Preface

Objectives of the Book

Since the seminal work of Sims (1980a), structural vector autoregressions have evolved into one of the most widely used models in empirical research using time series data. They are used in macroeconomics and in empirical finance, but also in many other fields including agricultural economics and energy economics. The evolution of the structural vector autoregressive (VAR) methodology since 1980 has not always been smooth. Over time many new ideas have been explored, sometimes uncritically applied or misunderstood by practitioners, then questioned, and later refined or replaced by alternative methods. The development of new methods of identification, estimation, and inference for structural VAR models continues at a rapid pace even today. One of the objectives of this book is to summarize these new developments and to put them in perspective. The other is to take stock of what we have learned about more traditional structural VAR models and to interpret these models from today's perspective. The profession's understanding of these models has evolved substantially, becoming more nuanced in recent years and allowing us to understand better some of the methodological debates of the past.

In this book, we not only review the ever-increasing range of structural VAR tools and methods discussed in the literature; we also highlight their pros and cons in practice and provide guidance to empirical researchers as to the most appropriate modeling choices. In addition, we trace the evolution of the structural VAR methodology and contrast it with other common methodologies including the narrative approach to identification and the use of calibrated or estimated dynamic stochastic general equilibrium (DSGE) models. We stress that structural VAR models should be viewed as one of several econometric tools used in empirical work, each of which has its own strengths and weaknesses.

The book is intended as a bridge between the often quite technical econometric literature on structural VAR modeling and the needs of empirical

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researchers. The focus of the book is not on providing the most rigorous theoretical arguments, but on enhancing the reader's understanding of the methods in question and their assumptions, allowing him or her to decide on the most suitable methods for applied work. In many cases, empirical examples are provided for illustration. References to articles in academic journals are provided for readers with an interest in the more technical aspects of the discussion.

Audience and Uses of the Book

The target audience includes graduate students in economics departments and in business schools as well as practitioners interested in a comprehensive yet accessible review of the literature. It also includes consumers of empirical studies using the structural VAR methodology.

The book is intended for a semester-long course on structural VAR analysis, but the material may be adapted to the time available to the instructor and the focus of the course. Parts of the book may also be used in teaching a course in macroeconometrics or in applied time series analysis, if preceded by a general introduction to univariate time series analysis in the first part of the course. Alternatively, selected chapters may be used in teaching a graduate-level quantitative methods course that focuses on the use of DSGE models and structural VAR models in macroeconomics.

For example, an instructor only interested in structural VAR models subject to short-run identifying restrictions would focus on Chapters 2, 4, 8, 9, and possibly 12, with the material in Chapters 6 and 7 providing additional motivation as needed. If one wanted to cover structural VAR models subject to long-run restrictions, one would add Chapters 3, 10, and 11. An extension to sign-identified structural VAR models instead would involve adding Chapters 5 and 13. Chapters 14 and 15 cover more advanced identification methods. Chapters 16, 17, and 18 deal with special topics such as large-dimensional VAR processes, nonfundamental shocks, and nonlinear structural VAR models that are more technically challenging and would only be covered in a full-semester graduate-level course. Chapter 19 covers topics such as trend adjustment, seasonality, and structural change. It relates to material that could be skipped at a first reading or used only selectively, but provides useful background material at a later stage, once the remainder of the book has been absorbed.

The book may not only form the basis of a graduate-level course, but it may also be used for self-study. Although structural VAR models are routinely relied on in teaching empirical macroeconomics and in published work, not every department provides instruction in the use of these methods. There is typically no room for teaching structural VAR analysis either in the econometric theory courses or in the macroeconomics courses of a Ph.D. program,

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as these fields have greatly expanded in recent years. Our book provides a self-contained resource for students wishing to complement the material on solving DSGE models typically provided as part of the first-year macroeconomics sequence by a review of the structural VAR methodology.

The need for such a book is self-evident. It has become increasingly difficult for students, practitioners, and even academic researchers to keep up with the proliferation of new methods and econometric results discussed in the literature. Not only are these results widely scattered across academic journals but there is no up-to-date treatise even of the traditional structural VAR literature. For example, the introductory discussion in Amisano and Giannini (1997) is not only terse but incomplete and outdated at this point. The more recent macroeconometrics textbook of Favero (2001) contains only one chapter on structural VAR models, which focuses primarily on VAR models of monetary policy. Even the textbook of Lütkepohl (2005) focuses mainly on reduced-form VAR analysis and devotes only one chapter to structural VAR analysis. Finally, the focus of Canova (2007), DeJong and Dave (2011), and Herbst and Schorfheide (2016) is more on the empirical evaluation of DSGE models than on structural VAR analysis, and the standard time series textbook by Hamilton (1994) only devotes 13 of 800 pages to structural vector autoregressions. Nor do handbook chapters such as Watson (1994) or Kilian (2013) provide a review of the structural VAR literature as comprehensive as this book.

Prerequisites

The book takes for granted that the reader is familiar with regression analysis and with asymptotic reasoning. It is also assumed that the reader has been exposed to univariate time series methods at the undergraduate level and is familiar with the concepts of stationarity and invertibility and with the Wold representation, white noise, unit roots, the estimation of univariate AR, MA, and ARMA models, GARCH models, and univariate forecasts. As a rule, the discussion is not more mathematical than it has to be to appreciate the material. An overview of the notation is provided at the end of the book. The reader is assumed to be familiar with vectors and matrices. A useful resource summarizing key mathematical and statistical results is appendix A-C in Lütkepohl (2005).

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Ann Arbor and Berlin, *Lutz Kilian and Helmut Lütkepohl*

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