ARTICLE IN PRESS

Global Finance Journal xxx (xxxx) xxx–xxx

Contents lists available at ScienceDirect

Global Finance Journal

journal homepage: www.elsevier.com/locate/gfj

Implied volatility linkages between the U.S. and emerging equity markets: A note

Anupam Dutta

Department of Accounting and Finance, University of Vaasa, Wolffintie 34, Vaasa 65200, Finland

A R T I C L E I N F O

JEL classification:
G15

Keywords:
VIX
ARDL bound tests
Emerging markets

A B S T R A C T

This paper investigates stock market integration among the U.S. and two leading emerging markets—China and Brazil—using their implied volatility indexes published by the Chicago Board of Options Exchange (CBOE). Employing ARDL bound tests, we find strong evidence of long-run transmission of uncertainty from the U.S. market to other markets. Additionally, results from a bivariate VAR-GARCH model indicate high correlations among the equity markets, which may diminish the gains from portfolio diversification between the U.S. market and the emerging markets under study. Finally, the Toda-Yamamoto version of the Granger causality test also suggests significant links among the volatility indexes under study.

1. Introduction

Over the past few decades, empirical research on return and volatility linkages among international stock markets has received ample attention in the finance literature, because to benefit from portfolio diversification, one must know how shocks and volatility are transmitted from one market to another. In addition, policy makers must understand the time-varying correlations among equity returns to prevent contagion during financial downturns or stock market crashes.

Globalization has increased correlations among international financial markets (Inci, Li, & McCarthy, 2011). High correlations tend to reduce the potential benefits of portfolio diversification (Campbell & Hamao, 1992; Eun & Shim, 1989; Taylor & Tonks, 1989). Several researchers (Bekaert & Harvey, 1995; Harvey, 1995; Korajczyk, 1996) document that investing in both emerging and developed economies might become profitable as a consequence of low correlations among the underlying stock markets, but these correlations have significantly increased in recent years. Lahrech and Sylwester (2011), for example, show that the conditional correlations between U.S. and Latin American equity returns have substantially increased, a trend that may lessen the advantages of portfolio diversification between the United States and these countries. Wang and Choi (2015) find a strong correlation between U.S. and Chinese stock returns, and they suggest that this correlation is likely to rise in the future as the Chinese equity market becomes more integrated with the stock markets of other countries, reflecting information more efficiently.

While these articles investigate U.S. and emerging stock market integration using the traditional price series, in this study, we explore the link between the implied volatility indexes (VIX) of these markets. That is, we examine a market's expectations of future uncertainty and changes in these expectations (Nikkinen & Sahlström, 2004). As forward-looking measures, implied volatilities can be considered better predictors of future volatility than historical volatility measures (Dutta, 2017; Dutta, Nikkinen, & Rothovius, 2017; Maghyereh, Awartani, & Bouri, 2016).

We use two different emerging market volatility indexes: Chinese VIX and Brazilian VIX. Our main objectives are twofold. First, we assess whether there is any long-run uncertainty relationship between U.S. and the two emerging equity markets. Second, we

E-mail address: adutta@uwasa.fi.

http://dx.doi.org/10.1016/j.gfj.2017.09.002
Received 30 June 2017; Received in revised form 25 September 2017; Accepted 26 September 2017

Table 1
Descriptive statistics for U.S., Chinese, and Brazilian volatility series.

	U.S. VIX	Chinese VIX (VXFXI)	Brazilian VIX (VXEWZ)
Panel A: level			
Mean	17.1041	27.4412	33.2953
Standard deviation	5.6408	7.0135	9.5304
Skewness	2.1279	1.6758	0.8653
Kurtosis	8.1325	6.3204	3.4584
Jarque-Bera test	2802.488***	1403.190***	198.161***
Panel B: logarithmic change			
Mean	− 0.0212	− 0.0108	0.0029
Standard deviation	3.2305	2.1584	2.1315
Skewness	0.7306	1.1344	− 0.6309
Kurtosis	6.6017	8.1661	22.3031
Jarque-Bera test	951.744***	2005.696***	23,574.610***

Note: *** indicates statistical significance at the 1% level.

examine the time-varying correlations among the volatility series under study. To the best of our knowledge, this is the first work to scrutinize the connections among the implied volatilities of these markets.

