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The Causal Relationship between Spot and Future Prices in India: A Select Case Study of NSE

KEYWORDS: Derivatives, Futures, Co-integration, Impulse response, Variance decomposition

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ABSTRACT *This paper empirically examines the causal relationship between spot and future prices of NSE CNX Nifty and some selected stocks of Nifty (TATA Motors, ICICI Bank, INFOSYS, ACC and ONGC) using daily data covering the period from January 2010 to December 2014. The dynamic relationships including lead-lag relationships between spot and future market are investigated using Johansen-Juselius cointegration test, Vector Error Correction Model(VECM), Impulse response,Variance Decomposition and Granger causality test. The results suggest that there is a long run relationship between spot and future prices of Nifty and all the five stocks considered in the study. It is also found that there is a unidirectional causal relationship running from future prices to spot prices of Nifty, TATA Motors and ACC. Further, the study finds a bidirectional causal relationship running from spot to future prices and future to spot prices in case of ICICI Bank, INFOSYS and ONGC.*

JEL Classification: G1, G13, G14,

I. Introduction

In the financial market in general and the equity market in particular, the derivative segment has increased its prominence as an instrument of risk management. Further, the presence of derivative segment partially transfers the price risk of the market participants. With the introduction of stock index futures in 1982 in the United States, this particular segment has become more popular across and attracted traders, regulators, academicians and practitioners for a number of reasons such as market increasing market efficiency, reducing volatility and curbing arbitrage opportunities. Some studies *e.g.*, Cornell and French (1983) argued that an equilibrium condition exists between future prices and spot index prices. But Mackinlay and Ramaswamy (1988) on the other hand put forward that future prices deviate substantially from their theoretical prices.

In perfectly efficient markets, new information disseminating into the market place should be immediately reflected in spot and future prices to avoid any profitable arbitrage opportunities. In efficient markets futures should be an unbiased estimator of future spot prices at the expiration date. But due to market frictions like transaction costs, regulatory constrains or market microstructure effects, future market processes information faster than spot market. So future price will lead to spot price which indicates the price discovery function of futures market. So it is important to determine the nature and location of price discovery which requires the study of long run relationship and causal relationship between spot and future market. The causal relationship will show how well the two markets are linked together *i.e.,* how fast one market reacts to the new information from other market, or which market will forecast the other market.

In India systematic studies on the relationship between sot and future prices are very limited. Thenmozi (2002) argued that future market leads to spot market, whereas Mukherjee and Mishra (2006) put forward that spot market plays an important role in price discovery and leads to future market. The purpose of the present study is to find out the presence and direction of causality between the nifty future and nifty spot prices for analysing the interdependence relationship using the daily data.

Including the introductory section, the study has been divided in to six sections. Section II briefly outlines the important studies conducted relating to this particular area. Section III discusses about the stylized facts on the development of the equity future markets in India. Sources of data for conducting the empirical tests and background about the methodologies used are given in the Section IV. Section V contains the analysis and findings of the empirical estimations. Major findings and concluding observations are highlighted in the Section VI.

II. Review of Literature

Chan and Lin (2004) tried to investigate price discovery capability of Taiwan Index Futures Market relating to all the index future contracts for the period from October 2001 to March 2002 by using the econometrics techniques such as error correction model, Gonzalo-Granger information share, Granger causality test and generalized impulse response function. The study found that three out of all four index future contracts traded in the Taiwan stock market play a very crucial role in price discovery process.

To empirically investigate the long-run and causal relationship between stock market cash prices index and stock market futures price index in Malaysia, Zakaria and Shamsuddin (2012) used the Cointegration and Granger Causality Test. Their study period covered from January 2006 to November 2011. The findings of their study in terms of Cointegration tests suggests that there is a long rung stable relationship between spot index and futures contract indexes of Malaysian stock market. The Granger causality tests, however, revealed that the there is a unidirectional causality running from cash market index to futures market indexes.

In Indian context, Pati and Padhan (2009) conducted a study to find out the price discovery process and lead-lag relationship between NSE CNX Nfty Stock Index futures and its underlying spot index by taking in to consideration of the daily closing prices of both the spot and future indices. The study used Johansen-Juselius Cointegration

Volume : 5 | Issue : 9 | September 2015 | ISSN - 2249-555X

technique and the impulse response function and variance decomposition results were estimated through the Vector Error Correction Model (VECM). Further, to find causality relationship between the spot and future index market the study used Toda-Yamamota Dolado-Lütkepohl (TYDL) causality test. The spatial coverage of the data used in the study ranged from January 2004 to December 2008. The empirical finding suggests that there is long-run relationship between spot and future prices. The causality test reveals that a unidirectional causal relationship running from future to spot market which is helping in the price discovery mechanism.

Dhanya and Janardhana (2011) in their study found that there is a lead lag relationship between Nifty futures and bank nifty futures and their respective spot markets during the period covering from April 2005 to March 2010 by using the Co-integration and Granger Causality Test. Further, the study also found that the both the future contracts helps in performing price discovery process.

With the help of using Engle and Granger's co-integration analysis, error correction model and Granger causality test and high frequency intra-day price of Nifty (NSE) spot and futures for the period covering form April 2005 to March 2006 Bhatia (2007) empirically found that the price discovery happens in both the futures and the spot market. However the S&P CNX Nifty Futures Index is more efficient than the S&P CNX Nifty Index and leads the spot index by 10 to 25 minutes.

Tang *et al*. (1992) in Hong Kong studied the causal relationship between the daily closing prices of Hang Sang Index futures and Hang Sang Index spot by using Vector autoregression and Granger causality test during the pre and post-crash period from May 1986 to February 1989. Their study found that during the pre–crash period there is a strong direct causal relationship running from futures to spot index price changes. After the stock market crash in October 1987 there is a bi-directional causal relationship found between spot and future price changes.

