NSSC 8
NUCLEAR SCIENCE and SECURITY CONSORTIUM

Nuclear Science and Security Consortium

September Workshop and
Advisory Board Meeting

State Participation in Nonproliferation Regime Networks

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Research Overview

GOAL: Utilize network science to assess efficacy of NPT and Nuclear Weapon Free Zones (NWFZs)

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METHOD: Calculate various network measures (from network analysis) to compare against state and global nuclear proliferation levels

OUTCOME: Network membership implies a self-enforcing mechanism for individual states, but increased overall participation negligibly affects global nonproliferation norms

Scope and Assumptions

- Affiliation Network: nodes are states and treaties

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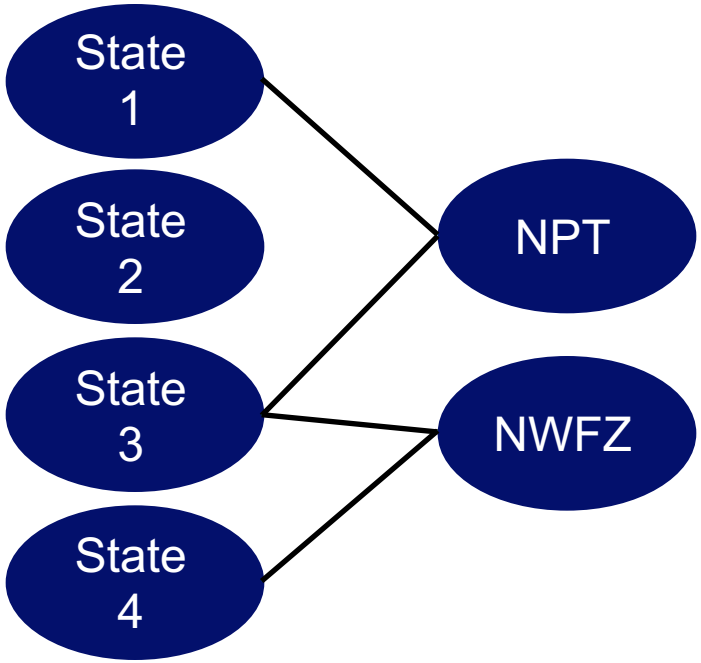

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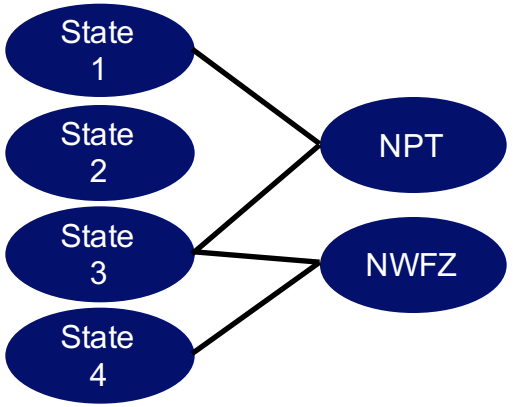

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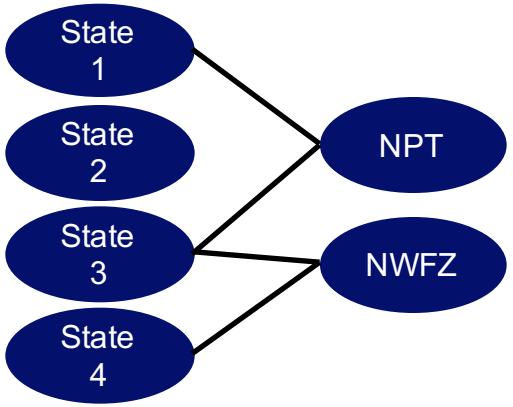

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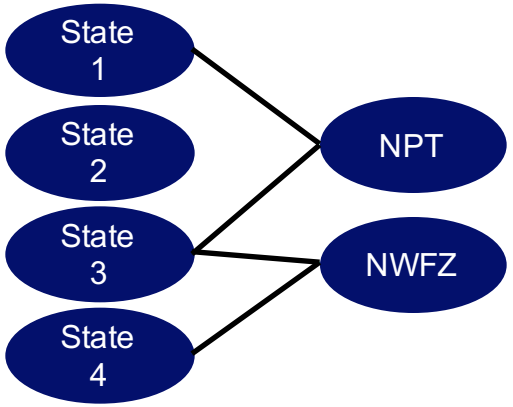

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Sources:
- UN Treaty Website
- CIA World Factbook
- 2004 Singh and Way proliferation dataset with 2012 update from Dr. Way

