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REVISITING BRIC ECONOMIES: TESTING STOCK MARKET INTERDEPENDENCE: COMPARISON BETWEEN PRE AND POST CRISIS PERIODS

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ABSTRACT

This study investigates the dynamic interdependence of the BRIC markets. Using data of end-of-day stock price indexes ranging from 9 January 2007 to 31 December 2012, we examine the stock market indexes of Brazil, Russia, India, and China. The index level series are tested for stationarity. We also apply the granger causality test to observe the lead lag relationship between the BRIC markets. Test for co-integration analysis and vector auto regressions (VAR) techniques were applied to model the interdependencies between the stock market of these 4 economies. We conduct the variance decomposition analysis to find the interdependencies between the markets under study. The results are robust to sensitivity tests based on partitioning the sample into periods before and after the global financial crises of 2008, after testing for structural break using the Chow breakpoint test & Quandt-Andrews unknown breakpoint test. Our results have important implications for the investors, so they can benefit from diversifying their portfolios by buying stocks in the BRIC countries.

KEYWORDS
Stock market inter-linkages, Stationarity, Granger Causality, Vector Auto Regression Model, Variance Decomposition Analysis, Portfolio diversification.

JEL CLASSIFICATION
F30, G15, F15

INTRODUCTION

Finance theory predicts that there are potential gains from international portfolio diversification if returns from investment in different national stock markets are not perfectly correlated and the correlation structure is stable. This has led economists and finance specialists to investigate the interdependencies among international share price indexes in some considerable detail. Previous empirical studies of the interrelationship of the major world stock price indexes have not provided consistent results. The results vary, depending on the choice of markets, the sample period chosen, the frequency of observations (daily, weekly or monthly), and the different methodologies employed to investigate the interdependence of stock markets. Most research has concentrated on mature stock markets and there are comparatively few studies of interdependencies among emerging markets. Given the divergent conclusions of the researches in this field, further insights should be obtainable through an investigation of an alternative set of financial markets, in particular, a set of emerging markets. Emerging markets present a separate data source because of their low correlations with more developed markets

In recent years, globalization and information technology revolution has had a tremendous impact on the structure of financial markets with the quick diffusion of information and the substantial deregulation and harmonization which led to increasing free flow of capital across markets that has fostered integration (Gallo & Otrando, 2007). Another finding in the literature is that linkages are variable over time and generally major events (like 1973 and 1979 oil price shocks, 1987 stock market crash, 1991 Gulf) affect the linkages significantly.

In economics, BRIC is a grouping and acronym that refers to the countries of Brazil, Russia, India and China, which are all deemed to be at a similar stage of newly advanced economic development. It is typically rendered as "the BRIC countries" or the "Big Four". The acronym was coined by Goldman Sachs global economist Jim O'Neill, in a 2001 paper entitled "Building Better Global Economic BRICs". The acronym has come into widespread use as a symbol of the shift in global economic power away from the developed G7 economies towards the developing world.

There are several reasons why these countries' stock prices may have a significant long-run relationship. The presence of strong economic ties and policy coordination between the relevant countries can indirectly link their stock prices over time. With technological and financial innovation, the advancement of international finance and trade, and deliberate regional and global co-operation, the geographical divide among various national stock markets are less obvious (Gelos and Sahay,2000). The major financial markets crisis during the time frame of our study is the global financial crisis of 2008. This crisis had a major effect on global securities markets.

There are studies that concentrate on linkages among BRIC markets but none has attempted to study the effects of global crisis of 2008 on these inter-linkages. This has become the motivation of the study. In particular, we investigate the extent to which index returns are independent of one another and how this interdependence changes over the crisis period.

The organization of the rest of the paper is as follows: Section 2 presents the survey of the existing literature. Section 3 discusses the methodology and data used. The empirical results are presented in Section 4 and Section 5 provides a summary and conclusions of this study.

REVIEW OF LITERATURE

Numerous studies have examined the inter-linkages among the developed markets. In this paper, however, we shall not be presenting the detailed review of the researches undertaken to study the linkages between stock markets of the developed nations.

Agarwal (2000), with a correlation coefficient of 0.01 between India and developed markets, concluded that there is a lot of scope for the Indian stock market to integrate with the world market.

R. Masih and Masih (2001) investigated the dynamic causal linkages among nine major international stock price indexes using the vector error-correction modelling and level vector autoregressive models. The empirical results supported the significant interdependencies between the established OECD and the Asian markets, and also the leadership of the U.S. and U.K. markets over the short and long run.

