Impact of Crude Price Volatility on Levels of Economic Activity: Evidence from Iraq

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Abstract

Global oil markets witnessed intense price volatility in the recent years. Volatility of crude oil price is perceived as a significant source of economic fluctuation. It could likely affect levels of economic activities whether in oil exporting or in oil importing economies. The following study proves that the impact of oil price shocks is not exclusive to oil importing economies. Iraq's developing economy which is highly dependent on oil exports as a main source of revenues is vulnerable to oil price shocks. This study employs a multivariate autoregressive regression (VAR) model to investigate the impact of crude oil price volatility on levels of economic activity in Iraq. The time series datasets employed in the study are tested for stationarity and co-integration using the augmented Dickey-Fuller (ADF) unit root test and Johansen test for cointegration respectively. The model's results confirmed the highly significant impact of volatility of crude oil price on levels of GDP in Iraq.

Keywords: Crude Price, Volatility, Crude Exports, Multivariate Vector Autoregressive (VAR) Models

Introduction

For the last few decades, levels of crude oil consumption and export are both used as indicators to measure economic growth whether in oil importing or in oil exporting economies. The kind of energy that crude oil generates, and the derivative products it provides affect almost every aspect of our modern life. As one of the most easily extracted source of energy, crude oil's favorable characteristics entitles it to stand globally as the most highly valued energy source. The importance of crude oil as a strategic commodity that affects global economic and national security stems from the fact that its availability and volatile prices influence the health, welfare, and security of billions of people and their nations.

Oil global supply is not very reliable and it is subject to instability and supply-side shocks. Multiple reasons stand behind this supply's uncertainty. Political instability and wars represent important generators of oil supply and price shocks. Upon the 1973 Arab oil embargo against the countries that supported Israel, Yom Kippur War (October 6, 1973) triggered the media and the economists' concerns about oil price surges. Another enormous supply shock occurred upon a huge drop in the Iranian's production of oil after the overthrow of the Shah regime in 1979. Supply shortages entail oil price increases, meanwhile oversupply of oil drags prices down. Iraq's resumption of oil exportation in 1999 upon the United Nations Oil-For-Food program flooded the market causing a remarkable reduction in its price (Alnasrawi, 2002). Besides, it coincided with the Asian financial crisis that decreased the Asian demand over oil. A recent reduction of crude oil price in the global market is also attributed to the oversupply of crude oil after the announced potential domestic reserves of United States that are expected to flood the global markets. Yet, increased demand on energy sources also triggers price surges, particularly when the supply does not confront the demand.

Global oil markets witnessed intense price volatility in the recent years. The fluctuations of oil prices in the global markets attracted economists' attention to the relationship between economic growth rates and changes in oil price, precisely, the form that it takes, and the extent to which it affects economic performance. From a theoretical perspective, oil price volatility affects levels of macroeconomic indicators through many transmission channels. The supply-side effect of surges in crude oil price on levels of real output is attributed to the impact that they may have on marginal costs of production. This effect is transmitted in its turn to the demand-side through the impact that crude price change may have on consumers' disposable income and investors earnings, thus, on levels of aggregate consumption and investment.

Since 1970s until recently, volatility of crude oil price is perceived as a significant source of economic fluctuation, and likely to affect many economies simultaneously. The consequences of oil price fluctuation on levels of real activities differ between oil importing and oil exporting countries. Positive surges of crude price are expected to boost revenues to finance development projects in oil exporting countries; meanwhile the effect of negative price shocks is expected to have reverse impacts. Empirical evidence proved that crude price increases have a significant negative impact on GDP growth and contributes to higher inflationary pressures in oil importing countries. The implications of oil price fluctuation also differ between developed and developing economies. The increase in oil price leads to energy efficient consumption in developed countries, but it is

not necessarily the case in developing countries where it may be reflected in increased human costs, food costs as cooking fuel may become less affordable.

Oil reserves are unevenly distributed as most of the known oil reserves are located in politically or economically unstable areas of the world. More than half of the world's reserves are located in the Middle East. According to the statistics of the Organization of Arab Petroleum Exporting Countries (OAPEC), the Middle East with its vast oil reserves represents a global powerful force that holds approximately 56.4% of the world's oil reserves with an increasing trend in its share of the global production. Iraq is one of the five major members of OPEC that holds the reserve of 115 billion barrels, which represents 17.57% of the Arab producing countries' reserves and 9.91 % of the world's oil reserves. Despite its vast oil reserves, Iraq is still a lower middle income developing economy that suffers from tremendous deficiencies in development projects. Iraq's large quantities of oil resources represent the most important source of income to Iraqi economy, yet are unable to support any process of sustained development (Owen & Pamuk, 1998).

