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Oil Price Shocks and Stock Markets in BRICs[1]

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Abstract

This paper examines the impact of oil prices on real stock returns for Brazil, China, India and Russia over 1999:1-2009:9 using VAR models. The results suggest that whereas 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. In addition, statistically significant asymmetric effects of oil price increases and decreases are observed in India. The analysis of variance decomposition shows that the contribution of oil price shocks to volatility in real stock returns is relatively large and statistically significant for China and Russia.

JEL classification: G12; O57; Q43

Keywords: Oil price shocks; Real stock returns; BRICs

1. Introduction

The year 1998 witnessed a serious decrease of crude oil prices, and futures prices of New York Mercantile Exchange light sweet crude oil fell to about USD10 per barrel. Oil prices, however, began to increase from the beginning of 1999 and their rise accelerated after 2003, hitting a record high of USD145 per barrel in July 2008. Because of the global financial turmoil in late 2008, oil prices plummeted to USD34 per barrel in February 2009, which have recently started to rise again. This situation has reinvigorated the debate on the effect of oil prices on the economy.

Many studies have examined the influence of oil prices on the macroeconomy, stimulated especially by dramatic crude oil price increases because of unstable economic and political situations in the Middle East. Rasche and Tatom (1981) examined the impact of sharp increases in the price of energy on output in the U.S., Canada, France, Germany, Japan, and the U.K. Bruno and Sachs (1982) reported on relations between input price shocks and economic deceleration in the U.K. Darby (1982) conducted tests of significance in real income equations of oil-price variables for the U.S., the U.K., Canada, France, Germany, Italy, Japan, and the Netherlands. Hamilton (1983) analyzed the influence of the oil price increase on the U.S. output. Burbidge and Harrison (1984) discussed the impact of oil price increases on the price level and industrial output in the U.S., Japan, Germany, the U.K. and Canada. Gisser and Goodwin (1986) reported on relations between oil price increases and macroeconomic indicators of the U.S.

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While crude oil prices were over USD 30 per barrel at the beginning of the 1980s, they plunged to about USD 15 in 1986. Mork (1989) reported on the relationship between oil prices and GNP in the U.S. data, taking into account the large oil price decrease in 1986. He indicated that although Hamilton (1983) demonstrated a strong correlation between oil price increases and gross national product growth in U.S. data, the question of whether the correlation persists in periods of price decline remained unanswered. The empirical results of Mork (1989) suggest that the impact of the oil price increase and decreases on the U.S. output was asymmetric.

Recent studies regarding the analysis of the influence of oil price shocks on the macroeconomy include Brown and Yücel (2002), Jimenez-Rodriguez and Sanchez (2005), Cunado and Perez de Garcia (2005), Cologni and Manera (2008), and Kilian (2008). Brown and Yücel (2002) presented a survey of the theory and evidence on the relationship between economic activity and oil prices. Jimenez-Rodriguez and Sanchez (2005) revealed that the effects of an increase in oil prices on real GDP growth were different from those of an oil price decrease, using data of G-7 countries, Norway and the Euro area as a whole. Cunado and Perez de Garcia (2005) indicated that oil prices have a significant effect on economic activity and price indices in six Asian countries, and found evidence of asymmetries in the oil prices-macroeconomy relationship for some countries. Cologni and Manera (2008) analyzed G-7 countries and suggested that for all countries except Japan and the U.K. the null hypothesis of an influence of oil prices on the inflation rate could not be rejected. Kilian (2008) estimated the effects of exogenous shocks to global oil production on inflation and real output in G-7 countries, and claimed that an exogenous oil supply disruption typically causes a temporary reduction in real GDP growth.

All these articles have analyzed relations between oil price changes and macroeconomic indicators and clarified the influence on production levels. Yet they do not provide any information about the impact on stock prices, which are significant because stock prices reflect the expected earnings of companies and provide us with different aspects regarding the influence of oil price changes. There are few studies on the influence of oil price shocks upon stock markets. Jones and Kaul (1996) found that in the postwar period, the reaction of U.S. and Canadian stock prices to oil shocks could be explained by the impact of these shocks on real cash flows alone. The analysis of Sadorsky (1999) suggests that positive shocks to oil prices depress U.S. real stock returns while shocks to real stock returns had positive impacts on interest rates and industrial production. Conversely, Huang et al. (1996) argued that oil futures returns were not correlated with U.S. stock market returns. Ciner (2001) provides evidence that oil shocks affected U.S. stock index returns, applying nonlinear causality tests, and that the linkage between oil prices and the stock market was stronger in the 1990s. Park and Ratti (2008) revealed that oil price shocks had a statistically significant impact on real stock returns in the U.S. and 13 European countries while there was little evidence of asymmetric effects on real stock returns of positive and negative oil price shocks for oil importing European countries.

