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**Speculation, Futures Prices,
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U.S. Real Price of Crude Oil**

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Abstract

In this study, we examine the relationship between the U.S. real price of oil and factors that affect its movement over time: futures prices, the value of the dollar, exploration, demand, and supply. All of these variables are treated as jointly endogenous and a reduced form vector error correction model, testing for cointegration amongst the variables, is estimated. We find that for model specifications with short-term futures contracts, supply does indeed dominate price movements in the crude oil market. However, for specifications including longer-term contracts that are inherently more speculative, the real price of oil appears to be determined predominantly by the futures price. Moreover, there is empirical evidence of hoarding in the crude oil market: both oil stocks/inventories and futures prices are found to be positively cointegrated/correlated with each other. From a policy perspective, the results of this analysis indicate that if regulators really wanted to limit speculation in the oil market, it should keep the shorter-term futures contracts and eliminate the more speculative six months futures contracts.

JEL Codes: C32, G00, Q41

Keywords: futures prices, cointegration, speculation, hoarding

Introduction

There are those who believe high oil prices are the result of market forces--limited supply meets endless demand, which makes barrels of crude more expensive. In an October 2004 National Review article, "The Oil Bubble: Set to Burst?" it was argued that oil prices, at that time \$62 a barrel, would soon collapse. In ten months, oil was \$73 a barrel.¹ All through oil's five-year price surge, rising to \$105 per barrel as of March 2008, there have been many voices asserting that the precipitous rise is all the result of speculation--unsupported by the rudiments of supply and demand.² Speculation will increase oil prices through hoarding or increasing private inventories of crude. Some espouse that inventories have remained at "normal" levels, which implies that the rise in oil prices is not the result of runaway speculation, but the consequence of decreasing supply and the rapid growth of developing economies like China and India.³ We would like to point out that the notion of high futures prices reducing physical supplies through "hoarding" has nothing to do with a "normal" level of inventories, but whether there exists a positive relationship between futures prices and oil stocks/inventories.

In this study, the relationship between the price of oil and factors that affect its movement over time: futures prices, the value of the dollar, exploration, world demand, and world supply, will be examined. We will treat all of these variables as jointly endogenous and estimate a reduced form VEC model, testing for cointegration amongst the variables. The advantage to using this approach is twofold: first, the statistical results we get are not subject to endogeneity

¹ Spot Price of WTI/Light Crude as traded on the New York Mercantile Exchange for delivery in Cushing, Oklahoma.

² Ibid.

³ Paul Krugman, *The Oil Nonbubble*, The New York Times Opinion, http://www.nytimes.com/2008/05/12/opinion/12krugman.html?_r=2&th&emc=th&oref=sl&oref=slogin

bias, since the models used have only predetermined or exogenous variables on the right-hand side. Second, given that we will test for cointegrating relationships, there is little concern about finding “spurious” associations among the variables that may exist when one simply correlates two or more random walks with each other (Enders (2004)). Our fundamental purpose will be to determine just how much influence futures prices/speculation has on the real spot price of oil in the long-run.

Theory

Commodity-index investing has increased to \$260 billion in 2008 from \$13 billion in 2003. The prices of the 25 commodities that make up key market indexes have increased by an average of 183 percent in the same period.⁴ Index-fund investors do not buy physical commodities—they trade in futures contracts which are agreements to buy or sell a specific amount of a commodity at a set price by a specific date.⁵ Thus, futures are benchmarks for prices across commodities markets.⁶ An oil refiner may use futures to ensure up a quantity of oil for delivery at a later date or a farmer may use them to guarantee a price for his crop, but an index fund investor is only interested in riding a price trend by trading in contracts.⁷ These investors in the fund are not financing new oil wells that could boost global crude supplies—they are just reaping price gains in the commodity markets.⁸ Crude oil was at \$54 per barrel in

⁴ <http://www.latimes.com/business/la-fi-petruno24-2008may24,1,6762856.column>.

⁵ *Ibid.*

⁶ *Ibid.*

⁷ *Ibid.*

⁸ *Ibid.*

January 2007, \$72 in August 2007, and \$105 in March 2008.⁹ Many believe that oil prices are set based upon rumor, greed, and the fear of world interruptions—all having little to do with physical supply and demand.

