Tug of War: The Heterogeneous Effects of Outbidding between Terrorist Groups *

Casey Crisman-Cox† Michael Gibilisco‡

April 2022

Abstract

We introduce a dynamic game of outbidding where two groups use violence to compete for evolving public support in a tug-of-war fashion. We fit the model to the canonical outbidding rivalry between Hamas and Fatah, using newly collected data on Palestinian support for the two groups. Competition produces heterogeneous effects, and we demonstrate that intergroup competition can deter violence. Competition from Hamas leads Fatah to use more terrorism than it would in a world where Hamas abstains from terrorism, but competition from Fatah can lead Hamas to attack less than it otherwise would. Likewise, making Hamas more capable or interested in competing increases overall violence, but making Fatah more capable or interested discourages violence on both sides. This deterrent effect of competition on violence is unexpected by current outbidding theories and emerges through the asymmetric contest: Fatah more effectively uses terrorism to boost its support although Hamas has smaller attack costs.

*First draft: November 2020. Thanks to Federico Echenique, Alex Hirsch, Karam Kang, Brenton Kenkel, Gabriel Lopez-Moctezuma, Jack Paine, Kirssa Cline Ryckman, Jean-Laurent Rosenthal, Matt Shum, William Spaniel, Yi Xin, and Caltech's Applied Political Theory Group for comments and discussions. Previous versions of this paper were circulated under the title "Tug of War: Dynamic Outbidding between Terrorist Groups."

†Texas A&M University. Email: `c.crisman-cox@tamu.edu`

‡California Institute of Technology. Email: `michael.gibilisco@caltech.edu`

1 Introduction

Outbidding is an explanation for terrorism where competing anti-government groups use violence to increase their share of popular support at the expense of their rivals. In this story, terrorism signals resolve or capacity to a population that is uncertain about which group best represents its interests. In turn, popularity and attention are critical for groups' recruitment numbers, financial resources, political influence, and day-to-day operations (Acosta 2014; Crenshaw 1981; Fortna 2015; Polo and González 2020). It is a particularly unique theory of terrorism because "the enemy is only tangentially related to the strategic interaction," and therefore outbidding "provides a potential explanation for terrorist attacks that continue even when they seem unable to produce any real results" (Kydd and Walter 2006, 77). Because scholars are still debating the degree to which terrorism helps groups achieve their long-term political objectives, outbidding provides an important explanation for persistent terrorism.[1]

Because of this unique status, outbidding is often used to explain terrorism and intrastate violence. Following Bloom's (2004) seminal work, researchers generally expect greater violence when groups have stronger incentives to compete although there is disagreement on how to identify competitive incentives or whether to measure the extent or intensity of terrorism. Conrad and Greene (2015, 547) concisely summarize a key theoretical mechanism underlying many of these studies: "Since competition directly and indirectly threatens the resource base necessary to sustain the organization and ensure its effectiveness, it follows that terrorist organizations should make tactical choices in an effort to increase their share of resources within a competitive environment."

This outbidding logic is incomplete, however. We still do not know how incentives to compete affect overall rates of violence because countervailing forces exist. On the one hand, if one group becomes more competitive, others may fight harder to keep up. This is the expected effect in the outbidding literature, where enhanced violence by and competition from one actor encourages others to use more violence. On the other hand, if one group becomes more competitive, others may recognize a lost cause and give up. This deterrent effect is overlooked in the outbidding literature. Furthermore, it can create an equilibrium feedback loop where even the most competitive group uses less violence as it expects little push back from its rivals.

The theoretical and experimental economic literature on contests demonstrates that the deterrent effect emerges when one participant is asymmetrically advantaged, e.g., has lower costs of effort or is favored in the contest success function (Dechenaux, Kovenock and Sheremeta 2015; Stein 2002). The effect also appears in dynamic contests where players

[1] Abrahms (2006, 2012), Jones and Libicki (2008), Fortna (2015), and Getmansky and Zeitzoff (2014) argue that terrorism can be ineffective in this regard. In contrast, Gould and Klor (2010) and Thomas (2014) find that terrorism can make governments or citizens more accommodating. For mixed effects see Beber, Roessler and Scacco (2014).

repeatedly compete over time (Konrad 2012). Overall rates of effort can therefore increase when one player becomes less competitive through handicapping the strong or providing head starts to the weak (Franke, Leininger and Wasser 2018; Kirkegaard 2012; Siegel 2014).

The degree to which asymmetries and the deterrent effect appear in real-world competition among terrorist groups is not obvious, however. The rivalry between Hamas and Fatah is the most well-studied example of outbidding, but even here it is unclear which actor, if either, is advantaged. Fatah might be an advantaged actor due to its status-quo leadership position and outside support from Israel and the U.S. Nonetheless, the ease at which Hamas uses violence may indicate that it is the advantaged actor. Without a systematic analysis connecting theory to data, we do not know if these asymmetries are relevant or are strong enough to create deterrent effects.

Common empirical strategies to test outbidding hypotheses are ill-suited to discovering the deterrent effect. Most frequently, studies regress measures of violence on proxies for incentives to compete—e.g., the number of groups in a conflict—using time-series-cross-sectional data and test for a positive association.[2] Within this framework, Findley and Young (2012) find no relationship between competition and violence, but Chenoweth (2010), Cunningham, Bakke and Seymour (2012), and Wood and Kathman (2015) find a positive relationship. Others highlight more limited or conditional findings (Conrad and Greene 2015; Conrad and Spaniel 2021; Nemeth 2014). This type of research design faces two challenges, however. First, it requires researchers to proxy for incentives to compete, but directly evaluating the strength of these proxies is difficult, especially when commonly used measures (e.g., number of terrorist groups) could be confounded by other aspects of the conflict (e.g., state strength). Second, it does not accommodate potentially heterogeneous effects of competition on violence. Hence, even when outbidding features prominently in the data generating process, regressions could find limited associations between competition and conflict because the encouragement and deterrent effects wash each other out in the aggregate.

In this paper, we systematically document the effect of competition on violence in the canonical example of outbidding: the rivalry between Hamas and Fatah. We find that competition has heterogeneous effects on violence. In particular, we provide strong evidence that the deterrent effect is a feature of this conflict. To do this, we first construct a novel model of outbidding as a dynamic contest wherein each side uses terrorism to pull public opinion towards itself and away from its opponent in a tug-of-war fashion. Second, we compile monthly survey data that records aspects of Palestinian public opinion from 1994 to 2018. The collected data provide fine-grained details on how Palestinians view the

[2] Of course, there are other research designs. Biberman and Zahid (2019), for example, use case studies to show that outbidding among factions within an organization can increase the likelihood of violence. Vogt, Gleditsch and Cederman (2021) argue that competition creates incentives for groups to expand the scope of their demands, leading to more violence.

conflict and the two groups, and we use it to measure the relative popularity of Hamas and Fatah. Third, we adopt the structural approach. We estimate the parameters of our model given data on public opinion and the groups' use of violence, and we then use the fitted model to quantify the substantive effects of competition on violence. Thus, our approach sidesteps the need for the indirect proxies of competition traditionally used in reduced-form regression. It fully embeds the intergroup strategic competition that defines outbidding into a unified theoretical and empirical framework.

We demonstrate competition's heterogeneous effects on violence using two types different counterfactual experiments. First, we compare the estimated equilibrium rates of terrorism to those in the counterfactual scenarios in which a group never anticipates violence from its rival. Comparing how a group behaves with and without violence from its rival is one way to compare group behavior in competitive and noncompetitive environments, respectively. We find that competition from Hamas has an encouragement effect on Fatah's use of violence, where Fatah is 34% more violent in equilibrium than when it expects Hamas to never attack. In contrast, we find that competition from Fatah has heterogeneous effects on Hamas's use of violence. After the Oslo era, we find the encouragement effect emerges, where Hamas uses about 37% more violence because of competition with Fatah. During the Oslo era between 1994 and 2001, Hamas is 4% less violent in equilibrium than in its single-agent problem. That is, competition from Fatah depresses Hamas's use of violence even during the time when the two groups are fighting for support from the Palestinians. This illustrates the deterent effect, which is unexpected in the outbidding literature.

Second, we conduct comparative statics exercises that quantify how equilibrium rates of violence change as a group becomes more or less competitive, i.e., has stronger or weaker incentives to compete. Whereas the first type of counterfactuals fixed behavior of one group, these exercises illustrate how the behavior of both groups change as exogenous incentives to compete change. In our framework (as in other contest models), groups become more competitive when they place greater value on their popularity, have smaller costs of attacking, or become more effective at using terrorism to attract support. We find that making Hamas more competitive along any of these three dimensions increases the probability that either group uses terrorism. This is the expected encouragement effect in the outbidding literature where increasing the competitiveness of an actor leads to an increase in violence for not only the group in question but all groups involved. If Fatah becomes more competitive along any of these dimensions, however, both groups' propensities for terrorism decrease. This is the unexpected deterrence effect of outbidding.

Furthermore, our theoretical framework explains these results via asymmetric competition. Although we find that Hamas has both lower costs to terrorism and places higher value on its public support than Fatah, Fatah is more effective at increasing its support through terrorist attacks than Hamas. That is, attacks by Fatah result in larger pro-Fatah shifts in public opinion than the corresponding effects of Hamas attacks on pro-Hamas shifts. Because Fatah is substantially more capable at moving public opinion with violence, if its incentives to compete increase, then the group is more willing to take on the immediate costs of violence to move popular opinion more quickly. Hamas cannot compete with Fatah's level of efficiency and reduces its use of terrorism. This creates an equilibrium feedback loop and decreases Fatah's propensity to attack as its rival Hamas becomes more nonviolent.

Our analysis leads to a rich set of substantive and policy implications. For the conflict literature, we show that intergroup competition can not only decrease violence among rival terrorist groups, but also that this unexpected deterrence effect emerges in the most well known and studied case of outbidding. We uncover the deterrence effect using a theory solely focused on outbidding and competition between two rivals. In the model, there are no free-riding effects from ideologically similar groups or endogenous government interventions, which might be other explanations for a negative relationship between competition and violence. The deterrence result is a new empirical finding within the outbidding literature, and scholars should account for the possibility that competition can encourage or discourage violence among groups in future studies that test outbidding hypotheses. Specifically, reduced-form correlations between competition and violence, like those reported in time-series cross-section regressions, cannot falsify outbidding hypotheses. Contests between potentially asymmetric terrorist groups can be consistent with either a positive or negative or null relationship between measures of competition and overall rates of violence. To disentangle encouragement and deterrent effects, we adopt the structural approach as detailed below, although alternative strategies may be useful too. But, it is clear that a close connection between formal theory and data is needed in future work.

