PRICE DISCOVERY EFFICIENCY OF INDIAN EQUITY FUTURES, OPTIONS AND CASH MARKET

KAMALPREET KAUR*

Present study investigates the price discovery efficiency of Indian equity derivatives (including both futures and options). For this purpose, Nifty Futures, Nifty Options (put and call) and Nifty daily closing prices have been evaluated in the error correction framework and it has been observed that long-run relationship between the equity derivatives and their underlying index prices exist. Both futures and put options observe bilateral causality with cash market, however, weak causal relationship has been observed for call options and cash market, which implies that significant arbitrage opportunities in three markets can help to correct short-run disequilibrium if any exists. Further, it has been analysed through Vector Auto regression methodology that Nifty futures leads both cash as well as options markets while call options leads cash market by two days, whereas put options lags cash market by two days.

Key words: *Equity derivatives, Price discovery, Cost-of-Carry and Arbitrage efficiency.*

I- Introduction

Derivatives are financial instruments, whose value is derived from their underlying security or basket of securities. Due to economic incentives of financial derivatives like lesser transaction cost and reduced initial investment, the traders may get highly leveraged position in market by using its products like Index Futures, Index Options, stock futures and stock options and can neutralize risk profile contained in their portfolio. Thus, these products serve as the instruments of price discovery, portfolio diversification and risk hedging for the traders.

Risk hedging can be done by the traders, if the value of the derivative Index contract deviates from the cost of buying the individual stock Index and then holding them till maturity [Mackinlay and Ramaswamy (1988)]. Since there is no short sales constraint in the derivative market, future and option prices are symmetric in reflecting the information [Kalok Chan (1992)] and help traders to conduct the hedging and speculation in different

* Research Scholar, Department of Commerce and Business Management, Guru Nanak Dev University, Amritsar – 143005, Punjab, India, Email: kamal54preet@gmail.com.

markets. Thus, derivative products act as the risk management tool for the traders, hedgers, speculators etc. In the context of Price Discovery, the basic question often occurs that whether the same security is valued at same price in different markets at same point of time? The answer to this is 'No'. Actually prices and volume in different markets hardly matches each other at one point of time. The technical reasons, which tend to introduce this situation in the markets, are (a) dissemination of the market wide information and intensity of trading activity in the markets (b) non-synchronous trading of stocks in the index market (c) the exposure of stock-specific announcements.

Further the various studies under the different markets {Kwaller et. al (1988), Kalok chin (1991), Kalok chan (1992), Fleming et. al (1996), Wahab and Lashgari (1993), Stoll and Whaley (1990), Jong and Donders(1998), Frino et. al (1999), Bae et. al (2004), Raju and Karande (2003), Gupta and Singh (2006)} concluded that the introduction of index futures is accompanied by a substantial improvement in the market quality of the underlying cash market and serve as an instrument of risk management.

Thus, most of the researchers found the futures market as price discovery vehicle for cash as well as options market but with relation to options market the results are somewhat different as Black and Scholes (1973) pricing model assumes options as redundant one and value them with no arbitrage relation . In short, they assumed that the introduction of redundant option has no impact on the underlying cash market. However it is argued by several researchers that this notion can not be always true. Black (1975) was the first to suggest that the informed traders may prefer to trade in the option market rather than the stock market. Grossman (1988) also suggested that the traded option can convey information that would otherwise be unobservable in an economy where the options can only be replicated. These results are then followed by several other researchers who found that the options market lead the cash market {Manaster and Rendleman (1982), Battacharya (1987), Anthony (1988), Grossman (1988), Fleming et. al (1996), Easley et. al (1998)}. While, some of the researchers found contradictory results that the information is firstly absorbed by the underlying stock market and then transferred to the options market {viz; Stephan and Whaley (1990), Kedarnath and Mishra (2005) and Jong and Donders (1998)}.

