Impacts Of The 2008 Financial Crisis On South American Equity Markets

Jae-Kwang Hwang, Virginia State University, USA
Young Dimkpah, Virginia State University, USA
Alex I. Ogwu, Elizabeth City State University, USA

ABSTRACT

This paper examines the transmission of the 2008 US financial crisis to four Latin American stock markets using daily stock returns from 2006 to 2009, analyzing returns before and during the 2008 financial crisis. The empirical evidence presents a financial integration by showing persistently higher volatility during the crisis period. This indicates that most of the stock markets in this study were severely hit by the US financial crisis. However, the evidence shows that Chile was less impacted by the 2008 financial crisis. The results here could be useful in international portfolio diversification decision-making in South American region.

Keywords: 2008 Financial Crisis; South American Equity Markets; Financial Integration

INTRODUCTION

The collapse of the US housing market and the bursting of the US mortgage bubble in the summer of 2007 triggered a global financial crisis. In the early stages of the crisis, financial reforms in emerging markets made it possible to temporarily insulate themselves from adverse shocks originating from the US until the summer of 2008. However, many financial institutions (e.g., Bear Stearns, Lehman Brothers, and American International Group) rapidly lost most of their market values because of a huge increase in the mortgages delinquencies and foreclosures in the US.

The Latin American equity markets have become attractive to international investors given that they have high prospects for economic growth. The issue of equity market co-movements in Latin America has been examined by many studies. Calvo and Reinhart (1996) enriched the set of theoretical sources of contagion. They have examined "spillover" or "contagion" effect in light of the Mexican crisis in December 1994. Edward and Susmel (2001) considered the systematic changes by employing the switching ARCH model. They found that many Latin American equity markets were significantly correlated which proved the existence of the contagion effect during the times of high market volatility.

Dufrenot, Mignon, and Peguin-Feissolle (2011) examined the link between the volatility of the five Latin American stock markets and the US subprime crisis by using daily data from 2004 to mid 2009 employing Markov-switching model. They found that the subprime crisis was transmitted to the Latin American stock markets' volatility. Mexico is the most vulnerable to the US financial crisis because of the closer links with the US financial markets. Samarakoon (2011) examined the contagion of the 2007-2009 financial crisis and finds that only 22 of the 62 markets experienced significant price contagion in the 2007-2009 U.S. financial crisis by using the VAR methodology.

Naoui, Liouane, and Brahim (2010) investigated the contagious effect of the 2007 subprime crisis in six developed and ten developing markets by using daily stock returns from January 2006 to February 2010. They showed that all three countries (Brazil, Mexico, and Argentina) had high conditional correlation with the US market during the crisis by estimating the dynamic conditional correlation model. Turgutlu and Ucer (2010) reported that most of the emerging markets had a significant dependence with the US stock markets and international stock markets are significantly interdependent, which leaves a smaller chance to benefit from international portfolio

diversification. Gklezakou and Mylonakis (2010) examined ten global stock markets to figure out the effect of economic crisis on the stock markets. They showed the empirical findings that the recent economic crisis increased their correlation, thus tightening the existing links.

Arouri, Bellalah, and Nguyen (2010) showed that the inter-market co-movements were significantly higher during the crisis period than during the tranquil period by using monthly data from January 1985 to August 2005 based on the estimation from the DCC-GARCH model. They also showed that there were still large rooms for international diversification. Other several studies (Chen et al., 2002; Pagan & Soydemir, 2000; Christofi & Pericli, 1999) showed statistically significant linkages between Latin American stock markets and the US market.

The objective of this study is to investigate the transmission of the US financial crisis to financial markets in Argentina, Brazil, Chile, and Mexico, analyzing before and during the 2008 financial crisis period. This study covers the most recent period of January 2006 to March 2009 using daily data. In particular, this study examines whether the cross-market linkages between these markets change due to the crisis by dividing the studying periods into the pre-crisis period and during the 2008 financial crisis period. This paper employs Vector auto-regression (VAR) model, impulse response functions (IRFs), and variance decompositions (VDCs) to answer the questions.

