Impact of US Crude Oil Inventory on West Texas Intermediate (WTI) Crude Oil Prices

Using the Structural Dynamic Model

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Abstract

The aim of this study is to examine the relationship between WTI crude oil prices and US crude oil inventory using the annual data from 1976 to 2009. At the beginning, the study estimates linear models using co-integration approach specifically Johansen techniques. Then, the study employs the approach to examine the relationship among WTI crude oil price, crude oil inventory, OPEC crude oil production, OPEC refinery capacity, and employment level and energy intensity.

Based on the VAR model, this study finds that the WTI crude oil price receives negative and significant influence from inventory, OPEC production, OPEC refinery capacity and energy intensity; and that employment affects WTI crude oil price insignificantly in positive direction.

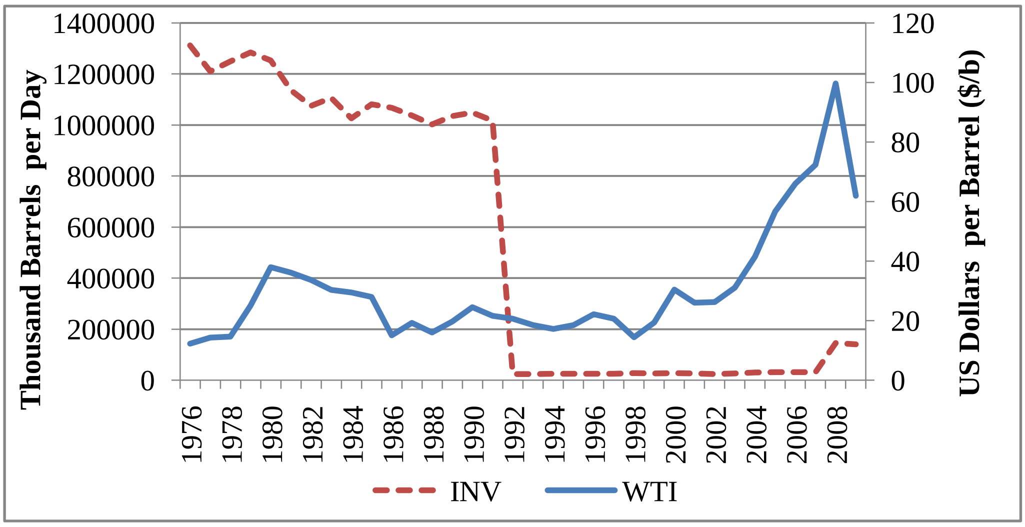
Keywords: Crude Oil Price, Crude Oil Inventory, VAR Model and West Texas Intermediate (WTI)

1. Introduction

Crude oil plays a very crucial role in the global economy and its price is usually characterised by wide price swings. Hikes in the price of oil often lead to inflation and subsequently have a negative impact on the economies of oil-importing nations. Conversely, Lower oil prices may lead to economic recession and political instability in oil-exporting countries as such economies are usually overly dependent on oil as primary source of revenue. Also, oil price volatility leads to economic losses. Owing to this, the need to determine the movement of oil price has been the global issue to be addressed by academic researchers and professionals.

Theoretically, the supply –demand imbalance leads to changes in crude oil price. The crude oil stock measures the gap between production and demand. Thereby, it could be considered as a significant factor that explains the physical condition of the supply-demand equality as it influences on oil price. For instance, a decrease in crude oil inventory in relation to excess demand in the market would result into a rise in oil price. The opposite situation occurs when an increased crude oil stock is above the market demand.

Figure 1.1: Historical Relationship between US Crude Oil Inventory and WTI Crude Oil Prices



Source: US Energy Information Administration (EIA, 2009), Washington DC

Figure 1.1 graphically depicts the correlation between the behaviour of WTI crude oil price and US crude oil price from 1976 to 2009. At the first year, both variables moved in opposite direction between 1976 and 1978. From 1978 upwards, positive relationship occurred between the two up until 1992 when inventory recorded the lowest figure and remained steady up to 2007. The drastic fall in crude oil stock from about 1,010,000 thousand barrels per day in 1990 to about 5,000 thousand barrels per day in 1992 could be as result of an increase in world oil consumption to 6.2 million barrels per day and a decrease in Russian oil production by 5 million barrels per day from 1990 to 2007(WRTG Economics, 2000). Price on the other hand, continued increase and finally reached its peak in 2008. In 2009, we can observe that price reached approximately $65 per barrel while inventory accounted for about 150, 000 thousand barrels per day.

2. Literature Reviews

Numerous studies have focused on modelling oil price using pure time series model, financial model and structural model; and some research combined both the time series and structural models. However, time model focuses on the historical time data to model oil price and ignores other economic variables that have influence on oil price. For the financial model, the oil price is modelled by the relationship between spot and future oil price while structural model considers macroeconomic variables that might determine oil price rather than the previous price in the time model and future price in the financial model.

For a nearly century, many theoretical and empirical studies such as Working(1934), Brennan (1958), Trelser (1958) Williams and Wright (1991), Pindyck (1994,2001) and Considine and Larson (2001) have been carried out to examine the relationship between the levels of commodity stocks and the spot prices. In addition, Dale and Zyren (1997) specifically stated that the futuristic behaviour of energy market is similar to agricultural commodity market.