0 → No Activity
1 → Explore
2 → Pursue
3 → Acquire

Test 1: Eigenvector Centrality

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$$(A^* A^{*\prime}) c^N = \lambda^2 c^N$$

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  - **Hypothesis:** as state centrality increases, state proliferation decreases

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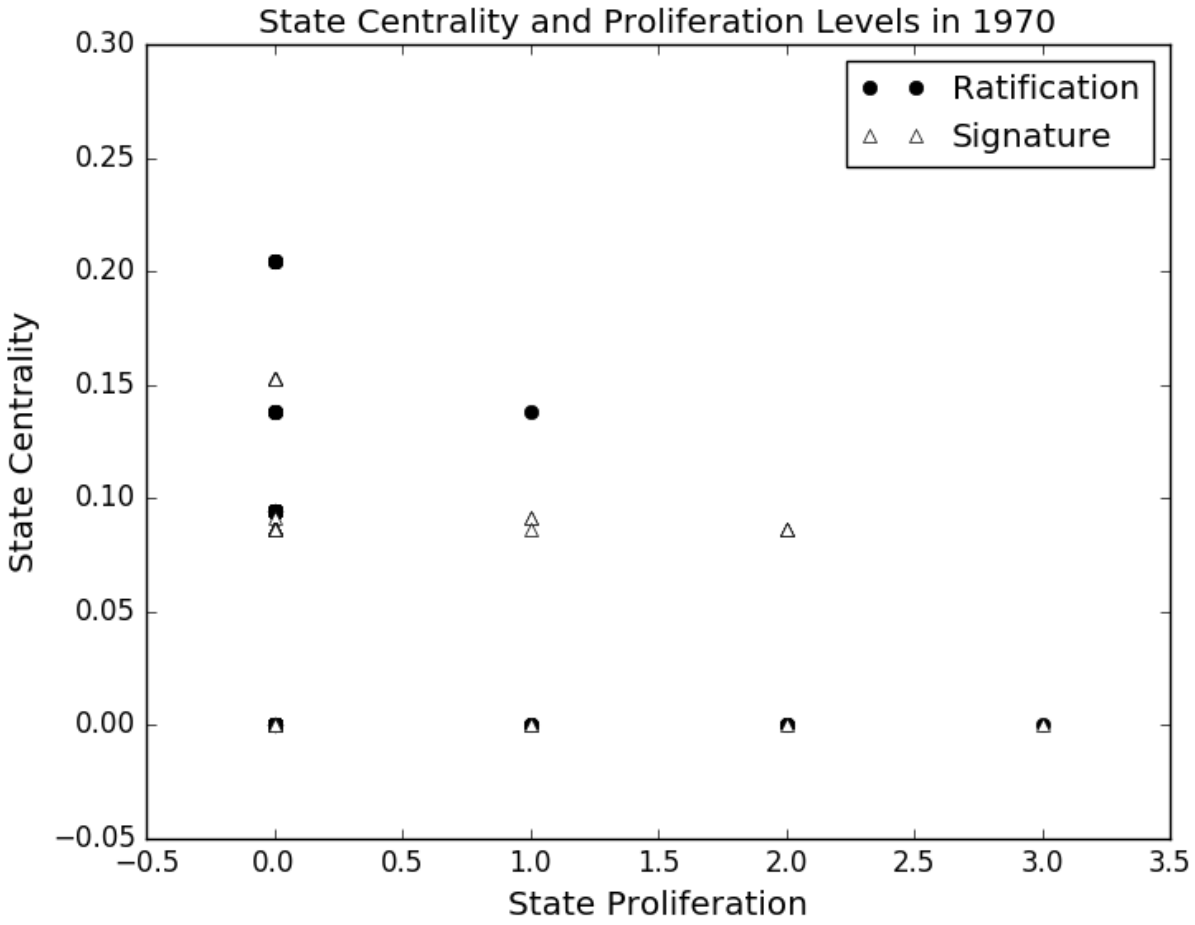

