DIGITALES ARCHIV

ZBW – Leibniz-Informationszentrum Wirtschaft ZBW – Leibniz Information Centre for Economics

Raju, Guntur Anjana; Shirodkar, Sanjeeta

Article

The lead lag relationship between spot and futures markets in the energy sector : empirical evidence from Indian markets

Provided in Cooperation with: International Journal of Energy Economics and Policy (IJEEP)

Reference: Raju, Guntur Anjana/Shirodkar, Sanjeeta (2020). The lead lag relationship between spot and futures markets in the energy sector : empirical evidence from Indian markets. In: International Journal of Energy Economics and Policy 10 (5), S. 409 - 414. https://www.econjournals.com/index.php/ijeep/article/download/9783/5301. doi:10.32479/ijeep.9783.

This Version is available at: http://hdl.handle.net/11159/7959

Kontakt/Contact ZBW – Leibniz-Informationszentrum Wirtschaft/Leibniz Information Centre for Economics Düsternbrooker Weg 120 24105 Kiel (Germany) E-Mail: *rights[at]zbw.eu* https://www.zbw.eu/econis-archiv/

Standard-Nutzungsbedingungen:

Dieses Dokument darf zu eigenen wissenschaftlichen Zwecken und zum Privatgebrauch gespeichert und kopiert werden. Sie dürfen dieses Dokument nicht für öffentliche oder kommerzielle Zwecke vervielfältigen, öffentlich ausstellen, aufführen, vertreiben oder anderweitig nutzen. Sofern für das Dokument eine Open-Content-Lizenz verwendet wurde, so gelten abweichend von diesen Nutzungsbedingungen die in der Lizenz gewährten Nutzungsrechte.

https://zbw.eu/econis-archiv/termsofuse

Terms of use:

This document may be saved and copied for your personal and scholarly purposes. You are not to copy it for public or commercial purposes, to exhibit the document in public, to perform, distribute or otherwise use the document in public. If the document is made available under a Creative Commons Licence you may exercise further usage rights as specified in the licence.





Leibniz-Informationszentrum Wirtschaft Leibniz Information Centre for Economics



INTERNATIONAL JOURNAL

International Journal of Energy Economics and Policy

ISSN: 2146-4553

available at http://www.econjournals.com



International Journal of Energy Economics and Policy, 2020, 10(5), 409-414.

The Lead Lag Relationship between Spot and Futures Markets in the Energy Sector: Empirical Evidence from Indian Markets

Guntur Anjana Raju¹ Sanjeeta Shirodkar^{2*}

¹Programme Director, Doctor of Philosophy (Commerce), Goa Business School, Goa University, Goa, India, ²Goa Business School, Goa University, Goa, India. *Email: sanjeetaparab@gmail.com

Received: 13 March 2020

Accepted: 18 June 2020

DOI: https://doi.org/10.32479/ijeep.9783

ABSTRACT

The study aims at finding the intraday Lead-Lag relationship between Spot and Futures Market for Energy Sectors Stocks on which Single Stock Futures (SSFs) is available, by applying 1-min Price Returns for the period ranging from April 1, 2017 to March 31, 2019. The study explores pricediscovery between stock futures and their underlying stocks by applying vector error correction model, Hasbrouck (1995) Information Shares, and Common Factor Component Weights of Gonzalo and Granger (1995). The findings indicate that trades in the Futures Market contribute more to Price-Discovery than Spot Market.

Keywords: Energy Sector, Single Stock Futures, Price-Discovery, Information Share, Vector Error Correction Model, Cointegration JEL Classifications: G11, G14

1. INTRODUCTION

Ever since the origin of Futures Market, Price-Discovery, Market stability, and Market efficiency associated with Spot Market and Futures Market have been crucial issues. Price-Discovery is a process through which the Market attempts to attain the equilibrium prices. Futures Market, in particular, is considered a primary means for discovering the Spot price of an asset as it contains information regarding the future expectation of investors related to the Spot prices. Under perfectly efficient Markets, new information is impounded simultaneously into Cash and Futures Markets. However, in reality, institutional factors such as liquidity, transaction costs, and Market restrictions may produce a Lead-Lag relation between the two Markets. Due to leverage benefits, low transaction costs, and lack of short sell restrictions, Futures Market incorporates information faster than the Cash Markets (Tse, 1999).

