Available online at www.sciencedirect.com
ScienceDirect
Computational Statistics & Data Analysis 52 (2007) 663–679
COMPUTATIONAL STATISTICS & DATA ANALYSIS
www.elsevier.com/locate/csda

Cobra: A package for co-breaking analysis

Michael Massmann*

Institute of Econometrics, University of Bonn, Adenauerallee 24-42, 53113 Bonn, Germany

Available online 27 November 2006

Abstract

Cobra, an econometric software package designed for CO-BReaking Analysis, is introduced. Cobra is programmed in Ox, the object-oriented statistical system, and consists of three modules: Firstly, CobraDgp is derived from the Database class and enables the user to generate a multivariate time series that is subject to multiple breaks in its intercept as well as linear trend. Secondly, the Cobra module is derived from the Modelbase class and implements two algorithms for the estimation of co-breaking relationships. Taking advantage of the capabilities provided by Modelbase, Cobra may be loaded into OxPack and used with the GUI GiveWin as front end. Finally, CobraSim is derived from the Simulation class and wrapped around CobraDgp and Cobra to allow a straightforward implementation of Monte Carlo experiments. A brief introduction of the concept of co-breaking is given before Cobra is illustrated by means of an empirical example as well as a simple Monte Carlo. Excerpts of Ox code as well as screenshots are provided.

Keywords: Co-breaking; Common features; Structural breaks; Ox; OxPack

1. Introduction

The purpose of this paper is to introduce Cobra, an econometric software package designed for CO-BReaking Analysis. The idea behind co-breaking is that some economic processes may be seen as subject to structural breaks in their intercept or trend although a linear combination of them, i.e. the so-called co-breaking relationship, is constant. Examples of such breaks include political, technological or legislative change in the economy. Co-breaking may thus be seen as the equivalent to cointegration when the non-stationarity of the process in question is seen to arise from a deterministic rather than a stochastic source. The concept was introduced by Hendry (1996) and has been reviewed by Hendry and Massmann (2006). It may be regarded as a special case of common features which Engle and Kozicki (1993) define to be characteristics present in each of two or more time series but not in a linear combination of them. Besides co-breaking and cointegration, examples of common features include common cycles, common seasonality or common dynamic factors; see the special issues edited by Urga (2006) and Anderson et al. (2006) for recent overviews.

The existing literature on co-breaking may be divided into two strands: While one deals with the estimation of co-breaking relationships given that their number is known the other strand focuses on the question of how many co-breaking relationships a given system of equations may contain. Following received terminology in the cointegration context, Hendry and Massmann (2006) call the former literature 'co-breaking regression analysis' and the latter

* Tel.: +49 228 733925; fax: +49 228 739189.
E-mail address: michael.massmann@uni-bonn.de.
URL: http://www.ect.uni-bonn.de/massmann.

0167-9473/$ - see front matter
doi:10.1016/j.csda.2006.11.001

'co-breaking rank analysis'. In particular, Chapman and Ogaki (1993), Hendry and Mizon (1998), Bierens (2000) as well as Morana (2002) all estimate co-breaking regressions of one form or another, using well-established algorithms such as least-squares, instrumental variables and maximum likelihood. Co-breaking rank analysis, as opposed to that, is still in its infancy, with three different testing and estimation procedures having so far been suggested in the literature. Firstly, Krolzig and Toro (2002) estimate a vector autoregressive model integrated of order zero ($I(0)$), augmented by structural breaks whose coefficient matrix is of reduced rank. Their co-breaking relationships are termed *conditional* by Hendry and Massmann (2006) due to the autoregressive nature of the estimated model. As opposed to that, Hatanaka and Yamada (2003) examine *unconditional* co-breaking relationships in an unobserved components model whose deterministic and stochastic components model the breaks and the process's dynamics, respectively. Yet since they assume the stochastic component to be $I(1)$, stochastic trends can, in small samples, often not be distinguished from breaking deterministic trends. Therefore, Massmann (2003) combines the two approaches by following Hatanaka and Yamada (2003) in estimating an unobserved components model, so as to obtain unconditional co-breaking relationships, while adopting an $I(0)$ reduced-rank model in the vein of Krolzig and Toro (2002) in order not to run into identification problems. Moreover, the resulting model affords the aforementioned interpretation that the non-stationarity in macroeconomic time series is attributed to structural breaks around $I(0)$ regimes rather than to accumulated small 'shocks' as modelled by an $I(1)$ process. Massmann (2003) then suggests two hypothesis tests with the help of which the number of co-breaking relationships may be ascertained, based on treatments by Reinsel and Velu (1998) and Johansen et al. (2000), respectively. Given that number, standard co-breaking regression procedures may be used to estimate the actual co-breaking vectors. The present `Cobra` software package implements these two testing and estimation algorithms.

`Cobra` is programmed in Ox, see Doornik (2001, 2004b), and consists of three modules: Firstly, the `CobraDgp` module is a class derived from Ox's `Database` class and enables the user to generate a multivariate time series that is subject to multiple breaks in its intercept or linear trend. Secondly, the `Cobra` module is derived from Ox's `Modelbase` class and implements the aforementioned two algorithms for the estimation and testing of co-breaking relationships, as outlined in Massmann (2003). Taking advantage of the capabilities provided by `Modelbase`, `Cobra` may be loaded into OxPack and used with the GUI GiveWin as front end, see Doornik and Hendry (2001a). Finally, `CobraSim` is derived from Ox's `Simulation` class and wrapped around `CobraDgp` and `Cobra` to allow a straightforward implementation of Monte Carlo experiments.

The outline of the paper is thus as follows. Sections 2 to 4 document the three modules `CobraDgp`, `Cobra` and `CobraSim`, respectively. Excerpts of Ox code provide illustrative examples. Section 5 then illustrates the use of the `Cobra` OxPack module by replicating the empirical analysis in Hendry and Massmann (2006). Screenshots of the package in action are provided. Section 6 concludes.

2. Generating a multiple time series subject to structural breaks

This section describes how the `CobraDgp` class may be used to generate a multiple time series that is subject to an arbitrary number of breaks in its intercept and/or trend. Excerpts of sample code are given, as are some illustrative graphs of generated series.

The general data generating process considered in the `CobraDgp` class is given by

$$X_t = \phi_t + u_t, \tag{1}$$

$$\phi_t = \tau_{c,0} + \tau_c D_{c,t} + \tau_{l,0} t + \tau_l D_{l,t}, \tag{2}$$

$$u_t = \sum_{i=1}^{g} \Pi_i u_{t-i} + \varepsilon_t \tag{3}$$

and

$$\varepsilon_t \sim \mathsf{NID}(0, \Sigma). \tag{4}$$

The equation for X_t in (1) describes an unobserved components process, made up of a deterministic component ϕ_t and a stochastic component u_t. The deterministic component ϕ_t, see (2), consists of an intercept term $(\tau_{c,0} + \tau_c D_{c,t})$ and a linear trend term $(\tau_{l,0} + \tau_l D_{l,t})$. The stochastic component u_t, see (3) and (4), is an autoregressive process of order