For policy, many U.S. administrations provide direct and indirect support for Fatah, building the group's governing and coercive capacity to counterbalance Hamas (Kalman 2006). There is little research about the effectiveness of such policies, and our results suggest countervailing effects. If third-party support for Fatah increases the group's effectiveness of using terrorism to increase public opinion or decreases its cost of attacking, then violence should decrease, as increasing Fatah's incentives to compete decreases violence from both groups. If third-party support makes Fatah less reliant on local support, then violence by both Fatah and Hamas should increase, as decreasing the value Fatah places on support decreases its incentives to compete, therefore increasing violence. If both factors are at play, future work is needed quantify the effects of Israeli government and third-party policies on competitive incentives.

2 Model

Hamas (H) and Fatah (F) compete over a countably infinite number of periods indexed by $t \in \{1, 2, \ldots\}$. In our data, a period corresponds to a calendar month. Period t's interaction explicitly depends on a publicly observed state variable $s^t \in \mathcal{S}$ measuring the relative popularity of Fatah over Hamas among the Palestinian public.[3] The set of states $\mathcal{S} = \{s_1, \ldots, s_K\} \subseteq \mathbb{R}$ is a finite set of $K \geq 3$ equally spaced popularity levels where $k > k'$ if and only if $s_k > s_{k'}$. We say Fatah is relatively more popular in state s than in state s' if $s > s'$ and vice versa for Hamas. In other words, smaller states represent periods where Hamas is more popular and larger states periods where Fatah is more popular.

Within each period t, Hamas and Fatah choose whether to commit a terrorist attack ($a_i^t = 1$) or not ($a_i^t = 0$), where $i = H, F$ indexes the group.[4] Given an action profile $a^t = (a_H^t, a_F^t)$, per-period payoffs are $u_i(a_i^t, s^t; \theta) + \varepsilon_i^t(a_i^t)$. The term ε_i^t is a vector of action-specific payoff shocks that is private information to group i. As is standard in these dynamic games, these shocks are drawn i.i.d. according to the type-1 extreme value distribution with density g, and they account for unobserved factors temporarily affecting the costs and benefits of terrorism. The term $u_i(a_i^t, s^t; \theta)$ is the systematic component of group i's per-period payoff, which is comprised of popularity benefits and attack costs:

$$u_i(a_i^t, s^t; \theta) = \underbrace{\beta_i \cdot s^t}_{\text{popularity benefit}} + \underbrace{\kappa_i \cdot a_i^t}_{\text{attack cost}}. \tag{1}$$

Because $\beta_i \cdot s^t$ captures i's benefit from relative popularity level s^t, we expect $\beta_H < 0$ and $\beta_F > 0$. That is, groups want more favorable public support (smaller states for Hamas and larger for Fatah). Thus, the magnitude of β_i captures the group's *value* of support. In addition κ_i denotes i's *cost* of attacking, so we expect $\kappa_i < 0$. The goal is to estimate $\theta = (\beta_H, \beta_F, \kappa_H, \kappa_F)$, which contains two (of three) competitive incentives for each group.

The sequence of the game in period t is as follows.

1. Group i observes s^t and ε_i^t.
2. Groups simultaneously chooses whether to attack $a_i^t \in \{0, 1\}$.
3. Payoffs are accrued.
4. Transition to period $t + 1$.

As the game transitions from period t to $t+1$, popularity evolves according to an AR-1 process with a mean that depends on the previously chosen actions and observed state. Given

[3] We focus on relative popularity because several theories of outbidding maintain an underlying assumption that the benefits are "primarily relative or positional—i.e., the value of the resources gained depends on how much of that resource the group's competitors possess" (Gibilisco, Kenkel and Rueda 2022, 9).

[4] We model actions as binary for two reasons. Theoretically, these discrete-choice models have well-understood equilibrium and identification conditions, and estimation procedures. Empirically, these groups rarely attack more than once month: Fatah attacks more than once (twice) a month in 2.7% (0.7%) of observations, and Hamas more than once (twice) a month in 26% (16%) of observations—see Figure A.2 in Appendix A.

today's support and attack decisions (a^t, s^t), we define the mean of tomorrow's support s^{t+1} as

$$\mu[a^t, s^t; \gamma] = \gamma_0 + \gamma_1 \cdot s^t + \sum_i (\gamma_{i,1} + \gamma_{i,2} \cdot s^t) \cdot a_i^t. \tag{2}$$

The term $(\gamma_{i,1} + \gamma_{i,2} \cdot s^t)$ represents group i's ability at using terrorist attacks to increase its support—what we call i's *effectiveness* of attacks, which is the third competitive incentive in the model.[5] We expect $\gamma_{H,1} < 0$ and $\gamma_{F,1} > 0$ so that attacks from group i pull popular support in i's preferred direction (smaller states for Hamas and larger ones for Fatah). Note that Equation 2 allows the effects of i's attacks to depend on the current popularity level s^t. *A priori*, it is not clear whether group i's attacks should be more or less effective as its popularity increases. On one hand, if its popularity is large, then its attacks may be more effective due to support from the local population, implying that $\gamma_{F,2} > 0$. On the other hand, if its popularity is large, then there is less of the population to be won over, implying that $\gamma_{F,2} < 0$. The model accommodates either possibility.

In period $t+1$, the probability $s^{t+1} = s' \in \mathcal{S}$ given action profile a^t and state s^t is $f(s'; a^t, s^t, \gamma)$. We specify f using a discretized normal distribution:

$$f(s'; a^t, s^t, \gamma) = \begin{cases} \Phi\left(\frac{s'+d-\mu[a^t,s^t;\gamma]}{\sigma}\right) - \Phi\left(\frac{s'-d-\mu[a^t,s^t;\gamma]}{\sigma}\right) & s' \in \{s_2, \ldots, s_{K-1}\} \\ \Phi\left(\frac{s_1+d-\mu[a^t,s^t;\gamma]}{\sigma}\right) & s' = s_1 \\ 1 - \Phi\left(\frac{s_K-d-\mu[a^t,s^t;\gamma]}{\sigma}\right) & s' = s_K \end{cases} \tag{3}$$

where Φ is the standard normal cumulative distribution function, σ is the standard deviation parameter, and $2d = s_2 - s_1$ is the distance between the equally spaced relative popularity levels. The parameters $\gamma = (\gamma_{H,1}, \gamma_{H,2}, \gamma_{F,1}, \gamma_{F,2}, \sigma)$ describe the transitions of the game, and we estimate them below. We choose this specification because γ can be estimated using standard techniques for continuous AR-1 models even though the model has a discrete state space (Tauchen 1986).

Before proceeding, three remarks are in order. First, because this is a model of outbidding, it explains variation in violence via intergroup competition and abstracts away from other motives for terrorism, such as spoiling, and from other nuances of conflict, such as government behavior. This spartan approach is critical for our argument: outbidding produces heterogeneous relationships between competition and violence, and one such relationship is a deterrent effect where competition decreases violence. Adding more moving pieces to the analysis only obfuscates this central result. Future work should consider the empirical strength of competing explanations for terrorism by developing and then estimat-

[5] We are using effectiveness in the context of outbidding. Of course, terrorism can have other dimensions of effectiveness in other environments, e.g., ability to hurt the government.

ing different structural models, which can be compared to ours through model fit exercises. A necessary first step in comparing theories of terrorism and their explanatory power is to provide models of each theory and fit them to the same data. We start this process with outbidding.

Second, we do not model the decision of individuals in the local population choosing a group to support, a simplifying assumption that appears in Conrad and Spaniel (2021) as well as in dynamic models of elections (e.g., Acharya et al. 2019; Iaryczower, Lopez-Moctezuma and Meirowitz 2021). Instead, individuals and their choices are captured by the functions $\mu[a^t, s^t; \gamma]$ and f, which describe how relative support evolves given the attack decisions of the two groups and their current popularity level. Rather than microfounding this behavior, we calibrate it to data by estimating the relevant parameters of interest, γ. Doing so allows us to sidestep additional assumptions detailing the decision of local individuals who may be myopic or adopt behavioral rules.[6] In other words, our groups best respond to the behavior of their rivals given the patterns of public support—explored in previous work and estimated below—observed in the data.

Third, by focusing on value, cost, and effectiveness, we explicitly borrow phrasing from the contest literature as our model has similarities with dynamic battles (e.g., Harris and Vickers 1985; Konrad and Kovenock 2005). Besides the structural approach, our key departure from this literature is that competition between our two groups is never fully decisive. Even when a group reaches its most favorable state, outbidding continues. Conrad and Spaniel (2021) also use a contest to study outbidding. Again besides the structural approach, our key departure is twofold. First, we consider a dynamic environment where popularity is a persistent and endogenous state variable, whereas Conrad and Spaniel (2021) consider a static model. Furthermore, because we are interested in studying the effect of competition using the version of the model most closely tethered to observables, we consider a fully asymmetric contest where the value of popularity, effectiveness of attacks, and costs of terrorism are all group-specific parameters. As described above, both dynamic and asymmetric contests generate countervailing forces between competition and violence.

