underline{x}_s - x_0)$. In this event, we have that $\frac{\partial \underline{x}_s}{\partial x_s} = \frac{u'(\underline{x}_s - x_s)}{u'(\underline{x}_s - x_s) - u'(\underline{x}_s - x_0)} < 0$, where the inequality follows from the fact that the numerator is positive and the fact that the convexity of u implies that the denominator is negative. The total membership of the splinter faction is $1 - F(\underline{x}_s)$. Increasing x_s decreases $\underline{x}_s$, which increases membership, so x_s cannot have been a best response.

   Suppose, instead, that $x_s > \underline{x}_s$. Then $\underline{x}_s$ is given by $\beta_s - c - u(x_s - \underline{x}_s) = \gamma - u(\underline{x}_s - x_0)$. Here we have that $\frac{\partial \underline{x}_s}{\partial x_s} = \frac{u'(x_s - \underline{x}_s)}{u'(x_s - \underline{x}_s) + u(\underline{x}_s - x_0)} > 0$. Total membership in the splinter faction is $1 - F(\underline{x}_s)$. Increasing x_s increases $\underline{x}_s$, which decreases membership, so doing so cannot be a best response. Membership, in this case, is thus maximized when $x_s = \underline{x}_s(x_s)$.
2. $\underline{x}_s^T > \underline{x}_s^O$. The argument in this case is identical to that in Case 1, substituting $\beta_t - u(\underline{x}_s - x_t)$ for $\gamma - u(\underline{x}_s - x_0)$. □

Proof of Remark 1

If the outside option constraint binds, the location of the original terrorist faction has no effect. If the factional competition constraint binds, then the x_s^* is given by $\beta_s - c - u(0) = \beta_t - u(x_s^* - x_t)$. Implicitly differentiating gives $\frac{\partial x_s^*}{\partial x_t} = 1$, establishing the result. □

Proof of Proposition 1

From Lemma 3, the splinter faction's value function can be written $V_s = 1 - F(x_s^*(x_t, \beta_s, \beta_t)) - k$. Differentiating gives $\frac{\partial V_s}{\partial x_t} = -f(x_s^*)\frac{\partial x_s^*}{\partial x_t} < 0$, where the inequality follows from $\frac{\partial x_s^*}{\partial x_t} > 0$ (Remark 1). □

Proof of Proposition 2

Recall from the proof of Remark 1 that x_s^* is given by $\beta_s - c - u(0) = \beta_t - u(x_s^* - x_t)$. Implicitly differentiating yields $\frac{\partial x_s^*}{\partial \beta_s} = \frac{-1}{u'(x_s^* - x_t)} < 0$. Now, differentiating V_s (from the previous proof) gives $\frac{\partial V_s}{\partial \beta_s} = -f(x_s^*)\frac{\partial x_s^*}{\partial \beta_s} > 0$. □

Proof of Lemma 4

I will make use of the following claim.

Claim 1 *The optimal position for the original faction, x_t^*, satisfies $x_t^* \geq \underline{x}_t(x_t^*)$.*

By Lemma 3, at the optimal x_s, $\beta_s - c - u(0) = \max\{\beta_t - u(x_s^* - x_t), \gamma - u(x_s^* - x_0)\}$. Hence, the factional competition constraint binds if and only if $\beta_t - u(x_s^* - x_t) > \gamma - u(x_s^* - x_0)$. By Claim 1, $\beta_t - u(x_i - x_t^*) \geq \gamma - u(x_i - x_0)$ for all $x_i > x_t^*$. Thus, given that $x_s^* > x_t^*$, the factional choice constraint binds. All that remains is to prove the claim.

