A study on Relationship of Spot and Future Prices in Indian derivative market (With special reference to Nifty Midcap 50)

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ABSTRACT

The future derivative trading on stock indexes has proliferated since inception and provides critical economic functions such as price discovery, portfolio diversification and opportunity for market participants to hedge against the risk of adverse price movements. Thus, the spot market prices have been influenced mainly by the hedging, speculation and arbitrage activity of futures markets. This makes it essential to understand the market efficiency of spot and futures markets and to understand lead-lag relationships between them. The essential areas of discussions are, first how well integrated the markets are and second, how quickly the markets reflect the arrival of new (and relevant) information relative to each other. Johansen's (1988) Cointegration and Vector Error Correction Model (VECM) were employed to examine the lead-lag relationship between NSE spot and futures markets of NIFTY MIDCAP 50. Augmented Dickey-Fuller (1979) and Phillips-Perron (1988) tests were employed to verify the stationarity of the data series. Further, the required lag length of the data was selected on the basis of Schwarz Information Criterion (SC). Johansen's Cointegration test is adopted to examine the long-run relationship among the variables after they are integrated in an identical order. Then, Johansen's (1988) Vector Error Correction Model (VECM) is employed to investigate the causal relationship between spot and future prices of NIFTY MIDCAP 50. Further granger causality test was applied to analyze the two-way impact of both the selected variables namely spot and future prices on each other.

Key Words: Nifty Midcap 50, Johansen's Cointegration, Granger Causality, lead-lag

Introduction:

Derivatives are unique financial instruments which derive their value from the underlying assets being used as a tool for risk management to reduce the future possibilities of risk. Derivatives are of different types which are forwards, Future, options, and swaps.out of which the most traded derivatives are future and options. Over the years, India has witnessed tremendous growth in the volumes of future and options. The trading in Index future markets was introduced in June 2000 and the trading in options index was commenced in June 2001.

Over the years trading in these derivative exchanges has proliferated since their inception and they provide some essential economic functions like price discovery, diversification of the portfolio and hedging from risk from adverse price movements. Which attracted researchers to explore the topic further Sushma Jolly (2017).

Thus the prices of spot market have been influenced immensely by the speculation, arbitrage, and hedging of futures markets. This brings a need to understand the pricing behavior of future and spot markets and also to understand the influence of one market on the other. Also, it becomes vital to understand the role of both spot and futures markets in price discovery. This has become a crucial research issue among regulators, academicians, and practitioners as this help to understand market efficiency, arbitrage opportunities, market volatility, and hedging effectiveness if any. The lead-lag relationship between the index futures and spot prices are based on two critical observations. First, whether this market is integrated and second, how quickly

these markets respond to the arrival of new information relative to each other. The lead-lag relationship tries to investigate whether future markets lead the spot markets or whether spot markets leads future markets, or there exists a bi-directional relationship between these markets. The lead-lag relationship illustrates how well the spot and futures markets are linked to each other, and how fast one market reflects the arrival of new information from the other market.

In an efficient market, All the information which arrives in the marketplace is immediately incorporated in the prices of the underlying. Thus, any new pieces of information disseminating in the market should be immediately reflected in both spot and future prices simultaneously. But in the real world, there exist external variables such as margin requirements, transaction costs, liquidity which creates differences in the futures prices and its spot prices. Such differences may result in a lead-lag relationship between the futures prices and its underlying spot prices. Also, if there exists an opportunity for the traders to gain economic incentives from one market over the other market, a price discovery process between spot and futures markets are likely to happen (Zou and Pinfold, 2001). Thus we can say that futures and spot market prices are inter-related and this can be traced under various market frictions through price discovery mechanism.

Review of Existing literatures:

There exist varying theoretical arguments prevailing in the market which shows the causal relationship between spot and futures markets due to information dissemination and together raises the significant questions that which market price reacts first (lead), whether (a) spot prices tend to influence future prices or (b) future prices tend to influence the spot prices or (c) a bidirectional feedback relationship exists between spot and futures prices.

(a)   Futures prices tend to influence spot prices

Yi-Tsung Lee Wei-Shao Wu Yun Hong Yang (2013) examined the information effects between the Taiwan spot and index futures returns. The study found that futures returns lead spot returns.

