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IMPACT OF OIL PRICE ON ECONOMIC GROWTH: A STUDY OF BRIC NATIONS

Pushpa Negi
Assistant Professor
Symbiosis Law School (SLS), NOIDA, Symbiosis International University, Pune
Block A 47/48, Sector-62, Noida, UP

ABSTRACT

This paper employed an empirical analysis to examine the impacts of oil price on GDP of the four largest fast growing emerging economies Brazil, Russia, India and China known collectively as the BRIC countries using a sample of observations from 1987 to 2014. The first step in the empirical analysis involved testing the normality of time series. Then the Ordinary Least Square (OLS), Fixed Effect Model (FEM) And Random Effect Model (REM) were used to find out Impact of Oil Price on GDP. To choose between Fixed Effect Model and Random Effect Model the Hausman test was applied because it has an asymptotic chi-square distribution. The results of Hausman test indicated that, the Fixed Effect Model was the most appropriate model for the study therefore finally the dummy variables were used to estimate the Fixed Effect Model. The result shows that, overall the Oil Price has a positive relationship with GDP. The negative coefficient values of China (-3.284280) and India (-0.086646) shows that, Increase in Oil Price has a negative relationship with GDP and on the other side the Positive coefficient values of Russia and Brazil depict the positive impact of increased Oil Price on GDP.

Key Words: Oil Price, GDP, BRIC, Ordinary Least Square (OLS) Model, Fixed Effect Model (FEM), Random Effect Model (REM)

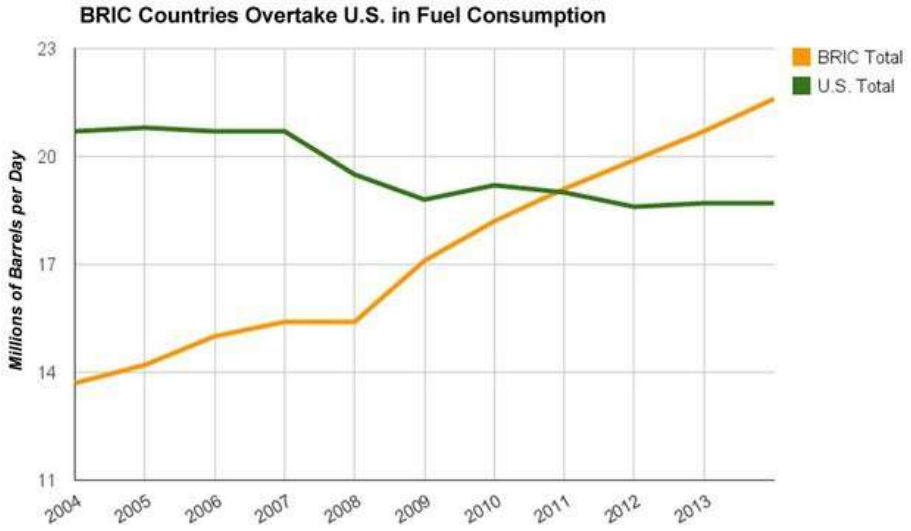
INTRODUCTION

Oil price affects the countries around the world differently. In general, low prices are considered good for importers of oil because it not only improves consumer spending but also improves the trade balance of a country. Therefore an increase in oil prices has a significant negative impact on the GDP growth in all oil importing countries. On the other side decrease in Oil Price is bad for oil exporters as it could put a depression in revenues of oil exporting countries where oil exports play an enormously important role in supporting economic growth and government finances. Moshiri &Banihashem (2012) concluded that, Many oil-exporting countries are heavily dependent on exports from oil revenues, so when oil prices are low, their economies suffer, and when oil prices are high, their economic activities boom. Some have suggested that oil price volatility, causes subdued economic performance in oil-exporting countries (Poelhekke and Ploeg, 2007).