What about the argument that oil price fluctuations are predominantly due to changes in demand and supply? Since early 2007, the U.S. demand for petroleum has fallen by one (1) percent and world demand has risen by 1.3 percent. Testifying to a U.S. Congressional Committee, Cambridge Energy Research Associates (CERA) has stated that world supplies are up and world oil production will increase significantly over the next seven years.¹⁰ Moreover, an analysis of global oil production and development demonstrates that the world is not running out of oil in the near-term, and a large increase in the availability of unconventional oils will expand global liquid hydrocarbons capacity by as much as one-fourth in the next ten years.¹¹ Oil has always been produced under conditions of imperfect competition. From the late nineteenth century days of John D. Rockefeller and the Standard Oil monopoly to the emergence of the “Seven Sisters” oligopoly--encompassing Standard Oil, Shell, BP, Texaco, Mobil, Gulf and Socal, to the rise of OPEC representing the major producing countries, the notion of a “free market” in the production of oil has been a delusion. One could argue that the predominant determinant of price has shifted from OPEC (having only 40% of the world production) and the oil companies to the speculators in the commodities markets. What transpires in the unregulated New York Mercantile Exchange (NYMEX), without the Commodity Futures Trading

⁹ Spot Price of WTI/Light Crude as traded on the New York Mercantile Exchange for delivery in Cushing, Oklahoma.

¹⁰ http://www.finfacts.com/irelandbusinessnews/publish/article_10004190.shtml.

¹¹ Ibid.

Commission (CFTC) enforced margin requirements, may be the source of increasing oil prices. Thus, the current market price may not be based solely upon physical supply and demand.

Alternatively, Krugman (2008) and other economists believe that there is no such thing as an “oil bubble.” He considers a scenario in which supply and demand balanced at a price of \$25 per barrel, and speculation drove the price up to \$100. What would occur? Drivers would cut back on driving, homeowners would turn down their thermostats, and owners of marginal oil wells would put them back into production. As a result, the balance between supply and demand would be replaced with a situation in which supply exceeded demand. This excess supply would drive prices back down--unless the excess was taken off the market. Thus, the only way speculation can increase oil prices is through hoarding. Krugman (2008) does not believe that speculation is prevalent in the market. He maintains that all through the period of the alleged bubble, inventories have remained at more or less normal levels. Therefore, the rise in oil prices is not the result of runaway speculation but rather the result of fundamental factors like the difficulty of finding oil and the rapid growth of emerging economies like China. As mentioned previously, the problem we have with this approach is the fact that the idea of speculation and high futures prices reducing physical supplies through “hoarding” has nothing really to do with what is considered “normal” inventories, but whether increases/decreases in futures prices are associated with increases/decreases in oil stocks or inventories.

As mentioned previously, our purpose here will be to determine just how much of an influence speculation has had on the market price of oil. The time period used is from January 1988 to March 2008. The following variables will be utilized in this analysis,¹²

¹²

See Appendix I for a complete description.

- $POIL_t$ - Crude Oil Spot Price at Cushing, Oklahoma (adjusted for inflation using the Personal Consumption Expenditure Chain Price Index),
- $FPOIL_{it}$ - Two, Three, Four, and Six Months Futures Price of Light, Sweet Crude Oil ($i = 2, 3, 4, 6$),
- EX_t - Real Trade Weighted Exchange Value of Dollar versus Major Currencies,
- $WELLS_t$ - Total Oil from New U.S. Wells,
- $DOIL_t$ - World Oil Demand,
- $SOIL_t$ - World Oil Supply, and
- $IRAQ_t$ - a Dummy Variable Indicating the Time Periods of the Gulf War and the Iraq War.

Time plots of the continuous variables may be found in Figure 1. All variables (except the dummy) are expressed in natural logarithmic units, so the estimated coefficients are interpreted as elasticities. The price of petroleum is generally measured as the spot price of either WTI/Light Crude, traded on the New York Mercantile Exchange (NYMEX) for delivery in Cushing, Oklahoma or the price of Brent as traded on the Intercontinental Exchange (ICE, into which the International Petroleum Exchange has been incorporated) for delivery at Sullom Voe. We decided to use the Spot Price at Cushing, Oklahoma, since it has historically been more of a U.S. crude oil “basket.” Not only is it used as the basis for U.S.-traded oil futures, but it's also a key benchmark for U.S. production. The two, three, four, and six month's contract settlement prices are the futures prices. The dummy variable is used in an attempt to capture periods in which there were supply interruptions, e.g., Iraq's oil production is 900,000 barrels per day below prewar levels. Inclusion of this variable may be considered to be somewhat controversial, as one can identify many such “structural changes” over the past ten or so years. While this is

case, we decided to include just the periods of the Gulf and Iraq wars since these are probably the most mentioned regarding their effects on the price of crude.

