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# **Towards Arms and Influence Networks**

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# The International Arms Trade

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## Arms Transfers: A State-to-State Network

- Economic Factors
  - Supply: domestic arms industry
  - Demand: military requirements
  - Treated here as exogenous
- Patterns of Trade - Network Structure
  - Hegemonic
  - Industrial
  - Restrictive

The network emerges from the combination of political and economic factors

# Overall Goals

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## Research Questions

- Why does any given arms transfer occur?
- Is there a dominant pattern?
- Forecast future transfers

## Why do we care?

- Make effective policy
- Prevent unintended consequences
- Identify opportunities

**Work in progress!**

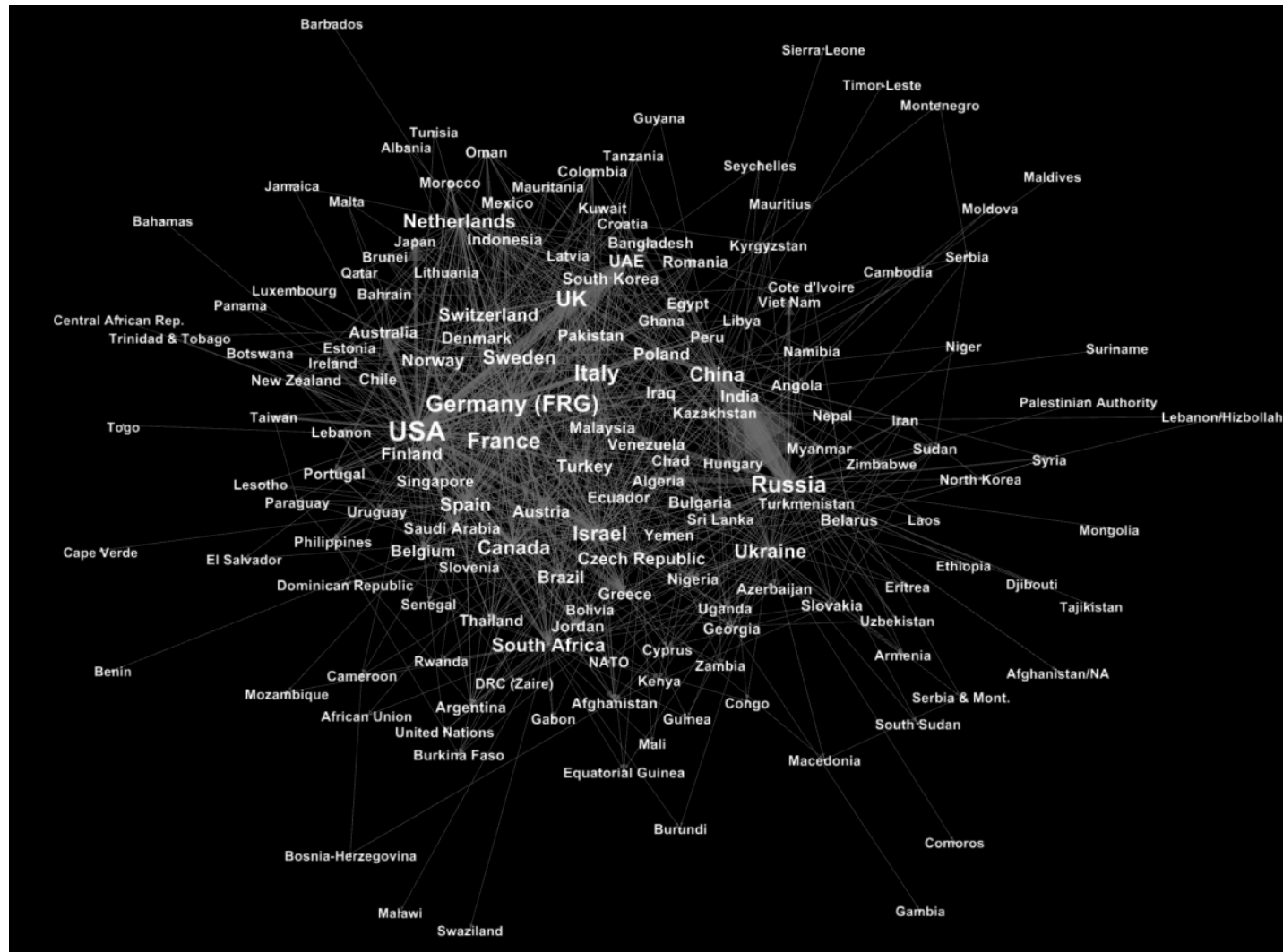
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# Data Sources

