Networking the Yield Curve: Implications for Monetary Policy

Tatjana Dahlhaus
Bank of Canada

Julia Schaumburg
Vrije Universiteit Amsterdam and Tinbergen Institute

Tatevik Sekhposyan
Texas A&M University

The Yield Curve and Monetary Policy

- We introduce a flexible, time-varying network model to trace the propagation of interest rate surprises across different maturities.
- This allows us to assess the role and interplay of all dimensions of monetary policy:
  1. Conventional (short-term interest rate targeting)
  2. Unconventional (QE or direct targeting of the yield curve)
  3. Forward guidance (communicating the path of future policy rates)
- Forward guidance and overall market conditions can determine the spillover intensity of the network.
- How do monetary policy surprises (e.g., deviations from expectations in the 3-month Tbill or 5-year Treasuries) spillover across different maturities? How does forward guidance affect these spillovers?

Contribution

Contributions are twofold:

- **Methodology:**
  - Novel econometric framework allowing for endogenous and asymmetric spillovers.
  - We demonstrate model properties and identification via simulation studies.
- **Economics:**
  - New, innovative way to *jointly* model interest rate surprises across different maturities.
  - Framework for assessing of how different dimensions of monetary policy affect these joint dynamics.

Starting Point: Dynamic Spatial Lag Model

$$y_{i,t} = \rho_t \sum_{j=1}^{n} w_{ij} y_{j,t} + \sum_{k=1}^{K} x_{ik,t} \beta_k + e_{i,t}, \qquad e_{i,t} \sim N(0; \Sigma)$$

where

- ρ_t is scalar time-varying spatial dependence or network intensity coefficient,
- w_{ij}, $j = 1, ..., n$, are nonstochastic spatial weights with $w_{ii} = 0$,
- $x_{ik,t}$, $k = 1, ..., K$ are individual-specific regressors,
- β_k are unknown coefficients (common across i's),
- Σ is a diagonal covariance matrix.

Dynamic Spatial Lag Model

Matrix notation:

$$y_t = \rho_t \underbrace{Wy_t}_{\text{'spatial lag'}} + X_t\beta + e_t \quad \text{or}$$

$$y_t = Z_t X_t \beta + Z_t e_t, \qquad \text{with } Z_t = (I_n - \rho_t W)^{-1}.$$

⇒ Model is **nonlinear** and captures **feedback** from shocks (e_t) as well as the regressors (X_t):

$$y_t = X_t\beta + \rho_t W X_t \beta + \rho_t^2 W^2 X_t \beta + ... + e_t + \rho_t W e_t + \rho_t^2 W^2 e_t + ...$$

⇒ Typically restrict $|\rho_t| < 1$ to make sure shocks die out over space.

Unobserved, Asymmetric Weights

$$y_t = \rho_t W y_t + X_t \beta + \epsilon_t, \quad \epsilon_t \sim N(0; \Sigma),$$

- Multinomial specification of w_{ij}:

$$w_{ii} = 0, \quad \text{and} \quad w_{ij} = \frac{\exp\left(-d_{ij}\right)}{\Sigma_{k \neq i} \exp\left(-d_{ik}\right)}, \; i \neq j$$

  where d_{ij} are freely estimated parameters.

- Score-driven approach:

  $\rho_t = h(f_t)$ with $h(\cdot) = \gamma tanh(\cdot)$, $0 < \gamma < 1$. f_t is assumed to follow a dynamic process

$$f_{t+1} = d + a s_t + b f_t + r_t' c,$$

  where $d = 1 - b$, a, b, c are unknown parameters.

Application: Yield Curve Surprises

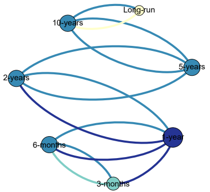
- Joint dynamic model for interest rate surprises, allowing for asymmetric connections across maturities.
- Dependent variable: Survey-implied surprises (consensus, realizations – 6-months-ahead expectations) of interest rates from the Blue Chip Financial Forecasts (BCFF).
- Seven maturities: 3m, 6m, 1y, 2y, 5y, 10y, 30y.
- Unit-specific regressors: Lagged yield changes.
- Fundamentals and forward guidance can affect spillover intensity.
- Sample: March 1988 - April 2016.

Dynamic Network of Yield Curve Surprises

Estimated Weights Matrix

	3m	6m	1y	2y	5y	10y	LR
3m	0	1.00	0	0	0	0	0
6m	0.20	0	0.80	0	0	0	0
1y	0.10	0.34	0	0.56	0	0	0
2y	0	0	0.58	0	0.42	0	0
5y	0	0	0	0.43	0	0.57	0
10y	0	0	0	0	0.63	0	0.37
LR	0	0	0	0	0	1.00	0

Network Graph

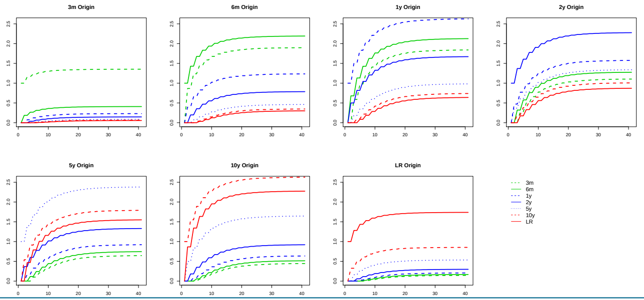


- There is sparsity in the network and adjacent maturities are more important for each other contemporaneously.
- Intensity of the network is high, on average.
- Controlling for forward guidance improves the fit.

Spatial Responses

- To showcase the network, we obtain spatial responses reflecting rounds of spillovers.
- One can look at short-term monetary policy surprises, long- or medium-term ones, or combinations (e.g., Operation Twist).

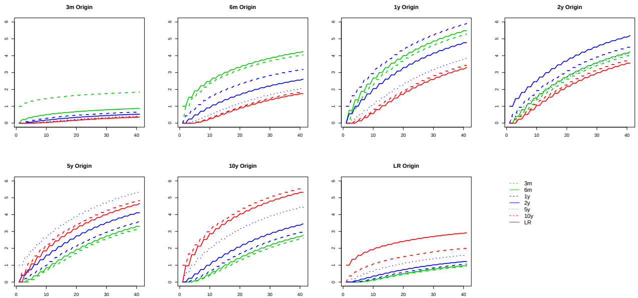
100bps Interest Rate Surprises: Average Intensity



Spatial Responses

- To showcase the network, we obtain spatial responses reflecting rounds of spillovers.
- One can look at short-term monetary policy surprises, long- or medium-term ones, or combinations (e.g., Operation Twist).

100bps Interest Rate Surprises: Maximum Intensity



Spatial Responses

- Operation Twist: network intensity of 0.95, shocks to match the observed daily changes in the bond markets on announcement on September 21, 2011
- a positive shock to the three-month T-bill rate of 1bps & a negative shock to the 10-year bond yield of 5bps

Network Responses to Operation Twist