Price Discovery in NSE Spot and Futures Markets of Selected Oil and Gas Industries in India: What Causes What?

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Johansen's cointegration technique followed by the Vector Error Correction Model (VECM) were employed to examine the causal relationship between National Stock Exchange (NSE) spot and futures markets prices of selected nine oil and gas industry stocks of India. The empirical analysis was conducted on the daily data series from May 12, 2005 to January 29, 2009. The analysis reveals that there exists a long-run relationship between spot and futures prices of each of the selected individual securities. Besides, the study also indicates a bidirectional relationship between spot and futures markets prices in the case of four oil industry stocks, spot leading the futures price in the case of three stocks, and the futures leading the spot price in the case of two selected gas and oil industry stocks.

Introduction

The futures market trading was introduced in Indian financial markets in June 2000 and options index commenced from June 2001, and subsequently trading of the options and futures on individual securities commenced from July 2001 and November 2001, respectively. The futures derivative trading on stock indexes as well as individual stocks has grown rapidly since its very inception and performs important economic functions such as price discovery, portfolio diversification and opportunity for market participants to hedge against the risk of adverse price movements. Hence, the movements of spot market price have been largely influenced by speculation, hedging and arbitrage activity of futures markets. Thus, understanding the influence of one market on the other and the role of each market segment in price discovery is the central question in market microstructure design and has become an increasingly important research issue among academicians, regulators and practitioners alike, as it provides an idea about the market efficiency, volatility, hedging effectiveness and arbitrage opportunities, if any. Price discovery is the process of revealing information about future spot prices through the futures markets. The essence of the price discovery function hinges on whether new information is reflected first in changes of futures prices or changes of spot prices. Hence, there exists a lead-lag relationship between spot and futures markets through information dissemination. All the information available in the marketplace is immediately

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incorporated in the prices of assets in an efficient market. So, new information disseminating into the market should be reflected immediately in spot and futures prices simultaneously. This will lead to perfect positive contemporaneous comovement between the prices of those markets and there will be no systematic lagged response, and therefore, no arbitrage opportunity. This prediction arises directly from the Cost-of-Carry (COC) model of futures pricing which postulates that:

$$F_t = S_t e^{(r-y)(T-t)} \quad \text{...(1)}$$

where F_t is the futures price of the stocks at time t, S_t is the spot price of the stocks at time t, r is the interest rate foregone while carrying the underlying stocks, y is the dividend yield on the stocks, and $T - t$ is the remaining life of the futures contract. Equation (1) is justified by the 'no-arbitrage' assumption, since $F_t > S_t e^{(r-y)(T-t)}$ would enable investors to make profit by selling futures and buying stocks, while $S_t e^{(r-y)(T-t)} > F_t$ would allow profit making by buying futures and short-selling stocks. The assumptions that underlie these arguments are that futures and spot markets are perfectly efficient, and the transaction costs are zero. This simple version of the model also assumes that the interest rate and dividend yield are constant over the life of the futures contract, although in practice they will vary, as will $r - y$, the net COC of the underlying stocks. Most importantly, in the real world, the existence of market frictions such as transaction costs, margin requirements, short-sale constraints, liquidity differences and non-synchronous trading effects may induce lead-lag relationship between the futures contract and its underlying spot market. In addition, if there are economic incentives for traders to use one market over the other, a price discovery process between the two markets is likely to happen (Zou and Pinfold, 2001). This implies that futures and spot market prices are complex in nature and can be traced under different market frictions through price discovery mechanism.

Accordingly, there exist diversified theoretical arguments pertaining to the causal relationship between spot and futures markets by information dissemination. The main arguments in favor of futures market leading spot market are mainly due to the advantages provided by the futures market such as higher liquidity, lower transaction costs, lower margins, easy leverage positions, rapid execution, and greater flexibility for short positions. Such advantages attract larger informed traders and cause the futures market to react first when market-wide information or major stock-specific information arrives. Thus, the futures prices lead the spot market prices. On the other hand, the low-cost contingent strategies and high degree of leverage benefits in futures market attract larger speculative traders from the spot market to a more regulated futures market segments. Hence, this ultimately reduces the informational asymmetries of the spot market by reducing the amount of noise trading and helps in price discovery, improves the overall market depth, enhances market efficiency, and increases market liquidity. This makes spot market to react first when market-wide information or major stock-specific information arrives.

There is also a possibility for the existence of bidirectional relationship between the futures and spot prices through price discovery process. This may be mainly due to the fact that futures markets attract larger informed traders to enjoy the advantages of higher liquidity, lower transaction costs, lower margins, and greater flexibility for short positions. Hence, these advantages make the futures markets lead the spot markets around macroeconomic or major stock-specific information releases. Consequently, the spot markets will lead the futures markets under the circumstances that these advantages of futures markets attract larger speculative traders from the spot market and reduce the informational asymmetries of the spot market by reducing the amount of noise trading, help in price discovery, improve the overall market depth, enhance market efficiency and increase market liquidity. This makes spot market react fast when market-wide information or major stock-specific information arrives. Thus, both the spot and futures markets are said to be informationally efficient and react more quickly than each other.