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- Stockholm International Peace Research Institute
    - Transfers between 1950 - 2011
    - Only major conventional weapons and components
    - Normalized to Trend Indicator Values (TIV)
  - United Nations General Assembly Votes
    - Votes on resolutions between 1946 - 2012
    - Cleaned of unanimous votes
    - Used to measure political affinity
  - Annual data aggregated together over longer periods to reduce noise
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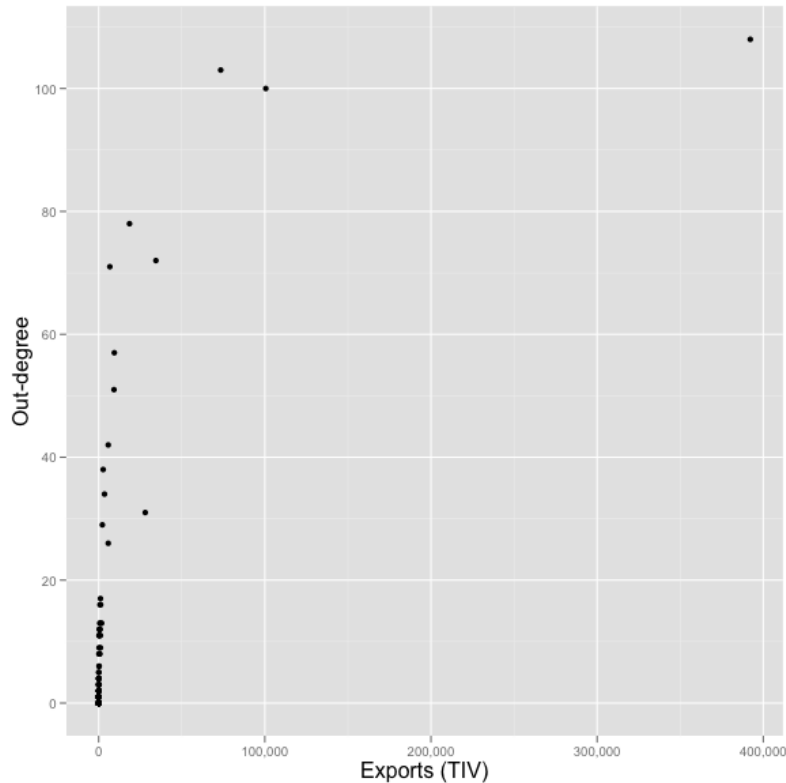
# Arms Trade Network Overview