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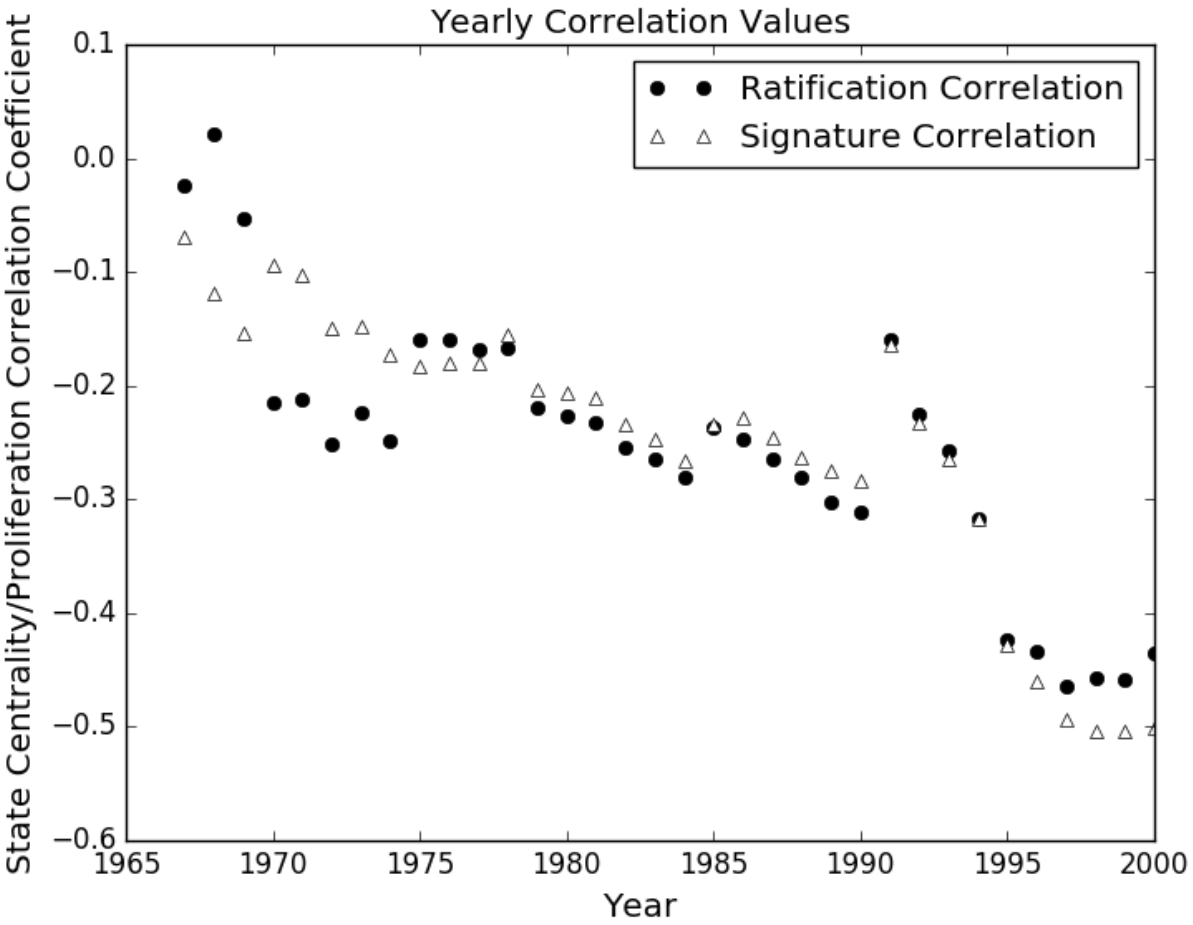
- For each year, correlated state centrality with state proliferation level
  - **Hypothesis correct:** as state centrality increases, state proliferation decreases; gets stronger through time



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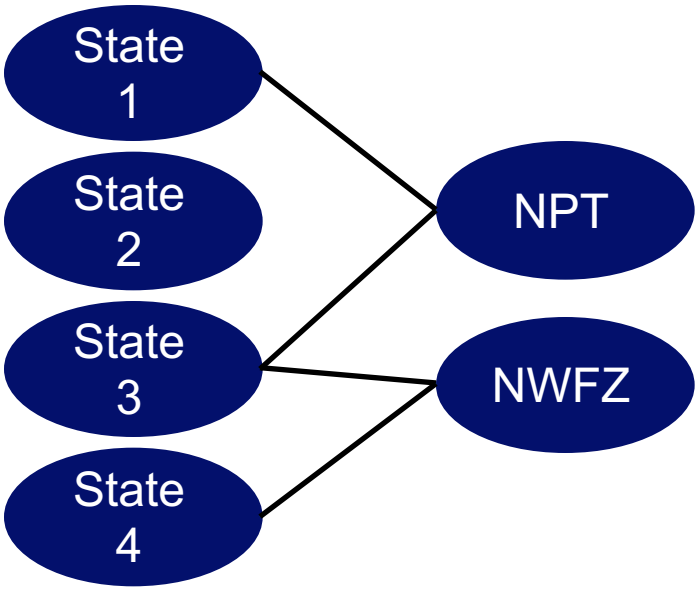