Yang Hou. Steven Li (2013) examined the price discovery of CSI300 index futures in China. The author found that the new information is reflected more rapidly in the CSI300 index futures market than the spot market thus making the futures market lead spot market.

Pratap Chandra Pati and Prabina Rajjib (2011) investigated the relationship between Futures and its spot returns (CNX Nifty index). Authors found that Nifty futures prices lead underlying prices and also claim that the Nifty futures market provides more contribution in price discovery.

(b)   Spot prices tend to lead futures prices

Kedar Nath Mukherjee(2006) investigated the possible lead-lag relationship, both regarding return and volatility, among the NIFTY spot index and index futures market in India. They concluded that even though there exists a bi-directional relationship among the returns of spot and futures market, the spot market has been found to be stronger in the leading role and therefore said to be more efficient.

Qian Zhang(2018) studied the price discovery mechanism of spot and futures markets they conducted empirical research under periods of stationary, boom and slump. The results showed that there is a long-term relationship between the CSI 300 index and CSI 300 index futures. In the stable periods of the Chinese stock market, the CSI 300 stock index futures are found to be sensitive to the short-term impact. On the other hand, during the period of boom and collapse, spot market is found to respond more in long-term.

(c)   Bidirectional feedback relationship exists between spot and futures prices

Dr. Sachita Yadav(2018) investigated the relationship between spot and futures prices for the stock market in India, for the period 12th June 2000 to 31st March 2014. For this purpose, they used S&P CNX Nifty Index Spot and S&P CNX Nifty Index Futures. The results showed i) Spot and Futures stock market are co-integrated. ii) Futures market played a leading role over the spot market. iii) Both the futures market and spot market are Granger Cause to each other.

Li-Ling Su(2017) examined the lead-lag dependence between the CSI 300 index spot and futures markets from 2010 to 2014. They adopted a nonparametric and non-linear method based on the thermal optimal path method. results of the study on the daily data indicate that the lead-lag relationship between the two markets is within one day but this relationship is volatile since neither of the two probable situations (the futures leads or lags behind the spot market) takes a dominant place.

Naliniprava Tripathy(2014) explored the lead-lag relationship between spot and futures markets in Indian derivative market. The lead-lag relationship between the spot market and futures markets reflects how well the two markets are linked and carries essential information for the traders. The study uses the daily closing price of S&P CNX Nifty Index and Nifty Index futures during the sample period from December 2005 to April 2013. The results suggest that there is a bi-directional causal relationship occur between spot and futures markets. The results also provide evidence of the existence of a long-run equilibrium relationship between the spot and futures markets

The above existing literature shows that there exist multiple views about the lead-lag relationship of futures and spot markets. Thus these mixed views make it essential to future investigate these markets so that the traders can understand the information dissemination process and price discovery mechanism

On the above background, the present article examines the lead-lag relationship between NSE spot and futures markets of NIFTY MIDCAP 50 index.

Objective:

a)   To further ensure the stationarity of the data.

b)   To examine the lead-lag relationship between NSE spot and futures markets of NIFTY MIDCAP 50.

c)   To analyse the two way impact of spot and future price variable in order to conclude and dissert the intensity of impact of one on the other.

d)   To examine and find out variable that finally leads to long term equilibrium.

Hypothesis:

H_{01}: The data is not normally distributed.

H_{11}: The data is normally distributed.

H_{02}: There is no significant cointegration between the selected time series namely nifty midcap 50.

H_{12}: There is significant cointegration between the selected time series namely nifty midcap 50.

H_{03}: There exists no significant impact of spot on future prices

H_{13}: There exists significant impact of spot on future prices

H_{04}: There exists no significant impact of future on spot prices.

H_{14}: There exists significant impact of future on spot prices.

H_{05}: There exists no significant impact of spot prices in terms of leading to long term equilibrium

H_{15}: There exists significant impact of spot prices in terms of leading to long term equilibrium

H_{06}: There exists no significant impact of future prices in terms of leading to long term equilibrium

H_{16}: There exists significant impact of future prices in terms of leading to long term equilibrium

Research Methodology, Data Analysis and Interpretation:

Sample selection :

The present study used stock index data of Nifty midcap 50 being collected from NSE website. The study collected daily values of spot and future from the period Feb 2010 to Dec 2017.