Kawaller (1987) tried to empirically test the lead lag relationship between S&P 500 futures and the S&P 500 index using the three-stage least square Regression method for the period from 1984 to 1985 and findings suggests that S & P 500 futures prices and the index are simultaneously related on a minute-to-minute basis throughout the trading day. Also the lead from futures to cash prices extends for between twenty and forty-five minutes, while the lead from cash prices to futures prices, though significant, rarely extends beyond one minute.

Wahab and Lashgari (1993) have used the cointegration analysis to examine the temporal causal link between stock index and stock index futures prices for both the S&P and FT-SE 100 indexes over the period from 1988 to 1992. The results show that the S&P 500 pair of spot and futures indices is cointegrated. FT-SE also confirms the same results for the test of cointegration. Although feedback exists between cash and futures prices for both the S&P 500 and FT-SE 100 indices, the spot- to- futures lead is more prominent across days relative to the futures-to-spot lead.

III. Futures Market in India: A Stylized Fact

In India NSE commenced trading in derivatives with the launch of Index futures on 12 June 2000.The Nifty Future contracts are based on popular benchmark CNX NIFTY Index. The Future Contracts have a maximum of 3 month trading cycle, the near month (one), the next month (two) and the far month (three).National Securities Clearing Corporation Limited (NSCCL) is the clearing and settlement agency for all deals executed on Futures contract.

The trends in both the number of contracts and turnover over indicate that there has notable increase in both the front (Table A) after the introduction of equity derivatives in India. However, the increase is quite substantial in case of NSE as compared with the BSE.

Table A: Trends in Turnover in Equity Derivatives

Year	No. of Contracts		Total	Turnover (Rs. crore)		Total (Rs.crore)
	NSE	BSE		NSE	BSE	
2003-2004	5,68,86,776	3,82,258	5,72,69,034	21,30,649	12,452	21,43,101
2004-2005	7,70,17,185	5,31,719	7,75,48,904	25,47,053	16,112	25,63,165
2005-2006	15,76,19,271	203	15,76,19,474	48,24,250	9	48,24,259
2006-2007	21,68,83,573	17,81,220	21,86,64,793	73,56,271	59,007	74,15,278
2007-2008	42,50,13,200	74,53,371	43,24,66,571	1,30,90,478	2,42,309	1,33,32,787
2008-2009	65,73,90,497	4,96,502	65,78,86,999	1,10,10,482	11,775	1,10,22,257
2009-2010	67,92,93,922	9,026	67,93,02,948	1,76,63,665	234	1,76,63,899
2010-2011	1,03,42,12,062	5,623	1,03,42,17,685	2,92,48,221	154	2,92,48,375
2011-2012	1,20,50,45,464	3,22,22,825	1,23,72,68,289	3,13,49,732	8,08,476	3,21,58,208
2012-2013	1,13,14,67,418	26,24,43,366	1,39,39,10,784	3,15,33,004	71,63,519	3,86,96,523
2013-2014	1,28,44,24,321	30,19,42,441	1,58,63,66,762	3,82,11,408	92,19,434	4,74,30,842

Sources: Various Issues of Indian Securities Market: A Review Published by National Stock Exchange of India Limited and Various Issues of SEBI Annual Report.

Volume : 5 | Issue : 9 | September 2015 | ISSN - 2249-555X

In NSE, the turnover of Nifty futures constitutes a major share in comparison to other index futures in the turnover of all index futures (Table B). Although the share of Nifty turnover has been declining over the years, still it constitutes about 74 per cent of the turnover of all index futures.

Table B: Trends in Nifty Futures and All Index Futures in NSE

Year	NIFTY Future		All Index Futures*	
	No. of Contracts	Turnover (Rs.crore)	Total No. of Contracts	Total Turnover (Rs.crore)
2006-2007	81,100,169	25,22,138	81,487,424	25,39,574
2007-2008	1,52,838,395	37,50,832	1,56,598,579	38,20,667
2008-2009	1,84,877,940	33,38,319	2,10,428,103	35,70,111
2009-2010	1,52,074,103	34,71,986	1,78,306,889	39,34,389
2010-2011	1,33,368,752	37,18,465	1,65,023,653	43,56,755
2011-2012	1,13,204,121	29,56,162	1,46,188,740	35,77,998
2012-2013	68,223,052	18,67,489	96,100,385	25,27,131
2013-2014	76,007,830	22,73,237	1,05,270,529	30,85,296

***** includes NIFTY, MINIFTY, BANKNIFTY, CNXIT, NFTYMCAP50, CNXINFRA, CNXPSE, DJIA, S&P500 and FTSE 100.

Sources: Various Issues of Indian Securities Market: A Review Published by National Stock Exchange of India Limited and Various Issues of SEBI Annual Report.

IV. Data Sources and Methodology of the Empirical Tests

IV. a. Sources of Data and Spatial Coverage

Secondary data have been used to conduct this study. The main sources of data are the websites and various publications of both Securities and Exchange Board of India (SEBI) – the regulator of the securities market of India and the National Stock Exchange of India Limited (NSE) - the leading stock exchange of India.

The study covers the period starting from January 2010 to December 2014. Near month future data traded at the NSE has been used to study the relationship between the spot and future market in India. The daily closing price data are taken for the econometric estimations. Also five different stocks of NIFTY50 (TATA Motors, ICICI Bank, INFOSYS, ACC and ONGC) from different sectors of the economy are taken to study the causal relationship between spot and futures market.

IV. b. Methodologies

In this study we have used the Augmented Dickey–Fuller test (ADF) and PP (Phillips–Perron) Test to check the stationary properties of the data / variable. Johansen Cointegration Test is being used to study the long-run relationship between the variables. Evidence of a Short-run relationship is derived by using the VECM model. The impulse response functions and forecast error variance decomposition results are reported further to cross check the dynamic relationship between the variables under consideration. Further, the Granger Causality results are reported to cross check the direction of causality between the variables. The entire variable is converted to logarithmic form to avoid heteroscedasticity and smoothen the series.

