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RESEARCH ARTICLE

Stock Market Volatility and Business Cycle: Exploring Cross-Country Spillovers

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This study explores the impact of the financial crisis on the relationship between stock market volatility and the business cycle. In addition, the possible spillover effects within a cross-country framework are also examined. The study is based on secondary macroeconomic data of monthly frequency for the time period of 1991:01 to 2012:12. Bivariate and multivariate causality techniques are used to arrive at results. Results of the study provide fresh evidence for the existence of strong bidirectional causality between stock market volatility and the business cycle for all sample countries. In fact, this bidirectional causality was found to be strong when accounted for financial crisis. Additionally, significant spillover effects between stock market volatility and the business cycle are also found.

Keywords: stock market volatility, business cycle, China, India, Brazil

JEL Classification: G01, G10, E32

During the recent financial crisis, we witnessed decrease in industrial production growth rate and the fall in share prices, which ultimately eroded around 30%–40% value of all indices during September 2008 and October 2008 (Bartram & Bodnar, 2009). Further, the crisis brought periods of high stock market volatility when compared to the volatility during expansion (Brandt & Kang, 2004; Hamilton & Lin, 1996; Schwert, 2011). Given these dynamics occurring together, Choudhry, Papadimitriou, and Shabi (2016); Corradi, Distaso, and Mele (2013); Bai, Wong, and Zhang (2010); Diebold and Yilmaz (2010); and Mele (2008) investigated the relationship between stock market volatility and the macroeconomic fundamentals, particularly the business cycle (proxed by industrial production growth rate). Their results provide evidence for bidirectional causality between stock market volatility and the business cycle. However, studies by Binswanger (2001) and Ahn and Lee (2006) found no such causal relationship in Canada and Japan, respectively. In fact, Ahn and Lee (2006) suggested that such a causal relationship has broken down since the 1980s. In a similar vein, no causality between stock market volatility and macroeconomic factors has been reported by Morelli (2002) for the UK. Nevertheless, the literature remained tilted towards the existence of bidirectional causality between stock market volatility and the

business cycle for some countries at the same time leaving the other. Additionally, this phenomenon has not been thoroughly researched; in fact, most of the literature remained focused on modelling volatility (Forbes & Rigobon, 2002; Mala & Reddy, 2007; Martens, 2002) rather than exploring its relationship with other variables (Diebold & Yilmaz, 2010).

On the other hand, there are few studies that consider the impact of a financial crisis on the relationship between stock market volatility and the business cycle (Brandt & Kang, 2004; Campbell, Lettau, Malkiel, & Xu, 2001; Schwert, 1990a). These studies suggested that the stock market is highly volatile to financial crises, and such volatility may have an effect on the causal relationship between stock market volatility and the business cycle. A study by Choudhry et al. (2016) proclaimed that such a causal relationship remained robust due to the inclusion of the recent financial crisis, and for some countries, this causal relationship strengthened during the crisis period. In addition, Choudhry et al. (2016) extended the literature further by exploring the possible spillover effects between stock market volatility and the business cycle across four major economies: Canada, Japan, the UK, and the US.

In this study, we further extend the literature by examining impact of the recent financial crisis on the relationship between stock market volatility and the business cycle (represented by the industrial production growth rate). Additionally, we explore the possible spillover effects within a cross-country framework. Specifically, we use the stock market volatility and the business cycle of a reference country (China in our case) to explore its impact on the stock market volatility and business cycle of India and Brazil. Our data set is of month frequency for the period of 1991:01 to 2012:12 for the countries China, India, and Brazil. It is worth to mention that these countries have been chosen because they are recognized as emerging industrial economies by the United Nations Industrial Development Organization. In addition, the bilateral trade between these economies has significantly grown in the recent years. To our knowledge, no other study has explored this phenomenon in the above-mentioned countries. Therefore, our results provide fresh evidence for policy makers of these countries.

The rest of the paper is organized into five sections. Section 2 provides the description of data. Section 3 presents the models and estimation approach. Section 4 discusses the findings, and Section 5 concludes the overall paper.

