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SPOT AND FUTURE PRICES OF CRUDE OIL: EVIDENCES OF CO-INTEGRATING RELATIONSHIP

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ABSTRACT

The study was intended to find out the relationship between the spot price and future price of crude oil which in turn will help in determining the prices of the commodities. While constructing a portfolio, high correlation among assets cannot be taken as a sufficient measure for long term diversification benefits, there is a need to enhance the standard risk-return modeling methodologies to take account of common long term trends among the asset prices. To complement this, the paper extends the traditional models by including a preliminary stage in which the asset prices are analyzed, and then augments the correlation analysis to include both short term and long term dynamics. The aim of the paper is to estimate the long and short run relation of asset prices applying the principle of co integration, vector error correction approach and granger causality to time series analysis.

KEYWORDS: ***spot price, future price, crude oil, asset prices, standard risk***

INTRODUCTION

Asset allocation is perceived as one of the most significant and strategic decisions to be taken by an investor or a Fund manager. Asset allocation is the amount of exposure (positive or negative) to a certain class of asset in the portfolio. While finalizing the portfolio, the fund manager has to decide on the types of asset to be included in the portfolio (Bansal, Kumar & Verma, 2014). The portfolio theory suggests that an asset having low or negative correlation with other assets in the portfolio should be included in the portfolio to ensure optimum performance. Correlation being a short term relationship indicator; the key issue faced by an investor or fund manager is how to incorporate the long term cosiderations in the asset prices (Kasa, 1992). Risk – return relationship models, pointed out that any long term trends in the data can be removed by differencing the prices of the assets. Although these trends are implicit in the returns data, but then these risk- return models does not include the decisions based on long term common trends in the price data (Alexander, 1999). To incorporate this long term effect in portfolio construction, the present study uses cointegration technique developed by Johansen (1988, 1991, 1992b) and Johansen and Juselius (1990) to test the long term co-movement of crude oil spot prices with future prices. Correlation and cointegration are two different concepts. Correlation having a short term implication reflects co-movements that are expected to have instabilities over time. So, correlation based portfolio strategies require frequent adjustments and interventions to improve the portfolio performance. As against this, cointegration indicates long run co-movements in prices that may occur even when static/low correlations appear among the assets. The high correlation of returns need not necessarily indicates high cointegration in the prices (Alexander, 1999). Thus, diversification decisions based on cointegration analysis may be more effective in the long term. By including the assets that are not cointegrated would result in a more effective portfolio that does not require frequent changes in the portfolio.

While constructing a portfolio, high correlation among assets cannot be taken as a sufficient measure for long term diversification benefits, there is a need to enhance the standard risk-return modeling methodologies to take account of common long term trends among the asset prices. To complement this, the paper extends the traditional models by including a preliminary stage in which the asset prices are analyzed, and then augments the correlation analysis to include both short term and long term dynamics. The aim of the paper is to estimate the long and short run relation of asset prices applying the principle of cointegration, and vector error correction approach in time series analysis.

