Motivation

- Huge literature on causes of wars/ends of wars:
  - Formal theories abound:
    - Costly lottery models (e.g., Fearon, Powell)
    - Repeated bargaining with uncertainty (Powell)
    - Commitment issues due to power shifts or resources
    - Role of ethic or economic trajectories (Patro, Miguel)
    - Global games (Yazganbas)

Basic Model

- Evolutionary model
- Population of mass 1
- Citizens can be from four possible strategy combinations
- Each period it is marked by a single attack on a target
  - Only two individuals interact each period
- Attacks are either “seen” (by the attacker) or “defended” (by the target)
- After each period, one with lower payoff has chance to change strategy.

Table: Possible Citizen Strategy Combinations

<table>
<thead>
<tr>
<th>C = 0</th>
<th>C = 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>( t_1 ) (C = 0, G = 0)</td>
<td>( t_1 ) (C = 0, G = 1)</td>
</tr>
<tr>
<td>( t_2 ) (C = 1, G = 0)</td>
<td>( t_2 ) (C = 1, G = 1)</td>
</tr>
</tbody>
</table>

Table: Key Symbols Used in Paper

- \( t \): citizen strategy type for group \( G \) - proportion of \( t \) relative to total population
- \( t_{i,j} \): average score in period \( j \)
- \( d \): attack type in period \( j \)
- \( g \): target score in period \( j \)
- \( w \): base utility of each citizen
- \( \mu_1 \): new target score from target’s strategy
- \( \mu_2 \): new target score from attacker’s strategy
- \( \mu_1, \mu_2 \): the period (or round) indicator
- \( p(t_1|\mu_1) \): probability of strategy type for group \( G \)
- \( P(t_1|\mu_1) \): probability of strategy type for group \( G \)
- \( f(\mu_1, \mu_2) \): probability of strategy type for group \( G \)

Table: Effects of Attacks on Various Targets

<table>
<thead>
<tr>
<th>Target Type</th>
<th>Population Type</th>
<th>Attack Type</th>
<th>Outcome</th>
<th>Utility Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Attacker</td>
<td>Loyalist</td>
<td>Defended</td>
<td>Win: 1</td>
<td>1</td>
</tr>
<tr>
<td>Target</td>
<td>Loyalist</td>
<td>Defended</td>
<td>Defend: 0</td>
<td>0</td>
</tr>
</tbody>
</table>

How it works...

- Population
- Result?
- Shift Behavior?

Some results...

\[ f_1 \cdot \frac{\partial T_m}{\partial \mu_1} = (\mu_1 + \mu_2 - 1) \frac{\mu_1 - \mu_2 - 2}{(\mu_1 + \mu_2 - 1)^2} \] (2a)

\[ f_2 \cdot \frac{\partial T_m}{\partial \mu_1} = (\mu_1 + \mu_2 - 1) \frac{\mu_1 - \mu_2 - 2}{(\mu_1 + \mu_2 - 1)^2} \] (2b)

\[ f_3 \cdot \frac{\partial T_m}{\partial \mu_1} = (\mu_1 + \mu_2 - 1) \frac{\mu_1 - \mu_2 - 2}{(\mu_1 + \mu_2 - 1)^2} \] (2c)

\[ f_4 \cdot \frac{\partial T_m}{\partial \mu_1} = (\mu_1 + \mu_2 - 1) \frac{\mu_1 - \mu_2 - 2}{(\mu_1 + \mu_2 - 1)^2} \] (2d)

\[ \Delta \theta = \frac{1}{1 + e^{(\theta - \theta_0)}} \] (2)

Threshold Values of \( \Delta \theta \)

Extensions

- Include government as (rational?) actor
- Make population discrete
- Permits stochastic interpretation of model
- Explore \( p(t_1) \), etc. (Example: \( p(t_1) = \sum_{i \in \text{attacker types}} p(t_1|\mu_1) \))
- Explore simulations/relative rates of convergence
- Different replicator dynamics
- Non-loyalists have chance for defense
- Change targeting structure