Although these studies determined the relations between oil prices and stock prices, they have featured only developed countries, and the situations in developing countries have not been discussed. This paper focuses on Brazil, China, India and Russia (BRICs), or leading emerging economies with rapid economic growth, which cover about 45% of the world population and have significant influence on the global economy. The analysis of this paper clarifies differences of the impact of oil price futures on stock markets or companies' expected earnings among BRICs. Furthermore, this article covers the period of unprecedented oil price increases from 1999 through mid-2008, providing information about the impact of oil price changes that is not discussed in former studies.

The outline of this paper is as follows. Section 2 describes the data sources for the analysis and methodological issues. Section 3 is a presentation of the empirical results. The last section presents the conclusions.

2. Data and Methodology

This study applies a multivariate vector autoregressive (VAR) model with monthly data of BRICs. The period analyzed in this paper is set from January 1999 through September 2010 because it aims to analyze the impact of dramatic oil price increases and following decreases on stock prices. In the analysis, three indicators are used as variables: oil prices, stock returns, and industrial production.

In accordance with former studies, linear and non-linear specifications of oil prices are used in the model. The value of linear specification of oil prices is calculated as the changes of real oil prices, or futures prices of New York Mercantile Exchange light sweet crude oil deflated by the U.S. Producer Price Index (this indicator is referred to as *OP*). Either the value denominated in U.S. dollars (see, e.g., Burbidge and Harrison, 1984) or in the national currency of each country (see, e.g., Abeysinghe, 2001) is used in this paper.

The two measures for the non-linear specifications are scaled oil price shocks described in Lee et al. (1995) and net oil price increases defined in Hamilton (1996). Considering that Lee et al. (1995) demonstrated that oil price volatility may have a significant impact on the real economy, this paper constructs the following GARCH (1,1) model.

$$\Delta OP_t = \alpha + \sum_{j=1}^{6} \beta_j \, \Delta OP_{t-j} + \varepsilon_t, \quad \varepsilon_t \big| I_{t-1} \sim N(0, h_t)$$
$$h_t = \gamma_0 + \gamma_1 \varepsilon_{t-1}^2 + \gamma_2 h_{t-1} \tag{1}$$
$$SOP_t = \hat{\varepsilon}_t \Big/ \sqrt{\hat{h}_t}$$

where ΔOP_t is the first log difference in real oil price, ε_t is an error term, I_{t-1} is the information set available at time $t-1$, and SOP_t is scaled oil price.

Hamilton (1996) introduced the indicator of net oil price increase (*NOPI*). If oil prices for the current quarter exceed the previous four quarters' maximum, the percentage change over the previous year's maximum is plotted. Otherwise, it takes the value of zero for time *t*. This paper specifies *NOPI* as follows:

$$NOPI_t = \max\left(0, OP_t - \max\left(OP_{t-1}, \cdots, OP_{t-6}\right)\right) \tag{2}$$

where OP_t is the log of level of real oil prices for time *t*.

The second variable used in the analysis is real stock returns, which are calculated as the difference between the continuously compounded return on the stock price index and the inflation rate specified by the log difference in the consumer price index. The variable is referred to as *RSR*.

Changes in industrial production are the third variable. This paper uses a log of the industrial production index, in which the same month of the pervious year is set to be 100 by the restriction of the data. The variable is referred to as *IP*.

In the analysis a VAR model is applied to evaluate the impact of oil price shocks on real stock returns. The VAR model of order *p* can be written as:

$$\mathbf{y}_t = \boldsymbol{\mu} + \sum_{j=1}^{p} \mathbf{A}_j \mathbf{y}_{t-j} + \boldsymbol{\varepsilon}_t \tag{3}$$

where $\mathbf{y}_t$ is a 3×1 vector of jointly determined variables, t is a linear time trend, consisting of indicators, $\boldsymbol{\mu}$ is a 3×1 vector of constants, $\mathbf{A}_j$ is a 3×1 matrix of coefficients to be estimated, and $\boldsymbol{\varepsilon}_t$ is a 3×1 vector of white noise error terms. Although Akaike's Information Criterion (AIC) as well as Schwarz's Bayesian Information Criterion (SBIC) indicate one lag is optimal in many cases, this paper sets the lag length to be six in order to clarify the effects of oil price changes in half a year.[3]

[3] These criteria are applied to determine how many lags should be used.

