

Switching Models in Econometrics

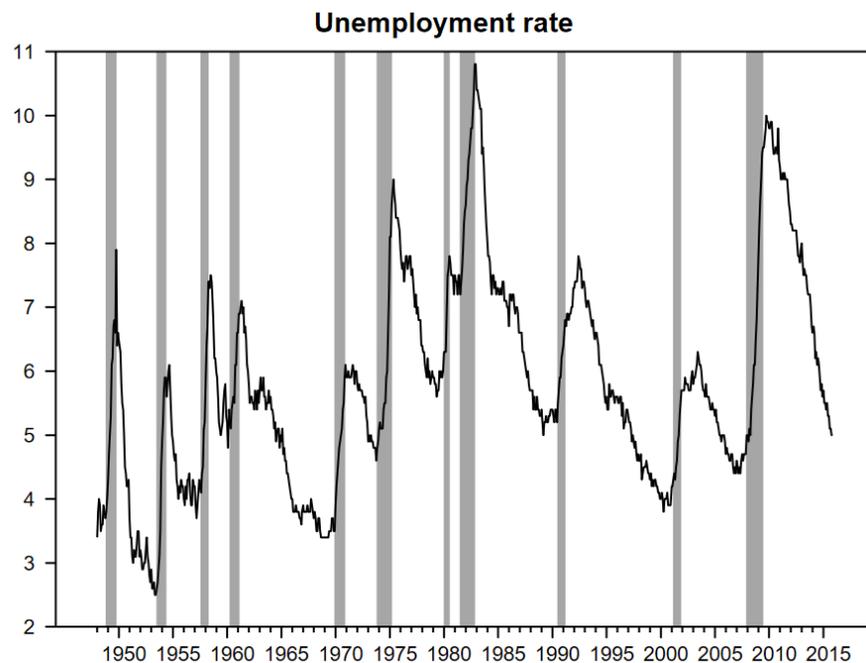
Part I: Markov Switching Models

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Developer, Econometrics Toolbox



What is a Switching Model?

- Economic environment moves among discrete states
- Statistical behavior of variables switches with state
- Each state has its own submodel
- Switching mechanism transitions between states



Classic Example: Business Cycles

From James Hamilton, *Macroeconomic Regimes and Regime Shifts*, National Bureau of Economic Research, Working Paper 21863, 2016

Live Script: Data Regimes

Figure 1. U.S. civilian unemployment rate, seasonally adjusted, 1948:M1-2015:M11. Shaded regions correspond to NBER recession dates.

Submodels

Univariate Series

% ARIMA submodel constructor:

```
mdl1 = arima('Constant',C1,'AR',AR1,'Variance',v1);
```

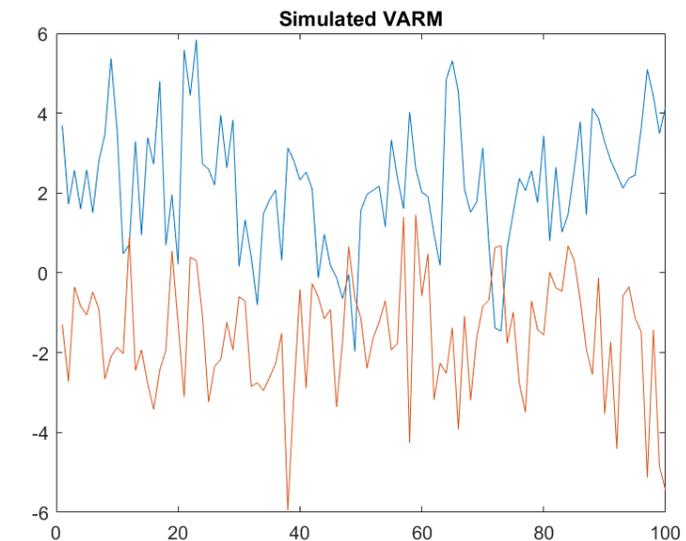
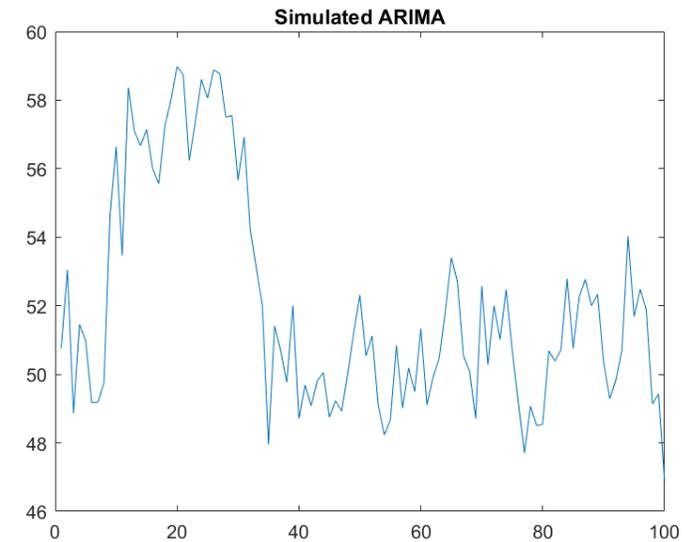
Live Script: ARIMA Submodels