IV.c. Unit Root Test

Before conducting any econometric test, the statationarity properties of the variables need to be checked through unit root test. Most commonly used method of checking the stationarity properties of the variables are Augmented Dickey-Fuller (ADF) Test and Phillips-Perron (PP) Test.

IV.c. i. Augmented Dickey-Fuller (ADF) Test

The testing for unit root in the time series was pioneered by Dickey and Fuller (Fuller, 1976; Dickey and Fuller, 1979). The objective behind the test was to examine whether there is a unit root in the time series data.

Augmented Dickey-Fuller (ADF) test using *p* lags of the dependent variable.

$$\Delta yt = \psi yt - 1 + \sum_{i=1}^{p} \alpha i \Delta yt - i + ut \quad \text{----------(Equ. 1)}$$

The lags of Δy_t absolves any dynamic structure present in the dependent variable, to ensure that u_t is not autocorrelated.

IV. c. ii. Phillips-Perron (PP) Test

Phillips and Perron have developed an alternative method of unit root test having less restrictive assumptions as that of ADF test regarding the distribution of errors. The AR(1) process of test regression is as follows:

$$\Delta Y \text{ t-1} = \alpha_0 + \psi y_{t-1} + \varepsilon_t \quad \text{----------(Equ.2)}$$

PP test corrects the t- statistics of the co-efficient from the above regression to account for the serial correlation in ε_t.

IV. d . Cointegration Test (Johansen and Juselius)

The Cointegration Test developed by Johansen and Juselius permits more than one cointegrating relationship when there are many I (1) time series. The test is validated through the following VECM (Vector Error Correction Model):

$$\Delta y_t = \Pi y_{t-k} + \Gamma_1 \Delta y_{t-1} + \Gamma_2 \Delta y_{t-2} + \cdots + \Gamma_{k-1} \Delta y_{t-(k-1)} + U_t \quad \text{----------(Equ.3)}$$

Where, $\Pi = \left(\sum_{i=1}^{k} \beta_i\right) - I_g$ and $\Gamma_{i=2} = \left(\sum_{j=1}^{i} \beta_j\right) - I_g$

$g \geq 2$

The Johansen Test centres around an examination of long-run coefficient matrix the rank of which helps in calculating the test for cointegration. If the variables are not cointegrated the rank $\lambda_{i=0}$ for all i. The Johansen approach employs two test statistics for testing cointegration

$$\lambda_{trace}(r) = -T \sum_{i=r+1}^{g} \ln(1 - \hat{\lambda}_i)$$

$$\lambda_{max}(r) = -T \ln(1 - \hat{\lambda}_{r+1})$$

IV. e . Granger Causality Test

Granger (1969) proposed a causality test to determine whether one time series data useful in forecasting another.

Volume : 5 | Issue : 9 | September 2015 | ISSN - 2249-555X

Granger causality test on two stationary time series X and Y involves estimating the following pair of regressions:

$$X_t = \sum_{i=1}^{m} \alpha_i Y_{t-i} + \sum_{j=1}^{n} \beta_j X_{t-j} + U_{1t} \quad \text{----------(Equ.4)}$$

$$Y_t = \sum_{i=1}^{m} \lambda_i Y_{t-i} + \sum_{j=1}^{n} \delta_j X_{t-j} + U_{2t} \quad \text{----------(Equ.5)}$$

Where, U_{1t} & U_{2t} are uncorrelated.

When inclusion of lagged values of X significantly improve the prediction of Y in a regression of Y on X (including its own past values), then it is said that X Granger causes Y. Similarly, Y Granger causes X can be defined.

IV. f . Impulse Response and Variance Decomposition

Impulse responses and variance decompositions partially find out whether changes in the value of a given variable have positive or negative effect on other variables of the system and the time taken for the effect of the variable to work through the system.

Impulse response functions are used to describe how the dependent variables react over time to exogenous impulses called 'shocks' to each of the variables in the VECM. Effects upon the VECM system are generated over time when a unit shock is applied to the error from each equation for each variable. Systems having g variables would generate g^2 impulse responses. For stable systems shocks should gradually die away.

Dynamic structure of the VAR enables the shock on the i^{th} variable to transmit to all other variables of the system. Variance decomposition determines how much of the forecast error variance of the dependent variables can be explained by exogenous shocks to other variables. The proportion of the movement in each variable is due to its own shocks versus shocks to other variables in the system.

V. Analysis of Empirical Results

The Unit Root Test results in form of ADF and PP reveals that all the variables under consideration are I(I), meaning that variables are non-stationary at level and stationary at their first differences (Table 1 and Table 2). The optimal lag lengths for ADF test are chosen based on AIC, while for the PP test, it is based on the automatic selection procedure of Newey-West (1994) for Bartlett kernel.

V. a. Unit Root Test

Table 1 : Unit Root Test (ADF and PP Test Results)

Index and Stocks	Level			
	ADF Test* (t-statistics) Variables		PP Test* (t-statistics) Variables	
	LNSC	LNFC	LNSC	LNFC
CNX NIFTY	-0.5309	-0.4288	-0.4331	-0.4740
TATA Motors	-1.7309	-1.7140	-1.6058	-1.6071
ICICI Bank	-1.0856	-0.9635	-0.8756	-0.7933
INFY	-2.6897	-2.6241	-2.9386	-2.9262
ACC	-1.9873	-1.9429	-2.0736	-2.0736
ONGC	-1.9037	-1.9054	-1.8915	-1.8940
Critical Values				
1%	-3.4354	-3.4354	-3.4354	-3.4354
5%	-2.8637	-2.8637	-2.8637	-2.8637
10%	-2.5680	-2.5680	-2.5680	-2.5680

ADF - Augmented Dickey- Fuller. PP - Phillips-Perron.

