The Pugwash Movement and International Nuclear Disarmament

Ted Hsuan Yun Chen
Pennsylvania State University
thc126@psu.edu

Nuclear disarmament is difficult

- States can generally gain from disarmament, but cooperation is difficult because of the security dilemma.
- Nuclear disarmament is particularly difficult because of the technological requirements associated with monitoring.
- There is evidence that membership in the nuclear regime reduces proliferation, but the determinants of states entering the regime is underexamined.

Scientists are transnational diplomats

Diplomacy is an antiquated vehicle. Our role is to remove obstacles from the path of this antique chariot.

—Lev Artsimovich, Soviet physicist
Addresing other Pugwash participants in 1963

- Throughout international relations history, scientists have played important diplomatic roles.
- In a spectrum ranging from full access to officials and full independence to act, scientists rests on the middle of the spectrum.
- If states utilize the resources, primarily informational, possessed by the transnational scientific network there is potential for increased likelihood of interstate cooperation
- The Pugwash Conferences is a group of scientists who gather to work toward influencing states in nuclear disarmament.

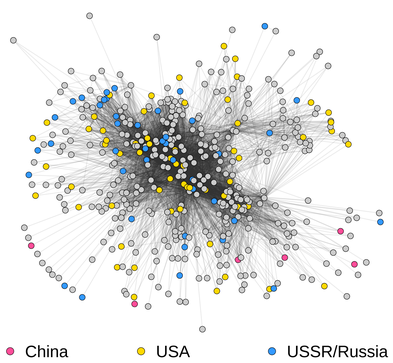


Figure 1. Pugwash Coparticipation Network, 1957-2007 collapsed

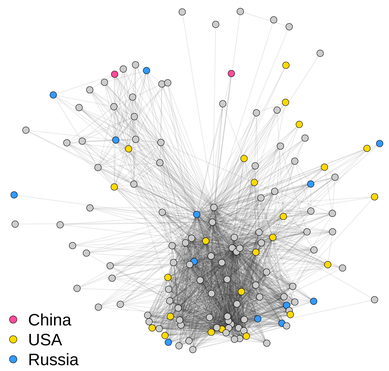


Figure 2. Pugwash Coparticipation Network, 1991-1996 collapsed

A delegation theory of scientific influence

- Transnational influence is an endogenous relationship between states opting into information from scientists, and scientists who attempt to influence state behaviour.
- "Influence" is the equilibrium in which scientist's proposal moves state behaviour away from status quo.

Expectations: Patterns of cooperation between states in the area of nuclear disarmament and control will resemble patterns of cooperation between nuclear scientists working toward global nuclear arms reduction.

- In open communication systems, information uptake is moderate: there is always flow but there is competition from multiple competing sources.
- In closed systems, influence is generally low, but in the presence of external shocks, the informational channels are direct and influence will be high.

The global system is a multilayer network

- States who jointly enter into the nuclear regime can are tied together in an interstate network. The interstate network is tied to the transnational scientific network through interlayer ties.
- The creation of this multilayer network, which is essentially the interdependent creation of every single one of these ties, is conditional on many factors.

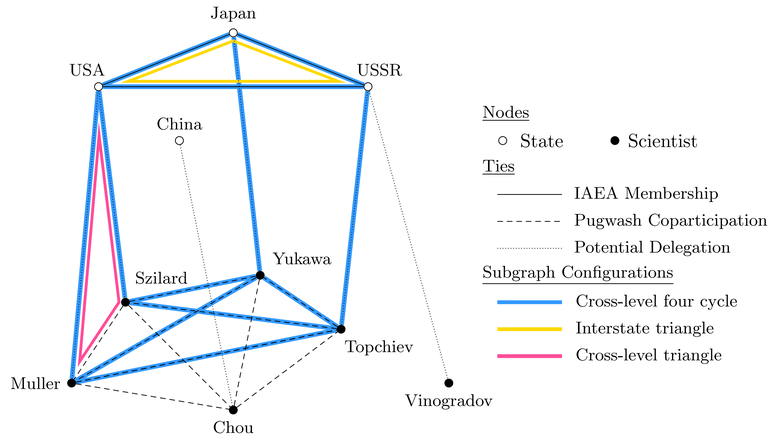


Figure 3. IAEA Membership and Pugwash Participation in 1957

Exponential random graph models for network inference

- The theoretical expectation that patterns of cooperation between states will resemble patterns of cooperation between scientists can be restated as expecting ties on the interstate network and ties on the scientific network to mutually reinforce each other.
- This kind of mutual reinforcement is a factor that is hypothesized to have generated the observed network.
- An ERGM is a statistical model that can test the different kinds of factors that underlies the generative process of the observed network.
- In an ERGM, the probability of observing a network $\mathbf{Y} = \{Y_{ij}\}$, where $Y_{ij} = 1$ indicates a tie between nodes i and j, is specified as

$$\Pr(\mathbf{Y}, \theta) = \kappa^{-1} \exp\{\theta' \mathbf{x}(\mathbf{Y})\},$$

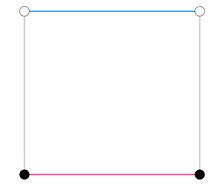
where θ is a vector of parameters and $\mathbf{x}$ is a vector function that yields a vector of observed network statistics computed on $\mathbf{Y}$. $\kappa = \sum_{\mathbf{Y}^* \in \mathcal{Y}} \exp\{\theta' \mathbf{x}(\mathbf{Y}^*)\}$, where $\mathcal{Y}$ is the set of all networks defined on the node set of $\mathbf{Y}$, is the normalizing constant that makes the equation a proper probability distribution.

- It does so by specifying *counts of different subgraph configurations* as its model terms.

An ERGM for transnational influence

- The subgraph configuration that captures the tendency for cross-layer mutual reinforcement is the cross-level four cycle.

Figure 4. Subgraph configurations for cross-network reinforcement



- Using the ERGM, we can estimate the log-odds of an interstate tie being formed, conditional on the existence of a scientific tie, and vice versa.