Methodologically, we employ autoregressive distributed lag (ARDL) bound tests to assess the long-term transmission of uncertainty among the volatility series. Additionally, we use a bivariate VAR-GARCH model to analyze whether these indexes are correlated during the sample period used.

The rest of the paper proceeds as follows. The following section describes the data. Section 3 outlines the methods. Results are discussed in Section 4, and Section 5 concludes.

2. Data

Like the U.S. VIX, the Chinese VIX (VXFXI) and the Brazilian VIX (VXEWZ) were introduced by the Chicago Board of Options Exchange (CBOE) to measure the market's expectation of 30-day volatility. Since both the VXFXI and the VXEWZ start from the beginning of 2011, our sample period ranges from March 16, 2011, to December 31, 2016, yielding a total of 1513 daily observations.

Table 1 reports the descriptive statistics of these series, while Fig. 1 depicts them. It is evident from Table 1 that the Brazilian equity market is more volatile than other markets, as is shown by the standard deviations reported in Panel A. Most of these volatility indices are positively skewed, except for DLVXEWZ (the log-difference of the Brazilian index), which has a longer left tail. Moreover, all kurtoses are larger than 3, implying that each volatility index has a leptokurtic distribution with asymmetric tails. J-B (Jarque-Bera) tests further reveal that none of these series is normally distributed.

3. Methods

3.1. ARDL bound tests

ARDL bound tests offer several benefits. First, all the testing equations are allowed to have different lags. Second, ARDL bound tests can be employed regardless of whether the underlying variables are stationary, that is, I(0); integrated of order one, that is, I(1); or fractionally integrated (Bouri, Jain, Biswal, & Roubaud, 2016). Finally, the method does not suffer from spurious regression (Liu, Ji, & Fan, 2013). It is important to note that this test requires that series under investigation should not be integrated of order 2 or higher.

Since Fig. 1 does not exhibit major trends in the volatility indexes used, we construct the following unrestricted ARDL regressions without any time trend component:

$$LVIX_t = \omega_1 + \sum_{i=1}^{n} \alpha_{1,i} DLVIX_{t-i} + \sum_{i=1}^{n} \beta_{1,i} DLVXFXI_{t-i} + \sum_{i=1}^{n} \gamma_{1,i} DLVXEWZ_{t-i} + a_1 VIX_{t-1} + b_1 VXFXI_{t-1} + c_1 VXEWZ_{t-1} + \varepsilon_{1t} \tag{1}$$

$$LVXFXI_t = \omega_2 + \sum_{i=1}^{n} \alpha_{2,i} DLVIX_{t-i} + \sum_{i=1}^{n} \beta_{2,i} DLVXFXI_{t-i} + \sum_{i=1}^{n} \gamma_{2,i} DLVXEWZ_{t-i} + a_2 VIX_{t-1} + b_2 VXFXI_{t-1} + c_2 VXEWZ_{t-1} + \varepsilon_{2t} \tag{2}$$

$$DLVXEWZ_t = \omega_3 + \sum_{i=1}^{n} \alpha_{3,i} DLVIX_{t-i} + \sum_{i=1}^{n} \beta_{3,i} DLVXFXI_{t-i} + \sum_{i=1}^{n} \gamma_{3,i} DLVXEWZ_{t-i} + a_3 VIX_{t-1} + b_3 VXFXI_{t-1} + c_3 VXEWZ_{t-1} + \varepsilon_{3t}, \tag{3}$$

where D and L refer to the first difference operator and logarithmic operator respectively. In order to verify whether a cointegrating