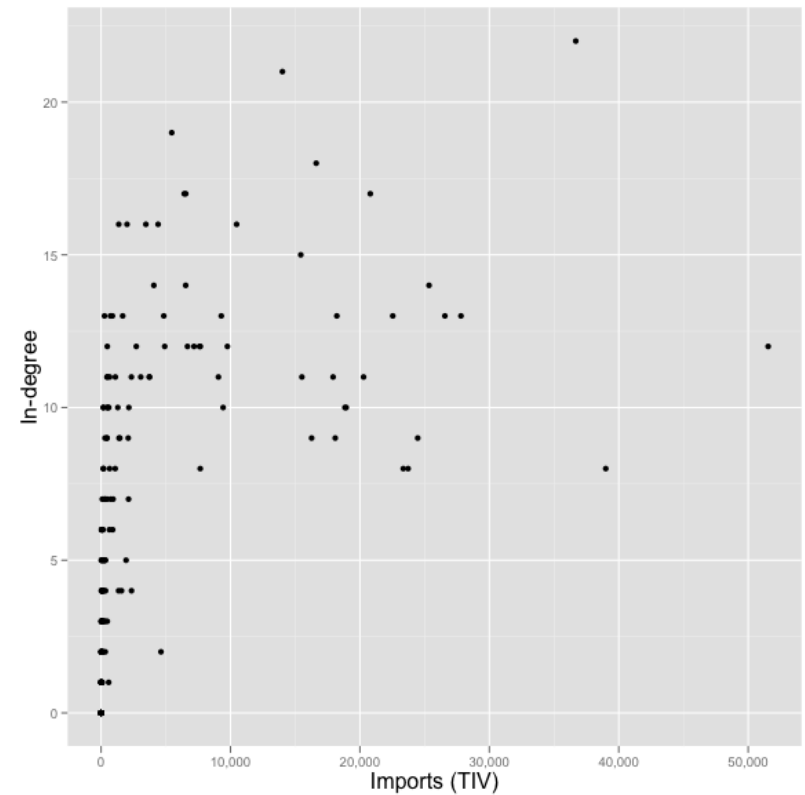
# Arms Trade Network Overview

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Cold War: 1950 - 1989



Spearman Corr : 0.99

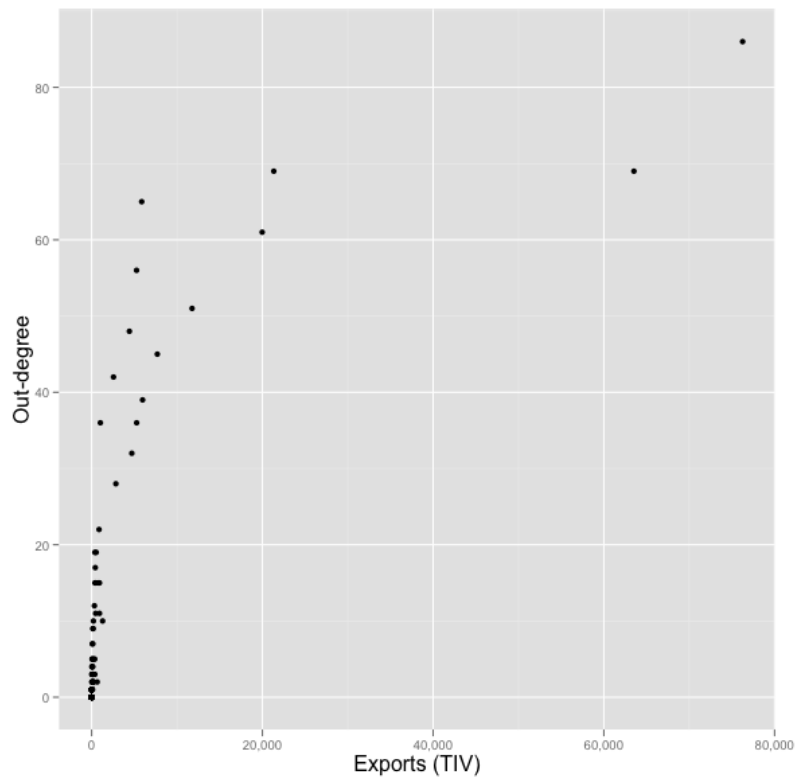


Spearman Corr: 0.89

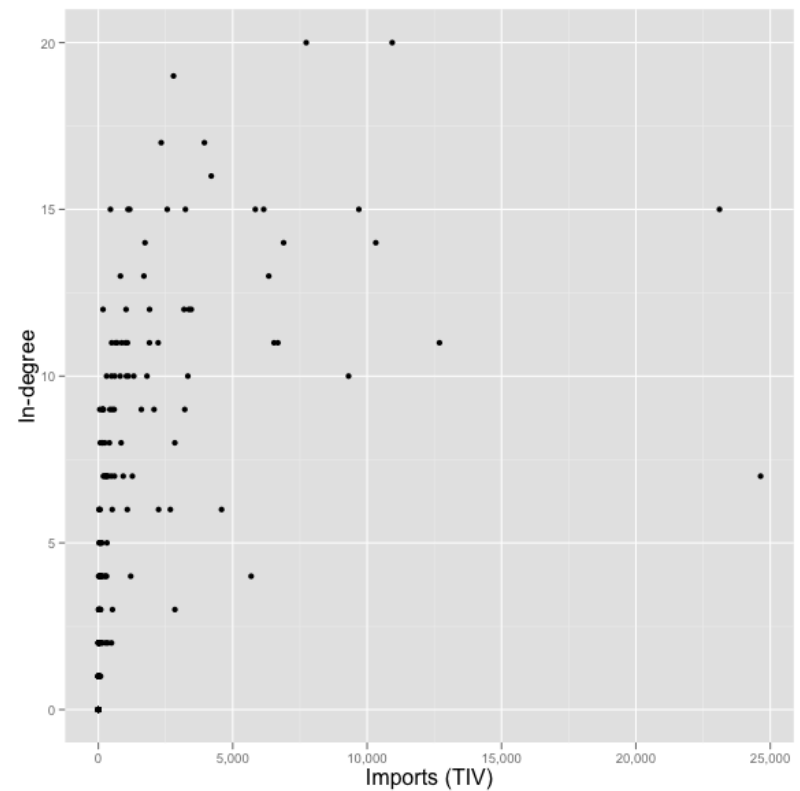
# Arms Trade Network Overview

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2001 - 2011



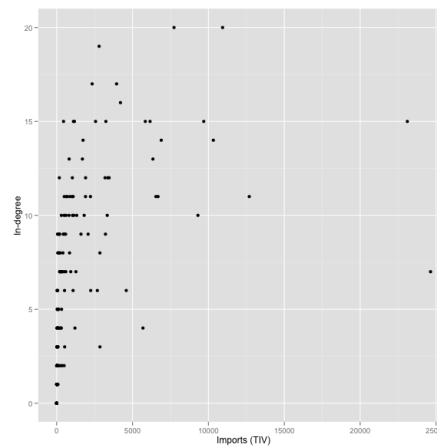
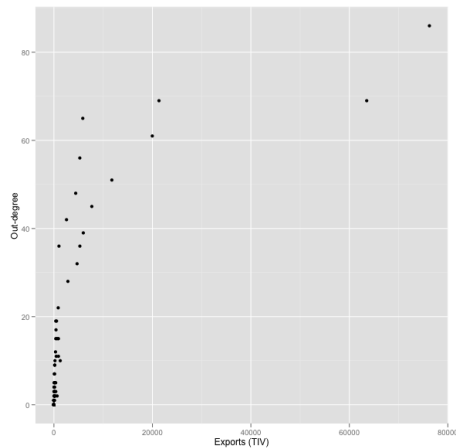
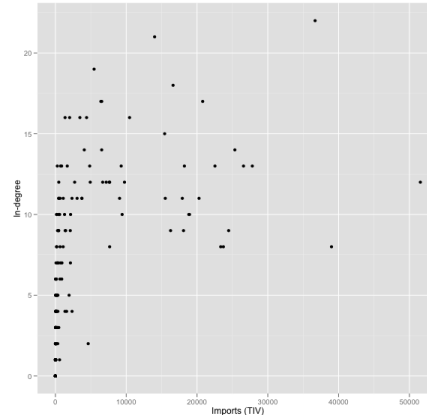
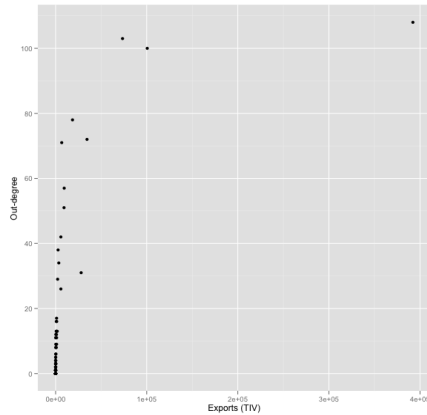
Spearman Corr : 0.99



Spearman Corr: 0.90

# Network Overview

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Appears to suggest that supply & demand are **preferential attachment factors**

