Relationship Between Spot/ Futures Prices of Crude Oil, and Equity Indices for Oil- Producing Economies and Oil- Related Industries

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ملخص

العلاقة بين أسعار البترول الفورية/ المستقبلية ومؤشر أسواق الأسهم فى اقتصاد الدول المنتجة للبترول والقطاع البترولى

هذه الدراسة تحلل العلاقة الديناميكية بين أسعار البترول ومؤشرات البورصة الدولية لخمس دول. وقد بنيت هذه الدراسة على نهاية بيانات الشهر من خلال البيانات الشهرية لمؤشرات أسواق الأسهم، وأسعار البترول الفورية والمستقبلية وذلك لمدة ثلاثة أشهر. وقد شملت هذه الدراسة: البحرين، وإندونيسيا، والمكسيك وفنزويلا، وكذلك سلة الأسهم البترولية فى الولايات المتحدة الأمريكية.

ونتيجة لهذه الدراسة فقد ثبت وجود عوامل قوية تدفع أسعار البترول مع مؤشرات الأسهم منتجة علاقة ثابتة بينهما على المدى البعيد. كما أن أسعار البترول لثلاثة أشهر تنبئ باتجاه مؤشرات أغلب أسواق الأسهم باستثناء مؤشر الأسهم فى البحرين الذى يتطلب فاصلاً زمنياً لمدة أربعة أشهر لمعرفة اتجاه مؤشر سوق الأسهم. كما أثبتت الدراسة وجود تأثيرات سلبية على أسواق الأسهم فى الدول التى شملتها الدراسة نتيجة لتقلبات أسعار البترول المستقبلية على مدى ثلاثة أشهر وتأثيراً إيجابياً على سلة الأسهم البترولية فى سوق الأسهم الأمريكية. ويتبين من هذه الدراسة ما يلى:

أولاً: أسعار البترول لمدة ثلاثة شهور آجلة تحتوى على بعض المعلومات المفيدة للتنبؤ باتجاه أسواق تلك الأسهم.

ثانياً: تقلبات أسعار البترول تؤثر تأثيراً سلبياً على أسواق الأسهم فى الدول المصدرة للبترول لذلك فإن استقرار أسعار البترول يفيد أسواق الأسهم فى هذه الدول.

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1- Introduction

The primary objective of this paper is to examine the dynamic relationships between spot and futures markets for WTI crude oil markets on one side, and the stock markets for four oil-producing countries (Bahrain, Indonesia, Mexico and Venezuela) and one oil industry for the United States on the other side. The paper specifically investigates cointegration, causal relationships and spillover effects between these two groups of oil and financial markets. The oil prices include the WTI spot traded at Cushing, Oklahoma center, and the three-month futures traded at the New York Mercantile Exchange (NYMEX), whose contracts are WTI delivered.

For many oil-exporting countries, oil prices and production determine their oil revenues, and because oil demand is inelastic, increases in the prices lead to higher oil revenues. For some of those countries, oil revenues are the primary mover of economic activity because they influence government revenues, which in turn affect government expenditures and aggregate demand. The aggregate demand effect influences corporate output, domestic prices that will eventually impact corporate earnings and share prices of the companies. Oil revenues also affect their balance of payments, which influences their exchange rates; however the effect of the latter on corporate earnings is not readily determined.

As indicated before, the oil-producing countries considered in this paper include four developing countries, Bahrain, Indonesia, Mexico and Venezuela; two of them are members of the Organization of Petroleum Exporting Countries (OPEC), while Bahrain is a minor producer geographically surrounded by major oil exporters. For the oil producing countries such as the United States, which is also a major oil consumer, oil prices, in addition to the national business cycle, affect oil-related or oil-dependent companies and thus impact their earnings and share prices. The oil industry considered in this paper includes the oil exploration, oil drilling, oil production companies and refineries whose shares are part of the AMEX Oil Index of the American Stock Exchange.

The main findings of this paper are: (1) Oil price data series are less volatile but more skewed and more peaked than the financial data series; (2) Those series combined together in one system are cointegrated, move by common forces and have long run equilibrium relationships; (3) The three-month futures price Granger causes all of the stock indices, with the exception of Indonesia's stock index, and thus it has some predicting power; and (4) There is a negative volatility effect spilling over from the oil prices to the stock indices for these oil producing countries, and a positive spillover to the index of the US oil industry;

The paper is organized as follows. After the introduction in section 1, section 2 gives a brief review of the oil and financial literatures on the relationships between spot and future oil price, and between international equity markets. Section 3 describes the oil and financial variables used in the analysis, and section 4 examines the distributional characteristics of the data series of those variables. Section 5 investigates the unit roots, co-integration, and causal relationships/error correction models employed in the analysis. Section 6 uses the ARACH/GARCH models to investigate the spillover effects from the oil prices to the oil-sensitive equity indices. Section 7 concludes this paper.

2- Literature Review

Our study distinguishes itself from previous ones in the oil and financial literatures in that it examines the linkages between equity markets of oil producing countries and oil markets using the most current end-of-month data for five stock market indices: Bahrain, Indonesia, Mexico, Venezuela, and AMEX oil index. The oil markets are represented by the WTI-Cushing spot price and the NYMEX three-month futures price (NYCOF3). Other studies examined the oil markets and the international equity markets but separately.