However, some research observe the feature of crude oil market in terms of its prices and future market (see Morana,2001; Chernenko et al.,2004; Abosedra ,2005; Lalonde et al. (2003), Ye et al. (2005), Radchenko (2005), Chin et al. (2005); and Murat and Tokat (2009).

The relationship between oil prices and inventories has been examined by many studies such as Zamani (2004); Ye et al. (2002, 2005 and 2006); and Salman (2005 and 2006) etc. Salman (2005) tests the response of WTI crude oil price to various oil stock levels in the US using autoregressive model with variables such as WTI crude oil price, oil stocks and trend all in levels. The author concluded by suggesting the number of the following areas for further research. Firstly, one area is to investigate how oil stock levels influence crude oil price volatility and explore how forecasting capability can be improved. A second possible area is to find out how the unexpected market behaviour such as the two Gulf Wars could be captured. Finally, another available area is to examine the influence of commercial and non- commercial oil stock on the market price. This can also be extended by finding out how the previous and future oil stock levels affect the oil price. The research has been carried out to examine the impact of the total stocks (crude and its product) on oil price but no study has investigated into the separation of crude oil and its product inventories.

The above suggestions lead to the following research questions which the paper seeks to answer:

- What is the impact of US crude oil inventory on West Texas Intermediate (WTI) crude oil price?
- What are the other key economic factors driving changes in West Texas Intermediate (WTI) crude oil price?
- What is the relative weight of the variables in explaining West Texas Intermediate (WTI) crude oil price fluctuations?

2.1 Theoretical Framework on Oil Price and Inventory

According to Ye et al. (2005), five features of crude oil inventory are identified. Firstly, crude oil stocks are refined for the production of oil products, and stocks of oil products are available for final consumption. Secondly, oil prices respond more to inventories than to production in the short run because crude oil stocks are considered as the marginal source of supply. Thirdly, inventories ensure the supply of products in bulks in order to aid a system in the period of excess demand. Fourth, the future price and the market condition influence the level of producers' inventories. Finally, fluctuation in production and demand leads to a rise or a decrease in crude oil stocks. Inventories serve as an important indication of market condition in the sense that a drop in oil stock implies that there is an excess demand in the market. Therefore, oil price is expected to rise. On the other hand, an increase in inventories relative to the market demand for oil, this invariably leads to a decline in oil price. This postulates that inventories increase when there is excess supply and fall when there is excess demand.

Holding the influence of other factors constant, the balance equation in the oil market is expressed as follows:

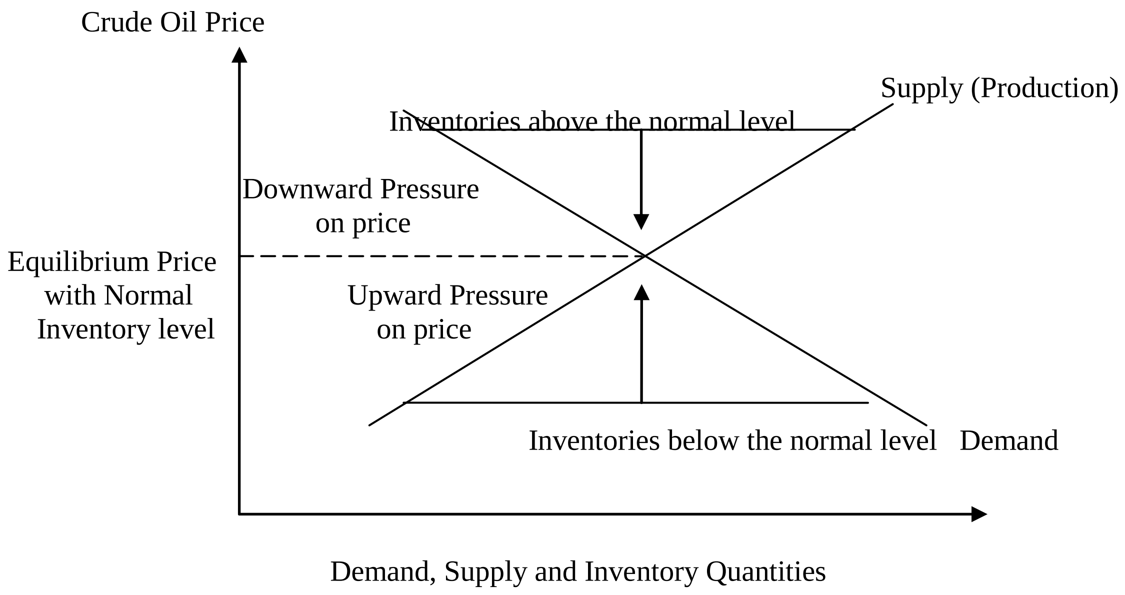
$$\text{Demand}_t = \text{Production} - \text{Inventory change}$$

Since inventory change = $\text{inventory}_t - \text{inventory}_{t-1,}$ (1) implies:

$$\text{Inventory}_t = \text{inventory}_{t-1} - (\text{Demand}_t - \text{Production}_t)$$

As shown in the figure 2.1, and assuming initial equilibrium inventories, if demand exceeds production in a given period, inventories will be drawn below the desired normal levels and there will be positive price pressure. Changes in oil stocks determine the extent of inequality between demand and supply. For instance, firms refine crude oil stock in excess relative to the demand during the spring and summer period with the expectation of high demand in the winter. Owing to this, there will be no positive pressure on the price. Subsequently, positive pressure on oil price occurs when the oil stock could not attain the desired normal level.