The following study proves that the impact of oil price shocks is not exclusive to oil importing economies. Oil exporting economies are also vulnerable to crude price volatility especially in the countries whose economic structure depends largely on crude exports revenue. Iraq's developing economy is highly dependent on oil exports as a main source of revenues. Oil production and exports are the main components of Iraq's economy. The demand over Iraqi oil exports is likely affected by the movement of crude oil prices in the global market. This is reflected in Iraq's real GDP via the impact on Iraq's exports and oil income. This study attempts to ascertain that the correlation exists between the movement of oil prices and Iraq's economic performance. The high dependency of Iraqi economy on oil exportation activities indicates the vulnerability of Iraq's economic stability to crude price shocks. Hypothetically positive surges in oil prices should have a positive impact on Iraq's GDP through its positive impact on revenues. However, these positive surges may decrease the demand on Iraq's oil exports due to other factors like fluctuation of exchange rates and other political and regional factors. Thus, the study employs multivariate autoregressive regression (VAR) model to investigate the impact of crude price volatility on levels of economic activity in Iraq. The study begins by investigating the results reported by linear regression models. Linear models predict Iraq GDP by its two former lags of the differenced real GDP as independent variables alongide other variables that proxy crude price volatility and Iraq macroeconomic indicators using different tansformations of the varaiables. Yet, all have reported insignficant

effect of oil price volatity on levels of real output. Thus, the study goes on to discover the resutls of VAR model that confirm the signficance of oil price volatility effect on levels of real activities. The times series datasets was tested for stationarity using the augmented Dickey-Fuller (ADF) unit root test. The long run relationships among the variables are traced using the Johansen cointegration test, and finally, vector error-correction models (VECM) confirmed the existence of long run relationships among a few of the independent variables.

Background Information on Iraq
      Iraq is a lower middle income developing Middle Eastern country with a population of almost 34 million. Iraq's large quantities of oil resources represent the most important source of income to Iraq economy which relies heavily on oil revenues. The oil sector is the only economic sector capable of generating a substantial and regular inflow of external revenue into the country. Most of Iraq's development projects including infrastructure, industrial, and service sectors are financed by oil income. Oil revenues always supported the development of related industries, especially the petroleum refining, chemicals, and fertilizers. In a country where oil exportation is the only economic activity that provides income to the economy, implications of oil global markets' instability on economic activities and its influence on the economic growth are expected to be significant.
      International sources estimated Iraq's proven oil reserves at 112 billion barrels, and they could likely reach 214 billion barrels in the future. Also the country is endowed with 3,360 billion m³ of proven gas reserves. The potential production capacity of the currently producing fields is about 2.5 million barrel per day (Kumins, 2005).
      Oil production in Iraq has always shown a fluctuating pattern. Positive surges in oil production were always followed by a sharp reduction due to wartimes. The increase in the production of the year1979 when oil revenues recorded a very large contribution to Iraq's income was followed by a sharp reduction due to the outbreak of Iraqi-Iranian War in 1980. The increase in the production between the years 1989-1990 that followed the recovery of the war alongside the implementation of some economic policies that boosted the private sector was also followed by a capacity reduction due to Iraq's invasion of Kuwait in 1990. Iraq's oil production peaked in 1990 to around 3.5 million barrel per day. Upon Iraq's invasion of Kuwait exports were halted by an economic sanction. After the first Gulf War, oil production was only sufficient for domestic consumption as it declined to about 500,000 barrels per day. Then with the start of the UN Oil-for-Food program, oil exports increased, and oil production averaged to 2.5 million barrel per day

during 1991-2001. Yet, this increase was followed by a decline in the production due to the 2003 US invasion of Iraq (Kumins, 2005).