Evidence for **industrial pattern**



# Community Detection

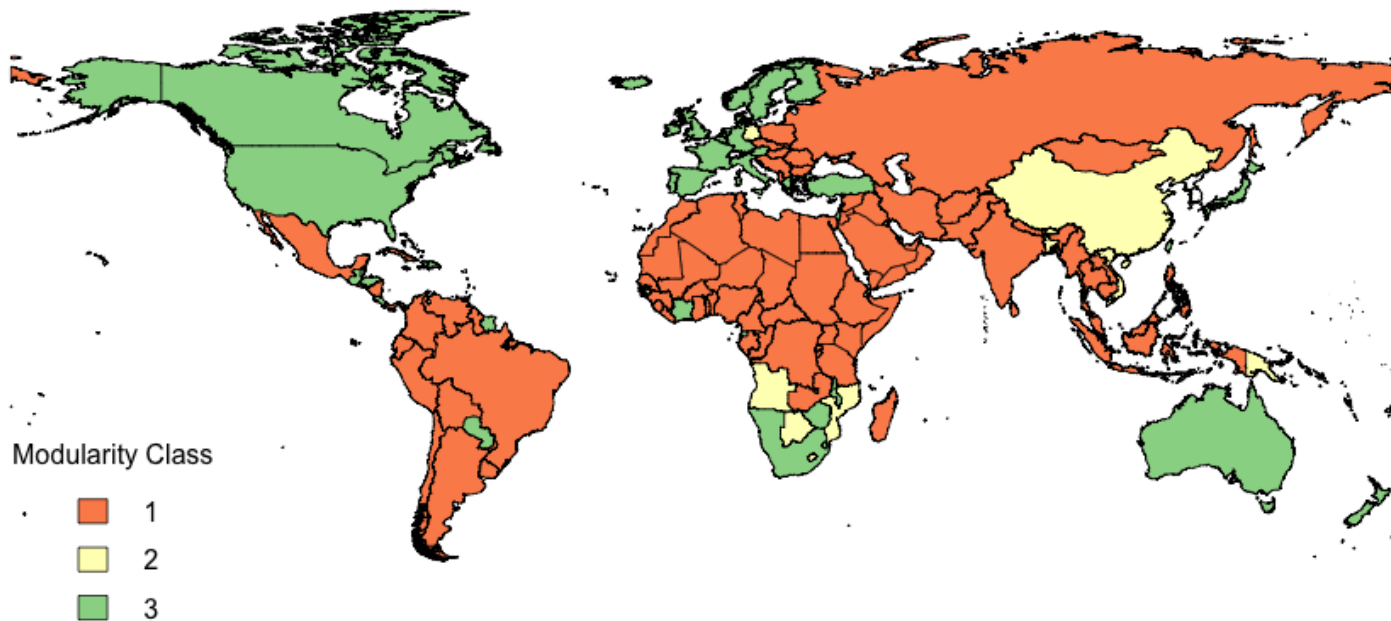
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- **Communities:** countries are 'closer' to other countries within their community than those outside of it
  - **Algorithm: Louvain Method**  
(Blondel et. al, “Fast unfolding of communities in large networks,” Journal of Statistical Mechanics: Theory and Experiment 2008)
  - **Does *not* specify a target # of communities**
  - **Hypotheses:**
    - Evidence for hegemonic pattern: overlap between SIPRI communities and known political structures
    - Evidence of industrial pattern: SIPRI communities surrounding major exporters
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# Community Detection