Figure 2.1: An Illustration of Supply, Demand and Inventory Behaviour on Price



Source: Ye et al. (2002)

It is crucial to note that the equilibrium price occurs when the supply-demand imbalance is normal taking into account seasonality and trend. Put differently, the equilibrium price is attained when the relative level of oil stocks (the difference between the actual inventory level and the desired normal inventory level) is zero. The importance of relative inventory level is that it serves as an indication of tight or loose market, and a rise or fall in price pressure.

3. Methodology

3.1 Scope of Study

The study covers the US as one of net oil-importing countries in the world. Also, West Texas Intermediate crude oil price is used since it is the international crude oil price in USA. This study requires data on WTI crude oil price, crude oil stocks and other key economic variables such as employment, OPEC production, OPEC refinery capacity and energy intensity from 1976 to 2009 for its empirical analysis. Data on WTI crude oil price, crude oil stocks and energy intensity are obtained from US Energy Information Administration (EIA). However, EIA only provides data from 1988 to 2009 for WTI crude oil prices; the remaining data prior to 1988 are obtained from BP statistical reviews while the data on OPEC crude oil production and refinery capacity are collected from OPEC Annual Statistical Bulletins. Data on employment level is obtained from US Bureau of Labour Statistics.

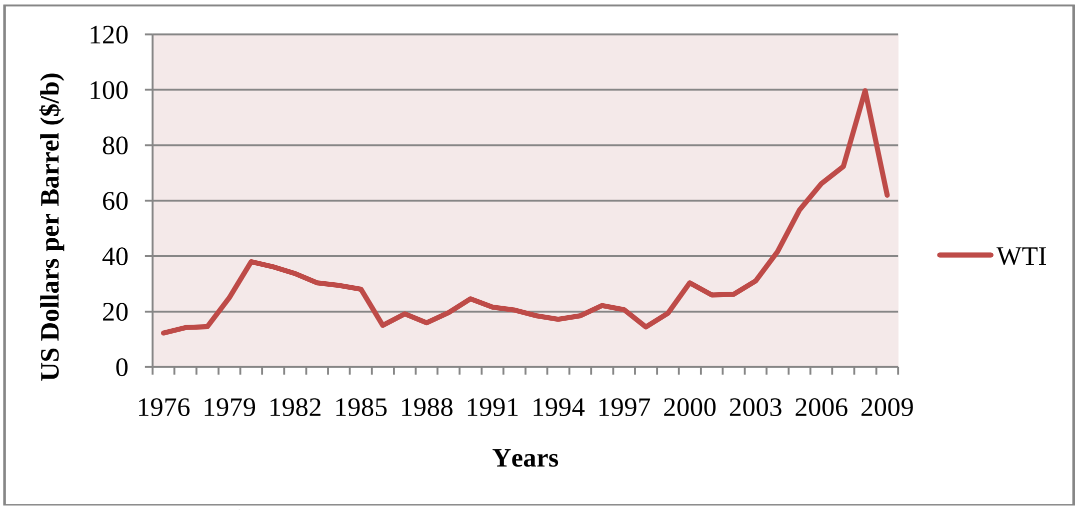
Based on the previous studies and background knowledge, assumption was made that crude oil price is influenced by inventory, OPEC production, OPEC refinery capacity, US employment and energy intensity. The aim of this research is to estimate the long-run and short-run inventory, crude oil production, refinery capacity, employment and energy intensity elasticities. The estimation of the model is carried out using the co integration method.

3.2 Description of all variables in the study

3.2.1 WTI crude oil price

Figure 3.1 plots the WTI crude oil price in the period 1976-2009. There was increase in WTI price of crude oil due to the 1990 Persian Gulf War, the PDVAS strike in late 2002, and Rita and Katrina hurricanes in 2005. Prior to the Iraq war in 2003, oil supply shortage led to an increase in oil price. The aforementioned events directly affect the supply side of crude oil market but the Asian crisis which is a clear illustration of an exogenous demand shock resulted into a drastic fall in the crude oil price in 1998 and 1999.