The remainder of this paper is organized as follows. The next section discusses the data and describes methodologies and empirical findings. Conclusions and suggestions for further research are given in the final section.

METHODOLOGY AND EMPIRICAL RESULTS

The Data

This study uses daily closing observations from Yahoo Finance stock market index data of five selected stock markets, namely Argentina, Brazil, Chile, Mexico, and the US covering the period from January 2006 to March 2009. In order to explore changes in the cross-market linkages among stock markets, this study divides the period of analysis into two periods, namely the pre-crisis and during 2008 financial crisis periods. The pre-crisis period covers January 2, 2006 through July 31, 2007. The 2008 financial crisis is defined from August 1, 2007 through the first repayment of Troubled Asset Relief Program (TARP) (March 31, 2009).

The missing data arising from holidays and special events are assumed to be the values of the previous day. The specific markets are Argentina (Merval), Brazil (Bovespa), Chile (Bolsa de Santiago), Mexico (Bolsa Mexicana de Valores), and US (S&P 500). Daily returns are obtained by taking the logarithmic difference of the daily stock index. That is, $r_t = (\log P_t - \log P_{t-1})*100$.

Preliminary Test: Unit Roots

Prior to testing for vector auto-regression (VAR), we need to examine the time series properties of the variables. Variables should be stationary after differencing each time series the same number of times. Most financial variables have been found to be non-stationary in their levels and stationary in first differences.

In testing for stationarity, this paper implements the augmented Dickey-Fuller (ADF) test. To implement the ADF test, we estimate the regression,

$$\Delta X_t = \alpha + \beta X_{t-1} + \sum_{j=1}^{k} \gamma_j \Delta X_{t-j} + \varepsilon_t \quad (1)$$

Where Δ is the difference operator, X is the series being tested, k is the number of lagged differences, and ε is an error term. If the t-statistics is less than the critical values, then the null hypothesis of a unit root ($\beta = 0$) cannot be rejected. However, if the t-ratio is larger than the critical value, the null hypothesis of non-stationarity can be rejected.

Vector Auto-Regression

VAR is useful for characterizing the dynamic relationships among the variables without imposing certain types of theoretical restrictions. The VAR treats all variables as jointly endogenous and imposes no prior restrictions on the structural relationships between variables being analyzed.

Let X_t be an (4×1) vector of I (1) variables, Δ represent the first-difference operator and assume this vector has a *k*th order vector autoregressive (VAR) representation with Gaussian errors ε_t:

$$\Delta X_t = A_1 \Delta X_{t-1} + \ldots + A_k \Delta X_{t-k} + \varepsilon_t \quad (2)$$

where each of A_i is (4×4) matrix of parameters.

The effects of the shocks on the variables are evaluated by computing variance decomposition (VDC) and impulse response functions (IRF). An impulse response function describes the response of an endogenous variable to one of the innovations. Specifically, it traces the effect on current and future values of the endogenous variable of one standard deviation shock to one of the innovations. Another way of characterizing the dynamic behavior of the model is through the variance decomposition. The variance decomposition of VAR gives information about the relative importance of the random innovations. This breaks down the variance of the forecast error for each variable into components that can be contributed to each of the endogenous variables.

Plotting the generalized impulse response function is a practical way to explore the response of a variable to a shock immediately or with various lags. Unlike the orthogonalized variance decomposition and impulse response functions obtained using the Cholesky factorization, the generalized variance decomposition and impulse response functions are unique and invariant to the ordering of the variables in the VAR.

Empirical Results

Table 1 presents the summary statistics of the stock returns. As expected, all the stock markets show positive average daily returns before the crisis while all the stock markets show negative average daily returns during the crisis. The Mexican market recorded the highest return at 0.12 percent, followed by Chile 0.12 percent, Brazil 0.11 percent, Argentina 0.07 percent, and US 0.03 percent in the pre-crisis period. During the crisis period, the Chilean market recorded the lowest loss at -0.05 percent, followed by Brazil -0.06 percent, Mexico -0.10 percent, US -0.14 percent, and Argentina -0.15 percent.

