EFFECT OF INCREASING CHINA OIL DEMAND
ON WORLD OIL PRICES

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Abstract

The explosive growth in China's oil consumption in the last two decades has triggered series of researches into its likely impact on the level of oil availability to other regions and to world oil price. This study assesses the impact of China's ever increasing demand for oil on world oil price. The result we got after estimating through Vector Error correction Modeling (VECM) reveals that increase in China's oil demand has the tendency to significantly push up world oil price, and that China's oil imports have insignificant relationship with the world oil prices. The 10-period horizon variance decomposition shows that aside shock caused by oil price itself in previous period, China's oil import and total oil demand account for more variations in oil price. The impulse response analysis corroborates the findings of the variance decomposition that a shock to China's oil import and its total oil demand has a high tendency to increase world oil price. Therefore, China's policy makers are encouraged to draft measures that will ensure energy security, as over-reliance on other nations for oil may trigger both price and demand shocks.

Keywords: Oil price, imports, shocks, variance-decomposition, impulse response, energy security

INTRODUCTION

An uncontested fundamental relationships that have existed over time is that anytime the world economy experiences growth, oil demand will increase. Though, the strength of such relationships varies across regions and countries. For example, the unprecedented growth that China had witnessed in the last 20 years has led to rapidly increased demand for oil. China has become a powerful force in the world economy with production capacity to produce low-price goods for the world and has provided huge market for goods and services with millions of business opportunities for both local and international investors. These remarkable economic achievements in China is evidently attributable to the availability and utilization of oil in driving the various sectors of her economy. Historically, China, till the early 1990s was known to meet its own oil demand needs. That however changed since the mid 1990s when it became a net-importer of oil, and presently imports more than half of the oil it needs.

According to 2014 Energy Information Administration (EIA) estimates, China consumed an estimated 10.7 million bbl/d of oil in 2013, up 380 thousand bbl/d, or almost 4%, from 2012. In 2009, China became the second-largest net oil importer in the world behind the United States, and average net total oil imports reached 6.2 million bbl/d in 2013. Notably, for the fourth quarter of 2013, China actually became the largest global net importer of oil. EIA projects that China is likely to surpass the United States in net oil imports on an annual basis by 2014 as U.S. oil production and Chinese oil demand increase simultaneously.

Figure 1: Top 10 net Oil Importers
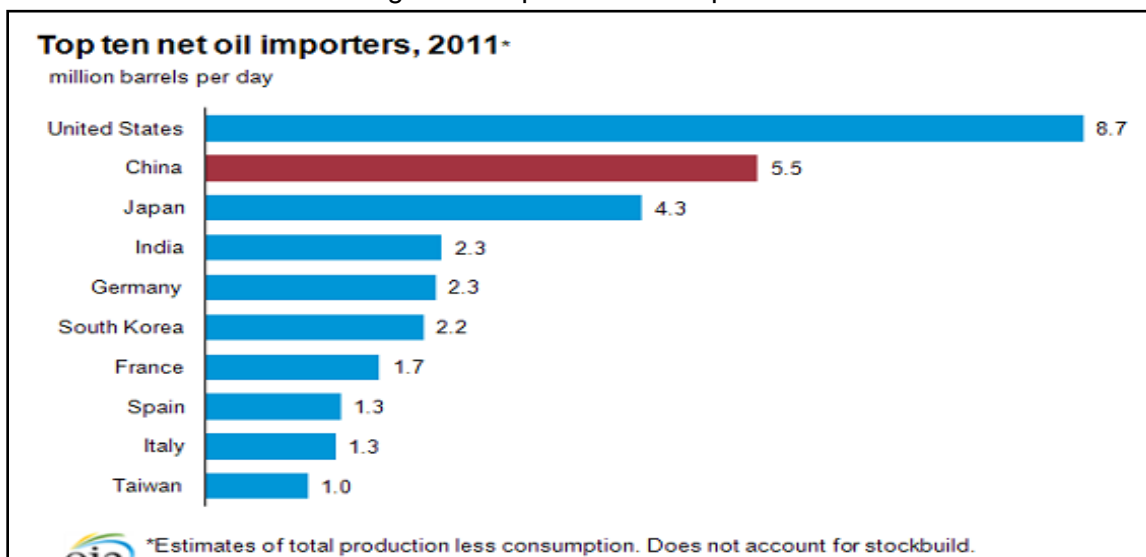
Source: British Petroleum Statistical Review of World Energy, June 2013

