Introduction to Multiple Time Series Analysis: Syllabus with Extended Information

1 Introductory Remarks

The course offers an introduction to multiple time series analysis, with a particular emphasis on impulse response analysis using vector autoregressive (VAR) models. We begin with a brief overview of key concepts in univariate time series analysis before moving on to the VAR framework and its estimation. The focus then shifts to structural VAR (SVAR) models, which are widely used for structural impulse response analysis. Structural impulse response analysis allows analyze the effects of economically interpretable structural shocks. We explore basic identification strategies to uncover the structural shock(s) of interest and examine tools such as forecast error variance decomposition and historical decomposition. The lectures are complemented by tutorial sessions that cover both empirical applications and the relevant statistical and algebraic foundations. Introduction to Multiple Time Series Analysis is a valuable companion to the course Time Series and Forecasting, but it can also be taken independently without difficulty.

Our focus will be on the tools of (S)VAR analysis, their practical application, and the interpretation of empirical results. We will not delve into statistical details such as the asymptotic properties of estimators or test statistics. As this is an introductory course, some simplifications and shortcuts are necessary. However, whenever appropriate, I will point out which additional steps would be required or which further issues should be considered for a more rigorous treatment.

If time permits, we may also discuss one or two related empirical research papers. I will provide further information on this in due course. During the tutorial sessions, the empirical exercises will be conducted using R code, which I will share with you in advance.

2 Grading

Grading will be based on a written exam (90 minutes), which accounts for 70% of the final grade, and two assignments consisting of two to three problems each, which together make up the remaining 30%.

3 Course Outline

1. Introduction and Overview (**KL**: Sect. 1.1), **SW**: Sect. 15.1),
2. Univariate time series concepts and AR model (**SW**: Sects. 15.2-15.3, 15.6-15.7; **KL**: Sect. 2.1)
    - Time series data, stochastic processes, and time series models
    - Time series concepts: transformations, polynomials, stationarity, autocorrelation

- Moving average (MA) model
- Stable univariate autoregressive (AR) model

3. Stable vector autoregressive (VAR) model (**SW**: Sect. 17.1, **E**: Sects. 10.5-10.6, **KL**: Sects. 2.2-2.3, 2.6.2-2.6.3, 2.7.1)
    - Model representation and properties
    - Estimation
    - Model selection and diagnostics
4. Structural VAR model and identification (**E**: Sects. 10.10-10.14, **KL**: Sects. 4.1, 7.6, Ch. 8, Sect. 9.1-9.2.1, 10.1, (15.2))
    - Model framework and identification problem
    - Short-run restrictions
    - Long-run restrictions
    - if time permits: Proxy-SVARs and external instruments
5. SVAR tools (**E**: Sects. 10.7, 10.9, **KL**: Sects. 4.1, 4.2-4.3, 12.1, (12.2), (15.2))
    - Impulse response analysis
    - Confidence intervals for impulse responses
    - Forecast error variance decomposition and historical decomposition

4 Literature

In the syllabus above, I have listed the relevant sections of the textbooks used in this course. Sections indicated in parentheses refer to additional material that may be covered if time allows. Below, I provide brief comments on the textbooks.

The main reference for the course is Kilian and Lütkpepohl (2018), (**KL**), which provides an in-depth treatment of structural VAR analysis. In this course, we will only cover a selected portion of the textbook. As the book is primarily designed for graduate-level study, you may find some parts challenging on first reading. In such cases, I recommend consulting the relevant sections of Stock and Watson (2019), (**SW**), and Enders (2015), (**E**) before returning to Kilian and Lütkepohl (2018).

Chapter 2 of Kilian and Lütkpepohl (2018) offers a concise overview of VAR models. If you wish, you are encouraged to read the entire chapter rather than limiting yourself to the listed subsections. The material on SVAR models, identification schemes, and SVAR tools is somewhat dispersed throughout the book. To support your study, I have compiled the relevant sections that correspond to the topics we will cover in class. However, I have collected the relevant sections to help you finding the material we discuss. Please note that our approach will deviate from that of the textbook. Specifically, we will begin with the identification problem and the associated schemes before introducing the SVAR tools. While I will generally follow

the textbook's notation, there is one exception: we will use B to denote the contemporaneous impact matrix instead of B_0^{-1} as used in the book.

If you feel comfortable with Kilian and Lütkpepohl (2018) you could skip the recommended sections of Stock and Watson (2019) and Enders (2015) for Parts 3 to 5 of the course. However, for Part 2, which covers univariate time series concepts, you should refer to Stock and Watson (2018), as Kilian and Lütkpepohl (2018) offers limited coverage of this material.

If you are interested in a deeper exploration of the econometric and statistical foundations of multiple time series analysis, you may consult Lütkepohl (2005). However, this is strictly an optional reference and can be skipped entirely without affecting your understanding of the course material.

Both Kilian and Lütkepohl (2018) and Stock and Watson (2019) are available online through the University Library.

References

Enders, W. (2015), *Applied Econometric Time Series*, 2nd ed., Wiley. (**E**)

Kilian, L. and Lütkepohl, H. (2018), Structural Vector Autoregressive Analysis, Cambridge University Press. (**KL**)

Lütkepohl, H. (2005), *New Introduction to Multiple Time Series Analysis*, Springer.

Stock, J.H. and Watson, M.W. (2019), Introduction to Econometrics, Pearson Education Ltd.. (**SW**)