From the middle of twentieth century onwards, crude oil has become one of the key indicators of economic activity worldwide, due to its outstanding importance in the supply of the world's energy demands (Ghalayini, 2011). For most developing countries oil accounts for a large proportion of gross domestic product expenditures in energy production (González & Nabiyev, 2009).Hence increases in energy prices lead to a considerable rise in production and transportation cost for many industries and hence drives wages and inflation upwards, which at the same time can dampen economic growth (O'Neill, Penm& Terrell,2008). A notable relation between energy prices and Gross Domestic Product (GDP) has been showed in different studies. Research conducted by Burbidge and Harrison (1984), Gisser and Goodwin (1986), and Bjørnland (2000) recommends that there is a significant effect of increasing oil price on economic activity. Therefore this paper breaks ground in the area by explicitly examining the impact of oil price on GDP of the four largest fast growing emerging economies Brazil, Russia, India and China known collectively as the BRIC countries which surpassed the U.S. in liquid-fuel consumption in 2011 and haven't looked back, according to data compiled by the Bloomberg Best (and Worst) Rankings (Figure-1).

As per the Los Angeles Research Group report (Figure-2), BRIC countries growth has been driven by each country's ability to change its political system and embrace capitalism. In addition, each nation contains vast natural resources and large populations. In total, the four BRIC countries encompass over 25% of the world's land coverage, contain about 40% of the world's population and account for about 17% of the world economy. Despite rapid growth, each BRIC country already accounts for a large portion of world GDP; China is the second largest economy in the world, while Brazil is the 7th, India is the 10th and Russia is the 11th.

Figure-1: Fuel Consumption of BRIC Countries



Source: World industrial reporter-BRIC Countries Overtake U.S. in Fuel Consumption, Released September 18, 2013

Figure-2: GDP Growth of BRIC Countries

Source: Los Angeles Research Group, 2015 (http://www.laresearchgroup.com/brazil-russia-india-china-bric-nations-gdp.html)

As per the U.S. Energy Information Administration (EIA) 2013, Brazil is the 8th largest total energy consumer and 10th largest producer in the world. India is the fourth-largest energy consumer in the world after China and it depends heavily on imported crude oil, mostly from the Middle East. Russia is the second-largest producer of dry natural gas and third-largest liquid fuels producer in the world. Despite its significant reserves of coal, it produces only modest amount of coal. Russia's economy is highly dependent on its hydrocarbons, and oil and gas revenues account for more than 50% of the federal budget revenues. Very limited studies have looked upon the oil price and the GDP. The objective of this study is to examine the impact of Oil Price on GDP of BRIC countries Brazil, Russia India and China during 1987 to 2014.

REVIEW OF LITERATURE

An emergent body of literature has provided evidence of empirical relationship between oil price and GDP. This feature has been emerged by a change in the pattern of oil price movements since the mid- 1980s. Hamilton (2009) and Ramey and Vine (2011), studied the importance of oil price increases for this economic slowdown. Kilian (2009) concluded that, oil price increases have very different effects on real economic activity depending on the underlying cause of the price increase. Jiménez-Rodríguez & Sanchez, (2004) empirically examined the effects of oil price shocks on the real economic activity of the main industrialized countries. They concluded that, oil price increases have an impact on GDP growth of a larger magnitude than that of oil price declines, with the latter being statistically insignificant in most cases. Further among oil importing countries, oil price increases were found to have a negative impact on economic activity in all cases.

Some of the literature suggested that external shocks affect growth and poverty in developing countries. A study conducted by Essama et al (2007) describes a macro-micro framework for examining the structural and distributional consequences of a significant external shock-an increase in the world price of oil-on the South African economy. The model provides changes in employment, wages, and prices that are used in the micro-simulation. The analysis finds that a 125 percent increase in the price of crude oil and refined petroleum reduces employment and GDP by approximately 2 percent, and reduces household consumption by approximately 7 percent. The oil price shock tends to increase the disparity between rich and poor. Christiano, Eichenbaum and Trabandt (2014) argue that the vast bulk of movements in aggregate real economic activity during the Great Recession were due to financial frictions interacting with the zero lower bound. Devarajan and Go (2003) simplified the CGE framework into aggregative distinction of tradable and non-tradable goods. They found that, Growth impact derived from either short-term vector auto regressive analysis (VAR) or long-term growth regression of various determinants. Heckman and Lochner (1998) constructed overlapping generation's general equilibrium model of labor earnings with heterogeneous agents in order to present both integration and dynamics the macro part.Ayadi, Chatterjee and Obi (2000) studied the effects of oil production shocks in Nigeria. A standard Vector Auto-Regression (VAR) process including oil production, oil exports, real exchange rate, money supply, net foreign assets, interest rate, inflation, and output is estimated over the 1975-1992 period. They found a positive effect after a positive oil production shock. Moreover, the impact response of output was less than one fifth of that of oil production, but the response of output after a year is slightly larger than that of oil production.