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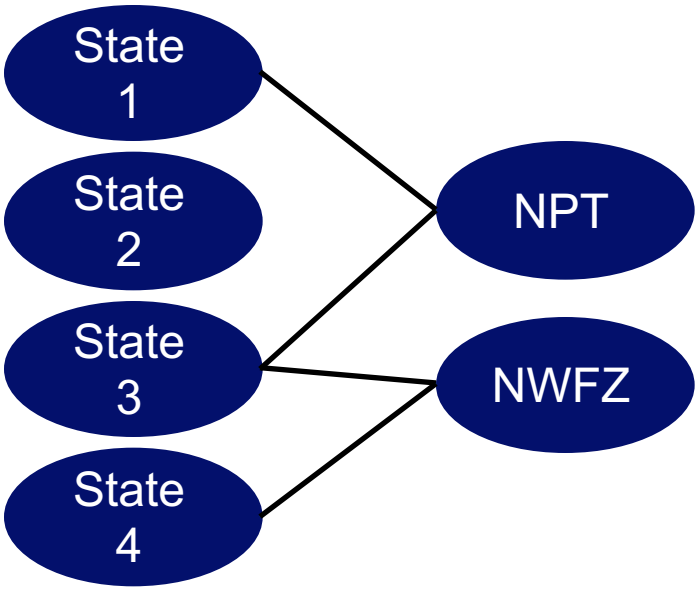
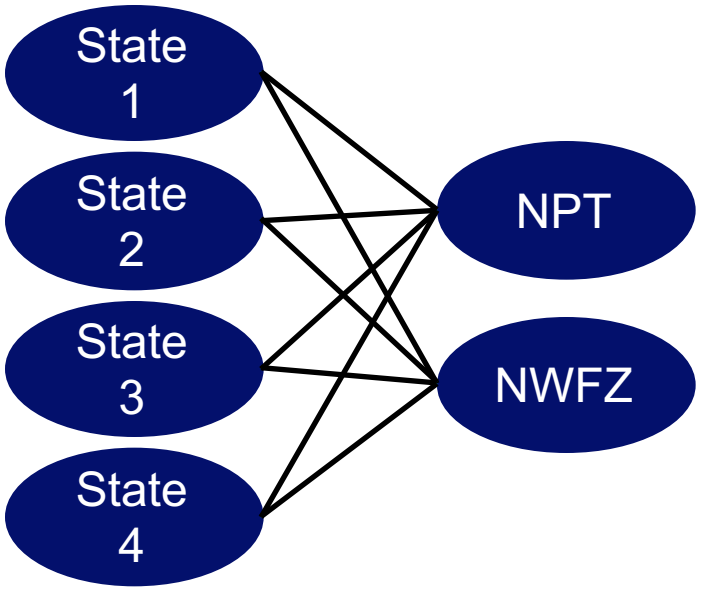


Density = 1



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  - **Hypothesis:** as network density increases, global proliferation decreases

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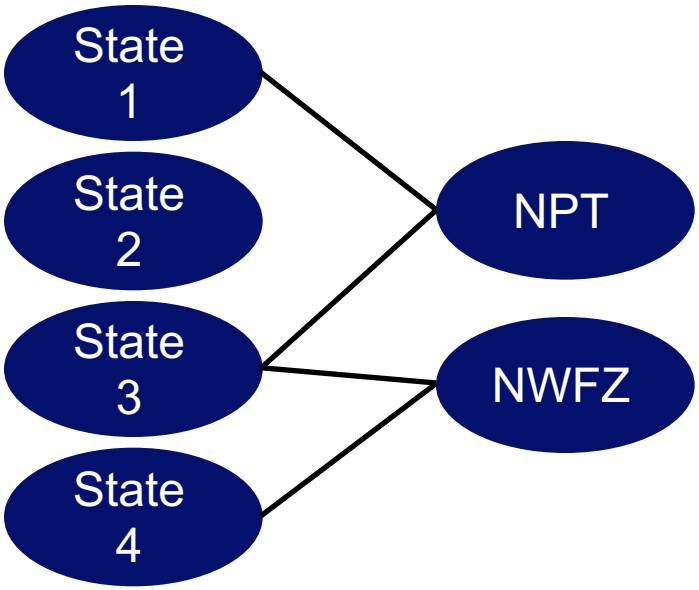