Mishra (2002) investigated the international integration of India's domestic financial market with the U.S. stock market. By applying the ordinary least squares (OLS) method and cointegration technique, he found a positive correlation between NASDAQ and BSE. He concluded that BSE was influenced by the movements of NASDAQ. But there is no cointegrating vector between BSE and NASDAQ indexes, which shows that there is no long-run relationship between these two stock exchanges.

Besides, the study of Kumar and Mukhopadhyay (2002) examined the short-run dynamic linkages between NSE Nifty and NASDAQ Composite during the period 1999-2001. The study supported a unidirectional Granger causality running from the U.S. stock market to Indian stock market.

Nath and Verma (2003) studied the transmission of market movements among the three major stock markets in the Asian region, namely, India, Singapore, and Taiwan. The results proved that there was no long-term interrelationship, and thus, international investors could achieve long-term gains by investing in the stock markets because of the independencies of the stock markets.

By using the BSE-200 index, Wong, Agarwal, and Du (2005) found that the Indian stock market is integrated with the matured markets of the world.

Moreover, Hoque (2007) found the evidence that stock prices of Bangladesh, the United States, Japan, and India share a common stochastic trend.

Phylaktis and Ravazzolo (2007) examined stock market linkages of a group of Pacific-Basin countries with the United States and Japan by estimating the multivariate cointegration model over the period 1980-1998. Their results showed that the stock market integrations were found to be significant in the 1990s.

Li and Majerowska (2008) analyzed the linkages between the emerging stock markets in Warsaw and Budapest and the established markets in Frankfurt and the United States. They found that the emerging markets are weakly linked to the developed markets.

Menon, Subha, and Sagaran (2009) examined whether the stock markets in the Indian subcontinent have any link with the major stock markets in China, Singapore, America, and Hong Kong. They found that the Indian markets are cointegrated to some of the markets around the world.

Bastos and Caiado (2010) found the evidence of integration and interdependence between the stock market returns of 46 developed and emerging countries for the period 1995-2009. Similarly, Park (2010) found strong co-movement between Asian markets. Among those, the countries with more developed financial systems (i.e., Japan, Singapore, and Hong Kong in Asia) exhibited stronger linkages to the rest of the Asian markets.

Using the time-series data ranging from June 2, 2005, to April 2, 2008, Arouri and Nguyen (2010) established no significant association between stock exchange of Gulf countries and the world stock markets.

Subhani, Hasan, Mehar, and Osman (2011) identified the linkage of stock prices of Karachi Stock Exchange with the stock prices of Nepal and Bombay stock exchanges except Dhaka stock exchange.

Samitas and Kenourgios (2011) supported the existence of long-term relationship among Balkan stock markets and developed markets (the United States, the United Kingdom, Germany).

Besides, Sakthivel and Kamaiah (2012) attempted to investigate the dynamic interlinkages among the Asian, European, and U.S. stock markets for the period January 1998 to June 2010. They showed that the U.S. and some of the European and Asian stock markets lead the Indian stock market.

Horvath and Petrovski (2012) examined the international stock market comovements between Western Europe vis-à-vis Central (the Czech Republic, Hungary, and Poland) and South Eastern Europe (Croatia, Macedonia, and Serbia) and found that the degree of co-movements is much higher for Central Europe and the correlation of South Eastern European stock markets with developed markets is essentially zero.

Tripathi and Sethi (2012) examined the short-run and long-run interlinkages of the Indian stock market with those of advanced emerging markets, viz., Brazil, Hungary, Taiwan, Mexico, Poland, and South Africa over the period ranging from January 1, 1992, to December 31, 2009. They showed that the short-run and long-run interlinkages of the Indian stock market with other markets have increased over the study period.

NEED/IMPORTANCE OF THE STUDY

In a country like India where the stock market is undergoing significant transformation with liberalization measures, and the analysis of the nature of integration with other developed and emerging markets would not only give an idea of the possible gains to be reaped out of portfolio diversification from Indian market, but may also provide some indication of the vulnerability of the country's stock market in case of a regional financial crisis and consequent reversal of capital flows from the region. In this context the study examines the integration of the stock market among the BRIC (Brazil, Russia, India and China) economies.

STATEMENT OF THE PROBLEM

In the course of our study we try to answer the following questions for both pre- and post-crisis periods: are the BRIC markets interlinked? Which market appears to be the most influential in the region? How much of the movements in one stock market can be explained by innovations in other markets? How rapidly are the stock price movements in one market transmitted to other markets?