It is believed that the Futures Market potentially performs a vital function of Price-Discovery. If so, then the Futures prices or movement thereof should contain useful information about

subsequent Spot prices, beyond that already embedded in the current Spot price. A Futures Market is an essential source of information about prices. The Futures Market is expected to reflect the new information first, and later it flows to the underlying Cash Market. Lower transaction costs, provision of leverage trading, higher liquidity, and availability of short selling opportunities are the main reasons attributed to the leading role of Futures Market in the Price-Discovery process (Wahab and Lashgari, 1993). The rest of this paper is structured as follows. The second section contains a literature review. The third section offers a description of the data while the Fourth section deals with the methodology. Results are discussed in the Fifth section, whereas the Sixth section concludes.

2. LITERATURE REVIEW

An overwhelming number of studies have analyzed the Price-Discovery process between Index Futures contracts and its underlying Indices and have found Futures Market to lead the Spot Market in the Price-Discovery process. Some of such examples includes Kawaller et al. (1987), Stoll and Whaley (1990), Chan

This Journal is licensed under a Creative Commons Attribution 4.0 International License

(1992), Frino et al. (2000), Brooks et al. (2001), Zhong et al. (2004), and Kang and Lee (2006). There are studies on the potential informational role of Index Options such as Fleming et al. (1996), Booth and So (1999), and Chakravarty et al. (2004).

Studies such as Wahab and Lashgari (1993), Chan and Lien (2001), Kumar and Chaturvedula (2007), Kumar and Tse (2009), Sriram and Senthil (2013), Zakaria (2012), Sehgal et al. (2015), Boney et al. (2018) have found the Spot Market playing a dominant role in the Price-Discovery process. In India, (Thenmozhi, 2002) and (Raju and Karande, 2003) analyzed the Lead-Lag and Price-Discovery of Equity Futures Market in India. (Raju and Karande, 2003) adopted Cointegration and GARCH model with dummy variables to study the Price-Discovery between Nifty and its Futures and found that Price-Discovery occurs in both Futures and Spot Markets.

In the Energy sector, empirical studies have stated that pricediscovery among futures and spot markets could be either unidirectional or a bidirectional. A study conducted by (Kim, 2015) suggests that the lead-lag relationship among crude oil spot and futures Prices is changing over time depending on macroeconomic events. Studies which have highlighted the existence of unidirectional influence include a study by (Schwarz and Szakmary, 2010) who analysed the long-run relationship between Spot and Futures prices of Crude Oil, Heating Oil and Gasoline sector from 1985 to 1991. Their results pointed out that the Futures Market plays a dominant role in Price-Discovery. Similar results were presented by (Ng and Pirrong, 1996), who also investigated the Price dynamics of two major refined Energy commodities, heating Oil and gasoline, from 1984 to 1990. They concluded that the Futures Market adjust faster to correct the disequilibrium in prices.

In the Natural Gas sector, (Tse and Xiang, 2005) stated that the introduction of e-mini Futures in 2002 in the sector enhanced the role of Futures Markets on Price-Discovery, leading Spot Markets to equilibrium. Contradictory findings were presented by (Chiou-Wei et al., 2008), who stated that Spot Markets plays, a dominant role in Price-Discovery. According to these scholars, shortage or surplus on the supply side would lead market participants to forecast Future Prices of the Commodity.

In accordance with the background and motivation presented, the current study aims at examining the lead-lag relationship between Spot and Futures Market for Energy Sectors Stocks on which SSF is available and to define which market is the primary source of Price-Discovery. The Energy sector or industry comprises of those companies which are involved in the exploration and expansion of Oil or gas reserves, Oil and gas drilling, and refining. It also includes integrated power utility companies such as renewable Energy and coal. Examining the lead-lag relationship between Energy Stock Futures and their Stocks can assist shareholders to decide which price should be followed during decision-making processes. It can also help in detecting potential arbitrage opportunities between Spot and Futures prices. The rules regarding margin requirements, market halts, and taxes on transactions can be better analyzed if the role and significance of the Futures market are well understood.

The present study contributes to the existing literature of Price-Discovery in many ways. First, studying the impact of Single Stock Futures will allow us to assess an individual Energy Sector company's response to Futures trading directly; in contrast to the Market-wide result obtained from Index Futures studies. Second, it is commonly known fact that Lead-Lag relationship between Spot and Futures Markets does not last for more than half an hour¹. So, even if there is an existence of the Lead-Lag relationship between Spot and Futures Market, it is not possible to find the evidence for such a relation using daily data. Therefore using high-frequency data is of utmost importance for fetching reliable results. This study will use high-frequency 1-min Price data to explore the Price-Discovery process using the most liquid markets for the Single Stock Futures in the World, i.e., National Stock Exchange (NSE).