Hence, several studies have been conducted globally for examining the relationship between future, option and the underlying spot prices specifically on the lead lag pattern. Most of these studies used the intraday quotes, but in this paper instead of intraday quotes, daily quotes of index for five years (July 2001 to July 2006) are used for examining the price discovery pattern of three markets i.e. the cash index, the index future, the index options (put and call both).

This article makes an effort to investigate the price discovery efficiency among the cash, futures and option markets in India with respect to the flow of information from one market to the other and its impact upon each other. The remaining paper has been organized as follows; section 2 discusses the review of literature relevant to this study, section 3 presents the data base and methodology, empirical findings are discussed in section 4 and the concluding remarks have been discussed in the section 5.

II- Review of Literature

The diverse literature is available on the subject relating to price discovery efficiency of the derivatives market but in India only few studies have been conducted on Price discovery. Thus, the current study makes an attempt to survey the literature on this subject and try to contribute the price discovery literature in India. The literature survey given in this study is categorized in two sub-sections. These sections deal with the Price discovery efficiency with relation to futures, options & Stock market and options market & stock market respectively.

Futures market, Options and Cash market

Kawaller et. al (1987), while observing U.S. market, analyze S&P 500 index for two years, 1984-85, and concluded that S&P index futures lead the cash index by 20 to 45 minutes, but the cash index does not lead the futures market by any more than two minutes. However, Harris (1989), Stoll and Whaley (1990) and Chin et. al (1991) also examines the relationship between the S&P 500 cash and futures Index in the U.S. market. After correcting infrequent trading; they confirm that the futures price movements lead the cash index by an average of 5 minutes while there is weak evidence for the cash market leading the futures market, but this effect appears to have

grown smaller over time. Chan (1992) confines his attention to the MMI cash Index and observed the same.

Fleming et. al (1996) examined S&P 500 index for futures, options and cash and observed that the futures market reflect the information for both options as well underlying cash market. Jong and Donders (1998) observed that in Amsterdam stock exchange (AEX) and European option exchange, futures market leads the cash market by 10 minutes.

Wahab and Lashgari (1993) in the U.K. market found weak evidence of bidirectional causality in both the S&P 500 and FT-SE 100 markets. Their study is based on the daily data and reported similar results that the futures market act as price discovery vehicle for the underlying cash market. However, Kyriacou and Sarno (1998) also studied the U.K. market and found the least impact of futures market on the cash market.

Frino et. al (2000), Illueaca et.al (2003), Bae et.al (2004), Raju and Karande (2003) and Gupta and Singh (2006) conducted studies on different markets like Australia, Spain, Korea and India respectively. They all observed futures market to be more efficient than that of underlying cash market. Thus most of the studies proved futures market as price discoverer with relation to stock market.

Table 1
Empirical Evidences on Price Discovery Efficiency of Futures and Options market

Study	Stock market	Sample size	Futures market act as price discovery vehicle	Options market act as price discovery vehicle
Kawaller, Koch and Koch (1987)	S&P500 Index, CME, U.S.market	1984 to 1985	Yes	---
Joseph H. Anthony (1988)	Chicago Board Option Exchange	25 firms	-----	No
Harris (1989)	S&P 500	Ten days	Yes	----

	Index, U.S.market	around the crash of 1987		
Stoll and Whaley (1990)	MMI Index and futures, S&P 500 market index U.S. market	July1984 to Mar1987 , April198 2 to Mar1987	Yes	----
Stephan and Whaley (1990)	NYSE American stock exchange U.S. market	Jan to Mar 1986	------	No
Kalok Chin and K.C.Chan and G.Andrew Karolyi (1991)	S&P 500 stock index and futures CME, U.S.market	Aug1984 to Dec1989	Yes	----
Kalok Chan (1992)	MMI cash index and futures, S&P 500 stock index and futures NYSE and CBOT	Aug1984 to June 1985, Jan to Sept1987	Yes	----
Wahab and Lashgari (1993)	S&P 500 stock index and FT-SE 100 index and futures U.K.market	Jan to Mar 1987	Yes	----
Kalok Chan, Chung and Johnson (1993)	NYSE American stock exchange U.S. market	Jan to Mar 1986	----	No
Fleming, Ostidiek and Whaley (1996)	S&P 500 Futures, S&P100 options and cash index U.S. market	March 1991	Yes	Yes