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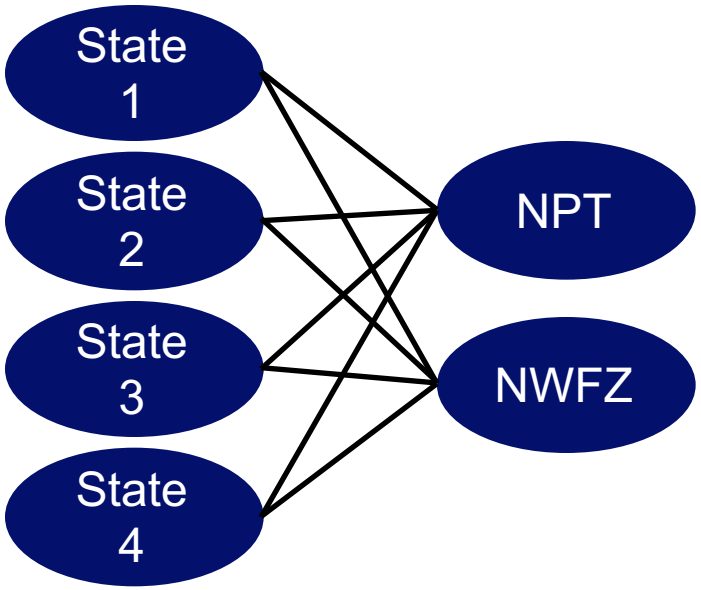
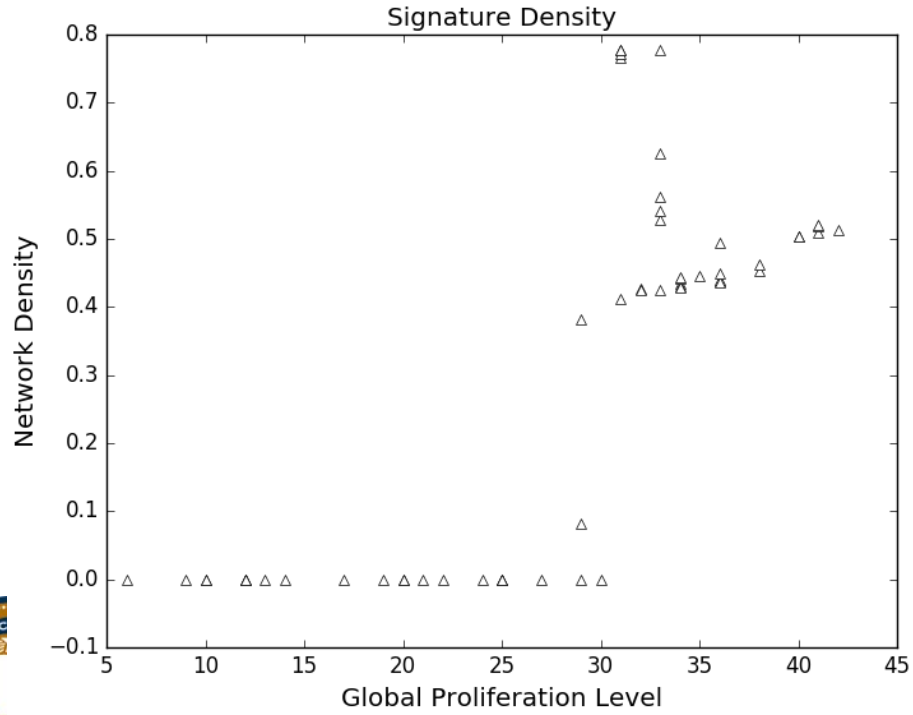


