Influence Networks in International Relations

Shahryar Minhas[1] Peter D. Hoff[2] Michael D. Ward[1]

[1]Duke University, Dept. of Political Science [2]University of Washington–Seattle, Dept. of Statistics & Biostatistics

Overview

In this project, we present a novel approach to modeling how relational data structures evolve. The core of our approach is a bilinear network autoregression model through which we can estimate the effects of endogenous and exogenous covariates, and construct a parameter space of how actors in this system are influencing one another. Within this framework we also provide a mechanism to assess what drives how influential certain actors are for others in the network. We employ this approach to understanding the evolution of material conflict within the ICEWS dataset from March 2001 to December 2012.

Network Autoregression

Let $Y = \{Y_t : t = 1, \ldots, T\}$ be a time series of sociomatrices.

$$M = \{\mu_{i,j,t}\} = A\tilde{Y}_t B^T$$

$$\mu_{i,j,t} = a_i^T Y_{t-1} b_j = \sum_{i'} \sum_{j'} a_{ii'} b_{jj'} \tilde{y}_{i'j't}$$

Social Influence Regression

What characteristics of i or i' are related to the influence $a_{ii'}$? To answer this, we consider a linear regression model for $a_{ii'}$ and $b_{jj'}$, given by $a_{ii'} = \alpha^T w_{ii'}$ and $b_{jj'} = \beta^T w_{jj'}$, where $w_{ii'}$ is a vector of nodal and dyadic covariates specific to pair ii'. The network autoregression model becomes

$$\begin{aligned}
\mu_{i,j,t} &= \sum_{i'j'} a_{ii'} \tilde{y}_{i'j't} b_{jj'} \\
&= \sum_{i'j'} \alpha^T w_{ii'} \tilde{y}_{i'j't} w_{jj'}^T \beta \\
&= \alpha^T \left(\sum_{i'j'} \tilde{y}_{i'j't} w_{ii'} w_{jj'}^T \right) \beta \\
&= \alpha^T X_{ijt} \beta
\end{aligned}$$

Additional variables can be accommodated by:

$$\mu_{ij,t} = \theta^T z_{ij,t} + \alpha^T X_{ij,t} \beta$$

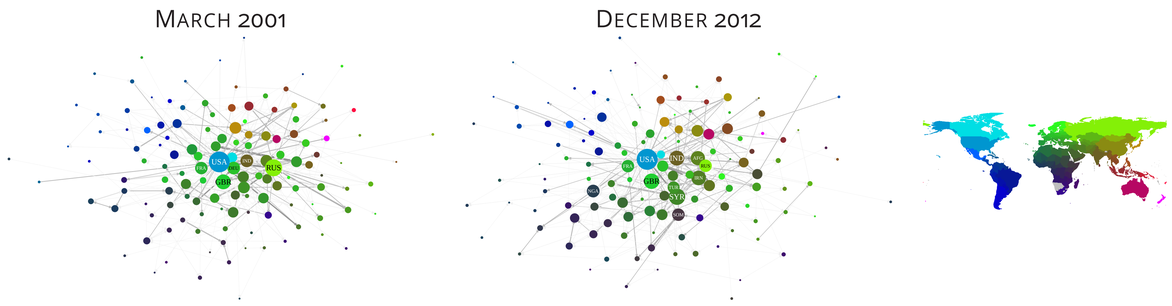
In our case Y is a times series of count matrices, thus we model $y_{i,j,t} \sim \text{Poisson}(e^{\mu_{i,j,t}})$, where $\tilde{y}_{i,j,t} = \log(y_{i,j,t-1} + 1)$.

Estimation

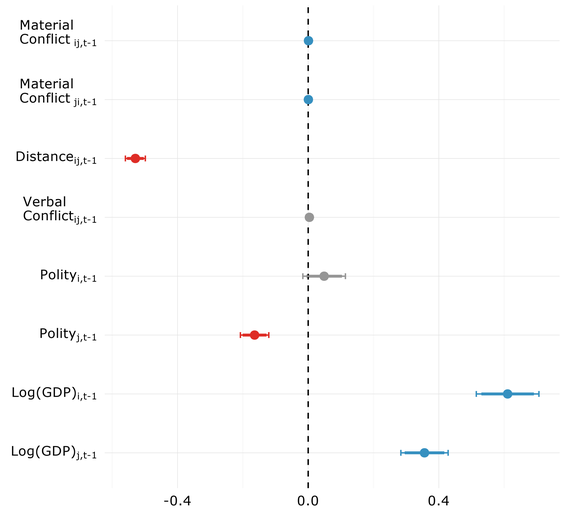
We use an iterative block coordinate descent method for estimation of θ, α and β. Given initial values of β, iterate the following until convergence:

1. Find the conditional MLE of (θ, α) given β using IWLS;
2. Find the conditional MLE of (θ, β) given α using IWLS.

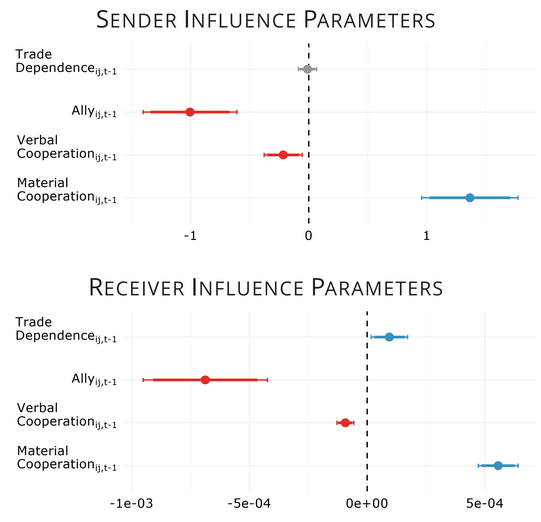
Integrated Crisis Early Warning System (ICEWS): Material Conflict



