# Impact of us Stock Market and Oil Price on Bric Stock Markets and their Interdependency

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## ABSTRACT

Globalization leads financial market of one country to become more integrated with other countries. In this environment the knowledge of dependency between the stock market helps the investors and portfolio managers for international investment and diversification. This paper investigates the linkage among BRIC market indices, i.e. Brazil, Russia, India and China, and their relation with US market and oil price. Restricted Vector Auto Regression (VAR) model is employed to gauge the interdependencies among the selected stock market and the short-term relationship is tested with the help of Granger causality test by using the daily data from 2nd January 1998 to 30th September 2014. Based on the result of Final prediction error (FPE) and Akaike information criterion (AIC) six lag lengths is selected as the optimal lag for the VAR model. The results of VAR model indicate that the return of Brazil, Russia and India having co-movement with US market and oil price. However, China does not exhibit the co-movement with US stock market but it does with oil price. Brazil market causes more other market than is caused by them, China and Russia Granger-cause each other. However, to the lesser extent, India Granger-cause China and Russian market. Us market has high significant positive influence than the oil price on Brazil, Russia and India. On the other hand, Oil price has significantly positive influence on China where as US market not influences the Chinese market.

## Introduction

Globalization of trade and economy has opened the door for discussion about the integration between the different economy and financial markets. More specifically, the integration between stock markets becomes the center of the discussion in the international investment and diversification. Moreover, the knowledge of stock market interdependence helps the global investors to protect from regional financial crisis. However, the rapid growth of modern communications and technology integrate the financial market and resulted in more cross - border capital flows. In this ground the emerging market firms rethink their operations and prefer cross - listing in international exchanges to attract

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the capital with low cost and more liquidity for their shares. Hence, the globalization and integration of stock market with one another is widely studied by both economist and academician. Moreover, as a leading economy of the world, to what extent the US market influence the emerging market also widely attempted by academician.

Login & Solnik (1995) found the evidence of significant linkages between stock markets around the world by using cross-country correlations. Chen, Firth, and Rui, (2002) tested the interdependency between the Latin American countries by employ the error correction VAR model using the daily return for the period from 1995-200. They concluded that the diversification among Latin American market is very limited. Mukherjee (2011) found that the US market has positive influence on the Indian market due to feel good factor generated by increased return in developed market. China registered the negative influence due to activities of international investors.

In the modern days crude oil is considered as lubricant for the smooth running of any economy. Hence, the shocks in oil price have wider influence on performance of the stock markets. In the year 1998, crude oil price decreased to a significant level and stood at USD 10 per barrel. And, immediately it starts to increase from the next year and sky rocketed from 2003 till touch the record height of USD 145 per barrel in July 2008. However, due to global financial turmoil it again plummeted to the ground and priced as USD 34 per barrel in February 2009. Once again it bounced in the year 2010 and slowly reached USD 110 per barrel in August 2013. In this background, Basher & Sadorsky (2006) pointed out that emerging economies tend to be more energy intensive than more advanced economies and are more exposed to higher oil prices. Consequently, oil price changes are likely to have a greater impact on profits and stock prices in emerging economies. Hence, there are lot of studies already examined the impact of oil price shock in various stock market.

In the new millennium, a group formed by Brazil, Russia, India and China, BRIC, catch the attention of investors and academia due to relatively large size middle-income emerging market economies and their significant contribution to the world economic development. Ono (2011) examined the impact of oil prices on Brazil, China, India and Russia over 1999:1-2009:9 using VAR models and found real stock returns positively respond to some of the oil price indicators with statistical significance for China, India and Russia, those of Brazil do not show any significant responses. Carrieri, Errunza and Hogan (2007) found that majority of the emerging stock markets are partially integrated with developed market but the degree of integration is time varying. Though there exists a literature on the relationship between oil prices and stock prices and the relationship between developed market and emerging stock market, the relationship between these two streams has, however, not been that closely studied, especially within the context of emerging economy stock markets. Hence, spontaneously this study considered to analyze the integrations between BRIC and combined impact of US stock market and oil price on BRIC stock markets.

## Data And Methodology

The daily closing values of the stock indices of Brazil (BOVSPA), Russia (RTSI), India (SENSEX), China (SHCOMP) and United States of America (S&P 500) was collected from yahoo finance for the

period from 2nd January 1998 to 30th September 2014, consisting of 3737 observations. The return was calculated by taking the natural logarithm of the first difference of the indices. The name of the respective country is used to refer the market return series where the trading takes place. Moreover, it is also assumed that the investor hedging the currency risk. The oil price information was collected from the US Energy information administration data base.