OBJECTIVES

The study aims to achieve the following objectives:
1. To study the return patterns in the equity markets of Brazil, Russia, India and China
2. To find out the linkages between the stock exchanges under study; and
3. To observe whether there exist enough opportunities for diversification among the stock exchanges of Brazil, Russia, India, China

RESEARCH METHODOLOGY

In attempting to answer the above questions, cointegration analysis, Granger causality tests are conducted to examine the co-movements among the pair-wise stock prices and returns. In addition, we also estimate vector-autoregressive models for both pre- and post-crisis periods to deal with the endogeneity problem. Given the wide popularity of these techniques, we refrain from rehashing the algebra of this methodology.

The time series used in this study are daily stock market indexes at closing time, in terms of local currencies. The secondary data is sourced from Bloomberg. The representative stock indexes are taken for all the 4 BRIC markets: Bovespa Brasil Sao Paulo Stock Exchange Index (Brazil), Russian Trading System Standard Index (Russia), National Stock Exchange CNX Nifty Index (India), Shanghai Stock Exchange Composite Index (China) for a period beginning on 1st January 2007 through 31st Decemebr2012 is considered the reference period. In this way, data of total 60 months are taken for the purpose of the study. Out of the time for which data is taken, we find that on few days, one or two of the exchanges were open while other(s) was (were) closed. We took the data for all the days on which all the three stock exchanges were open. Data have been analysed using econometric tools.

To examine the stability of the results we conduct analysis for the whole sample period (January 2007–December 2012) and for two sub-periods based on the dates of major financial crises. The sub-sample periods are January 2007 to October 2008 (prior to the global financial crisis); and from September 2008 to December 2012 (post the crisis). The partitioning of the period is done on the basis of the structural break test. Both chow breakpoint test and Quandt-Andrews unknown breakpoint test were conducted on the stock return series of all the 4 markets.

To test for a unit root (or the difference stationary process), we employ both the augmented Dickey–Fuller (ADF) test (Dickey and Fuller, 1979) and the Phillips–Perron (P–P) test (1988).

In order to make the series stationary, we take the log of the four series and arrive at the daily return of the two series. All the remaining analysis is performed at the daily return (log of the series) of the four exchanges. We name these variables as RBrazil, RRussia, RIndia, RChina. At the stationary log series of the four stock exchanges, we perform the Granger's causality model in order to observe whether the return at each stock exchange granger causes the return at the stock exchanges. The null hypothesis is that x does not Granger-cause y in the first regression and that y does not Granger-cause x in the second regression. Cointegration analysis is used to investigate long term relationship between the stock markets of BRIC economies.

The popular time series technique of VAR is due to the seminal work of Sim (1980). It is used to study the dynamic interrelations between n different variables. Many studies of stock markets have used VAR models to study inter-linkages. The analysis of variance decomposition reveal how much variance of market i is determined by the innovations of market j in the period.

To determine the appropriate lag length, we use Akaike's Information Criterion (AIC). In our case, the optimum lag length has been found out to be 8 for the full sample period, 9 for the pre-crisis period and 2 for the post crisis period.

RESULTS & DISCUSSION

The benefit of international diversification is limited when national equity markets are cointegrated because the presence of common factors limits the amount of independent variation. If two or more variables are cointegrated, then stationary linear combinations of the variables may exist even though the variables themselves are individually non-stationary. Thus, variables that are cointegrated exhibit stable long run relations. In the short run, financial time series across countries may deviate from each other, but investors' tastes and preferences, market forces and government regulations will bring them back to their equilibrium. A lack of cointegration suggests that such variables have no long-run link and variables can wander arbitrarily far away from each other. Cointegration among national equity markets implies that there are fewer assets available to investors than a simple count of the number. The theory of cointegration has been used to examine equity markets in different countries.

The stock index is an I (1) process and the series can be modeled by co-integration analysis. Johansen co-integration test is applied. The trace test and the maximal eigenvalues test indicate that the null hypothesis (no co-integration) is not rejected

The evidence suggests there is no cointegration in very recent stock price data. Thus, an analysis of the long-run co-movement of national stock prices with that of overseas stock prices and the short-run temporal relationship between the two is important for managing an international portfolio.

In the absence of long - run relationships between the stock prices of India and its major trading partners, the Granger causality test is used to examine the pair - wise short - run interactions between BRIC stock markets.

The structural break identified using chow breakpoint test and Quandt-Andrews unknown breakpoint test is tabulated for all the 4 markets.