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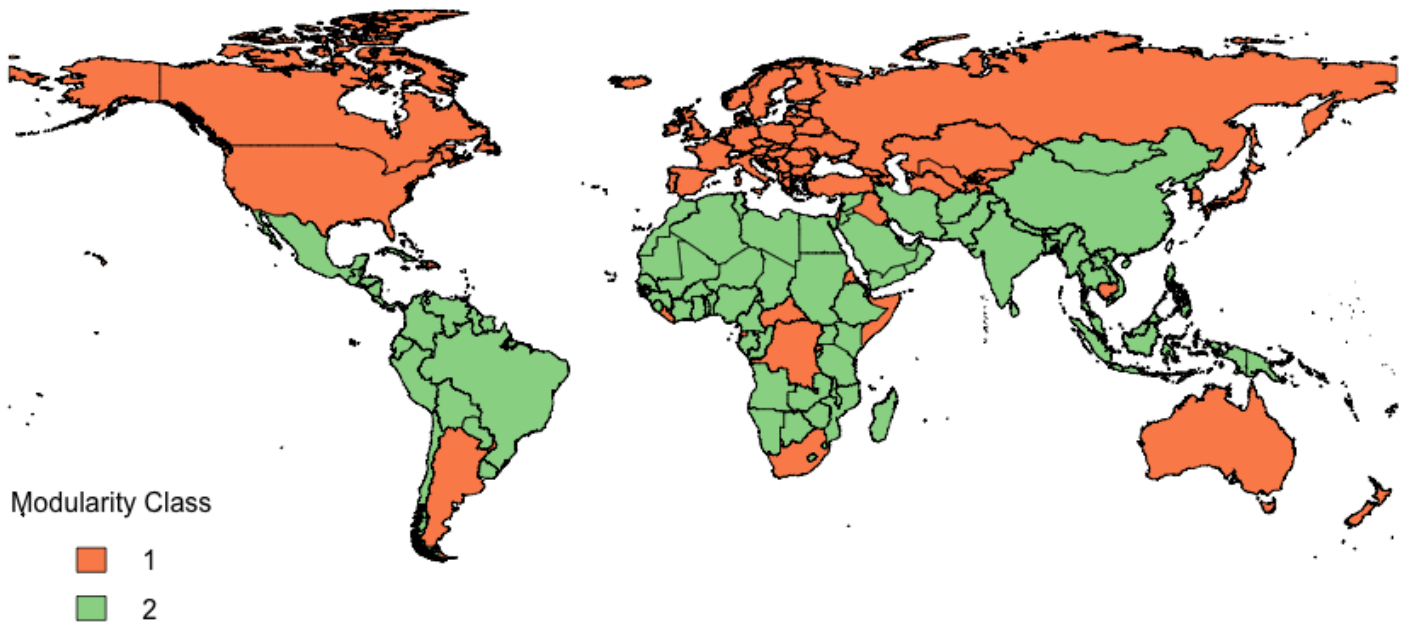
UN Voting Communities 1950-1989