Esfahani, Mohaddes & Pesaran (2009) developed a long run growth model for a major oil exporting economy and derives conditions under which oil revenues were likely to have a lasting impact. The long run theory was tested using a new quarterly data set on the Iranian economy over the period 1979Q1-2006Q4. They found real output in the long run is shaped by oil exports through their impact on capital accumulation, and the foreign output as the main channel of technological transfer. The results also showed a significant negative long run association between inflation and real GDP, which was suggestive of economic inefficiencies. Sachs & Warner (1995) showed the existence of a negative relationship between real GDP growth per capita and divergent measures of resource abundance, such as the ratio of resource exports to GDP. Another study conducted by Muhammad (2012) intended to explore the correlation between the oil price variability and export earnings. The study highlighted that there is a significant correlation among the export earnings and macroeconomics variables such as GDP growth, standard of living, balance of trade, oil price variability and Broad money M2. The finding of the VECM exhibited disequilibrium which may be adjusted within half a year.

For oil exporting countries, a price increase directly increases real national income through higher export earnings and Oilprice collapsed leads to significant shortfalls in government revenues, rising unemployment, falling income and expenditure, potential economic

recession as well as increased risk of social instability for exporting countries. The researches of Mork (1989) showed that increase in oil price had a considerably negative effect on the growth of gross national product of the USA; while, the decrease in oil price was led to no increase in economic growth. Boroujerdian (2007) studied the asymmetric effects of oil price shocks on the economic growth of Iran for the period from 1959 to 2005 using the theories of economic growth and Mork oil price analysis. The results of this study show that oil income shocks have significant effects on the economic growth (excluding oil sector), while the effects of negative shocks are considerably more significant than that of positive shocks. In other words, production growth reacts strongly to the shocks reducing oil incomes. Semboja (1994) studies the effects of oil price changes for Kenya, which is a net importer of oil. For this purpose, he calibrated a static computable general equilibrium model to obtain the impact responses, rather than estimating a VAR process to generate the dynamic responses. The impact responses suggested that an increase in oil prices lead to an increase of the trade balance, a decrease of output and of the price index, and a deterioration of the terms of trade.

Nordhaus (1980) outlined some of the key avenues through which oil prices can constrain the economy – principally, by raising energy expenditure (when price elasticity of demand are low) which raises the price of goods produced and reduces goods consumed, thus, harming GDP, as well as harming the balance of payments (when oil is imported) and generating inflationary pressures. Kilian (2008) mentions four different transmission mechanisms through which an increase in energy prices might affect GDP. Finn (2000) found that an energy price shock can be considered as an adverse technology shock (in the Solow model), since it causes technological capital to produce below capacity levels. According his model, an increase in energy prices would cause GDP to decrease more than twice the amount as would be expected on behalf of the energy share in GDP.Cologni and Manera (2006) investigate the asymmetric effect of an oil shock on different phases of the business cycle for each of the G-7 countries; and find regime dependent models to better capture the output growth process

DATA AND METHODOLOGY

The dependent variable in this study (BRIC countries) is Log of GDP and the independent variable that is expected to impact on GDP is log of Oil Price. The oil prices were taken from the Energy Information Administration - EIA (Agency for Statistics and analytical analysis of the U.S. Department of Energy). The real GDP data were compiled from official website of UNCTAD (United Nations Conference on Trade and Development). All prices were denominated in American dollar. The data were from 1987 to 2014 with yearly frequency of 28 observations. The daily data were not used in order to avoid time difference problems with international markets. So there are four cross-sectional units and 28 time periods. In all there are 112 observations. Different types of panel data models are applied to above mentioned data. They include the Ordinary Least Square (OLS), the Fixed Effects Model, i.e. least squares dummy variable (LSDV) model and the Random Effects Model.

