STATISTICAL CLASSIFICATION ALGORITHMS FOR MULTIVARIATE REGIME-SWITCHING MODELS WITH ASYMMETRIC ERRORS

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Multivariate regime-switching econometric models arise in economic and financial processes influenced by exogenous shocks [1, 2]. Previously, a multivariate regression model with Markov-switching regimes has been studied in [3]. In this paper, an independent-switching multivariate linear regression model with errors distributed according to a class SNI [4] of asymmetric distributions (hereafter–IS–MLR–SNI model) is presented.

Let the relation between endogenous and exogenous variables in the IS-MLR-SNI model be expressed as follows:

$$x_t = B_{d(t)} z_t + \eta_{d(t),t}, \quad t = 1, \ldots, T, \tag{1}$$

where for a period of time t: $x_t = (x_{t1}, \ldots, x_{tN})' \in \mathfrak{R}^N$ $(N \geqslant 1)$ — a vector of endogenous variables, $z_t = (z_{t1}, \ldots, z_{tM})' \in \mathfrak{R}^M$ $(M \geqslant 1)$ — a vector of exogenous variables, $d(t) \in S(L) = \{1, \ldots, L\}$ — a state of a system modeled, $B_{d(t)}$ — a regression coefficients matrix with a dimension $N \times M$, $\eta_{d(t),t} \in \mathfrak{R}^N$ — a random vector of heterogeneous errors.

For the model (1) the following assumptions are proposed.

1. Assumptions about observation errors: *a*) observation errors have zero means and are mutually uncorrelated: $\mathbf{E}\{\eta_{d(t),t}\} = 0_N$, $\mathbf{E}\{\eta_{d(t),t}(\eta_{d(\tau),\tau})'\} = 0_{M\times N}$, $t \neq \tau$, $(t, \tau = 1, \ldots, T)$; *b*) observation errors have asymmetric distribution from a class SNI [4] with different sets of parameters accross states. The class SNI includes such asymmetric distributions as skewed versions of normal distribution and t-distribution. The parameters of the distributions from the class mentioned are location parameter, covariance matrix, skewness parameter and parameters of mixing distribution that defines the certain distribution from the class SNI.

2. Assumptions about the regime-switching model: the sequence of states $\{d_t\}(t = 1, \ldots, T)$ following discrete-time and space process with the distribution $\mathbf{P}\{d_t = l\} = \pi_l > 0$ $(l \in S(L))$, where parameters $\{\pi_l\}$ $(l \in S(L))$ correspond to prior probabilities of states and must sum to one.

3. Assumption about exogenous variables: a vector of exogenous variables z_t is fixed for all realizations z $= 1$

In this study, to estimate structural breaks in the model parameters, a classification based approach is proposed. Therefore, for IS-MLR-SNI model (1) we have the following problems to solve: 1) estimation of the parameters $\{\pi_l, B_l, \Sigma_l, \lambda_l\}$ of the model and the vector of states $d = (d_1, \ldots, d_T)'$ on an unclassified sample of regression observations $\{x_t, z_t\}$, $t = 1, \ldots, T$; 2) classification of new observations $\{x_\tau, z_\tau\}$, $\tau = T+1, \ldots$ $\ldots, T+h$ with the model estimated on the train data sample of size T. To solve the problems mentioned, an EM-type algorithm has been developed for the model (1). An experimental study of the proposed algorithm is conducted on the simulated data.

References

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