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Tools:

Johansen's (1988) Cointegration and Vector Error Correction Model (VECM) were employed to examine the lead-lag relationship between NSE spot and futures markets of NIFTY MIDCAP 50. Augmented Dickey-Fuller (1979) and Phillips-Perron (1988) tests were employed to verify the stationarity of the data series. Further, the required lag length of the data series was selected on the basis of Schwarz Information Criterion (SC). Johansen's Cointegration test is then employed to examine the long-run relationship among the variables after they are integrated in an identical order. Then, Johansen's (1988) Vector Error Correction Model (VECM) is employed to investigate the causal relationship between spot and future prices of NIFTY MIDCAP 50.Further granger causalty test was applied to analyse the two way impact of both the selected vairables namely spot and future prices on each other.

The behaviour of both the selected indices during the sample period is shown below in figure 1
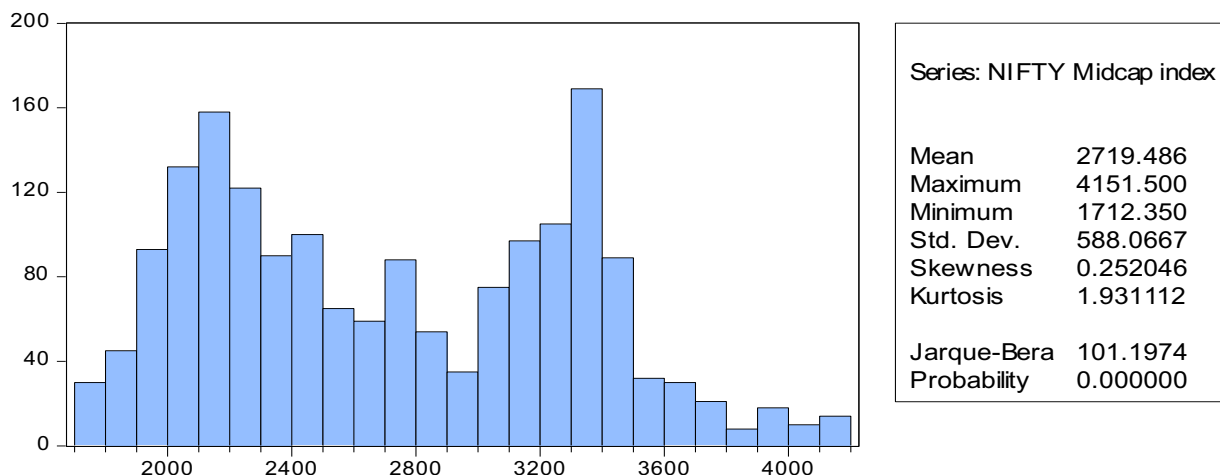
Table 1:Nifty Midcap Index
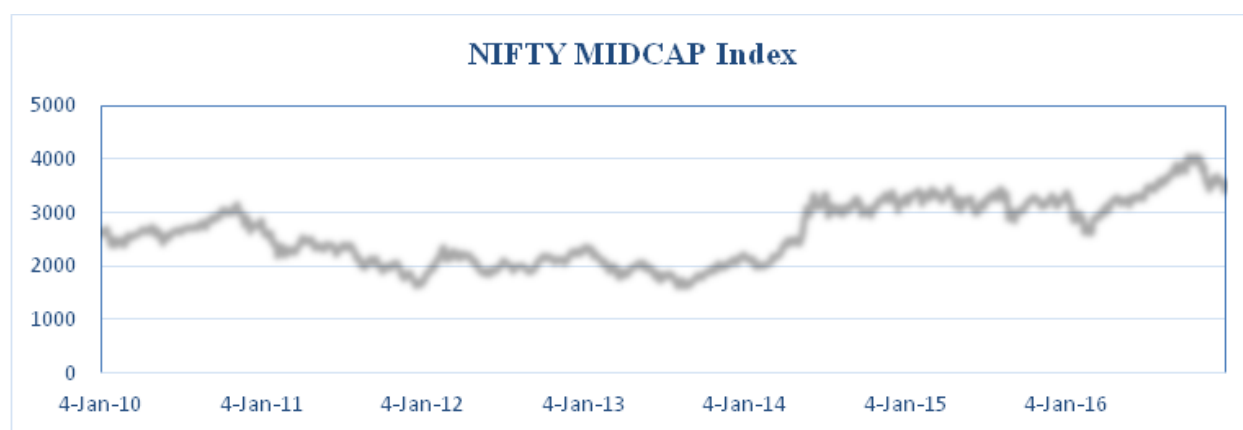
Source: computed by the researcher on the basis of data collected from nseindia.com