Multivariate Series

% VARMA submodel constructor:

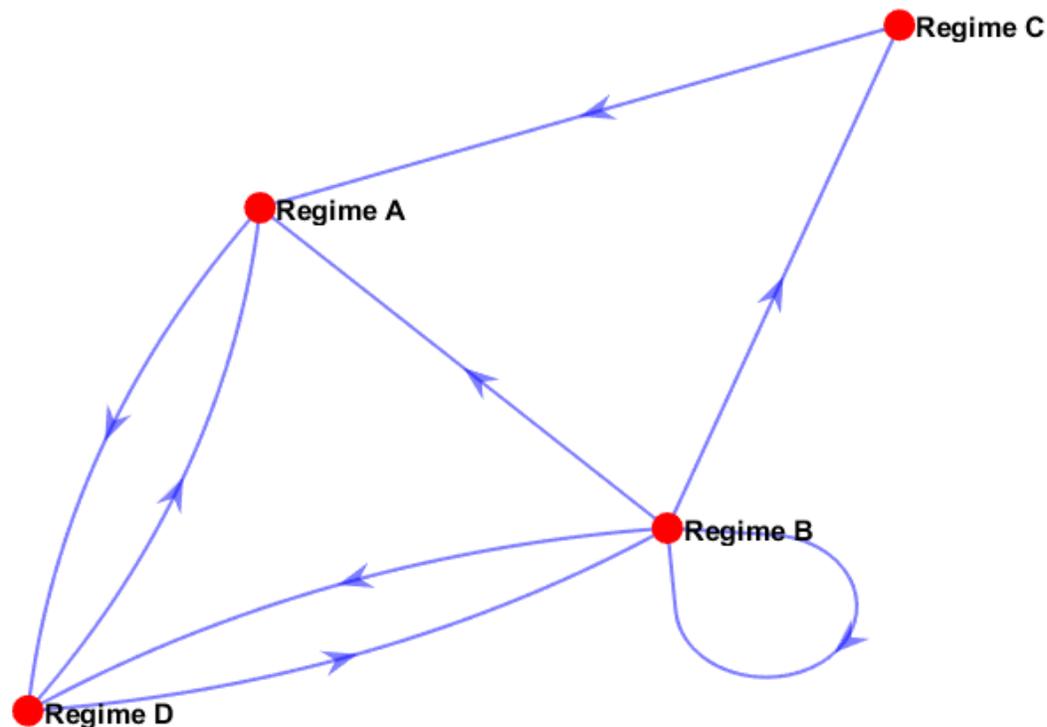
```
mdl2 = varm('Constant',C2,'AR',AR2,'Covariance',Sigma2);
```

Live Script: VARMA Submodels



Stochastic Switching: Markov Chains

- Switch among discrete latent states
- Nondeterministic transitions
- Characterized by a stochastic transition matrix
- Visualize with a directed graph



Live Script: Markov Chains

Submodels + Switch = Switching Model

To construct a **Markov switching model**:

1. Create a vector of ARIMA or VARMA submodels (@ARIMA, @VARMA)
2. Create a discrete-time Markov chain switching mechanism (@dtmc)
3. Assemble the switching model with the msVAR constructor (@msVAR)