DATA DESCRIPTION

For the purpose of this study, we use a sample of three major emerging industrial economies, namely, China, India, and Brazil. These economies are recognized as promising industrial countries by the United Nations Industrial Development Organization's Industrial Development Report (2018). Further, we employ monthly data of respective stock market indices like the SSE Composite Index (China), BSE Sensex (India), and Brasil Sao Paulo Stock Exchange Index (Brazil). We compute the continuously compounded monthly stock returns as follows:

$$R_t = ln\frac{P_t}{P_{t-1}} \qquad (1)$$

where P_t and P_{t-1} denote the stock index prices at time t and $t-1$, respectively; R_t represents the returns; and ln is the logarithm operator. Further, we employ total industrial production growth rate (in log changes and seasonally adjusted) of monthly frequency to represent the business cycle. The data for both the variables are obtained for the period of 2000:01 to 2018:12 and are sourced from Thomson Financial Datastream.

We use the univariate GARCH(1,1) model to estimate stock market volatility; these results are presented in Figure 1. In line with the results of the previous studies (Choudhry et al., 2016; Schwert, 2011), we find higher stock market volatility during the crisis period (2007–2010) as compared to normal periods for all the countries. Additionally, consistent with the prior literature (Choudhry et al., 2016), we find a prominent decrease in the industrial production growth rate of all countries during the crisis period (see Figure 2) and a gradual bounce back during 2009.

ESTIMATION APPROACH AND RESULTS

Unit Root Testing

Before proceeding with the estimation, we conduct the panel unit root test using the augmented Dickey and Fuller (1979) approach. The results of the unit root test suggest that the first differenced series is stationary at 1% level of significance. Having known of stationarity of the first differenced series, we proceed with the analysis.[1]