Figure 3.1: Historical Trend of Annual WTI Crude Oil Price

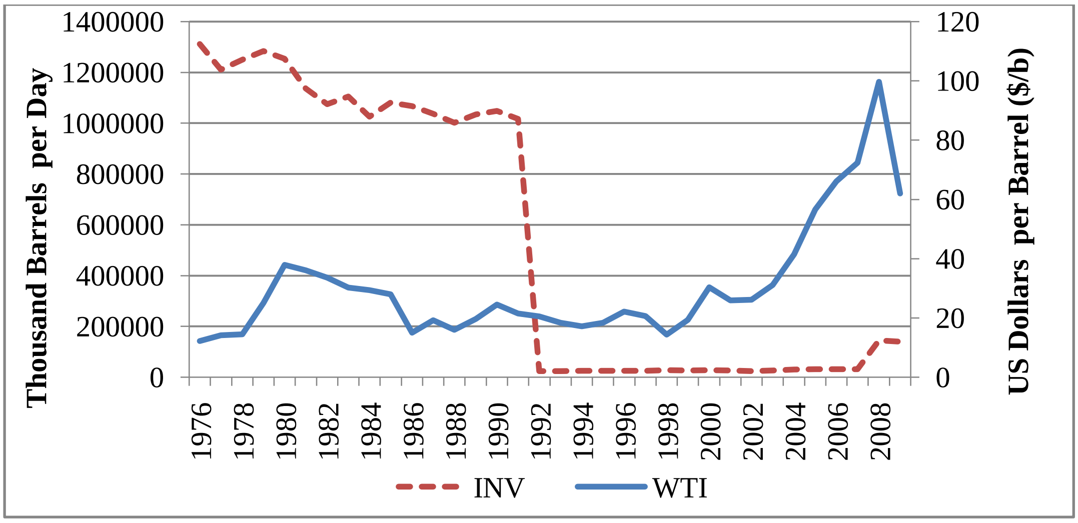


Data Source: US Energy Information Administration (EIA, 2009), Washington DC

3.2.2 US Crude Oil Inventory

Crude oil stock is the main factor that influences the short-run price of crude oil. However, many other commodities are produced to meet their direct demand; oil producers use their crude oil stock with the new production to balance demand level in the market. Obviously, inventories encourage producers to respond to the unexpected market condition (supply- demand imbalance) by taking from the existing crude oil stock. Figure 3.2 plots series of US crude oil inventory and WTI crude oil prices (see Figure 1.1 for more detail of the analysis). However, a negative relationship is expected between inventory and oil price based on economic theory described in Figure 2.1.

Figure 3.2: Historical Relationship between US Crude Oil Inventory and WTI Crude Oil Price

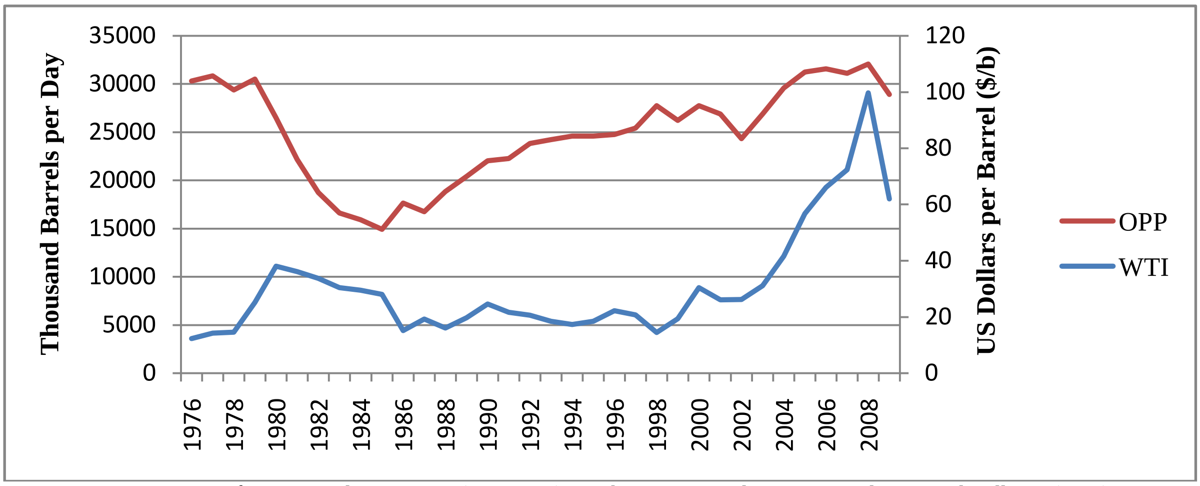


Data Source: US Energy Information Administration (EIA, 2009), Washington DC

3.2.3 OPEC Crude Oil Production

OPEC production, being the largest share of global production exhibits a significant influence on crude oil price. Figure 3.3 plots this time series of OPEC production (denoted as OPP) in thousands per day. Oil production witnessed a decline due to the Gulf War in 1990 and PDVAS strike in late 2002. However, the Asian crisis and the subsequent reduction in oil production in 1998 encouraged the Oil prices to revert to their previous value. Obviously, oil producing nations responded slowly to demand shocks due to the costs of adjusting oil production and the uncertain condition of the oil market. A prior expectation is that OPEC production has a negative influence on WTI crude oil price.

Figure 3.3: Historical Relationship between OPEC Production (OPP) and WTI Crude Oil Price (WTI)