In the oil literature, Schwartz and Szakwary (1994), for example, focused on price discovery and cointegration in petroleum markets. Silvapulle and Moosa (1999) examined the daily spot and futures prices of WTI crude using both linear and nonlinear causality testing. They found that linear causality testing reveals that futures prices lead spot prices but nonlinear causality testing reveals a bi-directional effect [(1)]. Gulen (1999) applied cointegration tests in a series of oil markets with pairwise comparisons on post 1990 data. He concluded that oil markets have grown more unified in the period 1994 to 1996 than in the period 1991 to 1994 Xiaowen and Tamuakis (2001) investigated the information transmission and the market leadership among the New York Mercantile Exchange, London's International Petroleum Exchange and Singapore Petroleum Exchange for NYMEX WTI crude oil and Brent crude futures. They analyzed the spillover effects and found that the NYMEX market is the true leader.

The financial literature examined the international equity markets separately from the oil markets. Most of this empirical work focused on short- run relationships between stock markets. Hamao et al (1990) and Longin and Solnik (1995), to name a few, investigated the interdependence of returns and their volatility across equity markets. Eun and Shim (1989) and Jeon and Von Furstenberg (1990) examined the speed and strength of intertemporal transmission of innovations across major stock exchanges.

Thus, while previous studies focused on either the international equity markets or crude oil futures markets separately, our study examines the linkages between the spot/futures oil prices and the international stock indices for the oil-producing countries and an oil industry. It examines unit roots, cointegration, Granger causality/vector error correction models and the spillover effects between the oil and stock markets for both developed and developing countries with varying degrees of economic development, population size, and relative importance of oil in total revenues and in stock markets.

3- Data Description for Oil Prices and International Equity Indices

The end-of- the month data series provided in this study are seven including two crude oil prices and five international equity series. The two oil prices are representatives of two trading oil centers: the Cushing, OK, trading center and the New York Mercantile Exchange. The five equity indices represent the stock markets of Bahrain, Indonesia, Mexico, Venezuela and the American Oil Exchange (AMEX). All prices for the Cushing center and the New York Mercantile Exchange are in dollars per barrel and are classified as spot and futures Prices. The monthly data of the above-mentioned stock indices are end-of-the-month value weighted and are calculated with dividend reinvestment.

The WTI crude oil spot price (denoted by WTIS) in this paper is the price of the West Texas Intermediate (WTI-Cushing, Oklahoma), which is a crude stream produced in Texas and southern Oklahoma. It serves as a reference or a marker for pricing a number of other crude streams and is traded in the domestic spot market at the Cushing, Oklahoma center. The crude futures prices traded at the New York Mercantile Exchange with three-months delivery (denoted by NYCOF3) have the underlying physical asset to he WTI delivered at the end of the domestic pipeline at Cushing, Oklahoma in parcels of 50,000 or 100,000 barrels.

The Amex oil index (denoted by AMEX) is designed to represent a cross section of widely held corporations involved in various phases of the oil industry. The index is price weighted, measuring the performance of the oil industry through changes in the sum of the prices of its 16 component stocks.

Bahrain Stock exchange composite (denoted by BAH) index depicts price movements for the markets a whole for the countries. The Bahrain Index is calculated on the basis of 25 issues and divided into sub-indices representing six economic sectors. As of the end of June 2000, the Bahrain Index represented 78.90% of the total market capitalization of all listed companies.

Jakarta Stock exchange index (IND), Indonesia, Composite Stock Price Index (CSPI) is a value-weighted index composed of all the listed stocks (including ordinary and preference shares). It was introduced on 1 April 1983. The base day for index calculation is 10 August 1982 and the base value is 100.

The Mexico IPC Index (denoted by MEX) is based on 1/10 th the level of the Indices de Precious y Cotizaciones ("IPC"). The IPC is a total return capitalization-weighted index of 36 major equity securities listed and traded on the Bolsa Mexicana de Valores ("BMV"). Caracas Stock Index (CSI which will be denoted by VEN) is a private-for-profit company regulated by the National Securities Commission, Venezuela.

All the data in the above series are end-of-the-month figures, available from January 2, 1991 until December 31, 2000. The data for the crude oil futures came from the New York Mercantile Exchange, while the data for spot came from Reuters. The data for international stock indices were obtained from Global Financial Data.

4- Descriptive Statistics for Oil Prices and Equity Indices

The descriptive statistics for all of the petroleum price and stock index data series are given in Table (1). The mean of the WTI-Cushing spot price is slightly greater than that of the NYMEX three-month futures price. Moreover, the relative volatility as measured by coefficient of variation for the WTI spot is also greater than that of the three-month futures.

For the financial variables, the Caracas stock market of Venezuela is the most volatile, while the Bahrain stock market is the least volatile. In fact, the Bahrain market has almost the same relative volatility as that of the WTI crude spot. The Mexico stock market is also very volatile, reflecting the recurrent economic and financial crises the country has endured.

