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DOMINANCE OF FUTURES MARKET IN PRICE DISCOVERY: A STUDY OF INDIAN EQUITY MARKET

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ABSTRACT

Derivatives were introduced and later developed on the recommendation of various committees in Indian equity market because of various benefits it provided such as price discovery, low transaction cost, improving trading efficiency and many more. The present study examined the efficiency of equity derivatives in general and futures market in particular, in price discovery by studying the long-run and short-run relationship along with the direction of relationship (causality) between CNX NIFTY Index (spot) and its futures market (FUTIDX) over a time span of 16 years ranging from 1st April 2001 until 31st March 2017. The study used simple Descriptive Statistics, Correlation, Unit root tests, Johansen's test of co integration, Vector Error Correction Model (VECM), Wald chi-square test. We found that stable long run relationship exists between CNX NIFTY and its futures market. The outcome of VECM showed that though in long-run there is clear bidirectional relationship but new information is first absorbed by future market then it spillovers some information to its underlying spot market. Further, the Wald test results revealed that in short run there is no causality from either side. Hence, we conclude that though price discovery process is slow in both the markets but futures market plays dominant role in price discovery.

***KEYWORDS**: FUTIDX, VECM, ADEX, CNX NIFTY, ASE, Price Discovery, Futures Market.*

Introduction

Derivative is a financial product that derived its value entirely from the value of the other financial instrument or contract called the underlying assets such as securities, index, commodities or anything else. The main reasons for introduction and development of exchange traded equity derivative market in India are the benefits reaped from it such as price discovery, low transaction cost, improving trading efficiency and many more. Price discovery is a mechanism of determining the new equilibrium price of the assets after assimilating new information available in the market. If an asset is traded in more than one equally efficient market such as spot and futures market then both the markets absorbs the new information at same pace and there is no issue of lead/lag relationship. However, this is not feasible in real world because the spot and futures market is not equally efficient due to difference in liquidity; transparency etc as such efficient market absorbs the new information at much faster rate than inefficient market. If it is a scenario then efficient market plays dominant/leading role in price discovery. This study basically focuses on analyzing the role of index future market in price discovery.

Literature Review

Turkington and Walsh (1999) made an attempt to study the price discovery and causality in the Australian share price index futures market. They have used high frequency intraday data collected after interval of 5 minute over the period ranging from 3rd January, 1995 to 21st December 1995. After

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applying various statistical tools such as ADF, Johansen co integration test, VAR and Impulse response graphs, they concluded that there was clear bi-directional causality from the ALL-Ordinaries Index (AOI) and its future index. However, there was no preferred market for informed trading because price discovery was quite slow in both the markets.

Kenourgios (2004) used daily price data on FTSE/ASE-20 stock index and its three-month futures contracts from the Athens Stock Exchange (ASE) and the Athens Derivatives Exchange (ADEX) respectively, over the period of August 1999 until June 2002 to examine the price discovery between futures and spot markets in Greece. The study concluded that there exists feedback relationship or informational linkage between the two markets and this would help investors in exploring significant arbitrage profits and hedging opportunities.

Zhong, Darrat and Otero (2004) conducted a study on new futures market of Mexico by investigating price discovery function and volatility spillovers between spot and future prices of the Mexican Price and Quotations Index, that is ,IPC by taking daily data from April15, 1999 through July 24, 2002. From the results, it was found that Mexican futures market effectively served the price discovery function, although it had also been a source of instability for its underlying spot market.

Bose (2007) analysed daily closing prices of NIFTY Index and its underlying futures market from March 2002 to September 2006 by applying Granger causality test for short run prediction and VECM for long run prediction. She concluded that in short run, futures market leads the spot market but in long run, there was bi-directional relationship exist between two markets, though NIFTY futures have minor edge over its spot market.