2.1 Equilibria

Given a sequence of states, actions, and payoff shocks $\{s^t, a_i^t, \varepsilon_i^t\}_{t=1}^{\infty}$, group i's total payoffs are $\sum_{t=1}^{\infty} \delta^{t-1} \left[u_i(a_i^t, s^t) + \varepsilon_i^t(a_i^t)\right]$ where $\delta \in (0, 1)$ is a fixed, common discount factor. Generally, discount factors are not identified in dynamic discrete choice models (Magnac and Thesmar 2002). As such, we fix the discount factor to $\delta = 0.999$, which resulted in

[6] Polo and González (2020) discuss the microfoundations of how terrorism can mobilize support and improve group popularity. A key background condition is out-group antagonism or when terrorist groups recruit or receive support from a specific ethnic or religious faction, which is a feature of Hamas and Fatah.

the highest log-likelihood when fitting the model given several fixed discount factors. This matches anecdotal descriptions of the groups that highlight their long time horizons.[7]

Markov equilibria in these discrete dynamic games have a straightforward characterization (Aguirregabiria and Mira 2007). Dropping references to time, let $v_i(a_i, s)$ denote i's net-of-shock expected utility from choosing action a_i in state s and continuing to play the game for an infinite number of periods. In other words, given a vector of expected utility values v_i and a vector of random shocks ε_i, group i chooses action a_i in state s if and essentially only if

$$a_i = \underset{a_i \in \{0,1\}}{\text{argmax}} \{v_i(a_i, s) + \varepsilon_i(a_i)\}.$$

Thus, v_i is identical to a cut-off strategy for group i. Because ε_i is distributed type-1 extreme value, i chooses a_i in state s with probability $P(a_i, s; v_i)$, where

$$P(a_i, s; v_i) = \frac{\exp\{v_i(a_i, s)\}}{\exp\{v_i(0, s)\} + \exp\{v_i(1, s)\}}\,. \tag{4}$$

We can write group i's average expected utility in state s as

$$V_i(s, v_i) = \int \max_{a_i} \{v_i(a_i, s) + \varepsilon_i(a_i)\}\, g(\varepsilon_i) d\varepsilon_i. \tag{5}$$

Consider a profile $v = (v_i, v_j)$ of action-state expected utility values. Then group i's iterative expected utility of action a_i in state s, denoted $\mathcal{V}_i(a_i, s; v, \theta, \gamma)$, is written as

$$\mathcal{V}_i(a_i, s, v; \theta, \gamma) = u_i(a_i, s; \theta) + \delta\left[\sum_{a_j} P(a_j, s; v_j) \sum_{s' \in \mathcal{S}} f(s'; a_i, a_j, s, \gamma) V_i\left(s', v_i\right)\right]. \tag{6}$$

An equilibrium is a profile v such that

$$v = \mathcal{V}(v; \theta, \gamma) \equiv \times_i \times_{(a_i, s)} \mathcal{V}_i(a_i, s, v; \theta, \gamma). \tag{7}$$

Notice Equations 4–7 characterize equilibria as a system of $4K$ equations, where K is the number of relative popularity levels. In Section 4, we use these equations to derive a likelihood that allows us to estimate the modeling parameters and equilibrium from observed data via maximum likelihood. We then study substantive features of the the fitted model using comparative statics and other counterfactual exercises.

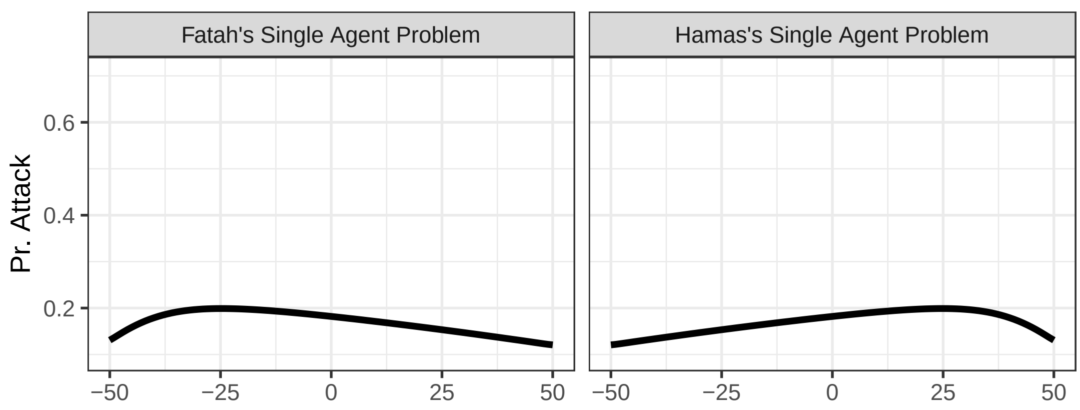
[7] *New York Times* Beirut Bureau chief Ben Hubbard describes it as follows: "It's sometimes shocking to sort of hear what their timeline is. And they'll say...well, we believe that justice is on our side and that we're doing the right thing. And if we're not able to do it, maybe our children will do it or maybe our grandchildren will do it. But they have this very long-term view of where this is going. And as long as they're not erased, they believe that they can keep going" ("Why Hamas Keeps Fighting and Losing", May 26 2021, `https://www.nytimes.com/2021/05/26/podcasts/the-daily/gaza-hamas-israel-war.html`).

2.2 Numerical example

To illustrate the strategic tensions in the model, we pick hypothetical values for the parameters and study the equilibria that arise. The specification is symmetric to aid in interpretation, but the model is more general, allowing the groups to have different competitive incentives. The popularity levels are $\mathcal{S} = \{-S, -S+1, \ldots, S-1, S\}$ where $S = 50$. For the payoff parameters, we set $\beta_F = \frac{1}{500} = -\beta_H$ and $\kappa_i = -2$. For the transitions, we assume $\mu[a^t, s^t; \gamma] = s^t - a^t_H + a^t_F$ and $\sigma = 2$. In other words, group i's attacks shift the mean of tomorrow's expected relative popularity by one in its preferred direction. The current popularity level does not change the effectiveness of attacks ($\gamma_{i,2} = 0$).

To build intuition, Figure 1 first presents group i's optimal attack probabilities when its rival never attacks, i.e., when i is the only relevant group. The probabilities range from 0.1 to 0.2. Notice i is most likely to attack when its relative popularity is weak (small s for Fatah and large s for Hamas), although end-point effects emerge because $\mathcal{S}$ is bounded. When the current state is at the boundary, a group's popularity cannot get worse or better tomorrow, which decreases the groups' incentives to attack. When a group is relatively unpopular, it has stronger dynamic benefits from using costly attacks to increase its popularity: attacking increases i's future payoffs for some time and decreases its need to use costly attacks in the future. Thus, comparing across the two single-agent problems, the groups generally attack in different states—the correlation coefficient of their attack probabilities is $\rho = -0.13$.

Figure 1: Attack probabilities without competition in the numerical example.



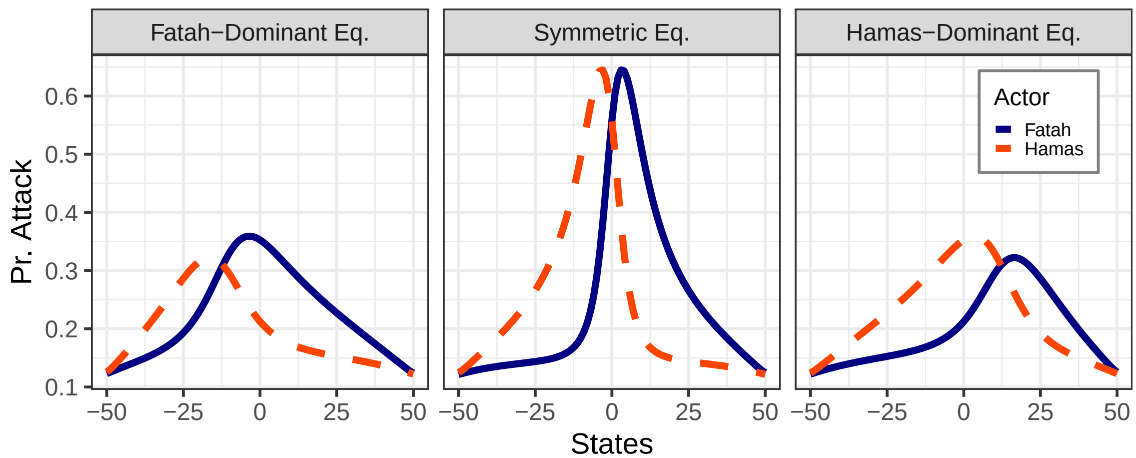
Note: Left panel graphs the probability that Fatah attacks (y-axis) as a function of the states (x-axis) in its single-agent dynamic programming problem, i.e., when Hamas never attacks. The right panel graphs the attack probabilities for Hamas's single-agent dynamic programming problem.

Turning to the strategic setting, we investigate equilibrium probabilities of attacking.[8] Three equilibria exist in this example, and Figure 2 graphs the attack probabilities for each

[8] To find equilibria, we repeatedly compute solutions to Equations 4–7 (with the fixed parameters specified in this example) using the Newton-Raphson method and different starting values. All computed solutions corresponded to one of three equilibria.

equilibrium. In the symmetric equilibrium, terrorism is most fierce when the groups are equally popular, and group i attacks with the highest probability once it begins to be slightly less popular than its rival. The other two equilibria are asymmetric but are essentially the same with the actors and states flipped. In these equilibria, one actor (labeled dominant) is using violence with higher probability than the remaining actor for the majority of the state space.[9]

Figure 2: Equilibria in the numerical example.



The example illustrates three features. First, violence between groups exhibits some strategic complementarities: attack probabilities are positively correlated across states. In the asymmetric equilibria, the correlation coefficient is $\rho = 0.41$, and in the symmetric equilibrium it is $\rho = 0.28$. These complementarities do not arise through the group's per-period payoffs in Equation 1, because i's per-period payoff does not depend on its opponent's action. In addition, the groups do not become more effective in certain states as $\gamma_{i,2} = 0$. Instead, the complementarities arise endogenously through tug-of-war dynamics in which competition can increase violence. Indeed, group i's attack probabilities in any of the three equilibria are larger than those in its single-agent problem. Thus, our dynamic model endogenizes the strategic complementarities for violence found in previous analyses using static games (Gibilisco, Kenkel and Rueda 2022).

Second, these complementarities are moderate, i.e., the attack probabilities are not perfectly correlated. In all equilibria, the state in which Hamas is most likely to attack is strictly less than the state in which Fatah is most likely to attack. This arises because, all else equal, Hamas wants to exert costly effort to attack at popularity levels where becoming more popular reduces Fatah's likelihood to attack. In contrast, Fatah wants to attack at levels where becoming more popular reduces Hamas's likelihood to attack. These incentives not only create but also temper the potential strategic complimentarities in the model.

[9]Figure A.1 in Appendix A graphs the invariant distribution for each of the three equilibria.