All of the oil and financial series are skewed to the right, which indicates that their distributions are non-symmetric. The oil prices are more skewed than the financial series. These statistics imply that all of the series have thicker upper tail than the lower tail. Among the stock indices, Indonesia has the lowest skewness while Venezuela has the highest.

The Kurtosis (K) provides a measure of the peakedness or flatness of the distribution relative to the normal distribution. When K is greater than 3, then the distribution is considered more peaked than the normal. Both data series for the oil prices, NYCOF3 and WTIS are significantly higher than 3, whereas all of the financial series have K less than 3.

Jarque-Bera is the test statistics for testing whether the series is normally distributed. Examining the probability values for this statistics, we conclude that among all of the oil and financial data series only the data for the Indonesia (Jakarta) stock exchange has a normal distribution.

5- Unit Root Tests, Cointegration, and Granger Causality/Error Correction Models

The empirical analysis of the relationships between the two oil price series and the five international stock index series requires that several time series tests be conducted. The unit root test should be conducted first to ascertain whether the series are non-stationary in the levels (they do not revert to long run or average values), and whether they are stationary in the first differences. Then the cointegration test is conducted to find whether those non-stationary series have common long run relationships.

Examination of the directional causality among the co-integrated series is then conducted through the use of the error correction model, which requires first differences of the cointegrated series. For the series that are not co-integrated but have a single unit root, directional causality between the variables are conducted by using the traditional Granger causality for pairs of the first differences of the series.

5-1- The Unit Root Test

The Augmented Dickey-Fuller (ADF) is used to explore for the existence of unit roots, which means that the series is non-stationary. The test is based on the estimation of the general equation for single unit roots:

$$\Delta y_t = \mu + \gamma y_{t-1} + \delta_1 \Delta y_{t-1} + \delta_2 \Delta y_{t-2} + \dots + \delta_{p-1} \Delta y_{t-p+1} + e_t$$

This equation corrects for higher order correlation by adding lagged difference terms of the dependent variable y_t to the regressors.

The estimated equation is then used to test $H_0: \gamma = 0; H_1: \gamma < 0$. The null hypothesis of a unit root is rejected against the one-sided alternative if the ADF teststatistic is less than (lies to the left of) the critical value. For the study under consideration, the ADF test is conducted for all oil spot and futures prices, as well as for the indices of the five international equity markets. This test was first conducted in levels on all of the natural logarithms of the series, and the number of the lagged level terms was chosen based on the AIC and SIC information criteria. The test shows that all the oil and financial series are non-stationary at the 5% significance level (see Table 2). The test was then carried out again in first differences, and the number of lagged first difference terms was also chosen on the basis of the information criteria. As Table (2) shows all of the oil and financial series in the first differences of the natural logarithms are stationary at the 5% significance level. Based on the above results, we can conclude that all of the oil and financial series under consideration are integrated of degree one, I (1). Thus, the ensuing analysis of the dynamic behavior of the series including causality and spillover effects must be conducted in first differences of the natural logarithms.

5-2- Johansen Cointegration Test

The concept of cointegration is based on the idea that, although economic time series exhibit trending behavior, an appropriate linear combination between trending variables could remove the trend component and, hence, time series could be cointegrated. The cointegration test is applied to non-stationary series that have the same order of integration. If the regression residual of a system of non-stationary variables is stationary then the system is cointegrated.

The cointegration approach is advantageous in several ways. First, it helps determine the number of the long run equilibrium relationships (cointegrating vectors), or equivalently the number of common stochastic trends in the system. Second, it helps determine the speed of various market adjustments to the long run equilibrium path(s). Finally, the finding of the presence of cointegration paves the way for using the error correction model.

Since the study contains two sets of data: the oil set which includes the WTI oil spot and the NYMEX three-month futures prices, and the stock market set which comprises five international stock market indices, the cointegration test will first be applied to each set separately. Then it will be employed to examine the cointegration between the oil prices and the whole stock index set. Finally, the presence of cointegration will be examined between an oil price and the individual stock market indices in one set. Based on the presence of cointegration, individual VAR systems will be constructed to serve as the error correction models for the individual stock markets. Several specifications for the VAR series and the cointegrating equation are attempted, and the selection was decided by the likelihood ratio test, in addition to the AIC and SIC information criteria.

Applying the cointegration test to the oil set suggests that there is one long- run relationship (or one cointegrating vector) between the two prices, or equivalently one common stochastic trend "see Table (3)". This may be due to the influence of the international business cycles or to OPEC's intervention policy which aims at keeping oil prices in alignment. Moreover, the underlying asset for the NYMEX WTI futures price is the Cushing WTI spot price, which suggests that the two series have a strong long-run relationship (see Fig. 1).