3. Empirical Results

3.1. Preliminary Research

This paper begins the analysis by testing the order of integration of the variables, using the augmented Dickey-Fuller unit root test (Dickey and Fuller, 1979). Table 1 shows that real oil prices for India and industrial production with constant and trend for Brazil cannot reject the null hypothesis of the existence of a unit root in their levels while they are stationary in their first differences. On the other hand, real stock returns can reject the null hypothesis of a unit root at the 1% level in all cases.

This paper further conducts the sequential minimal Dickey-Fuller test developed by Banerjee et al. (1992) that allows for a break in a deterministic trend in an unknown timing. As shown in Table 2, real oil prices for India and industrial production for Brazil cannot reject the null hypothesis of a unit root even with the allowance of a possible break in a linear trend.

Therefore, in first log differences, real oil prices for India and industrial production for Brazil, and, in log levels, real oil prices for Brazil, China and Russia, and industrial production for China, India and Russia, and real stock returns for all countries are $I(0)$ process.

Considering the above-mentioned results of unit root tests, this paper does not conduct cointegration tests and consequently, applies the vector autoregression (VAR) model for the analysis.

3.2. Impulse Responses

This section assesses the effects of oil price shocks on stock markets in terms of orthogonalized impulse response functions. The order of the variables to which a one standard deviation shock is given as follows: oil prices (world or national), *IP* and *RSR*.[4]

Figure 1 shows impulse responses of real stock returns to linear world oil price shocks for each country with 95% confidence bounds around each orthogonalized impulse response.

The linear world oil price shock had a statistically significant positive impact on the Indian and Russian real stock returns at the 5% and 1% levels in the same month, respectively, whereas it did not have a statistically significant impact on the real stock returns of Brazil and China. Furthermore, impulse responses of *NOPI* and *SOP* based on world oil prices were examined for each country (figures of these impulse responses are not presented to economize on space).

[4] The results could be different by the order of the variable to which a shock is given. In this paper, however, results with almost no difference were obtained.

Table 1 Augmented Dickey-Fuller unit root test

	Real oil prices (*OP*)			
	Level		**1st difference**	
	C	**C & T**	**C**	**C & T**
Brazil	-4.08 (0)***	-3.51 (0)***	-10.03 (0)***	-10.18 (0)***
China	-2.96 (1)**	-3.25 (1)*	-8.98 (0)***	-9.07 (0)***
India	-1.91 (1)	-2.74 (1)	-9.40 (0)***	-9.39 (0)***
Russia	-4.03 (1) ***	-3.91 (1) **	-9.39 (0)***	-9.43 (0) ***
World	-2.75 (1) *	-3.47 (1) **	-9.32 (0)***	-9.39 (0) ***
	Industrial production (*IP*)			
	Level		**1st difference**	
	C	**C & T**	**C**	**C & T**
Brazil	-2.77 (0)*	-2.76 (0)	-11.23 (0)***	-11.19 (0)***
China	-3.11 (2) **	-3.18 (2)*	-10.94 (2)***	-10.93 (2)***
India	-2.80 (1) *	-3.19 (1) *	-23.65 (0) ***	-23.58 (0) ***
Russia	-3.09 (0) **	-3.62 (0) **	-12.78 (0) ***	-12.75 (0) ***
	Real stock returns (*RSR*)			
	Level			
	C		**C & T**	
Brazil	-10.19 (0) ***		-10.15 (0) ***	
China	-6.37 (1) ***		-6.36 (1) ***	
India	-10.10 (0) ***		-10.10 (0) ***	
Russia	-8.05 (0) ***		-8.20 (1) ***	

*Notes: C: constant, T: trend. Figures in parentheses indicate lag length. Superscripts ***, ** and * denote rejection of the null hypothesis of the existence of a unit root at the 1%, 5% and 10% levels of significance, respectively.*