The descriptive statistics of the selected index nifty midcap 50 is also estimated in the study. This includes estimation of the mean, standard deviation, minimum, maximum and the skewness and kurtosis measures of the series. The descriptive statistics of nifty midcap series indicates that the series have the minimum value of

1712 and the maximum value of 4151 during the selected period in the study. The mean/average value of nifty midcap series during the selected period is found to be 2719. The results also indicates that the standard deviation of the 588 is found in the behaviour of nifty midcap index. The negligible positive skewness is found in the behaviour of nifty midcap index. In addition to this leptokurtic distribution is also detected in the distribution of nifty midcap series. The Jarque Bera test statistic of the distribution of the nifty midcap is found to be 101 with the probability value of 0.000 which is less than five percent level of significance. Thus the null hypothesis H01 of normal distribution of the nifty midcap index cannot be accepted here. The distribution of nifty midcap index is not normal due to the presence of leptokurtic distribution in the series.

Table 2: Descriptive Statistics for Nifty midcap 50

Series: NIFTY Midcap index

Mean	2719.486
Maximum	4151.500
Minimum	1712.350
Std. Dev.	588.0667
Skewness	0.252046
Kurtosis	1.931112
Jarque-Bera	101.1974
Probability	0.000000

Source: computed by the researcher on the basis of data collected from nseindia.com

The difference of the expected and the actual prices of the nifty midcap series is divided into two categories of normal backwardation and Contango. The descriptive statistics of both the cases are shown below:

Table 3: Descriptive Statistics for contango and backwardation

Case of Mispricing between expected and actual nifty midcap future prices		
	Normal Backwardation	Contango
Mean	-5.9579	7.0275
Std. Deviation	13.59060	11.87733
Skewness	-5.302	5.611
Kurtosis	35.285	47.370
Minimum	-126.85	.01
Maximum	.00	144.26

Source: computed by the researcher on the basis of data collected from nseindia.com

H_{01}: The data is not normally distributed.

H_{11}: The data is normally distributed.

Result 1: We reject null hypothesis (H_{01}) stating that the "data is not normally distributed" and accept the alternative hypothesis (H_{11}) stating that "the data is normally distributed".

Johansen's Co-Integration test:

Table 4: Johansen's Co-Integration Test on spot and future prices of nifty midcap index

Cointegration Between	Lag length selected	Cointegration test using	No. of Cointegrating Equations (CEs)	Eigen Value	Trace Statistic	Critical value at 5%	Probability **
Nifty midcap daily spot closing price and daily future closing price	1 to 4 (in first difference of 2 series)	Trace test	H_0: r=0 (None)	0.156	295.782	15.494	0.000
			$._1$: r ≤ 1 (At most 1)	0.0005	0.899	3.841	0.343
		Max-Eigen Value test	H_0: r=0 (None)	0.156	294.884	14.264	0.000
			H_1: r ≤ 1 (At most 1)	0.0005	0.899	3.841	0.343

Trace test indicates 1 Cointegrating equation at 5% level of significance
Max-eigen test indicates 1 Cointegrating equation at 5% level of significance
**Mackinnon et.al.(1999) estimated p values
Source: computed by the researcher on the basis of data collected from nseindia.com

The null hypothesis H_{02} of Johansen Cointegration test assumes that there exists no cointegration between the selected time series which is rejected at five percent level in both the Trace test statistics and maximum eigen value in case of Nifty Midcap daily spot closing price and daily future closing price. As shown in the results of Johansen Cointegration test that the p value of trace test as well as maximum Eigen value test is found to be less than five percent level of significance. Hence the null hypothesis of no cointegration in the relationship cannot be accepted. Thus it can be concluded that there exists long term relationship between the spot and future closing prices of Nifty midcap index. In addition to this the p value of alternative hypothesis of having one cointegrating relationship is found to be more than 0.05 indicating the presence of long term relationship between both the series. However, the alternate hypothesis of having one cointegrating relationship between the Nifty midcap daily spot closing price and daily future closing price series is accepted at five percent significance level.