Third, equilibrium rates of attacks are not perfect measures of competitive incentives. Consider the Fatah-dominant equilibrium. At the majority of popularity levels, Fatah is attacking with greater probability than Hamas, so one might conclude that Fatah has smaller attack costs or a greater value of popularity. The example is symmetric, however, and both groups have identical competitive incentives. Thus, incentives to compete do not directly map onto observed rates of violence as the relationship is mediated by a strategic interaction. As a result, reduced-form regressions using observed terrorism as the dependent variable may obscure some aspects of the outbidding process. Directly estimating the model's parameters allows for a deeper exploration of how competition affects violence.

In the online appendix, we consider some comparative statics to illustrate how changes in competitive incentives can affect violence. In this symmetric example, we find that increasing Hamas's value for public support can increase, decrease, or have mixed effects on each actor's willingness depending on the equilibrium. These comparative statics help to motivate the structural exercise as it is not clear what parameter values or equilibrium are empirically relevant. Furthermore, the example illustrates that enhanced incentives to compete can either increase or decrease overall violence levels, raising two questions: Which effect dominates in the data? and Do these effects vary when competition is asymmetric?

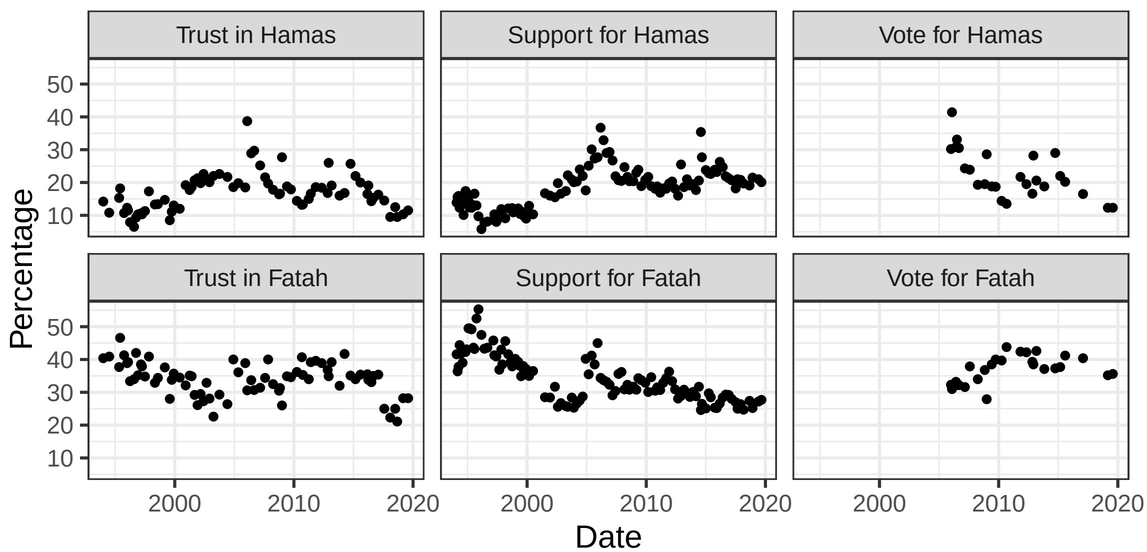
3 Data sources and measurement

Data on attacks are taken from the Global Terrorism Database (GTD) where we record all the terrorist attacks committed by Fatah/PLO and Hamas at the monthly level from January 1994 to December 2018 (START 2019b).[10] The GTD is a standard source for recording terrorist acts, which are defined as either a threat or an attack that meets two of the following conditions: occurring outside the confines of legitimate warfare, designed to signal to a larger audience than the immediate victims, and helps to attain a political, religious, or social goal (START 2019a, 6). Not only does the GTD record suicide bombings, which were the focus of Bloom (2004) and Findley and Young (2012), but it also records other types of attacks with and without fatalities, e.g., rocket attacks have become a greater part of violence against Israelis in recent years (Haushofer, Biletzki and Kanwisher 2010). Hamas engages in roughly 1.5 attacks per month with a range of 0-36 attacks in any given month, while Fatah engages in an average of less than 1 attack per month with a range of 0-15. The median number of attacks/month for both actors is 0 and it is relatively rare for either side to commit more than 2 attacks/month. To measure group i's attack decision in month t, we record a dummy variable indicating whether the group engaged in any terrorist attacks in that month.

[10] In Appendix E, we reestimate the model using different time frames; our results are stable across specifications.

The state variable in the model is the relative popularity for the two groups among the Palestinian population. To measure it, we treat relative popularity as a latent variable in a dynamic factor model that uses six public-opinion variables as indicators of relative popularity. These six variables are created using surveys from the Jerusalem Media & Communication Centre (JMCC N.d.) and the Palestinian Center for Policy and Survey Research (PCPSR N.d.).[11] We search through every survey published by these centers between 1994 and 2018 to track Palestinian public opinion for both actors using three dimensions. The first tracks whether respondents which political or religious group they trust the most. The second asks which political party each respondent supports. The third is similar and asks which party they intend to vote for in the upcoming legislative elections. For each of these three questions we track the proportion of respondents who answer Hamas or Fatah.

Figure 3: Survey responses over time.



Note: First column tracks JMCC questions (asked 2-6 times a year) about trusting Fatah or Hamas ("Which political or religious faction do you trust the most?"). Second tracks PCPSR questions (asked 2-9 times a year) related to political support ("Which of the following political parties do you support?"). Third tracks JMCC questions (asked 0-5 times a year starting in 2006) about voting in elections ("If Legislative Council elections were held today, which party would you vote for?").

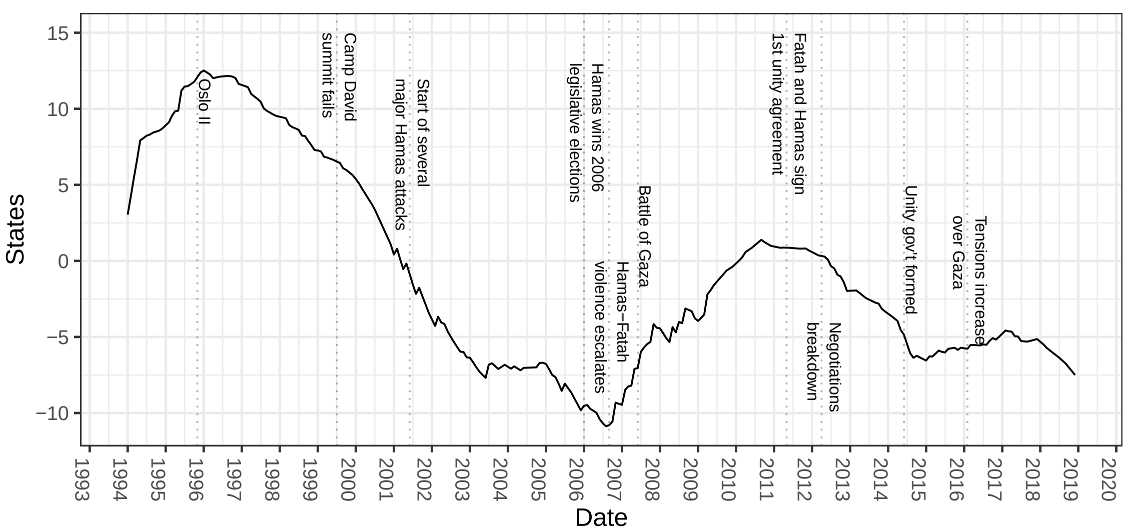
Figure 3 graphs responses to these six survey questions over time. These answers largely follow a basic trend where public attitudes towards Fatah and Hamas are inversely related. In general we see a decline in Fatah support during the 1990s and early 2000s, while Hamas's public support rises. These trends level out a bit in the later years, with Fatah maybe regaining some support here at the expense of Hamas. The surveys mostly correlate with each other in the expected directions, which suggests that they can be collapsed onto one

[11] More details on question wording and survey frequency can be found in Appendix B.

dimension (see Table B.2 in Appendix B). To do this, we use a dynamic factor analysis to transform these polling questions into a continuous representation $\tilde{s}^t$ of the theoretical state variable s^t. Additional information on the survey questions and the dynamic factor model can be found in Appendix B.

Once we fit the model and produce the continuous state variable $\tilde{s}^t$, we want to check its validity and understand its distribution.[12] Figure 4 shows how the state variable evolves from 1994-2018. Fatah is favored in the earlier periods of the data, where they peak during the 1996 Oslo II process (Jan. 1996 = 12.5). Likewise, Hamas is at its most popular relative to Fatah in 2006 during the aftermath of the general election in which they took control of the Gaza strip (Aug. 2006 = −10.9). The mean of this variable is −0.84 (median −2.99) with a standard deviation of 6.57 (IQR of −5.98 to 4.13).

Figure 4: Relative popularity of Fatah to Hamas over time.



Several important events in the conflict are listed in Figure 4, providing context and face validity to the idea that this latent variable captures the relative ups and downs between the two groups. Notably, the 1990s are typically regarded as an important period for the rise of Hamas and that is clearly reflected here, where Fatah struggles in popular support as the peace process unravels. Furthermore, our measure has a rich variation that exhibits substantial ups and downs that go undetected in existing measures of group popularity. For example, Tokdemir and Akcinaroglu (2016) do not find popularity differences between Fatah and Hamas after 1997.

[12] All survey responses load onto the factor in the expected directions: pro-Hamas responses are more likely when the state variable is small, and pro-Fatah responses are more likely when the state variable is large. See Table B.3 in Appendix B.

4 Estimation and identification

Following Rust (1994), we adopt a two-step estimation procedure where we first estimate how popular support evolves given the group's use of terrorism (γ) and then estimate the groups' payoff parameters (β, κ). To build the transition model, we first rewrite the AR(1) model in Equation 2 in terms of the continuous state variable $\tilde{s}^t$:

$$\tilde{s}^t = \gamma_0 + \gamma_1 \tilde{s}^{t-1} + \gamma_{H1} a_H^{t-1} + \gamma_{H2}(\tilde{s}^{t-1} \times a_H^{t-1}) + \gamma_{F1} a_F^{t-1} + \gamma_{F2}(\tilde{s}^{t-1} \times a_F^{t-1}) + \nu^t \tag{8}$$

where a_F^{t-1} and a_H^{t-1} are binary indicators for whether Fatah and Hamas attacks, respectively, and $\nu^t \sim N(0, \sigma^2)$.