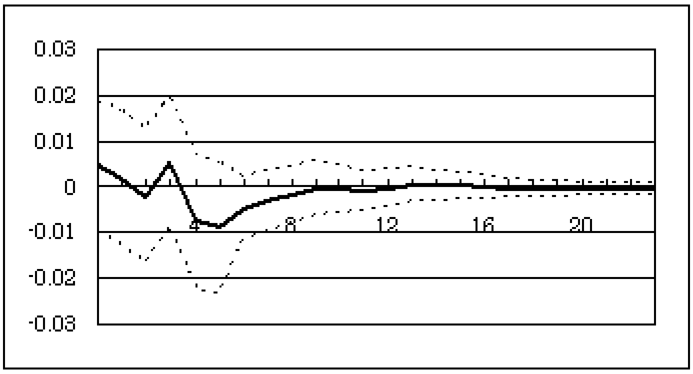
Table 2 Banerjee, Lumsdaine and Stock sequential minimal Dickey-Fuller test

	Real oil prices (*OP*) **Level**	**Industrial production (*IP*)** **Level**	**Real stock returns (*RSR*)** **Level**
Brazil	-5.53 (1) **	-2.96 (1)	-10.57 (1) **
China	-4.65 (1) **	-9.99 (1) **	-11.37 (1) **
India	-2.45 (1)	-8.20 (1) **	-10.42 (1) **
Russia	-4.62(1) **	-4.25 (1) *	-8.62 (1) **
World	-4.23 (1) *	–	–

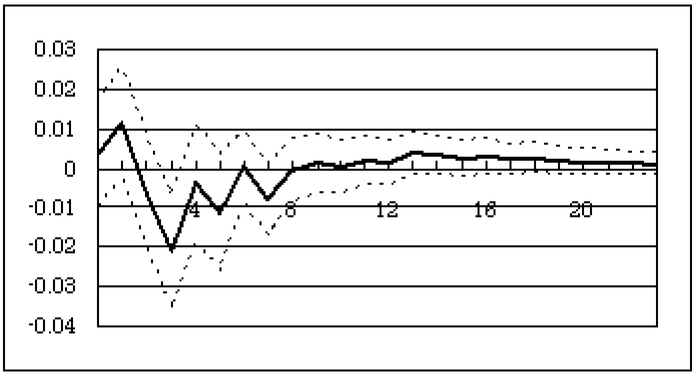
*Notes: Figures in parentheses indicate lag length. Superscripts ** and * denote rejection of the null hypothesis of the existence of a unit root at the 5% and 10% levels of significance, respectively.*

Figure 1. Orthogonalized impulse response functions of real stock returns to linear world oil price shocks in VAR

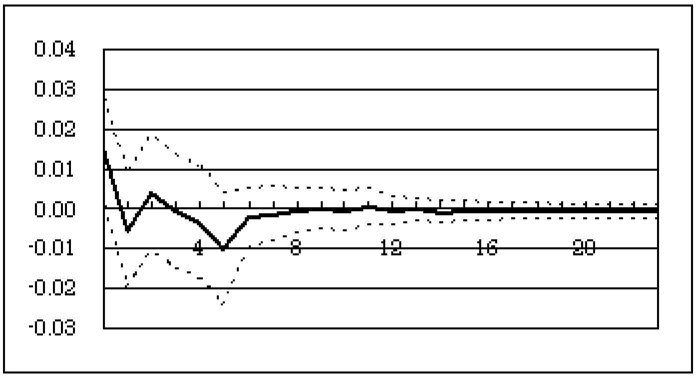
Brazil (*OP*, Δ*IP*, *RSR*)



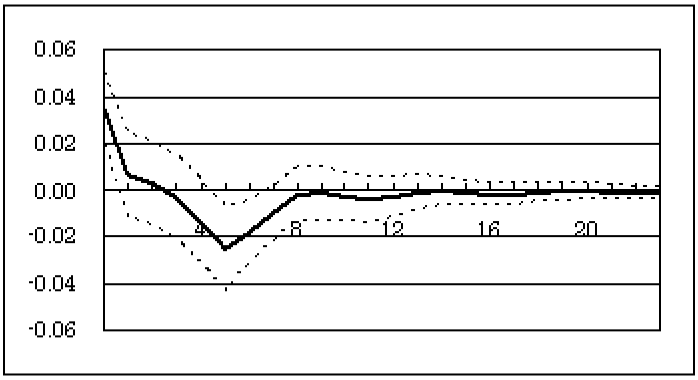
China (*OP*, *IP*, *RSR*)



India (*OP*, *IP*, *RSR*)



Russia (*OP*, *IP*, *RSR*)



Note: Δ is the first difference operator. OP – linear oil price; IP – industrial production; RSR – real stock returns.