Table 2: Unit Root Test (ADF and PP Test Results)

Index and Stocks	First Difference			
	ADF Test* (t-statistics) Variables		PP Test* (t-statistics) Variables	
	LNSC	LNFC	LNSC	LNFC
CNX NIFTY	-20.8781	-34.0483	-32.8075	-34.0465
TATA MOTORS	-33.4805	-33.6798	-33.4697	-33.6756
ICICI BANK	-21.3289	-33.3708	-33.3403	-33.3353
INFY	-34.7712	-34.6913	-34.7813	-34.7235
ACC	-33.9148	-34.2779	-33.9270	-34.2975
ONGC	-34.7268	-34.8213	-34.7315	-34.8264
Critical Values				
1%	-3.4354	-3.4354	-3.4354	-3.4354
5%	-2.8637	-2.8637	-2.8637	-2.8637
10%	-2.5680	-2.5680	-2.5680	-2.5680

Note: H_0 :The series under consideration has a unit root(Calculated value < Critical value)

H_1 :The series under consideration is stationary (Calculated value > Critical value)

V.b. Cointegration Test (Johansen Cointegration Test)

Table 3 reports the Johansen-Juselius cointegration test results. As shown in Table 3 (Panel A and B), the null hypothesis of zero cointegration (None) is rejected both by λ_{trace} and λ_{max} because in both the cases test statistics is greater than Johannes's tabular critical values. This means there is a cointegrating relationship between the two variables taken in to consideration. Further, there is a long run linear equilibrium relationship among future and spot prices for CNX Nifty and other five individual stocks (TATA Motors, ICICI Bank, INFOSYS, ACC and ONGC).

Volume : 5 | Issue : 9 | September 2015 | ISSN - 2249-555X

Table 3:Johansen-Juselius Cointegration test Results between Spot and Future Prices
(Data Trend: Linear with intercept and no trend)

Panel A: Unrestricted Cointegration Rank Test(trace)

Futures	Hypothesized no. of CE(s)	Eigen value	Trace statistics	5%Critical Value	p-Valu	Conclusion
CNX NIFTY	None*	0.054213	69.09424	15.49471	0.0000	1 Cointegrating equation
	At most 1	7.28E-05	0.090152	3.841466	0.7640	
TATA MOTORS	None*	0.346147	530.1197	15.49471	0.0001	1 Cointegrating equation
	At most 1	0.002296	2.852986	3.841466	0.0912	
ICICI BANK	None*	0.144011	190.9323	15.49471	0.0001	1 Cointegrating equation
	At most 1	0.000492	0.602674	3.841466	0.4376	
INFOSYS	None*	0.250435	365.1224	25.87211	0.0000	1 Cointegrating equation
	At most 1	0.005700	7.100094	12.51798	0.3342	
ACC	None*	0.205059	293.0596	25.87211	0.0000	1 Cointegrating equation
	At most 1	0.006449	8.035695	12.51798	0.2488	
ONGC	None*	0.197020	276.3050	15.49471	0.0001	1 Cointegrating equation
	At most 1	0.003038	3.779295	3.841466	0.0519	

Panel B: Unrestricted Cointegration Rank (Maximum Eigen Value)

Index and Stocks	Hypothesized no. of CE(s)	Eigen value	Max-Eigen statistics	5%Critical Value	p-Value**	Conclusion
CNX NIFTY	None*	0.054213	69.00408	14.26460	0.0000	1 Cointegrating equation
	At most 1	7.28E-05	0.090152	3.841466	0.7640	
TATA MOTORS	None*	0.346147	527.2668	14.26460	0.0001	1 Cointegrating equation
	At most 1	0.002296	2.852986	3.841466	0.0912	
ICICI BANK	None*	0.144011	190.3296	14.26460	0.0001	1 Cointegrating equation
	At most 1	0.000492	0.602674	3.841466	0.4376	
INFOSYS	None*	0.250435	358.0223	19.38704	0.0001	1 Cointegrating equation
	At most 1	0.005700	7.100094	12.51798	0.3342	
ACC	None*	0.205059	285.0239	19.38704	0.0001	1 Cointegrating equation
	At most 1	0.006449	8.035695	12.51798	0.2488	
ONGC	None*	0.197020	272.5257	14.26460	0.0001	1 Cointegrating equation
	At most 1	0.003038	3.779295	3.841466	0.0519	

Note:* denotes rejection of the null hypothesis of no cointegration at 0.05 level.
**MacKinnon-Haug-Michelis (1999) p-values.

V. c. Vector Error Correction Model (VECM)

The study has further used the VECM approach to find out the stability nature of the model and investigate the dynamic interaction among the variables. The error correction terms (ECT) derived from the VECM model indicates that, all the ECTs are negative and significant (Table 4). Further, all the models estimated through VECM approach are stable in nature; any short-run deviation is getting corrected. However, the adjustment period is different in each case depending on the value of the coefficient term. In case of CNX Nifty, any short-term deviation takes around 3 days to get corrected. For Tata Motors, ICICI Bank, Infosys, ACC and ONGC it takes 8 days, 9 days, 2 days, 12 days and 3 days, respectively.

Table 4: Estimated Vector Error Correction Model of Spot and Future

	D(LNFC)					
	CNX NIFTY	TATA Motors	ICICI Bank	INFOSYS	ACC	ONGC
ECT_{t-1}	-0.406341 [-2.54713]	-0.127773 [-1.68513]	-0.114567 [-2.74301]	-0.589966 [-17.0812]	-0.076350 [-1.97981]	-0.363197 [-15.0621]
D(LNFC(-1))	0.031998 [0.14493]	0.161676 [2.15852]	0.064841 [1.50498]	0.103417 [3.22850]	0.077651 [1.84861]	0.130886 [4.48753]
D(LNFC(-2))	0.383772 [1.72617]	NA	NA	-0.007141 [-0.43502]	0.052965 [1.33300]	0.038061 [2.61529]
D(LNSC(-1))	0.012960 [0.05715]	-0.018830 [-0.64352]	0.031775 [0.80947]	0.304077 [9.13576]	0.005486 [0.16978]	0.526587 [20.9228]
D(LNSC(-2))	-0.385664 [-1.69940]	NA	NA	-0.107998 [-3.63753]	0.018795 [0.60575]	-0.117478 [-4.13381]
C	0.000153 [1.13071]	-0.000141 [-0.21825]	0.000230 [0.93445]	-7.51E-05 [-0.42224]	0.00013 [0.67985]	-0.000188 [-0.68101]