The existing literature revealed that the oil price has influence on the US stock market [Jones (1996), Sadorsky (1999), Ciner (2001), Park and Ratti (2008) and Malik and Ewing (2009)]. Hence, to capture the impact of oil price on US stock market, the following regression equation was first employed.

$$R_{ust} = \alpha + \beta Oil_t + \varepsilon_t \qquad (1)$$

Where, $R_{ust}$ is the return of US stock market on the day t. $\alpha$ is the specific return of the US stockmarket, $\beta$ is the impact of oil price changes on US stock market, $Oil_t$ is the natural logarithm of the first difference of oil price on the day t and $\varepsilon_t$ is the error term in the model. From the result of equation (1), the residual (i.e. $\varepsilon_t$) and the specific return of US market (i.e. $\alpha$) is added to get thenew series after removing the impact of oil price in US stock market. Then after VAR Model wasemployed to test the impact of oil price, USA market return and lagged return of BRIC nation on thecurrent return of each BRIC countries separately.

The simple VAR model is simultaneous equation model where the current value of the dependent variable is depends on different combination of both lagged endogenous and exogenous variable. However, from the earlier literature it was observed that BRIC countries' market returns have nothing to influence the US market return and Oil price changes. Hence, in this study, the restricted VAR model is employed to test the spillover between BRIC nations and the combined impact of US market and oil price in BRIC nations. Hence, the model is specified as,

$$r_{it} = \alpha_i + \beta_{us} r_{us} + \beta_{op} Oil_t + \sum_{j=1}^{p} \sum_{k=1}^{4} r_{t-j,k}\, \beta_{j,k} + \varepsilon_{it} \qquad (2)$$

Where, $r_{it}$ is the return of country *i* in the time t, $\beta_{us}$ is the beta coefficient of the US market return, $r_{us}$ is the return of S&P 500 index, $\beta_{op}$ is the beta coefficient of logarithmic change in oil price, k indicate the BRIC countries (k= 1, 2, 3 and 4) and j denote the number of lag (i.e. j= 1,….6) included in the model, $r_{t-j,k}$ is the lagged return of BRIC countries, $\beta_{j,k}$ is the coefficient of the respective BRIC countries and $\varepsilon_{it}$ is the error term of the model.

However, to apply the equation (2) the data should be a stationary one. Hence, to test the stationary of the data, Augmented Dickey – Fuller (ADF) test and Phillips-Perron (PP) tests were employed.

Moreover, the VAR lag order selection criterion is adopted to select the optimum lag length. Finally, the Granger causality test also performed to measure the causality between the markets.

## Results And Discussion

The descriptive statistics for the return of the selected countries is presented in Table 1. From the result it is observed that the Russian market shows the highest variability followed this Oil price registered the next highest variability. However, the Brazil market registered the highest average return during the same period. On the other hand, lowest variability was observed in USA market. The

high level of Kurtosis and the negative Skewness of all the case, except Brazil, indicate that the return has long tail to the left. Moreover, Jarque-Bera test rejects the null hypothesis that return of the selected country during the period is normally distributed.

**Table 1: Descriptive Statistical for BRIC and US stock return and Oil Price**

| | Brazil | Russia | India | China | USA | OIL |
|---|---|---|---|---|---|---|
| **Mean** | 0.000447 | 0.000279 | 0.000533 | 0.000186 | 0.000190 | 0.000437 |
| **Maximum** | 0.288325 | 0.202039 | 0.159900 | 0.094008 | 0.104083 | 0.220521 |
| **Minimum** | -0.172082 | -0.336698 | -0.171840 | -0.127636 | -0.094695 | -0.176818 |
| **Std. Dev.** | 0.021489 | 0.027341 | 0.017371 | 0.016476 | 0.013043 | 0.026305 |
| **Skewness** | 0.409915 | -0.750552 | -0.395504 | -0.090706 | -0.303096 | -0.016681 |
| **Kurtosis** | 16.79347 | 15.48927 | 11.41468 | 8.106663 | 8.985881 | 9.928015 |
| **Jarque-Bera** | 29721.72 | 24631.93 | 11119.65 | 4064.599 | 5634.860 | 7471.767 |
| **Probability** | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| **Observations** | 3736 | 3736 | 3736 | 3736 | 3736 | 3736 |