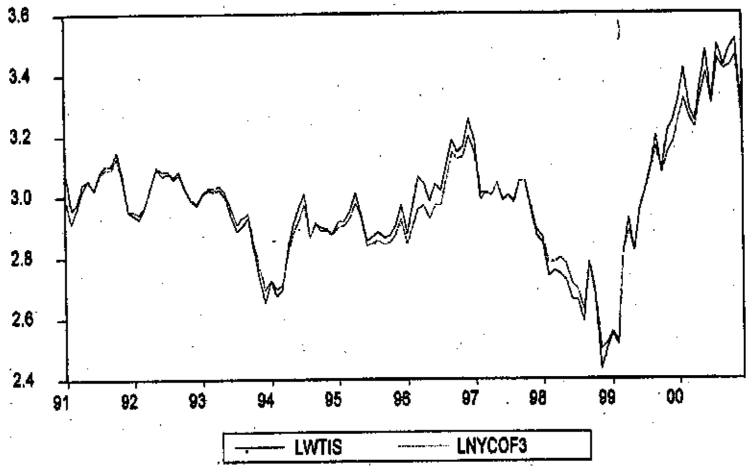

Figure (1)

Comovement of the WTI Spot and the NYMEX Three-Month Future Prices Expressed in Natural logarithms

Next, we apply the cointegration test to the five-index set with no oil prices included. The finding suggests there are four long run equilibrium relationships among them, or equivalently one common stochastic trend with four lags "see Table (4)". Those strong long-run relationships could be due to the occurrence of international business cycles, international financial crises, international political events and to changes in oil prices which affect all of their economies and commove those indices (see Fig. 2). In general, the more integrating vectors (i.e., less common trends) are in the system, the more stable the system is, and the more constrained the long run relationships among the variables are. The finding of four cointegrating vectors in this system suggests that the long run equilibrium relationships among the five indices are very stringent compared to a case of fewer cointegrating vectors. Those indices have tight comovements.

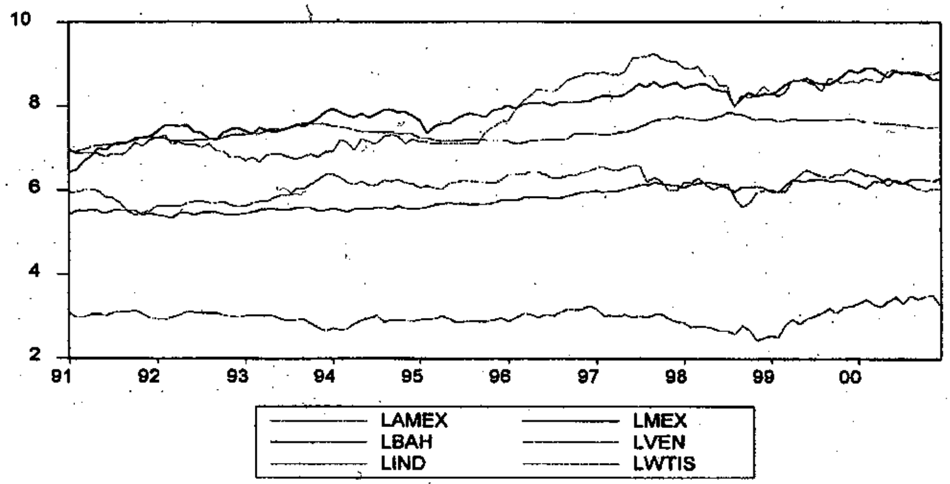

Figure (2)

Comovement of the WTI Spot Price and the Five Stock Indices Expressed in Natural logarithms

To find out if those stock market indices and the oil prices are cointegrated, we ran the cointegrating test for the mixed set that includes the five indices and the three-month futures price. The test suggests that there are three cointegrating vectors or long-run relationships between these six data series with five lags "see Table (5)". Comparing this result with the previous one of Table 4 indicates that there are fewer long run relationships when the oil price is included. This may be due to the elimination of some of the fundamental forces that may move those stock markets but have no common effects on the oil prices.

Upon examining cointegration for pairs that include the three-month futures price and each of the individual stock indices, the test suggests that each pair is cointegrated and has one cointegrating vector Table (6). However, these pairs require nine to eleven lags to show cointegration, which is longer than the lag lengths in Tables (4) and (5).

5- 3- Error Correction Models

If a set of non-stationary variables is cointegrated then an unrestricted vector auto-regression model (VAR) comprised of the first differences of the natural logarithms of these variables will be misspecified. That is because the first differences of non-stationary variables impose too many unit roots, and information on long-run equilibrium relationships among the variables will be lost. Then in this case the error correction model (VECM) must be used. This model includes a vector of error terms that represents deviations from the long run equilibrium, and lagged short-term deviation terms. The VECM model is represented by:

$$\Delta y_t = a_0 + B(L)\,\Delta y_{t-1} + a_1\,(\alpha' y_{t-1}) + e_t$$

where y_t is an n x 1 vector of variables that are cointegrated of order 1,1 denoted by CI(1,1), e_t is a n x 1 vector of separately uncorrelated errors (innovations) with zero mean, B(L) is an n x n matrix of the lagged polynomials, a_0 is an n x 1 vector of constants, a_1 is n x r matrix, and $\alpha' y_{t-1}$ are r stationary variables that are called the error correction terms representing deviations from the long run equilibrium relationship. If the term $\alpha' y_{t-1} = 0$, then it represents a convergence to the long-run equilibrium in the system. On the other hand, if this term is not equal to zero then the system is out of equilibrium.