Table 3 shows the results of the impulse response analysis examined with the data of *OP*, *NOPI* and *SOP*, in which statistically significant positive and negative impulse responses of real stock returns to world oil price shocks in the same month and/or with a one month lag are indicated. Whereas the Russian real stock returns positively responded to *OP, NOPI* and *SOP* with statistical significance, those of India demonstrated statistically significant positive responses to *OP* and those of China showed statistically significant positive responses to *SOP*. On the other hand, no statistically significant response was observed in the Brazilian real stock returns.

In addition, orthogonalized impulse response functions of real stock returns to national oil prices were examined. Figure 2 shows impulse responses of real stock returns to linear national oil price shocks for each country with 95% confidence bounds around each orthogonalized impulse response. A summary of the results of impulse responses of real stock returns to *OP*, *NOPI* and *SOP* based on national oil prices is presented in Table 4, in which statistically significant positive and negative impulse responses of real stock returns to national oil price shocks in the same month and/or with a one month lag are indicated. Whereas the Russian real stock returns positively responded to *OP, NOPI* and *SOP* with statistical significance, no statistically significant response was observed in the Brazilian, Chinese and Indian real stock returns.

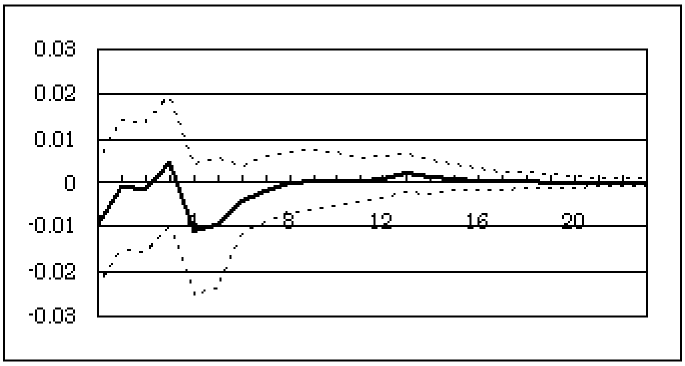
Table 3. Statistically significant impulse responses of real stock returns to world oil price shocks in the same month and/or with a one month lag

World real oil prices	Brazil	China	India	Russia
Response to *OP*			Posivie** 0.0145 (0.0068)	Positive*** 0.0355 (0.0078)
Response to *NOPI*				Positive** 0.0168 (0.0081)
Response to *SOP*		Positive* 0.0118 (0.0071)		Positive*** 0.0357 (0.0079)

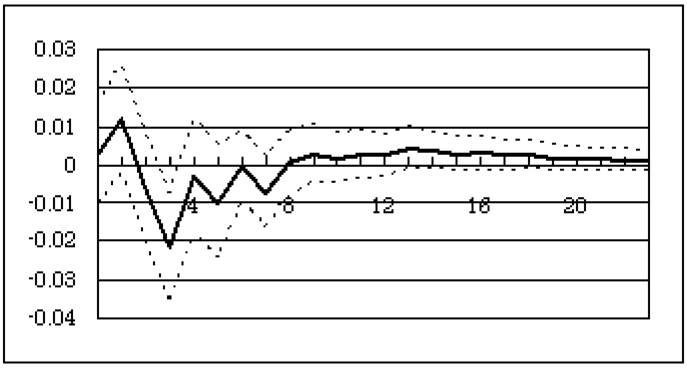
*Note: Positive (negative) indicates statistically significant positive (negative) impulse responses of real stock returns to oil price shocks in the same month and/or with a one month lag. Superscripts ***, ** and * denote statistical significance at the 1%, 5% and 10% levels, respectively. Figures in the middle row indicate the values of impulse responses. Figures in parentheses are standard errors.*

Figure 2. Orthogonalized impulse response functions of real stock returns to linear national oil price shocks in VAR

