

Research on Macroeconomics Effect from Oil Price Fluctuations --Empirical Evidence from Major Oil-exporting Countries

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Abstract. This study is focused on the impact of oil price fluctuation on two groups of countries: The Organization of the Petroleum Exporting Countries (OPEC) and non-OPEC. The data set include all eight OPEC and seven non-OPEC countries. The real GDP growth, inflation, and unemployment rate were chosen as macroeconomic variables with the period from 1993 to 2016. West Texas Intermediate (WTI) crude oil was taken as a measure of oil prices. The main purpose of the research is to find out whether the selected economic indicators of OPEC countries are more sensitive to fluctuation in oil prices than those in non-OPEC oil-exporting countries. In order to compare the two sorts of countries, two separate vector auto regression (VAR) models were used for non-OPEC and OPEC countries. The result of the research proved the existence of a connection between oil prices and inflation, real GDP, the unemployment rate for both OPEC and non-OPEC countries. In addition, results show that the relationship holds only in the short and medium run, but not in the long run. Impulse response function indicated that inflation and unemployment rate for OPEC countries are more sensitive to oil price fluctuation than in the case of non-OPEC countries. However, real GDP growth is more sensitive in non-OPEC countries.

1. Introduction

Energy resource such as crude oil is significant in the modern global economy. Crude oil and petroleum products are used in many industries such as cargo transportation (as gas for cars, planes, and ships), heating and chemical industry. Oil production has become the main resource of the budget and GDP in some countries and their economy may depend on changes in oil prices. With the advent of the automobile and the great need for gasoline, the oil-producing countries have experienced a huge and growing demand for petroleum products, which also had a positive effect on the economy of oil-exporting countries. However, rise in oil prices was also accompanied with oil price shocks and crises, such as oil price shock during the financial crisis of 2007–2008. Oil prices certainly affect budget revenues of many countries in the world. Obviously, high oil prices increase budget revenues of oil-exporting countries, but at the same time may have a negative impact on oil-importing countries.

The main purpose of this research is to find out whether there is a correlation between macroeconomic indicators such as real GDP growth, the unemployment rate, inflation, and crude oil prices. In order to find out the influence of oil price fluctuation on the economy, the study includes two groups of oil-exporting countries: OPEC and non-OPEC. 8 countries are from the Organization of the Petroleum Exporting Countries and 10 countries are not part of OPEC. The organization has a big role in oil production as one of the largest oil-producing cartels. Its oil reserves account for about 81% of world oil reserves and 33% of crude oil production of world production [1]. In total, the export of crude oil from selected OPEC countries is about 349,8 bln \$ in 2015. So, the analysis will focus on 8 OPEC countries such as Saudi Arabia, United Arab Emirates, Nigeria, Kuwait, Angola, Venezuela, Iran, and Algeria. All the countries from the list are developing economies [2].

1.1 Organization of Petroleum Exporting Countries (OPEC)

The organization of Petroleum Exporting Countries (OPEC) was formed by oil production countries with the purpose of controlling the oil production quotas. The organization was created in 1960 by 5 countries (Venezuela, Iran, Iraq, Saudi Arabia, and Kuwait). At that time, oil production was dominated by 7 multinational oil companies, which were named “Seven Sisters”. During the 1960s, the number of OPEC countries increased to 10. New members of OPEC were Qatar (1961), Libya

(1962), Indonesia (1962), United Arab Emirates (1967) and Algeria (1969). Since the 1970s, OPEC has become very influential in the oil industry and strongly influenced the price of oil. Their share of oil production increased from 44 percent in 1965 to 51 percent in 1973 from the total world barrels [3]. OPEC countries have the biggest world proven oil reserves. Oil reserves of 13 OPEC countries count about 1213,4 billion barrels, which is 81% of world proven oil reserves. Non-OPEC countries have 279,2 billion barrels or 19% from world total proven reserves. Venezuela has the biggest oil reserves among OPEC countries with 300,88 billion barrels and it is about 24,8 percent from total OPEC proved reserves. In the second place is Saudi Arabia with 266,46 billion barrels and it is 22% of total OPEC reserves. Iran`s oil reserves are about 158,40 billion barrels and Iraq has about 142,52 billion barrels. Other OPEC countries in total have about 345.18 billion barrels [1].

