

McAleer, Michael

Working Paper

Discussion of Principal Volatility Component Analysis by Yu-Pin Hu and Ruey Tsay

Tinbergen Institute Discussion Paper, No. 14-025/III

Provided in Cooperation with:

Tinbergen Institute, Amsterdam and Rotterdam

Suggested Citation: McAleer, Michael (2014) : Discussion of  Principal Volatility Component
Analysis  by Yu-Pin Hu and Ruey Tsay, Tinbergen Institute Discussion Paper, No. 14-025/III,
Tinbergen Institute, Amsterdam and Rotterdam

This Version is available at:

<https://hdl.handle.net/10419/98902>

Standard-Nutzungsbedingungen:

Die Dokumente auf EconStor dürfen zu eigenen wissenschaftlichen Zwecken und zum Privatgebrauch gespeichert und kopiert werden.

Sie dürfen die Dokumente nicht für öffentliche oder kommerzielle Zwecke vervielfältigen, öffentlich ausstellen, öffentlich zugänglich machen, vertreiben oder anderweitig nutzen.

Sofern die Verfasser die Dokumente unter Open-Content-Lizenzen (insbesondere CC-Lizenzen) zur Verfügung gestellt haben sollten, gelten abweichend von diesen Nutzungsbedingungen die in der dort genannten Lizenz gewährten Nutzungsrechte.

Terms of use:

Documents in EconStor may be saved and copied for your personal and scholarly purposes.

You are not to copy documents for public or commercial purposes, to exhibit the documents publicly, to make them publicly available on the internet, or to distribute or otherwise use the documents in public.

If the documents have been made available under an Open Content Licence (especially Creative Commons Licences), you may exercise further usage rights as specified in the indicated licence.

TI 2014-025/III

Tinbergen Institute Discussion Paper



Discussion of “Principal Volatility Component Analysis” by Yu-Pin Hu and Ruey Tsay

Michael McAleer

College of Technology Management, National Tsing Hua University, Taiwan; Econometric Institute, Erasmus School of Economics, Erasmus University Rotterdam, Tinbergen Institute, the Netherlands; Complutense University of Madrid, Spain.

Tinbergen Institute is the graduate school and research institute in economics of Erasmus University Rotterdam, the University of Amsterdam and VU University Amsterdam.

More TI discussion papers can be downloaded at <http://www.tinbergen.nl>

Tinbergen Institute has two locations:

Tinbergen Institute Amsterdam
Gustav Mahlerplein 117
1082 MS Amsterdam
The Netherlands
Tel.: +31(0)20 525 1600

Tinbergen Institute Rotterdam
Burg. Oudlaan 50
3062 PA Rotterdam
The Netherlands
Tel.: +31(0)10 408 8900
Fax: +31(0)10 408 9031

Duisenberg school of finance is a collaboration of the Dutch financial sector and universities, with the ambition to support innovative research and offer top quality academic education in core areas of finance.

DSF research papers can be downloaded at: <http://www.dsf.nl/>

Duisenberg school of finance
Gustav Mahlerplein 117
1082 MS Amsterdam
The Netherlands
Tel.: +31(0)20 525 8579

**Discussion
of
“Principal Volatility Component Analysis”
by
Yu-Pin Hu and Ruey Tsay**

Michael McAleer

Department of Quantitative Finance
College of Technology Management
National Tsing Hua University
Taiwan
and
Econometric Institute
Erasmus School of Economics
Erasmus University Rotterdam
The Netherlands
and
Tinbergen Institute
The Netherlands
and
Department of Quantitative Finance
Complutense University of Madrid
Spain

February 2014

*The author is most grateful for the financial support of the Australian Research Council and the National Science Council, Taiwan.

Abstract

This note discusses some aspects of the paper by Hu and Tsay (2014), “Principal Volatility Component Analysis”. The key issues are considered, and are also related to existing conditional covariance and correlation models. Some caveats are given about multivariate models of time-varying conditional covariance and correlation models.

Keywords: Principal Component Analysis, Principal Volatility Component Analysis, Vector time-varying conditional heteroskedasticity, BEKK, DCC, asymptotic properties.

JEL: C32, C55, C58, F37.

1. Discussion

It is a pleasure to provide some comments on the excellent and topical paper by Hu and Tsay (2014) on “Principal Volatility Component Analysis”.

The paper extends Principal Component Analysis (PCA) to Principal Volatility Component Analysis (PVCA), and should prove to be an invaluable addition to the existing multivariate models for dynamic covariances and correlations that are essential for sensible risk and portfolio management, including dynamic hedging.

As one of the key obstacles to developing multivariate covariance and correlation models is the “curse of dimensionality”, namely the number of underlying parameters to be estimated, the paper is concerned with dimension reduction through the use of PCA, which is possible if there are some common volatility components in the time series.

In particular, the method searches for linear combinations of a vector time series for which there are no time-varying conditional variances or covariances, and hence no time-varying conditional correlations.

The authors extend PCA to PCVA in a clear, appealing and practical manner. Specifically, they use a spectral analysis of a cumulative generalized kurtosis matrix to summarize the volatility dependence of multivariate time series and define the principal volatility components for dimension reduction.

The technical part of the paper starts in Section 2 with a vectorization of the volatility matrix, and a connection to the BEKK model of Engle and Kroner (1995).

However, as a primary purpose of PCVA is to search for the absence of multivariate time-varying conditional in vector time series, it would have been helpful to see how PCVA might be connected to the conditional covariances arising from various specializations of BEKK (for further details, see below).