Theoretical framework

Considering the commonalities between Iraq as an underdeveloped oil exporting country and other developing oil exporting countries, the below literature review demonstrates how the effect of oil price fluctuation on the level of economic activities has been approached in the literature using a few case studies of some oil exporting developing countries like Thailand and Nigeria. It also reviews studies developed to check the same effect on the level of real GDP in some industrialized oil importing and oil exporting OECD and European Union (EU) countries. The similarities between the Nigerian economy and Iraq's economy as net oil exporters and war-inflicted countries are also considered as both economies are largely affected by the intensity of domestic and regional conflicts and political instability. Thus, it could be inferred that, as does Nigeria's economy, Iraq's economy with its massive oil reserves and oil export revenue that are not efficiently used to sustain development could also be subject to Dutch Disease Syndrome (DDS).

Ibrahim and Chancharoechi (2014) paper attempts to analyze the inflationary pressure that oil price shocks create on the general levels and commodity-specific levels of prices in Thailand. The authors develop policy recommendations for targeting inflation and its welfare consequences in Thailand using a quantitative approach of symmetric and asymmetric co-integration models alongside error-correction modeling analysis.

Ibrahim and Chancharoechi conduct their empirical study using a quarterly time series dataset on Thailand economic aggregates that covers the period between 1993 and 2010. In order to analyze how the inflationary effect created by oil price volatility is transmitted to the other main economic sectors, they measure the inflationary effect of oil price shocks on the aggregate price levels expressed by Consumer Price Index (CPI) and a group of other disintegrated measures of price levels in different sectors that are directly and indirectly related to the oil sector. These measures are expressed by the following indexes: Food and Beverage Price Index (FBI), the Non-Food and Beverage Price Index (NFBI), Raw Food Price Index (RFI), Energy Price Index (EPI) and Non-Raw Food and Energy Price Index (NREI), alongside two more indexes for other two goods sectors: Transportation and Communication Price Index (TCI), Housing and Furnishing Price Index (HFI).

Ibrahim and Chancharoechi analyze that inflationary pressure that volatility in oil prices creates through a short run, then long run framework. They adopt LeBlanc and Chinn (2004) augmented Philips curve framework

that allows for discovering long run relationships among variables to analyze inflation dynamics on the long run. Their models include variables that measure aggregate and disaggregated consumer prices. They also include measures of real output represented by real GDP, US dollar oil prices represented by Brent spot crude oil, and a measure of Thai baht and US dollar exchange rate.

Ibrahim and Chancharoechi empirical approach is constructed in four steps. In the first step, they examine the integration, non-stationary properties of data using Dickey-Fuller and Phillips-Perron unit root tests. In the second step, upon proving that data on variables are non-stationary and integrated of the same order, they used residual based tests and VAR-based tests to examine long-run relations among variables. In the third step, they employed a Dynamic Ordinary Least Square (DOLS) to estimate the long-run coefficients for the co-integrated systems. Finally, they develop three alternative models for predicting the variables. The first model expresses the short run relations among goods prices and their determinants as it is developed to check the relations when the variables are not integrated. The other two models allow for inflation to respond to gaps in output and changes in oil price and exchange rate where they used lagged variables of the price level. Thus the two other models are used when the data are symmetrically and asymmetrically co-integrated.

Their results on the preliminary data show that the variables are integrated of order I, yet the null hypothesis of no co-integration is not rejected nor was the null hypothesis of symmetric adjustment. The results on long relations among variables show that an increase in real GDP by 1% leads to an expected increase in CPI by 0.42%. The exchange rate depreciation also creates inflationary effect. The variable that expresses the long-run inflationary effect of oil prices suggests that, in the long run, a ceteris paribus increase in oil prices by 10% creates an expected increase in the aggregated price measure of CPI by 0.89%. The same effect is also high for other disintegrated price measures in other sectors like transportation and communication TCI, and non-food and beverage prices NFBI. However, in the housing and furnishing sector HFI, the oil price inflationary effect was the lowest in the long-run because housing sector prices are governed more by non-oil related domestic market factors. Results on inflation dynamics shows that aggregate consumer prices and housing and furnishing prices show some degree of persistence. There is also a significant inflationary effect of exchange rate changes on all of CPI, NFBI, and HFI (Ibrahim & Chancharoechi, 2014).

In assessing Ibrahim and Chancharoechi paper, we should assert their main finding which is represented by confirming the large inflationary effects of the positive surges in oil price on some energy-intensive sectors

like transportation and communication sector, yet the same effect will reduce, to a large extent, the use of energy in other industrial and production sectors to achieve cost cuts. This energy use reduction could also be witnessed in consumers' energy consumption. The lower rates of per capita energy use that could be achieved in Thailand will definitely reduce the inflationary pressures that these positive surges in oil price create.