Proof of Claim 1: Suppose that the optimal x_t is less than $\underline{x}_t(x_t)$. Rearranging the definitions of $\underline{x}_s^O$ and $\underline{x}_s^T$ and comparing, shows that the factional competition constraint binds if and only if

$$x_t \geq x_0 + u^{-1}(\gamma - \beta_s + c + u(0)) - u^{-1}(\beta_t - \beta_s + c + u(0)) \equiv \hat{x}_t(x_t, \beta_s).$$

Differentiating and applying the inverse function theorem gives:

$$\frac{\partial \hat{x}_t(x_t, \beta_s)}{\partial \beta_s} = \frac{1}{u'(u^{-1}(\beta_t - \beta_s + c + u(0)))} - \frac{1}{u'(u^{-1}(\gamma - \beta_s + c + u(0)))} > 0,$$

where the inequality follows from the fact that u and u^{-1} are increasing and $\gamma > \beta_t$. Thus, the x_t required to make the factional competition constraint bind is increasing in β_s. This implies that, for a fixed x_t, the outside option constraint only binds if β_s is sufficiently large. Label the minimal β_s needed for the outside option constraint to hold with $\hat{\beta}_s(x_t)$. The argument above establishes that $\frac{\partial \hat{\beta}_s}{\partial x_t} > 0$.

Notice, further, that if the outside option constraint binds, then the original terrorist organization attracts no adherents in the second period. To see this, note that the outside option constraint binding implies that $\underline{x}_t > \underline{x}_s$. If this were not the case, then, by the definition of $\underline{x}_t$, at $\underline{x}_s$ we would have $\beta_t - u(\underline{x}_s - x_t) > \gamma - u(\underline{x}_s - x_0)$, contradicting the condition that the outside option constraint binds. And now, by Lemma 2 and the definition of $\underline{x}_s$, if $\underline{x}_t > \underline{x}_s$, no one joins the original faction. Now, there are several cases to consider.

1. $\tilde{\beta}_s \geq \hat{\beta}_s$: The original faction's payoff for any $x_t < \underline{x}_t(x_t)$ is

$$(1 - F(\underline{x}_t))(1 + G(\tilde{\beta}_s(x_t))).$$

The derivative of this with respect to x_t is

$$-f(\underline{x}_t)(1 + G(\tilde{\beta}_s(x_t)))\frac{\partial \underline{x}_t}{\partial x_t} + g(\tilde{\beta}_s(x_t))(1 - F(\underline{x}_t))\frac{\partial \tilde{\beta}_s}{\partial x_t} > 0,$$

where the inequality follows from the fact that Lemma 1 shows that $\frac{\partial \underline{x}_t}{\partial x_t} < 0$ for $x_t < \underline{x}_t(x_t)$ and the fact that $\tilde{\beta}_s$ is increasing in x_t.

2. $\tilde{\beta}_s < \hat{\beta}_s$: The original faction's payoff for any $x_t < \underline{x}_t(x_t)$ is

$$(1 - F(\underline{x}_t))(1 + G(\tilde{\beta}_s(x_t))) + \int_{\tilde{\beta}_s(x_t)}^{\hat{\beta}_s(x_t)} [F(\underline{x}_s^T(x_t, \beta_s)) - F(\underline{x}_t(x_t))]g(\beta_s)d\beta_s.$$

Using Leibniz's rule, the derivative of this payoff function with respect to x_t is

$$\begin{aligned}
&-f(\underline{x}_t)(1 + G(\tilde{\beta}_s(x_t)))\frac{\partial \underline{x}_t}{\partial x_t} + g(\tilde{\beta}_s(x_t))(1 - F(\underline{x}_t))\frac{\partial \tilde{\beta}_s}{\partial x_t} \\
&+ \int_{\tilde{\beta}_s(x_t)}^{\hat{\beta}_s(x_t)} \left[f(\underline{x}_s^T(x_t)) \left(\frac{\partial \underline{x}_s^T}{\partial x_t} + \frac{\partial \underline{x}_s^T}{\partial x_s}\frac{\partial x_s^*}{\partial x_t} \right) - f(\underline{x}_t)\frac{\partial \underline{x}_t}{\partial x_t} \right] g(\beta_s)d\beta_s \\
&+ [F(\underline{x}_s^T(\hat{\beta}_s)) - F(\underline{x}_t)]\, g(\hat{\beta}_s)\frac{\partial \hat{\beta}_s}{\partial x_t} - [F(\underline{x}_s^T(\tilde{\beta}_s)) - F(\underline{x}_t)]\, g(\tilde{\beta}_s)\frac{\partial \tilde{\beta}_s}{\partial x_t}.
\end{aligned}$$