NSE offers a common platform for Spot and the SSF segment, thereby offering data with marginal microstructure noise. Both Equity Spot and SSFs have a dominant market share in trading at NSE, thereby minimizing the measurement complexities that arise with fragmented trading. From the methodological aspect, we use techniques suggested by Hasbrouck (1995) Gonzalo and Granger (1995) to determine Information Shares and Common Factor Component Weights for the SSFs market relative to that of the underlying stock market.

3. DATA

The study aims at finding the intraday Lead-Lag relationship between Spot and Futures Market for Energy Sectors Stocks on which SSF is available. The resulting sample for our research comprises of sixteen single stock futures and underlying stocks belonging to the Energy Sector. For the present study, we use 1-min price returns of 30 single stock futures and their underlying stocks for the period ranging from April 1, 2017 to March 31, 2019. High-frequency data is not readily available, and the charges for procuring such data are very high. Fewer studies have investigated the Lead-Lag relationship at the level of individual stocks using intraday data in the Indian context. The present study is an attempt to fill this gap to some extent. Data has been sourced from NSE's data vending partner Dotex International Ltd.

4. TECHNIQUES AND METHODS

4.1. Vector Error Correction Model (VECM)

We first ascertain the Stationarity of the price series using augmented Dickey-Fuller (ADF) unit root tests. For the price series found to be non-stationary at levels but stationary at First difference, we use Johansen Cointegration tests to check for the long-run equilibrium relationship between Spot and Futures prices. There may be an existence of a long-run equilibrium relationship between two or more variables, but in the short-run, there could be disequilibrium. The nature of the relationship among Cointegrated pairs of Stock Futures and their Underlying Stocks in the short-run

⁽Kawaller et al., 1987), (Herbst, McCormack, and West, 1987), (Stoll and Whaley, 1990), (Pizzi and Economopoulos, 1987), (Kang and Lee, 2006), and (Bhatia, 2007).

can be investigated by implementing the Vector Error Correction Mechanism. A VECM is a restricted VAR that has Cointegration restrictions built into the specification. Since all the variables are integrated of the order I (1), we have used Johansen Cointegration for a long term relationship. VECM includes both the error correction terms and the lagged differences of the series as stated in equation (1) and (2):

$$\Delta s_t = \gamma_s + \alpha_s \left(s_{t-1} - a - \beta f_{t-1} \right) + \sum_{i=1}^n \infty_{s1} (i) \Delta s_{t-1}$$
$$+ \sum_{i=1}^n \infty_{s2} (i) \Delta f_{t-1} + \epsilon_{s,t}$$
(1)

$$\Delta f_{t} = \gamma_{f} + \alpha_{f} \left(s_{t-1} - a - \beta f_{t-1} \right) + \sum_{i=1}^{n} \infty_{f1} (i) \Delta s_{t-1} + \sum_{i=1}^{n} \infty_{f2} (i) \Delta f_{t-1} + \epsilon_{f,t}$$
(2)

Where *i* is the lag length as suggested by the Akaike information criterion and $\in_{s,t}$ and $\in_{f,t}$ are the disturbance terms. The error correction term of VECM specification signifies the rate at which it corrects its previous period disequilibrium or speed of adjustment to restore the long-run equilibrium relationship. The terms $\propto_{s1}(i)$, $\approx_{s2}(i)$, $\approx_{f1}(i)$, and $\approx_{f2}(i)$ are the short-run coefficients in the above equation α_s ($s_{t-1} - a - \beta f_{t-1}$), and α_f ($s_{t-1} - a - \beta f_{t-1}$) are the error correction terms representing the short-run adjustment arising due to the divergence from long-run equilibrium.