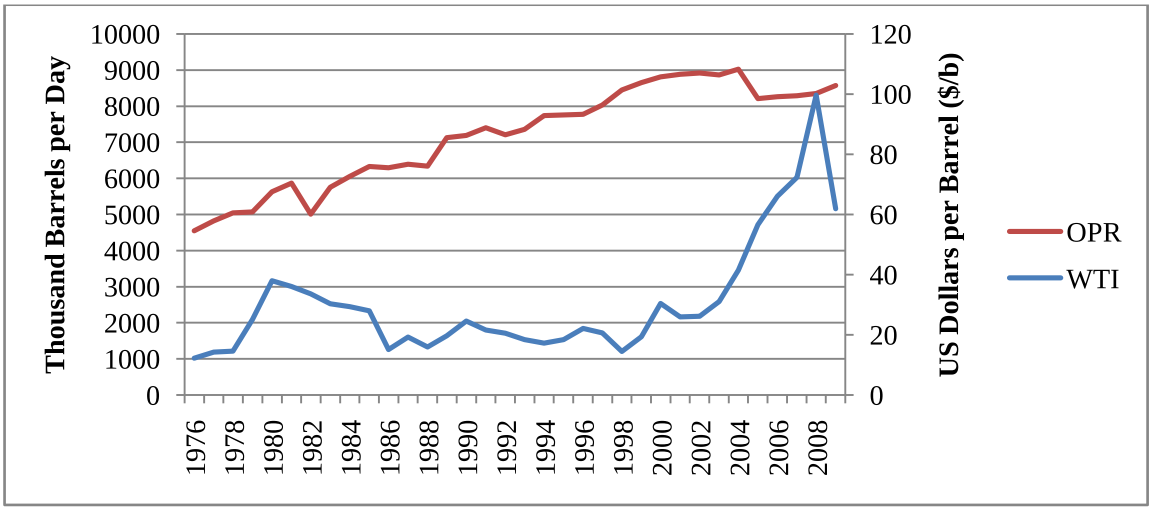


Data Source: US Energy Information Administration (EIA, 2009), Washington DC and OPEC Annual Statistical Bulletins (2009)

3.2.4 OPEC Refinery Capacity

Figure 3.4 plots the time series of refinery capacity denoted as OPR in thousands per day. The increase in the refinery capacity encourages the production of crude oil which in turn leads to a rise in the supply of crude oil. Consequently, this results into a fall in oil price. Economic theory suggests an inverse relationship between the two variables.

Figure 3.4: Historical Relationship between OPEC Refinery Capacity (OPR) and WTI Crude Oil Price (WTI)

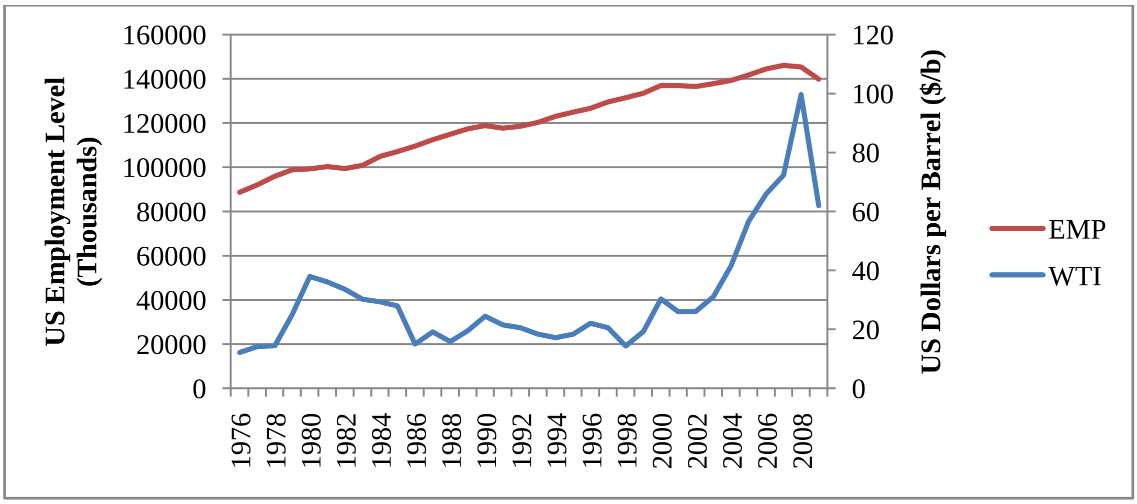


Data Source: US Energy Information Administration (EIA, 2009), Washington DC and OPEC Annual Statistical Bulletin (2009)

3.2.5 US Employment Level

This variable is used to capture the level of income in US. An increase in the level of employment will make more people to earn income. Owing to this, more people will demand for crude oil products which invariably increase the price for crude oil. Figure 3.5 plots the time series of employment between 1976 and 2009 measured in thousands. In the light of this, a positive relationship is theoretically expected to exist between employment and oil price.

Figure 3.5: Historical Relationship between US Employment Level (EMP) and WTI Crude Oil Price (WTI)

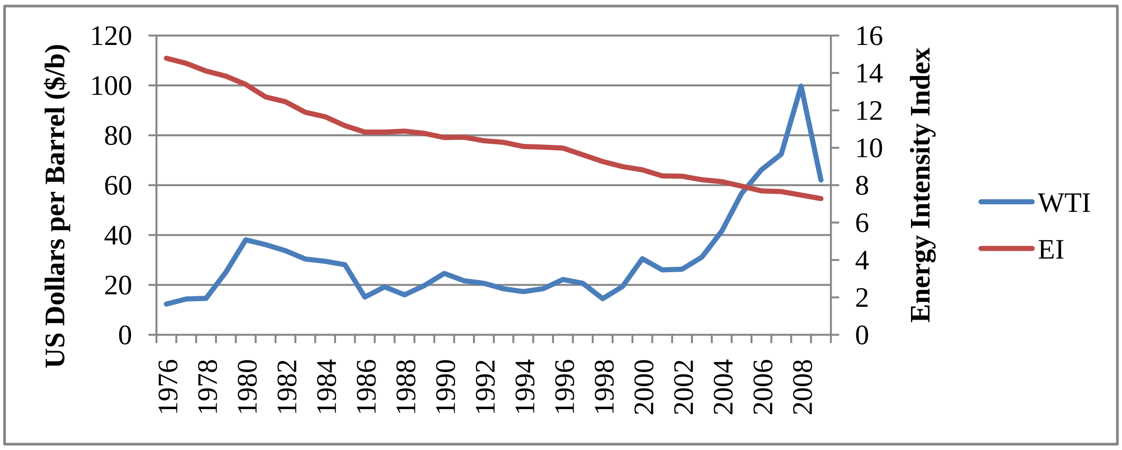


Data Source: US Energy Information Administration (EIA, 2009), Washington DC and US Bureau of Labour Statistics (2009).