Based on the objective of the study the Simple Mathematical Equation of dependent and independent variable using log-linear model is as follows:

$$LGDP_{it} = \alpha + \beta LOilprice_{it} + €_{it}$$

Where, $LGDP_{it}$ is the log of Real Gross Domestic Product in US$ for country i at time t

$LOilprice_{it}$ is the log of Oil Price in US$ for country i at time t

DATA ANALYSIS TOOL

Ordinary Least Square (OLS),

The Ordinary Least Square (OLS), Fixed Effect Model (FEM) And Random Effect Model (REM) are used to find out Impact of Oil Price on GDP. In constant coefficient model all intercepts and coefficients are assumed to be same (i.e. there is neither significant country nor significant temporal effects), in this way space and time dimensions of the pooled data are ignored, data is pooled and an ordinary least squares (OLS) regression model is run (Akbar, Imdadullah, Aman & Aslam, (2011). In other words, by combining four countries through pooling, the heterogeneity or individuality that may exist among four countries is denied and it is also assumed that the coefficients (including the intercepts) are the same for all the individual countries.

$$LGDP\ it = \beta_1 + \beta_2 LOilprice_{it} + \ldots.. + €_{it}$$

Where i stands for the i^{th} cross-sectional unit and t for the t^{th} time period.

Fixed Effects Models

To take into account the individuality of each country/ cross-sectional unit, intercept is varied by using dummy variable for fixed effects. The Fixed Effect or LSDV Model allows for heterogeneity or individuality among four countries by allowing to have its own intercept invariant. The term fixed effect is due to the fact that although the intercept may differ across countries, but intercept does not vary over time, that is it is time invariant.

$$LGDP\ it = \alpha_1 + \alpha_2 D2_i + \alpha_2 D_{3i} + \alpha_3 D4_i + \beta 1\ LOilprice_{it} + €_{it}$$

Where D_{2i} =1 if the observation belongs to cross-section 1 (Brazil), 0 otherwise; $D3_i$ =1 if the observation belongs to cross-section 2 (Russia),0 otherwise; D_{4i} =1 if the observation belongs to cross-section 3 (India),0 otherwise. The dummy variable is not used for china however the á1 represents the intercept of China.

Random Effects Model

In the random effects model the intercept is assumed to be a random out come variable, whereas the random outcome is a function of a mean value plus a random error. This model is adequate if we want to draw inferences about the whole population, not only the examined sample. Two ways random effects model is used for estimation purpose.

$$LGDP_{it} = \beta_{1i} + \beta_2 LOilprice_{it} + €_{it}$$

Instead of treating β_{1i} as fixed, it is assumed to be a random variable with a mean value of $\beta 1$ and the intercept for an individual company can be expressed as;

$$\beta_{1i} = \beta_1 + €_i \; I=1,2\ldots\ldots,N$$

Where $€_i$ is a random error with a mean value of zero and variance of $\sigma^2_€$. Therefore

$$LGDP_{it} = \beta_1 + \beta_2 LOilprice_{it} + €_{it} + \mu_{it}$$

Where $€_{it}$ is Within-country error and μ_{it} is Between-country error

Model Specification Test

To decide between fixed or random effects we can run Hausman test, Breusch-Pagan test, Bhargarva and Sargan Test where the null hypothesis is that the preferred model is random effects vs. the alternative the fixed effects. It basically tests whether the unique errors (ui) are correlated with the regressor, the null hypothesis is they are not. In the current study Hausman test is used.

RESULT AND DISCUSSION

Descriptive Statistics

Table-1 reports results of descriptive statistics for GDP and Oil Price variables. The Jarque-Beratest is applied to check the normality of data series GDP and Oil Price. The test statistic shows the value 4.523575 (Oil Price) and 5.557324 (GDP) which does not exceeds the critical value at significance level of 5% (5.99) thus it can be concluded that, the GDP and Oil Price follow a normal distribution.

Table 1: Descriptive Statistics

	OILPRICE	GDP
Mean	44.29357	1016203.
Median	24.72500	716342.1
Maximum	111.6300	2876570.
Minimum	12.76000	247125.0
Std. Dev.	34.42463	756682.8
Skewness	0.915097	1.090373
Kurtosis	2.273544	2.911870
Jarque-Bera	4.523575	5.557324
Probability	0.104164	0.062122
Sum	1240.220	28453679
Sum Sq. Dev.	31996.48	1.55E+13

Pooled-OLS Regression

From Table 2 it is clear that the coefficient of Oil price is statistically significant and also there is a positive relationship of Oil Price and GDP.The R^2 value indicates a good coefficient of determination (67%) which means the variable in the equation is useful for explaining

the impact of Oil price on GDP. The F statistic value is 225.9018 and is significant at the 5 percent level. The overall fit of the regression model measured by the F -statistic, is statistically significant at this level.