4.2. Hasbrouck Information Share Methodology and Common Factor Component Weights of Gonzalo and Granger (1995)

By following the methodology used by (Tse, 1999), (Chakravarty et al., 2004), (Kumar and Chaturvedula, 2007), (Shastri et al., 2008), (Kumar and Tse, 2009), and (Aggarwal and Thomas, 2011) Hasbrouck Information Share Methodology and Common

Table 1: Unit root test (Augmented Dickey-Fuller Test	t)
---	----

Factor Component Weights of Gonzalo and Granger (1995) has been used. The two approaches are based on a common implicit efficient price that is contained in the observed price of a security and can be estimated using a VECM framework. (Hasbrouck, 1995) introduces the information share measure which captures the variation in the underlying random walk introduced by each Market. Hasbrouck's Information Share focuses on the variance of the efficient price innovation. It measures the extent to which the efficient price variance can be attributed to the innovations from different associated markets. Hasbrouck (1995) Information Share Measure and Common Factor Component Weights of Gonzalo and Granger (1995) models VECM in the following form:

$$\Delta X_{t} = \Pi X_{t-1} + \sum_{i=1}^{k} \Gamma_{i} \Delta X_{t-1} + \dot{\varepsilon}_{t}$$
(3)

Where $X_t = \{X_{it}\}$ is an n × 1 vector of cointegrated prices. Π and Γ_i are n × n matrices of parameters, and ε_i is an n × 1 vector of serially-uncorrelated residuals with a covariance matrix $\Omega = \{\sigma_{ij}\}$. The long-run relation matrix Π has a reduced rank of r < n and can be decomposed as $\Pi = \alpha\beta$, where α and β are n × r matrices. The β matrix consists of the cointegrating vectors, and α is the error correction (or equilibrium adjustment) matrix. Hasbrouck (1995) Information Share Measures could be expressed as follows:

$$IS_{j} = \frac{\psi_{j}^{2}\Omega_{jj}}{\psi\Omega\psi'}$$

If Ω is diagonal, then $\psi \Omega \psi'$ will consist of "*n*" terms, each of these terms would represent the contribution to the efficient price innovation from each market. However, if Ω is not diagonal, then the proposed measure has the problem of attributing the covariance terms to each market. To overcome this, Hasbrouck (1995) suggested using the Cholesky decomposition and measure IS using orthogonalized innovations. This is done as follows by assuming "F" to be a lower triangular matrix such that $FF' = \Omega$.

Stock	S	РОТ	F	utures	Stock	S	РОТ	Futures	
	ADF at	ADF at first	ADF at	ADF at first		ADF at	ADF at first	ADF at	ADF at first
	level	difference	level	difference		level	difference	level	difference
ADANIPOWER	-2.669	-77.9823	-1.8401	-25.085	NTPC	-1.903	-252.625	-1.840	-251.084
	(-0.079)	(-0.00)	(-0.361)	(-0.00)		(-0.330)	(-0.000)	(-0.361)	(-0.000)
BPCL	-3.075	-14.3857	-3.067	-14.026	OIL	-2.8434	-264.133	-2.696	-264.045
	(-0.112)	(-0.000)	(-0.114)	(-0.000)		(-0.052)	(-0.000)	(-0.074)	(-0.000)
COALINDIA	-2.407	-216.989	-2.473	-218.720	ONGC	-1.793	-435.009	-1.887	-297.513
	(-0.139)	(-0.000)	(-0.121)	(-0.000)		(-0.389)	(-0.000)	(-0.333)	(-0.000)
GAIL	-2.496	(-240.736)	-420.76	-420.769	PETRONET	-1.436	-169.532	-1.450	-218.429
	(0.116)	(-0.000)	(-0.000)	(0.000)		(-0.565)	(-0.000)	(-0.558)	(-0.000)
HINDPETRO	-1.471	-305.751	-1.505	-189.269	PFC	-2.743	-254.133	-2.596	-254.045
	(-0.548)	(-0.000)	(-0.531)	(-0.000)		(-0.072)	(-0.000)	(-0.064)	(-0.000)
IGL	-1.476	-296.195	-1.189	-186.673	POWERGRID	-2.496	-240.736	-420.769	-420.769
	(-0.546)	(-0.000)	(-0.681)	(-0.000)		(0.116)	(-0.000)	(-0.000)	(0.000)
IOC	-1.903	-252.625	-1.840	-251.084	TATAPOWER	-1.683	-435.009	-1.797	-298.513
	(-0.330)	(-0.000)	(-0.361)	(-0.000)		(-0.389)	(-0.000)	(-0.333)	(-0.000)
MGL	-2.843	-264.133	-2.696	-264.045	TORNTPOWER	-1.803	-242.625	-1.740	-241.084
	(-0.052)	(-0.000)	(-0.074)	(-0.000)		(-0.320)	(-0.000)	(-0.351)	(-0.000)