[**Insert Figure 1 Here**]

We begin by specifying four separate reduced-form Vector Autoregressive (VAR) model using the above jointly endogenous variables,

$$\bar{X}_{it} = A_{i1}\bar{X}_{it-1} + A_{i2}\bar{X}_{it-2} + \dots + A_{ip}\bar{X}_{it-p} + \bar{\varepsilon}_{it}, \quad (1)$$

where,

$$\begin{aligned} \bar{X}'_{it} &= (POIL_t, FPOIL_t, EX_t, WELLS_t, DOIL_t, SOIL_t, IRAQ_t)', \quad i = 2, 3, 4, 6, \\ A_{ij} &- 7 \times 7 \text{ matrix of coefficients, } i = 2, 3, 4, 6, j = 1, 2, \dots, p, \text{ and} \\ \bar{\varepsilon}_{it} &- 7 \times 1 \text{ vector of random errors with variance-covariance matrix } \Sigma_{\varepsilon}. \end{aligned}$$

Using a simple transformation, the VAR in equation (1) can be rewritten in terms of first differences, creating a Vector Error Correction (VEC) model,

$$\Delta \bar{X}_{it} = \pi_i \bar{X}_{it-1} + \sum_{\sigma=1}^{p-1} \pi_{i\sigma} \Delta \bar{X}_{it-\sigma} + \bar{\varepsilon}_{it} \quad (2)$$

Alternatively, we can consider a VEC model with a deterministic term. The deterministic term, D_t , can contain a constant, a linear trend, seasonal dummy variables, or nonstochastic regressors,

$$\begin{aligned} \Delta \bar{X}_{it} &= \pi_i \bar{X}_{it-1} + \sum_{\sigma=1}^{p-1} \pi_{i\sigma} \Delta \bar{X}_{it-\sigma} + AD_t + \bar{\varepsilon}_{it}. \\ \pi_i &= \alpha_i \beta'_i \end{aligned} \quad (3)$$

Since the data is monthly and has not been seasonally adjusted, D_t will contain monthly seasonal dummy variables.

If the matrix has a full rank ($r = 7$), all components of \bar{X}_t are I(0) (stationary or integrated of order zero). On the other hand, \bar{X}_t are stationary in first differences if the $rank(\pi_t) = 0$. If the rank of the matrix is $r < 7$, there are $(7 - r)$ linear combinations that are nonstationary and r stationary cointegrating relations. Note that the linearly independent vector, $\beta'_i \bar{X}_{it}$, is stationary and this transformation is not unique unless $r = 1$. β is the matrix of cointegrating parameters and α is the matrix of weights with which each cointegrating vector enters the six equations of the VEC. α can also be considered as the matrix of the speed of adjustment parameters.

Our interest lies with the unique case where $r = 1$. $\beta'_i \bar{X}_{it}$ may be written as,

$$v_{it} = \beta_{i1} + \beta_{i2} POIL_t + \beta_{i3} FPOIL_{it} + \beta_{i4} EX_t + \beta_{i5} WELLS_t + \beta_{i6} DOIL_t + \beta_{i7} SOIL_t + \beta_{i8} IRAQ_t \quad (4)$$

One motivation for the VEC form is to consider $v_i = \beta'_i \bar{X}_{it}$ as defining the underlying economic relations and assume that the agents react to the disequilibrium error v_i through the adjustment coefficient α_i to restore equilibrium ($v_i = 0$); that is, they satisfy the economic relations. The econometric use of the term “equilibrium” is any long-run relationship among nonstationary variables. Cointegration does not require that the long-run relationship be generated by market forces or by the behavioral rules of individuals. In Engle and Granger’s (1987) use of the term, the equilibrium relationship may be causal, behavioral, or simply a reduced form relationship among similarly trending variables (Enders (2004)). The cointegrating vector, β_i , is sometimes referred to as the vector of *long-run parameters*. We can also *normalize* equation (4) with respect to β_{i2} ,

$$POIL_t = \theta_{i1} + \theta_{i2}FPOIL_{it} + \theta_{i3}EX_t + \theta_{i4}WELLS_t + \theta_{i5}DOIL_t + \theta_{i6}SOIL_t + \theta_{i7}IRAQ_t + \eta_{it} \quad (5)$$

$$\theta_{ij} = -\frac{\beta_{ij}}{\beta_{i2}} \quad \eta_{it} = -\frac{v_{it}}{\beta_{i2}}$$

Since all of the variables are in natural logarithmic units, the θ_{ij} and their estimates are elasticity coefficients and may be interpreted as the percentage change in the price of oil given a one percent change in the relevant explanatory variable, *ceteris paribus*. Moreover, the magnitude of the elasticities will tell us which variables have had the largest effect on the price of crude over this period.

Results

We first test each variable for the presence of a unit root using the more efficient Dickey Fuller Test with GLS Detrending (Elliot, Rothenberg, and Stock (1996)). The results are in Table I. The null hypothesis of a unit root cannot be rejected for each and it appears that the variables are all integrated of order one (I(1)).