Karmakar (2009) relied on Johansen Co-integration test, VECM and bivariate BEKK model to examine price discovery and volatility spillover between S&P CNX NIFTY and its underlying future market over a period of 7 years 9 months i.e. from 12th June 2000 to 29th March 2007. The study revealed that the NIFTY futures plays dominant role in price discovery process because it disseminate the information at much faster rate than its underlying spot market. Although, there is constant bidirectional volatility spillover from one market to another market but present volatility of the spot market has been significantly affected by its futures market past innovations.

Judge and Reancharoen (2014) analysed lead- lag relationship between Thailand equity's futures and spot market from 2006 to 2012 by applying Johansen co-integration test, ECM and Wald test and reached to conclusion that futures market plays powerful price discovery function.

Kapoor (2016) in their study for a time span of 15 years examined the price discovery process in context to S&P CNX NIFTY index and its relevant future market i.e. FUTIDX. With the use of tools like ADF test, Johansen Co-integration test, VECM, Granger Causality test, the results pinpoint that there is unidirectional causality moving from spot (NIFTY) to futures (FUTIDX) market. Further, in price discovery, dominant role is played by spot prices because it discovers and assimilates new information at much faster rate than futures prices.

Vasantha and Mallikarjunappa (2017) examined the intra-day relationship for the data set of major sectoral indices of NSE i.e. BANK Nifty index and its related future market by applying Johansen co-integration test and VECM. The intra-day data observed at one minute interval from the period of one month from 2nd May 2016 to 31st May 2016. The empirical results revealed that though bi-directional lead-lag relationship exists between selected index spot and future market but spot market of selected index has dominance over its future market.

Objective of the Study

To investigate the role of CNX NIFTY and its underlying futures market in price discovery.

Hypotheses

- H_{01} **:** There is no correlation between CNX NIFTY futures and spot returns.
- H_{02} **:** There is no long run association between CNX NIFTY futures and spot returns.
- H_{03} **:** There is no causal relationship between the CNX NIFTY futures and spot returns.

Research Design

- **Data:** The data sets used for analysis consist of daily closing spot and near month futures prices (highly traded and most liquid contracts) of the NIFTY Index from 1st April 2001 to 31st March 2017 taken from official website of NSE which is leading stock exchange of India. Though futures trading in Indian equity market commenced from June 2000 but for the purpose of study initial months are not considered because these are having low total number of future contracts. A total

of 3985 observations have been examined and analysis is done first by converting the daily closing price indices in to log futures/ spot and it is known as price series and after that this logged prices are converted into return series by taking log difference (dlog) i.e. Rt= *ln* [Pt/Pt-1].

- **Statistical Tools and Techniques for Hypothesis Testing:** To address the research objectives and to test the hypothesis, the data analysis carried in four steps: First, the correlation between two selected markets; second, the stationarity of data was checked by applying the unit root test such as the ADF (Augmented Dickey Fuller) test and Phillips-Perron (PP) test; third, the Johansen's test of co integration to investigate the long-run equilibrium relationship among the variables along with VECM; and fourth, the Wald test to examine the short-run relationship or the direction of causality among selected variable. The statistical software named as 'E-views 9' was employed for data analysis.

Empirical Analysis and Interpretation

- **Descriptive Statistics:** Before applying times series econometrics, we must have idea about basic characteristics of data sample under the study and using descriptive statistics will help in achieving this objective. Table 1 presents the descriptive statistics of NIFTY future and spot prices series and return series. It is clear from the table that in terms of average return both the markets are indifferent but in terms of volatility, future market (S.D=0.001914) is slightly more risky than spot market (S.D. =0.001817).

  In table 1, skewness of both returns series are negatively or left skewed that means number of low values are more in comparison to high values in data structure. Further, kurtosis of both return series is quite high (greater than 3) means the distribution is leptokurtic. Further, probability value corresponding to JB-test is less than 0.05, so we reject null hypothesis that the distribution is normal. Therefore, we conclude that NIFTY futures and spot return series are characterized by non-normality and this is one of common feature of return series taken from equity market.