The question that needed to be answered in view of the aforementioned is; what has been the impact of China's increased demand for oil on the world oil price?. The theoretical underpinnings behind this question could best be explained by demand shocks, as hypothesized by Hamilton (2009). He argued that in the short run, if supply infrastructure does not have any chance to adjust to demand changes, unexpected increases in demand could cause supply–demand imbalances, and if demand outpaces supply to a large extent, prices would increase. It could however be argued that shortage of crude oil is not the reason for the recent increase in oil price. In fact, production has exceeded quota levels and that the market is well supplied. According to the Oil Market Intelligence report (2008), it states that "*It's all about demand. OPEC supply continues to be relatively high and non-OPEC supply is rebounding from problems, but none of that matters in the face of burgeoning current and, probably more importantly, prospective demand for both physical and paper oil".* To corroborate this assertion, ChevronTexaco Chief Economist, Edgard Habib stated that the world has moved from a marginal supply world to a marginal demand world. He stated further that it was scarce supply that caused the increase in oil prices in the 1970s and 1980s, but in the 21st century, very strong demand has been the cause of the increase in oil price. Furthermore, Kilian (2009) distinguished oil price shocks between oil supply shocks, aggregate demand shocks, and precautionary demand shocks as the types of shocks that are specific to the oil industry and argued that the recent oil price hike that ran up until the mid-2008 is primarily driven by booming aggregate demand. He finds that the demand-driven shocks have very different effects on the real price of oil and tend to impact the real economic activity differently from supply-driven oil price shocks.

It is the aim of this study therefore, to examine in detail what the impact of China's continued increased demand for oil could have on the world oil price. Section two would briefly discuss the background study of China's oil demand and use in the last two decades. Section three concentrate on the methodology and empirical analysis, while section five is the conclusion of the study.

OVERVIEW OF CHINA'S DEMAND FOR OIL

China evidently is the world's most populous country with a fast growing economy that has led it to be the largest energy consumer in the world. The rapidly increasing demand of China for liquid fuels has made her extremely influential in the world energy market. Basically, coal supplied the vast majority of china's energy consumption as at 2011 report, where oil was the second-largest source, accounting for 18% of the country's total energy consumption. While China has made an effort to diversify its energy supplies, hydroelectric sources (6%), natural

gas (4%), nuclear power (nearly 1%), and other renewables (1%) accounted for relatively small shares of China's energy consumption. Despite China being the fourth largest producer of oil, her total production which serves only her domestic market has not kept pace with the local demand growth. In 2013, China was reported to produce an estimated 4.5 million barrels per day (bbl/d) of oil with a forecast that the production will rise to about 4.6 million bbl/d by the end of 2014.

Despite China's huge domestic oil production meant totally for local consumptions, substantial oil demand for economic activities have increased pressure to import greater volumes of oil. Oil imports have increased dramatically over the past decade. The increased demand for imported oil from China is fuelled by its fast economic development in recent decades and have increasingly become significant factor in the competition for limited resources in the world oil market. For example, WEO (2008) forecasted that OECD share of total world oil market would only manage to marginally increase by 1.6% from 49.5% in 2006 to 50.3% of world oil demand in 2012. Conversely, China's world oil demand would increase by 31% from 7.1% of world oil demand in 2006 to 9.3% in 2012.