In order to estimate a VECM for any of the individual stock index systems under consideration, we have to determine the number of lags in each equation of the first differences of the natural logarithms of the series. The lag lengths of two versus four lags are tested on the basis of the likelihood ratio (LR) test supplemented by the AIC and SIC information criteria. The finding suggests that all of the systems with the exception of the one that contains the Bahrain index, has two lags "see Table (7)". The Bahrain system has four lags which may be due to the lower sensitivity of its stock market to changes in oil prices, perhaps because its stock market includes shares of offshore companies whose fundamentals are determined by their home economies.

The estimates of all of the VEC systems suggest that the error correction terms for the cointegrating vector are significant in the first differences of the prices and index equations for all the countries under consideration, with the exception of the oil price equation in the systems for AMEX Oil Stock Index and Venezuela's index (see.Panel 7a and Panel 7e). This means that VER systems without the error corrections terms would be misspecified in the regression.

The estimates of these systems also suggest that the oil price Granger causes all the five stock indices without any exceptions. This implies that this oil price processes information that can be used in predicting the future movements of these stock indices. Moreover, there is a bi-directional causality between the oil price and the stock indices of the four oil-producing countries. This means that those four indices have also some predictive information for the oil price. The AMEX Oil Index, however, does not posses such information.

6- Spillover Effects from the Oil Markets to the Oil-Sensitive Stock Markets

We will use the ARACH/GARCH models to examine the volatility spillovers coming from the oil markets and going to the five international stock markets. The ARCH models were introduced by Engle (1982) and generalized as GARCH by Bollerslev (1986). They are widely used in various branches of econometrics, especially in financial time series analysis and are specifically designed to model and forecast conditional variances. Thus volatility is usually explored on the basis of those models, which give an estimate of the power that governs the persistence of volatility.

The standard ARCH (Autoregressive Conditional Heteroskedasticity) model is specified by the mean equation

$$\Delta y_t = a_0 + \sum_{i=0}^{n} \beta_i e_{t-i}, \text{ where } e_t \sim (0, \delta^2{}_t),$$

and the variance equation

$$\delta^2{}_t = \gamma_0 + \sum_{i=1}^{q} \gamma_i e^2{}_{t-i},$$

where $e^2{}_{t-i}$ is the i-th ARCH term, q is the order of the ARCH terms and δ_t^2 is the conditional variance of the residual. The Box-Jenkins methodology is used to identify the order of ARMA in the mean equation.

The LM test was used to ascertain whether the ARCH effects were present and that the use of ARCH/GARCH model was warranted. The ARCH model is first employed to generate the values of the variance for the three-month futures in the case of time-varying heteroskedasticity. Then the variance' generated values for this oil price are incorporated as regressors in the variance equations of the ARCH/GARCH models of the five stock index equations, and their significance is tested. In this case, these regressors are called the variance or volatility spillovers.

$$\Delta y_t = a_0 + \sum_{i=0}^{n} \beta_i e_{t-i} + \text{Mean Spillovers}$$

$$\delta^2{}_t = \gamma_0 + \sum_{i=1}^{q} \gamma_i e^2_{t-i} + \sum_{j=1}^{p} \lambda_j \delta^2_{t-j} + \text{Variance Spillovers}$$

where $\delta^2{}_{t-1}$ is the j-th GARCH term and p is the order of the GARCH terms. The autoregressive root, which governs the persistence of volatility shocks, is the sum of the ARCH term(s) and the GARCH term(s). If this sum is close to unity, it means that the shocks die out slowly. The ARCH/GARCH order is selected on the criterion of which model has the best fit.

The LM tests for all the oil and financial series indicate that the ARCH effects are significant at 1% level, suggesting the use of the ARCH/GARCH methodology is warranted "see Table (8)". For all the systems, the volatility spillovers from the three-month futures to the individual stock indices, with the exception of that of Indonesia, is significant at the 5% level "see Table (9)". This implies that if turbulence hits the oil market, it spills over to the stock markets of the oil-exporting countries and the stocks of the oil industries. The spillover is negative for the stocks of those countries and positive for the stocks of the oil industries. The magnitude of this effect ranges between 8-10% for the stocks of the oil producing countries and about 36 % for the stocks of the American oil industry.

8- Conclusions

This paper investigated the dynamic relationships between the WTI spot and futures oil prices and the five international stock market indices, using end-of-month data. Four of the indices are for the stock markets of oil producing, developing countries including Bahrain, Indonesia, Mexico and Venezuela, and one for the US oil industry.

Specifically, the paper examined distributional properties, and the presence of unit roots in non-stationary series, and cointegration and causality between the oil and financial series.

Employing the ADF test, the paper found that all these series have a single unit root, providing evidence of the presence of a stochastic trend in the data. Using, the Johansen cointegration test, the findings suggest that the three-month futures price and the five financial series have stable long run relationships, and that these series are driven by strong common forces. Utilizing the vector error correction model, the paper found that this oil price Granger causes all the stock indices, with the exception of Indonesia's index. This means that the three-month futures price has some predictive power regarding the future movements of those oil-sensitive financial indices. The implication of that is that investors and trader should pick up clues from the oil market before investing in the stock markets. Finally, the paper used the ARACH/GARCH model to examine the volatility spillover from the oil prices to the stock indices), and found significant spillover effect. This implies that if turbulence hits the oil market, it spills over to the stock markets of the oil-exporting countries and the stocks of the oil industries. The spillover is negative for the stocks of those oil-producing countries and positive for the stocks of the US oil industry. The policy implication is that oil-sensitive stock markets would benefit from stable oil prices.