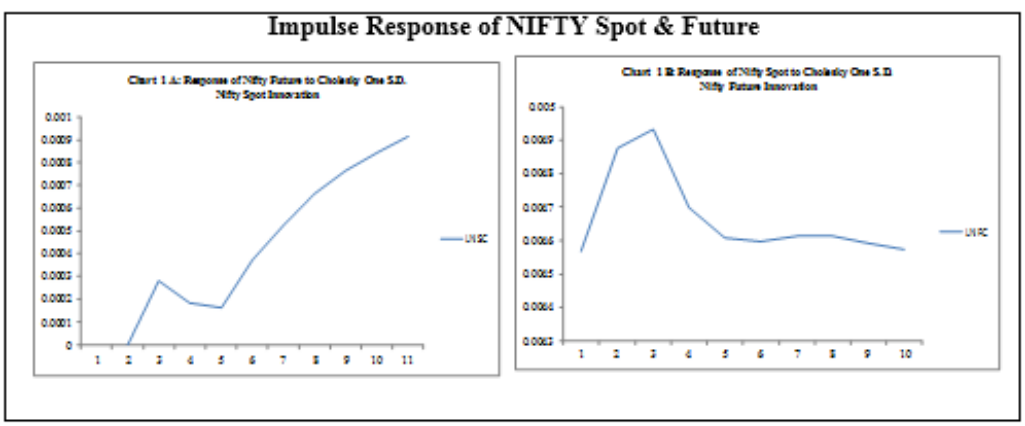
Note: t-statistics are given in parentheses.
NA: Lags are not taken in to consideration.

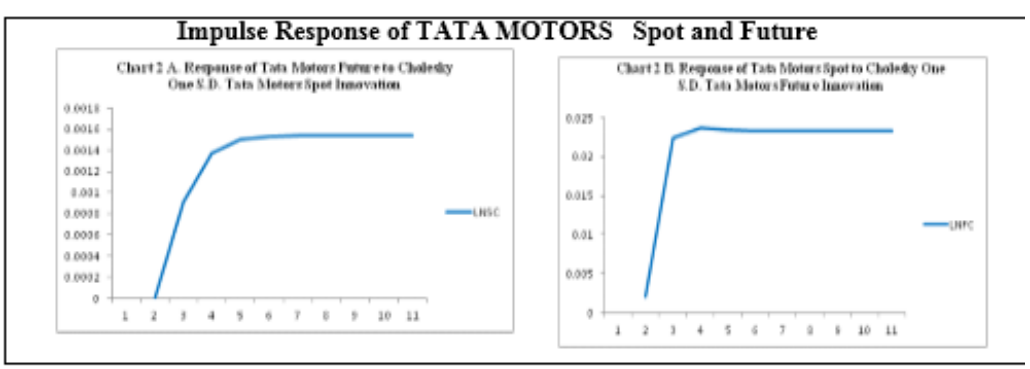
Volume : 5 | Issue : 9 | September 2015 | ISSN - 2249-555X

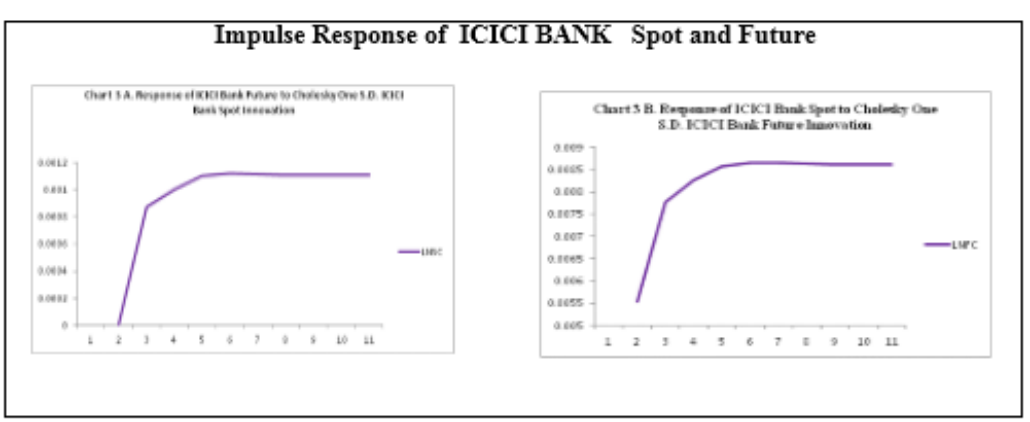
V.d. i. Impulse Response

To further investigate the dynamic interaction between spot and future prices of the CNX Nifty and other five select individual stocks, we have estimated the impulse response functions and variance decompositions through the VECM mechanism.