TABLE 1

Country	Breakpoint Date
Brazil	(10/28/2008)
China	(10/28/2008)
India	(10/28/2008)
Russia	(10/27/2008)

TABLE 2

Null Hypothesis	P value (Full Sample Period)	P value (Pre crisis period)	P value(Post crisis period)
RCHINA does not Granger Cause RBRAZIL	0.385300	0.8112	0.1094
RBRAZIL does not Granger Cause RCHINA	0.000000*	0.0016*	0.0000*
RINDIA does not Granger Cause RBRAZIL	0.011300**	0.0973***	0.0004*
RBRAZIL does not Granger Cause RINDIA	0.000000*	0.0000*	0.0000*
RRUSSIA does not Granger Cause RBRAZIL	0.000400*	0.0000*	0.0137**
RBRAZIL does not Granger Cause RRUSSIA	0.000000*	0.0000*	0.0000*
RINDIA does not Granger Cause RCHINA	0.000200*	0.0163**	0.2605
RCHINA does not Granger Cause RINDIA	0.001300*	0.1324	0.0761***
RRUSSIA does not Granger Cause RCHINA	0.000300*	0.3914	0.0304**
RCHINA does not Granger Cause RRUSSIA	0.157700	0.5156	0.2362
RRUSSIA does not Granger Cause RINDIA	0.000006*	0.0000*	0.0132**
RINDIA does not Granger Cause RRUSSIA	0.000000*	0.1105	0.0000*

***, ** and * mean significant at 10, 5 and 1%, respectively.

Results of Granger causality test indicates that there exists bidirectional Granger causality between India and Brazil, and Russia and Brazil for the full sample period and in both the pre-crisis and post crisis period. Also Brazil granger causes China in the full sample period and in both the pre-crisis and post crisis period. Unidirectional causality is running from Russia to India in the pre-crisis period. Bidirectional causality exists between Russia and India, and Russia and China only in post crisis period. Bidirectional Granger causality exists between India and China throughout the study period, but pre crisis India granger caused China and post crisis China granger causes India. Unidirectional causality is running from Russia to India and Brazil to china in the pre-crisis period.

VAR ANALYSIS

The tables in the appendix shows the result of VAR, IRF analysis.

In all cases the biggest shocks to each market come from its own innovations.

Specifically shocks to Brazil market come from its own innovations, followed by the shocks from India and Russia on the next day. Most of the transmission is completed within 5 days. In the pre-crisis period Russia has a stronger impact on Brazil which completely disappears post crisis when India impacts the Brazil market with a lag of 1 day.

The China stock market, before the crisis, is affected by India and Brazil and its own effect is only visible by the 8th day. The other markets do not seem to have much effect on it. After the crisis, we notice that the shock in Brazil is the only effect on China market. The effects of other markets disappear after the crisis. Therefore throughout the study period results suggests that only Brazil and India are the market affecting China.

In case of both Russia and India, the markets are affected by the shocks in all the other markets with the effect getting absorbed in a weeks' time.

During the pre-crisis India shows no effect on its own innovations and post crisis the shocks in Russia have zero effect on India. Similarly china has no effect on Russia pre crisis but post crisis the shocks in china shows impact with a lag of 1 day.

VARIANCE DECOMPOSITION ANALYSIS (2007-2012)

In the case of Brazil stock exchange table decomposes the variance of returns and reveals that by and large, the return at the exchange is composed by the previous days' levels/returns. Indian stock exchange and RTS shows a visible impact on Brazil stock exchange. In the case of China stock exchange table shows that the return at the China Stock Exchange is composed by the exchange itself for the periods 1 to 10. And the Brazil stock exchange show a large impact on the China stock exchange Indian stock exchange shows a visible impact on China stock exchange. In the case of Indian stock exchange table shows that the return at the Indian Stock Exchange is composed by the exchange itself for the periods 1 to 10. And the Brazil stock exchange also put the large impact on the Indian stock exchange, on the other hand the China stock exchange and RTS show a visible impact on Indian stock exchange. In case of Russian stock exchange table shows that the return at the Russian Stock Exchange is influenced by the return at the Russian exchange in the periods 1 to 10. China Stock exchange and Indian stock exchange leaves a visible impact on the RTS and the Brazil stock exchange also put the large impact on the Russian stock exchange.