Table 1: Summary Statistics of the Stock Returns

Period	Variables	US	Brazil	Mexico	Chile	Argentina
Pre-crisis	Mean	0.033	0.109	0.122	0.116	0.074
	Maximum	2.133	4.845	6.510	2.146	6.086
	Minimum	-3.534	-6.856	-5.977	-3.853	-7.786
	SD	0.671	1.479	1.315	0.654	1.357
	Skewness	-0.582	-0.368	-0.104	-1.413	-0.619
	Kurtosis	5.795	5.209	6.234	10.086	6.999
	Observations	411	411	411	411	411
During-crisis	Mean	-0.138	-0.064	-0.102	-0.051	-0.151
	Maximum	10.957	13.676	10.440	9.057	10.430
	Minimum	-9.469	-12.096	-7.266	-5.016	-12.951
	SD	2.288	2.851	2.037	1.250	2.504
	Skewness	-0.029	0.108	0.407	0.393	-0.607
	Kurtosis	7.098	6.492	6.630	10.709	7.760
	Observations	435	435	435	435	435

Notes: Pre-crisis period starts from January 2 2006 to July 31 2007. During-crisis spans from August 1 2007 to March 31 2009.

All the stock markets showed more volatility during the crisis compared to before the crisis. The skewness and kurtosis measures imply that the rate of return is not likely drawn from a normal distribution. As reported in the table, the excess kurtosis signifies that the distribution has fat tails, and all markets show evidence of fat tails.

Figure 1 provides plots of stock indexes for each market over the sample period. These plots reveal that all national stock prices fell substantially around the collapse of Lehman Brothers in September 2008. Figure 2 plots daily stock returns for each market. These plots show a clustering of larger return volatility during the 2008 financial crisis.