3.2.6 US Energy Intensity

The study adopts an index designed by US Energy Information Administration to measure the US energy intensity. This index is calculated by dividing US annual energy consumption with US annual real Gross Domestic Production. Figure 3.6 plots the index of US energy intensity during the period 1976-2009. A decline in the index implies improvement in energy efficiency vice versa. Therefore, the index is used as the proxy for energy efficiency and a prior expectation is that the energy intensity has positive influence on WTI crude oil price.

Figure 3.6: Historical Relationship between US Energy Intensity (EI) and WTI Crude Oil Price (WTI)



Data Source: US Energy Information Administration (EIA, 2009), Washington DC

3.3 Model employed in the study

The study utilises the linear model to examine the relationship between WTI crude oil price and Inventory using co integration techniques. The model includes the additional explanatory variables (macroeconomic variables) such as OPEC crude oil Production, OPEC refinery capacity, US employment and energy intensity. Inclusion of these variables in the models makes them structural and inclusion of the lag of the variables makes them dynamic. Therefore, the model is regarded as the structural dynamic model as indicated in the study title.

3.3.1 Description of Linear Model

This model is employed by modifying Salman's model (2006). The modification is made by excluding the time trend and including macroeconomic variables because the time trend may not be able to capture all other factors that might have influences on WTI crude oil price. Owing to this reason, variables that can influence non- physical demand and supply of crude oil, which in turns affects the WTI crude oil prices, are included in the model. The model examines the impact of inventory, OPEC crude oil production, OPEC refinery capacity, US employment and energy intensity on WTI crude oil price.

3.4 Methods of Estimation

The study aims to examine the long-term relationship between WTI crude oil Price and crude oil inventory in US between 1976 and 2009. Employing co-integration and Vector Error Correction Model (VECM) steps, the study will investigate the relationship between the two variables. The possible short-run features of the relationship among WTI crude oil price and inventory are obtained from the VECM application. Then, unit root, VAR, co-integration and Vector Error Correction Model (VECM) steps will be exploited.

4. Presentation and Interpretation of Study Results

4.1 Data Sources

For the purpose of this study, all the variables analysed have been expressed in a logarithmic form. This empirical study utilises the annual time-series data of WTI crude oil price, inventory, OPEC crude oil production, OPEC refinery capacity, US employment and energy intensity for the 1976-2009 periods. The choice of the starting year is based on the availability of data on WTI crude oil price. Also, the annual dataset employed in this study is due to non availability of quarterly data on some variable such as employment and energy intensity. All the variables are expressed into natural logarithm form in order to reduce the scale effect.

4.2 Unit Root Test and Order of integration

Table 4. 1: Summary of ADF tests of unit roots in the variables (with intercept and trend)

Variables	ADF(n)	1% Critical value	5% Critical value	10% Critical Value	
LWTI	-1.701	-4.263	-3.553	-3.210	Fail to reject the null at all significance levels
LINV	-1.266	-4.263	-3.553	-3.210	Fail to reject the null at all significance levels
LOPP	-3.392	-4.285	-3.563	-3.215	Fail to reject the null but not at 10% significance level
LOPR	-2.110	-4.263	-3.553	-3.210	Fail to reject the null at all significance levels
LEMP	-1.007	-4.273	-3.558	-3.212	Fail to reject the null at all significance levels
LEI	-1.828	-4.263	-3.553	-3.210	Fail to reject the null at all significance levels
$\Delta LWTI^A$	-5.029	-3.654	-2.957	-2.617	Reject the null at all significance levels
$\Delta LINV^A$	-5.537	-3.654	-2.957	-2.617	Reject the null at all significance levels
$\Delta LOPP^B$	-2.229	-2.642	-1.952	-1.610	Reject the null at least at 5% significance level
$\Delta LOPR^A$	-7.081	-3.654	-2.957	-2.617	Reject the null at all significance levels
$\Delta LEMP^B$	-2.061	-2.639	-1.952	-1.611	Reject the null at least at 5% significance level
ΔLEI^A	-4.730	-3.654	-2.957	-2.617	Reject the null at all significance levels

ADF (n): Augmented Dickey-Fuller with allowance for nth auto regressions. Note: Maximum Lag length of 4 is allowed in the unit root tests based on Schwarz information criterion. Where LWTI is the natural logarithm of US West Texas Intermediate crude oil prices, LINV is the natural logarithm of US crude oil inventory, LOPP is the natural logarithm of OPEC crude oil production, LOPR is the natural logarithm of OPEC refinery capacity, LEMP is the natural logarithm of US employment level and LEI is the natural logarithm of US energy intensity. Superscript A denote the ADF test for first difference with intercept only and superscript B denotes the ADF test for first difference without intercept and no trend. For the graphical representation of the variables in level and first difference (see Appendix 1)

Table 4.1 presents the results of unit root tests based on augmented Dickey–Fuller (ADF) statistics on the natural logarithms of the levels and the first differences of the variables. In ADF test, the null hypothesis is that the series has a unit root against the alternative of stationarity. The results reveal that all series are I (1) in nature. The results of the ADF test do not establish stationarity for the levels of any of the series. So, there are sufficient reasons to accept the null hypothesis of a unit root for the level series. For all the first differenced series, the ADF test suggests stationarity at the 5% significance level.