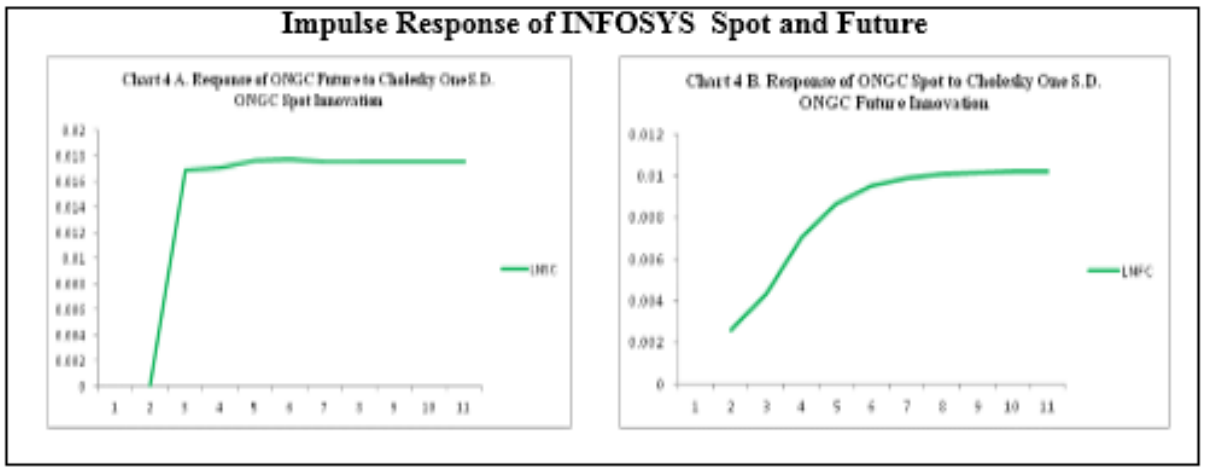
The impulse response function of the part A in the Chart 1 shows that one standard deviation shock in Nifty spot prices lead to an increase in Nifty future prices at the period two. However, the impact of the same increases further after some time with an intermittent correction. The impulse response function of the part B in the Chart 1 indicates that one standard deviation shock in Nifty future prices lead to an increase in spot prices in the 2nd day period. However, it dies down towards the 5th day period .Similarly for TATA Motors, ICICI bank, ONGC and INFOSYS{Chart-2,3,4,6(A)} one standard deviation shock to spot prices immediately increases the future prices till 4th to 5th period, then the pattern remains constant for some days to decay in the long run. Nearly similar pattern is seen when one standard deviation shock is given to future prices {Chart-2,3,4,6(B)} to know the impact on spot prices. For ACC in Chart 5 (A) when one standard deviation shock is given to spot prices there is immediate sharp increase of future prices to 4th period, which gets corrected by 8th period .Again from 8th period onwards there is a slight increase of the futures prices which die away in the long run. Further for ACC in Chart 5(B) when one standard deviation shock is given to future prices there is immediate increase of spot prices till 6th period which slowly gets corrected up to 8th period. Again there is slight increase of spot prices which subsequently fizzles out in the long run. Thus both future and spot markets give stability to the system to exogenous shocks in the long run.