PRE CRISIS PERIOD

In the case of Brazil stock exchange table decomposes the variance of returns at and reveals that by and large, the return at the exchange is composed by the previous days' levels/returns at the same. RTS shows a large impact on Brazil stock exchange. China stock exchange and Indian stock exchange show a visible impact on Brazil stock exchange.In the case of China stock exchange table shows that the return at the China Stock Exchange is composed by the exchange itself for the periods 1 to 10. And the Brazil stock exchange also show the large impact on the China stock exchange. Indian stock exchange also shows a visible impact on China stock exchange. In the case of Indian stock exchange table shows that the return at the Indian Stock Exchange is composed by the exchange itself for the periods 1 to 10. And the Brazil stock exchange also put the large impact on the Indian stock exchange, on the other hand the China stock exchange and RTS also show a visible impact on Indian stock exchange. In case of Russian stock exchange table shows that the return at the Russian Stock Exchange is influenced by the return at the Russian exchange in the periods 1 to 10. China Stock exchange and Indian stock exchange leaves a visible impact on the RTS and the Brazil stock exchange also put the large impact on the Russian stock exchange

POST CRISIS PERIOD

In the case of Brazil stock exchange table decomposes the variance of returns and reveals that by and large, the return at the exchange is composed by the previous days' levels/returns**.** Indian stock exchange shows a visible impact on Brazil stock exchange. In the case of China stock exchange table shows that the return at the China Stock Exchange is composed by the exchange itself for the periods 1 to 10. And the Brazil stock exchange also show the visible impact on the China stock exchange None of the remaining two exchanges seem to have any visible impact on the China Stock Exchange for any of the periods. In the case of Indian stock exchange table shows that the return at the Indian Stock Exchange is composed by the exchange itself for the periods 1 to 10. And the Brazil stock exchange also put the large impact on the Indian stock exchange, on the other hand the China stock exchange also shows a visible impact on Indian stock exchange. In case of Russian stock exchange table shows that the return at the Russian Stock Exchange is influenced by the return at the Russian exchange in the periods 1 to 10. China Stock exchange and Indian stock exchange leaves a visible impact on the RTS and the Brazil stock exchange also put the large impact on the Russian stock exchange

Overall the crisis has impact the dynamics in which the BRIC markets affect each other in terms of the direction and magnitude also.

RECOMMENDATIONS/SUGGESTIONS

This study examines the long - run and short - run relationships between the stock prices of BRIC (BRAZIL, RUSSIA, INDIA and CHINA), using daily data for the period April 2000 to March 2010. Based on the cointegration results, no evidence of long - run relationships was found between the stock price indices of BRIC partners before and after the financial crisis except Brazil. After the global financial crisis period there was no cointegration between India and Brazil. The policy implication of this finding for international investors is quite straightforward: in the long run, there are potential gains which can be leveraged by astute investors through portfolio diversification across BRIC markets.

Second, in terms of short - run movements of BRIC stock market returns, there is bidirectional Granger causality exists between India and Brazil, and India and China for the full sample period and the pre-crisis period but not in the post crisis period. Unidirectional causality is running from Russia to India in the pre-crisis period. Bidirectional relationship exists between India and Brazil and India and China throughout the study period. But the degree of causality was very high in the post crisis period. The empirical results presented in this paper support the view that international investors have long-run opportunities for portfolio diversification by acquiring stocks from these BRIC countries. However, in the short-run the scope of these opportunities is rather limited due to global financial crisis which are inherent to stock markets as evidenced by the causality test results.

Thus, these findings may be of interest to portfolio managers, private and institutional investors as well as funds that are active in emerging markets. The current study contributes to the literature in numerous ways. First, this is the study concentrating on the stock markets of BRIC and studies the linkages within these rather than with the developed world. Secondly, it uses a combination of the various methods used empirically to analyze the data.

CONCLUSIONS

In this paper, the inter-linkages among daily returns in 4 BRIC markets are examined for pre- and post-crisis periods separately, by using Granger causality tests, cointegration and VAR models. It is found that BRIC markets are closely linked with one another.

Here, there is no statistical support for cointegration and so there is no evidence of a single underlying equilibrium relationship. This result implies investors can diversify their portfolios by buying stocks in these 4 countries.

Our results add to the literature on dependencies in stock market indexes across national markets. While developed markets have received a lot of attention, research on emerging stock markets is relatively scant. The very different business environments of developing economies, combined with the lack of consensus in prior research, implies the results from studies on developed markets cannot be automatically extrapolated to emerging markets. We choose BRIC economies as the focus of our study because of its rapid economic growth and its opening up as a market for foreign investors.

Our findings have important implications for international portfolio management. Solnik (1974), Eun and Resnick (1984) and Errunza (1983) recommend that stock portfolios be diversified internationally to reduce systematic local risk.

The subprime crisis, October 2008 do not have a dramatic impact on the statistical dependencies across BRIC markets. There is no statistical support for co-integration and so there is no evidence of a single underlying equilibrium relationship, hence investors can benefit from diversifying their portfolios by buying stocks in the BRIC countries. Results indicate that for all the markets and in all the periods, a large proportion of the stock market index variance is explained by Brazil stock exchange. Russian stock exchange (RTS) shows more linkages than the other three stock exchanges as per the results.