4.3: Presentation of the Johansen Co-integration Results

Since the series examined have the same order of integration, this study is able to perform the Johansen and Juselius co-integration procedure. Co-integration tests have been subsequently applied, in order to find the long-run relationship between WTI crude oil price and inventory.

Table 4. 2: Selection of appropriate lag length

Lag	FPE	AIC	SC	HQ
0	9.53e-11	-6.07	-5.79	-5.98
1	5.76e-15	-15.81	-13.87*	-15.18
2	8.63e-15	-15.69	-12.07	-14.51
3	1.72e-15*	-18.18*	-12.90	-16.46*

Note: * shows appropriate lag length for each criterion.

Table 4.2 shows the optimal lag length selected in accordance with Final Prediction Error (FPE), Akaike Information Criterion (AIC), Schwarz Information Criterion (SC) and Hannan-Quinn Information (HQ). As reported in Table 4-2, while Final Prediction Error (FPE), Akaike Information Criterion (AIC) and Hannan-Quinn Information (HQ) suggest that the appropriate lag length for the model is “3”, Schwarz Information Criterion (SC) on the other hand, suggests that the appropriate lag length is 1.

Using a maximum likelihood procedure, the Johansen approach tests for the existence of co integration among non-stationary variables, and estimates the number of co integrating vectors in a multivariate context. If the co integration relationship is identified among the variables, then it is possible to estimate the parameters of long-run and short-run relationship.

Based on the result of unit root test, it is plausible to consider that all variables as endogenous variables in the unrestricted VAR model, which have long-run relationships and impacts. Initially, the lengths of the lags of endogenous variables were set at 3 (see table 4.4). Then, through a testing procedure and by using lag exclusion tests (Wald test) and lag length criteria (SC) suggested 1 in the first place; the final lag length in the unrestricted VAR model was selected to be one.

The next step is the test for the existence and the number of co integrating vectors. Using both the maximal eigenvalue test (L_{max}) and the trace test (L_{trace}), the table below illustrates the results of the test using a 5% significance level.

A linear deterministic trend was imposed on the data, which allowed for an intercept and trend in the VAR model, but not in the co integration equation.

4.3.1 Linear Inventory Model

In order to test the existence and the number of co integrating vector, both the maximal eigenvalue test (L_{max}) and the trace test (L_{trace}) are used. The table below illustrates the results of the test using a 5% significance level.

Table 4.3: The result of unrestricted co-integration rank test

Trace

H_0	H_1	Calculated Statistic	Critical value
$r = 0$	$r \geq 1$	121.70*	95.75
$r \leq 1$	$r \geq 2$	68.88	69.82
$r \leq 2$	$r \geq 3$	43.35	47.86
$r \leq 3$	$r \geq 4$	25.88	29.80
$r \leq 4$	$r \geq 5$	9.75	15.49
$r \leq 5$	$r \geq 6$	1.12	3.84

Note: * denotes the rejection of null of hypothesis at a 5% significance level.

λ_{max}

H_0	H_1	Calculated statistic	Critical value
$r = 0$	$r = 1$	52.82*	40.08
$r = 1$	$r = 2$	25.54	33.88
$r = 2$	$r = 3$	17.47	27.58
$r = 3$	$r = 4$	16.13	21.13
$r = 4$	$r = 5$	8.63	14.26

r = 5	r = 6	1.12	3.84

Note: * denotes the rejection of null of hypothesis at a 5% significance level.

Table 4.3 indicates the results of the johansen maximum likelihood co integration test using the Eviews package. Starting with the null hypothesis of no co integration among the variables, H_0: $r_0 = 0$, the trace test as shown in table 4.3, the null hypothesis of no co integration is rejected at the 5% level of significance.

Hence, results of both tests imply that the hypothesis of no co integrating equation is rejected at the 5% significance level. Turning to the maximal eigenvalue statistic is 52.82; this is above the 5% critical value of 40.08. Hence, the null hypothesis of r_0 is rejected at the 5% level of significance. However, under H_0: $r_0 = 1$, the trace and maximum eigenvalue statistics are 68.88 and 25.54, which are below the 5% critical value of 69.82 and 33.88, respectively.

Hence, the null hypothesis is accepted at the 5% significance level. These results imply that the series of the variables examined have one co-integrating equation; put differently, there is a long-run relationship among WTI crude oil price, inventory, OPEC production, OPEC refinery capacity, employment and energy intensity. Co-integration suggests the existence of Granger causality; however, it does not indicate the direction of the causality relationship.

Table 4.4: Estimates of Unrestricted Co integrating Vectors (β) and Loading Factors (α)

Variables	B	α
LWTI	1.00	0.10 (0.60)*
LINV	0.29 (5.83)	-0.68 (1.67)*
LOPP	1.57 (5.69)	-0.03 (-0.82)*
LOPR	9.22 (9.02)	-0.10 (-3.96)
LEMP	- 3.86 (-1.37)	-0.02 (-2.82)
LEI	5.15 (3.77)	-0.00(-0.46)*
C	-71.09	

Notes: t- statistics are given in parentheses and * denotes insignificant parameter.

