Stochastic State-Space Modeling in Finance:

Using a Kalman Filter to Estimate and Forecast the Diebold-Li Yield Curve Model

Rick Baker, Consulting Developer
MathWorks, Inc.
rick.baker@mathworks.com

State-Space Model (SSM) of the Econometrics Toolbox™:

- The State-Space Model is parameterized as a system of coupled equations:

$$\text{State (Transition) Equation:} \quad x_t = A_t x_{t-1} + B_t u_t$$
$$\text{Observation (Measurement) Equation:} \quad y_t = C_t x_t + D_t \epsilon_t$$

x_t: Unobserved (latent) states

y_t: Observed (measured) data

u_t: State disturbances (uncorrelated, unit-variance)

ϵ_t: Observation innovations (uncorrelated, unit-variance)

A_t, B_t, C_t, D_t are possibly time-varying coefficient matrices

High-Level Features of the SSM:

- Support for time-varying coefficients
- Ability to model missing observations (NaN values)
- Modeling features include:
  - Model creation with explicit and implicit representations (ssm)
  - Parameter estimation via maximum likelihood (estimate)
  - Filtering/forward recursion (filter)
  - Smoothing/backward recursion (smooth)
  - Forecasting of states & observations (forecast)
  - Monte Carlo simulation of states & observations (simulate)

Agenda

- Review of the Diebold-Li *Yields-Only* Model
- State-Space formulation of the Diebold-Li Model
- Two-Step estimation (Diebold and Li)
- State-Space estimation (Diebold, Rudebusch, and Aruoba)
- Comparison of in-sample estimation results & inferred factors
- Forecasting & Monte Carlo simulation
- Question and answer

Summary

- Fitted Diebold-Li model, a dynamic 3-factor model of the yield curve:
  - Level (long-term)
  - Slope (short-term)
  - Curvature (medium-term)
- Illustrated SSM estimation, smoothing, forecasting, & Monte Carlo simulation
- Additional resources:
  - Webinars & additional events
  - Econometrics Toolbox
  - Request a MATLAB trial