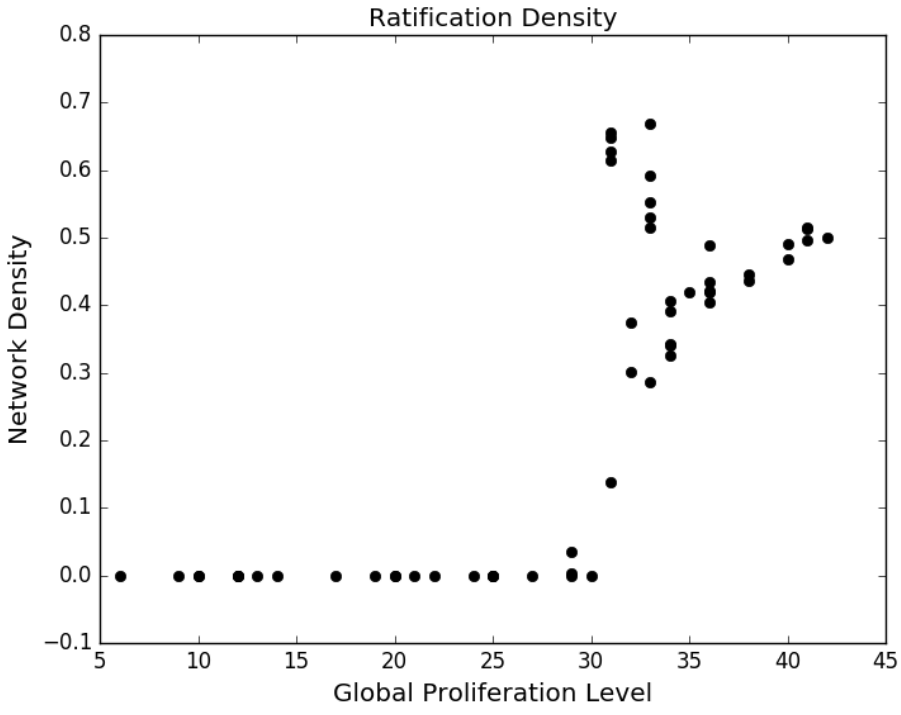
Test 2: Network Density

- Over all years, correlated annual density with global proliferation level
  - **Hypothesis wrong:** as network density increases, global proliferation ~~decreases~~ increases