() denote p-value

Then the Information Share of the *j*th market could be expressed as follow:

$$IS_{j} = \frac{([\psi'F]_{i})^{2}}{\psi \Omega \psi'}$$

On the other hand, the Component Share approach emphasizes on the composition of the efficient price innovation and measures the contribution of the market to Price-Discovery as its contribution to the efficient price innovation. Under this approach, P takes the form:

$$P_t = A_1 f_t + A_2 z_t$$

Where f is the permanent component, and z_t is the transitory component while A1 and A2 are the loading matrices. Component Share of the *j*th market is expressed as follow:

$$CS_j = \frac{\alpha_{\perp,j}}{\alpha_{\perp,j} + \beta_{\perp,j}}, j = 1,2$$

5. EMPIRICAL RESULTS

We use the Augmented Dickey-Fuller Unit Root test to examine the stationary properties of the 1-min Price Returns of select highly traded Single Stock Futures and their underlying Stocks. The result of the Unit Root Test is given in the Table 1.

All the variables are non-stationary at the level as the p-value is more than 0.05%. Therefore, we conduct the Unit Root test in the first difference for all the variables. All the series are stationary at first difference at a 1% level of significance. The results of the ADF Test indicate that all variables are integrated of the same order. Therefore we could proceed with the Johansen Cointegration for exploring the long term relationship between Single Stock Futures and their underlying Stocks. This also indicates the existence of the Price-Discovery process between the Underlying Stocks and their respective Futures Contract.

Table 2 displays the result of the Johansen Cointegration test. The following test has been performed by taking appropriate lag interval, which has been selected as per the optimum lag length suggested by different tests like Akaie Information Criterion (AIC), Schwarz Criterion (SC), and the Likelihood Ratio (LR) test. The result of the Johansen Cointegration test indicates the presence of at least one Cointegrating vectors at the 5% level of significance. This result has been supported by Trace test as well as Max Eigen values. Therefore null hypothesis of no Cointegration can be rejected at a 5% level of significance for all the pairs of Single Stock Futures and their underlying Stocks. Thus based on the above observation, it can be concluded that there exists a long term Cointegrating relationship between all the Single Stock Futures and their Underlying Stocks.

Table 3 displays the estimates of the VECM for select highly traded Single Stock Futures and their Underlying Stocks. ECT Coefficient measures the speed of adjustment to restore the balance between

Table 2: R	cesults of johansen	cointegra	tion test for stock	s futures and t	heir underlying	stocks				
Null	Stock	Trace	Critical value	Maximum	Critical value	Stock	Trace	Critical value at	Maximum Eigen	Critical value at
hypothesis		statistics	at 5% (p-value)	Eigen statistics	at 5% (p-value)		statistics	5% (p-value)	statistics	5% (p-value)
H0: $r = 0$	ADANIPOWER	164.262	15.494 (-0.000)	156.792	14.264 (-0.000)	NTPC	3958.365	15.4947 (0.000)	3948.358	14.264 (0.000)
H0: $r \le 1$		7.470	3.841 (-0.006)	7.470	3.841 (-0.006)		10.0073	3.8414	10.007	3.841 (-0.0016)
								(-0.0016)		
H0: $r = 0$	BPCL	169.376	15.494 (-0.000)	168.341	14.264 (-0.000)	OIL	3958.365	15.4947 (0.000)	3948.358	$14.2646\ 0.000$
H0: $r \le 1$		1.034	3.841(-0.309)	1.034	3.841(-0.309)		10.007	3.841 (-0.001)	10.007	3.841 (-0.001)
H0: $r = 0$	COALINDIA	450.391	15.494(-0.000)	441.876	14.264 (-0.000)	ONGC	258.282	15.494(0.000)	251.717	14.264(0.000)
H0: $r \le 1$		8.514	3.841 (-0.000)	8.514	3.841(-0.000)		6.5644	3.841(-0.010)	6.5644	3.841 (-0.010)
H0: $r = 0$	GAIL	209.995	$15.494\ 0.000$	208.215	$14.264\ 0.000$	PETRONET	8538.870	15.494(0.000)	8535.15	14.264(0.000)
H0: $r \le 1$		1.7800	3.841(-0.182)	1.7800	3.841 (-0.182)		3.7201	3.8414	3.720	3.841 (-0.053)
								(-0.0538)		
H0: $r = 0$	HINDPETRO	187.029	$15.494\ (0.000)$	182.793	$14.264\ 0.000$	PFC	700.465	15.494(0.000)	698.259	$14.264\ (0.000)$
H0: $r \le 1$		4.2357	3.841 (-0.039)	4.235	3.841 (-0.039)		2.205	3.841(0.137)	2.205	3.841(0.137)
H0: $r = 0$	IGL	119.690	15.494(0.000)	117.096	$14.264\ 0.000$	POWERGRID	490.744	15.494(0.000)	485.545	14.264(0.000)
H0: $r \le 1$		2.594	3.841(-0.1072)	2.594	3.841 (-0.107)		5.198	3.841 (-0.022)	5.198	3.841 (-0.022)
H0: $r = 0$	IOC	399.253	15.494(0.000)	396.775	14.264 (0.000)	TATAPOWER	148.8672	15.4947 (0.000)	145.821	14.2646 (0.000)
H0: $r \le 1$		2.478	3.841(0.115)	2.478	3.841 (0.115)		3.0461	3.8414	3.0461	3.8414(-0.0809)
								(-0.0809)		
H0: $r = 0$	MGL	318.041	$15.494\ (0.000)$	317.679	14.264 (0.000)	TORNTPOWER	2429.376	15.4947 (0.000)	2425.34	$14.2646\ (0.000)$
H0: $r \le 1$		0.361	3.841 (-0.547)	0.361	3.841 (-0.547)		4.0348	3.8414 (-0.044)	4.0348	3.841 (-0.044)
() denote n-val	ue									