Theorem 1 assumes the existence of fourth moments of a weakly stationary vector time series, but Theorems 2 and 3 assume the existence of sixth moments. The latter two Theorems beg the question as to whether the assumption is testable.

Interestingly, in the simulation study, the four simple ARCH models considered are understood to “not satisfy the moment condition of Theorems 2 and 3”, with a reference to Box and Tiao (1977) that traditional PCA works well in finite samples for non-stationary time series.

However, the purported connection between PCA for non-stationary time series, on the one hand, and time-varying conditional covariances and correlations for a weakly stationary vector time series, on the other, is not entirely clear.

The empirical analysis considers a data set of weekly log returns of seven exchange rates against the U.S. dollar from March 2000 to October 2011, giving 605 observations, which would be considered a relatively small number of observations for purposes of estimating dynamic vector covariance and correlation matrices.

The simple GARCH(1,1) model is used to estimate the conditional volatility models for the first six principal volatility components. It would have been useful to compare the GARCH estimates with the univariate asymmetric GJR and (possibly) leverage-based EGARCH alternatives.

A simple comparison is made of the PVCA results with the varying conditional correlation (VCC) model of Tse and Tsui (2002), though VCC is referred to as a “dynamic conditional correlation (DCC) model”.

As the effect of “news” in the VCC model has an estimated coefficient of 0.013 and a standard error of 0.004, it is stated that the model “works reasonably well for the 6-dimensional series”.

It is worth emphasizing some aspects of time-varying multivariate conditional covariance and conditional correlation models before any reasonable comparison can be made with the empirical results arising from PVCA.

In particular, it should be emphasized that only the scalar and diagonal BEKK models of the full BEKK model of Engle and Kroner (2005) can lead to statistical properties, other than by assumption (specifically, the multivariate log-moment condition for consistency (see Jeantheau (1988)) and the (untestable) 8'th moment condition for asymptotic normality (see Comte and Lieberman (2003))).

McAleer et al. (2008) established the consistency and asymptotic normality of scalar and diagonal BEKK, and argued that the Hadamard and full BEKK models that are widely estimated could not be derived from a vector random coefficient autoregressive process, so that any stated or claimed statistical properties were suspect.

They also developed the Generalized Autoregressive Conditional Correlation (GARCC) model, which has testable regularity conditions and standard asymptotic properties.

Caporin and McAleer (2008, 2012) showed the connection between the DCC and scalar BEKK models, and also questioned whether DCC had any statistical properties.

Caporin and McAleer (2013) referred to DCC as a “representation” rather than a “model”, and raised a number of problematic issues with DCC, namely that DCC:

- (1) does not directly yield conditional correlations;
- (2) is stated rather than derived;
- (3) has no moments;
- (4) does not have testable regularity conditions;
- (5) yields inconsistent two step estimators;
- (6) has no desirable asymptotic properties, if any at all;

- (7) is not a special case of GARCC;
- (8) is not dynamic empirically and the impact of variance misspecification is not known;
- (9) cannot be distinguished empirically from diagonal BEKK in small systems;
- (10) may be a useful filter or a diagnostic check, but it is not a model.

Similar reservations apply to the varying conditional correlation (VCC) model of Tse and Tsui (2002), which is used by Hu and Tsay (2014) in their empirical analysis.

For the reasons given above, the empirical results arising from PVCA should be compared only with the indirect conditional correlations arising from the scalar and diagonal BEKK models (see Caporin and McAleer (2008)).

2. Summary

The paper by Hu and Tsay (2014) is sure to become a widely used tool by practitioners in risk and portfolio management, at the very least as an accompaniment to the existing popular BEKK and DCC models, regardless of the statistical properties (or lack thereof) of the latter two models.

References

Box, G.E.P. and G.C. Tiao (1977), A Canonical Correlation Analysis of Multiple Time Series, *Biometrika*, 64, 355-365.

Caporin, M. and M. McAleer (2008), Scalar BEKK and Indirect DCC, *Journal of Forecasting*, 27, 537-549.

Caporin, M. and M. McAleer (2012), Do We Really Need Both BEKK and DCC? A Tale of Two Multivariate GARCH Models, *Journal of Economic Surveys*, 26(4), 736-751.

Caporin, M. and M. McAleer (2013), Ten Things You Should Know about the Dynamic Conditional Correlation Representation, *Econometrics*, 1(1), 115-126.

Comte, F. and O. Lieberman (2003), Asymptotic Theory for Multivariate GARCH Processes, *Journal of Multivariate Analysis*, 84, 61-84.

Engle, R.F. (2002), Dynamic Conditional Correlation: A Simple Class of Multivariate Generalized Autoregressive Conditional Heteroskedasticity Models, *Journal of Business and Economic Statistics*, 20, 339-350.

Engle, R.F. and K.F. Kroner (1995), Multivariate Simultaneous Generalized ARCH, *Econometric Theory*, 11, 122-150.

Hu, Y.-P. and R. Tsay (2014), Principal Volatility Component Analysis, to appear in *Journal of Business and Economic Statistics*.

Jeantheau, T. (1998), Strong Consistency of Estimators for Multivariate ARCH Models, *Econometric Theory*, 14, 70-86.

McAleer, M., F. Chan, S. Hoti and O. Lieberman (2008), Generalized Autoregressive Conditional Correlation, *Econometric Theory*, 24(6), 1554-1583.

Tse, Y.K. and A.K.C. Tsui (2002), A Multivariate GARCH Model with Time-varying Correlations, *Journal of Business and Economic Statistics*, 20, 351-362.