Given that $\underline{x}_t$ is not a function of β_s, this can be rewritten:

$$\begin{aligned}
&-f(\underline{x}_t)(1 + G(\hat{\beta}_s(x_t)))\frac{\partial \underline{x}_t}{\partial x_t} + g(\tilde{\beta}_s(x_t))(1 - F(\underline{x}_s^T(\tilde{\beta}_s))\frac{\partial \tilde{\beta}_s}{\partial x_t} \\
&+ [F(\underline{x}_s^T(\hat{\beta}_s)) - F(\underline{x}_t)]\, g(\hat{\beta}_s)\frac{\partial \hat{\beta}_s}{\partial x_t} \\
&+ \int_{\tilde{\beta}_s(x_t)}^{\hat{\beta}_s(x_t)} f(\underline{x}_s^T(x_t)) \left(\frac{\partial \underline{x}_s^T}{\partial x_t} + \frac{\partial \underline{x}_s^T}{\partial x_s}\frac{\partial x_s^*}{\partial x_t} \right) g(\beta_s)d\beta_s > 0,
\end{aligned}$$

where the inequality is justified as follows: The first term is positive because $\frac{\partial \underline{x}_t}{\partial x_t} < 0$ for $x_t > \underline{x}_t(x_t)$ by Lemma 1. The second term is positive because $\tilde{\beta}_s$ is increasing in x_t. The third term is positive because $\underline{x}_s^T > \underline{x}_t$ and $\hat{\beta}_s$ is increasing in x_t. The fourth term is positive because $\underline{x}_s^T$ is increasing in x_t (immediate from definition), $\underline{x}_s^T$ is increasing in x_s (immediate from definition), and x_s^* is increasing in x_t (Remark 1).

Thus, the original group's payoff is strictly increasing for any $x_t < \underline{x}_t(x_t)$. □

Proof of Proposition 4

Taking the cross-partial of the objective with respect to x_t and γ yields:

$$\frac{\partial^2 U_t}{\partial x_t \partial \gamma} = -2f'(\underline{x}_t)\frac{\partial \underline{x}_t}{\partial x_t}\frac{\partial \underline{x}_t}{\partial \gamma} - 2f(\underline{x}_t)\frac{\partial^2 \underline{x}_t}{\partial x_t \partial \gamma}.$$

Recall from Claim 1 that $x_t^* \geq \underline{x}_t(x_t^*)$, so $\underline{x}_t$ is implicitly defined by $\beta_t - u(x_t - \underline{x}_t) - \gamma + u(\underline{x}_t - x_0) = 0$. Implicitly differentiating shows that $\frac{\partial \underline{x}_t}{\partial \gamma} = \frac{1}{u'(x_t - \underline{x}_t) + u'(\underline{x}_t - x_0)} > 0$, $\frac{\partial \underline{x}_t}{\partial x_t} = \frac{u'(x_t - \underline{x}_t)}{u'(x_t - \underline{x}_t) + u'(\underline{x}_t - x_0)} > 0$, and $\frac{\partial^2 \underline{x}_t}{\partial \gamma \partial x_t} = -\frac{u''(x_t - \underline{x}_t)\left(1 - \frac{\partial \underline{x}_t}{\partial x_t}\right) + u''(\underline{x}_t - x_0)\frac{\partial \underline{x}_t}{\partial x_t}}{\left(u'(x_t - \underline{x}_t) + u'(\underline{x}_t - x_0)\right)^2} < 0$, where the inequalities follow from the facts that u' and u'' are positive and $\frac{\partial \underline{x}_t}{\partial x_t} \in (0, 1)$. Thus, the first term is positive (since $f' < 0$) and the second term is positive (since $f > 0$). This implies that $\frac{\partial^2 U_t}{\partial x_t \partial \gamma} > 0$ and Theorem 3 of Edlin and Shannon (1998) implies that at an interior solution x_t^* is strictly increasing in γ. The other claims now follow from Proposition 1 and Remark 1. □