Table (1)
Descriptive Statistics for International Equity Indices and Spot/ Futures Oil Prices

	AMEX	BAH	IND	MEX	VEN	WTIS	NYCOF3
MEAN	350.628	1684.536	462.745	3304.848	3496.775	20.222	19.911
MEDIAN	320.575	1598.215	468.011	2806.955	2032.035	19.795	19.505
MAXIMUM	537.970	2538.150	724.556	7473.250	10489.100	33.610	31.900
MINIMUM	212.650	997.930	226.684	622.985	793.247	11.370	12.140
STD.DEV	105.015	377.343	122..172	1741.919	2675.582	4.319	3.838
C. V.	0.299	0.224	0.264	0.527	0.765	0.213	0.19272
SKEWNESS	0.368	0.295	0.051	0.600	0.642	0.928	0.915
KURTOSIS	1.560	1.923	2.243	2.326	2.187	4.428	4.459
JARQUE-BERA	13.080	7.537	2.914	9.478	11.539	27.418	27367
PROBABILITY	0.001	0.023	0.233	0.009	0.003	0.000	0.000
OBSERVATIONS	120	120	120	120	120	120	120

Notes:

a) AMEX stands for the AMEX Oil Index, BAH for Bahrain IND for Indonesia,

b) MEX for Mexico, VEN for Venezuela, WTIS for Cushing- WTI spot and,

c) NYCOF3 for NYMEX WTI three- month futures price.

d) C. V. stands for coefficient of variation and represents relative volatility.

Table (2)

The Unit Root Test for the Oil Prices and Stock Indices

	Level				First – difference		
Variables	ADF – Stat	5% C. Value	Specification	Lags	ADF Stat	Specification	5% Cr. Value
LAMEX	-3.279698	-3.4481	Intercept + Trend	1	-11.89729	Intercept	-2.88559
LBAH	-2.165537	-2.8859	Intercept	1	-7.701522	Intercept	-2.8859
Lind	-2.25874	-2.8857	Intercept	1	-9.329864	No Intercept	-1.94227
LMEX	-2.558614	-2.8857	Intercept	0	-7.248867	No Intercept	-1.9427
LVEN	-0.670382	-2.8859	Intercept	1	-12.11796	No Intercept	-1.9427
LWTIS	-2.002423	-2.8857	Intercept	0	-5.561311	No Intercept	-1.9427
NYCOF3	-1.777952	-2.8857	Intercept	0	-10.29619	No Intercept	-1.9427

Notes:

a) Lag length is decided by the AIC and SIC.

b) Critical values are significant at the 5% level.

c) All the variables are expressed in natural logarithms.

Table (3)

Johansen Pairwise Cointegration Test: LWTIS and LNYCOF3

Eigenvalue	Likelihood Ratio	5 percent Critical Value	1 percent Critical Value	Hypothesized No. of CE (s)
0.135699	22.82352	19.96	24.60	None*
0.046471	5.615031	9.24	12.97	At most 1

Notes:

a) L.R test indicates I cointegrating equation (S) at the 5% significance level.

b) The lag length of I was decided by AIC and SIC.

c) VAR Specification: No trend, with an intercept only in the cointegrating equation; specification is decided by AIC and SIC.

Table (4)
Johansen Cointegration Test:
LAMEX, LBAH, LIND, LMEX, LVEN

Eigenvalue	Likelihood Ratio	5 percent Critical Value	1 percent Critical Value	Hypothesized No. of CE (s)
0.329559	105.9395	77.74	85.78	None**
0.180181	60.36015	54.64	61.24	At most 1*
0.147465	37.71154	34.55	40.49	At most 2*
0.133655	19.52383	18.17	23.46	At most 3*
0.0327407	3.167967	3.74	6.40	At most 4*

Notes:

a) * (**) denots rejection of the hypothesis at the 5% (1%) significance level.

b) L.R test indicates 4 cointegrating equation at the 5% significance level.

c) The lag length of 5 against 4 was decided by the likelihood ratio test.

d) VAR series specification: quadratic deterministic trend in the date, and intercept and trend in the cointegrating equation.

Table (5)
Johansen Cointegration Test:
LAMEX, LBAH, LIND, LMEX, LVEN, LNYCOF3

Eigenvalue	Likelihood Ratio	5 percent Critical Value	1 percent Critical Value	Hypothesized No. of CE (s)
0.355166	137.7409	104.94	114.36	None**
0.228949	87.72210	77.74	85.78	At most 1**
0.197114	58.08199	54.64	61.24	At most 2*
0.181968	33.05408	34.55	40.49	At most 3
0.054868	10.15673	18.17	23.46	At most 4
0.032135	3.723584	3.74	6.40	At most 5

Notes:

a) LNYCOF3 was chosen over LWTIS based on the AIC and SIC information criteria

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

c) L.R test indicates 3 cointegrating equation (s) at the 1% significance level.

d) The lag length of 5 over 6 was decided by the AIC and SIC.

e) VAR series Specification: quadratic deterministic trend with intercept and trend in the cointegrating equation, and it is decided by the LR test and by AIC and SIC.

