An agent-based model of military mechanization
CSS 645

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Military mechanization

States differ in the composition of their militaries, particularly ground forces

One axis of comparison is **mechanization**

- The degree to which an army is comprised of infantry vs. ground combat vehicles

Historical examples help illustrate the general idea

- 1970s Vietcong (low mechanization) vs. 1980s Israel (high mechanization)
- 1980s U.S. (higher mechanization) vs. present-day U.S. (lower mechanization)

The consequences of choices regarding force structure are great

Academic and professional consensus that choices regarding military composition (including but not limited to mechanization) condition battlefield effectiveness

Size, cost, and complexity dictate that states can only slowly alter military composition, even under great duress

"You go to war with the army you have"

The determinants of mechanization are disputed

One view stresses **security environment**: states adjust mechanization to be able to prevail in conflict

- Neighbors' and enemys' mechanization (e.g. 1930s France and Germany)
- Terrain (e.g. Switzerland)
- Insurgency (e.g. U.S.)

Another view stresses **political, economic, and cultural factors**: states are not pure security-maximizers

- Regime type (e.g. democracy vs. autocracy)
- Economic endowments (e.g. capital vs. labor)
- Cultural norms (e.g. Irish tanks)

Sechser and Saunders 2010 conclude the former matters much more than the latter

- Developed state-year level dataset on mechanization, 1979-2001
- Traditional econometric analysis (OLS)
- Cultural norms (e.g. Irish tanks)

Viewing their findings through an ABM lens

Emphasis on **spatiality**: what are my neighbors doing?

My actions affect your actions affect my actions... $\rightarrow$ **positive feedback loops**

Estimated statistical coefficients implicitly claim particular cognitive model

- If neighbors mechanization goes up by X, I raise my mechanization by β

My research question: do their findings hold up under an ABM formulation?

Model description

Agent = state actor

Attributes:

- Mechanization level (vehicles : infantry ratio, IISS data)
- Geographic neighbors (contiguous border per COW dataset)
- Enemies (defined based on 10-year MID history)
- Terrain (Fearon and Laitin 2004)

Cognition regarding mechanization

- Takes into account neighbors, enemies, terrain, wars
- Agents observe lagged global behavior (2 years prior) and calculate weighted average of neighbor mechanization; weighted average of enemy mechanization; own terrain; and wars
- For each of the above, adjust own mechanization by some coefficient
- Coefficients drawn from statistical distribution found by Sechser and Saunders, randomly assigned to agents (heterogeneity)

Model description

Initialized in 1979

Proceeds in two-year timesteps until 2001

Every turn, agents perceive neighbors, enemies, terrain, and wars, and adjust own mechanization accordingly

Because agent cognition has random element, model is stochastic and must be run many times

General research strategy: initialize with values from 1979, run, see if model results in 2001 match reality at both actor- and system-level

Example

Findings

Model results in significantly higher mechanization at both system- and agent-level than reality
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Influence of positive feedback loops

Results stem from positive feedback loop: you increase your mechanization, which causes me to increase my mechanization, which causes you to increase your mechanization...

Modeled system lacks countervailing negative feedback loop

Conclusion: some of the factors dismissed by Sechser and Saunders must play a role in mitigating rate-of-increase in the real-world system

Cannot say *which* factors, but the system-level point remains

Verification, validation, and other topics

In our taxonomy: analyzed-analyzed model

Validation central to research strategy: comparison of model-2001 to reality-2001

Significant amount of coding work was dealing with fact that composition of international system changed over time (e.g., 1991)

- Inheritance

Possible extensions

Alliances

More sophisticated cognition

Incorporation of other force structure choices (e.g. human capital)