REVIEW OF LITERATURE

Relatively, a number of empirical studies validate the low correlation among commodity futures and other asset classes over certain periods of time (Bodie & Rosansky, 1980; Erb & Harvey, 2005; Gorton & Rouwenhorst, 2006; Buyuksahin et al., 2010; Chong & Miffre, 2010) and these studies concluded that the return of an equal weight commodity futures portfolio was comparable to a stock portfolio. Following, Ankrim & Hensel (1993), Lummer & Seigel (1993), Satyanarayan & Varangis (1996), have shown that commodity futures provide a good diversification to the portfolio of equity and bond. Anson (1999) found out that commodity futures can prove to be a valuable asset for risk-averse investor, but the amount of investment in commodity futures depends upon certain factors like utility functions, level of risk tolerance and portfolio composition. Simon (2013) has modeled the conditional relationships between the Goldman Sachs Total Return Commodity Index and Sub-Indexes and the S&P 500 index using the bivariate GARCH framework and the results indicate that while the diversification benefits of commodities have diminished over the sample period, the estimated conditional correlations remain low enough for commodities to provide meaningful diversification benefits to equity investors. Buyuksahin et al. (2010) empirically investigated the relationship between ordinary, as well as extreme, returns on passive investments in commodity and equity markets using Johansen's Cointegration technique and identified that commodities provide substantial diversification to opportunities to passive equity investors. Perhaps one of the more important contributions to the literature is that of Gorton and Rouwenhorst (2006). They construct their own commodity futures index for the period 1959 – 2004 and examine how this compares with returns from stock and bond indices. They concluded that the average annualized return on the collateralized futures index was very similar to that on the S&P 500 over the whole period and both assets outperformed corporate bonds. They also found that the relative performance varied over time and that "the diversification benefits of commodities work well when they are needed most". Hence, one conclusion reached was that commodity futures are useful in creating diversified portfolios with respect to the idiosyncratic component of returns. Becker and Finnerty (2000) stated, with reference to the period from 1970 to 1990, that the risk and return of a portfolio composed of stocks and bonds had increased with the inclusion of commodities in asset allocation. They specify that this increase had been more valid in the 1970s compared to the following decade, due to high inflation in the first part of the study period. Bodie and Rosansky (1980) analyzed the returns of an equal weight commodity futures portfolio, and showed that the results obtained with medium and long-term portfolios were comparable to stock portfolios. Kasa (1992) is one of the first ones to use the multivariate cointegration method proposed by Johansen and Juselius (1990) to analyze co-movements in stock markets and found a common stochastic trend for the period 1974 – 1990 between the U.S., Japan, England, Germany and Canada. Arshanapalli and Doukas (1993) had used cointegration techniques to test the linkage and dynamic interactions among stock market movements and reported that The U.S. stock market has a considerable influence on the French, German and English markets in the post-crash period. On the same line of research, Meric and Meric (1997) analyzed changes in the co-movements of the 12 largest equity markets in Europe and the U.S. after the 1987 market crash and found that the benefits of international diversification decreased considerably in these developed markets after the crash. Wong et al. (2005) investigated the long run equilibrium relationship and short run dynamics between the Indian market and 3 developed countries (U.S., U.K. and Japan) for the period 1991- 2003 and found that the Indian market follows these markets and is therefore integrated with them in the long run. In essence, we are not interested in finding or explaining relationships between economies, but we are rather trying to find assets that move on their own in the long term, so that they can increase the portfolio performance.

Ghaith and Awad(2011), investigated the possible long-term relationship between the prices of crude oil and food commodities represented by maize, wheat, sorghum, soybean, barley, linseed oil, soybean oil, and palm oil. Time series econometric techniques (Unit root tests, Co-integration, and Granger causality) were applied. The study utilized monthly data over the period of 1980 to 2009. The results of this study reveal that there is a strong evidence of long-term relationship between crude oil and the food commodities prices. A traditional Granger Causality is used to check whether causality exists between two product prices. The outcome suggests that there is unidirectional causality between the prices crude oil and some of the food commodities under examination.

There is growing interest in finding out the relationship between the spot and future prices of oil and other commodities because of the long term implications resulting from commodity price movements. The commodity market for oil has experienced higher levels of volatility ever since the first oil crises reported in the 1970s. Last few years witnessed record oil prices and climate-change-related interest in biofuels, which in turn have resulted in search for explanations in this area. High commodity prices, whether or not related to oil prices, have obvious effects on purchasing power and economic growth (Chaudhuri, 2001, Zhang et al., 2010). This study is an attempt to look at the behavior of spot and future prices of crude oil by using cointegration analysis. Since the seminal paper of Balke and Forby (1997) on nonlinear cointegration, many empirical studies have demonstrated nonlinear and asymmetric adjustments to a long-run equilibrium in many economic time series (Lo and Zivot, 2001, Douglas, 2010). The statistical concept of linear cointegration, as originally defined, refers solely to linear combinations of variables linked through a long-run equilibrium relationship.