1.2 Non-OPEC oil-exporting countries

The research will focus on 10 countries which are the main oil exporters outside OPEC i.e. Canada, Kazakhstan, Mexico, Norway, Oman, Russian Federation, the United Kingdom, Colombia, Brazil, and Azerbaijan. In total, the export of crude oil from these countries was about 277,4 bln \$ in 2015. In contrast, 8 selected OPEC countries exported in total about 349,8 bln \$. Seven non-OPEC countries are developing economies and the UK, Norway and Canada are developed economies [2].

1.3 Consumption, production and price of crude oil

The consumption of crude oil was about 55,6 thousand barrels per day in 1973. In contrast, the amount of consumed oil in 2015 reached about 95 thousand barrels per day. It means that growth for 42 years exceeded 71% and it is until growing from year to year.

World crude oil production also grew in order to meet new demand. Production of OPEC countries decreased almost twice during the period from 1978 to 1986. The financial crisis of 2007–2008 also had a huge impact on oil prices. The crude oil price has increased continuously from 1999 with some small declined such as the housing crisis in U.S. 2006. The peak was in 2007 when the price was 140\$ per barrel. After that, prices dramatically dropped to less than 40\$ per barrel [4].

World crude oil export in 2015 was about 41654, 2 thousand barrels per day and there was a growth of about 3.3% compared with the previous year. OPEC is a significant exporter in world oil market. OPEC countries exported about 23,6 million barrels per day and it is about 56,6 percent from total crude oil export in the world.

2. Method

2.1 Description of Inflation (CPI) and the relationship to Oil Price

Nakro and Omezzine (2016), Aktas, Ozenc and Arica (2011) and Negi (2015) agreed that there is a positive relationship between inflation and oil prices. It may be due to the fact that oil is one of the major inputs into the econom [5], [6], [7].

Oil is used to produce raw materials for different types of goods or in transportation, and if the cost of intermediate input goes up, the cost of final goods will increase. Neely and Rapach (2011) agreed that inflation rates can move internationally, so that oil prices may influence worldwide inflation. However, in the long run, the monetary policy which is used by the Central Bank can reduce influence through using the target inflation rate [8].

Iwayemi and Fowowe (2011) made their research focusing on African oil-exporting countries such as Algeria, Egypt, Libya, and Nigeria over the period from 1970 to 2006. They used macroeconomic indicators such as real GDP growth rate, GDP deflator inflation, consumer price index (CPI) inflation, gross fixed capital formation growth rate, and industrial value-added growth rate. The authors used linear benchmark (percentage change in oil price) and 2 non-linear characteristics of oil price shocks (oil volatility and real oil price decrease and growth). Their main conclusion was that the effect of oil price changes was not significant on macroeconomic indicators in the short-run due to government subsidies and regulations in crude oil market. Also, the authors found out that the manufacturing industry of these 4 countries was not very active and do not highly affect by oil price shocks. They concluded that there is effect from oil price changes on macroeconomic environment, but they could not clearly estimate whether it is positive or negative. It could be due to frequent upward and downward changes. However, they also agreed that if these movements canceled out, the net effect of shocks to oil prices could be minimal or equal to zero [9].