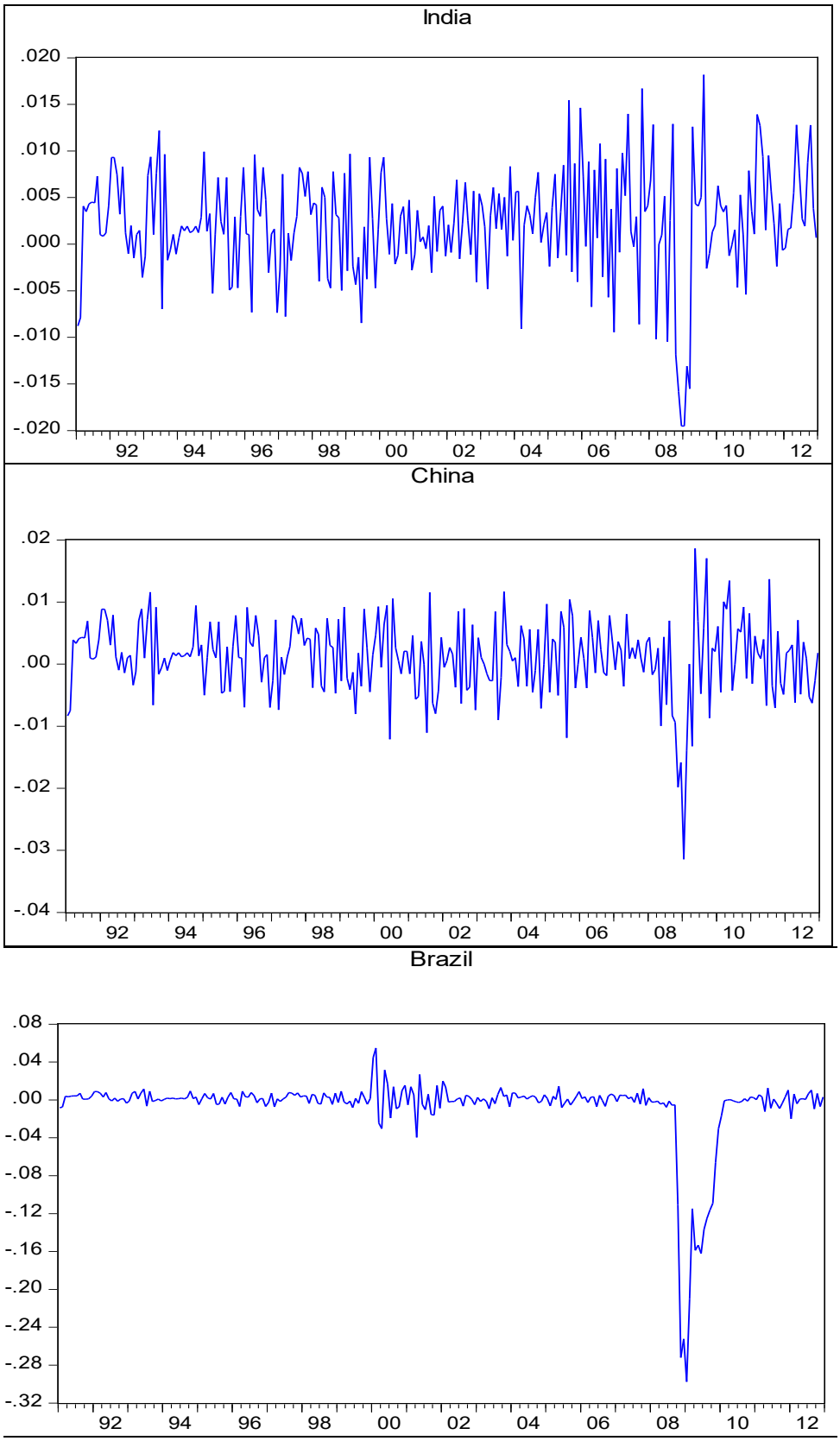

Figure 1. Industrial production growth rate. This figure presents the industrial production growth rate (in log terms) for India, China, and Brazil for the period of 1991:01 and 2012:12.