The above theoretical arguments create a phenomenon of futures market and spot market prices complex in nature and which can be traced under different market imperfections through price discovery mechanism. This is due to the fact that the causation may take place in the following alternative ways: (a) Futures prices tend to influence the spot prices; (b) Spot prices tend to lead the futures prices; and (c) Bidirectional relationship between futures and spot prices.

The above diversified theoretical arguments call for examining the earlier studies, which will be immensely useful in identifying the gap in the literature. Broadly speaking, stock index futures contracts were first studied by Zeck and Niederoffer (1983) with reference to the US. Correlation technique was employed to examine the objective, and the analysis revealed that futures led to spot market. A similar kind of correlation technique was employed by Finnerty and Park (1987) to examine the hypothesis that Major Market Index (MMI) futures price changes determine cash index changes. It was pointed out that correlation analysis provided only unidirectional results without any evidence of a bidirectional relationship.

Further, Kawaller *et al.* (1987) examined the intraday price relationship between the S&P 500 futures and index prices for the years 1984-1985. A three-stage least square regression analysis was employed to examine the objective. The analysis revealed that futures price movements consistently led the spot index movements by up to 45 minutes. Herbst *et al.* (1987) employed the cross-correlation analysis to determine that futures lead the cash index for S&P 500 and value line futures contracts. They found that futures index led the spot index between 0-16 minutes. Similarly, Harris (1989) examined the relationship between S&P 500 index and futures during the October 1987 stock market crash, using 5 minutes data. Correlation technique and Weighted Least Squares (WLS) model were employed to examine the objective. The analysis revealed that futures market led the spot market. An ARMA(p, q) process was employed by Stoll and Whaley (1990) to study the intraday price relationship between S&P 500 and the MMI futures for the period 1982-1987. They found strong evidence of futures market leading the spot market. Similarly, other studies like Cheung and Ng (1990), Chan (1992), Tang *et al.* (1992), Antoniou and Garrett (1993), Ghosh (1993), Fleming *et al.* (1996), Shyy *et al.* (1996), Yu (1997), Abhyankar (1998), Pizzi *et al.* (1998), Booth *et al.* (1999), Min and Najand (1999), Roope and Zurbruegg (2002), Thenmozhi (2002), Pattarin and Ferretti (2004), Gupta and Singh (2006), Christos and Vougas (2007), and Bhatia (2007) support the primacy of futures markets in the price discovery process.

On the other hand, Wahab and Lashgari (1993) used daily data to examine the causal nexus between stock index and stock index futures for both S&P 500 and FTSE 100 index for the period 1988-1992. Cointegration and Error Correction Model (ECM) were employed to examine the objective, and the analysis revealed that spot leading to futures markets appeared to be more pronounced across days relative to the futures leading to spot. Similarly, Abhyankar (1995) investigated the lead-lag relationship between FTSE 100 stock index futures and cash index using hourly data for the period 1986-1990. The author employed an AR(2) and exponential GARCH(1, 1) model to evaluate the lead-lag relations for periods with differential transactional costs, spot volumes and volatility, and good and bad news (measured by the size of returns). The empirical results revealed that the futures leading the spot index reduced, when transaction costs of the underlying asset declined. It was also observed that futures market led the spot market returns during periods of high volatility. Further, Mukherjee and Mishra (2006) employed cross-correlation and ECM to investigate the intraday lead-lag relationship between Nifty futures and spot index in India. They found bidirectional relationship between futures and spot market prices. However, the results revealed that spot market had a major role in price discovery and led over the futures market.

Besides, Turkington and Walsh (1999) employed ARMA (p, q), bivariate VEC and VAR models and impulse response functions to examine the high frequency causal relationship between Shares Prices Index (SPI) futures and the All Ordinaries Index (AOI) for Australia. The analysis revealed bidirectional causality between the SPI futures and spot AOI index. Similarly, the study by Chris *et al.* (2001) on the UK found feedback relationship between FTSE 100 stock index futures and the FTSE 100 index. Further, recent studies by Raju and Karande (2003) and Sah and Kumar (2006) on India, Ryoo and Graham (2004) on Korea, Kenourgios (2004) on Athens, and Chang and Lee (2008) on Taiwan found bidirectional relationship between spot index and futures prices.

The above-discussed existing literature pertaining to lead-lag relationship between price changes in international futures and spot markets are well-established by information dissemination. However, the results seem to be mixed. Most of the studies employed cointegration test and ECM to examine the causal nexus between futures and spot market prices. It revealed that Johansen's cointegration test and Vector Error

Correction Model (VECM) are the superior techniques used to investigate the issue because they indicate the possibility of long-run equilibrium between futures and spot markets, which gives the investors and traders a chance to attain the equilibrium price by adjusting the short-run price fluctuations. Further, it is important for investors and traders to trade in the leading market in the short run, as they can make arbitrage profit by trading in the leading market. The ECM estimates the leading market between spot and futures markets. Thus, the study can employ Johansen's cointegration test and VECM to investigate the causality between National Stock Exchange (NSE) spot and futures markets on individual securities of selected oil and gas industry in India, which will throw light on the possibility of acting spot or futures prices as an efficient price discovery vehicle and this will be immensely useful for the traders to hedge their market risk.