Chen, Chen, and Hardle (2014) discuss in their research the influence of crude oil prices on macroeconomic indicators of People's Republic of China (PRC). They use SVAR (Structural Vector Auto Regression) model in order to estimate data for the period from 1994 to 2012. Their main goal was to find out the influence of crude oil price changes on macroeconomic indicators using six

variables such as oil prices, the exchange rate, money supply, interest rate, output, and price level. Their finding was the evidence that the increase in price level in PRC was caused by oil price shocks and this effect is lower for their main trade partners. In addition, the import of oil in PRC has grown since 2004, while in other countries such as the US oil import declined from year to year. Another finding was that the exchange rate of PRC appreciates due to oil price increase. They also proved that the PRC output level is positively correlated with oil prices [10].

The macroeconomic effect of oil prices' fluctuation was investigated by Taghizadeh-Hesary and Yoshino (2015). Their research focused on comparing how changes in price of oil affect GDP Growth and Consumer Price Index. They estimate the influence of oil price fluctuations in 3 countries: China, United States, and Japan from 2000 to 2013. The empirical result showed that oil price changes had an impact on selected variables in the three countries. However, the results also indicated that for Japan and the US, the impact of oil price changes on GDP growth rate is much less than for China [11].

2.2 Description of Real GDP and the relationship to Oil Price

Jimenez-Rodriguez (2005), Mendoza (2010) agreed that crude oil price changes affect real GDP Growth with positive relationships. Of course, the impact is different for oil-exporting and oil-importing countries. For oil-importing countries, the increase in oil prices will have a negative impact, while for oil-exporting countries a positive one. A significant negative influence on the real GDP growth was found for all selected oil-importing countries, except for Japan, where the negative effect was not found. In oil-exporting countries, results were ambiguous. Crude oil price increases impact positively GDP growth in Norway, but negatively in the UK. They also conclude that US GDP growth is more dependent on oil prices than the GDP growth of the European Union (EU) countries [12], [13].

Hazarika (2015) analyses the impact of oil price fluctuation on OPEC countries. In the research, she used Brent Crude oil prices as an independent variable and export, GDP at current market prices, the exchange rate and the current account as a dependent variable. As a sample, the author used all OPEC countries. The main finding of the research showed the negative impact on selected macroeconomic indicators from the decrease of crude oil prices. However, the most important finding showed that the fluctuation of crude oil prices does not highly influence OPEC economies [14].

Ftiti, Guesmi, Teulon, and Chouachi (2015) discuss how crude oil prices affect economic growth in 4 OPEC countries: United Arab Emirates, Kuwait, Saudi Arabia, and Venezuela from 2000 to 2010, with the main aim of finding macroeconomic consequences of oil price shocks. They applied the evolutionary co-spectral analysis to distinguish the short-term and long-term movement. They conclude that aggregate demand-side of oil price shocks was the cause of a high correlation in the medium-term effect. At the same time, the short-term effect was due to changes in the preventive demand-side (such as war in Iraq, terrorist attacks, etc.) [15].

Aimer (2016) conducted research focused on the relationship between GDP in current prices and the price of crude oil in Libya. The aim of the research was to investigate the impact on Libyan GDP from the change in oil prices in the period from 2000 to 2005. The result of the research showed that there is no relationship between these 2 variables (crude oil prices and GDP) in the long run, but in the short run, there is a positive relationship between oil price change and GDP [16].

2.3 Description of the Unemployment rate and the relationship to Oil Price

Hamilton (1983) research was connected with the relationship between an oil price change and macroeconomic indicators. He found out the positive correlation between unemployment and oil prices during the period from 1948 to 1980 in the US [17]. Mellquist (2007) also partly confirm the previous finding based on the case of Sweden. The results of the research showed a positive relationship. Granger causality regression indicated that oil price influences the unemployment rate, but it is hard to estimate the exact effect of the increase in oil prices [18].

Rahma, Perera, and Tan (2016) discussed in their research consequences of oil price shocks for Sudan's unemployment rate and GDP growth. Using Vector Auto Regression Model (VAR) model, they investigated the influence of crude oil price shocks on the unemployment rate and real GDP growth over the period from 2000 to 2014. The variance decomposition analysis and impulse response function showed that the impact on GDP growth rate from crude oil price shock was symmetrical. In addition, the negative impact on the unemployment rate was detected. They underline main factors affecting the unemployment rate: separation of South Sudan (before 2011, South Sudan was part of Sudan, but in 2011 it declared independence), migration, and a drop of oil prices [19].