**Table 2: Pair wise Correlation between the BRIC, USA and Change in Oil price**

| | BRAZIL | RUSSIA | INDIA | CHINA | USA | OIL |
|---|---|---|---|---|---|---|
| **BRAZIL** | 1 | | | | | |
| **RUSSIA** | 0.327 | 1 | | | | |
| **INDIA** | 0.222 | 0.327 | 1 | | | |
| **CHINA** | 0.102 | 0.109 | 0.165 | 1 | | |
| **USA** | 0.593 | 0.295 | 0.198 | 0.029 | 1 | |
| **OIL** | 0.163 | 0.173 | 0.105 | 0.068 | 0.000 | 1 |

From the Table 2 it is observed that the correlation between the selected countries and the oil price change is positive. The highest correlation observed between USA and Brazil which is similar to the Bora et al (2009). On the other hand, China registered the lowest correlation with USA and Oil price. India has highest correlation with Russia as its natural friend, followed with USA. BRIC countries positive correlation with themselves and with the USA and Oil price indicate the co-movement of the BRIC's stock market with the oil price and USA stocks.

**Table 3: The Unit Root Test Results**

| | ADF Test | | PP test | |
|---|---|---|---|---|
| | T- Statistics | Prob. | T- Statistics | Prob. |
| **BRASIL** | -45.07 | 0.0001 | -60.03 | 0.0001 |
| **RUSIA** | -54.88 | 0.0001 | -54.87 | 0.0001 |
| **INDIA** | -59.78 | 0.0001 | -59.76 | 0.0001 |
| **CHINA** | -60.82 | 0.0001 | -60.85 | 0.0001 |
| **USA** | -66.32 | 0.0001 | -66.69 | 0.0001 |
| **OIL** | -63.05 | 0.0001 | -63.34 | 0.0001 |

Table 3 exhibit the result of Augmented Dickey Fuller (ADF) test and Phillips-Perron (PP) test. ADF and PP test were employed on first difference of the selected countries return series to test the null hypothesis that the data series has unit root. The p- value for all the data including the first difference of oil price is less than 0.01 ($p<0.01$). Hence the null hypothesis were rejected and concluded that the data were stationary at first difference.

**Table 4: VAR Lag Order Selection Criteria**

| Lag | LR | FPE | AIC | SC | HQ |
|---|---|---|---|---|---|
| 0 | NA | 1.31e-14 | -20.61211 | -20.59208 | -20.60499 |
| 1 | 305.8028 | 1.22e-14 | -20.68571 | -20.63897* | -20.66909* |
| 2 | 33.58882 | 1.22e-14 | -20.68617 | -20.61271 | -20.66004 |
| 3 | 41.49549 | 1.22e-14 | -20.68876 | -20.58859 | -20.65313 |
| 4 | 37.68934 | 1.21e-14 | -20.69034 | -20.56346 | -20.64520 |
| 5 | 36.21888 | 1.21e-14 | -20.69153 | -20.53794 | -20.63689 |
| 6 | 33.53389 | 1.21e-14* | -20.69201* | -20.51171 | -20.62787 |
| 7 | 29.25930* | 1.21e-14 | -20.69134 | -20.48433 | -20.61769 |
| 8 | 4.678773 | 1.22e-14 | -20.68402 | -20.45030 | -20.60088 |

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

VAR lag order selection criterion helped to determine the optimum lag length for the model. The results of the various lag order criteria up to 8 lag is presented in Table 5. For the given data Schwarz information criterion and Hannan-Quinn information criterion select the VAR (1), i.e. first order, as optimal. Conversely, Final prediction error (FPE) and Akaike information criterion (AIC) selects the VAR (6), i.e. six lag length, as the optimal for the model. Brooks (2008) clearly pointed out that the SC is strongly consistent but inefficient and AIC is not consistent but generally more efficient and hence he concluded as no criterion is definitely superior to others. Therefore, lag length is chosen based on AIC and FPE model which suggest adopting six lags for the data.

Table 5 exhibits the results of restricted VAR model. From the result it is observed that the oil price return significantly influence BRIC countries' stock returns. Though India and China are net oil importers and Brazil and Russia are net oil exporter the change in oil price positively influence the BRIC countries. The increasing in oil price may depreciate net oil importers' home currency against US dollar (i.e. China and India). Depreciation of home currency may attract more foreign investors into the country and at the same time domestic investors also not prefer to take their money out to invest in other countries. Hence, large flow of money into the domestic equity market from the foreign as well as domestic investors leads to increasing demand for stocks. Hence, increasing oil price might

influence the Indian and Chinese market positively. If the oil price decreases China's Yuan and India's Rupee will appreciate. This may give the good opportunity to the foreign investors to take their money from these market and the domestic investors also prefer to diversify globally. This may lead to fall in India's and China's stock market. On the other hand, Russia is a net exporter of oil and hence oil price positively influence the Russian equity returns. Brazil meets its oil demand through local production and ethanol and it become the net oil exporter since 2006. As the oil price increase it will positively influence export revenue. Hence, changes in oil price significantly positively influence the Brazil stock market return.