Against this background, the present paper examines the lead-lag relationship between NSE spot and futures markets prices of selected oil and gas industry stocks in India. The paper presents the methodology of the study, and then discusses the empirical results. Finally, it offers the conclusion.

Methodology

Johansen's (1988) cointegration and VECM were employed to examine the lead-lag relationship between spot and futures markets prices of selected oil and gas industry stocks in India. As a preliminary investigation, Augmented Dickey Fuller (ADF) (Dickey and Fuller, 1979) and Phillips-Perron (PP) (Phillips and Perron, 1988) tests were employed to verify the stationarity of the data series. Further, the necessary lag length of the data series was selected on the basis of Schwarz Information Criterion (SC). Johansen's cointegration test was employed to examine the long-run relationship among the variables after the variables were found to be integrated of an identical order.

After identifying a single cointegration vector between spot and futures prices, the VECM was employed to examine the long-run relationship between the two and it is presented below:

$$\Delta SPOT_t = c_1 + \sum_{k=1}^{n} \alpha_{1i}\, \Delta SPOT_{t-k} + \sum_{k=1}^{n} \beta_{2i}\, \Delta FUT_{t-k} + \rho_1 ECT_{t-k} + u_{1t} \qquad \text{...(2)}$$

$$\Delta FUT_t = c_2 + \sum_{k=1}^{n} \beta_{1i}\, \Delta FUT_{t-k} + \sum_{k=1}^{n} \alpha_{2i}\, \Delta SPOT_{t-k} + \rho_2 ECT_{t-k} + u_{2t} \qquad \text{...(3)}$$

where $SPOT_t$ and FUT_t are spot and futures market prices at time t, u_{1t} and u_{2t} are white noise disturbance terms, and ECT_{t-k} is the lagged error correction term.

In terms of the VECM represented by Equations (2) and (3), FUT_t Granger causes $SPOT_t$ if some of the β_{2i} coefficients, $i = 1, 2, 3, ..., n - 1$, are not equal to zero and the error coefficient ρ_1 in the equation for spot prices is significant at conventional levels. Similarly, $SPOT_t$ Granger causes FUT_t if some of the α_{2i} coefficients, $i = 1, 2, 3, \ldots, n - 1$, are not zero and the error coefficient ρ_2 in the equation for futures prices is significant at conventional levels. These hypotheses can be tested by using either t-test or F-test on the joint significance of the lagged estimated coefficients. If both $SPOT_t$ and FUT_t Granger causes each other, then there is a feedback relationship between spot and futures markets prices. The error correction coefficients, ρ_1 and ρ_2, serve two purposes. They: (1) Identify the direction of causality between spot and futures prices; and (2) Measure the speed with which deviations from the long-run relationship are corrected by changes in the spot and futures prices.

The VECM represented by Equations (2) and (3) provides a framework for valid inference in the presence of I(1) variable. Moreover, the Johansen (1988) procedure provides more efficient estimates of the cointegrating relationship than the Engle and Granger (1987) estimator (Gonzalo, 1994). Also Johansen (1988) tests are shown to be fairly robust to the presence of non-normality (Cheung and Lai, 1993) and heteroscedasticity disturbances (Lee and Tse, 1996).

The data for the study consists of daily closing prices of spot and stock futures on nine selected oil and gas industry stocks traded on NSE. The list of the selected oil and gas industry stocks considered for the study are presented in the Appendix. The data span of the study is from May 12, 2005 to January 29, 2009. The near month contract of stock futures has been used in the study, as they are mostly heavily traded compared to next month and far month futures contracts. All the required data information for the study has been retrieved from the Futures and Options (F&O) segment of the NSE website.

Empirical Results and Discussion

Table 1 presents the results of summary statistics of spot and futures markets returns of selected oil and gas industry stocks. The table shows that the mean returns of spot and futures markets of selected oil and gas stocks are found to be positive and the standard deviations of both spot and futures returns series of the selected stocks range between 0.137 and 4.007, which indicate that the volatile nature of the selected stocks are quite meager, except ESSAROIL. Further, the table also reveals that the skewness statistics of selected stocks are significantly different from zero for both the market return series, i.e., they are skewed either to the right or to the left. Also, the kurtosis values of spot and futures markets returns series of selected stocks show that they are fat-tailed or leptokurtic compared to the normal distribution. In addition, the Jarque-Bera test statistics indicate that the null hypothesis of normality of spot and futures returns series of selected oil and gas industry stocks had been rejected at 1% significance level. Hence, it can be concluded that both the spot and futures markets returns series of selected stocks

