



## Financial market interdependencies: A quantile regression analysis of volatility spillover



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### ABSTRACT

This paper investigates the degree and structure of interdependence between emerging (Asian and Latin American) and developed (USA and Japan) stock markets through the study of volatility spillovers for the period spanning from January 1, 1993 to October 13, 2010. Using both standard GARCH model and quantile regression approach, we find the evidence of significant interdependence between financial markets which may give evidence of volatility transmission. The volatility transmission is closely associated with geographical proximity as well as with crisis periods which confirm the presence of contagion. The analysis of upper and lower quantiles allows observing that the interdependence increases during bullish markets while decreases during bearish markets. Accordingly, the structure of interdependence is asymmetric for both Asian and Latin American emerging markets. These findings open up new insights for government policy makers as well as for managerial purposes.

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### 1. Introduction

The financial crises that have shaken the current synchronized world economy were more frequent and more insistent especially for the emerging economies. A number of studies show that the sustainable international financial integration (IFI) in addition to the synchronization of economic sectors are essentially the basis of these financial turbulences. Econometric tests in studies of Phylaktis (1999) and Phylaktis and Ravazzolo (2002) show that financial openness made the integrated financial markets more sensitive to external or common shocks. Other studies, including that of Calvo and Reinhart (1996) show that financial interdependencies between stock markets results frequently in volatility spillovers and amplifies the transmission of crises from one country to another.

The financial literature has recently focused on the study of stock markets interdependence and especially volatility spillover, particularly after the multiplicity of financial crises such as Mexico 1994, Asia 1997, Brazil 1998, Turkey 2001, and the recent 2008 subprime crisis as the mostly affecting on emerging markets. Empirical results provided by previous works

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made use of several methodologies to deal with the concept of volatility transmission, including VAR and cointegration models, known as traditional measurement techniques of interdependencies and conditional variance modeling, regime switching models and stochastic volatility (SV) models, which represent the most robust and relevant techniques in terms of estimation. More recently, the VAR-GARCH approach of [Ling and McAleer \(2003\)](#) considers dynamic return links and volatility transmission through first and second conditional moments respectively. This methodology made success to capture interdependencies and spillover mechanisms either in bivariate or in multivariate system. It is worth mentioning that the majority of previous studies have led to the existence of unidirectional and sometimes bidirectional spillovers between international stock markets more amplified in times of financial crises and variant depending on the degree of integration ([Gilenko and Fedorova, 2014](#); [Bekiros, 2013](#); [Ben Rejeb, 2013](#); [Aroui et al., 2011](#); [Li, 2007](#); [Choudhry, 2004](#); [Darrat and Benkato, 2003](#); [Xu and Fung, 2002](#); [Caporale et al., 2002](#); [Kasch-Haroutounian and Price, 2001](#); [Forbes and Rigobon, 2001, 2002](#)).

Certainly, the increase in the volatility of financial asset prices results in spreads from one country to another during turbulence periods through a mechanism of contagion worries of emerging market governments that are most affected by these crises. This leads us to believe that a rigorous study of financial markets interdependencies in terms of volatility would be useful for governmental policy regulators as well as for portfolio manager.

In this framework, we focus first on the issue of volatility transmission between emerging and developed markets and second on the contagion effects that occurred during the recent financial crises. Our main objective is to look at the interdependencies in terms of volatility transmission between emerging and developed financial markets during both normal and turmoil periods. To achieve our objective, we adopt a more appropriate methodology which is generally characterized by its accuracy and suitability for non-standard shaped distributions and by a non linear behavior ([Koenker, 2005](#)), contrary to other classical regression models which, in our view, has not been yet used in this context. It is the Quantile Regression (QR) model, which has been previously used in the financial literature to study the value-at-risk ([Engle and Manganelli, 2004](#); [Rubia and Sanchis-Marco, 2013](#)), the systemic risk ([Adrian and Brunnermeier, 2011](#)) the prediction of failure ([Li and Miu, 2010](#)) and also the modeling of dependence between financial variables ([Bassett and Chen, 2001](#); [Chuang et al., 2009](#); [Baur et al., 2012](#); [Lee and Li, 2012](#); [Tsai, 2012](#); [Ciner et al., 2013](#); [Gebka and Wohar, 2013](#)). This approach seems to be more robust because it uses different measures of central tendency and dispersion statistics for an advanced analysis of the relationship between variables.

The QR as in the case of the copula functions gives information on the average dependence as well as the upper and lower tail dependence but differ from it in that the copulas directly relates the quantiles of both the dependant and the conditioning variables.

Additionally, given the special features of financial time series, the QR seems more fitting for some types of truncated or censored data, fat-tailed distributions and of course the non-linearity. It handles the entire conditional distribution of the dependent variable, not solely the mean. Accordingly, the median regressor estimators can be more efficient than mean regressor estimator in so far as heteroscedasticity might be detected. Finally, the QR is robust against outliers and avoids the assumption that the error terms are independent and identically distributed (iid).

The QR gives also an accurate overview of the interdependencies between stock markets in different market circumstances, namely: Bearish markets (lower quantile), balanced markets (average quantile) and bullish markets (upper quantile). In addition, the QR approach allows capturing the complex dependence between financial time series and marginal effects derived from various stock markets, particularly where financial crises are considered. Thus, we used time-varying crises indices to take into account the evolutionary characteristics of emerging stock markets.

The remaining of this article is organized as follows: The second section presents a review of literature on the transmission of volatility and contagion. The third section presents the econometric methodology. The fourth section describes the data and their statistical properties. The fifth section reports results of both the conditional volatility and the quantile regression models. The sixth section discusses the policy implications and concludes.

## 2. Literature review

Studies on volatility spillovers have involved the interest of many researchers for a long time. During the last decades, several studies in empirical finance and financial economics have focused on the analysis of volatility transmission between emerging markets with regard to the increase in their degree of financial integration after their liberalization process ([Gilenko and Fedorova, 2014](#); [Bekiros, 2013](#); [Bensafta and Semedo, 2011](#); [Kearney, 2000](#); [Leachman and Francis, 1996](#); [Karolyi, 1995](#); [Hamao et al., 1990](#)). By reviewing the financial literature, we can remark that several methods have been applied to investigate the interdependencies between financial markets in terms of volatility. In the following, we present an overview on the pioneering studies on this subject by reference to their methodologies.

Since the introduction of conditional variance models, numerous ARCH/GARCH specifications have been widely applied to study the relationship between financial markets and especially the international volatility transmission. In that framework, [Neaime \(2002\)](#) uses the Johansen cointegration techniques and the Vector Error Correction Model, to firstly explore the interrelations between MENA markets and their counterparts in the US, UK and France and secondly, to further look at the long and short-run dynamics of the stock market return series. Empirical results show first, that the GCC equity markets offer international portfolio diversification benefits while other emerging MENA stock markets such as Turkey, Egypt, Morocco and to a lesser extent Jordan have matured and become integrated in international financial markets and second, that shocks

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