Alongside the inclusion of disaggregated sectoral measures of price that allows for analyzing the specific-policy measure that should be developed to target each sector separately, Ibrahim and Chancharoechi analysis of the asymmetrical inflationary effect of changes in oil price on all other price measures represents the tide of their empirical research. Their paper is important because it does not only consider the short-run effects, but the long-run dynamics and the symmetry and asymmetry in the behavior of the inflationary pressures. So, hikes in oil prices will be immediately transmitted to other sectors as majority of the above measures experienced a positive short-run surges created by positive fluctuation in oil prices. However, the opposite effect is asymmetric, which means that negative surges or declines in oil price are never transmitted immediately to other sectors. Neither aggregated nor disaggregated sectoral measures of goods prices experienced any subsequent declines to the declines in oil prices.

Yet, in order to extend the analysis to include other developing countries than Thailand, the study should consider the different effects that such fluctuations bear on economic aggregates in the contextual case and the specificity of each economy, whether an oil-exporting or an oil-importing economy. The factor that Alley, Asekomeh, Mobolaji, and Adeniran (2014) considered in their estimation of the effect of oil price volatility on economic growth rates in Nigeria.

Alley et al. (2014) provide a quantitative analysis to the impact of fluctuations in oil prices on the Nigerian economy. They apply the General Methods of Moment (GMM) to estimate the effect of positive and negative surges of oil price using data that covers the period between 1981 and 2010 during which Nigeria has experienced increasing rates of oil exports. Their findings confirm the positive impact of oil price increases on Nigerian oil-exporting economy. Yet, the negative impact is represented by the uncertainty that such surges create regarding the expected revenue of oil exports.

Alley et al. start by reviewing the paradox that haunts the Nigerian oil-exporting economy which, despite its abundant resources, still suffers from high rates of poverty and inadequate economic development rates. Policy mistakes and mismanagement of oil revenue alongside the volatility in oil prices made the economy vulnerable to what is denoted as the Dutch Disease Syndrome (DDS). Thus, the high proceeds that are realized during

positive surges in oil prices disturbs the sectoral balance of economy by making oil sector more attractive for investments on the expense of non-oil sectors that are mandatory for development.

Alley et al. also identify some origins and causes of oil price shocks. Alongside the political factors that may affect market forces and contribute to oil price shocks, they identify some economic factors. The low price elasticity of supply and demand on oil resources is one of the economic factors that contribute to oil price fluctuations. The time required to adjust capital stock to more energy-efficient substitutes create time lags that makes demand and supply less responsive to price changes. Another cause is the shifts in demand for oil particularly of emerging economics and shifts in precautionary/inventory demand targeted to moderate price surges. The higher than unity income elasticity is another factor that causes oil price volatility. Finally, the shift of oil contractual agreements from long term, predetermined spot prices contracts to short term market-based prices contracts also contributes to the volatility of oil prices.

The authors also provide a comparative analysis of the different forms of impacts that oil price shocks have on economic activities in oil-exporting and oil-importing economies. In oil-importing economies, positive surges increase production costs which in turn create an inflationary pressure that reduces economic growth rates. Meanwhile, positive surges stimulate oil revenues in oil-exporting economies; however, stimulating oil sector may expose the economy to the Dutch disease syndrome that makes the net effect of such positive surge not as pleasant. On the other hand, negative surges in oil prices reduce flow of foreign revenue to oil-exporting economies that in turn causes economic, and sometimes political, instability. They also confirm the asymmetrical effects of negative surges of oil price on oil-importing economies. While oil price rise negatively affect the level of economic activities in oil-importing economies, yet negative surges in oil prices do not stimulate economic growth.

Alley et al. econometric model is based on the main equation of GDP where the dependent variable is the natural logarithm of Nigeria's real GDP and the independent variables are also represented in the natural logarithm of GDP components. Transforming the equation to the logarithmic form allows for interpreting the variables in terms of growth rates. It also minimizes the problem of different units of measurements among variables.