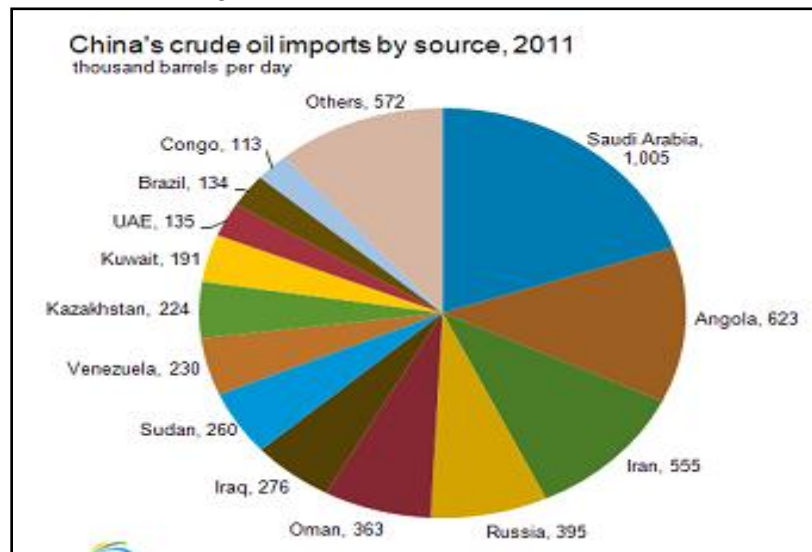Table 1: World oil demand by region, 2006-2030 (millions of barrels per day)

Region	Million barrels per day						% Growth 2006–2030
	2006	2012	2015	2020	2025	2030	
North America	25.3	26.2	26.6	27.0	27.3	27.4	8.3
Western Europe	15.7	15.8	16.0	16.1	16.2	16.2	3.2
OECD Pacific	8.5	8.3	8.3	8.2	8.1	7.9	− 7.1
OECD	49.5	50.3	50.9	51.3	51.6	51.5	4.0
Latin America	4.4	4.9	5.2	5.6	5.9	6.2	40.9
Middle East & Africa	3.1	3.7	4.0	4.5	5.0	5.6	80.6
South Asia	3.2	4.3	5.0	6.1	7.2	8.5	165.6
Southeast Asia	4.5	5.4	5.8	6.6	7.4	8.2	82.2
China	7.1	9.3	10.3	12.0	13.6	15.4	116.9
OPEC	8.0	9.1	9.7	10.6	11.4	12.2	52.5
DCs	30.3	36.7	40.0	45.4	50.5	56.1	85.1
FSU	3.9	4.2	4.3	4.4	4.5	4.7	20.5
Other Europe	0.9	1.0	1.0	1.0	1.0	1.1	22.2
Transition economies	4.8	5.2	5.3	5.4	5.5	5.8	20.8
World	84.6	92.2	96.2	102.1	107.6	113.4	34.0

Source : World Energy Outlook (2008)

According to China's customs data and FGE (2013), China imported 5.4 million bbl/d of crude oil on average in 2012, rising 7% from 5.1 million bbl/d in 2011. In 2013, import growth slowed to about 4.4% from 2012 levels, and crude oil imports averaged 5.6 million bbl/d. Crude imports now outweigh domestic supply, and they made up over half of total oil consumption in 2013. The Middle East remains the largest source of China's crude oil imports, although African

countries, particularly Angola, began contributing more to China's imports in recent years. As part of China's energy supply security policy, the country's National Oil Corporations (NOCs) are attempting to diversify supply sources in various regions through overseas investments and long-term contracts. In 2013, the Middle East supplied 2.9 million bbl/d (52%). Other regions that export to China include Africa with 1.3 million bbl/d (23%), the Americas with 562,000 bbl/d (10%), the Asia-Pacific region with 129,000 bbl/d (2%), and 736,000 bbl/d (13%) from other countries. Saudi Arabia and Angola are China's two largest sources of oil imports, together accounting for 33% of China's total crude oil imports.

Figure 2: China's Crude Oil Imports

China's crude oil imports by source, 2011
thousand barrels per day

Others, 572
Congo, 113
Brazil, 134
UAE, 135
Kuwait, 191
Kazakhstan, 224
Venezuela, 230
Sudan, 260
Iraq, 276
Oman, 363
Russia, 395
Iran, 555
Angola, 623
Saudi Arabia, 1,005

Source: Facts Global Energy

Before going into the empirical analysis of the quantifying impact of China's demand for oil on world oil price, we review some literatures in the field.