Bansal, Y, Kumar, S and Verma,P(2014), examined the long term statistical relationship of commodity future prices with equity prices using various tools including Augmented Dickey Fuller Test, Vector Auto Regression and Johansen's

Cointegration technique. The paper also investigated the short term dynamics of prices by testing for the existence and direction of inter-temporal Granger-causality between the indices. The analysis shows that there is no long term cointegration between the commodity future prices and equity prices therefore, an investor with long term investment horizon would benefit by including commodity futures to a traditional portfolio.

RELEVANCE OF THE STUDY

Cointegration among spot and future price of crude oil is conducted in order to find out whether there exists a long run relationship between the spot price and future price of crude oil which in turn will help in determining the prices of the commodities. One of the major objective of the companies is to provide accurate price of the commodities to the clients thereby providing better service to them and for helping them to generate the expected profit margin. Co-integration analysis of spot and future price of crude oil can help in determining the relationship between them and forecasting the price of crude oil accurately based on it.

OBJECTIVES OF THE STUDY

- To analyse the cointegration among spot and future price of crude oil.
- To study the long-run statistical relationship between the spot and future price of Crude oil

RESEARCH METHODOLOGY

The study attempts to provide evidences on the extent to which the spot and future price of crude oil move together so that the investor is able to take better investment decisions. The study is conducted, by giving due consideration to the perspective of an investor while analyzing the relationship between spot and future prices. Modern portfolio theory suggests that the relevant information matrix for such an investor includes the expected asset returns, the variability of these returns, as well as cross-asset correlations (Buyuksahin et al., 2010). Additionally, leads or lags in the time series make correlations almost useless. For example, if the data is lagged by one or two days some of the daily time series, the effect on the correlation between the series will be significant, the correlation might even turn from positive to negative. On the other side, the effect on the common long term relationship between the series will be minimal. Cointegration allows for short term divergence between two different time series, meaning that in a day to day basis, the series does not necessarily have to go up or down at the same time, one might go up while the other goes down, thus there is no need for the two series to move in daily synchrony at all. In the long run, however the two price series cannot wander off in opposite directions for very long without coming back to their long term equilibrium. The distinction between stationary and non stationary time series is extremely important because stationarity is a precondition to make statistical inferences. If the mean or variance of time series change with time, then it is impossible to generalize results from regressions made for a specific period of time into a different period of time. So, it is necessary to identify whether the time series is stationary or not before making any statistical inference. If one perform regression analysis on time series where the dependent, independent, or both variables have a unit root process, then the results will have no economic significance, in particular, the estimates will be biased and the results of hypothesis tests will be invalid. This is the problem of spurious regression which was first reported back in 1926 by Yule. In order to confirm stationarity of the series, Augmented DickeyFuller test was conducted. To analyze long-term cointegration, the study made use of the daily closing prices for both spot and future. The study was based on the methods of Johansen's cointegration analysis. The idea for the analysis is that if two series each follow upward trend, then, in general, they will diverge in the long run. The data analysis comprises of four parts: (1) testing for a unit root in both the series (2) testing for the number of cointegrating vectors in the systems of asset prices, provided the null hypothesis of a unit root for every series is not rejected, (3) testing the vector autoregression between the assets, and (4) testing the causality effect among the two assets.

Unit Root Test

To test for a unit root in each series, the researcher employed the Augmented Dickey-Fuller (ADF) (Dickey and Fuller, 1981) Test. The tests are conducted with and without a deterministic trend (t). The general form of ADF test is estimated by the following regression

$$\Delta Yt=\alpha 0+Zt+ \alpha 1Yt-1+\sum \alpha t\ \Delta Yt-1+\varepsilon t$$

where $\alpha 0$ is constant, t is a deterministic trend, and enough lagged differences (p) are included to ensure that the error term becomes white noise. If the autoregressive representation of Yt contains a unit root, the t-ratio for á1 should be consistent with the hypothesis $\alpha 1=0$ However, the ADF test loses power for sufficiently large values of p.