Table 1: Summary Statistics of Spot and Futures Markets Returns of the Selected Oil and Gas Industry Stocks					
Name of the Stocks	**Mean**	**Standard Deviation**	**Skewness**	**Kurtosis**	**Jarque-Bera Statistics**
	Spot Market Returns				
BONGAIREFN	4.080	0.258	0.352	2.316	37.15*
BPCL	5.898	0.138	–0.265	3.256	13.40*
ESSAROIL	4.281	4.007	0.960	2.421	155.10*
GAIL	5.690	0.243	0.490	2.342	53.70*
HINDPETRO	5.613	0.149	–0.475	2.594	41.14*
IOC	6.123	0.151	0.566	3.523	60.02*
MRPL	3.932	0.337	1.291	4.065	300.96*
ONGC	6.890	0.170	–0.288	2.862	13.58*
RELIANCE	7.202	0.471	–0.010	1.876	48.62*
	Futures Market Returns				
BONGAIREFN	4.081	0.258	0.374	2.310	39.95*
BPCL	5.898	0.137	–0.320	3.359	20.84*
ESSAROIL	4.278	4.001	0.954	2.408	153.99*
GAIL	5.685	0.245	0.533	2.347	60.29*
HINDPETRO	5.614	0.153	–0.457	2.572	39.26*
IOC	6.125	0.152	0.585	3.540	64.07*
MRPL	3.935	0.338	1.290	4.097	303.08*
ONGC	6.886	0.171	–0.276	2.807	13.25*
RELIANCE	7.205	0.470	–0.005	1.880	48.34*

Note: * denotes significance at 1% level.

significantly depart from normality. However, the ADF and PP test results presented in Table 2 reveal that the hypothesis of a unit root in the spot and futures returns series of each of the selected oil and gas stocks is strongly rejected. Therefore, spot and futures returns follow a stationary process at first-order level, even though they fail to be normally distributed. Thus, the unit root test results reveal that both the data series of futures and spot prices of each of the selected stocks are stationary at first-order level and integrated of order, I(1).

Table 2: Augmented Dickey-Fuller and Phillip-Perron Tests Results							
Name of the Stocks	Market	ADF Test Statistics			PP Test Statistics		
		Intercept	With Intercept and Trend	Without Intercept and Trend	Intercept	With Intercept and Trend	Without Intercept and Trend
Levels							
BONGAIREFN	Spot	–2.50	–2.79	–0.84	–2.17	–2.42	–0.91
	Futures	–2.37	–2.62	–0.89	–2.30	–2.56	–0.87
BPCL	Spot	–2.70	–2.86	0.01	–2.78	–2.67	–0.02
	Futures	–2.73	–2.89	0.04	–2.76	–2.66	0.05
ESSAROIL	Spot	–1.44	–1.45	0.13	–1.48	–1.47	0.16
	Futures	–1.47	–1.50	0.12	–1.36	–1.18	0.22
GAIL	Spot	–1.76	–1.29	–0.18	–1.66	–1.13	–0.19
	Futures	–1.70	–1.19	–0.17	–1.60	–1.04	–0.18
HINDPETRO	Spot	–2.59	–3.24	–0.28	–2.84	–2.81	–0.40
	Futures	–1.13	–2.73	–1.16	–2.83	–2.48	–0.43
IOC	Spot	–2.62	–3.18	–0.19	–2.71	–2.74	–0.11
	Futures	–2.63	–3.29	–0.20	–2.61	–2.63	–0.10
MRPL	Spot	–1.82	–1.75	–0.34	–1.75	–1.66	–0.33
	Futures	–1.85	–1.78	–0.32	–1.70	–1.58	–0.30
ONGC	Spot	–1.90	–2.53	–0.43	–1.82	–2.45	–0.44
	Futures	–1.94	–2.58	–0.39	–2.03	–2.63	–0.41
RELIANCE	Spot	–1.93	–0.62	0.85	–1.92	–0.50	0.89
	Futures	–2.04	–0.30	0.97	–1.95	–0.53	0.87
First Differences							
BONGAIREFN	Spot	–24.95*	–24.94*	–24.93*	–24.55*	–24.53*	–24.56*
	Futures	–18.46*	–18.45*	–18.47*	–25.91*	–25.90*	–25.92*
BPCL	Spot	–17.24*	–17.23*	–17.25*	–28.99*	–28.98*	–29.01*
	Futures	–17.52*	–17.51*	–17.53*	–28.82*	–28.80*	–28.83*
ESSAROIL	Spot	–12.19*	–12.20*	–12.18*	–26.42*	–26.43*	–26.41*
	Futures	–14.35*	–14.36*	–14.34*	–26.94*	–26.93*	–26.96*

Table 2 (Cont.)

Name of the Stocks	Market	ADF Test Statistics			PP Test Statistics		
		Intercept	With Intercept and Trend	Without Intercept and Trend	Intercept	With Intercept and Trend	Without Intercept and Trend
First Differences							
GAIL	Spot	–14.99*	–15.08*	–15.01*	–31.69*	–31.71*	–31.74*
	Futures	–16.96*	–17.04*	–16.97*	–32.17*	–32.23*	–32.19*
HINDPETRO	Spot	–15.94*	–15.93*	–15.92*	–28.04*	–28.02*	–28.05*
	Futures	–17.37*	–17.35*	–17.36*	–28.64*	–28.63*	–28.65*
IOC	Spot	–16.03*	–16.02*	–16.04*	–24.98*	–24.96*	–24.99*
	Futures	–15.51*	–15.50*	–15.52*	–24.60*	–24.59*	–24.61*
MRPL	Spot	–13.39*	–13.40*	–13.38*	–26.82*	–26.80*	–26.84*
	Futures	–17.56*	–17.55*	–17.57*	–27.42*	–27.40*	–27.44*
ONGC	Spot	–14.73*	–14.79*	–14.75*	–29.74*	–29.78*	–29.75*
	Futures	–15.68*	–15.73*	–15.69*	–30.31*	–30.33*	–30.32*
RELIANCE	Spot	–18.78*	–18.93*	–18.75*	–29.04*	–29.14*	–29.03*
	Futures	–13.20*	–13.43*	–13.15*	–29.31*	–29.41*	–29.30*