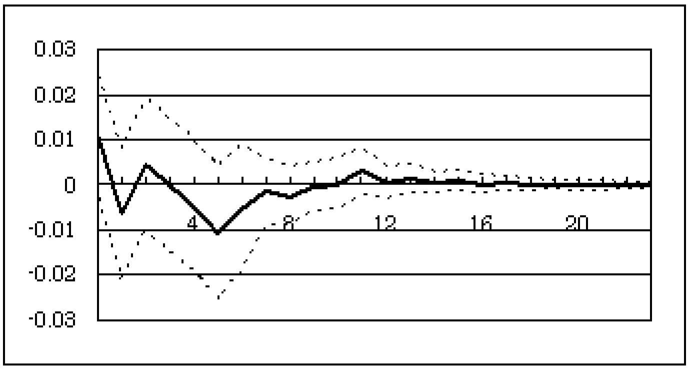
Brazil (*OP*, Δ*IP*, *RSR*)



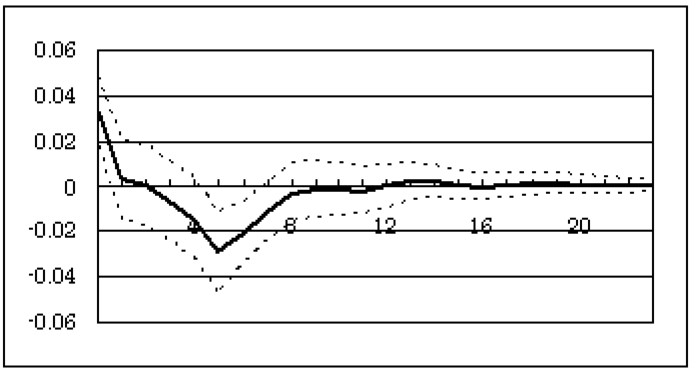
China (*OP*, *IP*, *RSR*)



India (Δ*OP*, *IP*, *RSR*)



Russia (*OP*, *IP*, *RSR*)



Note: Δ is the first difference operator. OP – linear oil price; IP – industrial production; RSR – real stock returns.

Table 4. Statistically significant impulse responses of real stock returns to national oil price shocks in the same month and/or with a one month lag

World real oil prices	Brazil	China	India	Russia
Response to *OP*				Positive*** 0.0333 (0.0077)
Response to *NOPI*				Positive** 0.0172 (0.0081)
Response to *SOP*				Positive*** 0.0342 (0.0077)

*Note: Positive (negative) indicates statistically significant positive (negative) impulse responses of real stock returns to oil price shocks in the same month and/or with a one month lag. Superscripts ***, ** and * denote statistical significance at the 1%, 5% and 10% levels, respectively. Figures in the middle row indicate the values of impulse responses. Figures in parentheses are standard errors.*

3.3. Spillover Effects from the New York Stock Market

The capitalization and volumes of operations in the New York stock market are predominant in the world stock markets. Therefore, the situations in the New York stock market could exert a considerable influence on the real stock returns of BRICs. In this context, real stock returns of the S&P 500, one of the major indices in the New York Stock Exchange, will be included in this paper's VAR specifications, following Park and Ratti (2008) (Henceforth, this indicator is referred to as *NY*). The order of the variables to which a one standard deviation shock is given is as follows: oil prices (world or national), *IP*, *NY* and *RSR*.

Table 5 presents a summary of statistically significant impulse responses of real stock returns to oil price shocks in the same month and/or with a one month lag in VAR models including the data of *NY*. Whereas Russia's real stock returns positively responded to *OP*, *NOPI* and *SOP* based on both world and national oil prices with statistical significance, those of India showed statistically significant positive responses to *OP* and negative responses to *SOP* or oil price volatility based on world oil prices. On the other hand, Brazil and China did not show any statistical significant responses of its real stock returns to oil prices.

Table 5. Statistically significant impulse responses of real stock returns to oil price shocks in the same month and/or with a one month lag

	Brazil	**China**	**India**	**Russia**
World real oil prices				
Response to *OP*			Positive** 0.0145 (0.00694)	Positive*** 0.0343 (0.00789)
Response to *NOPI*				Positive** 0.0171 (0.00828)
Response to *SOP*			Negative* -0.0121 (0.00692)	Positive*** 0.0346 (0.00801)
National real oil prices				
Response to *OP*				Positive*** 0.0321 (0.00787)
Response to *NOPI*				Positive** 0.0166 (0.00823)
Response to *SOP*				Positive*** 0.0329 (0.00786)

Note: Positive (negative) indicates statistically significant positive (negative) impulse responses of real stock returns to oil price shocks in the same month and/or with a one month lag. Superscripts ** and * denote statistical significance at the 1%, 5% and 10% levels, respectively. Figures in the middle row indicate the values of impulse responses. Figures in parentheses are standard errors.

