APPLIED TIME SERIES ECONOMETRICS

Module 2, 2014–2015

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Course information

Course Website: my.nes.ru

Instructor's Office Hours: any time I am in office

Class Time: lectures Monday and Wednesday 11:45–13:15, sections Wednesday 16:10–17.40

Room Number: 3.13 (Mon), 3.19 (Wed), 3.05 (sect)

TA: Alexey Khazanov

Course description

The course is devoted to the modern applied time series analysis. First we will discuss principles of non-structural time series modeling and review various model selection procedures. After that we will study popular models of conditional mean dynamics such as linear autoregressions and vector autoregressions as well as nonlinear structures like threshold, smooth transition and regime switching models. We will also explore such issues as stationarity, integratedness and unit roots, and get acquainted with the notion of Brownian motion useful in other contexts too. Then we will turn to modeling conditional variance and, more generally, volatility. We will also review modeling and forecasting more complex conditional objects. Finally, we will study methods of dealing with structural instability.

Course requirements, grading, and attendance policies

The course presumes the use of publications in applied time series and computer work. There will be a few (≈ 3) empirical home assignments (40% of the grade) with empirical work; one can use any software that seems more convenient for a problem at hand. The exam (60% of the grade) will contain questions on a published time series 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

I. Modeling methodology and model selection

- Structural and non-structural time series modeling.
- Object of dynamic modeling: conditional mean, conditional variance, conditional quantile, conditional direction, conditional density.
- Model selection: diagnostic testing, information criteria and prediction criteria.
- General-to-specific and specific-to-general methodologies. Data mining.

II. Modeling conditional mean

- Stationary AR models: properties, estimation, inference, forecasting.
- Stochastic and deterministic trends, unit root testing. Brownian motion, FCLT.
- Nonlinear autoregressions: threshold autoregressions, smooth transition autoregressions, Markov switching models, state-space models.
- Stationary VAR models: properties, estimation, analysis and forecasting.
- VAR models with elements of nonlinearity.
- Spurious regression and cointegration.

III. Modeling conditional variance

- The class of ARCH models: properties, estimation, inference and forecasting.
- Extensions: IGARCH, ARCH-t. Time-varying risk and ARCH-in-mean.
- Multivariate GARCH. Copulas.
- Other measures of financial volatility: implied volatility, realized volatility.

IV. Other topics on modeling and forecasting

- High frequency data models: ACD, UHF–GARCH.
- Modeling and forecasting conditional density. ARCD and GARCHSK models.
- Modeling and forecasting direction-of-change. Directional predictability.
- Modeling and forecasting conditional quantiles. Value-at-risk. CAViaR model.

V. Structural instability

- Identification, estimation and testing for structural breaks.
- Retrospection and monitoring for structural stability.

Sample tasks for course evaluation

1. Test the unemployment rate for a unit root using the Augmented Dickey-Fuller test. Take a first difference of the unemployment rate. Perform the tests for mean and sign predictability. Fit the linear autoregression and threshold autoregression repeating Bruce Hansen's strategy. For the linear autoregression, compute and graph impulse responses and predictions with corresponding error bands. Fit the logistic smooth transition autoregression, including a test for linearity. Compute and graph impulse responses.
2. Analyze the Russian monthly unemployment series for structural breaks. Interpret. Split the unemployment sample into a 'retrospection portion' and 'monitoring portion'. Using a model with an intercept only and the OLS-based CUSUM and fluctuation tests, perform retrospection of structural stability with horizontal boundaries, and monitoring of structural stability with 'parabolic' and 'linear' boundaries.
3. Now make bivariate analysis of the Russian unemployment rate and inflation. Construct a suitable linear triangular SVAR. Compute and graph impulse responses. Extend the SVAR analysis to nonlinear triangular SVAR. Economically motivate your model.
4. Take a series of daily prices for an arbitrary but liquid individual stock for a long period of time and turn it to a series of log-returns. Graph the series, present and discuss its summary statistics. Run a test for ARCH effects. Then construct a good model of your choice from the ARCH family that would account for leverage effect and asymmetric and heavy-tailed conditional distribution.
5. Take long series of daily exchange rates (relative to the US$) of two frequently traded currencies. Estimate and interpret a DCC-GARCH(1,1) model. Show how the conditional correlation evolves over time.
6. Name a model mentioned in class that is ideologically (not necessarily technically!) close to the proposed model. What is that critical feature of the two models that makes them ideologically close?
7. Describe a possible application where non-financial time-series data are analyzed, and where it would be appropriate to apply a simplified version of the model presented in the article. Write out your model in full, and explain why each part of it is important for the series under analysis.