Note: * indicates significance at 1% level. Optimal lag length is determined by the Schwarz Information Criterion (SC) and Newey-West criterion for ADF and PP tests, respectively.

Johansen's cointegration test is performed to examine the long-run relationship between spot and futures markets prices of selected oil and gas industry stocks and the results are presented in Table 3. The table shows that Johansen's max-eigen (λ_{max}) and trace (λ_{trace}) statistics indicate the presence of one cointegrating vector between the futures and spot markets prices at 1% level in the case of each of the selected individual stocks. The Johansen's cointegration test confirms the existence of long-run relationship between the spot and futures prices of each of the selected stocks of oil and gas industry.

According to the Granger representation theorem (Engle and Granger, 1987), if a set of variables are cointegrated, then there exists a valid error correction representation of the data. For this purpose, the VECM is estimated and the results are presented in Table 4. Besides, VECM is sensitive to the selection of optimal lag length. The necessary lag length of futures and spot prices series of each of the selected stocks is determined

Table 3: Johansen's Cointegration Test Results			
Name of the Stocks	**Vector (r)**	**Trace Statistics (λ_{trace})**	**Max-Eigen Statistics (λ_{max})**
BONGAIREFN	$H_0: r = 0$	47.78*	41.48*
	$H_1: r \leq 1$	6.309	6.309
BPCL	$H_0: r = 0$	83.01*	72.21*
	$H_1: r \leq 1$	10.78	10.78
ESSAROIL	$H_0: r = 0$	61.44*	58.61*
	$H_1: r \leq 1$	2.829	2.829
GAIL	$H_0: r = 0$	45.65*	42.70*
	$H_1: r \leq 1$	2.950	2.950
HINDPETRO	$H_0: r = 0$	84.13*	84.05*
	$H_1: r \leq 1$	0.071	0.071
IOC	$H_0: r = 0$	89.98*	84.05*
	$H_1: r \leq 1$	10.84	10.84
MRPL	$H_0: r = 0$	64.18*	61.22*
	$H_1: r \leq 1$	2.952	2.952
ONGC	$H_0: r = 0$	74.81*	66.66*
	$H_1: r \leq 1$	8.150	8.150
RELIANCE	$H_0: r = 0$	68.86*	63.67*
	$H_1: r \leq 1$	5.190	5.190

Note: * denotes significance at 1% level. r is the number of cointegrating vectors under the null hypothesis H_0, and H_1 represents the alternative hypothesis.

by SC, and it reveals optimal lag of two for BONGAIREFN, BPCL, GAIL, IOC, ONGC and RELIANCE and of three for ESSAROIL, HINDPETRO and MRPL. The VECM results reveal mixed findings. There exists a bidirectional relationship between spot and futures markets prices in the case of four oil industry stocks, namely, BONGAIREFN, ESSAROIL, MRPL and ONGC. On the other hand, the spot leads the futures price in the case of three oil industry stocks, namely, BPCL, HINDPETRO and IOC. The futures price leads the spot market price in the case of two selected gas and oil stocks, viz., GAIL and RELIANCE. The variation in the price discovery mechanism of the selected oil and gas industry stocks depends on the relative proportions of informed to uniformed (noise) traders migrating from the spot market to the futures market or vice versa.

Table 4: Results of Vector Error Correction Model for the Selected Stocks of Oil and Gas Industry