[Insert Table I Here]

As noted above, there are four futures price variables: two months, three months, four months, and six months contracts. This means that there are four models estimated using each futures price variable ($i = 2, 3, 4, 6$). We determined the lag length, p , by fitting the VAR equation (1) for each model and using the lag length criteria test in Eviews 6.0.¹³ The lag length tests were performed using the likelihood ratio test statistic recommended by Sims (1980).¹⁴ Following this, the Johansen procedure (Johansen (1988)) was used to test for cointegration and the results may be found in Table II. It is interesting to note that the null hypothesis of $r = 0$ is

¹³ EViews 6.0 was the software that was used for this entire analysis.

¹⁴ See Enders (2004), page 363 for a complete explanation of the procedure. For reasons of brevity, the results will be made available upon request from the authors.

rejected in favor of the alternative that $r = 1$ in each case. However, in the models with the shorter two and three months contracts, there is some ambiguity regarding the number of cointegrating relationships at $\alpha = .05$ ($r = 3$ and $r = 2$, respectively), albeit the null hypothesis that $r = 0$ is rejected in each case at $\alpha = .01$. When there are multiple cointegrating vectors, it is not straightforward to interpret their meaning, since you have to know what restrictions should be imposed on the system. Given the rejection of the null hypothesis that $r = 0$ in each case at the .01 level, we shall proceed to estimate the VEC equation (3) and equation (5) for each futures price.

[Insert Table II Here]

The estimation results for equation (5) are in Table III. Since our predominant interest lies with the cointegrating relation, for reasons of brevity, the estimates of the entire VEC model are not presented here.¹⁵ The initial most noteworthy result is the increasing magnitude and statistical significance of the futures price coefficients for each of the equations in Table III,

	<u>Coefficient</u>
• Two Months Contract:	.920
• Three Months Contract:	1.100
• Four Months Contract:	1.186
• Six Months Contract:	1.565

A one percent increase in the shorter-term two and three-months contracts is associated with a close to one percent increase in the real price of crude—a proportionate or unitary elastic response. However, a one percent increase in the six-months contract futures price is associated with a 1.6 percent increase in the real price of oil—a more than proportionate or elastic response. What is even more interesting is the magnitude of the coefficients of the remaining variables as

¹⁵ The estimation results of the VEC model will be made available upon request from the authors.

the contract length increases. For example, in the equations for the two, three, and four months contracts futures prices, the predominant variable in terms of its effect on the real price of oil is world supply,

Coefficient on Supply Variable

- Two Months Contract: -3.180
- Three Months Contract: -2.094
- Four Months Contract: -1.916

Thus, for these shorter-term futures prices, one could argue that “the economic data show that oil price levels are being driven by powerful fundamental economic forces and the laws of supply and demand,” not by speculation.¹⁶ Changes in shorter-term futures prices are not unimportant in predicting oil prices levels but changes in supply have a larger effect on real oil prices.¹⁷

[Insert Table III Here]

However, the situation is different for the six months contract futures price. *Not only is the coefficient on the six-months futures price elastic and statistically significant, but it is the only statistically significant variable (other than the Iraq war dummy variable) in the equation.* In one sense, this is not a surprising finding given that fact that a six months futures contract would be inherently more speculative than the shorter contract periods. Therefore, the six months futures price, not supply nor demand, appears to be driving the real price of oil in the market, *ceteris paribus*. These results imply that if the six months futures price were to fall by twenty percent, the real price of crude would decline by more than thirty percent from its present-day levels.

¹⁶ <http://www.latimes.com/business/la-fi-petruno24-2008may24,1,6762856.column>.

¹⁷ We should note that the elasticity coefficient on futures price for each equation is the second largest (after supply) in the two, three, and four months model (Table III).

Conclusion

We have found that for model specifications that include shorter-term futures contracts, supply does indeed dominate price movements in the crude oil market. However, for longer-term contracts, the real price of oil appears to be determined principally by the futures price.