Cointegration Test

To investigate the existence of a long-term relationship between spot and future prices of crude oil, cointegration analysis was performed. If the spot and future prices are cointegrated with one another, then this will provide statistical evidence for the existence of a long-run relationship. Though, a set of economic series are not stationary, there may exist some linear combination of the variable which exhibit a dynamic equilibrium in the long run (Engle and Granger 1987). The study employed the maximum-likelihood test procedure established by Johansen and Juselius (1990) and Johansen (1991). Specifically, if Yt is a vector of n stochastic variables, then there exists a p-lag vector auto regression with Gaussian errors of the following form:

$$\Delta Yt=k+\gamma 1\Delta Yt\ -1+\ldots+\ \gamma \rho-1\Delta Yt-\rho+1+\ \Pi\ Yt-1+zt$$

where $\gamma 1, \ldots\ldots \gamma p-1$ and Π are coefficient matrices, zt is a vector of white noise process and k contains all deterministic elements. The focal point of conducting Johansen's cointegration tests is to determine the rank (r) of matrix γk. In the present application, there are three possible outcomes. First, it can be of full rank, (r = n), which would imply that the variables are stationary processes, which would contradict the earlier finding of nonstationarity. Second, the rank of k can be zero (r = 0), indicating that there is no long-run relationship among the variables. In instances when γk is of either full rank or zero rank, it will be appropriate to estimate the model in either levels or first differences, respectively. Finally, in the intermediate case when there are at most r cointegrating vectors $0 \leq r \leq n$(i.e., reduced rank), it suggests that there are (n -r) common stochastic trends. The number of lags used in the vector Error Correction model is chosen based on the evidence provided by Akaike's Information Criterion. The cointegration procedure yields two likelihood ratio test statistics, referred to as the maximum eigenvalue(λ -max) test and the trace test, which will help in determining which of the possibilities is supported by the data.

VECM and Granger Causality

If the variables are found to be cointegrated in long run, then the next step is to employ vector error correction model followed by the granger causality. The vector error correction (VECM) is commonly used for forecasting systems of interrelated time series and for analyzing the dynamic impact of random disturbances on the system of variables. The optimum lag length is identified using Akaike Information Criteria (AIC). The VECM approach sidesteps the need for structural modelling by treating every endogenous variable in the system as a function of the lagged values of all of the endogenous variables in the system.

Consider two time-series variables, yt and xt. Generalizing the discussion about dynamic relationships to these two interrelated variables yields a system

$$\begin{aligned} y\ t&= \beta 10+ \beta 11yt-1+\beta 12xt-1+ vt^{y} \\ xt&= \beta 20+ \beta 21yt-1+\beta 22xt-1+ vt^{x} \end{aligned}$$

The equations describe a system in which each variable is a function of its own lag, and the lag of the other variable in the system.

DATA AND EMPIRICAL ANALYSIS

The daily closing prices for spot and future of crude oil, was obtained from Indian commodity market, (MCX COMDEX) and are examined for the period June 2009 to December 2015. Daily data was preferred because any transmission mechanism between the stock markets in the ECM (Error

Correction Model) is most likely to occur within few days. A drawback in using daily data Autoregressive Conditional heteroskedastic (ARCH) residuals - the variance of the residuals in one period is dependent on their variance in the previous period. the ARCH processes of the residuals were not eliminated.

Unit Root Tests

The study tests the stationarity by running Augmented Dickey Fuller test (ADF) on the level variables. The optimal lag length is determined using minimum Akaike Information Criteria (AIC). The null hypothesis in case of ADF test is that the series under reference has a unit root, which implies that the series are not stationary in nature. A probability value of below 0.05 does not accept the null hypothesis at 5% level of significance and implies that the series under reference are stationary at 5% level of significance.