H_{02}: There is no significant cointegration between the selected time series namely nifty midcap 50.

H_{12}: There is significant cointegration between the selected time series namely nifty midcap 50.

Result 2: We reject null hypothesis (H_{02}) stating "There is no significant cointegration between the selected time series namely nifty midcap 50" and accept the alternative hypothesis (H_{12}) stating that "there is significant cointegration between the selected time series namely nifty midcap 50".

Granger causality Test

Models:

$Future_t = β_0 + β_1 Spot_t + μ_i$............... **(1)**
$Spot_t = β_0 + β_1 Future_t + μ_i$...............**(2)**

Causality is closely related to the idea of cause-and-effect, although it isn't exactly the same. A variable X is causal to variable Y if X is the cause of Y or Y is the cause of X. In our study we have taken two variables in order to estimate their causal relationship and ultimately conclude the impact of one on the other by judging their mutual impact. The table below provides us with the result of our test.

Table 5:Granger causality test

VEC Granger Causality/Block Exogeneity Wald Tests

Dependent variable: D(Nifty midcap spot)			
Excluded	Chi-sq	df	Prob.
D(ACTUAL_FUTURE)	3.563502	2	0.1683
All	3.563502	2	0.1683
Dependent variable: D(ACTUAL_FUTURE)			
Excluded	Chi-sq	df	Prob.
D(SPOT)	7.407729	2	0.0246
All	7.407729	2	0.0246

Source: computed by the researcher on the basis of data collected from nseindia.com

H_{03}: There exists no significant impact of spot on future prices

H_{13}: There exists significant impact of spot on future prices

H_{04}: There exists no significant impact of future on spot prices.

H_{14}: There exists significant impact of future on spot prices.

Result 3: The results suggest that their exists significant impact of spot prices on the future prices We reject null hypothesis (H_{03}) stating that " there exists no significant impact of spot on future prices" and accept the alternative hypothesis (H_{13}) stating that "there exists significant impact of spot on future prices".

Result 4: on the basis of the above analysis we found that future do not granger cause spot . Thus We accept null hypothesis(H_{04}) stating "there exists no significant impact of future on spot prices". and   reject the alternative hypothesis (H_{14}) stating "there exists significant impact of future on spot prices".

Error Correction mechanism:

The equilibrium relationship between the non-stationary variables (Nifty midcap spot and future prices) provides the motivation to study the relationship further. The cointegrating relationship between Nifty midcap spot and future prices can be explained with help of error correction mechanism existing in the system. An error correction model provides the statistical description of the economic dynamics between the series. With the help of understanding the pull and push forces in the system, the restoration of equilibrium relationship in case of error or disequilibrium can be explained. In stock markets the future prices can be estimated using deterministic models as well the demand and supply forces in the market. Theoretically the future prices of the stock indices should be equal to the spot prices plus cost of carry. In the stock market, the cost of carry includes the capital cost (interest at risk free rate). Any difference between the theoretical and actual prices of the stock index may leads to arbitrage opportunities in the market. These arbitrage opportunities motivate the arbitrageurs to participate and takes position to take the benefits of mispricing. The

positions taken by the arbitrageurs helps in correcting the disequilibrium between the spot and future prices of the Nifty midcap index in the stock market. The cointegrating vector ascertains long run causality relationship between the markets, whereas the coefficients of respective error correction terms indicate the speed of adjustments in the event of any disequilibrium.