3.4. Asymmetric Effects of Oil Price Shocks

Asymmetric relations between oil price shocks and macroeconomic indicators have been indicated in many articles, which claim that economic accelerating effects from oil price increases are larger than economic decelerating effects from oil price decreases (see, e.g., Mork, 1989; Mork et al., 1994; Lee et al., 1995; Hamilton, 1996; Hooker 1996; and Hooker 2002). As for the relations between oil price shocks and stock prices, Park and Ratti (2008) suggested that there was no evidence for asymmetric effects of oil price shocks on European stock returns, with the exception of Norway.

This paper examines the asymmetric effects of oil price shocks on real stock returns by including variables of oil price increases (*OPI*) and decreases (*OPD*) in the same equation. Specifically, *OPI* and *OPD* are defined as follows:

$$OPI_t = \max(0, OP_t), \text{ and } OPD_t = \min(0, OP_t) \quad (4)$$

Equation (5) is the specification of real stock returns with *OPI* and *OPD*. In addition, this paper also estimates real stock returns, taking into account spillover effects from the New York stock market, the specification of which is expressed in Equation (6).[5]

$$RSR_t = \alpha_0 + \sum_{k=1}^{6}\alpha_{1,k}OPI_{t-k} + \sum_{k=1}^{6}\alpha_{2,k}OPD_{t-k} + \sum_{k=1}^{6}\alpha_{3,k}IP_{t-k} + \sum_{k=1}^{6}\alpha_{4,k}RTR_{t-k} + u_t \quad (5)$$

$$RSR_t = \alpha_0 + \sum_{k=1}^{6}\alpha_{1,k}OPI_{t-k} + \sum_{k=1}^{6}\alpha_{2,k}OPD_{t-k} + \sum_{k=1}^{6}\alpha_{3,k}IP_{t-k} + \sum_{k=1}^{6}\alpha_{4,k}NY_{t-k} + \sum_{k=1}^{6}\alpha_{5,k}RTR_{t-k} + u_t \quad (6)$$

A conventional Chi-square test was conducted under the null hypothesis that the coefficients of *OPI* and *OPD* are equal to each other at each lag, that is, $\alpha_{1,k} = \alpha_{2,k}$, $(i = 1, \cdots, 6)$. According to the results reported in Table 6, while the null hypothesis of symmetric effects of oil price shocks could not be rejected for Brazil, China and Russia, the null hypothesis in both world and national real oil prices could be rejected for India.

[5] Although a simple Granger causality test does not show the causality from the New York Stock Market to stock markets in BRICs, it would be useful to analyze the difference between the model in which there is no spillover effects, and the model in which spillover effects are taken into account.

Table 6. Chi-square test results regarding asymmetric effects of oil price shocks

	Brazil	**China**	**India**	**Russia**
World real oil prices				
OP	10.10	7.33	14.83 **	8.51
OP with spillover effects	9.93	4.90	14.75 **	10.31
National real oil prices				
OP	10.33	6.63	15.55 **	8.23
OP with spillover effects	6.06	8.39	13.48 **	8.81

*Note: Superscripts ** and * denote statistical significance at the 5% and 10% levels, respectively.*

3.5. Variance Decomposition

Table 7 presents the variance decomposition of real stock returns due to real oil price shocks. Figures in the table indicate the percentage explained by oil price shocks among the unanticipated changes of real stock returns over a 24 month horizon. The variance decomposition of real stock returns was calculated for the shocks of *OP*, *NOPI* and *SOP* based on either world or national oil prices in VAR models including the variables of oil prices, *IP* and *RSR*. Furthermore, the spillover effects from the New York market were also taken into account for the analysis.

The contribution of oil price shocks to volatility in real stock returns exceeded 17% in 8 cases for Russia with statistical significance at the 1% level. For China, oil prices contributed to volatility in real stock returns with statistical significance in all cases, in which oil prices accounted for more than 10% of the volatility in real stock returns. Brazilian and Indian cases did not show any statistical significant contribution of oil prices to volatility in real stock returns.