The probability value of more than 0.05 for future price and spot price, at its level, as presented in Tables 1 and 2, implying that the null hypothesis is accepted and both the variables have a unit-root, which confirms that the series are not stationary, meaning that differencing is required to make the variables stationery.

Table 1 Unit Root results for Future Price

Null Hypothesis: FUTURE_PRICE has a unit root
Exogenous: Constant
Lag Length: 1 (Automatic - based on SIC, maxlag=10)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.877039	0.0541
Test critical values:	1% level	-3.546099	
	5% level	-2.911730	
	10% level	-2.593551	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: FUTURE_PRICE
Method: Least Squares

Variable	Coefficient	Std. Error	t-Statistic	Prob.
FUTURE_PRICE(-1)	-0.173480	0.060298	-2.877039	0.0057
D(FUTURE_PRICE(-1))	0.175442	0.125028	1.403221	0.1661
C	16.33465	5.533440	2.951988	0.0046

R-squared	0.139070	Mean dependent var	0.552203
Adjusted R-squared	0.108322	S.D. dependent var	4.722872
S.E. of regression	4.459746	Akaike info criterion	5.877570
Sum squared resid	1113.803	Schwarz criterion	5.983207
Log likelihood	-170.3883	Hannan-Quinn criter.	5.918806
F-statistic	4.522968	Durbin-Watson stat	1.928953
Prob(F-statistic)	0.015104		

Table 2 Unit Root results for Spot Price

Null Hypothesis: SPOT_PRICE has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=10)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.039588	0.2696
Test critical values:	1% level	-3.544063	
	5% level	-2.910860	
	10% level	-2.593090	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: SPOT_PRICE

Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
SPOT_PRICE(-1)	-0.120479	0.059070	-2.039588	0.0460
C	11.44583	5.355158	2.137346	0.0368

R-squared	0.066923	Mean dependent var	0.606000
Adjusted R-squared	0.050835	S.D. dependent var	5.222992
S.E. of regression	5.088504	Akaike info criterion	6.124610
Sum squared resid	1501.787	Schwarz criterion	6.194421
Log likelihood	-181.7383	Hannan-Quinn criter.	6.151917
F-statistic	4.159921	Durbin-Watson stat	1.752805
Prob(F-statistic)	0.045955		

The probability value of less than 0.05 for differenced future price D (future price) and differenced spot price, D (spot price) as presented in Tables 3 and 4, implying that the null hypothesis is not accepted and the variable does not have a unit-root, which confirms that the series is stationary meaning that both the variables are integrated of the order 1, I(1). The stationarity is verified at all the three conditions, i.e.,no intercept - no trend, intercept but no trend, no intercept but trend. Since the series are observed to be stationary in nature after the first differential, further econometric analysis can be performed on the differenced series.

Cointegration Test

Johansen and Juselius (1990) cointegration test was applied to determine whether there is any cointegration among the two series.

The results are shown in Table 5.

Table 3 Unit Root results for D (future price)

Null Hypothesis: D(FUTURE_PRICE) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=10)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-6.843735	0.0000
Test critical values:	1% level	-3.546099	
	5% level	-2.911730	
	10% level	-2.593551	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(FUTURE_PRICE,2)
Method: Least Squares

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(FUTURE_PRICE(-1))	-0.892354	0.130390	-6.843735	0.0000
C	0.503416	0.619386	0.812766	0.4197

R-squared	0.451061	Mean dependent var	0.098983
Adjusted R-squared	0.441431	S.D. dependent var	6.336700
S.E. of regression	4.735891	Akaike info criterion	5.981527
Sum squared resid	1278.434	Schwarz criterion	6.051952
Log likelihood	-174.4550	Hannan-Quinn criter.	6.009018
F-statistic	46.83671	Durbin-Watson stat	1.885686
Prob(F-statistic)	0.000000		

Table 4 Unit Root results for D(Spot price)

Null Hypothesis: D(SPOT_PRICE) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=10)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-7.144567	0.0000
Test critical values:	1% level	-3.546099	
	5% level	-2.911730	
	10% level	-2.593551	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(SPOT_PRICE,2)
Method: Least Squares