2.4 Data and Methodology

The most suitable for this research was using of four-variable vector autoregression to find out the impact of oil price fluctuation on macroeconomic indicators of 18 major oil exporters. Selected macroeconomic variables will be the inflation rate (at the end of period consumer prices) (INF), real Gross Domestic Product growth (RGDP), and the unemployment rate (UNM). The real GDP growth, inflation, and unemployment are important indicators, which have influence on economic growth in countries. Data for research are annual and during the period from 1993 to 2016. The data was collected from International Monetary Fund. Unemployment data during the period from 2015 to 2016 was collected from International Labour Organization. West Texas Intermediate (WTI) was chosen as the main indicator of the price of oil. WTI, on a par with BRENT, is one of the most important classes of crude oil in the world. The price for most types of oil depends on WTI and BRENT crude oil prices. Data for prices of WTI oil were collected from the Federal Reserve Bank of St. Louis database for the period from 1993 to 2016 on an annual basis (average price per year).

The main criterion of choosing exact countries was the rank of petroleum oil exporters by exported value in 2015 [20]. Selected countries should be divided into 2 categories: OPEC and non-OPEC, such as in the table 1.

Table 1. Selected countries, OPEC and Non-OPEC.

Non-OPEC Countries	OPEC Countries
Azerbaijan	Algeria
Brazil	Angola
Canada	Iran
Colombia	Iraq*
Kazakhstan	Kuwait
Mexico	Qatar*
Norway	Nigeria
Oman	Saudi Arabia
Russian Federation	United Arab Emirates
United Kingdom	Venezuela

Source: International Trade Centre [20].

* Countries were excluded from the research due to the lack of data.

3. Results and discussion

3.1 VAR model for OPEC countries

For OPEC countries, the results of the Panel Unit Root tests (LLC, IPS, ADF, and PP) show that for two variables (real GDP growth and inflation) there is no unit root in levels. However, for oil prices and the unemployment rate, the unit root was not found only on the first difference. Therefore, for the accuracy of data, it is needed to use the first stationery of two variables in the VAR model. Panel Unit Root test for non-OPEC countries shows that for real GDP growth rate and inflation data is stationary and does not contain unit root. However, for oil prices and unemployment rates, data contains unit root in levels. In the first difference data is stationary and does not contain unit root.

Figure 1-3 presents the impulse response of inflation based on the VAR model, real GDP growth and unemployment rate by oil prices for OPEC countries. It was used 20-year period of the figures in order to obtain more correct and long-term results.

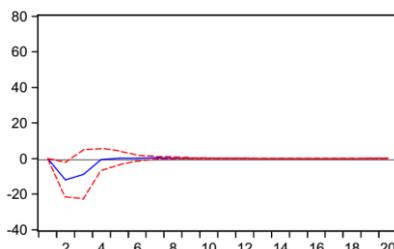


Fig. 1. Response of Inflation to WTI oil price for OPEC countries.

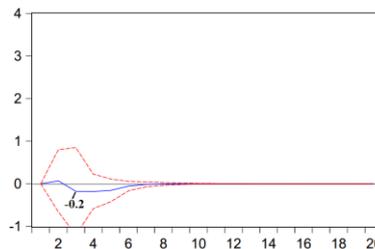


Fig. 2. Response of Real GDP growth to WTI oil price for OPEC countries

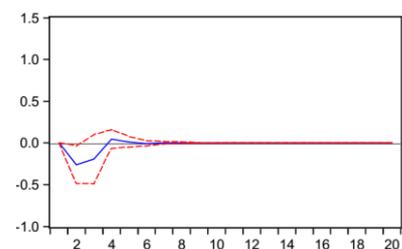


Fig. 3. Response of Unemployment to WTI oil price for OPEC countries.