Table 5. Estimates of vector error correction mou	Table 3: Estimate	es of	vector	error	correction	mode
---	-------------------	-------	--------	-------	------------	------

Stock		Depende	nt variable		Stock	Dependent variable				
	Spo	ot	Futu	res		Spo	t	Futu	res	
	ECT	p-value	ECT	p-value		ECT	p-value	ECT	p-value	
	coefficient		coefficient			coefficient		Coefficient		
ADANIPOWER	-0.0297	0.000	0.0000	0.5823	NTPC	-0.0011	0.000	0.0000	0.8530	
BPCL	-0.0016	0.000	0.0000	0.6290	OIL	-0.0003	0.043	-0.0003	0.0000	
COALINDIA	-0.0023	0.000	-0.0001	0.3007	ONGC	-0.6264	0.000	0.0000	0.8090	
GAIL	-0.0546	0.000	-0.0004	0.0000	PETRONET	-0.0011	0.000	0.0001	0.4369	
HINDPETRO	-0.0529	0.000	-0.0001	0.2360	PFC	-0.0020	0.000	0.0000	0.5723	
IGL	-0.0038	0.000	0.0001	0.5647	POWERGRID	-0.0279	0.000	0.0000	0.8351	
IOC	-0.0039	0.000	0.0001	0.2794	TATAPOWER	-0.1528	0.000	-0.0002	0.1086	
MGL	-0.1810	0.000	-0.0006	0.0000	TORNTPOWER	-0.0135	0.000	-0.0001	0.2439	

Table 4: Hasbrouck (1995) information share measures and common factor component weights of Gonzalo and Granger (1995)

Stock	Hasbr	ouck	Gonzalo G	ranger Stock Hasbrouck Gonzal		Stock Hasbrouck		Gonzalo	o Granger	
	informati	on share	factor we	eights		informatio	on share	factor v	weights	
	Stock	SSF	Stock	SSF		Stock	SSF	Stock	SSF	
ADANIPOWER	0.46	0.54	0.53	0.47	NTPC	0.41	0.59	0.39	0.61	
BPCL	0.14	0.86	0.22	0.78	OIL	0.36	0.64	0.45	0.55	
COALINDIA	0.02	0.98	0.06	0.94	ONGC	0.06	0.94	0.1	0.9	
GAIL	0.03	0.97	0.14	0.86	PETRONET	0.04	0.96	0.11	0.89	
HINDPETRO	0.18	0.86	0.33	0.67	PFC	0.43	0.57	0.42	0.58	
IGL	0.08	0.92	0.07	0.93	POWERGRID	0.16	0.84	0.28	0.72	
IOC	0.22	0.78	0.34	0.66	TATAPOWER	0.02	0.98	0.03	0.97	
MGL	0.16	0.84	0.28	0.72	TORNTPOWER	0.16	0.84	0.31	0.69	

Stock Futures and Underlying Stocks. If the ECT is negative and significant, it indicates a stable long term relationship between Dependent variables and Independent variables.

