



# Volatility and dynamic conditional correlations of worldwide emerging and frontier markets



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## ABSTRACT

This study examines the relationship between time-varying correlations and conditional volatility among 32 worldwide emerging and frontier stock markets and the MSCI World stock market index from January 2000 to December 2012. Correlations are estimated in the standard and asymmetric dynamic conditional correlation model frameworks. The results can be summarized by three main findings: (1) asymmetry in volatility is not a common phenomenon in emerging and frontier markets; (2) asymmetry in correlations is found only with respect to the Hungarian stock market; and (3) the relationship between volatility and correlations is positive and significant in most countries. Thus, diversification benefits decrease during periods of higher volatility.

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## 1. Introduction

One of the most significant and discussed concepts in the field of modern finance is portfolio theory, which is based on the principle that investors can reduce the variability of portfolio returns by holding assets with low- or negative-return correlations. A common belief is that there are such asset classes in international markets, particularly in emerging or frontier markets; therefore, most studies analyze such correlations among stock market returns. The earliest empirical studies in the field of stock market co-movement (see Grubel, 1968; Lessard, 1974; Ripley, 1973) demonstrated that the equity return correlations throughout different international markets are low and can be attributed to national factors and that diversification among these markets is advisable.

A decade after the latest of these studies, many researchers noted a substantial increase in the interdependence between national stock markets (e.g., Eun and Shim, 1989; Grinold et al., 1989; Jaffe and Westerfield, 1985; Meric and Meric, 1989; Schöllhammer and Sand, 1985). In the aftermath of the October 1987 US stock market crash, co-movement between national markets increased significantly (see, Arshnapalli and Doukas, 1993; King and Wadhvani, 1990). This co-movement led to another broad area of research in the framework of

stock market integration: the “contagion effect”. Forbes and Rigobon (2002) described this effect as “a significant increase in cross-market linkages after a shock to one country (or group of countries)”. The implications of contagion are broad; from the perspective of a practical investor, contagion leads to a weakening of diversification benefits.

Cappiello et al. (2006) examined whether the correlations between international developed equity (and bond) market movements correspond with volatilities. This relationship has several implications with respect to portfolio management and, notably, the risks are significantly larger than might be assumed by an examination of correlations or volatilities.

This paper explores possible international diversification benefits by estimating the dynamic conditional correlations (DCC), using both standard and asymmetric DCC models, among 32 worldwide emerging markets and the MSCI World stock market index during the period from January 2000 to December 2012. The study will link the correlations to conditional volatility to examine whether the correlations between international markets are correspondingly higher during periods of high volatility (or vice versa). If the relationship between conditional volatility and the correlations is positive, this suggests that diversification benefits decrease during volatile periods, i.e., during the times when they are most valuable.

The remainder of this paper is organized as follows. The next section provides a short review of the empirical studies. Section 2 describes the data, followed by Section 3 with methodology, and Section 4 presents the main results of the study. In Section 5 robustness tests are provided and Section 6 obtains concluding remarks.

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## 2. The related literature

The evidence concerning increasing stock market linkages depends on the study period and on the methodology employed; however, most studies indicate that international stock market linkages have increased in recent decades. [Lahrech and Sylwester \(2011\)](#) applied a smooth transition logistic trend model to establish the degree of stock market integration between the US and Latin American stock markets from December 1988 to March 2004. The smooth transition model was fitted to the standard DCCs between the US equity market and the Argentine, Brazilian, Chilean, and Mexican markets. The results demonstrated an increase in the degree of co-movements among these markets over time; however, the speed and magnitude of integration varied with the country examined. A similar approach was utilized by [Durai and Bhaduri \(2011\)](#), who studied the correlations from July 1997 to August 2006 among the following sample markets: the US, the UK, Germany, India, Malaysia, Indonesia, Singapore, South Korea, Japan, and Taiwan. The results showed that the correlations are higher among the returns of developed markets and lower between the returns of the Indian stock market with the developed and Asian stock markets. The low correlations of the Indian market continue to suggest the possibility of international diversification benefits.

[Guesmi and Nguyen \(2011\)](#) concluded that emerging market regions (Latin America, Asia, Southeastern Europe, and the Middle East) are segmented from other world markets. With the exception of the Latin American region, calculated DCCs for emerging markets did not exhibit a significant increase from March 1996 to March 2008.

Using a sample of CEE-3 countries (the Czech Republic, Poland, and Hungary), Germany, and the US, [Baumöhl et al. \(2011\)](#) demonstrated that endogenously detected unconditional volatility breaks in stock market returns are significantly associated with DCCs. When the breaks are linked to a decrease in volatility, the correlations between the indices also decrease. Similarly, a sudden increase in volatility is accompanied by an increase in DCCs, which supports the presence of a shift contagion effect. [Kenourgios et al. \(2011\)](#) also provide evidence of contagion on a sample of the BRIC emerging markets (Brazil, Russia, India, China)<sup>1</sup> and two developed markets (UK and US) from 1995 to 2006 using an asymmetric time-varying framework (AG-DCC). Similar findings are those of [Dimitriou et al. \(2013\)](#), who applied FIAPARCH-DCC approach on a sample of BRICS countries (Brazil, Russia, India, China, and South Africa), as well as the US, during different phases of the recent crisis. Increasing co-movements among the US and BRICS are identified from early 2009 onwards period, implying that correlations tend to be higher in bullish than in bearish markets.