The results of the vector error correction model are shown in table below:

Table 6: Error correction process

Series	Variables	Δ(Nifty midcap Spot Price)		Δ(Nifty Midcap Future Price)	
		Coefficient	t value	Coefficient	t value
Nifty midcap	Equilibrium Error	-0.106	-0.698	0.920	5.638
	ΔSpot(-1)	-0.042	-0.296	0.0248	0.161
	ΔSpot(-2)	-0.244	1.86	-0.231	1.64
	ΔSpot(-3)	-0.123	-1.048	-0.151	-1.196
	ΔFuture(-1)	-0.118	0.840	0.059	0.392
	ΔFuture(-2)	-0.235	1.831	0.223	1.619
	ΔFuture(-3)	-0.149	1.304	0.181	1.472
	Constant	-0.515	0.552	0.515	0.514

Source: computed by the researcher on the basis of data collected from nseindia.com

The results of error correction model indicate that in case of Nifty midcap 50 index the equilibrium is maintained by the future series of the index as indicated by t statistics of equilibrium error as 5.638. However, the t statistic in case of nifty midcap spot index is found to be -0.698 indicating that the spot series as an exogenous series. In addition to this, the speed of adjustment in case of midcap future index is found to be 0.920 which is significantly higher than speed of adjustment in case of spot midcap index(-0.106).

The error correction of the equilibrium is found to be maintained by the Nifty midcap future prices. In other words, when the disequilibrium exists between the Nifty midcap future and spot prices, the future series will bring the equilibrium back in the system.

Table 7: VEC Lag Exclusion Wald Tests

	D(Nifty midcap spot)	D(Nifty Midcap future)	Joint
DLag 1	10.70807	10.76351	13.13952
	[0.004729]	[0.004600]	[0.010614]
DLag 2	3.467144	2.692965	3.661917
	[0.176652]	[0.260154]	[0.453689]
DLag 3	2.949743	3.590028	3.693857
	[0.228808]	[0.166125]	[0.449020]
DLag 4	7.412884	7.643625	8.999454
	[0.024565]	[0.021888]	[0.061113]
DLag 5	2.419206	2.226167	2.611039
	[0.298316]	[0.328544]	[0.624869]

Source: computed by the researcher on the basis of data collected from nseindia.com

H_{05}: There exists no significant impact of spot prices in terms of leading to long term Equilibrium.

H_{15}: There exists significant impact of spot prices in terms of leading to long term equilibrium

H_{06}: There exists no significant impact of future prices in terms of leading to long term equilibrium

H_{16}: There exists significant impact of future prices in terms of leading to long term equilibrium

The results thus help us to conclude that there is no significant impact of spot prices to ultimately lead to the long term equilibrium and there certainly is a significant impact of future prices in order to lead to long term equilibrium.

Result 5: The above analysis help us accept the null hypothesis (H_{05}) stating "there exists no significant impact of spot prices in terms of leading to long term equilibrium' and reject the alternative hypothesis (H_{15}) staing that "there exists significant impact of spot prices in terms of leading to long term equilibrium".

Result 6: We reject null hypothesis (H_{06}) stating "there exists no significant impact of future prices in terms of leading to long term equilibrium"and accept the alternative hypothesis (H_{16}) stating "there exists significant impact of future prices in terms of leading to long term equilibrium".

Conclusion and Findings:

Findings :

Our results have been significantly supporting the assumptions. We have made six hypotheses to estimate and support four objectives out of which few were rejected and few were accepted. Firstly in the study, we concluded that the data is not normally distributed and has been demonstrated in result 1. Further, the study demonstrated the existence of cointegration between the data set which is being demonstrated in result 2. The study also examined the causal relationship between our chosen variables namely spot and future prices and thus the results helped to conclude that it is the spot prices that impact the future prices and not exactly the other way round. We postulated two models in the study of Granger causality and examined both spot and futures prices as independent and dependent variables to estimate the causal effect. Hence result 3 and result 4 demonstrated that spot granger cause the future prices and not vice versa. Further, the study ended with vector error correction process and found that in long run the future prices tend to bring the equilibrium whenever there exists disequilibrium in-between spot and future prices, this is demonstrated in result 5 and result 6.

Conclusion :

The argument that underlies the analysis of lead-lag relationships between indices and index futures is predicated on the observation that this relationship is indicative first of how well integrated the markets are and second of how quickly the markets reflect the arrival of new (and relevant) information relative to each other. The lead-lag relationship investigates whether the spot market leads the futures market, whether the futures market leads the spot market or whether the bi-directional feedback between the two markets exists.

In our study, we found that there was a cointegrating relationship between both spot and future prices but because of market factors there exists disequilibrium between the two markets.

The future prices are correcting this disequilibrium in long run. In other words, it's the future prices which bring correction in the markets thus making the future market more efficient.

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