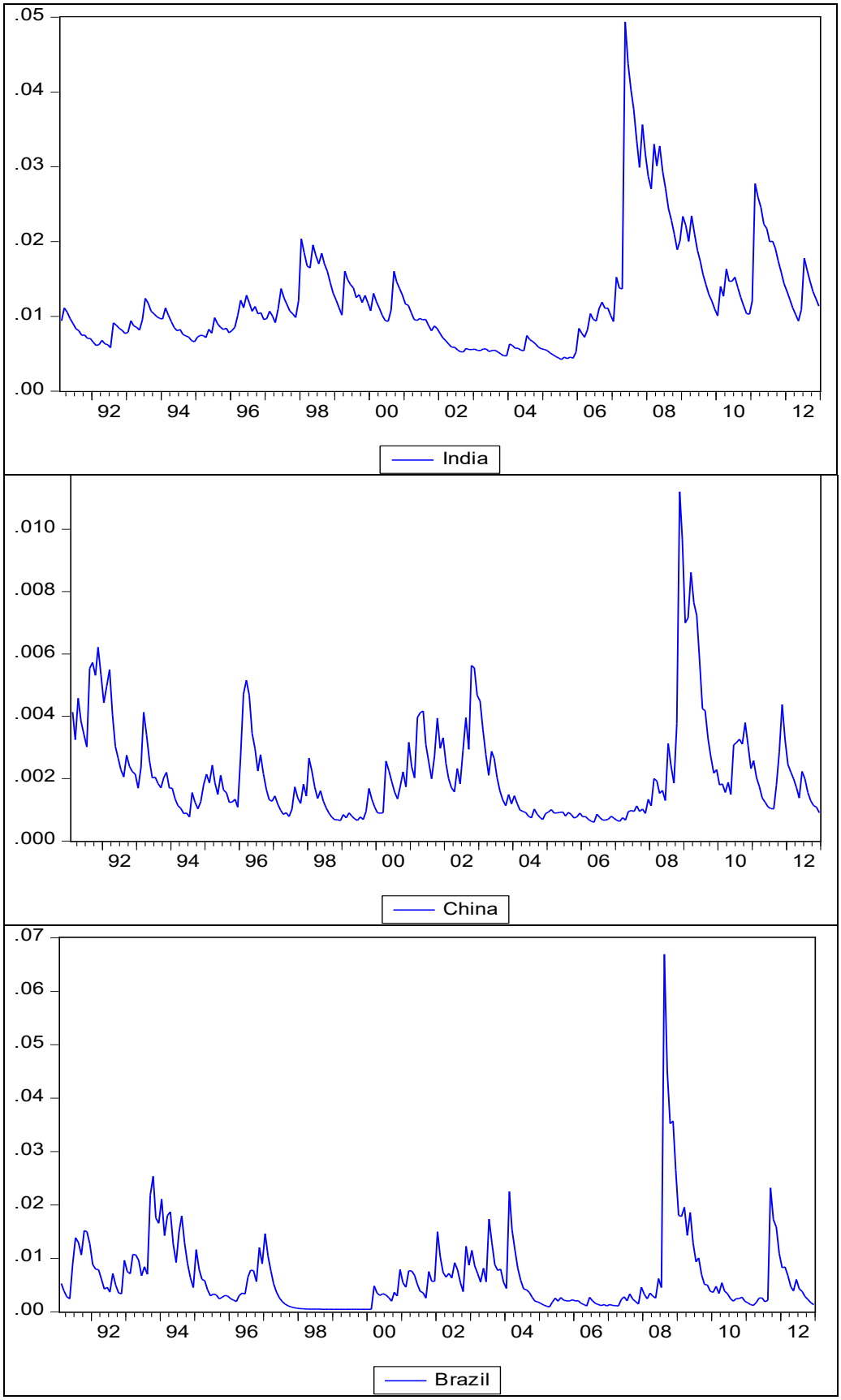

Figure 2. Stock market volatility. This figure presents the stock market volatility for India, China, and Brazil estimated via GARCH (1,1) for the period of 1991:01 and 2012:12.

Bivariate and Multivariate Causality

We use widely accepted vector autoregression (VAR) and the corresponding Granger causality test (Granger, 1969) to examine the relationship between stock market volatility and the business cycle indicator (i.e., the industrial production growth rate) within each market (China, India, and Brazil). Specifically, if the variable x_t Granger causes the variable y_t, then lags of x_t explain the current values of y_t. Therefore, the bivariate VAR model can be expressed as

$$x_t = \gamma_1 + \sum_{i=1}^{m} \alpha_i \; x_{t-i} + \sum_{i=1}^{m} \beta_i \; y_{t-i} + \mu_{1t} \quad (2)$$

$$y_t = \gamma_2 + \sum_{i=1}^{m} \emptyset_i \; x_{t-i} + \sum_{i=1}^{m} \delta_i \; y_{t-i} + \mu_{2t} \quad (3)$$

where x_t is the first difference of stock market volatility; y_t is the log difference of the business cycle indicator (industrial production BCI); m is the optimal lag length chosen on the basis of the Akaike information criterion; α_i, β_i, ϕ_i, and δ_i are the estimated coefficients; γ_1 and γ_2 are constant; and μ_{1t} and μ_{2t} are residuals. We are interested in examining the bidirectional causality that runs in both directions.

Further, we are also interested in examining the possible spillover effects among countries, and for examining this phenomenon, we examine causality in a multivariate setting. Additionally, for the purpose of examining spillover effects, we use China as the reference country because China is economically more prosperous as compared to India and Brazil. To account for spillover effects, we augment Equations (2) and (3) with the stock market volatility and business cycle of China and vice versa.

EMPIRICAL RESULTS

Bivariate Causality

The results of bivariate causality are presented in Table 1. Specifically, Panel 1 presents the results of the precrisis period (1991:1 to 2007:06), and Panel 2 presents the results of the full sample period (i.e., 1991:01–2012:12). The results presented in Panel 1 signify the presence of a significant causal relationship between the business cycle and stock market volatility for all the countries at 5% level of significance, since the F statistics for all the countries are significant at 5% level of significance. On the other hand, we find stock market volatility significantly causes the business cycle in China at 1% level of significance and those in India and Brazil at 5% level of significance. Further, Panel 2 presents the results of the full sample period, which enables us to understand that impact of crisis on the relationship between stock market volatility and the business cycle. Specifically, we find a significant casual relationship in either direction for all the countries. We find that the business cycle causes stock market volatility in China and India at 1% level of significance and in Brazil at 5% significance. On the other hand, stock market volatility causes the business cycle in China and India at 1% and 5%, respectively, and it causes the business cycle in Brazil at 10% of level of significance.

