Prof. Dr. Kai Carstensen Institute of Statistics and Econometrics

Multivariate Time Series Analysis and Forecasting

Home Assignment - Summer Term 2025

Presentation-Based Evaluation: 2nd of July at 16:15

Preliminary remarks:

1. This is a **voluntary** exercise.
2. You can earn up to **10 bonus points** that are added to the oral examination of the SS2025.
3. Use MATLAB as a software package.
4. You are allowed to work in **pairs or individually**.
5. You will be evaluated through a 15-minute presentation (plus 5 minutes for questions), where you will briefly explain your MATLAB code, findings, and interpretations.
6. You will work with real macroeconomic data using VAR(p) models. The evaluation criteria will focus on your ability to present the economic reasoning behind your modeling choices, policy implications based on your estimated impulse response functions, and interpretation of forecasting results.
7. Each participant (or group) must schedule a 15-minute time slot for the 2nd of July via email to [redacted]@stat-econ.uni-kiel.de.

Energy Prices and Macroeconomic Dynamics in Germany

The energy crisis following Russia's invasion of Ukraine exposed how deeply energy prices affect the real economy, business expectations, and monetary policy – particularly in Germany, given its industrial structure and energy dependence. In this assignment, you will use a VAR(p) framework to investigate how energy price shocks transmit to inflation, output, and business expectations in Germany. You will also explore the implications of these dynamics for macroeconomic forecasting and stabilization policies. The available dataset `Germany_Macro_Monthly.mat` comprises 240 monthly observations from 2005M1 to 2024M12 on *HICP inflation, excluding food and energy* (index), *industrial production* (index), orders received by industry (index), *ifo business expectations* (index), *HICP energy prices* (index), and *ECB interest rates* (annual percent rate). *Note*: all variables are seasonally adjusted.

Questions

1. **(2P) Initial Data Assessment.** Load the data set, transform the variables into stationary time series, and plot the transformed variables into one single figure. Discuss:

   (a) What is the relevance of the stationarity assumption for VAR estimation?

   (b) What patterns stand out pre- and post-2020?

   (c) What challenges do energy price volatility and economic turbulence pose for time series models? Which modeling strategies would you suggest to properly account for pandemic effects within the VAR framework?

2. **(3P) Model Selection.** Create a dummy variable for March-June 2020 that accounts for the unusual dynamics observed in the aftermath of the pandemic shock. Then estimate VAR(p) models with lags ranging from $p = 1$ to $p = 4$. Which model delivers the best fit according to the Akaike (AIC) and Bayesian (BIC) information criteria? Discuss:

   (a) Why might AIC and BIC suggest different lag orders?

   (b) How would your selection change if your objective were policy analysis versus forecasting? Explain your reasoning based on the bias-variance tradeoff.

   Moreover, check whether business expectations Granger-cause industrial production and vice-versa for the AIC-optimized VAR(p) model.

3. **(3P) Impulse Response Analysis.** Estimate and plot the impulse responses of the AIC-optimized VAR(p) model with 95% bootstrap confidence intervals for 12 horizon periods and $B = 100$ bootstrap simulations. Discuss:

   (a) Why the suggested VAR ordering might be a reasonable choice for policy analysis based on a Choleski decomposition?

   (b) How do shocks to energy prices propagate through the macroeconomic system? Specifically, interpret the transmission of energy shocks to output, using industrial production, orders, and business sentiment. How does monetary policy, proxied by the ECB rate, respond to such shocks?

4. **(2P) Forecasting Exercise.** Using an expanding window scheme, generate one-step ahead forecasts of VARs with lags $p = 1$ up to $p = 4$ for the out-of-sample period of 2021M1 to 2024M12. Discuss:

   (a) Which VAR model outperforms in terms of root mean squared errors (RMSE) for core inflation and industrial production? Plot the best forecast for core inflation against the actual data over the out-of-sample period.

   (b) How do the energy price shocks during this period influence the forecasting performance?