In order for the relationship between futures prices and the market price of oil outlined above to be valid, two associations would have to exist: futures prices and inventories would have to be positively cointegrated and supply and inventories would have to be inversely cointegrated. As mentioned previously, the only way futures prices/speculation can increase oil prices is through hoarding which would increase inventories and remove oil from the market. There is empirical evidence of hoarding in the crude oil market. The estimation results of the following equations may be found in Tables IV and V,

$$\begin{aligned} STOCKS_t &= \gamma_1 + \gamma_2 FPOIL_{6t} + \gamma_3 DOIL_t + \gamma_4 SOIL_t + \xi_t, \\ SOIL_t &= \varphi_1 + \varphi_2 STOCKS_t + \tau_t, \end{aligned} \tag{6}$$

where the variable $STOCKS_t$ is U.S. stocks of crude oil excluding the Strategic Petroleum Reserve. It is important to note that the six months futures price is positively and significantly related to inventories with an elasticity coefficient of .135 and oil stocks are inversely and significantly related to market supply with a coefficient of 3.82. Thus, a ten percent increase in the six month futures price is associated with 1.35 percent increase in inventories which is in turn associated with a decrease in oil supplies of 5.16 percent. While this may not appear to be a large percentage, consider that fact that in January 2004 the six months futures contract settlement price for WTI/Light Crude was \$176.45 per barrel and in January 2008 it was \$512.09 per barrel--**a 190 percent increase**. In addition to the above empirical analysis, it is possible to discern graphically from Figure 3 that there was a slight increase in oil inventories with a

concomitant “leveling-off” of supply after 2005—indicating that perhaps some of the more current precipitous oil price increases are indeed due to speculation (shaded yellow area in Figure 3).

[Insert Table IV Here]

[Insert Table V Here]

[Insert Figure 3 Here]

From a policy perspective and given the current Congressional Hearings on the role of speculation in rising oil prices, the results of this analysis indicate that if regulators really wanted to limit speculation in the oil market, it could keep the shorter-term futures contracts and eliminate the inherently more speculative six months futures contracts.

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Appendix I

Variable Descriptions

(All Variables Downloaded from <http://www.haverselect.com>)

$POIL_t$ - Crude Oil Spot Price at Cushing, Oklahoma (\$/bbl) (adjusted for inflation using the Personal Consumption Expenditure Chain Price Index)

$FPOIL_{it}$ - Two, Three, Four, and Six Months Futures Price of Light, Sweet Crude Oil (\$/bbl) ($i = 2, 3, 4, 6$)

EX_t - Real Trade Weighted Exchange Value of Dollar versus Major Currencies (March 73 = 100)

$WELLS_t$ - Total Oil from New U.S. Wells (DOE)

$DOIL_t$ - World Oil Demand (Mil. b/d)

$SOIL_t$ - World Oil Supply (Mil. b/d)

$IRAQ_t$ - a Dummy Variable Indicating the Time Periods of the Gulf War and the Iraq War (August 1990 - February 1991, March 2003 -)

$STOCKS_t$ - Total U.S. Stocks of Crude Oil (000 BBL, DOE)

Figure 1

Time Plots

(All Variables are in Natural Log Units)