Multivariate Causality

In this section, we focus on multivariate causality in order to explore the possible spillover between stock market volatility and the business cycle across countries. Specifically, we follow Choudhry et al. (2016) and extend the bivariate causality of individual countries to incorporate stock market volatility and the business cycle of the reference country (China). Therefore, we are interested in exploring the spillover effects among China and the other two countries, India and Brazil. Additionally, like bivariate setting, we explore the possible effect of crisis on the spillovers.

These results are presented in Table 2; specifically, Panel 1 provides the results of the precrisis period (1991:01 to 2007:06), and Panel 2 provides the results of the full sample period (1991:01 to 2012:12). Perusing Table 2 (Panel 1), we find that there is significant spillover from the Chinese stock market volatility and business cycle to the Indian stock market volatility at 10% level of significance. In reverse, the Indian stock market volatility and business cycle are also causing changes in the Chinese stock market volatility and business cycle at 5% level of significance. Additionally, the stock market volatility and business cycle of China are causing the changes in the business cycle of India at 1% level of significance. In reverse, the stock market volatility and business cycle of India cause changes in the business cycles of China at 5% level of significance. These spillovers may be due to the fact that bilateral trade between India and China expanded substantially in recent years; in fact, the bilateral trade

Table 1. *Results of Bivariate Causality*

	China	India	Brazil	China	India	Brazil
Panel 1. Precrisis Period (1991:01 to 2007:06)						
	Business Cycle → Stock Market Volatility			**Stock Market Volatility → Business Cycle**		
Lags	10-7	9-3	12-4	9-5	6-2	11-4
F-stat	2.012**	2.010**	2.112**	2.94***	2.118**	2.132**
Adj. R^2	0.141	0.139	0.187	0.129	0.132	0.146
SSE	0.000	0.000	0.000	0.000	0.000	0.000
RSS	0.001	0.001	0.008	0.021	0.001	0.052
RESET	1.114	1.218	1.261	2.018	2.013	2.019
White	183.000	189.106	182.10	180.10	181.03	183.061
LB	7.873	7.851	7.832	5.043	5.012	5.016
JB	10.172	8.102	9.019	10.013	5.614	8.219
Panel 2. Full Sample Period (1991:01 to 2012:12)						
	Business Cycle → Stock Market Volatility			**Stock Market Volatility → Business Cycle**		
Lags	11-9	10-4	12-3	13-4	12-4	15-3
F-stat	2.916***	2.713***	2.03**	2.712***	2.13**	1.93*
Adj. R^2	0.141	0.139	0.187	0.129	0.132	0.146
SSE	0.000	0.000	0.000	0.000	0.000	0.000
RSS	0.001	0.001	0.008	0.021	0.001	0.052
RESET	1.114	1.218	1.261	2.018	2.013	2.019
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JB	10.172	8.102	9.019	10.013	5.614	8.219

Note. BC = business; SSE = standard error of estimate squared; RSS = residual sum of squares; RESET = Ramsey's specification test; White = White's heteroskedasticity test; LB = Ljung–Box (1978) test for autocorrelation; JB = Jarque–Bera normality of residuals test.
****Significance at 1% level.*
***Significance at 5% level.*
**Significance at 10% level.*

between China and India touched a record high of US$89.6 billion in 2017–18. Additionally, Sino-Indo (India–China) trade relations began early in 1950 and from then have grown substantially.

Additionally, when we consider the interaction between China and Brazil, we observe that China's stock market volatility and business cycle cause the stock market volatility of Brazil at 5% and 10 % levels of significance, and the opposite is also true in the case of both stock market volatility and business cycle. Further, with regard to the business cycle, we find the stock market volatility and business cycle of China cause changes in the business cycle of Brazil at 10% level of significance, but the opposite is true in the case of both stock market volatility and business cycle at 5% level of significance. It is therefore concluded that in the precrisis period, there are strong spillovers between India and China but weak spillovers between China and Brazil. These results point to the strengthening relations between China and Brazil. In fact, these results complement the bilateral trade relations among the three industrial giants of Asia.