In the equation with Spot return as a dependent variable, all the sixteen Stocks are having negative Error Correction Term and significant p-value. However, in the equation with Futures return as the dependent variable, the Error Correction Term is negative and significant for only three out of sixteen Stocks. The speed of adjustment in the Futures Market for all the Stocks is higher than the Spot Market. It indicates that when there is a disequilibrium in the cointegrated series in the short-run, Futures Market makes more significant adjustments than the Spot Market to restore the equilibrium. Futures Market appears to play a more efficient role in Price-Discovery than the Spot Market for Stocks in the Energy Sector.

Table 4 reports Hasbrouck (1995) information shares and Common Factor Component Weights of Gonzalo and Granger (1995) computed using 1-min price data for Select highly traded Stocks and their respective Future Contracts. It could be inferred from Table 4 that the Information Share is generally higher in Stock Futures Segment consistently for the majority of the stocks. The average Information Share of the Futures Market is 81% and 18% for the Spot Market. The estimates of the Hasbrouck Information Share indicate that the Futures Market leads the Spot Market in the Price-Discovery process. Similar findings are also presented by Component Share Weights, where the Component Share of Futures Market is 75% and 25% for the Spot Market. The results of Hasbrouck (1995) information shares and Common Factor Component Weights of Gonzalo and Granger (1995) indicate that Futures Markets leads the Price-Discovery Process while the Spot Market follows.

6. CONCLUSION

Through this study, we attempted to understand the Price-Discovery process between SSFs and their underlying stocks using high-frequency data of Energy Sector. The findings of the study suggest that Single Stock Futures play a crucial role in the Price-Discovery and leads the Spot Market in the process of Price-Discovery. VECM test indicated that when there is disequilibrium in the Cointegrated series, Futures Market makes more significant adjustments than the Spot Market to restore the equilibrium. For India's economy, Futures Market appears to play a more efficient role in Price-Discovery than the Spot Market.

Hasbrouck Information Share indicates that Price-Discovery concentrates on the Futures market with the Information Share of 81%. The estimates of the Hasbrouck Information Share indicate that the Futures Market leads the Spot Market in the Price-Discovery process. Similar findings are also presented by Component Share Weights, where the Component Share of Futures Market is 75% and 25% for the Spot Market. The findings of the Hasbrouck Information Share is contradicting the findings offered by (Kumar and Tse, 2009), who found the stock market contributing more to Price-Discovery than the Futures markets. The results of Hasbrouck (1995) information share and Common Factor Component Weights of Gonzalo and Granger (1995) provide evidence to support the dominant role played by the Stock Futures Market. The findings of the study are in line with

Kawaller et al. (1987), Stoll and Whaley (1990), Chan (1992), Frino et al. (2000), Brooks et al. (2001), Zhong et al. (2004), and Kang and Lee (2006).

The Futures Market is expected to reflect the new information first, and later it flows to the underlying Cash Market. Lower transaction costs, provision of leverage trading, higher liquidity, and availability of short selling opportunities are the main reasons attributed to the leading role of Futures Market in the Price-Discovery process. The study points towards the fact that Price-Discovery happens in Spot Market as well as the Futures Market. However, Stock Futures are more efficient relative to its corresponding underlying Stocks, as it processes information faster. Overall findings of the study point towards the fact that Single Stock Price quotes are more informative and overpower the Spot Market in the Price-Discovery process.