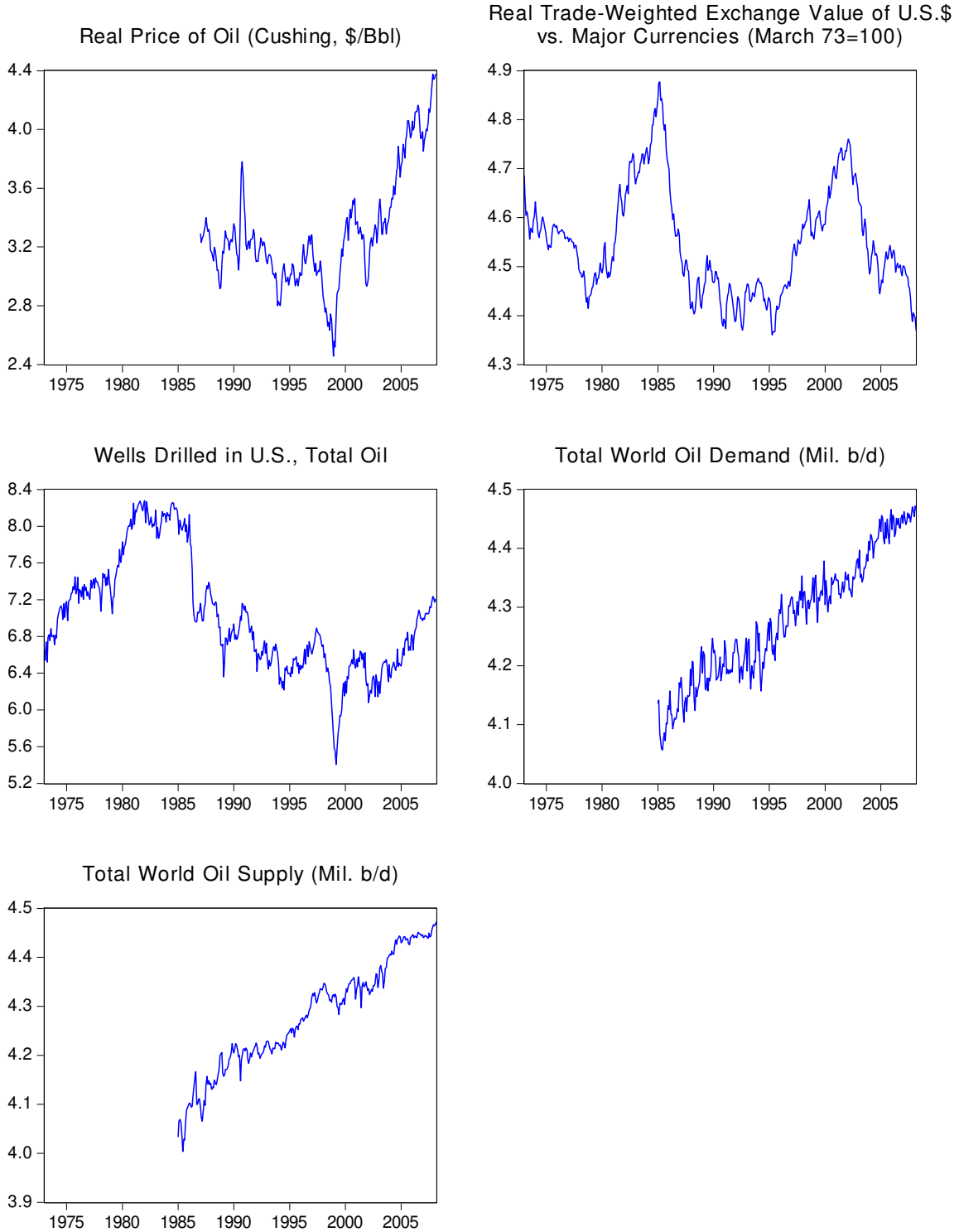


Figure 2

Real Price of Oil vs. Futures Prices

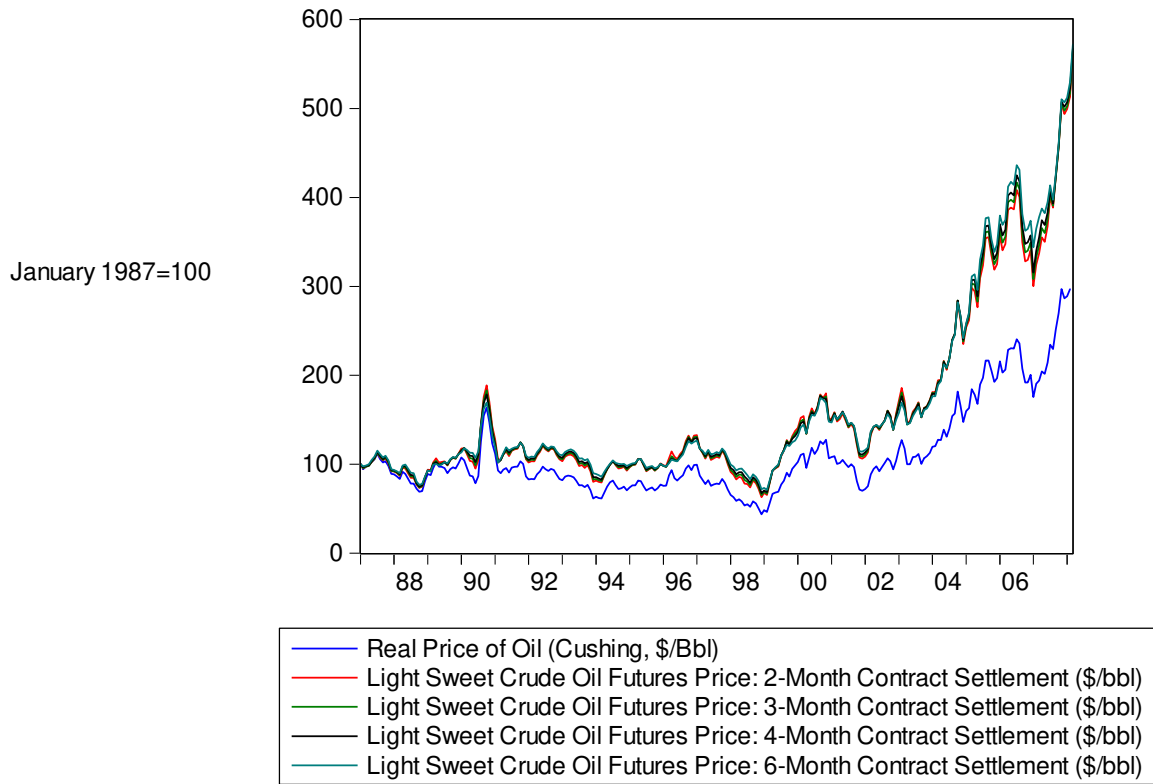


Figure 3

Stocks of Crude Oil vs. Oil Supplies

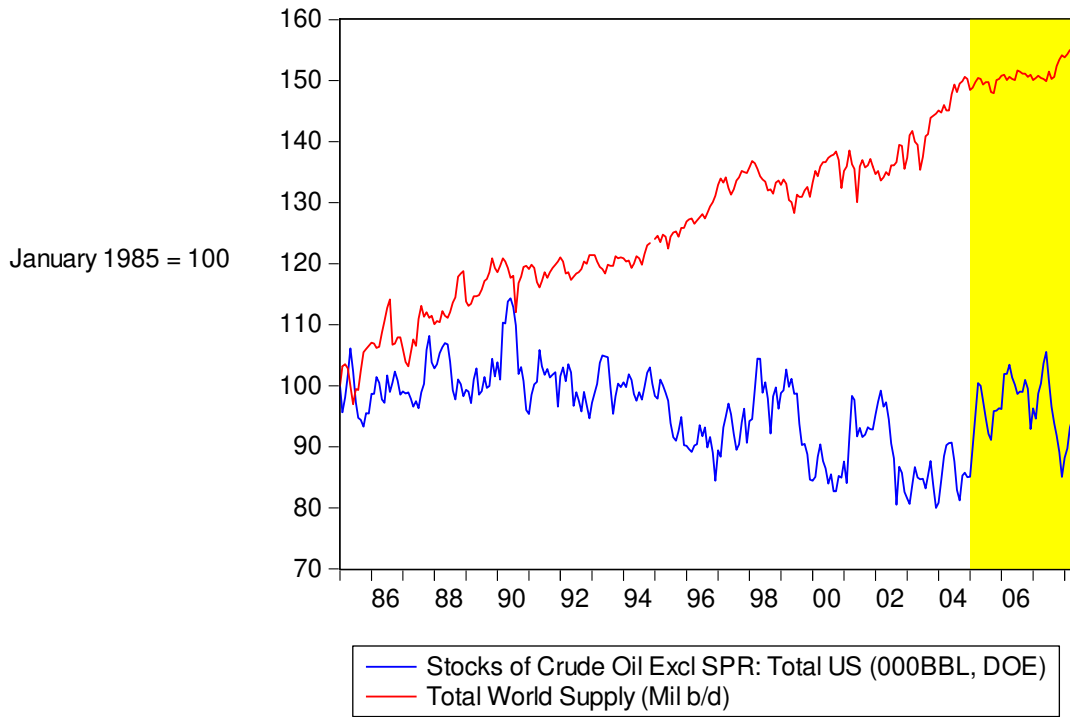


Table I

Unit Root Tests

Dickey-Fuller Tests with GLS Detrending

<u>Variable</u>	H_0 : Series has a Unit Root <u>t</u> Statistic
$POIL_t$ - Crude Oil Spot Price at Cushing, Oklahoma (adjusted for inflation using the Personal Consumption Expenditure Chain Price Index)	-1.015
$FPOIL_{it}$ - Two, Three, Four, and Six Months Futures Price of Light, Sweet Crude Oil ($i = 2, 3, 4, 6$)	-.492, -.618, -.242, -.312
EX_t - Real Trade Weighted Exchange Value of Dollar versus Major Currencies	-.899
$WELLS_t$ - Total Oil from New U.S. Wells	-1.555
$DOIL_t$ - World Oil Demand	-2.110
$SOIL_t$ - World Oil Supply	-2.170

Table II**Johansen Cointegration Tests****Maximum Eigenvalue Test**

$$H_0 : Rank(\pi_i) = r$$

$$H_A : Rank(\pi_i) = r + 1$$

1. Model using two months contract futures price:

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	5 Percent Critical Value	1 Percent Critical Value
None **	0.199033	53.48658	45.28	51.57
At most 1 *	0.170095	44.93289	39.37	45.10
At most 2 **	0.150309	39.25458	33.46	38.77
At most 3	0.091173	23.03964	27.07	32.24
At most 4	0.062096	15.45000	20.97	25.52
At most 5	0.021932	5.344337	14.07	18.63
At most 6	0.000600	0.144706	3.76	6.65

Max-eigenvalue test indicates 3 cointegrating equation(s) at the 5% level

Max-eigenvalue test indicates 1 cointegrating equation(s) at the 1% level

*(**) denotes rejection of the hypothesis at the 5%(1%) level

2. Model using three months contract futures price:

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	5 Percent Critical Value	1 Percent Critical Value
None **	0.208862	56.69632	45.28	51.57
At most 1 *	0.157357	41.43334	39.37	45.10
At most 2	0.116121	29.87119	33.46	38.77
At most 3	0.079595	20.07181	27.07	32.24
At most 4	0.048214	11.95842	20.97	25.52
At most 5	0.024076	5.897672	14.07	18.63
At most 6	6.38E-05	0.015439	3.76	6.65