To capture the essence of the Nigerian economy as a net oil exporter, they develop their model on a few steps starting by disintegrating export into oil-export and non-oil export variables. They also disintegrate oil export variable into its basic equation of quantity of exports and price of exports. A variable that captures the influence of oil price shocks is also included in the model and is computed through an autoregressive process in which the

residual is regressed on its mean and lagged forms. The model is tested for co-integration among variables and the Johansen system co-integration test's results confirm the long run relations that exist among variable. Moreover, the unit root test confirms that all the series are stationary of the first order.

The model's empirical results confirm the significant positive impact of oil exports on economic growth alongside the significant effect of oil price on economic growth. However, the negative impact of oil price volatility is statistically insignificant. Still, this negative impact could be interpreted in terms of the uncertainty that this volatility create on predicting government budget and the disturbance that this uncertainty causes to government's plans and fiscal operations. When negative surges may incline budgetary cuts, positive surges may incline an expansion in government spending that absorbs excess oil revenue.

Considering the specificity of the Nigerian economy as a net oil exporter and the differences in the impacts that oil price volatility create on levels of economic activities in other exporting economies represents the strength point of Alley et al. analysis. Another strength point is the analysis the authors provide for the presence of the Dutch disease syndrome (DDS) in the Nigerian economy which stands as an example of other developing, oil-exporting economies that are characterized by the same paradoxical situation of massive resources and poor development rates. Economies that are not diversified to depend on productive economic sectors other than oil industry are more exposed to inflationary pressure created by oil revenue inflows that are caused by positive surges in oil prices. The authors extend their analysis of DDS to include the effect that such inflation has on exchange rate. The appreciation of domestic currency makes other non-oil sector tradable goods more expensive and less competitive in global markets, by which absorbing the windfalls of the appreciated price of oil exports (Alley et al., 2014)

Another study that considers the repercussions of oil price volatility on the Nigerian Economy is Okoro's (2014). Okoro's uses Vector Autoregressive (VAR) model to examine the effect of volatility in oil prices on economic growth where the dependent variable is levels of GDP and the independent variables are: crude oil price, oil revenue, and oil price volatility measured by the World Bank indicator for Nigeria. The VAR frameworks allows for measuring the change of a particular variable in terms of its own lags and the lags of the other variables.

The data are tested for stationery and co-integration. Okoro's conducts the Augmented Dickey Fuller (ADF) unit root test and the result shows that all variables, except oil price volatility variable which is computed as ratio, are non-stationery. The existence of long run relationships among variables are tested using Johansen co-integration test which shows that such long run relationships exist among all of the variables. Therefore,

as more than one co-integration equation exists in the model, this allowed for estimating over-parameterized and parsimonious error correction. Over-parameterized and parsimonious error correction mechanisms (ECM) were used to deciding the most appropriate lag length and to deleting insignificant variables. Okoro's results confirm a significant negative impact of volatility in oil price on levels of economic growth in Nigeria. The study also provides some policy recommendations to minimize the effect of oil price shocks on the Nigerian economy which depends to a large extent on oil revenue. The recommendations include the diversification of the resources of budget revenue and the reduction of crude oil fiscal receipts monetization (Okoro, 2014).

Okoro's analysis develops on Jimenez-Rodriguez and Sanchez (2004) analytical framework presented in their working paper that provides empirical evidence of oil price shocks impact on real GDP growth in some OECD countries. Jimenez-Rodriguez and Sanchez (2004) work in its turn develops on the extensive work that Jimenez-Rodriguez conducted on analyzing the effects of oil price volatility on levels of real activities in multiple countries within different contextual regional circumstances.

Jimenez-Rodriguez (2004) first evidence of the existing nonlinearity in the relationship between US GDP growth and fluctuations in the price of crude oil was first presented in her work in 2004 when she argues that the non-linearity exists when using data prior to 1984, and even before 1977. She uses a Vector Autoregressive (VAR) model that summarizes economic activity through a seven-variable system using time series dataset that covers the period between 1972 up to 2001. The variables are: chain-weighted real GDP and unemployment rate as output variables, long run interest rate and federal funds rate as financial variables, wage, consumer price index and a measure of oil price change as prices variables. She discusses the results of the Granger-causality analysis in a bivariate and a multivariate context. The results therefore indicate that the interaction between oil price changes and macroeconomic variable is significant, with oil price changes Granger-causing the other variables included in the model (Jimenez-Rodriguez, 2004).

