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# Structure and Asymptotic Theory for Multivariate Asymmetric Conditional Volatility

Michael McAleer , Suhejla Hoti & Felix Chan

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## Abstract

Various univariate and multivariate models of volatility have been used to evaluate market risk, asymmetric shocks, thresholds, leverage effects, and Value-at-Risk in economics and finance. This article is concerned with market risk, and develops a constant conditional correlation vector ARMA-asymmetric GARCH (VARMA-AGARCH) model, as an extension of the widely used univariate asymmetric (or threshold) GJR model of Glosten et al. ([1992](#)), and establishes its underlying structure, including the unique, strictly stationary, and ergodic solution of the model, its causal expansion, and convenient sufficient conditions for the existence of moments. Alternative empirically verifiable sufficient conditions for the consistency and asymptotic normality of the quasi-maximum likelihood estimator are established under non-normality of the standardized shocks.

Keywords:

- Asymmetric effects
- Asymptotic theory
- Conditional volatility
- Multivariate structure
- Regularity conditions

JEL Classification:

- C32
- C51
- C52

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Notes

Notes: 1. The dynamic conditional correlation (DCC) model of Engle (2002) and the varying conditional correlation (VCC) model of Tse and Tsui (2002) always have the same number of parameters, while the CCC and VARMA-GARCH models have the same number of parameters only in some special cases, such as in Table 1. 2. Although the VARMA-GARCH and VARMA-AGARCH models are specified as having interdependence between  $h_{it}$  and  $h_{jt}$  for  $i, j = 1, \dots, m$ ;  $k = 1, \dots, r$ ; and  $l = 1, \dots, s$ ; for purposes of Table 1,  $h_{it}$  is specified to depend only on  $h_{jt}$ .

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