Table 1: Descriptive Statistics Results

Descriptive Statistics	Price Series		Return Series	
	Log Future Prices	Log Spot Prices	Future Returns	Spot Returns
Mean	8.201178	8.201005	6.58E-05	6.52E-05
Median	8.475193	8.476012	8.45E-05	0.000107
Maximum	9.126714	9.124101	0.019529	0.019704
Minimum	6.751569	6.750165	-0.022334	-0.017879
Std. Dev.	0.694793	0.693238	0.001914	0.001817
Skewness	-0.647657	-0.650624	-0.553269	-0.380471
Kurtosis	2.114883	2.119846	15.23408	13.34775
Jarque-Bera	408.5711	409.6741	25042.65	17866.25
Probability	0.000000	0.000000	0.000000	0.000000
Obdservations	3984	3984	3984	3984

Note: Price Series: Log values of future/ spot closing prices
Return Series: First log differenced future/spot prices

- **Correlation Analysis**

Correlation Analysis is one of the most common used methods to check the relationship between two markets. But when we applied correlation on non stationary time series then results provided by it is not reliable or we also called it spurious correlation which can be evaluated by running regression test between both variable at levels. If the coefficient of determination (R-squared) is greater than Durbin-Watson (D-W) statistics (R-squared > D-W) then we conclude that our regression model is spurious and subsequently existing sham correlation. We first applied correlation on logarithm spot and futures prices (i.e. on price series) and then run regression.

Table 2: Correlation Coefficient between NIFTY Futures and Spot Market

Types of series	Correlation Coefficient
Price series (non stationary)	0.999984
Return Series (stationary)	0.983401

It is evident from table 2 that there is positive high correlation (0.999984) between logged price series of variables under study as such we reject first null hypothesis (H01) but that correlation is not real because in table 3 value of R-squared (corresponding to price series) is higher than D-W statistics. Therefore, to overcome the problem of spurious regression or to calculate the real correlation we need to use stationery time series data and it is confirmed from Table 3 R-squared and D-W statistics corresponding to return series.

Table 3 Regression Results

Types of series	Dependent variable	Independent variable	Coefficient	P-value	R-squared (R^2)	Durbin-Watson statistics	Decision
Price series (non stationary)	Futures price	Spot price	1.002227	0.0000	0.999967	0.466148	Spurious Regression (R^2>DW)
	Spot price	Futures price	0.997745	0.0000	0.997745	0.466101	
Return Series (stationary)	Futures Return	Spot Return	1.035848	0.0000	0.967078	2.580499	Non Spurious regression
	Spot Return	Futures Return	0.93361	0.0000	0.967078	2.480385	

- **To Check Stationarity**

Before applying group statistics such as co-integration, Wald test and VECM test, we must ensure the series under reference must be stationary otherwise it will provide nonsense regression results as discussed above. In our study we checked the stationarity of time series data initially by plotting graph and then applying unit root test.

- **Graphical Presentation of Data**

First of all, we plot the graph of logged future and spot prices. It is evident from Figure 1 and 2 that over the time, both the series having rising trend with short term falls. Such trend is usually the product of stochastic process and look like a random walk with drift because the mean and variance of both series not remains constant over time. Thus, logged values of NIFTY index spot and its future prices having unit root and in other words we can say that both the series are non stationary in levels.