Jimenez-Rodriguez and Sanche (2004) extend the same analytical approach to include data on OECD countries. They use multivariate autoregressive models to assess the effects of oil price volatility on levels of real output in a few main industrialized OECD oil importing countries, alongside the United Kingdom and Norway as oil exporters. Jimenez-Rodriguez and Sanche developed both linear and non-linear models using quaterly data for each of the country under study. The resutls of the VAR model indicate the evidence of the non-linear impact of oil price volatility on GDP growth whether on importing or exporting economies.

The effects of an increase in oil prices on real GDP growth are found to differ substantially from those of an oil price declines. This finding contradicts the results of the linear approach which assume that oil prices have symmetric effects on the levels of real economic activities. The comparison between different models indicates that there is an evidence of non-linear impact of oil prices on real GDP growth in both oil importing and exporting countries (Jimenez-Rodriguez & Sanchez, 2004).

Yet, in the light of the political instability that is currently hitting major exporters of oil especially in the Middle Eastern region, applying a similar approach in order to analyze the same phenomena in other developing countries would be more insightful if it considers the political context within which oil transactions are taking place. Adding a binary variable that accounts for periods of political stability and period of political unrests and upheavals in regions of oil-importing countries may allow for discovering the interdependencies between economic and political factors that may cause oil price volatility. The inclusion of such a variable may also allow for discovering differences in the impacts of oil price volatility on levels of economic activates in different political context.

Wolfers and Zitzewitz (2008) consider the effect of political factors like war expectations on oil prices. They develop a prospective estimate to the effect of a policy change on stock prices and oil prices using a financial market-based approach. They attempt to estimate how financial market participants incorporate an expected probability of a policy change like a war event into their expectations of price stock change, and how they behave accordingly. In their particular case it is the ouster of Saddam Hussein regime. They use a financial instrument known as the "Saddam Security" that was extensively traded online in Iowa Electronic Market where this contingent asset's payoff of $10 was conditional to the ousting of Saddam Hussein as the leader of Iraq by a certain date. Wolfers and Zitzewitz focus on the June security that pays only if Saddam was out-of-office by June 30th, 2003. Their *ex-ante* analysis that was conducted one month before the 2003 Iraq war shows that the flow of war-related news affected to a large extent the variation in the movement of daily oil and equity prices. Their findings show a strong positive relationship between spot oil prices where a 10% increase in the probability of 2003 Iraq war was associated with a $1 increase in the per barrel spot oil prices. This increase could be interpreted by the market participants' expectations on price rise that reflects wartime supply disruptions. So, they conclude that the probability of war econometrically explains over 75% of the variation in spot oil prices during the period between September 2002 and February 2003 (Wolfers & Zitzewitz, 2008).

The following analysis develops on Okoro's (2014) framework which in its turn develops on Jimenez-Rodriguez (2004) and Jimenez-Rodriguez and Sanche (2004) approach of extending the analysis beyond linear modeling to the use of non-linear VAR models in order to predict the effect of crude price volatility on levels of macroeconomic indicators. The study was supposed to consider a factor of economic instability, yet it did not include any binary variable to account for the effect of economic instability because the dataset covers the decade that followed the overthrowing of Saddam Hussein's regime during which the country was inflicted with civil wars, sectarian conflicts, terrorist attacks, and the emergence of extremest Islamic currents as no data exist to covers any previous periods. Thus, the data timeframe did not allow for the inclusion of a dummy variable that allows for a comparative analysis to the effect of oil price volatility on Iraq's GDP between periods of political stability and periods of upheavals.

Data Description and Data Source

The time series datasets used in this study are derived from the database of Quandle Financial and Economic Data search engine with a specific source for each variable. The dataset on Iraq gross domestic products (GDP) measured at current prices billion US is used to proxy the level of economic activity in Iraq. Data on Iraq's GDP is derived from Angus Maddison Project Database published in 2015. The variable is differenced to overcome the problem of non-stationarity and two time lags of Iraq's GDP are included in the model as independent variables.

The time series datasets on all of the variables cover the period between 2003 until 2015 that represents the post-Saddam Hussein era. The era that followed the overthrown of Al-Ba'ath party regime that ruled Iraq since late 1970s led by President Saddam Hussein whose regime was overthrown by US troops intervention in April 2003.