# Community Detection

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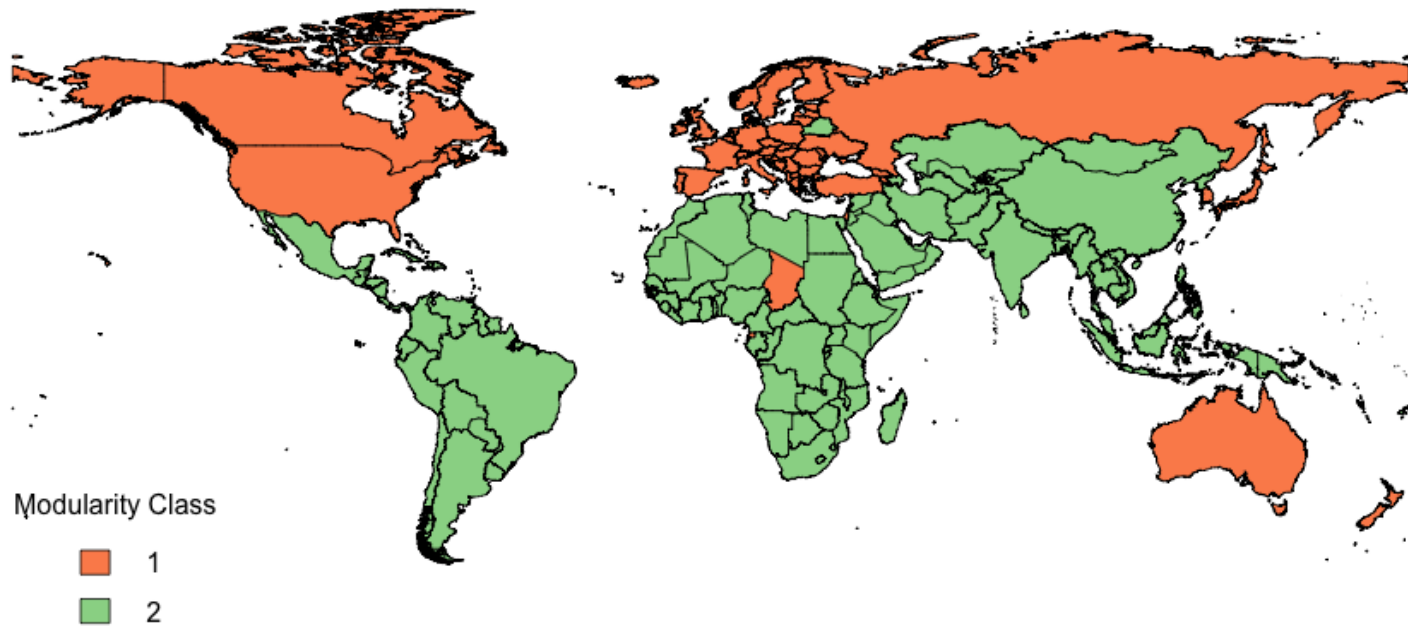
UN Voting Communities 1990-2000



# Community Detection

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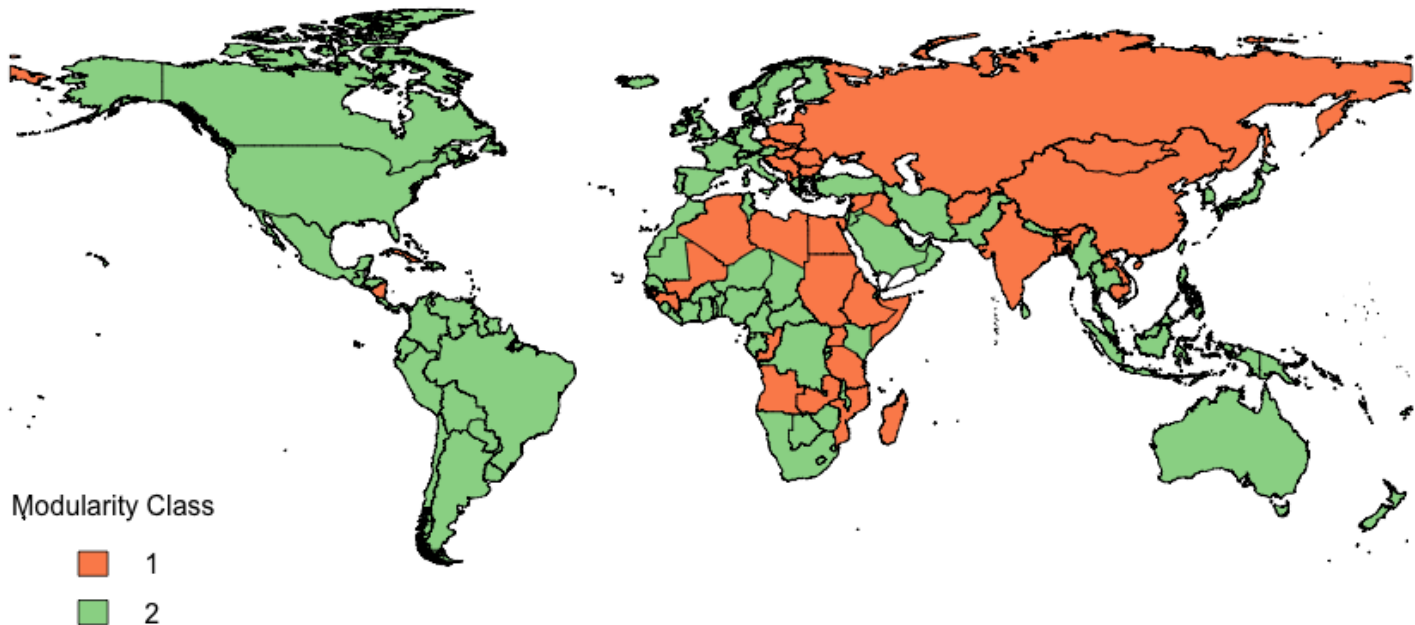
UN Voting Communities 2001-2012