Course materials

Required textbooks and materials

- Franses, Philip and Dick van Dijk (2000). *Nonlinear Time Series Models in Empirical Finance*, Cambridge University Press
- Анатольев, Станислав (2013). Объекты неструктурного моделирования временных рядов, *Квантиль*, №11, стр. 1–11
- Hansen, Bruce (1997). Inference in TAR models. *Studies in Nonlinear Dynamics & Econometrics*, vol. 2, pp. 1–14

Additional materials

- «Эконометрический ликбез: прогнозирование временных рядов», *Квантиль*, №1, сентябрь 2006 г., стр. 3–62. Доступно на http://quantile.ru/01/N1.htm
- «Эконометрический ликбез: волатильность», *Квантиль*, №8, июль 2010 г., стр. 1-122. Доступно на http://quantile.ru/08/N8.htm
- «Эконометрический ликбез: временные ряды», *Квантиль*, №9, июль 2011 г., стр. 1–34. Доступно на http://quantile.ru/09/N9.htm

Reader

1. Hansen, Bruce E. (1999). Discussion of 'Data mining reconsidered.' *Econometrics Journal*, vol. 2, pp. 192–201
2. Qi, Min (1999). Nonlinear predictability of stock returns using financial and economic variables. *Journal of Business & Economic Statistics*, vol. 17, pp. 419–429
3. Hansen, Bruce E. (1997). Inference in TAR models. *Studies in Nonlinear Dynamics & Econometrics*, vol. 2, pp. 1–14
4. Lanne, Markku and Pentti Saikkonen (2002). Threshold autoregressions for strongly autocorrelated time series. *Journal of Business & Economic Statistics*, vol. 20, pp. 282–289
5. Ösal, Nadir and Denise R. Osborn (2000). Business cycle non-linearities in UK consumption and production. *Journal of Applied Econometrics*, vol. 15, pp. 27–43
6. Guidolin, Massimo and Allan Timmermann (2009). Forecasts of US short-term interest rates: A flexible forecast combination approach. *Journal of Econometrics*, vol. 150, pp. 297–311
7. Papell, David H., Charles J. Murray, and Hala Ghiblawi (2000). The structure of unemployment. *Review of Economics and Statistics*, vol. LXXXII, pp. 309–315

8. Evans, George W. (1989). Output and unemployment dynamics in the United States: 1950–1985. *Journal of Applied Econometrics*, vol. 4, pp. 213–237
9. Balke, Nathan S. (2000). Credit and economic activity: Credit regimes and nonlinear propagation of shocks. *Review of Economics and Statistics*, vol. LXXXII, pp. 344–349
10. Hsieh, David A. (1989). Modeling heteroscedasticity in daily exchange rates. *Journal of Business & Economic Statistics*, vol. 7, pp. 307–317
11. Chan, Wing H. and John M. Maheu (2002). Conditional jump dynamics in stock market returns. *Journal of Business & Economic Statistics*, vol. 20, pp. 377–389
12. Leon, Angel, Gonzalo Rubio, and Gregorio Serna (2005). Autoregressive conditional volatility, skewness and kurtosis. *Quarterly Review of Economics and Finance*, vol. 45, pp. 599–618
13. Lanne, Markku (2006). A mixture multiplicative error model for realized volatility. *Journal of Financial Econometrics*, 4, pp. 594–616

Academic integrity policy

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