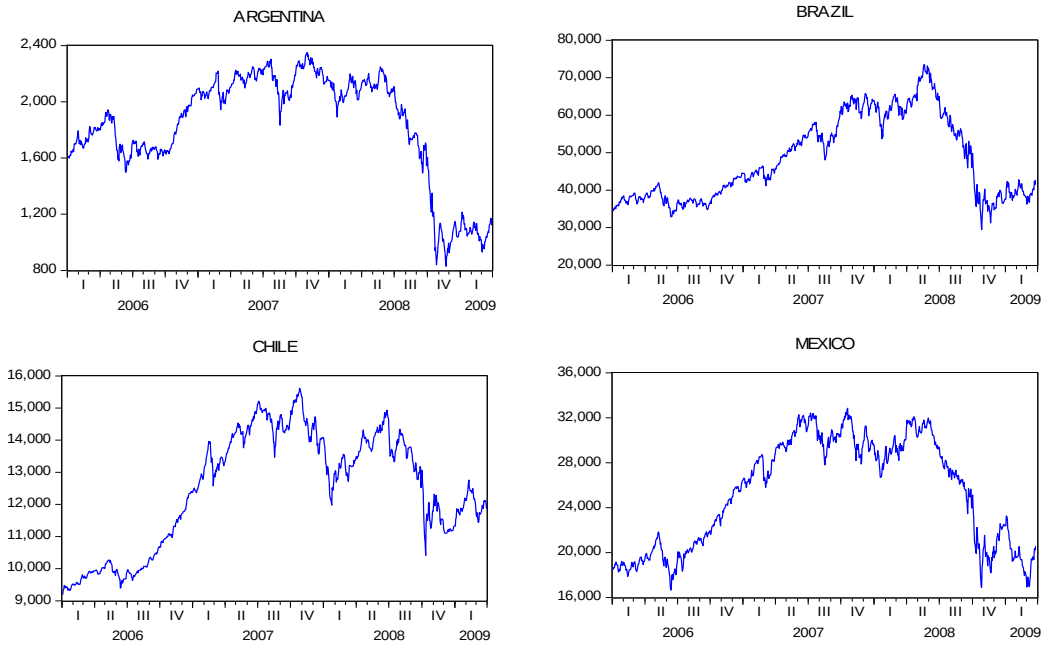

Figure 1: Daily Stock Prices

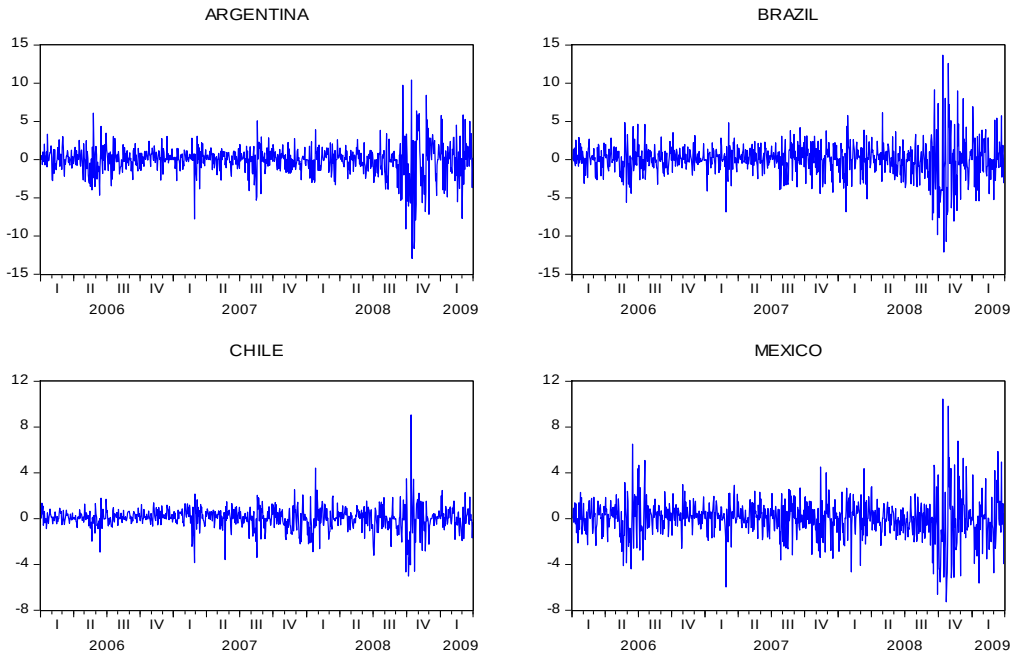

Figure 2: Daily Stock Returns

Table 2 reports the correlations of stock returns. All the stock markets show relatively higher degree of correlation between each other in the period during the crisis compared to the pre-crisis period. It suggests that the benefits of the diversification are limited within the advanced markets during the crisis. However, there may be the benefits of portfolio diversification between the US and Chile markets.

Table 2: Correlation of the Stock Returns

Period		US	Brazil	Mexico	Chile	Argentina
Pre-crisis	US	1	-	-	-	-
	Brazil	0.751	1	-	-	-
	Mexico	0.701	0.727	1	-	-
	Chile	0.521	0.485	0.521	1	-
	Argentina	0.655	0.714	0.630	0.437	1
During-crisis	US	1	-	-	-	-
	Brazil	0.763	1	-	-	-
	Mexico	0.804	0.775	1	-	-
	Chile	0.552	0.602	0.634	1	-
	Argentina	0.613	0.672	0.637	0.549	1

Table 3 presents the ADF tests for all the stock markets indices in levels and first differences. It indicates that all indices are first-difference stationary. It means that all variables are non-stationary in levels. Then, we examine whether there exists long-run relationships among these stock markets.

Table 3: Unit Root Test

	Pre-Crisis		During-Crisis	
	Levels	First-Difference	Levels	First-Difference
US	-0.610	-21.014*	-0.155(2)	-18.363*
Brazil	-0.412	-21.272*	-0.966	-21.751*
Mexico	-0.353	-18.078*	-0.747	-19.540*
Chile	0.357	-8.935*	-1.735	-17.094*
Argentina	-1.166	-20.979*	-0.429	-20.407*

Notes: * denotes significance at the 1 percent level. Figures are the pseudo t-statistics for testing the null hypothesis that the series is non-stationary. The critical values of the ADF test statistics with a constant are –3.44, -2.87, and –2.57 at the 1, 5, and the 10 percent, respectively. Lag length in parenthesis is selected such that the Ljung-Box Q-statistic fails to reject the null hypothesis of no serial correlation of the residuals.

