The Network of Foreign Direct Investment Flows: Theory and Empirical Analysis[1]

John Schoeneman[2]
jbs5686@psu.edu
PhD Candidate

Boliang Zhu[2]
bxz14@psu.edu
Assistant Professor

Bruce Desmarais[2]
bdesmarais@psu.edu
Associate Professor

Workshop Modeling Spatial and Network Interdependence in International Relations, December 7-8, 2018, St. Gallen

December 8, 2018

[1]Work supported in part by NSF grants SES-1558661, SES-1619644, SES-1637089, CISE-1320219, and DGE-1144860.

[2]Pennsylvania State University

Introduction

- Motivation
  - Explain FDI networks
  - Violation of Independence Assumptions
  - Theoretical Importance of Dependence Terms
- FDI as a Network
  - Reciprocity
  - Transitivity
- Demonstrate how to integrate dependence and covariates

Variables

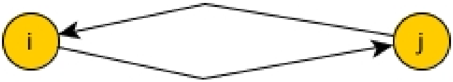
Bilateral FDI:

- Modeled on the rounded logarithmic scale (i.e., count).
- Data from UNCTAD, covering the time-period of 2001 to 2012

- Dyad-level Covariates
  - Gravity +
  - Contiguity +
  - Common Language +
  - Four Types of Defense Treaties +
  - Colonial Relationships +
  - PTA depth +
- Country-level Covariates (s/r)
  - GDP per capita +/-
  - GDP Growth Rate +/+
  - Polity IV +/+
  - Political Violence -/-
  - Trade Openness +/+

Reciprocity

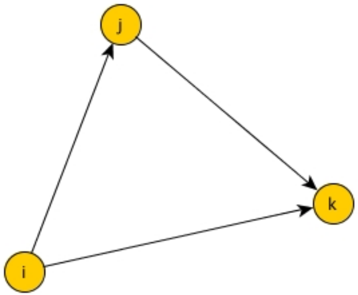
- Reciprocity



- Standard practice to resolve political opposition from competing firms

Transitivity

- Transitivity



- MNC expansion and supply-chain fragmentation

The Count Exponential Random Graph Model (ERGM)

The probability (likelihood function) of observing the network is:

$$\Pr_{\boldsymbol{\theta};h;\boldsymbol{g}}(\boldsymbol{Y} = \boldsymbol{y}) = \frac{h(\boldsymbol{y})\exp(\boldsymbol{\theta} \cdot \boldsymbol{g}(\boldsymbol{y}))}{\kappa_{h,\boldsymbol{g}}(\boldsymbol{\theta})}$$

Decomposition:

$$\underbrace{\boldsymbol{h}\left(\boldsymbol{y}\right)}_{Distribution} \quad \underbrace{\boldsymbol{\theta}}_{Effects} \quad \underbrace{\boldsymbol{g}\left(\boldsymbol{y}\right)}_{Net\ Stats} \quad \underbrace{\boldsymbol{\kappa}_{h,\boldsymbol{g}}(\boldsymbol{\theta})}_{Normalizer}$$

Constants:

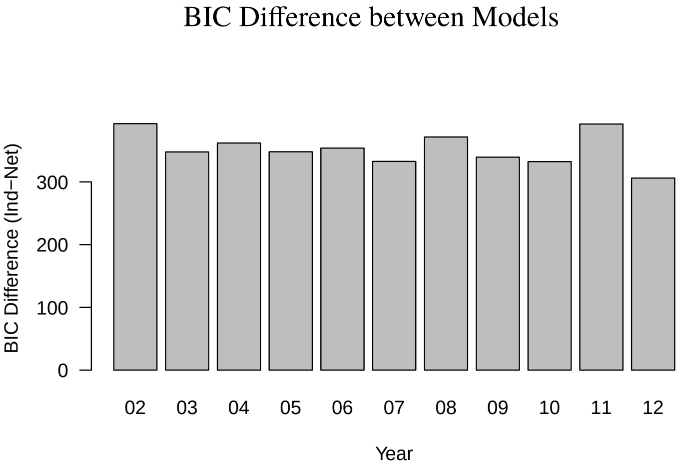
- Sum, Sum$^{(1/2)}$, and Nonzero

ERGM Dependence Terms

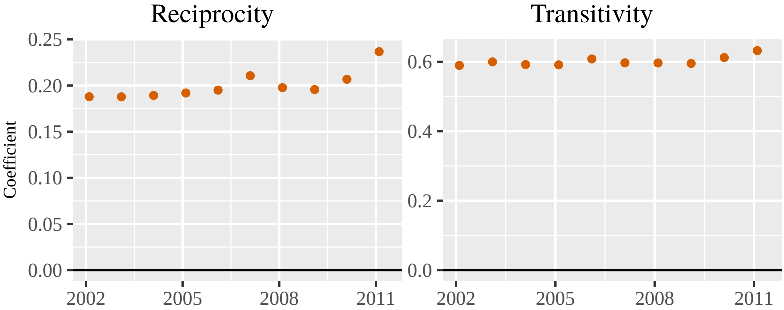
$$\text{Reciprocity} : \boldsymbol{g}\left(\boldsymbol{y}\right) = \sum_{(i,j)\in\mathbb{Y}} min(\boldsymbol{y}_{i,j}, \boldsymbol{y}_{j,i})$$

$$\text{Transitive Weights} : \boldsymbol{g}\left(\boldsymbol{y}\right) = \sum_{(i,j)\in\mathbb{Y}} \min\left(\boldsymbol{y}_{i,j}, \max_{k\in N}\left(\min(\boldsymbol{y}_{i,k}, \boldsymbol{y}_{k,j})\right)\right),$$