REFERENCES

- Aggarwal, N., Thomas, S. (2011), When do Stock Futures Dominate Price-Discovery? When do Stock Futures Dominate Price-Discovery? 24th Australasian Finance and Banking Conference 2011 Paper, IDGR.
- Boney, V., Giannikos, C., Guirguis, H. (2018), Pricing dynamics between single stock futures and the underlying spot security. International Journal of Business and Economics, 17(2), 179-191.
- Booth, G.G., So, R.W. (1999), Price-discovery in the german equity index derivatives markets. The Journal of Futures Markets, 19(6), 619-643.
- Brooks, C., Rew, A.G., Ritson, S. (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, 17(1), 31-44.
- Chakravarty, S., Gulen, H., Mayhew, S. (2004), Informed trading in stock and option markets. The Journal of Finance, 59(3), 1235-1257.
- Chan, K. (1992), A further analysis of the lead-lag relationship between the cash market and stock index futures market. The Review of Financial Studies, 5(1), 123-152.
- Chan, L., Lien, D. (2001), Cash Settlement and price discovery in futures markets. Quarterly Journal of Business and Economics, 40, 65-77.
- Chiou-Wei, S.Z., Chen, C.F., Zhu, Z. (2008), Economic growth and energy consumption revisited-evidence from linear and nonlinear Granger causality. Energy Economics, 30(6), 3063-3076.
- Fleming, J., Ostdiek, B., Whaley, R.E. (1996), Trading costs and the relative rates of discovery in option markets. The Journal of Futures Markets, 387(4), 353-387.
- Frino, A., Walter, T., West, A. (2000), The lead-lag relationship between equities and stock index futures markets around information releases. The Journal of Futures Markets, 20(5), 467-487.
- Gonzalo, J., Granger, C. (1995), Long-memory in cointegrated systems components. Journal of Business and Economic Statistics, 13(1), 27-35.
- Hasbrouck, J. (1995), One security, many markets: Determining the

contributions to price-discovery. The Journal of Finance, 50(4), 1175-1199.

- Kang, J., Lee, S. (2006), An empirical investigation of the lead-lag relations of returns and volatilities among the KOSPI 200 Spot, futures and options markets and their explanations. Journal of Emerging Market Finance, 3, 235-261.
- Kawaller, I.R.A., Koch, P.D., Koch, T.W. (1987), The Temporal price relationship between S&P 500 futures and the S&P 500 index. The Journal of Finance, 32(5), 1309-1329.
- Kim, A. (2015), Does futures speculation destabilize commodity markets? Journal of Futures Markets, 35(8), 696-714.
- Kumar, K.K., Chaturvedula, C. (2013), Price leadership between spot and futures markets. Journal of Applied Finance and Banking, 3(1), 1-6.
- Kumar, U., Tse, Y. (2009), Single-stock futures: Evidence from the Indian securities market. Global Finance Journal, 20(3), 220-234.
- Ng, V.K., Pirrong, S.C. (1996), Price dynamics in refined petroleum spot and futures markets. Journal of Empirical Finance, 2(4), 359-388.
- Raju, M.T., Karande, K. (2003), Securities and Exchange Board of India. Price-Discovery and Volatility on NSE Futures Market.
- Schwarz, T.V., Szakmary, A.C. (2010), Price-discovery in petroleum markets: Interval the time of analysis. Journal of Futures Markets, 14(2), 147-167.
- Sehgal, S., Ahmad, W., Deisting, F. (2015), An investigation of pricediscovery and volatility spillovers in India's foreign exchange market. Journal of Economic Studies, 42(2), 261-284.
- Shastri, K., Thirumalai, R.S., Zutter, C.J. (2008), Information revelation in the futures evidence from single stock futures. Journal of Futures Markets, 28(4), 335-353.
- Sriram, M., Senthil, M. (2013), Market efficiency and volatility spill over in spot and futures currency market. International Journal of Management Excellence, 1(3), 45-53.
- Stoll, H.R., Whaley, R.E. (1990), The dynamics of stock index and stock index futures returns. Journal of Financial and Quantitative Analysis, 25(4), 441-468.
- Thenmozhi, M. (2002), Do the S&P CNX Nifty Index and Nifty Futures Really Lead/Lag? Error Correction Model: A Co-integration Approach. Mumbai: NSE Publication.
- Tse, Y. (1999), Price-discovery and volatility spillovers in the DJIA index and futures markets. Journal of Futures Markets, 19(8), 911-930.
- Tse, Y., Xiang, J. (2005), Market quality and price-discovery: Introduction of the E-mini energy futures. Global Finance Journal, 16(2), 164-179.
- Wahab, M., Lashgari, M. (1993), Price dynamics and error correction in stock index and stock index futures markets: A cointegration approach. International Journal of Research in Finance and Marketing, 13(7), 711-742.
- Zakaria, Z. (2012), Relationship between stock futures index and cash prices index: Empirical evidence based on malaysia data. Journal of Business Studies Quarterly, 4(2), 103-112.
- Zhong, M., Darrat, A.F., Otero, R. (2004), Price-discovery and volatility spillovers in index futures markets: Some evidence from Mexico. Journal of Banking and Finance, 61(7), 3037-3054.