Name of the Stocks	Regression Equation	C	$\Delta SPOT_{t-1}$	$\Delta SPOT_{t-2}$	$\Delta SPOT_{t-3}$	ΔFUT_{t-1}	ΔFUT_{t-2}	ΔFUT_{t-3}	ECM_{t-1}	F-Statistics	Inference
BONGAIREFN	ΔS on ΔF	8.19E–06 (0.007)	–1.625* (–8.080)	–0.717* (–5.118)	–	1.279* (6.115)	0.494* (3.533)	–	1.788* (7.659)	59.98*	$F \leftrightarrow S$
	ΔF on ΔS	3.03E–07 (0.0002)	–1.519* (–7.467)	–0.648* (–4.574)	–	1.232* (5.823)	0.466* (3.299)	–	2.758* (11.676)	87.14*	
BPCL	ΔS on ΔF	–2.79E–05 (–0.026)	–0.941* (–3.420)	–0.525* (–3.206)	–	0.315 (1.131)	0.234 (1.419)	–	0.096 (0.267)	82.95*	$S \rightarrow F$
	ΔF on ΔS	–2.50E–05 (–0.023)	–1.220* (–4.485)	–0.594* (–3.669)	–	0.607** (2.206)	0.318** (1.996)	–	1.751* (4.899)	85.36*	
ESSAROIL	ΔS on ΔF	5.94E–05 (0.033)	–3.421* (–3.758)	–2.344* (–3.649)	–1.426* (–4.114)	2.766* (3.050)	1.916* (2.995)	1.187* (3.455)	2.860* (2.680)	59.96*	$F \leftrightarrow S$
	ΔF on ΔS	8.02E–05 (0.043)	–4.109* (–4.394)	–2.652* (–4.018)	–1.547* (–4.345)	3.450* (3.702)	2.217* (3.374)	1.299* (3.682)	5.130* (4.540)	65.41*	
GAIL	ΔS on ΔF	–1.14E–05 (–0.009)	0.186 (0.720)	0.046 (0.293)	–	–0.847* (–3.341)	–0.422* (–2.715)	–	–1.161* (–3.425)	103.20*	$F \rightarrow S$
	ΔF on ΔS	–1.84E–05 (–0.015)	–0.177 (–0.670)	–0.118 (–0.724)	–	–0.509** (–1.994)	–0.269 (–1.610)	–	0.536 (1.546)	104.08*	
HINDPETRO	ΔS on ΔF	–1.30E–05 (–0.012)	–0.769* (–2.673)	–0.613* (–2.973)	–0.261** (–2.223)	0.110 (0.388)	0.213 (1.051)	0.056 (0.494)	0.064 (0.189)	60.56*	$S \rightarrow F$
	ΔF on ΔS	–9.66E–06 (–0.009)	–1.242* (–4.301)	–0.747* (–3.614)	–0.378* (–3.211)	0.579** (2.030)	0.355 (1.747)	0.169 (1.488)	2.009* (5.930)	74.95*	

Table 4 (Cont.)

Name of the Stocks	Regression Equation	C	$\Delta SPOT_{t-1}$	$\Delta SPOT_{t-2}$	$\Delta SPOT_{t-3}$	ΔFUT_{t-1}	ΔFUT_{t-2}	ΔFUT_{t-3}	ECM_{t-1}	F-Statistics	Inference
IOC	ΔS on ΔF	–2.66E–05	–0.827*	–0.587*		0.320	0.287		–0.323	61.31*	$S \rightarrow F$
		(–0.027)	(–2.626)	(–3.090)	–	(1.007)	(1.493)	–	(–0.782)		
	ΔF on ΔS	–3.30E–05	–1.106*	–0.664*		0.606	0.382**		1.300*	55.73*	
		(–0.033)	(–3.483)	(–3.466)	–	(1.892)	(1.972)	–	(3.118)		
MRPL	ΔS on ΔF	1.99E–05	–2.950*	–2.492*	–1.694*	2.276*	2.063*	1.454*	1.285	60.43*	$F \leftrightarrow S$
		(0.014)	(–3.985)	(–4.589)	(–5.318)	(3.079)	(3.806)	(4.615)	(1.452)		
	ΔF on ΔS	2.87E–05	–3.333*	–2.656*	–1.812*	2.646*	2.219*	1.566*	2.986*	63.58*	
		(0.019)	(–4.321)	(–4.694)	(–5.463)	(3.437)	(3.930)	(4.771)	(3.240)		
ONGC	ΔS on ΔF	–1.53E–05	–0.254	–0.155		–0.382	–0.135		–0.669**	84.60*	$F \leftrightarrow S$
		(–0.014)	(–0.942)	(–0.997)	–	(–1.435)	(–0.889)	–	(–2.012)		
	ΔF on ΔS	–2.40E–05	–0.542**	–0.268		–0.115	–0.037		1.076*	92.86*	
		(–0.021)	(–1.987)	(–1.691)	–	(–0.423)	(–0.242)	–	(3.000)		
RELIANCE	ΔS on ΔF	–6.05E–05	0.681	0.275		–1.265**	–0.541		–2.248*	74.08*	$F \rightarrow S$
		(–0.054)	(1.062)	(0.735)	–	(–1.990)	(–1.456)	–	(–2.681)		
	ΔF on ΔS	–6.63E–05	0.420	0.177		–1.029	–0.453		–0.582	74.75*	
		(–0.059)	(0.650)	(0.470)	–	(–1.607)	(–1.211)	–	(–0.689)		

Note: Parentheses show *t*-statistics; * and ** indicate significance at 1% and 5% level, respectively; and optimal lag length is determined by SC.