Like in bivariate causality analysis, Panel 2 (Table 2) presents the results of the full sample period and thus enables us to understand that impact of crisis on the spillovers between the countries. Consistent with the

results of Panel 1, we find strong spillovers between the stock market volatility and business cycle of China and India in both directions and with both stock market volatility and business cycle as dependent variables. On the other hand, we find China's stock market volatility and business cycle as a significant predictor of Brazil's

Table 2. *Multivariate Causality*

	India			**China**		
Panel 1. Precrisis Period (1991:01 to 2007:06)						
Dependent Variable: Stock Market Volatility						
	BC_{India}	SV_{China}	BC_{China}	BC_{China}	SV_{India}	BC_{India}
Lags	7	5	3	6	4	5
F-stat	2.81***	1.92*	1.87*	2.32**	1.96**	2.03**
Dependent Variable: Business Cycle						
	SV_{India}	SV_{China}	BC_{China}	SV_{China}	SV_{India}	BC_{India}
Lags	7	9	4	8	4	4
F-stat	2.29**	2.92*	3.01*	2.89*	1.98**	2.05**
	Brazil			**China**		
Dependent Variable: Stock Market Volatility						
	BC_{Brazil}	SV_{China}	BC_{China}	BC_{China}	SV_{Brazil}	BC_{Brazil}
Lags	4	3	5	6	5	3
F-stat	2.81*	1.99**	1.86*	2.08**	2.03**	2.12*
Dependent Variable: Business Cycle						
	BC_{India}	SV_{China}	BC_{China}	SV_{China}	SV_{India}	BC_{India}
Lags	5	4	1	6	3	2
F-stat	2.01**	1.89*	1.82*	2.16**	2.34**	2.33**
	India			**China**		
Panel 2. Full Sample Period (1991:01 to 2012:12)						
Dependent Variable: Stock Market Volatility						
	BC_{India}	SV_{China}	BC_{China}	BC_{China}	SV_{India}	BC_{India}
Lags	10	7	6	9	6	5
F-stat	2.89*	2.78*	2.92*	2.93*	2.93*	3.02*
Dependent Variable: Business Cycle						
	SV_{India}	SV_{China}	BC_{China}	SV_{China}	SV_{India}	BC_{India}
Lags	11	8	5	8	3	2
F-stat	3.01*	2.87*	2.95*	2.78*	2.73*	3.19*
	Brazil			**China**		
Dependent Variable: Stock Market Volatility						
	BC_{Brazil}	SV_{China}	BC_{China}	BC_{China}	SV_{Brazil};	BC_{Brazil}
Lags	10	8	7	12	8	4
F-stat	2.01**	2.92*	1.99**	2.24**	1.32	1.12
Dependent Variable: Business Cycle						
	SV_{Brazil}	SV_{China}	BC_{China}	SV_{China}	SV_{Brazil}	BC_{Brazil}
Lags	8	7	5	11	7	5
F-stat	2.10**	3.01*	2.01**	2.09**	1.18	1.29

****Significance at the 1% level.*
***Significance at the 5% level.*
**Significance at the 10% level.*

stock market volatility and business cycle at the 1% and 5% levels of significance. Not surprisingly, we find Brazil's stock market volatility and business cycle having a causal effect on China's stock market volatility and business cycle.

CONCLUSIONS

In this study, we examine the impact of financial crisis on the relationship between stock market volatility and the business cycle. Additionally, we explore the possible spillover effects within a cross-country framework. Using the data set of monthly frequency for the period of 1991:12 to 2012:12 from China, India, and Brazil, we provide fresh evidence for the existence of strong bidirectional causality between stock market volatility and the business cycle for all sample countries. In fact, this bidirectional causality was found to be strong when accounted for financial crisis. Additionally, we found significant spillover effects between stock market volatility and the business cycle among these countries with China as a reference country.

Our findings provide some implications for the policy makers regarding the potential spillover effects from other countries, thereby paving the way for due consideration for building political and economic coordination with other members of trade and creating business opportunities that would strengthen the fabric of cooperation among the trading partners.

NOTE

[1] The results of GARCH and unit root are available upon request.

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