SCOPE FOR FURTHER RESEARCH

The study can be extended further and the effect of Eurozone debt crisis can be analysed too. The number of markets studied can be increased to also include the other emerging markets of South Africa, Indonesia and South Korea (BRIICKS)

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APPENDIX

VAR IRF (2007 -2012)

RBRAZIL = 0.0003-0.0795*RBRAZIL(-1) -0.1054*RBRAZIL(-2)-0.1072*RBRAZIL(-3)-0.0142*RBRAZIL(-4)-0.0412*RBRAZIL(-5)-0.0242*RBRAZIL(-6)-0.0681*RBRAZIL(-7)+0.0060*RBRAZIL(-8)+0.0125*RCHINA (-1)-0.0113*RCHINA (-2)+ 0.0106*RCHINA (-3) +-0.0256*RCHINA (-4) +-0.0377*RCHINA (-5) +-0.0229*RCHINA (-6) +0.0244*RCHINA (-7) +-0.0486*RCHINA (-8) +0.0944*RINDIA (-1) +0.0490*RINDIA (-2) +-0.0062*RINDIA (-3) +0.0044*RINDIA (-4) +0.0701*RINDIA (-5) +-0.0392*RINDIA (-6) +-0.0184*RINDIA (-7) +0.0528*RINDIA (-8) +0.0557*RRUSSIA(-1) +0.0322*RRUSSIA(-2) +0.0220*RRUSSIA(-3) +0.0470*RRUSSIA(-4) +-0.0761*RRUSSIA(-5) +-0.0031*RRUSSIA(-6) +0.0481*RRUSSIA(-7) +-0.0147*RRUSSIA(-8)

RCHINA = **0.1782*RBRAZIL(-1)**-0.0385*RBRAZIL(-2)-0.0248*RBRAZIL(-3)**+0.0807*RBRAZIL(-4)**+0.0158* RBRAZIL(-5) +0.0548* RBRAZIL(-6)+0.0290* RBRAZIL(-7)+0.0182* RBRAZIL(-8)-**0.0606*RCHINA (-1)**+0.0043*RCHINA (-2)+0.0502*RCHINA (-3)+0.0251*RCHINA (-4)-0.0269* RCHINA (-6)-0.0467* RCHINA (-7)-**0.0023* RCHINA (-8)**-0.0711*RINDIA (-1) +0.0368*RINDIA (-2)-0.0004*RINDIA (-3)-0.0307*RINDIA (-4)-0.0151*RINDIA (-5)+0.0537* RINDIA (-6)-0.0305* RINDIA (-7) **+0.0247* RINDIA (-8)**+0.1024*RRUSSIA(-1)+0.0170*RRUSSIA(-2)+0.0177*RRUSSIA(-3)-0.0346*RRUSSIA(-4) +0.0054*RRUSSIA(-5)-0.0083 RRUSSIA(-6) +0.0065 RRUSSIA(-7)+0.0261 RRUSSIA(-7)-0.0228 RRUSSIA(-8)-0.0003

RINDIA = 0.0002**+0.2327*RBRAZIL(-1)**+0.0581*RBRAZIL(-2)**+0.0654* RBRAZIL(-3)**+0.0403*RBRAZIL(-4) +0.0138*RBRAZIL(-5)**+0.0696*RBRAZIL(-6)**-0.0116*RBRAZIL(-7)+0.0418*RBRAZIL(-8)-**0.0844*RCHINA (-1)**-0.0029*RCHINA (-2)**+0.0577*RCHINA (-3)-0.0659*RCHINA (-4)-0.0647*RCHINA (-5)**-0.0010*RCHINA (-6) +0.0331*RCHINA (-7) +0.0024*RCHINA(-8) **-0.0647*RINDIA (-1)**-0.0589*RINDIA (-2)-0.0816*RINDIA (-3) +0.0133*RINDIA (-4) +0.0111*RINDIA (-5)-**0.0824*RINDIA (-6)**-0.0291*RINDIA (-7)+0.0060*RINDIA (-8)-0.0030*RRUSSIA(-1)**+0.0516*RRUSSIA(-2)**-0.0212*RRUSSIA(-3)+0.0282*RRUSSIA(-4)-0.0164*RRUSSIA(-5)-0.0152*RRUSSIA(-6)**+0.0654*RRUSSIA(-7)**+0.0006*RRUSSIA(-8)