Beirne et al (2013) assess the externality impact of China's excessive growth as a China factor on the world economy via examining the effect of Chinese GDP growth on oil prices. The study further estimates the impact of world aggregate demand on oil prices. Using this two-stage approach, the study finds that China's excessive growth adds a premium to the price of oil which increases over time. The policy implication of this result deals with the sustainability of the Chinese faster growth rate from the perspective of its negative externalities to the world.

Niklaus and Inchauspe (2013) addressed the question of how increased demand for crude oil by China and India affects the world crude oil market. Using VAR approach, the result finds that China and India have high price-elasticity in the short-run but relatively inelastic in the

medium-run. It also found that an increase in OPEC production relative to the total production produces a significant increase in consumption in China and India during the first two quarters.

Mu and Ye assess the role of China's net import in the evolution of the crude oil price. Based on a vector autoregression (VAR) analysis on the monthly data on China's net oil import from January 1997 to June 2010, the study finds that the growth of China's net oil import has no significant impact on monthly oil price changes and that there is no Granger causality between the two variables . The historical decomposition indicates that shocks to China's oil demand have only played a small role in the oil price run-up of 2002-2008.

Skeer and Wang (2007) transport energy uses under different transport growth scenarios and forecast China's need to import to be between 52% and 68% of its oil demand in 2020. Korhonen and Ledyaeva (2009) examine the effects of oil prices shocks on oil producing and consuming countries and find that China is one of the worst affected economies, highlighting the negative impact of high oil prices on Chinese economy.

Choosing China and India as a representative of emerging markets, Li and Lin (2011) sought to examine if the quantity of crude oil imported by China and India is significant in the existing oil pricing system. With data that sprang from 2002 to 2010 together with the adoption of cointegration and error correction model framework, the results indicate that demand from emerging markets has become a significant factor in the world oil pricing system since 2003. The result thereby lends support to the widely held conjecture that the oil shock of 2007-2008 is a demand-led shock.

METHODOLOGY

Model Specification

Given the growing demand for imported crude oil by China, there is need to assess its impact on world oil price. Kaufmann (2004) sets out a pricing rule in an attempt to knowing how supply shortages, demand shocks and other economic and political factors affect the price of crude oil. It was originally used to provide evidence to identify OPEC behaviour- competitive Vs cooperative, as well as being applied to include simultaneous estimation of variables within a system. Following this pricing rule, we define an econometric model that estimates world oil price. A regression model would be set up with world oil price as the dependent variable while variables such as; China's import of oil, China's domestic oil production, and the total quantity of oil demanded by China (which assumed to linked to the level of economic activities).

The model is specified thus;

$$P_{oil} = \beta_0 + \beta_1 import + \beta_2 Prod + \beta_3 TotDd_{oil} \qquad \text{_____ (1)}$$

Price is the real Brent price averaged on a monthly basis, and is measured in US dollars per barrel. **Import** is the value of china's oil imports, measured in billion dollars. The value of import is equal to the price per unit of quantity of oil imports multiplied by the number of quantity units. **Prod** is China's oil refinery throughput measured in thousand barrels per day. That is, the total oil refined in all the refineries located in China meant entirely for domestic consumption. **TotDd$_{oil}$** is the total oil demand by China. Oil demand generally is linked to the level of economic activity. That is, as a country expands in economic terms, it will need more raw materials, which would include oil, where oil drives virtually all the sectors that make the Chinese economy. The demand for oil therefore, for the purpose of this study is measured by China's gross domestic product (GDP).