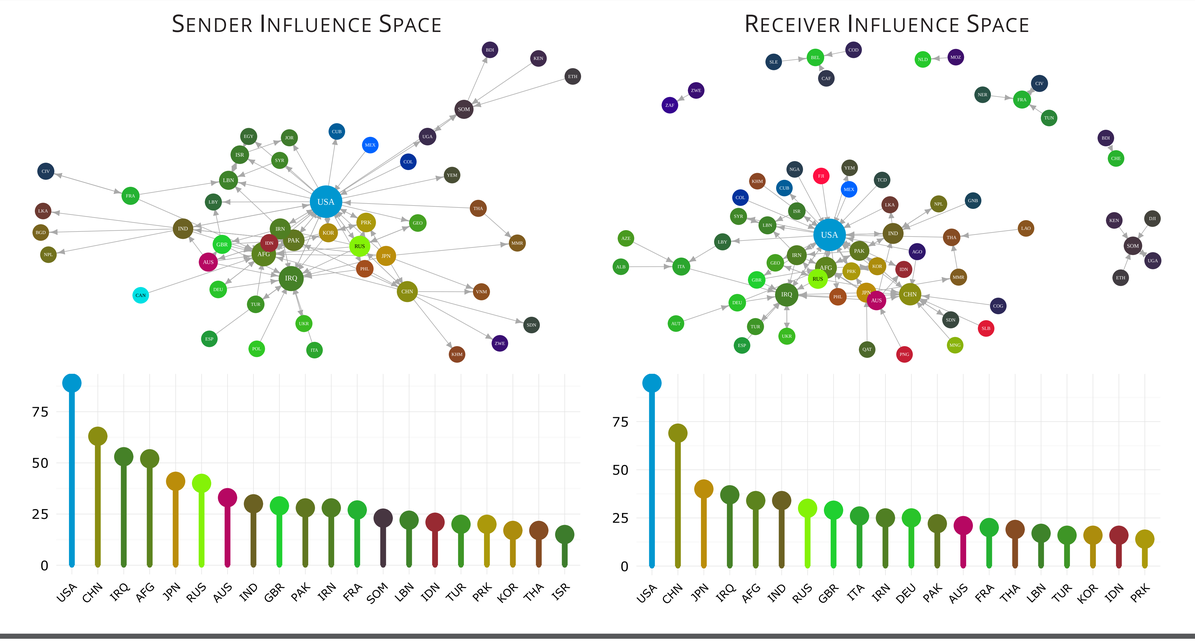
Correlates of Conflict



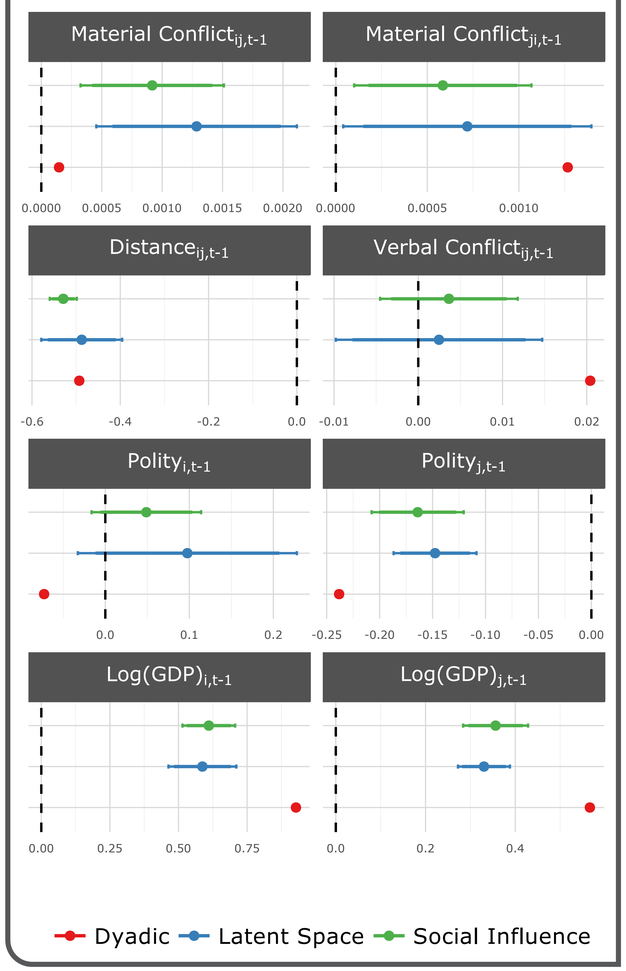
Correlates of Influence



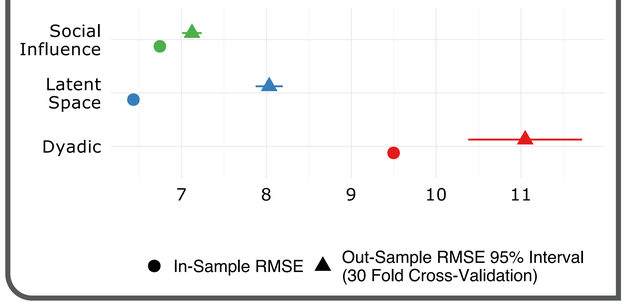
Influence Relationships



Parameter Comparison



Predictive Performance



Other Network Approaches?

Criterion	ERGM	SAOM	Latent Space	Social Influence
Able to Test relational theories	✓	✓		✓
Heterogeneity Across Nodes			✓	✓
Weighted, Temporal Networks			✓	✓