Max-eigenvalue test indicates 2 cointegrating equation(s) at the 5% level

Max-eigenvalue test indicates 1 cointegrating equation(s) at the 1% level

*(**) denotes rejection of the hypothesis at the 5%(1%) level

3. Model using four months contract futures price:

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.213405	58.09017	46.23142	0.0018
At most 1	0.151167	39.66196	40.07757	0.0556
At most 2	0.118609	30.55358	33.87687	0.1185
At most 3	0.084249	21.29855	27.58434	0.2586
At most 4	0.046635	11.55736	21.13162	0.5917
At most 5	0.024469	5.995163	14.26460	0.6138
At most 6	4.76E-06	0.001152	3.841466	0.9723

Max-eigenvalue test indicates 1 cointegrating eqn(s) at the 0.05 level

* denotes rejection of the hypothesis at the 0.05 level

Table II (Continued)

Johansen Cointegration Tests

Maximum Eigenvalue Test

$$H_0 : Rank(\pi_i) = r$$

$$H_A : Rank(\pi_i) = r + 1$$

4. Model using six months contract futures price:

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.205918	55.79766	46.23142	0.0036
At most 1	0.142071	37.08252	40.07757	0.1047
At most 2	0.117888	30.35563	33.87687	0.1244
At most 3	0.085598	21.65541	27.58434	0.2386
At most 4	0.047838	11.86289	21.13162	0.5613
At most 5	0.024614	6.031163	14.26460	0.6092
At most 6	3.05E-05	0.007375	3.841466	0.9311

Max-eigenvalue test indicates 1 cointegrating eqn(s) at the 0.05 level

* denotes rejection of the hypothesis at the 0.05 level

Table III

Cointegration Estimation Results

Variable	Estimated Coefficients (t Statistics Below in Parenthesis)			
	Two-Months	Three Months	Four Months	Six Months
$POIL_t$	1	1	1	1
$FPOIL_{it}$.920 (30.84)**	1.10 (24.27)**	1.186 (19.475)**	1.565 (12.596)**
EX_t	.070 (1.28)	-.182 (-2.06)*	-.240 (-1.994)*	-.430 (-1.718)
$WELLS_t$	-.084 (-3.83)**	.020 (.567)	-.012 (-.254)	-.152 (-1.582)
$DOIL_t$	1.97 (4.06)**	.129 (.165)	.405 (.378)	3.128 (1.391)
$SOIL_t$	-3.18 (-7.32)**	-2.094 (-2.992)**	-1.916 (-1.999)*	-.596 (-.298)
$IRAQ_t$.035 (1.54)	-.008 (-.233)	.043 (.889)	.199 (1.962)*
Intercept	4.65	7.246	8.459	13.386

* - statistically significant at $\alpha = .05$

** - statistically significant at $\alpha = .01$

Table IV

Cointegration and VEC Estimation Results

Six Months Futures Price and U.S. Inventories

1. Johanson Cointegration Test:

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.105006	29.50957	27.58434	0.0280
At most 1	0.052065	14.22294	21.13162	0.3470
At most 2	0.022287	5.995269	14.26460	0.6138
At most 3	0.000175	0.046592	3.841466	0.8291

Max-eigenvalue test indicates 1 cointegrating eqn(s) at the 0.05 level

* denotes rejection of the hypothesis at the 0.05 level

2. Estimated Cointegration Vector:

Variable Estimated Coefficients (t Statistics Below in Parenthesis)

$STOCKS_t$	1
$FPOIL_{6t}$.135 (3.696)**
$DOIL_t$	-2.980 (-2.625)**
$SOIL_t$	1.886 (1.880)

** - statistically significant at $\alpha = .01$

Table V

Cointegration and VEC Estimation Results

Supply and U.S. Oil Inventories

1. Johanson Cointegration Test:

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.173906	52.72903	15.89210	0.0000
At most 1	0.023577	6.585256	9.164546	0.1501

Max-eigenvalue test indicates 1 cointegrating eqn(s) at the 0.05 level

* denotes rejection of the hypothesis at the 0.05 level

2. Estimated Cointegration Vector:

Variable Estimated Coefficients (t Statistics Below in Parenthesis)

*SOIL*_t 1

*STOCKS*_t -3.820
 (-3.259)**

** - statistically significant at $\alpha = .01$