According to the findings of Park and Ratti (2008), the contribution of oil prices to variability in real stock returns was statistically significant in most cases for the U.S. and European countries, ranging from 4 to 11% in statistically significant cases. For Norway, an major oil-exporting country, the value was about 6%, which is statistically significant at the 5% level. In this paper's analysis for Russia, the world's second largest oil exporter, the contribution of oil prices to variability of real stock returns varied from 17 to 24% in the statistically significant cases. In China's cases oil prices contributed to variability of stock returns from 10 to 15%.

Table 7. Variance decomposition of variance in real stock returns due to real oil price shocks (percentage, 24 month horizon)

	Brazil	China	India	Russia
World oil prices				
VAR (*OP*, *IP*, *RSR*)	3.00	10.99**	5.23	22.11***
VAR (*OP*, *IP*, *NY*, *RSR*)	2.72	11.30*	4.94	19.19***
VAR (*NOPI*, *IP*, *RSR*)	1.63	14.28**	5.27	6.16
VAR (*NOPI*, *IP*, *NY*, *RSR*)	1.40	14.51**	5.44	5.71
VAR (*SOP*, *IP*, *RSR*)	3.28	12.00**	5.20	20.35***
VAR (*SOP*, *IP*, *NY*, *RSR*)	2.71	12.31**	6.21	17.28***
National oil prices				
VAR (*OP*, *IP*, *RSR*)	4.47	11.25**	5.00	23.40***
VAR (*OP*, *IP*, *NY*, *RSR*)	4.99	11.59**	4.92	19.76***
VAR (*NOPI*, *IP*, *RSR*)	3.02	13.16**	6.37	6.50
VAR (*NOPI*, *IP*, *NY*, *RSR*)	4.34	12.75*	6.40	5.59
VAR (*SOP*, *IP*, *RSR*)	2.52	12.45**	5.35	23.53***
VAR (*SOP*, *IP*, *NY*, *RSR*)	2.71	12.96**	6.11	19.65***

*Note: Superscripts ***, ** and * denote statistical significance at the 1%, 5% and 10% levels, respectively.*

4. Conclusion

This paper analyzed the impacts of oil prices on real stock returns for BRICs on the basis of data from January 1999 through September 2010, using a VAR model. The results of the analysis suggest that real stock returns responded positively to some of the oil price indicators with statistical significance for China, India and Russia whereas no statistically significant response was observed in the Brazilian real stock returns. In cases in which spillover effects from the New York Stock Exchange were taken into account, Russia's real stock returns responded positively to *OP*, *NOPI* and *SOP* while those of India showed statistically significant positive responses to *OP* and negative responses to *SOP* based on world oil prices.

Furthermore, this paper examined the asymmetric effects of oil price shocks. In the analysis, statistically significant asymmetric effects were observed in all 4 cases for India. However, in the Brazilian, Chinese and Russian cases no asymmetric effects of oil prices were detected.

The following section analyzed the decomposition of variance in real stock returns due to real oil price shocks. For Russia, the contribution of oil price shocks to volatility in real stock returns was relatively large and statistically significant in 8 cases. For China, oil price shocks contributed to volatility in real stock returns with statistical significance in all 12 cases and the contribution of oil prices to volatility in real stock returns in China exceeded 10% in all cases. Brazilian and Indian cases did not show any statistical significant contribution of oil prices to volatility in real stock returns.

Appendix - Data Sources

The data used in this paper are from January 1999 through June 2008 for Brazil, China, India and Russia.

Nominal oil price: Futures prices of New York Mercantile Exchange light sweet crude oil at Cushing, Oklahoma, Contract 1 (near month). The data is available at the Energy Information Administration (official energy statistics from the U.S. government).

World real oil price: Nominal oil price deflated by the U.S. producer price index.

National real oil price: World real oil price denominated in each country's currency deflated by the consumer price index of each country.

U.S. producer price index: FRED. Producer price Indices All Commodities (PPIACO).

Exchange rate: IMF, International Financial Statistics, period average.

Consumer price index: Index rebased to 2005=100 by the Economist Intelligence Unit for each country.

Industrial production: Percentage change in industrial production over the same month of the previous year. The data was derived from the Economist Intelligence Unit.

Share prices: IBOVESPA for Brazil; Shanghai A-Share Share Price Index for China; BSE Sensex 30 Share Price Index for India; and RTS Index for Russia.

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