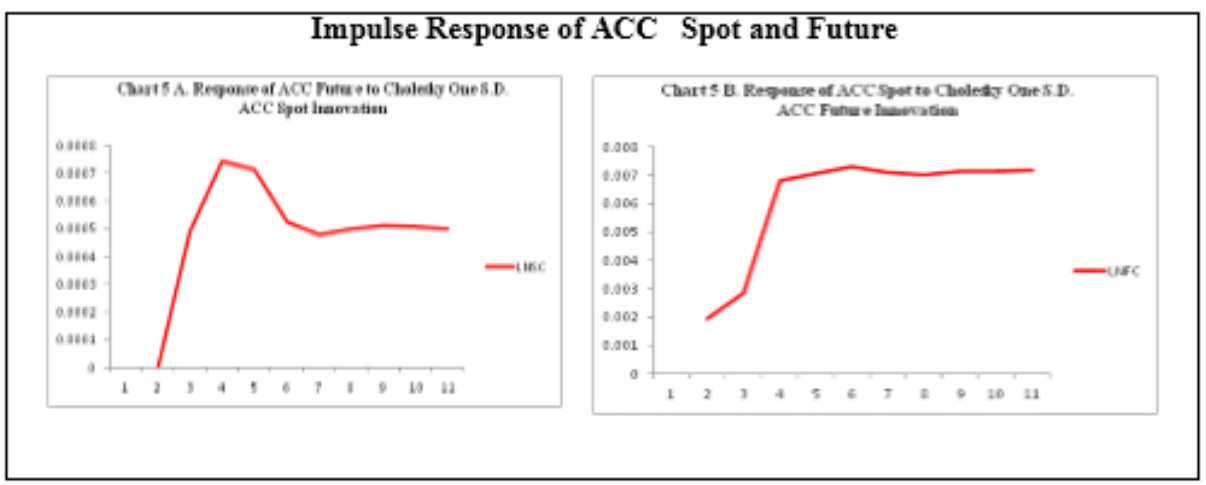


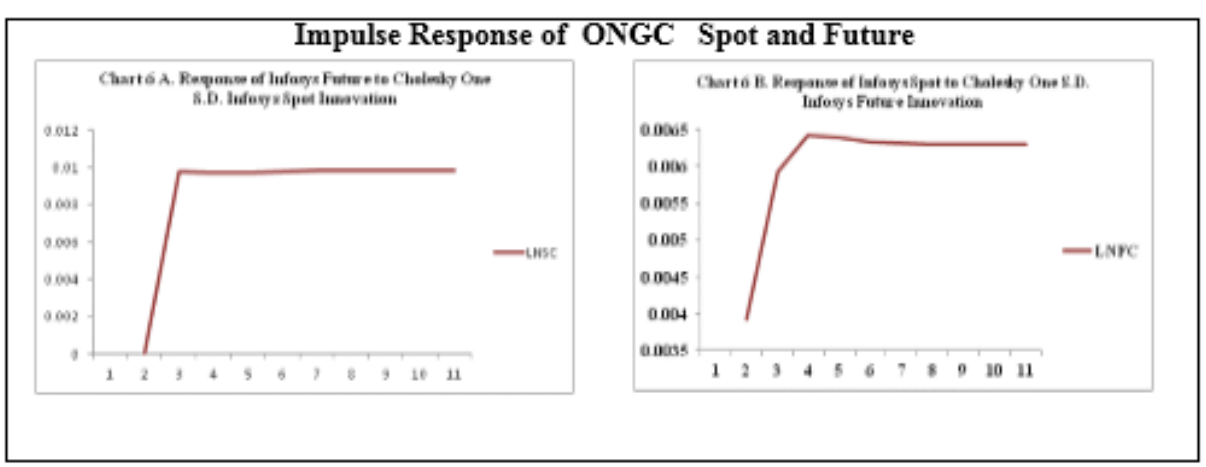




Volume : 5 | Issue : 9 | September 2015 | ISSN - 2249-555X







V.e. ii. Variance Decomposition or Forecast Error Variance Decomposition

The variance decomposition result of the Nifty spot (Table 5.i) shows that the variance in the Nifty spot prices is predominantly explained by variance in the Nifty future prices. However, the variance decomposition of the Nifty future (Table 5.ii) indicates that it predominantly explained by its own. The contribution of Nifty spot variance to the future is quite insignificant. Table 6.i showing variance decomposition results of Tata Motors spot return indicates that in the first period of the forecasting horizon, 93.93 per cent variation in the forecast error of spot market is explained by its own. After that it starts decaying at a faster pace. Whereas leaving the 1st day, in all other days the forecast error variance of spot market is predominantly explained by future market. Similarly, Table 6.ii shows that forecast error variance of Tata Motors future is explained by its own and the role of spot market is not significant.

Variance decomposition of ICICI bank spot in Table.7.i indicates that variance in ICICI spot prices are mostly explained by its own in the 1st period. After that it decreases gradually and the contribution of futures market increases

Volume : 5 | Issue : 9 | September 2015 | ISSN - 2249-555X

gradually. However, the variance decomposition of ICICI bank future (Table. 7. ii) indicates that both spot market and futures market play important role in it. Table .8.i of variance decomposition of INFOSYS spot indicates that the variation of forecast error of spot market is mostly explained by its own but the role of future market cannot be denied as its contribution from 2nd day onwards increases from 18.38 per cent to 27.25 per cent on 10th day.
Further Table.8.ii of variance decomposition of INFOSYS future shows that though future and spot market play significant role, contribution of future market decreases with time and spot market increases with time.

Table (9.i and 9.ii) showing variance decomposition of ACC spot and ACC future respectively indicates that both spot and future prices variance is mostly explained by future market in long run. Variance decomposition of ONGC spot in Table.10.i is explained predominantly by its own. However variance decomposition of ONGC future in Table.10.ii is mostly explained by its own in initial period. But gradually the contribution of future market decrease and spot market increases. Thus for NIFTY, TATA Motors and ACC future price leads to spot price means there is a price discovery function from future market to spot market. For ICICI bank, INFOSYS and ONGC though both spot and future market play important role in price discovery the contribution of spot market is more than that of future market.

Table 5. (i): Variance Decomposition of NIFTY Spot

Day /s	NIFTY Spot	NIFTY Future
1.	2.106005	97.89399
2.	1.976087	98.02391
3.	1.719843	98.28016
4.	1.780396	98.21960
5.	1.896038	98.10396
6.	2.031943	97.96806
7.	2.177617	97.82238
8.	2.324524	97.67548
9.	2.468542	97.53146
10.	2.607422	97.39258

Table 5. (ii): Variance Decomposition of NIFTY Future

Day /s	NIFTY Future	NIFTY Spot
1.	100.0000	0.000000
2.	99.81138	0.188618
3.	99.80704	0.192956
4.	99.68987	0.310131
5.	99.53598	0.464024
6.	99.36413	0.635869
7.	99.18080	0.819205
8.	98.99319	1.006808
9.	98.80599	1.194015
10.	98.62233	1.377671

Table 6. (i):Variance Decomposition of TATA Motors Spot

Day/s	TATA MOTORS Spot	TATA MOTORS Future
1.	93.93784	6.062159
2.	13.15149	86.84851
3.	6.903414	93.09659
4.	4.813465	95.18653
5.	3.747790	96.25221
6.	3.098717	96.90128
7.	2.662088	97.33791
8.	2.348361	97.65164
9.	2.112061	97.88794
10.	1.927677	98.07232

Table 6. (ii): Variance Decomposition of TATA Motors Future

Day/s	TATA MOTIORS Future	TATA MOTORS Spot
1.	100.0000	0.000000
2.	99.92320	0.076796
3.	99.83247	0.167533
4.	99.77102	0.228983
5.	99.73110	0.268899
6.	99.70384	0.296161
7.	99.68422	0.315783
8.	99.66947	0.330530
9.	99.65800	0.342003
10.	99.64882	0.351180

Table 7. (i):Variance Decomposition of ICICI Bank spot

Day/s	ICICI BANK Spot	ICICI BANK Future
1.	100.0000	0.000000
2.	91.76052	8.239484
3.	84.08020	15.91980
4.	77.97681	22.02319
5.	74.02091	25.97909
6.	71.47503	28.52497
7.	69.75971	30.24029
8.	68.52357	31.47643
9.	67.58102	32.41898
10.	66.83301	33.16699

Table 7. (ii): Variance Decomposition of ICICI Bank Future

Day/s	ICICI BANK Future	ICICI BANK Spot
1.	52.31212	47.68788
2.	47.26582	52.73418
3.	45.17371	54.82629
4.	43.84103	56.15897
5.	43.00234	56.99766
6.	42.44469	57.55531
7.	42.05484	57.94516
8.	41.76623	58.23377
9.	41.54275	58.45725
10.	41.36387	58.63613

Table 8. i: Variance Decomposition of Infosys Spot

Day/s	INFOSYS Spot	INFOSYS Future
1.	88.54256	11.45744
2.	81.61396	18.38604
3.	77.80154	22.19846
4.	75.89443	24.10557

Volume : 5 | Issue : 9 | September 2015 | ISSN - 2249-555X

5.	74.81598	25.18402
6.	74.12386	25.87614
7.	73.63405	26.36595
8.	73.26546	26.73454
9.	72.97757	27.02243
10.	72.74666	27.25334