There are some complications in fitting equation 8. The correlation between s_t and s_{t-1} is very close to 1, suggesting that this relationship is very close to a random walk. However, we can exploit the fact that $\tilde{s}^t$ and $\tilde{s}^{t-1}$ are cointegrated. Cointegration means that we can directly fit the model in Equation 8 using ordinary least squares (OLS) to obtain superconsistent estimates of the parameters, but the sampling distribution of the parameters is unknown and possibly non-symmetric because of the unit root. However, we only need good point estimates to proceed with the second stage analysis, and so exploiting the cointegration here provides us with the best use of our limited number of observations. To test the hypotheses about each group's effectiveness, we also fit the model using the Engle-Granger error correction method (ECM).

The first-step estimates are then used to construct the Markov transition probabilities. First, we define the lowest (most Hamas friendly) state s_1 of the discrete state as the 2.5th percentile of the continuous state variable, $\tilde{s}^t$. Likewise, the largest state (most Fatah friendly) s_K is set to the 97.5th percentile. States between 1 and K are defined at equally spaced intervals of $2d = 0.05$ (i.e., $s_2 - s_1 = 0.05$). Let $\mu[a, s; \hat{\gamma}]$ be the fitted values from the first model in Table 1 for all possible combinations of action profiles with the discrete states. Plugging these fitted values and the estimate of σ into Equation 3 produces the transition probabilities. Finally, we discretize the observed states variable by mapping values of the continuous latent variable $\tilde{s}^t$ into the closest value of the discrete state space $\mathcal{S}$.

To estimate the payoff parameters, we use the constrained maximum likelihood estimator (CMLE) introduced by Su and Judd (2012). Specifically, let $Y = \left(s^t, a_H^t, a_F^t\right)_{t=1}^T$ denote the time series of observed data (relative popularity levels and attacks), and recall that $\theta = (\beta, \kappa)$. We fix the transition probabilities using the first stage estimates ($\hat{\gamma}$ from the OLS results in Step 1) and the definition of f in Equation 3. The CMLE estimates $(\hat{\theta}, \hat{v})$ maximize the log-likelihood

$$L(v|Y) = \sum_{t=1}^{T} \left[\log P(a_H^t; s^t, v_H) + \log P(a_F^t; s^t, v_F)\right]$$

subject to the equilibrium constraint equations $v = \mathcal{V}(v; \theta, \hat{\gamma})$. Results from Silvey (1959) demonstrate that the CMLE is consistent in T and characterize its asymptotic distribution. Standard errors are computed using this characterization for constrained MLE and are corrected using the Murphy and Topel (1985) approach for two-step estimation.

The game between Hamas and Fatah can have multiple equilibria. The CMLE allows for this multiplicity with its main identification assumption being that the data in Y are generated from only one of these equilibria (Crisman-Cox and Gibilisco 2018, 2020; Su and Judd 2012). By treating the endogenous equilibrium expected utilities, v, as auxiliary parameters in the model, the CMLE selects the values of v that best describe the data while still being an equilibrium of the model. In other words, the CMLE selects the equilibrium that produces the highest likelihood value while avoiding the need to repeatedly enumerate the set of equilibria.

Along with the assumption that one equilibrium is generating the data, three empirical moments pin down our parameters of interest. We estimate γ through observed variation in the state variable over time. We know that each action profile has a positive probability of being played at each relative popularity level given the distributional assumptions on ε_i^t, and the probability of transitioning from level s to level s' is positive for all s and s'. As such, f can be estimated non-parametrically from frequency estimators with a sufficiently long time frame because, eventually, the equilibrium path will visit all states and all action profiles will be played in every state. When the transition probabilities are known, the payoff parameters are identified by their relationship to the equilibrium constraint $\mathcal{V}$ in Equation 6. A group's attack costs are identified through its baseline propensity to attack regardless of the state, and a group's value of public support is identified by the variation in its propensity to attack across states. To see why, note that when $\beta_i = 0$ (or $\delta = 0$), then Equations 1 and 6 imply i's probability of attacking is constant across states and only depends on its attack costs κ_i.

5 Parameter estimates

Table 1 presents the results of the first-stage estimation and shows that attacks by Fatah and Hamas move the state space in the expected direction. Recall that these are estimates of γ and reflect each group's effectiveness at using terrorism to shift public support towards itself and away from its rival. In months when Hamas attacks, their relative popularity improves by an average of about 0.11-0.29 in the following month depending on the current support $\tilde{s}^t$. Likewise, when Fatah attacks, they can expect the state space to improve in their direction by about 0.86-1.4 on average. Both of these effects are statistically significant in the ECM model, and we reject the hypothesis that the groups are equally effective at moving pubic opinion at every level of relative popularity. These results provide evidence

Table 1: Regressing relative popularity (state variable) on terrorist attacks.

	Dependent variable:	
	State	Δ State
	AR(1)	ECM
Hamas attack	−0.21	−0.21
		(0.04)
Fatah attacks	1.12	1.03
		(0.05)
Lag state	1.00	
Δ Lag state		0.33
		(0.04)
Hamas attacks × lag state	0.01	0.002
		(0.01)
Fatah attacks × lag state	0.03	0.01
		(0.01)
Constant	−0.02	−0.01
		(0.02)
T	299	298
adj. R^2	0.999	0.720
$\hat{\sigma}$	0.216	0.183

Note: Newey-West standard errors in parenthesis. No standard errors are reported for the AR(1) model due to unit root.

that groups are capable of outbidding and that acts of terrorism carry popularity benefits to the group, which supports results from Jaeger et al. (2015). Likewise, these results support findings from Polo and González (2020) who find that terrorism can be used to build support among a civilian audience, particularly when the audience is well defined along ethnic or religious lines (as is the case here). In addition, our estimates indicate that Fatah's use of terrorism more effectively increases public support of Fatah than Hamas's uses of terrorism increases support of Hamas.

In the Appendix C, we consider several additional control variables to ensure that these relationships are robust to economic and political factors, e.g., unemployment or the onset of the Second *Intifada*. Additionally, we also consider alternative measures of attacks (counts rather than indicators) and models with and without the interaction terms. Across these checks, the main relationship between attacks and shifts in public support are largely unchanged in either direction or magnitude. Even when we measure violence using fatalities or fatalities per attack, we find Fatah's violence more effectively increases its support than Hamas's violence increases its support—see models 3 and 4 in Table C.4.

Table 2 presents estimates for β (value of popularity) and κ (the costs of terrorist

Table 2: Payoff estimates.

	Estimate	Std. Error
Hamas value for outbidding (β_H)	-0.0071	0.0055
Fatah value for outbidding (β_F)	0.0005	0.0004
Hamas attack cost (κ_H)	-0.95	0.28
Fatah attack cost (κ_F)	-2.45	0.39
Log-Likelihood	300	
T	-278.09	

Note: All values rounded to two significant digits; two-step standard errors from Murphy and Topel (1985)

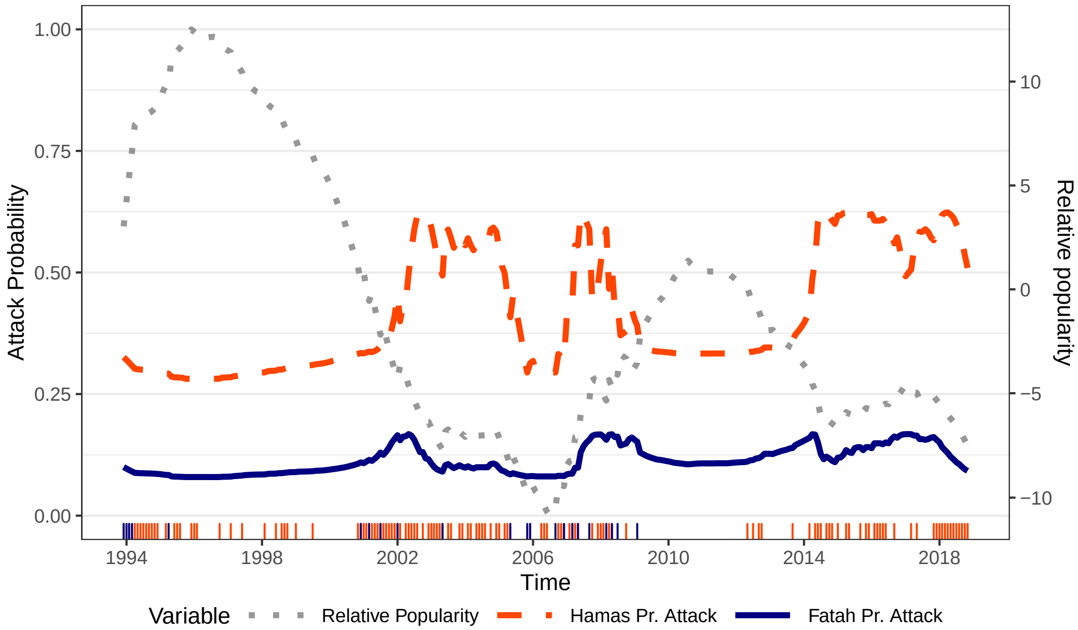
attacks). The sign on each estimate is in the expected direction. Both actors like being relatively more popular than their opponent, which is to say that Hamas's most preferred state is s_1 and Fatah most prefers s_K. Interestingly, Hamas values its public opinion more than Fatah with $|\hat{\beta}_H|$ being an order of magnitude larger than $|\hat{\beta}_F|$. One explanation for this difference is that Fatah derives more support from non-Palestinian actors like the Israeli government or the U.S. than Hamas. As such, Fatah might be less reliant on the local population for its day to day activities.

Intuitively, we find that terrorism is less costly for Hamas than Fatah. One explanation is that these costs reflect more than just the tactical cost of terrorism and also include the cost each actor pays for either continuing (Hamas) or deviating (Fatah) from their main posture. This result fits with the historical record of the conflict, which typically depicts Hamas as a strong, violent actor, while Fatah works hard to maintain a reputation as a more practical, political entity. Such differences reflect the "zealots and sellouts" logic from Kydd and Walter (2006) and presents the interesting problem faced by Fatah: they are more skilled at moving the state space than Hamas, but they face a much higher cost to doing so.