The VAR model includes the following dependent variables to account for the effect of oil price volatility on the level of economic activity in Iraq during the above mentioned period of time. Two variables are included to measure the change in oil prices, a variable that represents the change in OPEC crude oil prices and Crude Oil Exchange Trade d Funds (ETF) Volatility Index. Two more variables are included to account for macroeconomic indicators: Iraqi government revenue of oil exports measured in billions of current US dollars and the exchange rate of the Iraqi national currency, Iraqi Dinar (ID), to US dollar.

The variable that measures the change in crude oil price is derived from the database of the Organization of Petroleum Exporting Countries (OPEC). The variable measures the change in the price of OPEC crude oil basket that includes prices of crude oil of a few major crude exporting

countries including the price of Basra light crude of Iraq, Arab light crude of Saudi Arabia, Qatar Marine crude of Qatar, Saharan Blend crude of Algeria, Iran Heavy crude, and more other non-Middle Eastern countries. The value of the change in measured in current US dollar. The variable is differenced and lagged for non-stationarity.

To account for the effect of oil price volatility, Crude Oil ETF Volatility Index that measures the market-based 30 days volatility expectations of the US Oil Fund LP using the Oil Volatility Index Ticker (OIL VIX, or OVX) methodology is used. The variable is transformed into the natural logarithm form to minimize the problem of differences in units of measurement used to measure the magnitude of different variables included in the VAR model. This logarithmic transformation of variables also allows for measuring the impact of dependent variable in terms of growth rate and non-percentage change. The data set of crude oil ETF Volatility Index is derived from Chicago Board Option Exchange (CBOE) database.

Dataset on Iraqi government annual revenue of oil exports as the main economic sector and largest sectoral share in GDP measured in billion current US dollar is derived from IMF Cross Countries Macroeconomic Statistics. Dataset on the annual exchange rate of Iraqi Dinar (ID) to US dollar is derived from the PENN World Table of the UC Davis Center of International Data. Both of the variables are transformed into their natural logarithmic form for the same reasons mentioned above; especially for the exchange rate as the difference in the unit of measurement is very huge since 1 US dollar stands for thousands of Iraqi dinar. They are also differenced and lagged for non-stationarity, yet the variable that measures export revenue was differenced twice as the first difference reported non-stationary time series, while the second difference did not.

Methodology

Building on Jimenez-Rodriguez (2004) and Jimenez-Rodriguez and Sanche (2004) findings regarding the use of linear models that was lossing their significane in terms of predicting the effects of oil price volatitiy on levels of economic activities, this study starts by developing linear models that predict Iraq GDP as a dependent variable by two former lags of the differenced GDP as independent variables alongside all of the above mentioned varibles of oil price volatility and Iraq macroeconomic indicators using different tansformations of the varaiables and different level-log, log-log, log-levels models. Yet, all of the linear models reported low measures of goodness of fit alongside high p-values for the independent varibles confirming Jimenez-Rodriguez (2004) findings of insignificant effect that oil price fluctuation has on levels of GDP. However, multivariate vector autoregressive models reported completely different results that confirm the

signficance of oil price volatility effect on levels of real activities. Thus, the study follows Okoro's (2014) theoretical apporach of using VAR model to predict oil price volatility effect on Iraq's GDP. The dependent variable is the first order difference of Iraq's real GDP, and the set of independent variables includes two lags of the same differenced variable. The augmented Dickey-Fuller (ADF) unit root test is conducted to test of non-sationarity of time series datasets. Johansen cointegration test in conducted to trace long run relationships among the variables, and the results of Vector error-correction models (VECM) are developed to conclude the findings.

Data Analysis and Results

The multivariate VAR model reports significant measures of goodness of fit as the model's R-squared value reported that 97.75 of the variation in the dependent variable, Iraq GDP, is explained by the variation of its former differenced lags and the log transformation of the above mentioned set of independent variables. The model also reported a low value of the Root Mean Squared Error (RMSE) measure of goodness of fit of time series prediction models that measures the goodness of fit from the opposite direction or the typical error side of the R-squared measure. The reported p-values associated with all of the independent variables indicate that all of them are significant in predicting Iraq GDP with a very highly significant negative effect of both of the change in OPEC crude oil price and the Crude Oil ETF Volatility Index on the level of real activity. This effect could be explained by the disturbance that such unanticipated changes in crude oil price create on government budget allocations for economic activities, especially when considering the huge budget allocation for public employment and the lack of revenue planning and economic forecasting that inflict Iraq's economic structure that totally depends on oil exports. The negative effect of the fluctuation in Iraqi Dinar (ID) to US dollar exchange rate also turned to be highly significant the thing that looks reasonable when considering the fact that the Iraqi economy is almost fully dollarized as the US dollar is used interchangeably in association with the ID for all large-scale and small-scale market-based transactions.