This study uses a time series data which spans from the periods 1990 through 2012. The world oil price and the oil refinery throughput are sourced from the British Petroleum Statistical Review of World Energy (2013). The value of China's oil import on the other hand is extracted from the International Financial Statistics (IFS, 2013). Finally, the total oil demand by China which is proxied by the GDP at current prices is extracted from the World Bank Development Indicators (WDI, 2012)

Estimation Technique and Diagnostic Test

The comprehensive empirical framework approach that this study shall adopt includes;

Unit Root Test

The unit root test is used to determine the stationarity of the variables in the model. This test checks if unit root is present in each of the variables in the model. The presence of unit root means that the variable is not stationary and vice versa. The most common method for testing for unit root is the Augmented Dickey- Fuller (ADF) test, and it would be adopted for the purpose of this study.

Basically, ADF test estimates the following equation

$$\Delta y_t = c_1 + c_2 t + \omega y_{t-1} + \sum_{i=1}^{r} d_1 \Delta y_{t-i} + v_t \underline{\hspace{6cm}} (2)$$

In equation 2 above, y_t is the relevant time series, Δ is a first difference operator, t is a linear trend and v_t is the error term. The error term should satisfy the assumptions of normality, constant error variance and independent (uncorrelated) error terms. The ADF test corrects for high-order serial correlation by adding a lagged differenced term on the right hand side.

Cointegration

Co-integration analysis refers to a group of variables that drift together, although individually they are non-stationary in the sense that they tend to go upwards and downwards over time (Egwaikhide and Tochukwu 2007). This common drifting of variables makes linear relationships between these variables over long period of time, thus translating into equilibrium relationships of economic variables (Gujarati, 2003). If these linear relationships do not hold over long period of time then the corresponding variables are not co-integrated.

There are several ways of testing for cointegration. The tests can be categorized into two broad categories: those that are residual based such as the Engle Granger approach and those that are based on maximum likelihood estimation on a VAR system, such as the Johansen method. The former category of the tests for cointegration suffers from numerous problems, such as the usual finite sample problem of a lack of power in unit root and cointegration tests, inability to perform any hypothesis tests about the actual co integrating relationships and their inability to detect more than one co integrating relationships that may exist in a model (Akintoye and Olowolaju 2008).

Since our model is multivariate, there is a likelihood of having more than one co-integrating vector. If there is more than one co-integrating relationships, the Engle-Granger approach would produce inconsistent estimates. Thus, in light of these problems, we prefer the Johansen methodology.

Vector Error Correction Modeling (VECM)

A unique feature of the VECM is that it treats each variable in the system as potentially endogenous and relates each variable to its own past values and to past values of all other variables. In essence, assumptions about the exogeneity of each of the explanatory variables can also be tested within the VECM using the data. This representation treats the world price of oil and the specified explanatory variables as interdependent, where an adverse shock on any of the explanatory variables used in this research work will have follow up impacts on the world price of oil.

Moreover, with a VECM representation it becomes easy to assess the effect of a particular shock on all variables by using the impulse response analysis. It traces the effect on the system of an exogenous shock to one of the variables in the model. Also variance decomposition forecast of private investment is essential as it helps to examine how much of the variance is explained by the explanatory variables within a certain year period.

ANALYSIS & RESULTS

Results of the Stationarity Test

The summary of the unit root test statistics used in this empirical study is represented in table 3 below. The variables for our analysis are subjected to Augmented Dickey fuller test (ADF), and the null hypothesis is that there is presence of a unit root.

The result indicates that all the variables are stationary at levels. That is, the estimated ADF statistics at levels for these non-stationary variables are smaller than the critical values at all the standard levels of significance. This means therefore, that all the variables have to be differenced to transform them to stationarity (Gujarati, 2003). In the second stage, the order of integration of the non-stationary variables was performed, still by means of ADF tests. After differencing the variables once, they all present I(1) behaviour at all the standard levels of significance. Thus the conclusion is that the non stationary variables become stationary after first difference.