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(SPOT_PRICE(-1))	-0.936272	0.131047	-7.144567	0.0000
C	0.674174	0.686036	0.982709	0.3299

R-squared	0.472441	Mean dependent var	0.157797
Adjusted R-squared	0.463186	S.D. dependent var	7.152164
S.E. of regression	5.240219	Akaike info criterion	6.183914
Sum squared resid	1565.214	Schwarz criterion	6.254339
Log likelihood	-180.4255	Hannan-Quinn criter.	6.211405
F-statistic	51.04484	Durbin-Watson stat	1.892140
Prob(F-statistic)	0.000000		

Table 5 Results of Johansen Cointegration among spot and future prices of crude oil

```
                 Series: FUTURE PRICE and SPOT PRICE

                 Lags interval (in first differences): 1 to 2

              Unrestricted Co-integration Rank Test (Trace)
=========================================================================
   Hypothesized                       Trace         0.05
    No. of CE(s)       Eigenvalue   Statistic   Critical Value         Prob.**
=========================================================================
      None *            0.493517    63.22908      15.49471             0.0000
    At most 1 *         0.348852    24.45403      3.841466             0.0000
=========================================================================
                     Trace test indicates 2 cointegrating eqn(s) at the 0.05 level
                       * denotes rejection of the hypothesis at the 0.05 level
              **MacKinnon-Haug-Michelis (1999) p-values

                  Unrestricted Cointegration Rank Test (Maximum Eigenvalue)
=========================================================================
   Hypothesized                     Max-Eigen       0.05
    No. of CE(s)       Eigenvalue   Statistic   Critical Value         Prob.**
=========================================================================
      None *            0.493517    38.77505      14.26460             0.0000
    At most 1 *         0.348852    24.45403      3.841466             0.0000
=========================================================================
                 Max-eigenvalue test indicates 2 cointegrating eqn(s) at the 0.05 level
                       * denotes rejection of the hypothesis at the 0.05 level
              **MacKinnon-Haug-Michelis (1999) p-values

                Unrestricted Cointegrating Coefficients (normalized by b'*S11*b=I):
=========================================================================
 D(FUTURE_PRICE)     D(SPOT_PRICE)
    -1.475971          1.494437
     0.575040         -0.222421
=========================================================================


              Unrestricted Adjustment Coefficients (alpha):
=========================================================================
D(FUTURE_PRICE,2)      -0.781309     -3.150512
  D(SPOT_PRICE,2)      -1.971328     -3.225270
=========================================================================

                                          Log
     1 Cointegrating Equation(s):      likelihood     -266.9442
=========================================================================
                Normalized cointegrating coefficients (standard error in parentheses)
 D(FUTURE_PRICE)     D(SPOT_PRICE)
     1.000000         -1.012511
                      (0.03222)

     Adjustment coefficients (standard error in parentheses)
D(FUTURE_PRICE,2)      1.153189
                      (1.11451)
  D(SPOT_PRICE,2)      2.909622
                      (1.20170)
=========================================================================
```

Table 6 Results and critical values for the λtrace and λmax test for spot and Future Prices of Crude Oil

Lag:2						
H0	**λtrace**	**CV (trace,5%)**	**Prob.**	**λmax**	**CV (max,5%)**	**Prob.**
r=0	63.22908	15.49471	0.0000	38.77505	14.26460	0.0000
r=1	24.45403	3.841466	0.0000	24.45403	3.841466	0.0000

Source: Compiled from Johansen's cointegration test results

Table 5 shows the results of Johansen Cointegration test run among the variables. The results are further compiled in Table 6. Johansen Cointegration results can be studied either on the basis of Trace value or Max Eigen value. From the above table, trace value indicates that there is no cointegration at level as p-value of 0.0000 is less than 0.05 and critical value(15.49471) is less than the trace statistic(63.22908), therefore the study fails to accept the null hypothesis that there is no cointegration equation among the variables. On the similar lines, Max-eigen value also indicates existence of cointegration by rejecting the null hypothesis that there is zero cointegration equations among the variables, with p-value 0.0000 less than 0.05 and critical value(14.26460) is less than the max eigen statistics (38.77505). Therefore, both the tests indicate that there exists cointegration among spot and future prices of crude oil.