Correlation: 0.76
p-value: 7.60 e-12

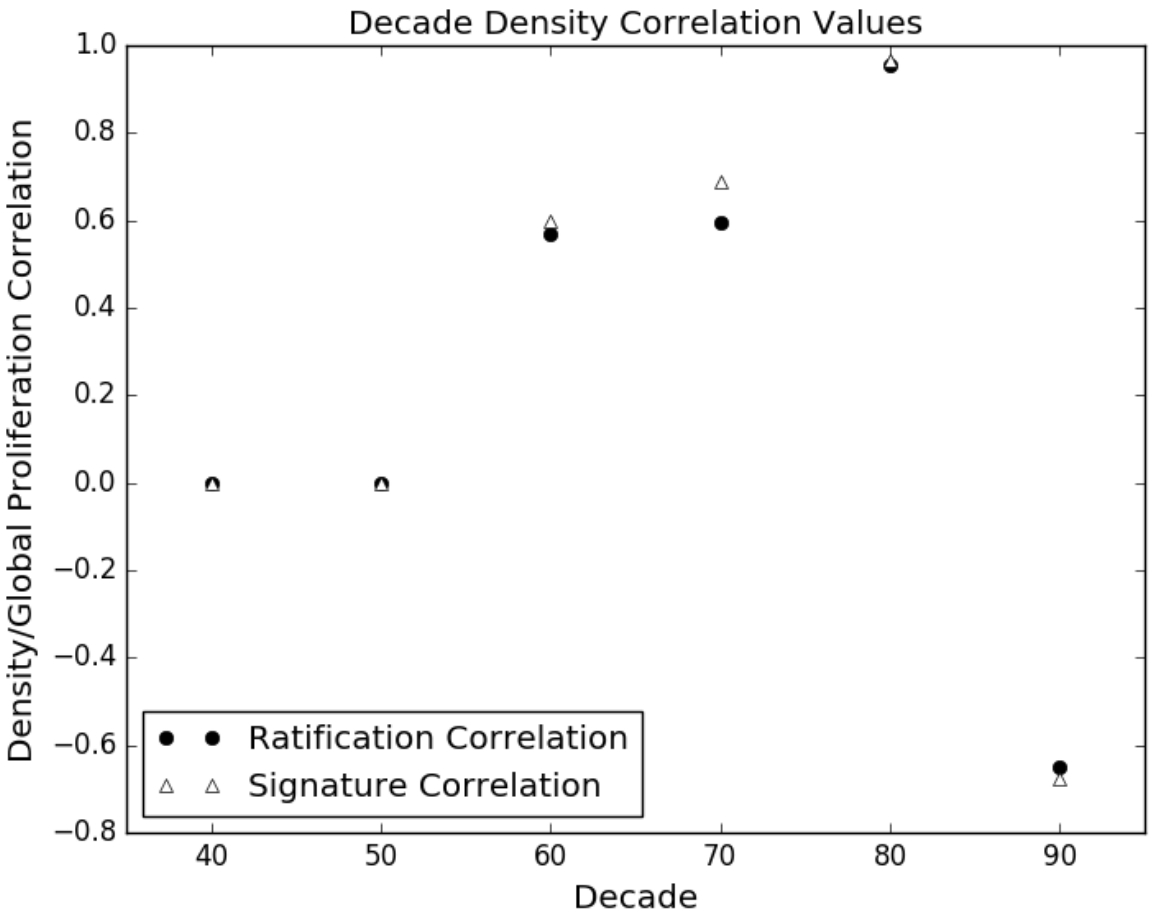


Correlation: 0.77
p-value: 3.50 e-12



Test 2: Network Density

- Over all years, correlated annual density with global proliferation level
  - **Hypothesis sometimes correct:** as network density increases, global proliferation decreases in 1990-2000



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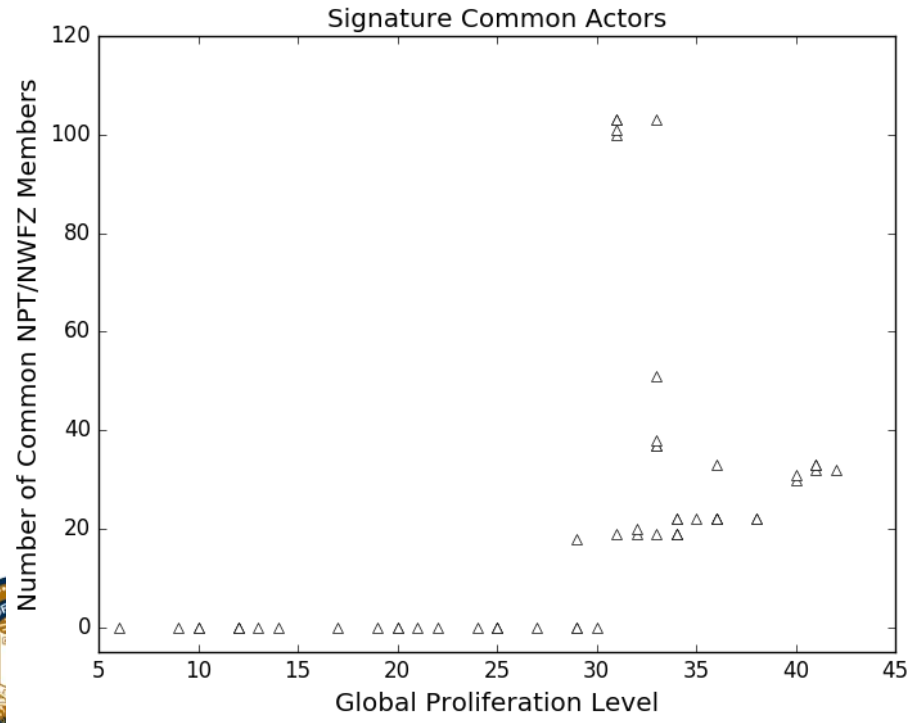
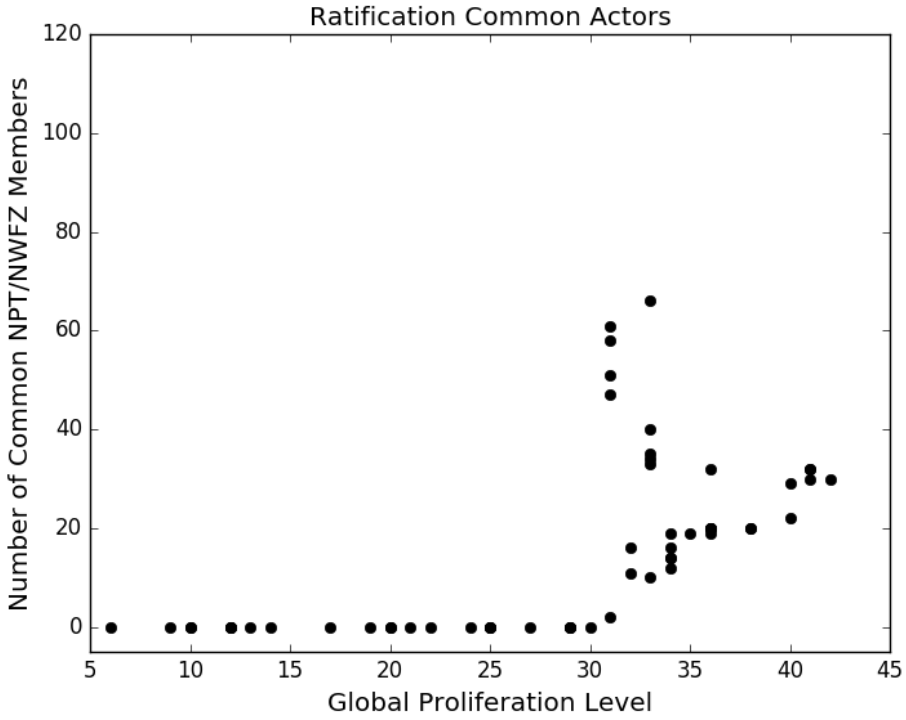
Correlation: 0.47
p-value: 2.57 e-4