Table 4 summarizes the results of cointegration analysis. This paper uses the Johansen maximum likelihood approach employing both the maximum eigenvalue and trace statistics to test for cointegration. Both tests provide not to reject the null of zero cointegrating vectors at the 5 percent level. Having verified that the variables are not cointegrated, a VAR model in first differences can be applied. The likelihood ratio test is employed to determine the appropriate lag length of the model.

Table 4: Results of Johansen Maximum Likelihood Estimation

	Pre-Crisis		During-Crisis	
Null Hypothesis	Trace	L-max	Trace	L-max
$r \leq 0$	52.919	26.960	54.687	21.848
$r \leq 1$	25.958	13.264	32.838	17.034
$r \leq 2$	12.694	6.530	15.803	10.218
$r \leq 3$	6.164	4.792	5.585	5.583
$r \leq 4$	1.371	1.371	0.001	0.001

Tables 5 and 6 present the results of variance decompositions in the pre and during-crisis periods over the 5-day horizons, respectively. The variations in the Brazilian market increased due to the US financial crisis from 55 percent (pre-crisis period) to 60 percent (during-crisis period) of the Brazilian stock market's forecast error variance. This implies that the benefits of investment diversification during the crisis period are limited because of the market integration between two markets. Likewise, the variations in the Mexican stock market due to the US shocks increased from 50 percent (pre-crisis period) to 70 percent (during-crisis period) of the Mexican market's forecast error variance. However, the variations in the Chilean stock market due to the US shocks increased from 25 percent

(pre-crisis period) to 37 percent (during-crisis period) of the Chinese market's forecast error variance. Likewise, the variations in the Argentine stock market due to the US shocks increased from 43 percent (pre-crisis period) to 46 percent (during-crisis period) of the Argentine market's forecast error variance. This finding shows that Argentina and Chile are less likely hit by the 2008 financial crisis. The results here could be useful in international portfolio diversification decision-making in South American markets.

Table 5: Generalized Variance Decomposition: Pre-Crisis Period

	Horizon	US	Brazil	Mexico	Chile	Argentina
US	1	100.00	0.00	0.00	0.00	0.00
	2	98.02	0.17	1.51	0.02	0.27
	5	94.77	0.88	1.94	1.92	0.47
Brazil	1	55.90	44.09	0.00	0.00	0.00
	2	54.56	43.40	2.01	0.03	0.01
	5	51.84	41.39	2.79	3.61	0.34
Mexico	1	49.33	8.59	42.06	0.00	0.00
	2	48.54	8.31	43.06	0.00	0.07
	5	46.19	8.89	42.29	2.15	0.46
Chile	1	25.23	1.34	2.78	70.63	0.00
	2	24.87	1.30	5.20	68.37	0.23
	5	23.63	1.92	5.17	68.06	0.65
Argentina	1	43.11	10.68	1.54	0.14	44.50
	2	42.81	10.81	1.92	0.27	44.17
	5	41.53	10.49	2.51	2.10	43.35

Notes: The reported numbers indicate the percentage of the forecast error in each variable that can be attributed to innovations in other variables.

Table 6: Generalized Variance Decomposition: During-Crisis Period

	Horizon	US	Brazil	Mexico	Chile	Argentina
US	1	100.00	0.00	0.00	0.00	0.00
	2	96.83	0.12	0.35	0.05	2.63
	5	94.35	0.52	0.66	1.17	3.27
Brazil	1	60.79	39.20	0.00	0.00	0.00
	2	59.08	38.77	1.42	0.19	0.51
	5	57.15	38.65	1.60	0.83	1.75
Mexico	1	69.88	3.83	26.27	0.00	0.00
	2	68.56	3.83	26.25	0.01	1.34
	5	66.21	4.23	25.61	0.38	3.54
Chile	1	37.69	5.36	2.82	54.10	0.00
	2	39.67	5.19	2.80	51.13	1.19
	5	38.76	5.22	4.81	49.85	1.33
Argentina	1	46.04	9.14	0.25	0.49	44.06
	2	46.74	8.89	0.68	0.50	43.18
	5	44.04	10.50	2.66	2.47	40.31

Notes: The reported numbers indicate the percentage of the forecast error in each variable that can be attributed to innovations in other variables.