Three major emerging market crises (Asian crisis, Russian default, and Argentine turmoil), along with the recent US subprime crisis, are investigated in the study of [Kenourgios and Padhi \(2012\)](#). The sample covers period from January 1994 to December 2008 and includes emerging stock and bond markets from various regions around the world (Latin America, Middle East and Africa, Asia, and Emerging Europe). Standard cointegration analysis revealed long- and short-run dynamics among emerging stock markets during the Russian and the Asian crises, for both stock and bond markets during the subprime crisis, but Argentine turmoil had no significant impact. The isolated nature of the Argentine turmoil has been also confirmed using the AG-DCC approach.

In a separate study, [Kenourgios and Samitas \(2011\)](#) examine the correlations of Balkan emerging stock markets (Turkey, Romania, Bulgaria, Croatia, and Serbia) with developed European markets (UK, Germany, and Greece) from January 2000 to February 2009 and provide evidence that the dependence increased between the Balkans and the developed equity markets, which supports the presence of herding

<sup>1</sup> The extent of the recent global crisis on a sample of the BRIC countries was also examined by [Aloui et al. \(2011\)](#) using a multivariate copula approach to study the extreme co-movements.

**Table 1**

Countries and stock market indices that are included in the sample.

Country	RIC	Country	RIC
Argentina	.MERV	Malaysia	.KLSE
Brazil	.BVSP	Malta	.MSE
Ivory Coast	.BRVMCI	Mexico	.MXX
Croatia	.CRBEX	Oman	.MSI
Czech Republic	.PX	Philippines	.PSI
Egypt	.EGX30	Poland	.WIG
Estonia	.OMXTGI	Qatar	.QSI
Hungary	.BUX	Romania	.BETC
Chile	.IGPA	Russia	.IRTS
China	.SSEC	Saudi Arabia	.TASI
Indonesia	.JKSE	South Africa	.JALSH
Israel	.TA100	Sri Lanka	.CSE
Jordan	.AMMAN	Taiwan	.TWII
Kuwait	.KWSE	Thailand	.SETI
Latvia	.OMXRGI	Turkey	.XU100
Lithuania	.OMXVGI	Venezuela	.IBC

Note: RIC stands for the Reuters Instrument Code.

behavior that appeared to be evident during the 2008 stock market crash period.

[Samarakoon \(2011\)](#) conducted an extensive study of stock market integration and contagion among 62 emerging and frontier markets and the US market from April 2000 to September 2009. Using shock models,<sup>2</sup> [Samarakoon \(2011\)](#) found that shocks are more likely driven by the US market during periods of tranquility, whereas shocks from emerging markets impact the US during periods of crisis. There are important interdependencies among emerging and frontier markets with the US market that prevent emerging markets and frontier markets from acting as effective hedges for US investors during US shocks and periods of crisis.

[Syllignakis and Kouretas \(2011\)](#) applied a rolling regression analysis of conditional correlations with conditional volatility on a sample set that included the stock markets of the US, Germany, Russia, the Czech Republic, Estonia, Hungary, Poland, Romania, Slovakia, and Slovenia from October 1997 to February 2009. Their results imply that the usefulness of the Central and Eastern European stock markets as a diversification tool has diminished in recent years, most notably during the recent financial crisis and the 2008 stock market crash.

[Horvath and Petrovski \(2013\)](#) compared the CEE-3 market correlations with those of Southeastern Europe (Croatia, Macedonia, and Serbia). These authors found that during their study period from January 2006 to May 2011, the degree of co-movement between the CEE-3 markets and the Stoxx Europe 600 index is much higher than between the Southeastern European markets and the Stoxx Europe 600.

The asymmetric DCC model was used in the study by [Gjika and Horvath \(2013\)](#) to estimate the correlations between the CEE-3 stock markets and the aggregate Euro-zone index Stoxx 50 from December 2001 to October 2011. This study observed a significant increase in correlations after the entry of the CEE-3 countries into the European Union; moreover, the correlations remained at higher levels (approximately 0.6) during the recent financial crisis. Although asymmetries in volatility were present in all cases, an asymmetry in correlations was significant only for the BUX (Hungary) and WIG (Poland) pair of indices; these authors also linked the correlations to conditional volatility but not all of the relationships were significant.

## 3. Data description

Our dataset consists of the daily closing prices of 32 emerging and frontier stock market indices and the MSCI World stock market index

<sup>2</sup> First, unexpected returns (returns shocks) were calculated by specifying an autoregressive model of returns allowing for time-variation of expected returns for the US market and for each emerging/frontier market. Second, the US return shocks were related to the shocks in another market (and vice versa), using the VAR framework.

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