RRUSSIA = -0.0004 **+0.3337* RBRAZIL(-1)**+0.0297*RBRAZIL(-2)-0.0194*RBRAZIL(-3) **+0.1451*RBRAZIL(-4)** **+0.1579*RBRAZIL(-5)**+0.0798*RBRAZIL(-6)-0.0109*RBRAZIL(-7) **+0.1480*RBRAZIL(-8)-0.1360*RCHINA (-1)** +0.0221*RCHINA (-2)+0.0379*RCHINA (-3) -0.0298*RCHINA (-4) **-0.1249*RCHINA (-5)**+0.0266*RCHINA (-6) +0.0121*RCHINA (-7)-0.0057*RCHINA (-8)**+0.1463*RINDIA (-1)+0.1143*RINDIA (-2)-0.1095*RINDIA (-3)**-0.0614*RINDIA (-4)+0.0476*RINDIA (-5)-0.0471*RINDIA (-6)-0.0168*RINDIA (-7)**+0.1290*RINDIA (-8)-0.1035*RRUSSIA(-1)**-0.0586*RRUSSIA(-2)-0.0497*RRUSSIA(-3)-0.0537*RRUSSIA(-4)-**0.0777*RRUSSIA(-5)-0.1116*RRUSSIA(-6)**+0.0477*RRUSSIA(-7)-**0.1473*RRUSSIA(-8)**

VAR IRF (Pre-crisis period)

RBRAZIL = -0.0164*RBRAZIL(-1) - **0.233*RBRAZIL(-2) - 0.147*RBRAZIL(-3)** + 0.059*RBRAZIL(-4)- 0.0308*RBRAZIL(-5)+0.0042*RBRAZIL(-6) - 0.0941*RBRAZIL(-7) - **0.201*RBRAZIL(-8) - 0.1749*RBRAZIL(-9)** + 0.0287*RCHINA(-1) + 0.0177*RCHINA(-2) - 0.0193*RCHINA(-3) -0.0618*RCHINA(-4) - 0.032*RCHINA(-5) - 0.0266*RCHINA(-6) - 0.0187*RCHINA(-7) - 0.038*RCHINA(-8) + 6.8626-05*RCHINA(-9) + 0.0352*RINDIA(-1) + 0.117*RINDIA(-2) - 0.0122*RINDIA(-3) + 0.0796*RINDIA(-4) + 0.0817*RINDIA(-5) - 0.0461*RINDIA(-6) + 0.055*RINDIA(-7) + 0.092*RINDIA(-8) - 0.0091*RINDIA(-9) + 0.0636*RRUSSIA(-1) **+ 0.139*RRUSSIA(-2)** + 0.0049*RRUSSIA(-3) **+ 0.122*RRUSSIA(-4)** - 0.0786*RRUSSIA(-5) - **0.136*RRUSSIA(-6) + 0.176*RRUSSIA(-7) + 0.126*RRUSSIA(-8)** + 0.103*RRUSSIA(-9) + 0.00019

RCHINA = **0.2047*RBRAZIL(-1) - 0.1547*RBRAZIL(-2)** + 0.0090*RBRAZIL(-3) + 0.1044*RBRAZIL(-4) + 0.0537*RBRAZIL(-5) + 0.129*RBRAZIL(-6) + 0.0725*RBRAZIL(-7) + 0.0226*RBRAZIL(-8) + 0.0131*RBRAZIL(-9) - 0.0637*RCHINA(-1) + 0.00139*RCHINA(-2) + 0.0653*RCHINA(-3) + 0.0769*RCHINA(-4) - 0.0354*RCHINA(-5) - 0.04659*RCHINA(-6) - 0.01745*RCHINA(-7) - **0.1219*RCHINA(-8)** - 0.01454*RCHINA(-9) + 0.1303*RINDIA(-1) + 0.0274*RINDIA(-2) - 0.1338*RINDIA(-3) - 0.0485*RINDIA(-4) + 0.0563*RINDIA(-5) - 0.07049*RINDIA(-6) + 0.08229*RINDIA(-7) **+ 0.1755*RINDIA(-8)** - 0.0804*RINDIA(-9) + 0.0280*RRUSSIA(-1) + 0.0288*RRUSSIA(-2) - 0.04344*RRUSSIA(-3) + 0.0556*RRUSSIA(-4) - 0.08235*RRUSSIA(-5) + 0.00077*RRUSSIA(-6) - 0.0084*RRUSSIA(-7) - 0.104*RRUSSIA(-8) + 0.0180*RRUSSIA(-9) - 0.001173