Augmented Dicky-Fuller (ADF) Unit Root Test

Upon conducting the Augmented Dicky-Fuller (ADF) Unit Root Test on the lagged and differenced transformations of each of the variables' time series individually, the null hypothesis of non-stationarity was rejected for all variables at all of the 1%, 5%, and10% critical values except for the first difference of export revenue variable that reported non-stationary time series. The problem of non-stationarity was eliminated by taking the second difference of the variable time series.

Johansen Test of Co-integration and Vector Error-Correction Models (VECM)

The results of the Johansen test of co-integration among the variables time series indicates the co-integration of the time series and existence of long-run relationships among the variables of the levels of GDP, growth rate of oil export revenue, and the change in the annual exchange rate of ID to US dollar. The test indicates a co-integrated vector and the existence of one co-integrating equation. Therefore, upon predicting the vector error-correction models (VECM), the co-integrating equation integrates the change in the annual exchange rate of ID to US dollar and the crude oil ETF volatility index, while other variables co-integration is not significant.

Conclusion

Crude price volatility is a major source of economic instability in exporting countries whose economy depends largely on crude export revenue. Iraq economy that is endowed with massive reserves of crude oil and an extensive level of crude export is expected to be vulnerable to a large extent to oil price shocks in global markets. To investigate the impact of crude price volatility on levels of economic activities in Iraq, this study estimates a multivariate autoregressive regression (VAR) model that predicts Iraq GDP in terms of a set of independent variables that measure crude price volatility in global markets and levels of Iraq macroeconomic aggregates. Two independent variables are used to proxy the volatility of crude oil, namely the change in the price of OPEC crude oil basket that includes prices of crude oil of a few major crude exporting countries and Crude Oil ETF Volatility Index. Both of the levels of government revenue of crude oil exports and exchange rate of Iraqi Dinar to US dollar are used to proxy Iraq economic indicators. The time series datasets employed in the study are tested for stationarity and co-integration using the augmented Dickey-Fuller (ADF) unit root test and Johansen test for cointegration respectively. Contrary to the results reported by applying linear models, VAR model results prove that the indicators used to measure oil price volatility are significantly affecting levels of GDP. They also confirm the existance of long run relationships among the economic indicators used to proxy the levels of crude oil exports.

References:

Alley, I., Asekomeh, A., Mobolaji H., & Adeniran, Y. A. (2014). Oil price shocks and Nigerian economic growth. *European Scientific Journal*, *10*(19), 375-392

Alnasrawi, A. (2002) *Iraq's Burden: Oil, sanctions, and underdevelopment,* Greenwood Press

Ibrahim, M. H., & Chancharoechi, K., (2014). How Inflationary are oil price hikes? A disaggregated look at Thailand using symmetric and asymmetric co-integration models. *Journal of the Asia Pacific Economy*, *19*(3), 409–422

Jimenez-Rodriguez,R. (2004). Oil price shocks: Testing for non-linearity. Center for Studies in Economics & Fiance - Working Paper , No. 115.

Jimenez-Rodriguez,R., & Sanche, M. (2004). Oil price shocks and real GDP growth: Empricial evidence from some OECD countries. European Central Bank Workign Paper Series, No. 362

Kumins, L. (2005). Iraq oil: Reserves, production and potential revenues. Congressional Research Service CRS, RS21626

Okoro, E., G. (2014). Oil price volatility and economic growth in Nigeria: A vector auto-regression (VAR) approach, Acta Universitatis Danubius Audoe, 10(1), 70-82

Owen, R., & Pamuk, S. (1998). *A history of Middle East economies in the twentieth century*. LB Tauris & Co. Ltd.

Wolfers, J., & Zitzewitz, E., (2009). Using markets to inform policy: The case of the Iraq war, *Economica*, *76* (302), 225-250. doi:10.1111/*j*.1468-0335.2008.00750