Table 8. ii: Variance Decomposition of Infosys Future

Day/s	INFOSYS Future	INFOSYS Spot
1.	100.0000	0.000000
2.	46.94622	53.05378
3.	39.96145	60.03855
4.	36.99784	63.00216
5.	35.23026	64.76974
6.	34.11704	65.88296
7.	33.35891	66.64109
8.	32.80930	67.19070
9.	32.39241	67.60759
10.	32.06513	67.93487

Table 9. i: Variance Decomposition of ACC Spot

Day/s	ACC Spot	ACC Future
1.	85.81221	14.18779
2.	73.11643	26.88357
3.	37.08930	62.91070
4.	24.16425	75.83575
5.	18.37151	81.62849
6.	14.89569	85.10431
7.	12.52333	87.47667
8.	10.83826	89.16174
9.	9.590127	90.40987
10.	8.627535	91.37246

Table 9. ii: Variance Decomposition of ACC Future

Day/s	ACC Future	ACC Spot
1.	100.0000	0.000000
2.	99.84413	0.155873
3.	99.57193	0.428065
4.	99.39999	0.600010
5.	99.29349	0.706511
6.	99.21392	0.786084
7.	99.15160	0.848403
8.	99.10331	0.896687
9.	99.06534	0.934657
10.	99.03470	0.965295

Table 10. i: Variance Decomposition of ONGC Spot

Day/s	ONGC Spot	ONGC Future
1.	98.16003	1.839973
2.	96.45835	3.541654
3.	93.08541	6.914585
4.	89.78342	10.21658
5.	87.08308	12.91692
6.	85.03949	14.96051
7.	83.52173	16.47827
8.	82.37700	17.62300
9.	81.49187	18.50813
10.	80.78960	19.21040

Table 10. ii: Variance Decomposition of ONGC Future

Day/s	ONGC Future	ONGC Spot
1.	100.0000	0.000000
2.	40.02092	59.97908
3.	31.65568	68.34432
4.	28.41303	71.58697
5.	26.99355	73.00645
6.	26.40477	73.59523
7.	26.12249	73.87751
8.	25.96351	74.03649
9.	25.85885	74.14115
10.	25.78161	74.21839

V. f . Causality Test

In Granger's causality test when probability value is significant at 5%, the null hypothesis is rejected. Accordingly, it is observed that there is a unidirectional causality running from future prices to spot prices of NIFTY, TATA Motors and ACC (Table. 10, 11 and 14). However, bi-directional causality is found between spot and future prices of ICICI bank, INFOSYS and ONGC (Table, 12, 13 and 15).

Table 11: Granger Causality Test of NIFTY Spot and Future

Null Hypothesis:	No. Observations	F-Statistic	Prob.
DLNFC does not Granger Cause DLNSC	1238	0.96906	0.0234
DLNSC does not Granger Cause DLNFC		1.38291	0.2377

Table 12: Granger Causality Test of TATA MOTORS Spot and Future

Null Hypothesis:	No. Observations	F-Statistic	Prob.
DLNFC does not Granger Cause DLNSC	1241	4602.55	0.0000
DLNSC does not Granger Cause DLNFC		0.06959	0.7920

Table 13: Granger Causality Test of ICICI BANK Spot and Future

Null Hypothesis:	No. Observations	F-Statistic	Prob.
DLNFC does not Granger Cause DLNSC	1226	56.5608	0.0000
DLNSC does not Granger Cause DLNFC		3.72276	0.0244

Table 14: Granger Causality Test of INFOSYS Spot and

Volume : 5 | Issue : 9 | September 2015 | ISSN - 2249-555X

Future

Null Hypothesis:	No. Observations	F-Statistic	Prob.
DLNFC does not Granger Cause DLNSC	1242	11.2849	0.0000
DLNSC does not Granger Cause DLNFC		1104.13	0.0000

Table 15: Granger Causality Test of ACC Spot and Future

Null Hypothesis:	No. Observations	F-Statistic	Prob.
DLNFC does not Granger Cause DLNSC	1242	330.904	0.000
DLNSC does not Granger Cause DLNFC		1.29686	0.2738

Table 16: Granger Causality Test of ONGC spot and Future

Null Hypothesis:	No. Observations	F-Statistic	Prob.
DLNFC does not Granger Cause DLNSC	1242	2.75252	0.0642
DLNSC does not Granger Cause DLNFC		1487.89	0.0000

VI. Major Findings and concluding Observations

Numerous studies have been conducted on the relationship between future and spot prices of the equity market across the developed and emerging markets. However, there are few literature available in the Indian context. Keeping in view of that this study tries to empirically investigate and gives an insight of the causal relationship and lead lag relationship between stock index futures and its underlying stock index in the Nifty. This study also includes some of the prominent stocks such as TATA Motors, ICICI Bank, INFOSYS, ACC and ONGC in the empirical investigation. The Johansen-Juselius cointegration test used in the study finds one co-integrating vector indicating long-run relationship between future and spot prices of CNX Nifty and all the five considered stocks. The estimated Error Correction Terms (ECT) are found to be negative and significant which further validating the relationship.

From impulse response graph in case of CNX Nifty and all the five selected stocks it is found that both the spot and future markets give are highly sensitive to each others shocks. The findings of variance decomposition indicate that in case of Nifty, TATA Motors and ACC future market dominate over the spot market in explaining variations in both spot and future market meaning future price leads to spot price. But in case of ICICI bank, INFOSYS and ONGC both the spot and future market play an important role in explaining the variations in future market. However, the study finds unidirectional Granger Causality running from future prices to spot prices of Nifty, TATA Motors and ACC meaning future market plays the role of price discovery. Further, bi-directional causal relationship is found between spot and future prices of ICICI Bank, INFOSYS and ONGC meaning both spot and future market play significant role in explaining each other's movements.

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