Finally, Figure 5 graphs the estimated attack probabilities for each group over time, that is, $P(a_i = 1; s^t, \hat{v}_i)$, where $\hat{v}_i$ is group i's equilibrium expected utilities estimated from the CMLE and s^t is the observed state.[13] In addition, we also graph the relative popularity level s^t over time on the second horizontal axis for reference. Notice that Hamas has a higher probability of attacking than Fatah regardless of its relative popularity. Averaging over the observed states, Hamas attacks with probability 0.42 and Fatah with probability 0.11. This maps onto our estimates. Hamas cares more about its popularity than Fatah, and it has a comparatively smaller cost to commit terrorism although Fatah more effectively uses terrorism to increase its support. In addition, terrorism is particularly prevalent when Hamas is relatively popular, specifically during the Second Intifada and after the group

[13] Figure A.4 in Appendix A, graphs the estimated attack probabilities as a function of the state.

Figure 5: Estimated equilibrium probability of attacking over time.



Note: Horizontal axis denotes sample months/periods. Left vertical axis is the estimated probability that i attacks in month t, i.e., $P(1; s^t, \hat{v}_i)$ where s^t is the observed relative popularity level in period t and $\hat{v}_i$ is estimated from the CMLE. For reference, s^t is also plotted on right vertical axis. The rug plot indicates observed attacks.

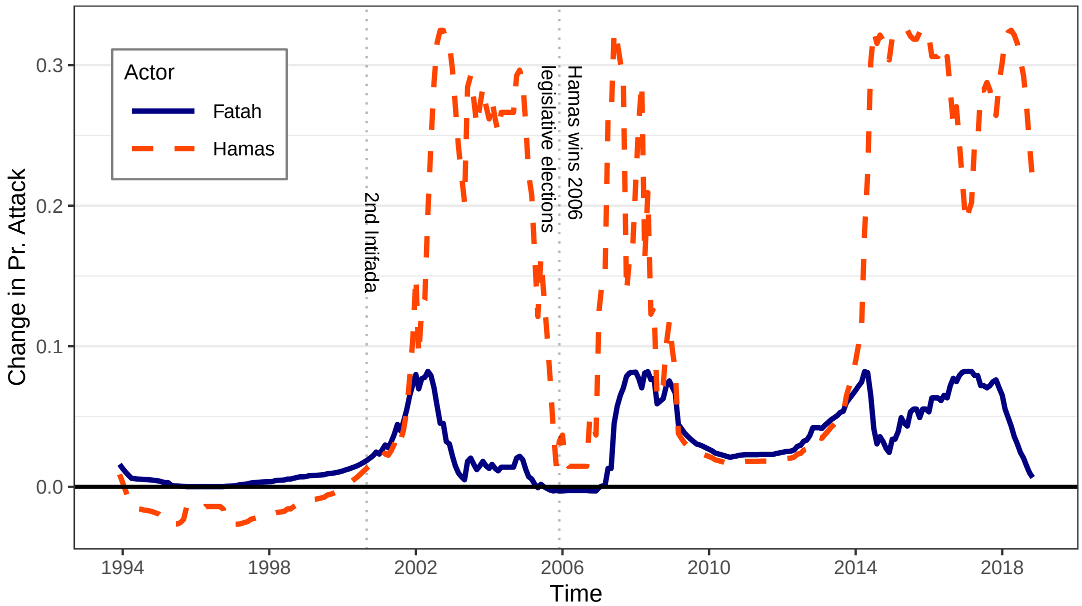
wins legislative elections in 2006.

6 Substantive effects of competition on violence

Outbidding studies generally expect an encouragement effect in which enhanced competition leads to more violence. Nonetheless, our point estimates uncover substantial asymmetries between Hamas and Fatah, where Fatah is more effective at using terrorism to boost its popularity but Hamas has smaller attack costs and cares more about its popularity. If these asymmetries are sufficiently strong, outbidding could exhibit a deterrent effect in which enhanced competition depresses violence. To see which effect dominates, we conduct a series counterfactual exercises on the estimated model. The goal is to warp different aspects of competition in order to quantify the substantive effects of competition on violence.

First, we compare how a group behaves with and without violence from its rival. That is, would Fatah use more or less violence if Hamas did not engage in terrorism and vice versa? Specially, we compare group i's estimated equilibrium probability of attacking (in Figure 5) to the probability of attacking in group i's single-agent problem, i.e., i's predicted use of violence if it expects its rival to never attack. Subtracting the latter from the former is one way to quantify the effect of competition on violence where the equilibrium attack probabilities represent violence in a competitive environment and the single-agent attack

Figure 6: Effects of competition on violence given observed states.



Note: For each month t (horizontal axis), we compare group i's equilibrium probability of terrorism to the probability that would arise if i expects its rival to never use violence, by subtracting the latter from the former given the observed state s^t. Positive values indicate that competition increases violence by group i in period t with state s^t; negative values indicate that competition decreases violence by group i. Vertical dashed lines indicate the start of the Second Intifada and Hamas winning legislative elections.

probabilities are from a noncompetitive environment. Figure 6 graphs these differences over time given the observed relative popularity s^t. Positive values indicate a positive effect of competition on violence in period t, i.e., a group's equilibrium probability of attacking is larger than its probability of attacking in its single-agent problem. Negative values indicate a negative effect.[14]

For Fatah, the values are entirely positive indicating that Hamas encourages Fatah to use more violence than it would use absent competition. Averaging over time, competition from Hamas increases Fatah's use of violence by 34% from the baseline noncompetitive environment (i.e., Fatah's single-agent problem). This is the expected encouragement effect of competition on violence from the outbidding literature. Table 3 decomposes the effect over three time periods. It shows that Fatah's propensity for terrorism increases by about 3 percentage points due to competition from Hamas, especially after the start of the Second Intifada. For Hamas, however, the story is different as heterogeneous effects exist. Competition from Fatah depresses Hamas's use of violence during the Oslo era, although we find a positive effect after the Second Intifada. Table 3 indicates that, during this initial period, Hamas's propensity for terrorism would increase by 1-2 percentage points in the absence of competition from Fatah. More specifically, the estimates indicate that, in equilibrium,

[14] Whereas Figure 6 graphs the difference between equilibrium and single-agent attack probabilities over time conditional on the observed relative popularity s^t, Figure A.5 in Appendix A graphs the difference as a function of all potential relative popularity levels.

Hamas used 4–5% less violence during Oslo lull than if it thought Fatah would never attack, i.e., in its single-agent problem. This is the deterrent effect of competition on violence where a group uses less violence in the competitive environment than in a noncompetitive one.

Table 3: Average Effect of Competition on Violence in Three Time Periods

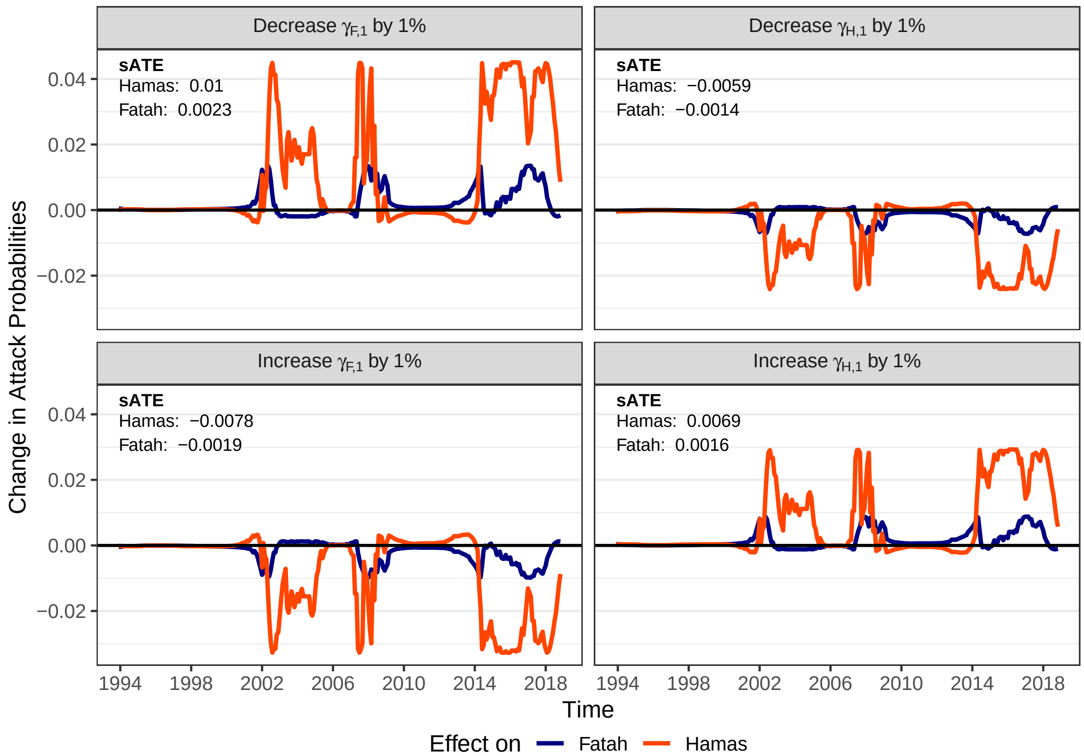
	Oslo era	2nd Intifada	post-2006 election
Hamas	−0.014	0.177	0.148
	(0.001)	(0.010)	(0.007)
Fatah	0.005	0.027	0.043
	(0.0003)	(0.002)	(0.001)

Note: Average difference between equilibrium and single-agent attack probabilities from three time periods with standard errors in parentheses. Positive values indicate the former are larger than the latter, i.e., more violence in the competitive (equilibrium) environment than the noncompetitive (single-agent) environment. Oslo era is Jan. 1994–Sep. 2000, 2nd Intifada is Oct. 2000–Dec. 2005, and post-2006 election is Jan. 2006–Dec. 2018.

Thus, the presence of a rival terrorist group can depress violence. With a rival that is an effective outbidder (Fatah), a group (Hamas) may use less violence than it normally would because it sees the competition as a lost cause. As Figure 6 illustrates, this deterrent effect emerges in the Oslo era where Fatah was relatively more popular than Hamas. Although some outbidding studies argue that that increasing the number of terrorist groups—a common proxy for the level of competition—can decrease violence, their underlying mechanisms do not appear in this setting. For example, Nemeth (2014) argues that increasing the number of ideologically similar groups should decrease violence through free-riding dynamics. Hamas and Fatah are generally seen as ideologically opposed, however, and there are no free-riding incentives in the model. Another example is Conrad and Spaniel (2021) who argue that the government may change its demands in response to a large number of groups, leading to a negative correlation between terrorist group numbers and violence. As Figure 6 and Table 3 demonstrate, endogneous government demands are not necessary for competition to have a negative effect on violence.