Conclusion

Johansen's cointegration technique followed by VECM are employed to examine the causal relationship between NSE spot and futures markets prices of selected nine oil and gas industry stocks of India. The empirical analysis is conducted on the daily data series over the period, May 12, 2005 to January 29, 2009. The analysis reveals that there exists a long-run relationship between spot and futures prices of each of the selected individual securities. Besides, it also indicates a bidirectional relationship between spot and futures markets prices in the case of four oil industry stocks, spot leading the futures price in the case of three stocks and the futures leading the spot price in the case of two selected gas and oil industry stocks. ❖

References

1. Abhyankar A (1995), "Return and Volatility Dynamics in the FTSE 100 Stock Index and Stock Index Futures Markets", *The Journal of Futures Markets*, Vol. 15, No. 4, pp. 457-488.
2. Abhyankar A (1998), "Linear and Nonlinear Granger Causality: Evidence from the UK Stock Index Futures Market", *The Journal of Futures Markets*, Vol. 18, No. 5, pp. 519-540.
3. Antoniou A and Garrett I (1993), "To What Extend Did Stock Index Futures Contribute to the October 1987 Stock Market Crash?", *The Economic Journal*, Vol. 103, No. 421, pp. 1444-1461.
4. Bhatia Shalini (2007), "Do the S&P CNX Nifty Index and Nifty Futures Really Lead/Lag? Error Correction Model: A Co-integration Approach", NSE Research Paper No. 183, National Stock Exchange, India.
5. Booth G G, So R W and Tse Y (1999), "Price Discovery in the German Equity Index Derivatives Markets", *The Journal of Futures Markets*, Vol. 19, No. 6, pp. 619-643.
6. Chan Kalok (1992), "A Further Analysis of the Lead-Lag Relationship Between the Cash Market and Stock Index Futures Market", *Review of Financial Studies*, Vol. 5, No. 1, pp. 123-152.
7. Chang C C and Lee Y H (2008), "Asymmetric Causal Relationship Between Spot and Futures in Taiwan", *International Research Journal of Finance and Economics*, No. 14, pp. 113-121.
8. Cheung Y and Lai K (1993), "Finite Sample Sizes of Johansen's Likelihood Ratio Tests for Cointegration", *Oxford Bulletin of Economics and Statistics*, Vol. 55, No. 3, pp. 313-328.
9. Cheung Y W and Ng L K (1990), "The Dynamics of S&P 500 Index and S&P 500 Futures Intraday Price Volatilities", *Review of Futures Markets*, Vol. 9, No. 2, pp. 458-486.
10. Chris B, Alistar G W and Stuart T (2001), "A Trading Strategy Based on the Lead-Lag Relationship Between the Spot Index and Futures Contract for the FTSE 100", *International Journal of Forecasting*, Vol. 17, No. 1, pp. 31-44.

11. Christos Floros and Vougas D V (2007), "Lead-Lag Relationship Between Futures and Spot Markets in Greece: 1999-2001", *International Research Journal of Finance and Economics*, No. 7, pp. 168-174.

12. Dickey D A and Fuller W A (1979), "Distribution of the Estimators for Autoregressive Time Series with a Unit Root", *Journal of the American Statistical Association*, Vol. 74, No. 366, pp. 427-431.

13. Engel R F and Granger C W J (1987), "Cointegration and Error-Correction, Representation, Estimation, and Testing", *Econometrica*, Vol. 55, No. 2, pp. 251-276.

14. Finnerty J and Park H (1987), "Stock Index Futures: Does the Tail Way the Dog?", *Financial Analysts Journal*, Vol. 43, No. 2, pp. 57-61.

15. Fleming J, Ostdiek B and Whaley R (1996), "Trading Costs and the Relative Rates of Price Discovery in Stock Futures and Option Markets", *The Journal of Futures Markets*, Vol. 16, No. 4, pp. 353-387.

16. Ghosh Asim (1993), "Cointegration and Error Correction Models: Intertemporal Causality Between Index and Futures Prices", *The Journal of Futures Markets*, Vol. 13, No. 2, pp. 193-198.

17. Gonzalo J (1994), "Five Alternative Methods of Estimating Long-Run Equilibrium Relationship", *Econometrica*, Vol. 60, Nos. 1-2, pp. 203-233.

18. Gupta Kapil and Singh Balwinder (2006), "Price Discovery and Causality in Spot and Futures Markets in India", *The Icfai Journal of Derivatives Markets*, Vol. 3, No. 1, pp. 30-41.

19. Harris C (1989), "The October 1987 S&P 500 Stock-Futures Basis", *The Journal of Finance*, Vol. 44, No. 1, pp. 77-99.

20. Herbst A F, McCormack J P and West E N (1987), "Investigation of Lead-Lag Relationship Between Spot Stock Indices and Their Futures Contract", *The Journal of Futures Markets*, Vol. 7, No. 4, pp. 373-382.

21. Johansen S (1988), "Statistical Analysis and Cointegrating Vectors", *Journal of Economic Dynamics and Control*, Vol. 12, No. 4, pp. 231-254.

22. Kawaller I P, Koch P and Koch T (1987), "The Temporal Price Relationship Between S&P 500 Futures and S&P 500 Index", *The Journal of Finance*, Vol. 42, No. 5, pp. 1309-1329.

23. Kenourgios D F (2004), "Price Discovery in the Athens Derivatives Exchange: Evidence for the FTSE/ASE-20 Futures Market", *Economic and Business Review*, Vol. 6, No. 3, pp. 229-243.