An alternative way to obtain information regarding the relationships among the variables is through the generalized impulse response functions. In the pre-crisis period, Figure 3 shows the positive responses of the all stock markets to the shocks in the US market. The impacts reach their maximum at the one-day horizon and decline afterwards at the two-day horizon. During the crisis period, Figure 4 also presents the positive responses of these stock markets to the US shocks. The shock in the US market affect immediately and positively other stock markets, then gradually subside to zero within two or three days. Based on the results above, this study supports the view that the stock markets tend to be more integrated during the financial crisis period, resulting in lesser benefits of diversification among them.

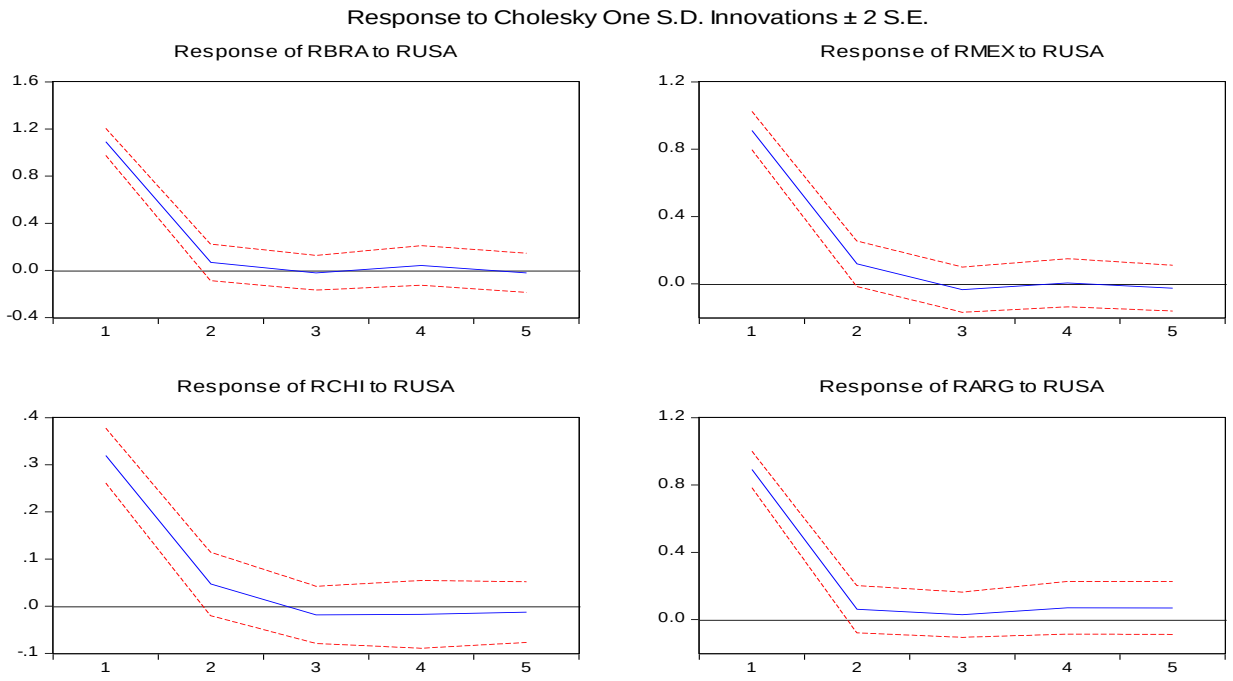

Figure 3: Generalized Impulse Responses of the Stock Markets to Innovations in the US Market during the Pre-Crisis Period

