Macroeconometrics

Module 4, 2017-2018

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Course description

This course provides a survey of recent developments in time series econometrics, with a strong emphasis on macroeconomic applications, rather than on econometric theory. We will begin with a quick overview of the simple univariate models and filters. Then, we will cover multivariate models: VAR and SVAR models, different methods of their identification, multivariate unit roots, cointegration and vector error-correction models. After that, we will study the models in data-rich environment: factors models and FA-VARs. And, finally, we will discuss different methods of estimation and inference of the dynamic stochastic general equilibrium models (DSGE), in particular, simulated method of moments, maximum likelihood, Bayesian methods and hybrid models (DSGE-VAR).

Course requirements, grading, and attendance policies

There will be a few (maximum 4) home assignments (50% of the grade). The take-home exam (50% of the grade, 24 hours, open book, questions are allowed) will contain questions on a published applied macroeconomic article handed out in advance. All these components (including all home assignments), as well as at least 70% attendance, are mandatory for getting a passing grade.

Course contents

1. **Univariate time series models:** business cycles and time series econometrics, the Wold representation theorem, stationary ARMA models, spectrum, data transformations and univariate filters

2. **Reduced-form Vector Autoregressions:** definition, estimation, inference and forecasting, Granger causality, impulse response functions, variance decomposition

3. **Structural Vector Autoregressions:** definition, impulse response functions, variance decomposition, historical decomposition, identification: short-run restrictions, long-run restrictions, sign restrictions, applications

4. **Unit roots, spurious regressions and cointegration:** definition, testing the unit roots, spurious regression, cointegration, testing and estimation of co-integrating relations, VECM representation of cointegrated VAR, applications

5. **Factor models and FAVAR:** static and dynamic factor models, principal components analysis, determining a number of static and dynamic factors, structural FAVAR and its identification, applications

6. **DSGE models and their estimation:** definition, approximating and solving DSGE, calibration, GMM and simulated GMM estimation, ML estimation, Bayesian estimation of DSGE models

Sample tasks for course evaluation

Problem 1: Spectra and Univariate Filters

For this exercise you may write your own code in MATLAB, GAUSS, R, etc. or use any user-written code found in internet (with proper citations). You should understand every single line of the code used.

1. Download quarterly data on real GDP in Russia from Rosstat database. Draw a plot illustrating dynamics of the (log) of GDP. Estimate and plot spectrum for unfiltered (log) of real GDP using:

   - sample periodogram
   - parametric method by fitting AR(8) model
   - nonparametric method with Bartlett kernel

   (5 points)

2. Use the following four filters to extract business cycle component from log-transformed GDP series using:

   - first differences
   - Hodrick-Prescott filter
   - Baxter-King band-pass filter
   - Christiano-Fitzgerald band-pass filter

   Draw plots illustrating the filtered data. Interpret the results. *(5 points)*

3. Estimate spectra (using three methods) for all series after applying each of the four filters and draw them. Discuss the differences with the spectrum for the unfiltered series. *(5 points)*

4. Generate 100 observations from the random walk process with drift: $y_t = 0.04 + y_{t-1} + e_t,\ e_t \sim N(0, 1)$. Repeat steps 1-3 for generated series. Discuss the results. *(5 points)*

Problem 2: Bayesian Estimation Using Dynare

Consider the following RBC model with a variable utilization rate of capital u_t and a second shock that represent exogenous variations in the price of imported oil p_t (this is adapted from Finn, 1995). The representative agent solves:

$$\max E_0 \sum_{t=0}^{\infty} \beta^t \left(\ln C_t + \theta \ln(1 - N_t)\right) \tag{1}$$

subject to

$$\begin{aligned}
&Y_t = Z_t N_t^{\alpha} (u_t K_t)^{1-\alpha}, \\
&K_{t+1} = Y_t + (1 - \delta(u_t))K_t - C_t - p_t Q_t, \\
&\delta(u_t) = \frac{u_t^{\gamma}}{\gamma}, \\
&\frac{Q_t}{K_t} = \frac{u_t^{\zeta}}{\zeta}, \\
&\ln Z_t = (1 - \rho^Z) \ln \bar{Z} + \rho^Z \ln Z_{t-1} + \epsilon_t^Z, \epsilon_t^Z \sim N(0, \sigma^Z), \\
&\ln p_t = \rho^p \ln p_{t-1} + \epsilon_t^p, \epsilon_t^p \sim N(0, \sigma^p)
\end{aligned}$$

with K_0, Z_0 and p_0 given. C_t denotes consumption in period t, N_t are working hours, K_t is the stock of capital, and Q_t is the quantity of oil imported at the price p_t. A more intense utilization of capital increases the amount of energy required per unit of capital. Thus, if the price of oil rises, capital utilization will decrease.

1. Write down equilibrium conditions characterizing this model. *(4 points)*

2. Write down the log-linear approximation of the model around the steady state. *(4 point)*

3. Fix the following structural parameters as: $\beta = 0.99$, $\alpha = 0.7$, $\rho^p = 0.95$, $\rho^Z = 0.95$. Download from my.nes HP-filtered data on (log of) real GDP and (log of) real oil price in US (file USData.xls). Estimate the remaining structural parameters: θ, γ, ζ, σ^p, σ^Z and $\bar{Z}$ by Bayesian methods using Dynare. Use the following values as prior means of the estimated parameters: $\theta = 10$, $\gamma = 10$, $\zeta = 2$, $\sigma^p = 0.05$, $\sigma^Z = 0.001$ and $\bar{Z} = 1$. Choose appropriate prior distributions. *(8 point)*

4. Plot impulse responses of the endogenous variables in the estimated model to oil price and productivity shocks, ϵ_t^p and ϵ_t^Z. Demonstrate that if the price of oil rises, capital utilization will decrease. Interpret the results. *(4 point)*

Course materials

Required textbooks and materials

1. Hamilton, James D., *Time Series Analysis*, Princeton University Press, 1994
2. DeJong, David N. & Dave, Chetan, *Structural Macroeconometrics*, Princeton University Press, 2nd ed., 2011

Additional materials

1. Lutkepohl, Helmut, *New Introduction to Multiply Time Series Analysis*, Springer, 2007
2. Canova, Fabio, *Methods for Applied Macroeconomic Research*, Princeton University Press, 2007
3. Favero, Carlo A., *Applied Macroeconometrics*, Oxford University Press, 2001

I will also provide a reading list of papers applying models and methods discussed in the class, with the rate of about 2-3 per week.

Academic integrity policy

Cheating, plagiarism, and any other violations of academic ethics at NES are not tolerated.