Table 2: Augmented Dickey Fuller (ADF) test of Stationarity

Variables	Levels	First Difference	MacKinnon Critical Value at 1%	MacKinnon Critical Value at 5%	MacKinnon Critical Value at 10%	Order of Integration
L(Oilprice)	0.097021	4.328868	3.808546	3.020686	2.650413	I(1)
L(Prod)	0.415821	4.370246	3.808546	3.020686	2.650413	I (1)
L(Import)	0.351627	4.414033	3.808546	3.020686	2.650413	I (1)
L(TotDd)	0.460675	2.987578	3.788030	3.012363	2.646119	I (1)

The Cointegration Analysis, Results and Interpretations

The table below reveals that both trace statistics and max-eigen statistics indicates one co integrating equation each at 5% level of significance. The null hypothesis of no cointegrating vectors could conveniently be rejected and accept the alternative hypothesis of the presence of co integrating vectors. We can then conclude that there exists a long run relationship among the variables considered for this study.

Table 3: Johansen- Juselius Maximum Likelihood co integration Test Results

Hypothesized No. of CE(s)	Eigen value	Trace Statistic	Critical value 5 %	P-value	Max-Eigen Statistic	Critical value 5 %	P-value
None*	0.6955	49.731*	47.856	0.03	24.973	17.584	0.04
At most 1	0.556	24.759	29.797	0.170	17.077	21.122	0.168
At most 2	0.306	7.682	15.494	0.500	7.665	14.264	0.414
At most 3	0.0008	0.017	3.841	0.897	0.017	3.841	0.897

VECM Estimation Results and Interpretation

The result of table 5 shows the short run regression model using VECM. VECM is an important tool to use here as it endogenizes all the variables in the model and expresses each of them as a function of its past values and the past values of other variables in the model (lag length of order 2).

The dynamic adjustment towards the long run equilibrium is defined by the ECM estimates as shown in table 5. The speed of adjustment suggests that world oil price makes an adjustment of 1.34% towards the equilibrium relationship. This means that the adjustment oil price towards the long run equilibrium is negligibly driven by the explanatory variables (Prod, import, TotDd). The coefficient of determination denoted by R-squared is above average at 65%, indicating the success of the explanatory variables in predicting the value of the dependent variable (oil price).

Furthermore, China's total demand for oil from the VEC estimates was found to have a positive and significant relationship with world oil price. At a coefficient of 1.552, the result shows that a one percent increase in china's demand has the tendency to push up world oil price by 1.55%, though the relationship was negative at the 2-lag year period but the impact is found to be insignificant. Furthermore, China's oil import at both the first and the second lag periods have insignificant relationships with the world price of oil.

Table 4: Vector Error Correction Estimates

Equations for Variables	D(L(OILPRICE))	D(L(PROD))	D(L(IMPORT))	D(L(TOTDD))
ECM	-1.343085	-0.478964	-0.727150	-0.070111
	(0.89239)	(0.15108)	(1.13191)	(0.34838)
	[-1.50504]	[-3.17034]	[-0.64241]	[-0.20125]
D(L(OILPRICE(-1)))	1.127466	0.341284	1.768381	0.005103
	(0.70674)	(0.11965)	(0.89644)	(0.27590)
	[1.59530]	[2.85241]	[1.97268]	[0.01849]
D(L(OILPRICE(-2)))	0.228163	0.050313	0.305056	0.227395
	(0.67249)	(0.11385)	(0.85299)	(0.26253)
	[0.33928]	[0.44193]	[0.35763]	[0.86617]
D(L(PROD(-1)))	4.202143	0.235750	3.672169	0.538005
	(1.71298)	(0.29000)	(2.17275)	(0.66872)
	[2.45312]	[0.81294]	[1.69010]	[0.80452]
D(L(PROD(-2)))	-0.263074	0.275350	-3.808136	0.002381
	(2.11539)	(0.35812)	(2.68318)	(0.82582)
	[-0.12436]	[0.76887]	[-1.41926]	[0.00288]

Table 4…..