The response of inflation to WTI oil price is displayed in Figure 1. It is visible that increases in oil prices lead to a drop in inflation at the beginning (first 2 years). From the second to fifth year,

inflation increased and goes back to the natural level. There is a negative correlation between oil prices and inflation in the short and medium run period. However, in the long run, there is no relationship between oil prices and inflation.

In the second Figure 2, the response of real GDP growth to oil prices is presented. If the oil prices go up, the real GDP increased. However, after two years, it begins to grow and goes back to the initial position. There is a relationship in the short and medium run, but in the long run a relationship between the oil prices and real GDP growth is absent.

In Figure 3, the response of the unemployment rate to WTI oil prices could be seen. If oil price goes up, in first two years unemployment decreased, but then it goes up above the natural level. After the fourth year, the unemployment rate decreased and it comes back to the natural level. The situation is slightly different for real GDP growth and inflation, because in the short-run unemployment decreased, but in the medium run it goes up. In the long run, price of oil has no impact on the unemployment rate.

3.2 VAR model for non-OPEC countries

Using lag order selection criteria, particularly Schwarz information criteria, one lag for OPEC countries was found. Secondly, the inverse roots of the characteristic AR polynomial are used in order to test stability (stationarity) of the VAR model. For non-OPEC countries, all four roots are inside the circle and have modulus less than one, so that VAR is stable. Finally, after conducting all tests and finding lags, the correct VAR model was constructed. The Dione lag was used according to Schwarz information criteria in order to build a more precise model for non-OPEC countries.

Figure 4-6 presents the impulse response of inflation, real GDP growth and unemployment rate by oil prices for non-OPEC countries. It was used 20-year period of the figures in order to obtain more correct and long-term results.

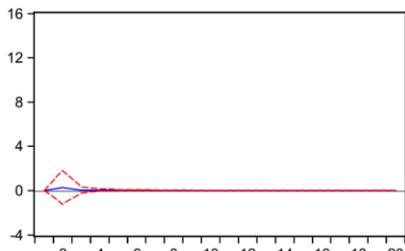


Fig. 4. Response of Inflation to WTI oil price for non-OPEC countries.

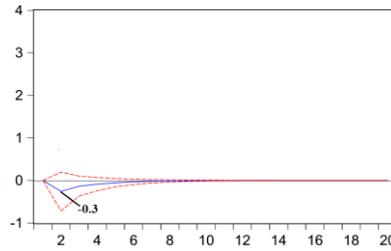


Fig. 5. Response of Real GDP g to WTI oil price for non-OPEC countries.

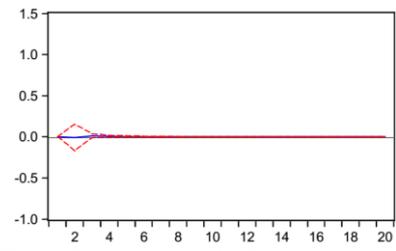


Fig. 6. Response of the Unemployment rate to WTI oil price for non-OPEC countries.

Figure 4 indicates the response of inflation to WTI oil prices. If the oil price goes up, inflation increases, but only in a period of 2 years. In the long-term perspective, there is no direct impact on inflation from oil price changes. In the short run, there is a positive correlation between the oil prices and inflation, but in the long run the relationship was not found.

Figure 5 shows the response of real GDP growth to WTI oil prices. If oil prices increased, real GDP firstly will go up and will reach the minimum in 2 years. After that, real GDP will increase and go back to the natural level. The negative correlation was founded between real GDP growth and the oil prices in the short and medium run. However, in the long run, there is no direct influence from changes in oil prices to real GDP growth.

In Figure 6, the response of the unemployment rate to oil prices is indicated. The situation is similar to inflation and oil prices. If the price of oil goes up, the unemployment rate slightly goes up in the short and medium run, but not in the long run. A positive relationship was found for unemployment and oil prices in the short and medium run.