24. Lee T and Tse Y (1996), "Cointegration Tests with Conditional Heteroscedasticity", *The Journal of Econometrics*, Vol. 73, No. 2, pp. 401-410.

25. Min J H and Najand M (1999), "A Further Investigation of Lead-Lag Relationship Between the Spot Market and Stock Index Futures: Early Evidence from Korea", *The Journal of Futures Markets*, Vol. 19, No. 1, pp. 217-232.

26. Mukherjee K N and Mishra R K (2006), "Lead-Lag Relationship Between Equities and Stock Index Futures Market and Its Variation Around Information Release: Empirical Evidence from India", NSE Research Paper, National Stock Exchange, India.

27. Pattarin Francesco and Ferretti Riccardo (2004), "The MIB30 Index and Futures Relationship: Econometric Analysis and Implications for Hedging", *Applied Financial Economics*, Vol. 14, No. 18, pp. 1281-1289.

28. Phillips P and Perron P (1988), "Testing for a Unit Root in Time Series Regression", *Biometrica*, Vol. 75, No. 2, pp. 335-346.

29. Pizzi M A, Economopoulos A J and O'Neill H M (1998), "An Examination of the Relationship Between Stock Index Cash and Futures Markets: A Co-integration Approach", *The Journal of Futures Markets*, Vol. 18, No. 3, pp. 297-305.

30. Raju M T and Karande K (2003), "Price Discovery and Volatility on NSE Futures Market", *SEBI Bulletin*, Vol. 1, No. 3, pp. 5-15.

31. Roope M and Zurbruegg R (2002), "The Intra Day Price Discovery Process Between the Singapore Exchange and Taiwan Futures Exchange", *The Journal of Futures Markets*, Vol. 22, No. 3, pp. 219-240.

32. Ryoo Hyun-Jung and Graham Smith (2004), "The Impact of Stock Index Futures on the Korean Stock Market", *Applied Financial Economics*, Vol. 14, No. 4, pp. 243-251.

33. Sah A N and Kumar A A (2006), "Price Discovery in Cash and Futures Market: The Case of S&P Nifty and Nifty Futures", *The Icfai Journal of Applied Finance*, Vol. 12, No. 4, pp. 55-63.

34. Shyy G, Vijayraghavan V and Scott-Quinn B (1996), "A Further Investigation of the Lead-Lag Relationship Between the Cash Market and Stock Index Futures Market with the Use of Bid/Ask Quotes: The Case of France", *The Journal of Futures Markets*, Vol. 16, No. 4, pp. 405-420.

35. Stoll H R and Whaley R E (1990), "The Dynamics of Stock Index and Stock Index Futures Returns", *Journal of Financial and Quantitative Analysis*, Vol. 25, No. 4, pp. 441-468.

36. Tang Y N, Mak S C and Choi D F S (1992), "The Causal Relationship Between Stock Index and Cash Index Prices in Hong Kong", *Applied Financial Economics*, Vol. 2, No. 4, pp. 187-190.

37. Thenmozhi M (2002), "Futures Trading, Information and Spot Price Volatility of NSE-50 Index Futures Contract", NSE Research Paper, National Stock Exchange, India.

38. Turkington Joshua and Walsh David (1999), "Price Discovery and Causality in the Australian Share Price Index Futures Market", *Australian Journal of Management*, Vol. 24, No. 2, pp. 97-113.

39. Wahab M and Lashgari M (1993), "Price Dynamics and Error Correction in Stock Index and Stock Index Futures Markets: A Cointegration Approach", *The Journal of Futures Markets*, Vol. 13, No. 7, pp. 711-742.

40. Yu S W (1997), "Price Discovery and Lead-Lag Effect in Nikkei 225 Stock Index Futures", *The Journal of Security Development*, Vol. 9, No. 2, pp. 29-62.

41. Zeck Lauser R and Niederoffer V (1983), "The Performance of Market Index Futures Contracts", *Financial Analysts Journal*, Jan-Feb, pp. 59-65.

42. Zou L and Pinfold J (2001), "Price Functions Between NZSE-10 Index, Index Futures and TENZ: A Cointegration Approach and Error Correction Model", Working Paper No. 01, Department of Commerce, Massey University, Auckland, pp. 1-31.

Appendix

List of Selected Oil and Gas Industry Stocks Considered for the Study			
S. No.	**NSE Code/Name of the Stocks**	**Name of the Oil and Gas Industry**	**Sector**
1.	BONGAIREFN	Bongaigaon Refinery Ltd.	Refineries
2.	BPCL	Bharat Petroleum Corporation Ltd.	Refineries
3.	ESSAROIL	Essar Oil Ltd.	Refineries
4.	GAIL	GAIL (India) Ltd.	Gas
5.	HINDPETRO	Hindustan Petroleum Corporation Ltd.	Refineries
6.	IOC	Indian Oil Corporation Ltd.	Refineries
7.	MRPL	Mangalore Refinery and Petrochemicals Ltd.	Refineries
8.	ONGC	Oil & Natural Gas Corp. Ltd.	Oil Exploration/ Production
9.	RELIANCE	Reliance Industries Ltd.	Refineries

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