RINDIA = **0.3195*RBRAZIL(-1)** - 0.0309*RBRAZIL(-2) + 0.176*RBRAZIL(-3) **+ 0.0584*RBRAZIL(-4) + 0.0578*RBRAZIL(-5)** + 0.108*RBRAZIL(-6) + 0.0666*RBRAZIL(-7) - 0.0199*RBRAZIL(-8) - 0.0648*RBRAZIL(-9) - 0.0775*RCHINA(-1) - 0.00136*RCHINA(-2) + 0.0267*RCHINA(-3) - 0.04588*RCHINA(-4) - **0.089*RCHINA(-5)** - 0.00064*RCHINA(-6) + 0.0230*RCHINA(-7) + 0.0388*RCHINA(-8) - 0.0162*RCHINA(-9) - 0.0158*RINDIA(-1) + 0.0548*RINDIA(-2) - 0.0937*RINDIA(-3) - 0.0416*RINDIA(-4) + 0.0623*RINDIA(-5) - 0.0339*RINDIA(-6) + 0.0262*RINDIA(-7) - 0.0717*RINDIA(-8) - 0.0223*RINDIA(-9) - 0.010*RRUSSIA(-1) + 0.037*RRUSSIA(-2) - **0.112*RRUSSIA(-3) + 0.1179*RRUSSIA(-4)** - 0.0804*RRUSSIA(-5) - **0.115*RRUSSIA(-6) + 0.133*RRUSSIA(-7)** + 0.065*RRUSSIA(-8) + 0.0757*RRUSSIA(-9) - 0.0007

RRUSSIA = **0.4115*RBRAZIL(-1)** - 0.0521*RBRAZIL(-2) - 0.0997*RBRAZIL(-3) **+ 0.2499*RBRAZIL(-4) + 0.2818*RBRAZIL(-5)** + 0.0862*RBRAZIL(-6) + 0.0211*RBRAZIL(-7) + 0.0013*RBRAZIL(-8) - 0.1415*RBRAZIL(-9) - 0.0903*RCHINA(-1) + 0.0443*RCHINA(-2) + 0.025*RCHINA(-3) - 0.09308*RCHINA(-4) - 0.1606*RCHINA(-5) + 0.03979*RCHINA(-6) + 0.00719*RCHINA(-7) - 0.00259*RCHINA(-8) + 0.05428*RCHINA(-9) + 0.0803*RINDIA(-1) + 0.131*RINDIA(-2) - 0.0584*RINDIA(-3) - 0.0358*RINDIA(-4) + 0.0605*RINDIA(-5) + 0.0054*RINDIA(-6) - 0.0215*RINDIA(-7) + 0.1235*RINDIA(-8) - **0.139*RINDIA(-9) - 0.189*RRUSSIA(-1)** + 0.1143*RRUSSIA(-2) - 0.0672*RRUSSIA(-3) - 0.0551*RRUSSIA(-4) - 0.0674*RRUSSIA(-5) - **0.2501*RRUSSIA(-6)** + 0.108*RRUSSIA(-7) **+ 0.128*RRUSSIA(-8) + 0.345*RRUSSIA(-9)** - 0.00253

VAR IRF (Post-crisis period)

BRAZILR = -0.1373*BRAZILR(-1) + 0.0003*BRAZILR(-2) + 0.0222*CHINAR(-1) -0.0387*CHINAR(-2) + 0.1308*INDIAR(-1) + 0.0386*INDIAR(-2)+ 0.0393*RUSSIAR(-1) -0.0395*RUSSIAR(-2) + 0.0004

CHINAR = 0.1930*BRAZILR(-1) + 0.0102*BRAZILR(-2) -0.0444*CHINAR(-1) + 0.0093*CHINAR(-2) -0.0383*INDIAR(-1) -0.0576*INDIAR(-2) + 0.0106*RUSSIAR(-1) + 0.0057*RUSSIAR(-2) + 0.0002

INDIAR = 0.1980*BRAZILR(-1) + 0.1215*BRAZILR(-2) -0.1094*CHINAR(-1) +0.0029*CHINAR(-2)-0.0527*INDIAR(-1) -0.1092*INDIAR(-2) + -0.0183*RUSSIAR(-1) + 0.0331*RUSSIAR(-2) + 0.0007

RUSSIAR = 0.2061*BRAZILR(-1) + 0.0317*BRAZILR(-2)-0.1280*CHINAR(-1) + 0.0128*CHINAR(-2) + 0.1642*INDIAR(-1) + 0.1286*INDIAR(-2) -0.0850*RUSSIAR(-1) -0.1390*RUSSIAR(-2) + 0.0007

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