3.3 Discussion of the results

In Figure 1 and Figure 4, we can compare the impact of oil price changes on inflation among OPEC and non-OPEC countries. The increase in oil prices for OPEC countries leads to decrease in inflation in the short and medium run, while for non-OPEC countries the increase of oil prices leads to minor increase in inflation in short run. In addition, for OPEC countries, after the decrease in inflation, inflation increased above the natural level. In the long run, the situation is similar for both sets of countries and without direct connections between oil prices and inflation.

Figures 2 and Figure 5 indicate the response of real GDP growth to oil prices for two sets of countries. The impact of the increase in oil prices is quite similar. For OPEC economies, real GDP growth rate slightly increased until the second year and after that inflation goes down. However, for

non-OPEC countries, the decrease was started from first year and goes until the second year. After the decline, real GDP started to grow again and returned to the initial position for both sets of countries.

Changes in the unemployment rate could be seen in Figures 3 and Figure 6. Impulse response function shows different results from OPEC and non-OPEC countries. For OPEC countries, after the rise in oil prices, the unemployment rate goes down up to 2 years and after that, it recovers to the natural level in 4 years. After the fourth year, inflation slightly goes up and in the sixth year goes back to the initial level. For non-OPEC countries, we can observe minor and insignificant growth of the unemployment rate in the short term, but then it goes back to the initial position.

To sum up, from the impulse response function, it is visible that the increase of oil prices influenced all selected variables in the short and medium run for both sets of countries. In the long run, there is no effect from oil prices increase for OPEC and non-OPEC countries for all selected macroeconomic indicators. In OPEC countries, inflation and the unemployment rate are more sensitive to oil price fluctuations than in non-OPEC countries. However, for the real GDP growth rate, the results differ. In OPEC countries, the real GDP growth firstly increased, but then decreased, while in non-OPEC countries real GDP only decreases. In non-OPEC countries, the real GDP is more sensitive to oil prices with the lowest point of -0.3, while for OPEC countries the lowest point was -0.2.

The empirical results can lead to the conclusion that all OPEC countries can have a greater dependence on oil exports and their selected indicators i.e. unemployment and inflation are more sensitive to oil price changes. This may be due to the fact that more workers are involved in oil industry in OPEC countries so that with changes in oil prices, unemployment also changed. Inflation could be more sensitive due to the dependence of the exchange rate on the price of oil. For instance, the decline in oil prices could lead to the devaluation of home currency and it leads to inflation growth. In contrast, real GDP of Non-OPEC countries is more sensitive to oil price changes than in OPEC countries. There is a negative correlation between oil prices and real GDP. It could be due to the fact that a group of countries included three developed countries that depend less on oil exports but use oil in many spheres.

4. Conclusion

This current research analyzed the relationship between oil prices and selected macroeconomic variables, i.e. real GDP growth rate, inflation, and the unemployment rate. The study focused on analyzing OPEC and non-OPEC countries during the period from 1993 to 2016. The main goal of the research was to find out whether the selected economic indicators of OPEC countries are more sensitive to oil price fluctuations than non-OPEC oil-exporting countries. For the research, two separate VAR models were used.

The hypothesis of the research was partly proved: in selected OPEC countries, inflation and unemployment are more sensitive to oil price changes than in non-OPEC countries, but the situation is the opposite for real GDP. Real GDP in non-OPEC countries is more sensitive to oil price changes than in OPEC countries. The results of the research indicate that there is a connection between oil prices and inflation, real GDP and the unemployment rate. The impulse response function showed the connection between these variables. Moreover, it was found that the increase in oil price has an impact on variables only in the short and medium run. The long-term relationship was not found.

Further research could investigate more countries and may use other models or include more variables in the VAR model. Variables such as currency exchange, the balance of payment and foreign direct investment can expand the VAR model.

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