Live Script: Markov Switching Model

Estimation, Simulation, Forecasting

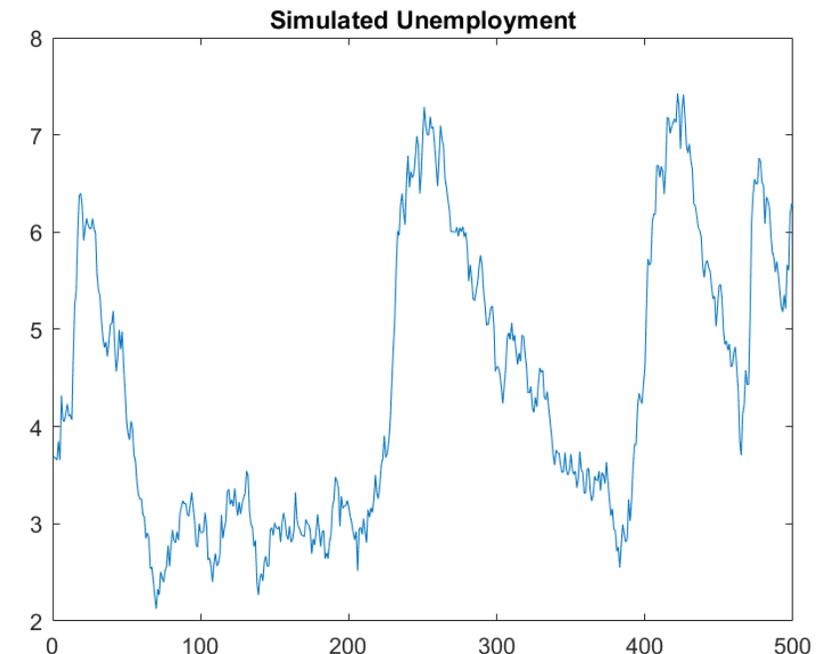
Each modeling framework in Econometrics Toolbox (ARIMA, VARMA, msVAR, etc.) has methods for:

- **Estimating** model parameters from data
- **Simulating** specified models over multiple paths
- **Forecasting** model means from current data

Live Script: Estimation

Live Script: Simulation

Live Script: Forecasting



Documentation

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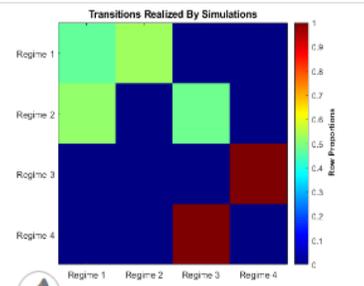
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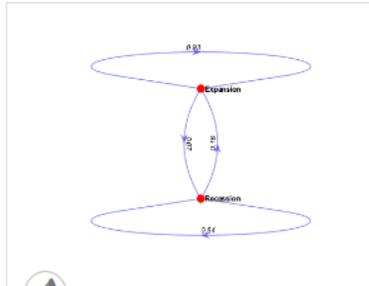
Regime-Switching Models — Examples

R2021b



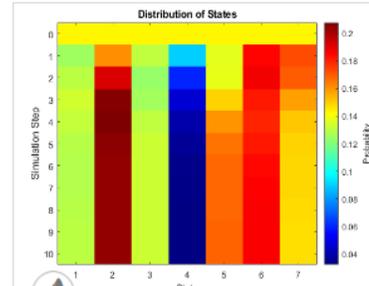
Visualize Markov Chain Structure and Evolution

Visualize the structure and evolution of a Markov chain model by using `dtmc` plotting functions.



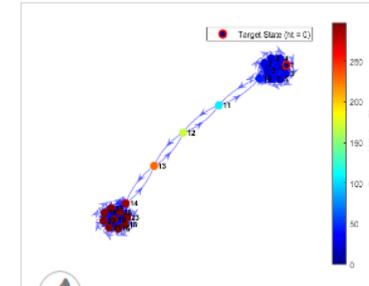
Work with State Transitions

Work with transition data from an empirical array of state counts, and create a discrete-time Markov chain (`dtmc`) model characterizing state



Determine Asymptotic Behavior of Markov Chain

Compute the stationary distribution of a Markov chain, estimate its mixing time, and determine whether the chain is ergodic and reducible.



Compare Markov Chain Mixing Times

Compare the estimated mixing times of several Markov chains with different structures.

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