Table 2 : Pooled OLS regression Results

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-2.440481	0.264579	-9.224016	0
OILPRICE	0.670514	0.044612	15.03003	0
R-squared	0.672523	Mean dependent var		1.527817
Adjusted R-squared	0.669546	S.D. dependent var		0.315143
S.E. of regression	0.18116	Akaike info criterion		-0.561172
Sum squared resid	3.610099	Schwarz criterion		-0.512628
Log likelihood	33.42565	Hannan-Quinn criter.		-0.541476
F-statistic	225.9018	Durbin-Watson stat		0.272686
Prob(F-statistic)	0			

* Significant at 5% level of significance.

On the other side to take into account the individuality of each country/ cross-sectional unit, intercept is varied by using dummy variable for fixed effects. The p-value (0.0000) stands against the null hypothesis (it is that, the pooled *OLS* model is adequate) which is in favor of the fixed effects as an alternative.

Fixed Effect Model

Individuality of each country / cross-sectional unit is accounted by letting the intercept vary for each country. It is also assumed that the slope coefficients are still constant across cross-section. From Table 3 it is evident that the estimated coefficient of factor Oil price is highly significant (p-value= 0.0000) The result shows that, Oil Price has a positive relationship with GDP.

Table 3 : Fixed Effects Model Result

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-3.299048	0.220465	-14.96401	0
OILPRICE	0.815584	0.037187	21.93177	0

* Significant at 5% level of significance

Random Effect Model

To measure the random deviation (error component) of individual intercept from mean value of all cross-sectional intercept which is $\beta 1$ ονε way Random Effects model is applied on the data. From Table 4, it is clear that the coefficient has significant effect (p-value = 0.0001) on *GDP* . The mean value of the random error component €$_i$ is the common intercept value of 2.440481.

Table 4 : Random Effects Model Result

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-3.299048	0.220465	-14.96401	0
OILPRICE	0.815584	0.037187	21.93177	0
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-2.440481	0.199973	-12.20404	0
OILPRICE	0.670514	0.033718	19.88581	0
	Effects Specification			
			S.D.	Rho
Cross-section random			0	0
Idiosyncratic random			0.136924	1

* Significant at 5% level of significance

Hausman test

Statistically, fixed effects are always a reasonable thing to do with panel data (they always give consistent results) but they may not be the most efficient model to run. Sometime Random effects can give better P-values as they are a more efficient estimator, so we should run random effects if it is statistically justifiable to do so. To choose between Fixed Effect Model and Random Effect Model the Hausman test is used because it has an asymptotic chi-square distribution.

H_0: Random Effect Model is appropriate

H_1: Fixed Effect Model is appropriate

The results (Table:5) indicates that the probability value (0.0000) is significant and less than 5% meaning that the null hypothesis is rejected. Which imply that, the Fixed Effect Model is most appropriate model to find out the impact of Oil Price on GDP of BRIC Nations.

Table 5 : Hausman Test Result

Test Summary	Chi-Sq. Statistic	Chi-Sq. d.f.	Prob.
Cross-section random	85.557183	1	0

* Significant at 5% level of significance.

Fixed Effect Model with Dummy Variable

The results of Hausman test suggested the application of fixed effect Model. So finally the dummy variables are used to estimate the Fixed Effect Model. We have got the same outcome of Fixed Effect Model as before. Meaning that, the coefficient of oil price is the same as before. That means the coefficient of independent variable should be same for all ways of estimating Fixed Effect Model. In this model the intercept of China is taken as comparison country. From Table 6 it is evident that the estimated coefficient of factor Oil price is highly significant (p-value= 0.0000) and R2 (0. 0.818028) is also very high. The result shows that, overall the Oil Price has a positive relationship with GDP. The coefficients of dummy for countries Brazil, Russia, India and china are also significant. The negative

coefficient values of China (-3.284280) and India (-0.086646) shows that, Increase in Oil Price has a negative relationship with GDP and on the other side the Positive coefficient values of Russia and Brazil depict the positive impact of increased Oil Price on GDP.