Proof of Proposition 5

Taking the cross-partial of the objective with respect to x_t and x_0 yields:

$$\frac{\partial^2 U_t}{\partial x_t \partial x_0} = -2f'(\underline{x}_t)\frac{\partial \underline{x}_t}{\partial x_t}\frac{\partial \underline{x}_t}{\partial x_0} - 2f(\underline{x}_t)\frac{\partial^2 \underline{x}_t}{\partial x_t \partial x_0}.$$

Using the fact that $\underline{x}_t$ is implicitly defined by $\beta_t - u(x_t - \underline{x}_t) - \gamma + u(\underline{x}_t - x_0) = 0$ and differentiating yields:

$$\frac{\partial \underline{x}_t}{\partial x_0} = \frac{u'(\underline{x}_t - x_0)}{u'(x_t - \underline{x}_t) + u'(\underline{x}_t - x_0)} = 1 - \frac{\partial \underline{x}_t}{\partial x_t},$$

and

$$\frac{\partial^2 \underline{x}_t}{\partial x_t \partial x_0} = \frac{u''(\underline{x}_t - x_0)u'(x_t - \underline{x}_t)^2 - u''(x_t - \underline{x}_t)u'(\underline{x}_t - x_0)^2}{\left(u'(x_t - \underline{x}_t) + u'(\underline{x}_t - x_0)\right)^3}.$$

The first term of the cross-partial of the objective function is clearly positive, since $\frac{\partial \underline{x}_t}{\partial x_0} > 0$, $\frac{\partial \underline{x}_t}{\partial x_t} > 0$, and $f' < 0$. Thus, it will complete the proof to show that the second term is positive, which is true if $\frac{\partial^2 \underline{x}_t}{\partial x_t \partial x_0} < 0$. This, in turn, is true if $u''(\underline{x}_t - x_0)u'(x_t - \underline{x}_t)^2 < u''(x_t - \underline{x}_t)u'(\underline{x}_t - x_0)^2$ which can be rewritten $\frac{u'(x_t - \underline{x}_t)^2}{u''(x_t - \underline{x}_t)} < \frac{u'(\underline{x}_t - x_0)^2}{u''(\underline{x}_t - x_0)}$. Since both u' and $\frac{u'}{u''}$ are increasing, it suffices to show that $\underline{x}_t - x_0 > x_t - \underline{x}_t$. This is true if and only if $\underline{x}_t > \frac{x_t + x_0}{2}$. To see that this is the case, recall that $\underline{x}_t$ is given by $\beta_t - u(x_t - \underline{x}_t) - \gamma + u(\underline{x}_t - x_0) = 0$. The left-hand side of this condition is clearly increasing in $\underline{x}_t$. Moreover, evaluated at $\underline{x}_t = \frac{x_t + x_0}{2}$, the left hand-side is negative (since $\beta_t < \gamma$). Thus, $\underline{x}_t > \frac{x_t + x_0}{2}$. □

Proof of Proposition 6

The first claim is from Proposition 2. From Lemma 3, the splinter faction's location is given by $\beta_s - c - u(0) = \beta_t - u(x_s^* - x_t)$. Implicitly differentiating gives $\frac{\partial x_s^*}{\partial \beta_s} = \frac{-1}{u'(x_s^* - x_0)} < 0$. □

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