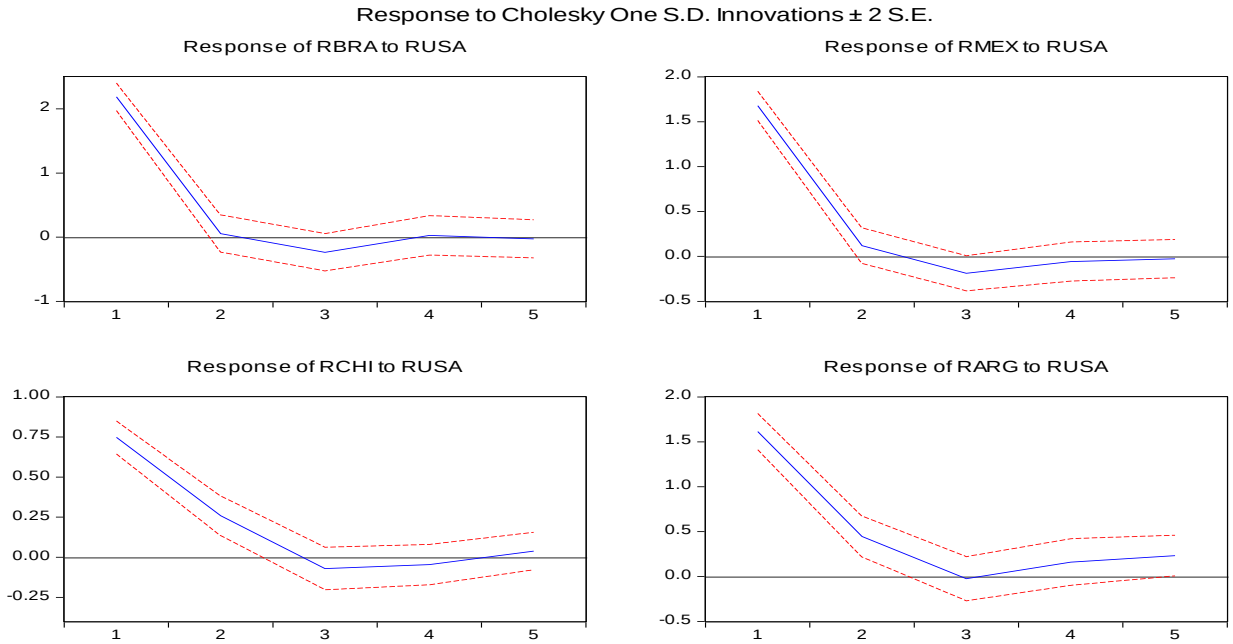

Figure 4: Generalized Impulse Responses of the Stock Markets to Innovations in the US Market during the Crisis Period

CONCLUSION

The objective of this paper is to examine the effects of the 2008 financial crisis on the South American stock markets using daily stock market returns from January 2006 to March 2009, analyzing returns before the crisis and during the crisis. In this regard, previous studies have pointed out that diversification benefits would decrease with higher financial integration. This paper employs VAR model to empirically study the nature of stock market

integration among the US stock market and four South American markets, namely Argentina, Brazil, Chile, and Mexico.

The results present significant linkages between South American markets and the US market. During the crisis period, all the stock markets had average daily negative returns compared to average daily positive returns in the pre-crisis period. The results of this paper support the theory that the Chilean market tends to be relatively less integrated with the rest of the markets and the US market before the crisis as well as during the crisis period. Therefore, there is still substantial opportunity to improve the risk-return performance between Chile and other markets.

A further possible extension of the paper is to study how time varying correlations will be changed in global stock markets in the pre- and during the 2008 financial crisis. This might help us understand the application of portfolio diversification strategies as well as the vulnerability of a financial system to the financial crisis.

AUTHOR INFORMATION

Dr. Jae-Kwang Hwang earned his Ph. D. at the University of Alabama, Tuscaloosa in 2000. He is currently an associate professor of Finance at Virginia State University, Petersburg, Virginia, USA. E-mail: jhwang@vsu.edu (Corresponding author)

Dr. Young Dimkpah earned his Ph. D. at the Howard University in Washington DC. He is currently an associate professor of Finance at Virginia State University, Petersburg, Virginia, USA. E-mail: ydimkpah@vsu.edu

Dr. Alex I. Ogwu earned his Ph. D. at the Howard University in Washington DC. He is currently a professor of Finance at Elizabeth City State University, Elizabeth City, Virginia, USA. E-mail: aiogwu@mail.ecsu.edu

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