Normalized for $LWTI_t$, the unrestricted co integrating vector is given by

$$v_t = LWTI_t + 0.29LINV_t + 1.57LOPP_t + 9.22LOPR_t - 3.86LEMP_t + 5.15LEI_t - 71.09 \quad (4.1)$$

This can be written as

$$LWTI_t = -0.29LINV_t - 1.57LOPP_t - 9.22LOPR_t + 3.86LEMP_t - 5.15LEI_t + 71.09 + v_t \quad (4.2)$$

As shown in Table 4.4, the t- statistics for the individual parameters (calculated by the method suggested by Juselius and Hargreaves 1992) indicate that the parameters in the β vector except LEMP are all individually significantly different from zero. Moreover, the co integration vectors have been normalized by the WTI crude oil price coefficient. Consequently, the co integrating vectors associated with LINV, LOPP, LOPR, LEMP and LEI can be considered as long-run inventory, production, refinery capacity, employment and energy intensity elasticities of WTI crude oil price. In addition, all the explanatory variables except energy intensity have correct signs as theoretically expected.

On the other hand, the loading factors associated with LWTI, LINV, LOPP and LEI were estimated to be insignificant at 5% level of significance. In contrast, the loading factor for the LOPR and LEMP are significantly different from zero with negative signs. This implies that the adjustment towards the long-run equilibrium is governed by adjustment in the LOPR and LEMP.

The equation (4.2) indicates that in the long-run equilibrium, a 1% increase in inventory, crude oil production, refinery capacity and energy intensity is accompanied by approximately 0.29%, 1.57%, 9.22% and 5.15% decrease in WTI crude oil prices respectively while a 1% rise in the US employment level is accompanied by about 3.86% increase in WTI crude oil prices, ceteris paribus. The t statistics for testing the significance of individual variables in the co-integrating vector indicates that variables (LINV, LOPP, LOPR and LEI) are significant at 1% significance level while variable LEMP is insignificant.

Table 4-5: VECM results (t-statistics in brackets)

	ΔLWTI	ΔLINV	ΔLOPP	ΔLOPR	ΔLEMP	ΔLEI
ECT	0.096	-0.679	-0.040	-0.100	-0.018	-0.004
	(0.605)	(-1.666)	(-0.823)	(-3.955)	(-2.818)	(-0.465)
ΔLWTI(-1)	-0.144	1.413	0.015	0.130	0.006	-0.011
	(-0.467)	(1.781)	(0.158)	(2.621)	(0.484)	(-0.642)
ΔLINV(-1)	-0.013	0.046	-0.002	0.014	-0.003	-0.002
	(-0.184)	(0.249)	(-0.114)	(1.260)	(-0.924)	(-0.467)
ΔLOPP(-1)	0.277	0.656	0.218	0.155	-0.012	0.053
	(0.396)	(0.364)	(1.022)	(1.386)	(-0.404)	(1.407)

ΔLOPR(-1)	-0.581 (-0.470)	-0.131 (-0.041)	0.345 (0.920)	0.179 (0.905)	0.102 (1.997)	0.044 (0.668)
ΔLEMP(-1)	7.091 (1.189)	3.754 (0.245)	-0.432 (-0.238)	-1.826 (-1.913)	0.205 (0.834)	-0.171 (-0.535)
ΔLEI(-1)	3.650 (0.911)	-15.951 (-1.551)	2.032 (1.670)	-0.374 (-0.584)	-0.007 (-0.042)	0.084 (0.392)
C	0.034 (0.311)	-0.554 (-1.999)	0.040 (1.217)	0.027 (1.561)	0.007 (1.642)	-0.017 (-3.011)

Hence, starting with the error-correction term (ECT), the results as shown in Table 4.5 suggest that the value of 0.096 for the coefficient of error correction term in the LWTI equation is not significant and does not have a correct sign while for the other equations , the error correction terms coefficients for LOPR and LEMP equations are negatively significant. This implies that the long-run disequilibrium error of the LWTI equation is not influencing the LINV, LOPP and LEI equations but influencing the LOPR and LEMP equations. In the short run LWTI equation, all the explanatory variables are not significantly different from zero as indicated in the Table 4.5.

4.4 Interpretation of the Results

The above model is estimated using the co-integration techniques to examine the influence of crude oil inventory on the WTI crude oil price. The linear inventory model is able to achieve the aim of this study because crude oil inventory is inversely significant in determining the WTI crude oil price in the model. In addition, this implies that the model is able to capture the influence of inventory on crude oil prices in the short-run and long-run situations. Also, the result of the linear inventory model conforms to the previous findings in the literature (Salman, 2006; Ze et al. 2002).

5. Conclusion

A policy implication of the results suggests that US should focus more attention on oil inventory as this influences the WTI crude oil prices and since the OPEC production and refinery capacity are beyond their control being the uncontrollable external influences. To address this influence of the oil prices, US should rely more on its fiscal policy for oil inventory rather than monetary policy.

Based on the aforementioned findings, this study adds to the existing literature, as it has a particular focus on the impact of crude oil inventory on the WTI crude oil price under examination. Also, it examines a large economy such as US being the largest net oil-importing country in the world rather than a regional economy which has been extensively studied in the past. Moreover, this study utilises the recent annual data which consider the recent oil crisis period.

In conclusion, an interesting area for further research is to examine the relationship between inventory and crude oil price using the structural dynamic model based on daily or weekly or monthly or quarterly data rather than annual data employed in this study. Also, future research can look at the relationship between the oil price and inventory in different regions in US in order to examine the regional differences in terms of their relationship.

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