Table (6a)
Johansen Pairwise Cointegration Test:
LAMEX and LNYCOF3

Eigenvalue	Likelihood Ratio	5 percent Critical Value	1 percent Critical Value	Hypothesized No. of CE (s)
0.137180	16.23599	15.41	20.04	None*
0.001403	0.153084	3.76	6.65	At most 1

Notes:

b) LNYCOF3 was chosen over LWTIS based on the AIC and SIC information criteria

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

c) L.R test indicates 3 cointegrating equation (s) at the 5% significance level.

d) The lag length of 10 was decided by the AIC and SIC.

e)VAR Specification: Linear trend, with an intercept only in the cointegrating equation and it is decided by the AIC and SIC.

Table (6d)
Johansen Pairwise Cointegration Test:
LMEX and LNYCOF3

Eigenvalue	Likelihood Ratio	5 percent Critical Value	1 percent Critical Value	Hypothesized No. of CE (s)
0.113115	16.19941	15.41	20.04	None*
0.029511	3.235139	3.76	6.65	At most 1

Notes:

a) The lag length is 11. Other notes are the same as in Table 6a.

Table (6c)

Johansen Pairwise Cointegration Test:

LIND and LNYCOF3

Eigenvalue	Likelihood Ratio	5 percent Critical Value	1 percent Critical Value	Hypothesized No. of CE (s)
0.163178	22.92544	15.41	20.04	None*
0.029816	3.329599	3.76	6.65	At most 1

Notes:

a) The lag length is 9.

b) L.R test indicates 3 cointegrating equation (s) at the 1% significance level.

c) Other notes are the same as in Table 6a.

Table (6d)

Johansen Pairwise Cointegration Test:

LMEX and LNYCOF3

Eigenvalue	Likelihood Ratio	5 percent Critical Value	1 percent Critical Value	Hypothesized No. of CE (s)
0.125153	18.82540	18.17	23.46	None*
0.026828	3.181727	3.74	6.40	At most 1

Notes:

a) Lag length is 2.

b) VAR series specification: quadratic deterministic trend with intercept and trend in cointegrating equation.

c) Other notes are the same as in Table 6a.

Table (6e)
Johansen Pairwise Cointegration Test:
LVEN and LNYCOF3

Eigenvalue	Likelihood Ratio	5 percent Critical Value	1 percent Critical Value	Hypothesized No. of CE (s)
0.135043	16.46714	15.41	20.04	None*
0.007371	0.798974	3.76	6.65	At most 1

Notes:

a) The lag length is 11.

b) Other notes are the same as in Table 6a.

Table (7a)
VECM for LNYCOF3 and AMEX Oil Stock Index

Dependent Variable	D (DLAMEX)	D (DLNYCOF3)
Coint Eq1	-1.570521 (-8.07519)	-0.178519 (-0.58330)
D (DLAMEX (-1))	0.387121 (2.54072)	0.050944 (0.21247)
D (DLAMEX (-2))	0.177736 (1.77179)	-0.184635 (-1.16962)
D (DLNYCOF3(-1))	-0.311211 (-4.21748)	-0.680152 (-5.85735)
D (DLNYCOF3(-2))	-0.182435 (-2.90005)	-0.432611 (-4.37009)
C	0.000489 (0.00448)	-0.002337 (0.00706)
Log Likelihood	**335.0979**	
AIC	**-5.536172**	
SIC	**-5.203842**	

Table (7b)
VECM for LNYCOF3 and Indonesia's Stock Market Index

Dependent Variable	D (DLIND)	D (DLNYCOF3)
Coint Eq1	-0.826844 (-6.15567)	0.309959 (3.38503)
D (DLIND(-1))	0.034721 (0.30472)	-0.431114 (-5.55021)
D (DLAMEX (-2))	-0.022644 (-0.22755)	-0.180105 (-2.65494)
D (DLNYCOF3(-1))	-0.412119 (-3.03076)	-0.576089 (-6.21477)
D(DLNYCOF3(-2))	-0.189766 (-1.56025)	-0.389616 (-4.69915)
C	-0.000314 (-0.03377)	-0.002245 (-0.35445)
Log Likelihood	**255.5059**	
AIC	**-4.163894**	
SIC	**-3.831564**	

Notes:

a) All variables are expressed in first differences of the natural logarithms.

b) The numbers in parentheses are t- statistics.

c) Lag lengths are decided by the L. T. test, and by the AIC and SIC criteria.