**Table 5: VAR Estimation Result**

| | BRASIL | RUSIA | INDIA | CHINA |
|---|---|---|---|---|
| BRASIL(-1) | 0.038912 | 0.260628 | 0.154412 | 0.057757 |
| | [ 2.75604]* | [ 12.6132]* | [ 11.3008]* | [ 4.29830]* |
| BRASIL(-2) | -0.038927 | -0.007041 | 0.036438 | -0.019885 |
| | [-2.68865]* | [-0.33228] | [ 2.60055]* | [-1.44314] |
| BRASIL(-3) | -0.016473 | 0.016449 | 0.042049 | -0.002468 |
| | [-1.13614] | [ 0.77520] | [ 2.99674]* | [-0.17883] |
| BRASIL(-4) | -0.024116 | 0.028533 | 0.010749 | 0.011985 |
| | [-1.66530] | [ 1.34629] | [ 0.76700] | [ 0.86959] |
| BRASIL(-5) | -0.021453 | 0.039200 | 0.021298 | 0.010467 |
| | [-1.48421] | [ 1.85313] | [ 1.52259] | [ 0.76088] |
| BRASIL(-6) | -0.026924 | 0.011388 | 0.017959 | 0.021989 |
| | [-1.86643] | [ 0.53942] | [ 1.28643] | [ 1.60171] |
| RUSIA(-1) | 0.017131 | 0.054339 | 0.010555 | 0.018008 |
| | [ 1.48261] | [ 3.21341]* | [ 0.94392] | [ 1.63756] |
| RUSIA(-2) | -0.000768 | -0.003966 | -0.008836 | -0.007959 |
| | [-0.06643] | [-0.23439] | [-0.78964] | [-0.72325] |
| RUSIA(-3) | 0.017477 | 0.017750 | 0.005160 | 0.007221 |
| | [ 1.51516] | [ 1.05148] | [ 0.46225] | [ 0.65782] |
| RUSIA(-4) | -0.009291 | 0.006683 | 0.005745 | 0.024782 |
| | [-0.80610] | [ 0.39617] | [ 0.51508] | [ 2.25924]* |
| RUSIA(-5) | 0.026587 | -0.002912 | -0.011637 | 0.002386 |
| | [ 2.30571]* | [-0.17256] | [-1.04283] | [ 0.21747] |
| RUSIA(-6) | 0.007215 | -0.003404 | 0.019322 | -0.019528 |
| | [ 0.63458] | [-0.20455] | [ 1.75594] | [-1.80456] |
| INDIA(-1) | 0.040191 | 0.011259 | -0.017104 | 0.034559 |
| | [ 2.27775]* | [ 0.43601] | [-1.00162] | [ 2.05796]* |
| INDIA(-2) | -0.027591 | -0.016538 | -0.039071 | 0.006851 |
| | [-1.56426] | [-0.64067] | [-2.28888] | [ 0.40811] |
| INDIA(-3) | 0.003432 | 0.023836 | -0.031332 | 0.008468 |
| | [ 0.19481] | [ 0.92462] | [-1.83800] | [ 0.50513] |
| INDIA(-4) | 0.007755 | -0.065061 | 0.043466 | -0.013232 |
| | [ 0.44053] | [-2.52525]* | [ 2.55128]* | [-0.78978] |