Second, we examine how one group's incentives to compete affect the propensity of both groups to use violence. For example, how would overall violence levels change if group i became a more effective outbidder, i.e., $\gamma_{H,1}$ becomes more negative or $\gamma_{F,1}$ becomes more positive? Whereas the first counterfactual fixed the behavior of one group, this exercise illustrates how the behavior of both groups changes as a function of competitive incentives. To do this, we fix the transition parameters estimated from Table 1, the payoff parameters in Table 2, and the equilibrium expected utilities from the CMLE. For each group i, we then change how effectively i can boost its popularity through terrorism by increasing and decreasing the magnitude of $\gamma_{i,1}$ by 1%. As the effectiveness of attacks changes, the equilibrium probabilities of attacks will change as well.[15] Figure 7 graphs theses differences given the change in $\gamma_{i,1}$ and observed state s^t. Positive values indicate that violence from group i in observed state s^t increases in the counterfactual scenario, whereas negative values indicate that violence decreases.

Figure 7: Relationship between terrorism and effectiveness of attacks in observed states.



Note: In each panel, we increase and decrease $\gamma_{i,1}$ for $i = H, F$ from its estimated value by 1%; all other parameters are held constant at their estimated values. Incentives to compete are greater when $\gamma_{i,1}$ is larger in magnitude. The horizontal axis denotes the period/month t. The vertical axis is the difference between equilibrium attack probabilities (Figure 5) and counterfactual attack probabilities given the change in $\gamma_{i,1}$ and observed state s^t. Positive (negative) values indicate that violence by group i increases (decreases) in the counterfactual.

Focusing on the effects of Hamas's competitive incentives, we find evidence of outbidding's expected encouragement effect: when Hamas has greater incentives to compete, violence by both groups increases. We estimate that a 1% increase in Hamas's effectiveness results in a 1 percentage point increase in the frequency of terrorism by Hamas and a 0.1 percentage point increase in the frequency of terrorism by Fatah. On average, this implies Hamas would increase its use of violence by 2% and Fatah by 1%. Likewise, a 1% decrease

[15] Multiple equilibria may exist under the estimated parameters, so we cannot just vary $\gamma_{i,1}$, compute a new equilibrium, and compare choice probabilities under the old and new parameter values. Doing so would not guarantee that the new equilibrium bears any resemblance to the estimated one. That is, we want to ensure that equilibrium selection is fixed in the counterfactuals. To address this problem, we adopt the homotopy method from Aguirregabiria (2012) that maps equilibria as locally continuous functions of the relevant parameters. Specifically, we follow the procedure outlined in Crisman-Cox and Gibilisco (2018, Appendix H).

in Hamas's effectiveness results in a 1 percentage point decrease in the frequency of terrorism by Hamas and a 0.1 percentage point decrease in the frequency of terrorism by Fatah. These encouragement effects are even stronger when focusing on more recent observations after the Oslo era.

Focusing on the effects of Fatah's competitive incentives, we find evidence of outbidding's *unexpected deterrent effect*: when Fatah has greater incentives to compete, violence by both groups decreases. We estimate that a 1% increase in Fatah's effectiveness results in a 1 percentage point decrease in the frequency of terrorism by Hamas and a 0.2 percentage point decrease in the frequency of terrorism by Fatah. On average, this implies both groups would decrease their violence by 2% if Fatah were to have greater incentives to compete via becoming 1% more effective at outbidding. Similarly, a 1% decrease in Fatah's effectiveness results in a 1 percentage point increase in the frequency of terrorism by Hamas and a 0.2 percentage point increase in the frequency of terrorism by Fatah. Again, these deterrent effects are even stronger after the Oslo era.

In Appendix A, we repeat the same exercise for the value of support, β_i, and the costs of attacking, κ_i—see Figures A.6 and A.7, respectively. The main takeaways are similar: when Hamas becomes more competitive, both sides attack more frequently (as expected by the outbidding literature), but when Fatah becomes more competitive, both sides tend to attack less frequently (in contrast to expectations in the outbidding literature).

These deterrent effects arise from asymmetric competition. Fatah is a relatively advantaged player due to its effectiveness at using terrorism to increase public support, that is, $|\gamma_{F,1}|$ is substantially larger than $|\gamma_{H,1}|$. When Fatah's incentive to compete increase, it more readily absorbs the up-front costs of terrorist attacks in order to more quickly increase public opinion levels in the future. This effects Hamas's equilibrium strategy. When Fatah becomes more aggressive, Hamas generally attacks less as it cannot efficiently compete against the more aggressive and more capable Fatah. In equilibrium, this creates a feedback loop where Fatah uses less violence as Hamas becomes more nonviolent. Thus, stronger incentives to compete against a rival for one group can deter terrorism from all groups.

7 Robustness

Measurement model. To measure the state variable, we aggregate six public opinion measures using a dynamic factor analysis. In Appendix B, we demonstrate that our latent measure of relative popularity is robust to five different model specification choices, such as heteroskedasticity and choices of which survey questions we include. The state variables produced across these five alternatives correlate very highly (0.87-0.999), demonstrating that our relative popularity levels are picking up meaningful variation over time.

First-stage results. The first-stage regressions in Table 1 show how effective attacks by Fatah and Hamas are at shifting relative popularity between the two groups. These relationship are modeled without additional control variables, however, raising concerns about spurious relationships. In Appendix C, we consider alternative measurements of attack behavior and additional control variables. The best fitting measure of group actions is the binary attack measure. In addition, our conclusion that Fatah is more effective than Hamas at using violence to boost popularity remains even when we measure violence using monthly counts of fatalities or fatalities per attack. Regarding controls, we examine economic conditions in the occupied territories, underlying attitudes about violence towards Israel, an indicator for the Second *Intifada*, the time since the last Israeli election, and the number of Palestinians killed by Israeli forces. None of these controls changes the estimated effects reported in Table 1 in a meaningful way.

Time frame. It could be the case that outbidding is less relevant as Fatah moves away from violence over the last decade or as Hamas uses more rocket attacks after Israel pulls out of the Gaza Strip. Our baseline analysis considers the 1994–2018 time frame to maximize the number of observations. Appendix E presents robustness checks with four smaller time frames that end at plausible change points in the Fatah-Hamas relationship: 2014 agreement, 2011 agreement, 2006 elections, and the start of the Second *Intifada* in 2000. These cutoffs reflect points where the groups' preferences (β and κ) may change in response to changes in the relationship between the groups. We show that our estimates are relatively stable across the different time frames.

8 Conclusion

We show that the relationship between intergroup competition and terrorism is not as clear cut as the current outbidding literature suggests. Although previous studies focus on an encouragement effect where enhanced competition leads to more violence, we document a deterrent effect in which competition can depress violence. This effect emerges in the rivalry between Hamas and Fatah, the canonical example of outbidding. To do this, we construct and estimate a new model of outbidding among the two groups. The exercise involves compiling monthly-level survey data and estimating Palestinian support for the two groups between 1994–2018.

Through a series of counterfactual exercises, we highlight two different types of deterrent effects. First, we find that when Fatah is relatively popular like during the Oslo era between 1993 and 2000, competition from Fatah deters Hamas from using violence. That is, Hamas would use more violence if it expected no violence from Fatah. Second, we find that were Fatah's competitive incentives to increase, equilibrium rates of violence from either group would decrease.

Our theoretical framework explains these deterrent effects through the logic of asymmetric contests. We find that, although Hamas has smaller attack costs, Fatah is a more effective outbidder than Hamas in the sense that Fatah attacks lead to larger pro-Fatah swings in public opinion than Hamas attacks lead to pro-Hamas swings. This asymmetry leads to the two deterrent effects. When Fatah is overwhelmingly popular, it is very difficult for Hamas to win back public opinion in the face of competition from Fatah. As such, Hamas tempers its use of violence in the presence of competition with a popular Fatah. Likewise, when Fatah's incentives to compete increase, it more readily absorbs its high, up-front costs of attacking to quickly increase its popularity. Hamas cannot compete with a more aggressive and capable Fatah, so the group would become less violent, leading to an equilibrium feedback loop where both groups use less violence.

More substantively, these results highlight an uncomfortable tension surrounding Fatah. As the actor most invested in the peace process, Fatah has to appeal to not only Palestinians but also Israel and an international audience. These outside concerns provide one explanation for why we find that Fatah cares less about its popularity among Palestinians than Hamas. While Fatah's outside focus may be part of its peace effort, it is also associated with increased violence. Thus, one policy implication from this analysis is that efforts to make Fatah more accountable to the Palestinian people, e.g., further promotion of democratic institutions and political competition within the Palestinian territories, may lead Fatah to care more for its relative popularity and result in an overall decrease in violence. Although care needs to be taken here, because if these policies also make Hamas care about its support then violence may increase.

The paper leaves open several important avenues for future research. First, Israeli defense policy only enters the analysis indirectly and non-strategically through its effect on the exogenous parameters of interest. Theoretically, this omission was following the outbidding literature, so our model focuses on the competition among terrorist groups; however, it is perhaps clear that this competition should unfold in the shadow of government intervention. Empirically, this omission reflects the lack of data on actions taken in response to or anticipation of terrorist attacks. Future work will focus on collecting this data and using it to fit an expanded three actor model. We can then test for whether military responses are effective at attenuating competitive incentives or not. Government attacks may raise a group's cost of committing terrorism, but they may also make the population more sympathetic to the group's cause, thereby increasing the group's ability to win over public support. Disentangling the effects of competition in this situation presents a challenging, but fundamentally important, next step in the study of outbidding.

Second, one recurrent point of skepticism surrounding structural estimation in conflict studies and international relations has been a lack of high-quality and high-frequency data. This concern reflects the use of structural estimation to study the strategy behind international crisis escalation (e.g., Crisman-Cox and Gibilisco 2018; Kenkel and Ramsay 2021; Signorino 1999). Militarized interstate disputes are relatively rare, and historical disputes may be subject to measurement error. We therefore hope our analysis highlights the natural complementarities between events data and structural estimation. Structural exercises often demand many observed moments in the data to pin down the parameters of interest, so the prevalence of high-frequency events data is promising. Likewise, events data often record endogenous actions of strategic actors, e.g., when governments repress, where protesters meet, or when terrorists attack. Explicitly accounting for these strategic interactions in a structural model can help scholars answer a greater variety of questions.