Model Fit and Bias

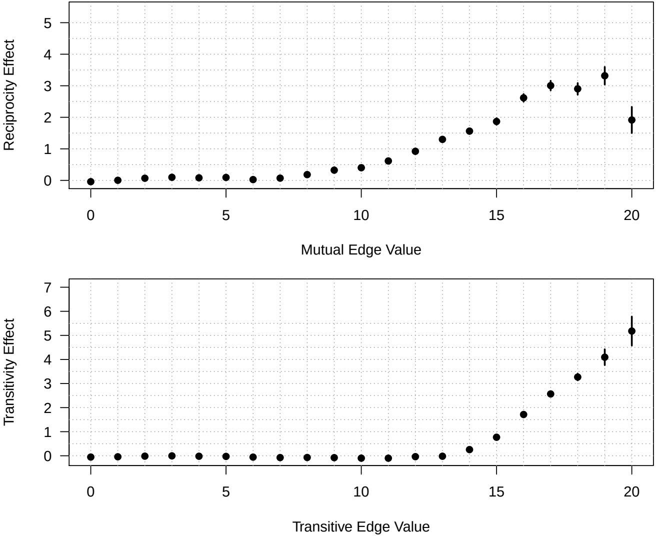


Count Model and Network Dependencies

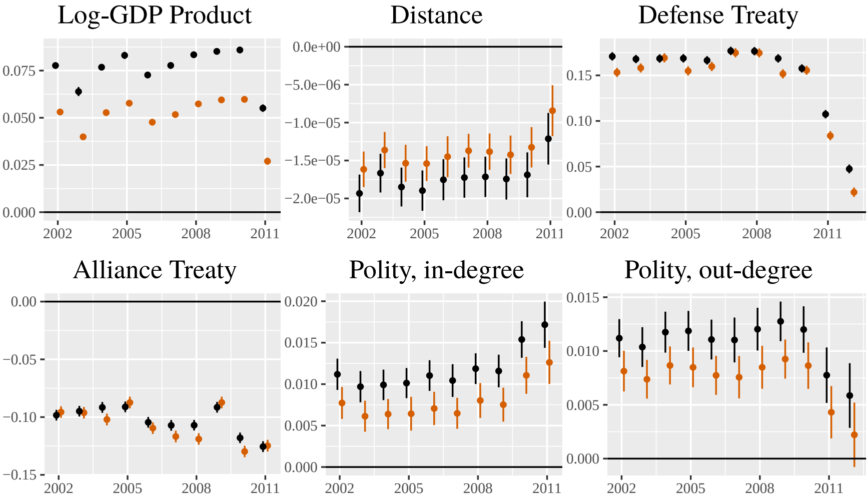


Network Effects Interpretation

Change in expected value relative to independence model:

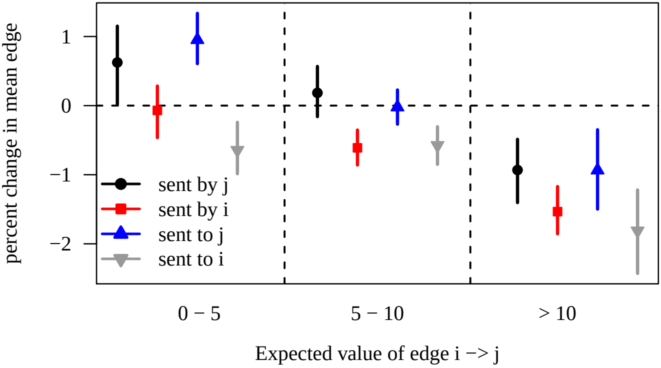


Covariate Results



Implications: FDI Ripple Effects

How does the network equilibrate in response to an edge elimination?



Conclusion and Future Research

- Dyadic FDI characterized by network interdependence
- Network terms need to be modeled instead of being assumed away
- Raises additional complications related to missing data

ERGM Constants

$$\text{Sum} : \boldsymbol{g}\left(\boldsymbol{y}\right) = \sum_{(i,j)\in\mathbb{Y}} \boldsymbol{y}_{i,j}$$

$$\text{Sum, Fractional Moment} : \boldsymbol{g}\left(\boldsymbol{y}\right) = \sum_{(i,j)\in\mathbb{Y}} \boldsymbol{y}_{i,j}^{1/2}$$

$$\text{Non-Zero} : \boldsymbol{g}\left(\boldsymbol{y}\right) = \sum_{(i,j)\in\mathbb{Y}} \mathbb{I}(\boldsymbol{y}_{i,j} \neq 0)$$

ERGM Covariates

$$\text{Dyadic Covariate} : \boldsymbol{g}\left(\boldsymbol{y}, \boldsymbol{x}\right) = \sum_{(i,j)} \boldsymbol{y}_{i,j} x_{i,j}$$

$$\text{Sender Covariate} : \boldsymbol{g}\left(\boldsymbol{y}, \boldsymbol{x}\right) = \sum_{i} x_i \sum_{j} \boldsymbol{y}_{i,j}$$

$$\text{Receiver Covariate} : \boldsymbol{g}\left(\boldsymbol{y}, \boldsymbol{x}\right) = \sum_{j} x_j \sum_{i} \boldsymbol{y}_{i,j}$$