Table (7c)
VECM for LNYCOF3 and Bahrain's Stock Market Index

Dependent Variable	D (DLBAH)	D (DLNYCOF3)
Coint Eq1	-0.166814 (-1.62831)	-0.924237 (-4.80960)
D (DLBAH (-1))	-0.412930 (-3.18442)	0.496445 (2.04101)
D (DLBAH(-2))	-0.253771 (-1.96395)	0.635610 (2.62241)
D (DLBAH(-3))	-0.133926 (-1.11702)	0.519547 (2.31015)
D (DLBAH(-4))	-0.161978 (-1.57520)	0.150103 (0.77820)
D (DLNYCOF3 (-1))	0.179269 (2.00464)	-0.035529 (-0.21181)
D (DLNYCOF3 (-2))	0.104654 (1.30090)	-0.151696 (-1.00527)
D (DLNYCOF3 (-3))	0.153808 (2.32896)	0.005354 (0.04322)
D (DLNYCOF3 (-4))	0.113840 (2.24935)	-0.081633 (-0.85990)
C	-0.000725 (-0.21416)	-0.000595 (-0.09374)
Log Likelihood	**372.8045**	
AIC	**-6.154465**	
SIC	**-5.626427**	

Notes: See Panels 7a and b.

Table (7d)
VECM for LNYCOF3 and Mexico's Stock Market Index

Dependent Variable	D (DLMEX)	D (DNYCOF3)
Coint Eql	-0.885 (-5.52)	3.637 (1.44)
D (DLMEX (-1))	-0.122 (-0.93091)	-5.281 (-2.55)
D (DLMEX (-2))	-0.088006 (-0.90981)	-3.131 (-2.06)
D (DNYCOF3(-1))	-0.010465 (-1.73)	-0.681 (-7.21)
D (DNYCOF3(-2))	-0.001 (-0.19)	-0.447 (-4.96)
C	-0.001 (-0.14)	-0.073 (-0.15)
Log Likelihood	**-101.133**	
AIC	**1.985**	
SIC	**2.317**	

Table (7e)
VECM for LNYCOF3 and Venezuela's Stock Market Index

Dependent Variable	D (DLVEN)	D (DNYCOF3)
Coint Eq1	-0.694 (-4.97)	0.228 (-288561)
D (DLVEN(-1))	-0.391 (-3.17)	-0.247 (-3.57)
D (DLVEN (-2))	-0.158 (-1.75)	-0.174 (-3.43)
D (DLNYCOF3(-1))	-0.663 (-2.99)	-0.372 (-2.98)
D(DLNYCOF3(-2))	-0.476 (-2.75)	-0.286 (-2.94)
C	-0.001 (-0.06)	-0.002 (-0.33)
Log Likelihood	**220.270**	
AIC	**-3.556**	
SIC	**-3.224**	

Notes: See Panels 7a and b

Table (8)
Lagrange Multiplier (LM) Test.

	D (AMEX)	D (BAH)	D (MEX)	D (IND)	D (VEN)	D (WTIS)	D (NYCOF3)
Constant	6.5466 (5.1483)	7.5545 (63.5036)	8.4264 (29.2022)	6.112 (42.2565)	6.8564 (38.4756)	3.0055 (29.1644)	3.0064 (28.3773)
AR (1)	0.9905 (64.6343)	0.9669 (66.6282)	0.9612 (63.3450)	0.93885 (29.7438)	0.9324 (62.4733)	0.9265 (25.2348)	0.93965 (27.6805)

Notes:

a) The p- values of the F- statistics for all the series strongly rejects the null hypothesis of no ARACH.

b) Numbers in parentheses are t- statistics.

Table 9
The Volatility Spillover Effects from NYCOF3 to Stock Indices

	DLAMEX	DLBAH	DLIND	DLVEN	DLMEX
Mean Equation					
SQR (GARCH)	- -	- -	- -	- -	-7.5747 (-288561.90)
Constant	0.0063 (-1.63)	0.0025 (0.73)	0.004 (0.36)	0.0125 (1.43)	0.7108 (297636.70)
AR (1)	-1.1063 (-1.03)	- -	0.1984 (2.07)	-0.1695 (-1.18)	- -
MA (1)	- -	- -	- -	- -	-0.071 (-128501.40)
ARCH/ GARCH Variance Equation					
Constant	0.002 (0.27)	0.0018 (5.53)	0.0003 (1.53)	0.0008 (4.50)	0.0058 (57411611)
ARCH (1)	0.1204 (0.98)	0.0185 (0.19)	0.0232 (1.85)	-0.0626 (-2.52)	0.1741 (18092.05)
GARCH (1)	- -	- -	1.8864 (51.61)	1.0351 (37.22)	- -
GARCH (2)	- -	- -	-0.9611 (-31.75)	- -	- -
GARCDLNYC OF3MA	0.3657* (1.91)	0.0984* (-2.67)	0.0379 (0.76)	-0.0767 (-1.84)	-0.0794* (-861285.1)
AIC	**-3.2809**	**-3.761**	**-1.8362**	**-1.3852**	**27.9027**
SIC	**-3.1629**	**-3.667**	**-1.6719**	**-1.2443**	**28.0436**
Log Likehood	**196.9326**	**225.8993**	**115.3386**	**87.7278**	**-1640.257**

Notes:

a) All variables are in the first difference of the natural log.

b) Numbers in parentheses are z – statistics.

c) * denotes variance spillover lagged one period.

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1) For studies on non- oil commodity see Schroeder and Goodwin (1991).

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