# Community Detection

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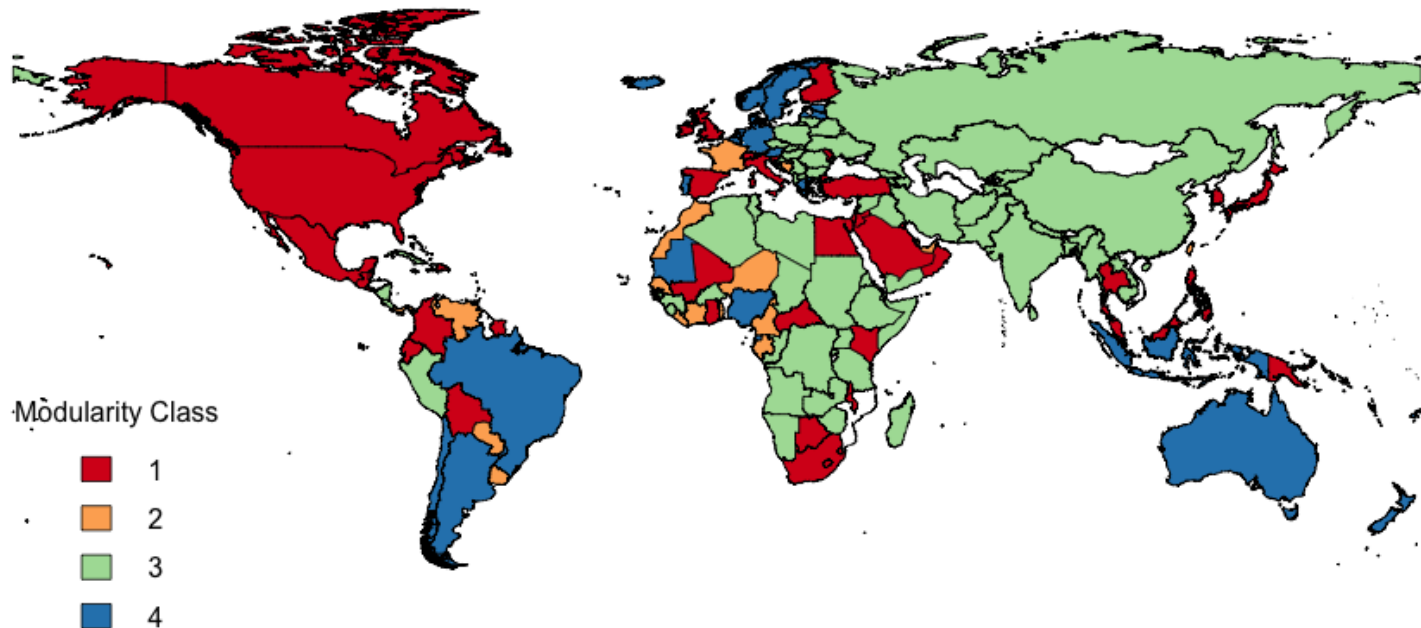
SIPRI Communities 1950-1989