| | | | | |
|---|---|---|---|---|
| INDIA(-5) | 0.008585 | -0.042970 | -0.051988 | 0.013813 |
| | [ 0.48732] | [-1.66662] | [-3.04928] | [ 0.82384] |
| INDIA(-6) | 0.032460 | 0.002767 | -0.016116 | 0.036914 |
| | [ 1.85475]* | [ 0.10804] | [-0.95153] | [ 2.21624]* |
| CHINA(-1) | -0.022135 | -0.079008 | -0.039178 | -0.012500 |
| | [-1.26733] | [-3.09091]* | [-2.31784]* | [-0.75201] |
| CHINA(-2) | 0.021830 | 0.079137 | 0.016578 | 0.005602 |
| | [ 1.24973] | [ 3.09557]* | [ 0.98065] | [ 0.33698] |
| CHINA(-3) | -0.028298 | 0.027005 | -0.016256 | 0.052043 |
| | [-1.61844] | [ 1.05534] | [-0.96069] | [ 3.12744]* |
| CHINA(-4) | 0.024303 | 0.031265 | 0.010472 | -0.000850 |
| | [ 1.39089] | [ 1.22266] | [ 0.61932] | [-0.05112] |
| CHINA(-5) | 0.008352 | -0.065649 | -0.008678 | -0.037408 |
| | [ 0.47799] | [-2.56737]* | [-0.51320] | [-2.24962]* |
| CHINA(-6) | 0.033276 | 0.019140 | -0.026096 | -0.028105 |
| | [ 1.90699] | [ 0.74946] | [-1.54529] | [-1.69234] |
| C | 0.000240 | -2.09E-05 | 0.000401 | 6.28E-05 |
| | [ 0.85248] | [-0.05071] | [ 1.47015] | [ 0.23413] |
| S_P_500 | 0.960003 | 0.607750 | 0.269674 | 0.033057 |
| | [ 43.6826]* | [ 18.8959]* | [ 12.6796]* | [ 1.58047] |
| OIL | 0.055928 | 0.125692 | 0.044650 | 0.036982 |
| | [ 5.15622]* | [ 7.91797]* | [ 4.25353]* | [ 3.58250]* |
| Adj. R-squared | 0.361516 | 0.156720 | 0.087506 | 0.019726 |
| F-statistic | 82.20748 | 27.65458 | 14.75391 | 3.886160 |
| Note: t-statistics in [ ], * indicate the significance at 5 %. | | | | |

USA stock market return significantly positively influence the Brazil, Russia and India whereas it does not significantly influence the Chinese market as there is a restriction on free movement of capital in China. Morales (2011) found the evidence of weak integration of Chinese financial markets with the U.S. stock market. On the other hand, Brazilian, Indian and Russian markets are more sensitive to international shocks arisen from U.S. markets and also to oil market instability. This result also consistent with the earlier studies and conclude that the Chinese market does not influenced by the US market.

Moreover, one lagged return of Brazil positively significantly influences not only its return but also other BRIC nations. This clearly evidenced that the Brazil stock market is the most influential market among BRIC nations. However, one lagged return of Indian market influence the Chinese market and Brazil market whereas it does not significantly influence on its own return. Russian stock returns not influenced any market but its own lagged return positively influenced itself.

China's one lagged return shows negatively significant influence on Indian and Russian markets. These negatively significant coefficients indicate that the Indian and Russian markets offer hedging opportunity for the international investors in the Chinese market. On the other hand, one lagged return of Indian market significantly positively influence the Chinese market return and Brazil market which states that there is no hedging opportunities for the global investors in Brazil and China against the Indian market.

**Table 6: p-values of Granger causality test for BRIC Countries returns**

| | | Independent | | | |
|---|---|---|---|---|---|
| | | Brazil | Russia | India | China |
| Dependent | Brazil | | 0.094 | 0.084 | 0.079 |
| | Russia | 0.000 | | 0.1044 | 0.001 |
| | India | 0.000 | 0.439 | | 0.121 |
| | China | 0.000 | 0.058 | 0.095 | |
| | All | 0.006 | 0.000 | 0.000 | 0.000 |

Granger causality test were employed to test the causality between the return of two countries. If the lagged return of one country (independent variable) does not helps to predict another country return (dependent), it will conclude that the independent country return does not Granger Cause the dependent country return. Table 6 presents the results of Granger causality test. From the result it is observed that the Brazilian one lagged return significantly influence all other countries return but it does not influenced by any other BRIC countries return. China granger causes the Russian return and not vice versa. However, jointly BRIC countries granger cause BRIC countries return. This result also confirms the restricted VAR model.

## Conclusion

The main aim of this study is to examine the linkage of stock market among the BRIC nations and their relationship with oil price and US stock market. The restricted VAR model is employed with six lags to identify the interdependence among BRIC nation stock returns. Granger Causality tests also employed to test causality between Brazil, Russia, India and China. The result revels that Brazil, Russia and India were influenced by the US stock market whereas Chinese market were independent from the US influence. However, oil price positively influence the BRIC nations. Moreover, the past return of Brazil significantly influences the other BRIC countries and itself. On the other hand, the past return of Russia influence itself and not influence the Indian and Chinese return. This clearly indicates the opportunity for international diversification from Russia to India and China. This is also confirmed by insignificant coefficient between past return of India and Russia and negatively significant coefficient between past return of China and Russia. Indian market returns were significantly negatively influenced by the past return of Chinese market. This shows there is an availability of diversification between Indian market and Chinese market for risk reduction.

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