Additionally, this model can easily be applied to other cases of intergroup competition. For example, competition among republican groups in Northern Ireland, leftist groups in Colombia, or Tamil groups in Sri Lanka are natural places to study outbidding. Our model provides a framework to consider these cases and identify competitive incentives of all the relevant actors. The formal and statistical model can easily be expanded to any number of groups. The main limitation to studying alternative conflicts is the need for public support data, but as intrastate conflict data becomes more available and fine-grained, we anticipate being able to fit these kinds of models to any number of relevant contests.

References

Abrahms, Max. 2006. "Why Terrorism Does Not Work." *International Security* 31(2):42–78.

Abrahms, Max. 2012. "The Political Effectiveness of Terrorism Revisited." *Comparative Political Studies* 45(3):366–393.

Acharya, Avidit, Edoardo Grillo, Takuo Sugaya and Eray Turkel. 2019. "Dynamic Campaign Spending.". Unpublished manuscript. erayturkel.github.io/files/campaigns-printcopy.pdf.

Acosta, Benjamin. 2014. "Live to Win Another Day: Why Militant Organizations Survive Yet Few Succeed." *Studies in Conflict & Terrorism* 37(2):135–161.

Aguirregabiria, Victor. 2012. "A Method for Implementing Counterfactual Experiments in Models with Multiple Equilibria." *Economics Letters* 114(2):190–194.

Aguirregabiria, Victor and Pedro Mira. 2007. "Sequential Estimation of Dynamic Discrete Games." *Econometrica* 75(1):1–53.

Beber, Bernd, Philip Roessler and Alexandra Scacco. 2014. "Intergroup Violence and Political Attitudes: Evidence from a Dividing Sudan." *The Journal of Politics* 76(3):649–665.

Biberman, Yelena and Farhan Zahid. 2019. "Why Terrorists Target Children: Outbidding, Desperation, and Extremism in the Peshawar and Beslan School Massacres." *Terrorism and political violence* 31(2):169–184.

Bloom, Mia M. 2004. "Palestinian Suicide Bombing: Public Support, Market Share, and Outbidding." *Political Science Quarterly* 119(1):61–88.

Chenoweth, Erica. 2010. "Democratic Competition and Terrorist Activity." *Journal of Politics* 72(1):16–30.

Conrad, Justin and Kevin Greene. 2015. "Competition, Differentiation, and the Severity of Terrorist Attacks." *Journal of Politics* 77(2):546–561.

Conrad, Justin and William Spaniel. 2021. *Militant Competition: How Terrorists and Insurgents Advertise with Violence and How They Can Be Stopped*. Cambridge University Press.

Crenshaw, Martha. 1981. "The Causes of Terrorism." *Comparative Politics* 13(4):379–399.

Crisman-Cox, Casey and Michael Gibilisco. 2018. "Audience Costs and the Dynamics of War and Peace." *American Journal of Political Science* 62(3):566–580.

Crisman-Cox, Casey and Michael Gibilisco. 2020. "Estimating Crisis Signaling Games in International Relations: Problems and Solutions." Forthcoming at *Political Science Research and Methods*.

Cunningham, Kathleen Gallagher, Kristin M. Bakke and Lee J.M. Seymour. 2012. "Shirts Today, Skins Tomorrow: Dual Contests and the Effects of Fragmentation in Self-Determination Disputes." *Journal of Conflict Resolution* 56(1):67–93.

Dechenaux, Emmanuel, Dan Kovenock and Roman M. Sheremeta. 2015. "A Survey of Experimental Research on Contests, All-pay Auctions and Tournaments." *Experimental Economics* 18(4):609–669.

Findley, Michael G. and Joseph K. Young. 2012. "More Combatant Groups, More Terror? Empirical Tests of an Outbidding Logic." *Terrorism and Political Violence* 24(5):706–721.

Fortna, Virginia Page. 2015. "Do Terrorists Win? Rebels' Use of Terrorism and Civil War Outcomes." *International Organization* 69(3):519556.

Franke, Jörg, Wolfgang Leininger and Cédric Wasser. 2018. "Optimal Favoritism in All-pay Auctions and Lottery Contests." *European Economic Review* 104:22–37.

Getmansky, Anna and Thomas Zeitzoff. 2014. "Terrorism and Voting: The Effect of Rockets in Israeli Elections." *American Political Science Review* 108(3):588–604.

Gibilisco, Michael, Brenton Kenkel and Miguel R. Rueda. 2022. "Competition and Civilian Victimization." *Journal of Conflict Resolution* OnlineFirst.

Gould, Eric D. and Esteban F. Klor. 2010. "Does Terrorism Work?" *The Quarterly Journal of Economics* 125(4):1459–1510.

Harris, Christopher and John Vickers. 1985. "Perfect Equilibrium in a Model of a Race." *Review of Economic Studies* 52(2):193–209.

Haushofer, Johannes, Anat Biletzki and Nancy Kanwisher. 2010. "Both Sides Retaliate in the Israeli–Palestinian Conflict." *Proceedings of the National Academy of Sciences* 107(42):17927–17932.

Iaryczower, Matias, Gabriel Lopez-Moctezuma and Adam Meirowitz. 2021. "Career Concerns and the Dynamics of Electoral Accountability." *American Journal of Political Science* forthcoming.

Jaeger, David A., Esteban F. Klor, Sami H. Miaari and M. Daniele Paserman. 2015. "Can Militants Use Violence to Win Public Support? Evidence from the Second Intifada." *Journal of Conflict Resolution* 59(3):528–549.

Jerusalem Media and Communication Centre (JMCC). N.d. "Polls." Accessed November 2019 from http://www.jmcc.org/polls.aspx.

Jones, Seth G. and Martin C. Libicki. 2008. *How Terrorist Groups End: Lessons for Countering Al Qa'ida*. Santa Monica, CA: Rand.

Kalman, Matthew. 2006. "U.S. training Fatah in anti-terror tactics." *San Francisco Chronicle*. Published 14 December 2006. Accessed 22 July 2020 from https://www.sfgate.com/news/article/U-S-training-Fatah-in-anti-terror-tactics-2465370.php.

Kenkel, Brenton and Kristopher W. Ramsay. 2021. "The Effective Power of Military Coalitions: A Unified Theoretical and Empirical Model." Unpublished manuscript. https://bkenkel.com/files/structwar.pdf.

Kirkegaard, René. 2012. "Favoritism in Asymmetric contests: Head Starts and Handicaps." *Games and Economic Behavior* 76(1):226–248.

Konrad, Kai A. 2012. "Dynamic Contests and the Discouragement Effect." *Revue d'économie politique* 122(2):233–256.

Konrad, Kai A. and Dan Kovenock. 2005. "Equilibrium and Efficiency in the Tug-of-war." Unpublished manuscript. http://dx.doi.org/10.2139/ssrn.844644.

Kydd, Andrew H. and Barbara F. Walter. 2006. "The Strategies of Terrorism." *International Security* .

Magnac, Thierry and David Thesmar. 2002. "Identifying Dynamic Discrete Decision Processes." *Econometrica* 70(2):801–816.

Murphy, Kevin M. and Robert H. Topel. 1985. "Estimation and Inference in Two-Step Econometric Models." *Journal of Business & Economic Statistics* 3(4):370–379.

National Consortium for the Study of Terrorism and Responses to Terrorism (START). 2019*a*. "Codebook: Inclusion Criteria and Variables." Global Terrorism Database. Accessed December 2019.

National Consortium for the Study of Terrorism and Responses to Terrorism (START). 2019*b*. "Global Terrorism Database.". Accessed December 2019 from https://www.start.umd.edu/gtd/.

Nemeth, Stephen. 2014. "The Effect of Competition on Terrorist Group Operations." *Journal of Conflict Resolution* 58(2):336–362.

Palestinian Center for Policy and Survey Research (PCPSR). N.d. "Index Survey Research." Accessed November 2019 from https://www.pcpsr.org/en/node/105.

Polo, Sara MT and Belén González. 2020. "The Power to Resist: Mobilization and the Logic of Terrorist Attacks in Civil War." *Comparative Political Studies* 53(13):2029–2060.

Rust, John. 1994. Structural Estimation of Markov Decision Processes. In *Handbook of Econometrics*, ed. Robert F Engle and Daniel L McFadden. Oxford: Elsevier pp. 3081–3143.

Siegel, Ron. 2014. "Asymmetric Contests with Head Starts and Nonmonotonic Costs." *American Economic Journal: Microeconomics* 6(3):59–105.

Signorino, Curtis. 1999. "Strategic Interaction and the Statistical Analysis of International Conflict." *American Political Science Review* 93(2).

Silvey, S. D. 1959. "The Lagrangian Multiplier Test." *The Annals of Mathematical Statistics* 30(2):389–407.

Stein, William E. 2002. "Asymmetric Rent-seeking with More than Two Contestants." *Public Choice* 113(3):325–336.

Su, Che-Lin and Kenneth L. Judd. 2012. "Constrained Optimization Approaches to Estimation of Structural Models." *Econometrica* 80(5):2213–2230.

Tauchen, George. 1986. "Finite State Markov-Chain Approximations to Univariate and Vector Autoregressions." *Economics letters* 20(2):177–181.

Thomas, Jakana. 2014. "Rewarding Bad Behavior: How Governments Respond to Terrorism in Civil War." *American Journal of Political Science* 58(4):804–818.

Tokdemir, Efe and Seden Akcinaroglu. 2016. "Reputation of Terror Groups Dataset: Measuring popularity of terror groups." *Journal of Peace Research* 53(2):268–277.

Vogt, Manuel, Kristian Skrede Gleditsch and Lars-Erik Cederman. 2021. "From Claims to Violence: Signaling, Outbidding, and Escalation." *Journal of Conflict Resolution* p. forthcoming.

Wood, Reed M. and Jacob D. Kathman. 2015. "Competing for the crown: Inter-rebel competition and civilian targeting in civil war." *Political Research Quarterly* 68(1):167–179.