Table 6 : Fixed Effects Model Result

Variable	Coefficient	Std. Error	t-Statistic	P-value
Constant	-3.28428	0.220933	-14.86552	0
Oil Price	0.815584	0.037187	21.93177	0
Brazil	0.234769	0.038128	6.157394	0
Russia	0.08905	0.036819	2.418594	0.0173
India	-0.086646	0.036807	-2.354067	0.0204
R-squared	0.818028	Mean dependent var		1.527817
Adjusted R-squared	0.811225	S.D. dependent var		0.315143
S.E. of regression	0.136924	Akaike info criterion		-1.095165
Sum squared resid	2.006057	Schwarz criterion		-0.973804
Log likelihood	66.32925	Hannan-Quinn criter.		-1.045925
F-statistic	120.2507	Durbin-Watson stat		0.503567
Prob(F-statistic)	0			

* Significant at 5% level of significance.

The reason of negative impact of increased oil price on GDP of India and China is that, India is the fourth-largest energy consumer in the world after China and it depends heavily on imported crude oil. As it is already being discussed that, low prices are considered good for importers of oil, because it not only improves consumer spending but also improves the trade balance of a country. The similar results of Mork (1989) showed that increase in oil price had a considerably negative effect on the growth of gross national product of the USA; while, the decrease in oil price was led to no increase in economic growth. Mory (1993) also established the same findings and showed that the increase in oil price had negative effect on the economy of the US. Jin (2008) discovered that the oil price increases exerts a negative impact on economic growth in Japan and China and a positive impact on economic growth of Russia. The result of Fixed Effect Model of the study shows that, increase in Oil Price has a positive impact on the GDP of Russia and Brazil. Brazil is the 10th largest producer of Crude oil and Russia is the second-largest producer of dry natural gas and third-largest liquid fuels producer in the world. Therefore it is considered good for oil exporters as it could increase revenues of oil exporting countries.

CONCLUSION

This paper employs an empirical analysis to examine the impacts of oil price on GDP of the four largest fast growing emerging economies Brazil, Russia, India and China known collectively as the BRIC countries using a sample of observations from 1987 to 2014. The first step in the empirical analysis involves testing the normality of time series. The test statistic shows the value 4.523575(Oil Price) and 5.557324 (GDP) which does not exceeds the critical value at significance level of 5% (5.99) thus it can be concluded that, the GDP and Oil Price follow a normal distribution.

Next the Pooled-OLS Regression was applied and the result shows that the coefficient of Oil price is statistically significant and also there is a positive relationship of Oil Price and GDP. The R^2 value indicates a good coefficient of determination (67%) which means the variable in the equation is useful for explaining the impact of Oil price on GDP. Then to take into account the individuality of each country/ cross-sectional unit, intercept is varied by using dummy variable for fixed effects. The result evident that the estimated coefficient of factor Oil price is highly significant (p-value= 0.0000) The result shows that, Oil Price has a positive relationship with GDP. Statistically, fixed effects are always a reasonable thing to do with panel data (they always give consistent results) but they may not be the most efficient model to run. Sometime Random effects can give better P-values as they are a more efficient estimator, so we should run random effects if it is statistically justifiable to do so. To choose between Fixed Effect Model and Random Effect Model the Hausman test was applied because it has an asymptotic chi-square distribution. The results of Hausman test indicated that the probability value (0.0000) is significant and less than 5% meaning that the null hypothesis is rejected. Which imply that, the Fixed Effect Model is most appropriate model to find out the impact of Oil Price on GDP of BRIC Nations.

So finally the dummy variables are used to estimate the Fixed Effect Model. In this model the intercept of China is taken as comparison country. From Table 6 it is evident that the estimated coefficient of factor Oil price is highly significant (p-value = 0.0000) and R2 (0. 0.818028) is also very high. The result shows that, overall the Oil Price has a positive relationship with GDP. The coefficients of dummy for countries Brazil, Russia, India and china are also significant. The negative coefficient values of China (-3.284280) and India (-0.086646) shows that, Increase in Oil Price has a negative relationship with GDP and on the other side the Positive coefficient values of Russia and Brazil depict the positive impact of increased Oil Price on GDP. The reason of negative impact of increased oil price on GDP of India and China is that, India is the fourth-largest energy consumer in the world after China and it depends heavily on imported crude oil. The result of Fixed Effect Model of the study also shows that, increase in Oil Price has a positive impact on the GDP of Russia and Brazil. Because Increase in Oil Price is considered good for oil exporters as it could increase revenues of oil exporting countries.

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