Graphical Presentation of Price Series

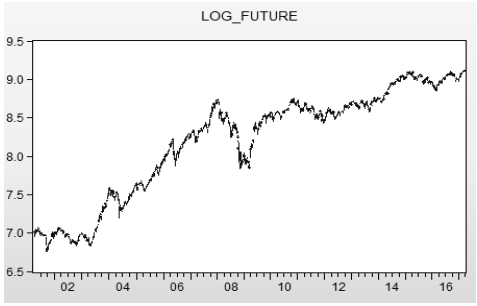

Figure1: Graph of Logged NIFTY Future Index Prices in Level

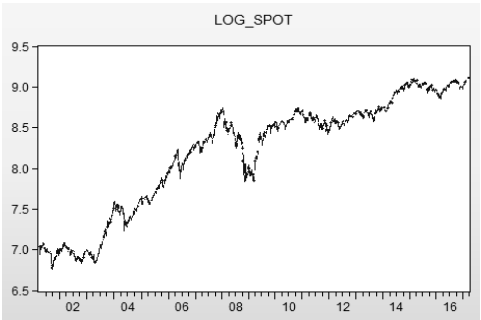

Figure2: Graph of Logged NIFTY Future Index Prices in level

However, it's evident from Figure 3 and Figure 4 that after taking log difference (dlog) i.e. converting the price series in to return series, both the series becomes stationery because their means and variances are not changing over time. Therefore it is evident from graph that both the series are integrated of order 1 [I (1)]. Further, there was huge disturbance in both series during the year 2004 due to two major reasons such as unpredicted defeat of the NDA and during the period 2008-09 due to global financial crisis.

Graphical Presentation Return Series

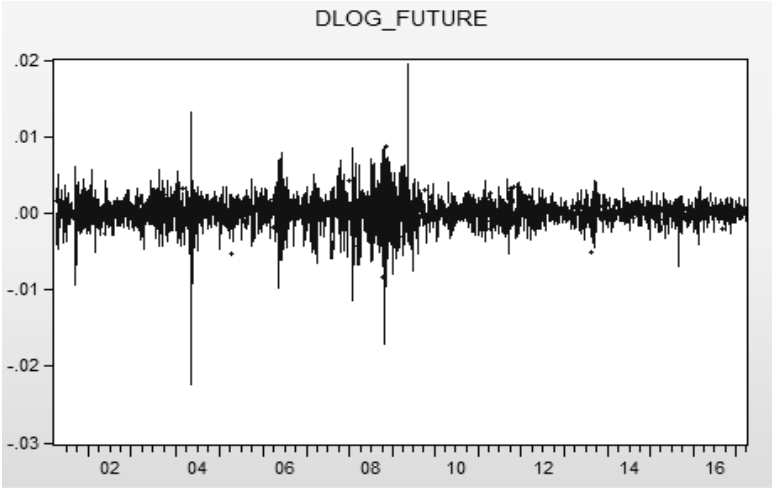

Figure 3: Graph of Logged NIFTY Future Index Prices in First Difference

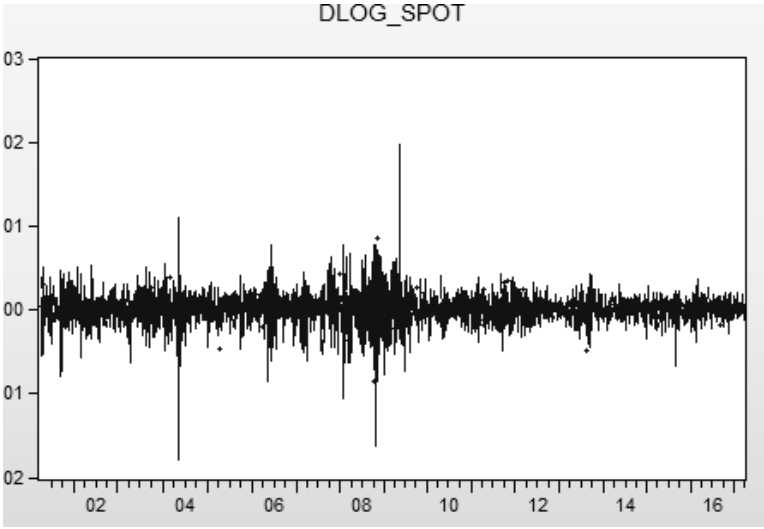

Figure 4: Graph of Logged NIFTY Future Index Prices in First Difference

- **Unit Root Test Results**

Since it is clear from graphs that log values of future and spot price series are not stationary but after taking log difference, both the series become stationary. However, to double check the robustness of the graph results, ADF test and PP test was also employed on the both time series. The result of these two tests in level and in first difference with intercept and trend presented in table 4. The results of ADF and PP tests concluded the same that both the price series have unit root in level but after taking first difference of both the log series we can accept the alternative hypothesis (the return series not having unit root or stationary) at 1 percent level of significance. Therefore, we conclude that NIFTY futures and spot return series are integrated of order 1 i.e. I (1).