# Community Detection

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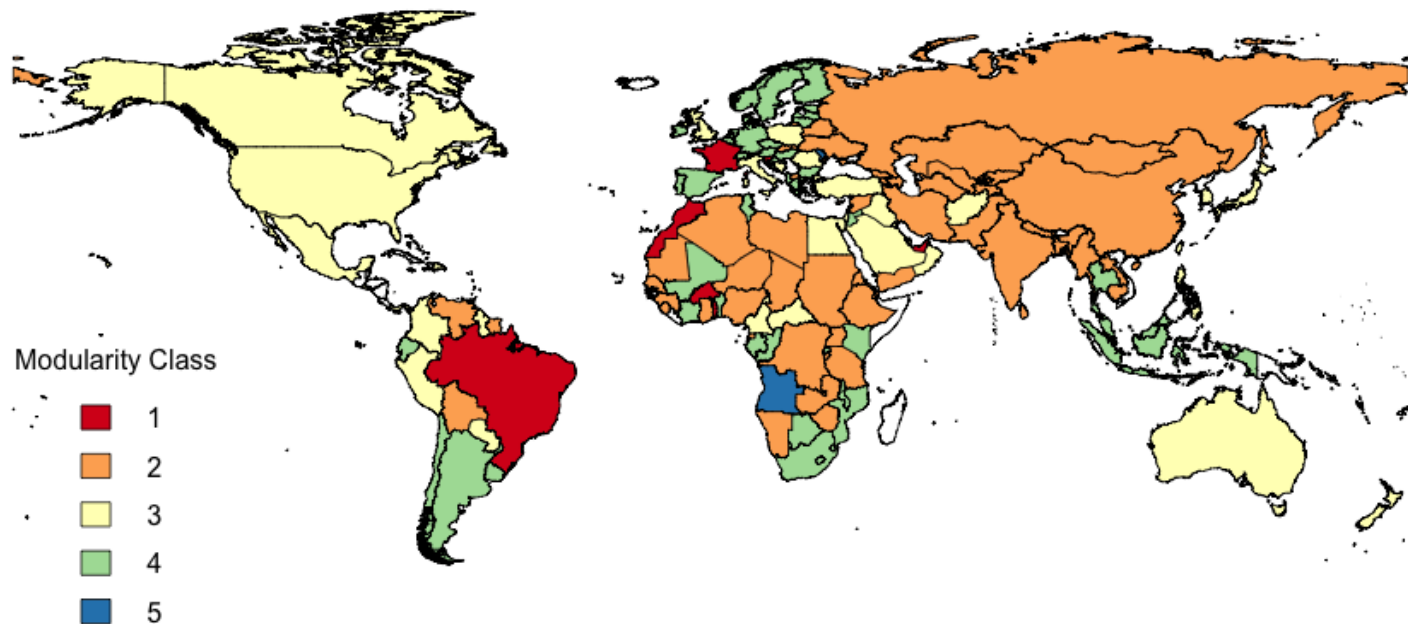
SIPRI Communities 1990-2000



# Community Detection

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SIPRI Communities 2001-2011



# Exponential Random-Graph Model

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- Method for estimating tie formation
  - Stochastically generate possible network configurations, based on observed network statistics
  - Estimate log-odds of tie formation, along with statistical significance
    - Functionally similar to regression
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# Exponential Random Graph Model

1975-1985

Network Statistic	Variable	Hegemonic	Models	Industrial Model	Mixed	Models
		Model 1	Model 2	Model 3	Model 4	Model 5
Node Matching	UN Community	-3.701*** (0.049)			-3.540*** (5.16e-02)	
Edge Existence	UN Similarity		-7.491*** (0.088)			-8.138*** (0.109)
Node In- Degree	Import Vol.			-9.72e-04*** (1.9e-05)	-5.38e-04*** (1.47e-05)	-3.19e-05** (1.03e-05)
Node Out- Degree	Export Vol.			3.75e-06** (1.18e-06)	2.66e-05*** (1.42e-06)	4.79e-05*** (1.47e-06)
	<i>BIC</i>	26,729	12,472	38,250	23,293	11,445

# Exponential Random Graph Model

2001 - 2011

Network Statistic	Variable	Hegemonic	Models	Industrial Model	Mixed	Models
		Model 1	Model 2	Model 3	Model 4	Model 5
Node Matching	UN Community	-3.508*** (0.044)			-3.289*** (4.4e-02)	
Edge Existence	UN Similarity		-5.722*** (0.057)			-6.187*** (6.79e-02)
Node In- Degree	Import Vol.			-9.27e-04*** (1.8e-05)	-4.4e-04*** (1.36e-05)	3.61e-05*** (7.34e-06)
Node Out- Degree	Export Vol.			-2.05e-06 (1.57e-06)	2.18e-05*** (1.93e-06)	4.83e-05*** (1.7e-06)
	<i>BIC</i>	27,340	11,409	39,889	24,920	10,694

# Exponential Random-Graph Model

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## Takeaway:

- Smaller change than expected between Cold War and contemporary patterns
  - Industrial model appears insufficient on its own
  - **Neither pattern dominates; best explanation combines both.**
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# Agent-Based Model

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- Goal: explain the arms transfer network using state-level behavior model
  - Model outline:
    - Each country is an agent
    - Agents act in random sequence
      - Agent proposes a transfer to another
      - Potential receiver may accept or reject
    - Agent behavior:
      - Maximize exports
      - Be close to allies
      - Be far from rivals
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# Agent-Based Model

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**Work in progress!**

## **Initial observations:**

- Complete random behavior: ~5% overlap with observed network
  - Export-maximizing only: ~15% overlap with observed network
  - UN Affinity-weighted export maximizing: ~22% overlap with observed network
  - Computationally expensive!
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# Future Work

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- Add and test additional variables
  - Dynamic network analysis
  - Continue refining ABM
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# Questions?

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