D(L(IMPORT(-1)))	-1.475243	-0.366910	-1.626855	-0.140152
	(0.66093)	(0.11189)	(0.83833)	(0.25802)
	[-2.23208]	[-3.27915]	[-1.94060]	[-0.54318]
D(L(IMPORT(-2)))	-0.175029	-0.136648	0.118170	-0.144760
	(0.67034)	(0.11348)	(0.85026)	(0.26169)
	[-0.26110]	[-1.20411]	[0.13898]	[-0.55317]
D(L(TOTDD(-1)))	1.551905	0.086500	0.289297	0.720069
	(1.07543)	(0.18206)	(1.36408)	(0.41983)
	[1.44306]	[0.47511]	[0.21208]	[1.71513]
D(L(TOTDD(-2)))	-0.662777	0.340444	-0.629404	-0.327050
	(1.09027)	(0.18458)	(1.38290)	(0.42563)
	[-0.60790]	[1.84447]	[-0.45513]	[-0.76840]
C	-0.116273	0.033635	0.378532	0.088342
	(0.26485)	(0.04484)	(0.33593)	(0.10339)
	[-0.43902]	[0.75015]	[1.12680]	[0.85443]
R-squared	**0.651047**	**0.742965**	**0.672667**	**0.302162**
Adj. R-squared	**0.336989**	**0.511634**	**0.378068**	**-0.325892**

Restricted Variance Decomposition

The variance decomposition analyses the impact of an exogenous shock to one of the variables by analyzing how the n-period ahead forecast innovations are explained. It analyses the possibility of contemporaneous shocks to the explanatory variables and measures the proportion of each of the shock to total variations in the endogenous variable. For example, it is expected that a shock to oil demand will bring about shock to oil production. Accordingly, we proceed to decompose the total variance of the forecast error of the world oil price, to examine how much of this variance is explained by China's total oil demand, China's oil import, and China's oil domestic production.

Table 5: Variance Decomposition of Log(Oil price)

Period	S.E.	LOG(OILPRICE)	LOG(PROD)	LOG(IMPORT)	LOG(TOTDD)
1	0.202833	100.0000	0.000000	0.000000	0.000000
2	0.276407	89.62304	0.028803	0.515323	9.832839
3	0.315682	71.19120	1.461797	12.00164	15.34536
4	0.392075	58.83905	11.92816	18.80178	10.43101
5	0.499708	65.18379	8.214133	15.04658	11.55550
6	0.589540	70.98225	6.780249	12.30660	9.930893
7	0.651975	70.38162	7.315474	11.73563	10.56728
8	0.711278	68.28118	8.459477	11.14395	12.11540
9	0.769937	66.52963	9.092863	11.24853	13.12898
10	0.831177	65.73849	9.574703	10.92220	13.76461

The result of the 10-period horizon variance decomposition of oil price shows that variation in oil price is predominantly attributed to its own shock. In period 2, Oil price accounts for 89.6% of total variations. This is followed by total oil demand which accounts for 9.83%, followed also by China's oil import. It is also observed that between periods 4 to periods 7, shock to China's oil import accounts more variations to oil price compared to total oil demand, and vice versa from periods 8 downward. It is clear from this table therefore, that aside shocks to oil price itself, shocks to China's import and China's total oil demand contribute to total variations in the world price of oil.

Impulse Response Analysis

The essence of impulse response is to enable us examine further the dynamic interactions among our variables of interest. Although, the variance decomposition show the importance of a variable to movement in another variable, the direction of these movements can only be observed from the impulse functions. Response to shock is either positive or negative. A positive value indicates that the variable increases when the shock occur. The effect can be either transitory or permanent, transitory response stabilizes at zero in the future after the effect of the shock has normalised. The effect is said to be permanent if it stabilizes at a value below or above zero in later period.