Table 4: Stationarity Test Results
Unit Root Tests

	Augmented Dickey-Fuller (ADF) (t-values)		Phillips-Perron (PP) (t-values)	
Logged Prices	Level (Price series)	First Difference (Return series)	Level (Price series)	First Difference (Return series)
NIFTY Futures				
a) Trend and Intercept	-1.947 (0.6292)	-61.463* (0.0000)	-1.925 (0.6410)	-61.442* (0.0000)
NIFTY Spot				
a) Trend and Intercept	-1.990 (0.6055)	-44.942* (0.0000)	-1.887 (0.6610)	-58.464* (0.0000)

Note: Values in parentheses indicate MacKinnon (1996) one-sided p-values & * sign denotes significant at 1% level.

- **Co integration Test Results**

In this section, we estimate long run association between the NIFTY future and spot market. Since both the return series are integrated of same order i.e. I(1), Johansen co-integration test can be carried out to check whether long-run equilibrium relationship exist between the selected return series or not.

Table 5: Test for existence of Co integration

Johansen Cointegration Test				
Lags Interval: 1 to 2	**Trace Test**		**Max-Eigen Test**	
NIFTY Logged Spot and Future Prices	**Trace Statistic**	***p*-value****	**Max-Eigen Statistics**	***p*-value****
H0: r=0*	237.5606 (15.494)	0.0001	236.5238 (0.7219)	0.0001
H0: $r \leq 1$	1.036790 (3.841)	0.3086	1.036790 (3.841)	0.3086

Note: Values in parentheses indicate critical values at 5% level of significance.
*Rejection of null hypothesis at the 0.05 level and ** Mackinnon-Haug-Michelis (1999) p-values.

Table 5 presents results of Johansen co integration test. Both trace statistics and max-eigen statistics reject the H02 null hypothesis at 0.05 level of significance because p value (in both test) corresponding to r=0 is 0.001 which is less than 0.05. Since the result indicates that only one co integration equation exists, it means stable long run relationship exists between NIFTY spot and future market and this also ensures that there must be a valid Error Correction Model between these two series.

- **Vector Error Correction Model (VECM)**

It is evidenced from above analysis that co integration exist between the NIFTY spot and future market but within their long run relationship there can be short run deviations which can leads to momentarily disturbance in their long run association. Therefore to estimate this short run as well as long run convergence towards equilibrium VECM is used. Before applying VECM we need to select optimum lag value for the model. Various Information criteria's are available but Schwarz Information Criteria (SC) is selected for the purpose of study and according to the Table 6, the number of lag selected is 3. But when we applied VECM model, lag 2 is used i.e. one less than lag suggested by SC because we lose 1 degree due to differencing in VECM.

Table 6: Lag Length Criteria

Lag	LogL	LR	FPE	AIC	SC	HQ
0	12190.44	NA	7.32e-06	-6.14957	-6.14639	-6.14844
1	29320.33	34233.85	1.29e-09	-14.7903	-14.7808	-14.7869
2	29540.52	439.8228	1.16e-09	-14.8994	-14.8835	-14.8937
3	29561.45	41.79279	1.15e-09	-14.9079	**-14.88570***	**-14.90002***
4	29567.38	11.82549	1.15e-09	-14.9089	-14.8803	-14.8988

While using VECM model, initially least square method is used for estimating equation and after that diagnostic tests: Serial correlation LM test and Heteroskadasticity test applied on output. The results show that the residuals are not serially correlated but suffering from the problem of heteroskedasticity. Therefore, to overcome this problem least square method is now replaced by ARCH method and results of this method given in Table 7.