Vector Error Correction Model(VECM)

Since cointegration analysis show that there is cointegration among the two variables, Vector Error Correction Model was run among spot and future prices of crude oil, to identify the cause and effect relationship. The results are shown in Table 7.

Table 7 Vector Error Correction Model Estimates among Spot and Future Price of Crude Oil

Cointegrating Eq:	CointEq1	
FUTURE_PRICE(-1)	1.000000	
SPOT_PRICE(-1)	-0.745346	
	(0.07034)	
	[-10.5968]	
C	-24.18692	
Error Correction:	D(FUTURE_PRICE)	D(SPOT_PRICE)
CointEq1	-0.736710	-0.670553
	(0.30153)	(0.33631)
	[-2.44321]	[-1.99385]
D(FUTURE_PRICE(-1))	0.341176	0.271840
	(0.52064)	(0.58068)
	[0.65531]	[0.46814]
D(FUTURE_PRICE(-2))	0.825303	1.134791
	(0.51736)	(0.57703)
	[1.59522]	[1.96661]
D(SPOT_PRICE(-1))	-0.138169	-0.115614
	(0.46906)	(0.52316)
	[-0.29457]	[-0.22099]
D(SPOT_PRICE(-2))	-0.804160	-1.113752
	(0.46236)	(0.51569)
	[-1.73924]	[-2.15973]
C	0.418278	0.624612
	(0.60154)	(0.67092)
	[0.69534]	[0.93098]

R-squared	0.155753	0.139208
Adj. R-squared	0.074576	0.056439
Sum sq. resids	1060.600	1319.356
S.E. equation	4.516209	5.037085
F-statistic	1.918673	1.681894
Log likelihood	-166.5767	-172.9077
Akaike AIC	5.950920	6.169229
Schwarz SC	6.164070	6.382379
Mean dependent	0.447586	0.602586
S.D. dependent	4.694654	5.185545
Determinant resid covariance (dof adj.)		35.42163
Determinant resid covariance		28.47209
Log likelihood		-261.7157
Akaike information criterion		9.507437
Schwarz criterion		10.00479

Table 8 OLS for Spot and future Prices of Crude Oil

Dependent Variable: FUTURE_PRICE
Method: Least Squares

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	11.89638	1.783911	6.668704	0.0000
SPOT_PRICE	0.879634	0.019619	44.83672	0.0000

R-squared	0.971488	Mean dependent var	91.27033
Adjusted R-squared	0.971005	S.D. dependent var	10.09249
S.E. of regression	1.718537	Akaike info criterion	3.953061
Sum squared resid	174.2487	Schwarz criterion	4.022270
Log likelihood	-118.5684	Hannan-Quinn criter.	3.980184
F-statistic	2010.332	Durbin-Watson stat	0.504490
Prob(F-statistic)	0.000000		

From the table it can be inferred that there is only one cointegrating equation and that for the equation Future Price = C*spot price, the coefficient is significant, therefore, spot price causes future price of crude oil in long run.. These results reconfirm the results of cointegration analysis.

CONCLUSION

The study examined both the short run and long run cause and effect relationship between spot and future prices of crude oil, so that crude oil futures could be considered as a diversification tool for investors to earn an extra return by using the data across 2009-2014. The analysis shows that there is a strong correlation among the two variables and the two variables are also found to be cointegrated, resulting in evidences for long term relation between the two variables meaning that the two series share a common stochastic move. If a passive investor includes crude oil futures to the traditional crude oil spot, he/she would be able to earn high return in lieu of low risk. The present study do support the diversifying properties of commodity futures. Future research can be conducted in other commodities, so that the results can be more generalized.

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