Figure 3: Impulse Response
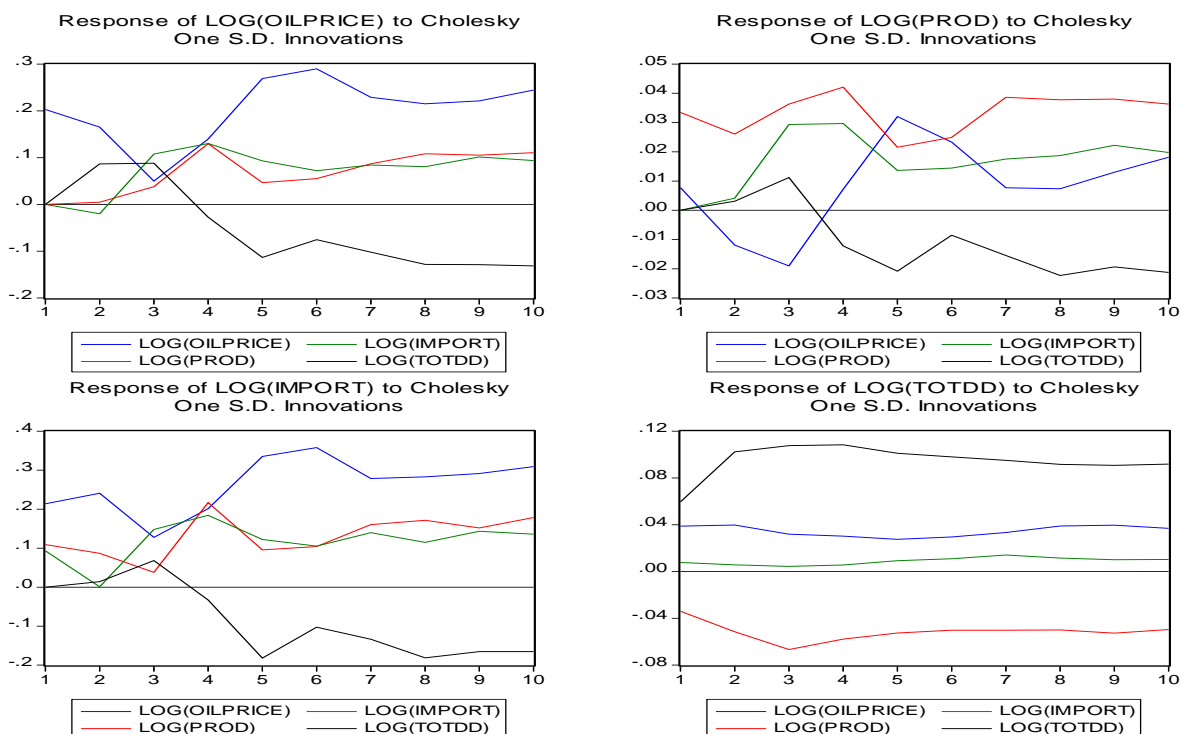
The impulse response function as shown in table 6 above shows clearly that a shock to China's oil import increases the world oil price, and forecasted such impact will continue for the next ten-year period. The same conclusion could also be drawn from shock to China's total demand for oil as shock to China's oil demand increases the price oil.

CONCLUSION

The focus of this study is to assess the impact of china's increasing oil demand on oil price. The research was conducted by adopting and modifying the pricing rule model built by Kaufmann (2004) to know how supply shortages, demand shocks and other economic and political factors affect the price of crude oil. A number of diagnostic tests (Unit root test and Cointegration test) were conducted to examine the behaviour of the data as to know how fit they are at accurately ascertaining the relationships that this study aims at achieving. The unit root test confirms the presence of unit root in all the variables, meaning that all the variables were non-stationary. The variables thereafter were first differenced which as a result, became stationary. The Cointegration test shows one co-integrating vector which means that those individually non-stationary variables jointly possess long run relationships. This thereby suggests that long run relationship exist between China's oil import and world oil price. The result of the 10-period horizon variance decomposition of oil price shocks actually reveals that aside shock caused by oil price itself in previous period, China's oil import and total oil demand account for more variations in oil price. The impulse response analysis corroborates the findings of the variance decomposition that a shock to China's oil import and its total oil demand has a high tendency to increases world oil price.

The high growth rates in economic output and increase in personal incomes in China have been accompanied by the ever increasing demand for oil. The growing population is demanding new roads, new cars and other infrastructures that are heavily driven by oil. This trend should send signals to the Chinese policy makers on how to go about the growth in its oil import, as the slightest shock/volatility to/of both price and availability would largely be felt on the cost to China and the level of availability.

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