Table 7: VECM Results

	Dependent Variable					
VEC long run causality	Future Return			Spot Return		
	Coefficient	z-Statistics	Prob.	Coefficient	z-Statistics	Prob.
Error Correction term (ECT)	-0.29193	-5.06326	**0.0000****	0.13368	2.400092	**0.0164****

Note: **significant at 5 percent

Independent Variable	**Dependent Variable**					
VEC short run causality	Future Return			Spot Return		
	Coefficient	z-Statistics	Prob.	Coefficient	z-Statistics	Prob.
Futures return (-1)	-0.08077	-0.88845	0.3743	0.138521	1.575573	**0.1151**
Futures return (-2)	-0.17969	-2.08219	0.0373	-0.07494	-0.89157	**0.3726**
Spot return (-1)	0.128866	1.373137	**0.1697**	-0.05505	-0.59791	0.5499
Spot return (-2)	0.162154	1.857541	**0.0632***	0.052665	0.613504	0.5395

Note: * significant at 10percent.

In the above Table 7, VECM results are further sub-divided in two parts: VEC long run causality and VEC short run causality. To check whether long run causality exists or not, the error correction term (ECT) should be analysed and to ensure the existence of short run causality, independent variables: lags of future and spot return should be analysed.

- **Long Run Causality:** This part of VECM results represents adjustments to long run equilibrium and measures how the dependent variable adjusts to the previous period's deviation from long run equilibrium (Bose, 2007). Firstly, the value of ECT, which is also called speed of adjustment coefficient, is significant at 5percent in both the return series. This implies that whenever there is disequilibrium then both the markets respond to correct this deviation. However, the rate (magnitude) and direction (opposite or same) at which both the markets restore equilibrium varies. Secondly, the magnitude of future long run coefficient (ECT=29 percent) is higher than spot return coefficient. This implies that new information is first absorbed by future market then it spillovers some information to its underlying spot market. Thirdly, the negative ECT implies that futures market reacted negatively to the previous period deviation from equilibrium. However, vice-versa in case of spot market because it has positive ECT. It implies that whenever there is disequilibrium e.g. co-intergrating vector is above the equilibrium then future returns decrease by 29 percent and spot returns increase by 13 percent. Fourthly, the correction process is very slow in both markets due to low coefficient value.

- **Short Run Causality:** This part of VECM results represent short run effects of the previous period's price changes on the current period's price changes (Bose, 2007). In the spot return equation, the lagged values of futures is not significant even at 10 percent because the probability value corresponding to future return (-1) & (-2) is 0.1151 and 0.3726 respectively which is not less than 0.10. However, in the future return equation, only spot return (-2) is significant at 10 percent indicating that spot market lead the futures market only by at most 2 days. To further analyze this short term causality and to see the joint significance of spot return (-1) and (-2) Wald Test has been applied.

- **Wald Test:** It is clear from table 5 that jointly neither the lags of spot return nor the lags of futures return causes, futures returns and spot returns respectively. This all suggests that though there is bidirectional causality in spot and future returns of CNX NIFTY index in long run but in short run there is no causality from either side.

Table 5 Wald Test Results

Null Hypothesis	**Chi-square**	**Df**	**Probability (p-value)**	**Results**	**Direction of causality**
H_{03a}: Spot market does not lead futures market	4.031305	2	0.1332	p-value>0.05, Accept H03a	Short run causality is running neither from spot to futures nor other way around.
H_{03b}: Futures market does not lead spot market	5.328247	2	0.0697	p-value>0.05, Accept H03b	

Conclusion

It is concluded that in long run there is no possibility of earning arbitrage gain because long run relationship existing between CNX NIFTY and its futures market. The result shows that in long run the futures market plays dominant role in price discovery process, suggesting that new information if first absorbed by CNX NIFTY futures market and then transmitted to the underlying spot market. The results of Wald test shows that in short run, neither the lags of spot return nor the lags of futures return has any impact on futures and spot return respectively, suggesting that in short run there is no causality from either side.

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