Correlation: 0.60
p-value: 1.02 e-6



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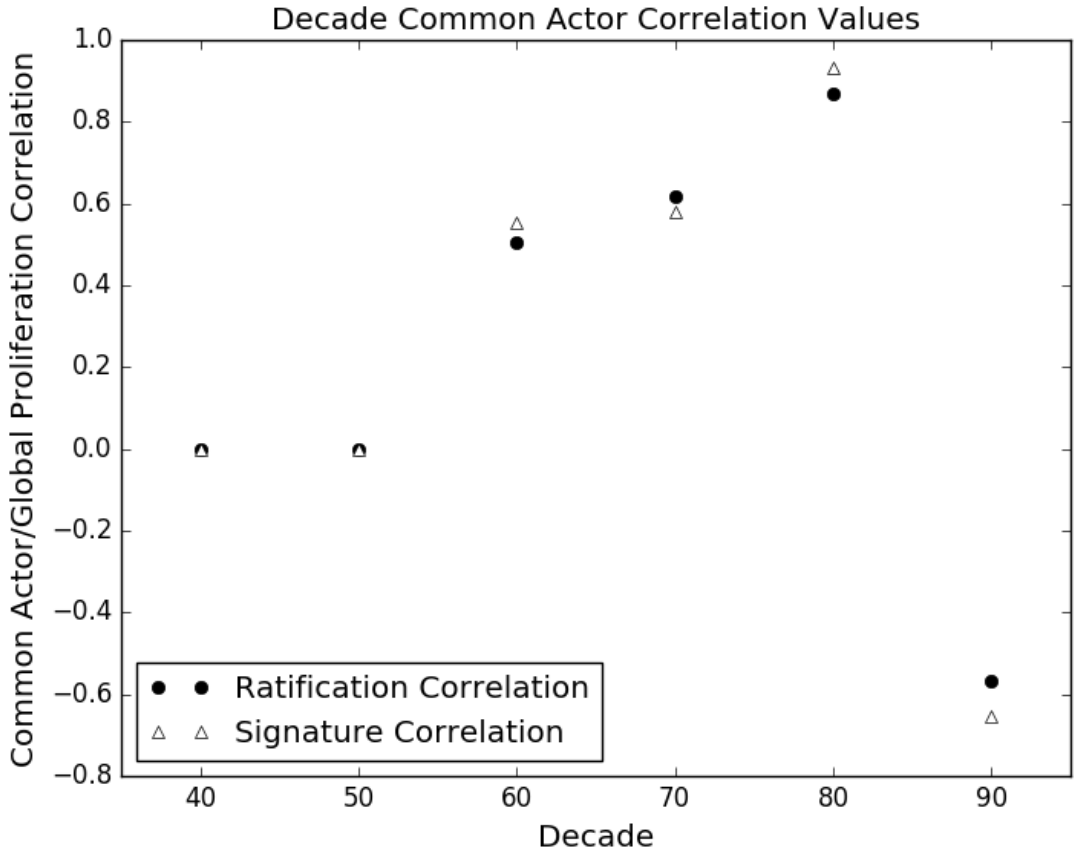

Final Thoughts

Conclusions:

- Joining the NPT and a NWFZ is a ***self-enforcing*** mechanism encouraging nonproliferation tendencies in the ***individual state***
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Future Work:

- NPT Additional Protocols
- Additional nonproliferation treaties

Acknowledgments & Disclaimer

I would like to thank my co-researchers from (1) UC Berkeley: Bethany Goldblum, Elie Katzenson, Nathanial Mahowald, Yara Mubarak, Lakshmi Ramesh, Austin Wright; (2) National Securities Technologies, LLC: Hart Kornell; and (3) Sandia National Laboratories: Zoe Gastelum.

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