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# Co-movement measure of information transmission on international equity markets<sup>☆</sup>



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## HIGHLIGHTS

- The paper captures volatility linkages among various developed and emerging markets.
- Return co-movement effects between AUS and Asian countries are bi-directional.
- The US market has a higher volatility spillover on the UK than that of AUS market.
- The UK has a higher volatility spillover on the AUS market than that of US market.
- The HKG market has the largest volatility spillover on the TWN, AUS, and JPN markets.

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## ABSTRACT

Recently, Bhatti and Nguyen (2012) used EVT and various stochastic copulas to study the cross-country co-movements diversification and asset pricing allocation. Weiss (2013) observed that Dynamic Conditional Correlation (DCC) models outperform various copula models. This paper attempts to contribute to the literature on multivariate models for capturing forward and backward return co-movement, spillover effects and volatility linkages. It reflects cross-country forward and backward co-movements more clearly among various coupled international stock markets relating to information transmission and price discovery for making investment decisions. Given the reality of fat-tail or skewed distribution of financial data, this paper proposes the use of VECM-DCC and VAR-DCC models which capture dynamic dependences between the Australian and other selected international financial stock markets. We observe that the return co-movement effects between Australian and Asian countries are bidirectional ((AUS ↔ Hong Kong), (AUS ↔ Japan)) with the exception of Taiwan (AUS → Taiwan). We also observe that the volatility spillover between the Australian and both the UK and the US markets are bidirectional with a larger volatility spillover from both toward the AUS market. Further, the UK market has a higher volatility spillover on the Australian market compared to the US market and the US market has a higher volatility spillover on the UK than that of the Australian market.

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## 1. Introduction

Recently, Weiss [1] questions the accuracy of the copula-GARCH model and suggests the use of DCC models for forecasting the value-at-risk (VaR) and expected shortfall (ES) of 1500 bivariate portfolios of stocks, commodities and foreign exchange futures. He observes that the VaR and ES estimates based on DCC models are positively correlated with the portfolio marginal volatility, while the opposite is true for the elliptical copulas. For the Archimedean copulas, the excess kurtosis of the marginal has a significant positive influence on the quality of the VaR and ES estimates. Moreover, Boubaker and Sghaier [2] use extreme value theory (EVT) and copula models (see for example, [3]) by employing time-varying Normal and Symmetrized Joe–Clayton (SJC) copulas. Their empirical results show that the dynamic dependence between American and Japanese stock markets is symmetric whereas American and European stock markets are asymmetric.

However, the application of VAR and VECM show mixed results (for a recent literature review, see [4]). Some of the recent studies rely on DCC–GARCH [5,6] and regime switching models [7], and provide evidence of asymmetric dependence [8]. In particular, they find greater correlation during market downturns than market upsurge. It is a stylized fact that stock market returns are generally not normally distributed but characterized by time-varying skewness [9] and time-varying kurtosis [10,11]. Therefore, the linear correlation coefficient is unsuitable for measuring the dependence and can largely lead to misleading results (see, e.g., [12–16]).

This paper is motivated by Weiss's idea and attempts to employ DCC model on the data set used by Bhatti and Nguyen [3] to see if DCC model gauges better co-movement and spillover effects in financial risk associated with returns during extreme events. Bhatti and Nguyen's work is related to extreme events which may occur rarely, e.g., once in a decade whereas our study addresses the more general scenario and uses a 15 years data and it implies two versions of the DCC models to assess return performance.

The DCC model is related to a vector multiplicative error model (VMEM) as proposed by Manganelli [17] and followed by Cipollini et al. [18]. The copula-based Gaussian transformation of observations allows identifying non-linear dependences between trading variables and yields a natural separation of (multivariate) dynamics in first and second conditional moments. The latter are conveniently captured using DCC models as proposed by Engle [19]. It is a flexible approach applicable in high dimensions and can be extended in various directions. Multiplicative Error Models (MEMs) labeled according to Engle [20] are workhorses for the modeling of dynamic processes of non-negative random variables, such as trading volumes, volatilities, trading intensities or market depth and financial markets' bivariate linkages. The DCC methodology allows for flexibility by using a single equation GARCH process [21] to estimate time-varying variance and covariance structures and to construct the conditional correlations without using multivariate GARCH (MGARCH) specifications—see, e.g., [22,23]. It provides direct estimates of conditional correlation coefficients as the standardized residuals from GARCH processes [24]. Therefore, we attempt to use the DCC model to see how estimates of the parameters (which are dynamic over time) are obtained.

The rest of the paper is organized as follows. In the subsequent sections, the summary of data description is given and the general form of the DCC model is presented to demonstrate its usefulness to international financial markets. In Section 3, the relevant research design of the empirical study is presented. Results and discussions are given in Section 4 whereas the final section contains some concluding remarks.

## 2. The data and the models

### 2.1. The data

We apply the DCC Model to spot equity market data, which is taken from the main market index on the Australian Securities Exchange (ASX). The data set for Australian market and all other international markets was collected from Data-stream and covers a nearly 15-year period from January 1993 to June 2008 and represents the daily settlement prices. The total numbers of observations in the sample are 3782 which is well suited to our study. The descriptive statistics of stock returns calculated as the natural log differences in stock prices are given in Table 1. Note that these returns are positive with the exception of Japan which was positively skewed with Hong Kong. Volatility in returns in Hong Kong market is observed to be the highest, followed by Taiwan and Japan whereas US, UK and Australian markets return were less volatile relative to their Asian counterparts.

Table 2 shows the results of unit root tests of the time series data based on the Augmented Dickey–Fuller (ADF) test. The results suggest that the index prices are non-stationary at level specification, however, interestingly their first log differences turned out to be stationary.

To further examine the data, we conducted Johansen and trace co-integration tests in Table 3 and observed that the prices series for Australia-related pairs are co-integrated at 1% significance level.

### 2.2. The models

In this study we used DCC–GARCH model to capture the time-varying coupled correlation which is evidence among international markets while comparing co-movement and contagiousness from one country to others. Moreover, the model

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