Easley, O'Hara and Srinivas (1998)	NYSE, American stock exchange U.S. market	50firms for Oct-Nov 1990	----	Yes
Frank De Jong and Monique W.M. Donders (1998)	AEX, EOE	Jan20 to July17, 1992 and Jan4 to June 18 1993	Yes	No
Boyle and Byoun (1999)	S&P 500 Index U.S.market	Aug 1998 to Dec 1998	---	Yes
Kyriacou and Sarno (1999)	FTSE 100 Index U.K. market		No	----
Finucane (1999)	FTSE –100 stock index and futures U.K. market	Nov & Dec 1990	----	No
Frino, Walter and West (2000)	SPI & ASX share price and futures Index, Australian market	Aug 1995 to Dec 1996	Yes	---
Pan J. and Allen M. Poteshman (2003)	CBOE	1990-2001	---	Yes
Illueca and Lafuente (2003)	Spanish stock index and future market.	1987-1989	Yes	---
M.T Raju and Kiran Karande (2003)	Nifty spot index and index futures NSE, Indian market	June 2000 to 2002	Yes	---
Bae, Kwon and Won park (2004)	KOSPI 200 stocks in KSE.	Jan 1990 to Dec 1998	Yes	---

Kedarnath, Mishra, R.K. (2005)	Nifty spot index and index futures NSE Indian market	April to Sept 2004	---	No
Gupta and Singh (2006)	Nifty spot index and index futures NSE Indian market	2000 to 2005	Yes	---

Where; AEX= Amsterdam Exchange, ASX= Australian Stock Exchange, CBOT= Chicago Board of Trade, CBOE= Chicago Board of Option Exchange, CME= Chicago Mercantile Exchange, EOE= European Option Exchange, FT-SE= Futures Stock Exchange, KOSPI= Korean Composite Stock Price Index, KSE= Korean Stock Exchange, NYSE= New York Stock Exchange, NSE= National Stock Exchange, U.S. = United States, U.K. = United Kingdom.

Options market and Cash market

Enough Literature regarding Price discovery efficiency of Options market and Cash market is also available. Manaster and Rendleman (1982) studied the daily data on individual sock options from April 1973 to June 1976 and documented the evidence in support of options market leading stock market and thus the option trader is likely to be more informed than the average stock investors.

Anthony (1988) and Poteshman (2003) studied the price discovery under Chicago Board Option Exchange. Anthony (1988), using Granger causality tests, finds the weak evidence that options market volume leads the stock market volume however, Pothesman (2003) found the opposite result that equity options volume possess the information for future changes in stock prices.

In U.S. market, Stephan and Whaley (1990) examined both the options and stock markets, using the tick-level data for first three months of 1986. They found evidence that the stock market unilaterally act as price discovery vehicle and thus leads the options market by 15 to 20 minutes. Chan et. al (1993), however, argues that this results vanishes when quote midpoints are used instead of transaction prices and thus found the evidence that options lead the stocks as proved by many studies in U.S. market. Easley et.al (1998),

Fleming et. al (1999) and Byoun and Boyle (1999) also come out with similar result. However, Jong and Donders (1998) found that relation between options and cash market is not completely unidirectional. In the Indian context, Kedarnath and Mishra (2005) concluded that the information is first absorbed by the underlying stock market and then transferred to the options market.

Thus the options market under different countries present the divergent views and majority of the studies discovered stock market to be efficient one with comparison to options market.

III- Data Base and Methodology of the study

Objectives of the study

The Indian Capital market has undergone remarkable changes after Second-generation reforms. Certain steps taken by Regulators and Policymakers to place the market on a strong footing and develop it to meet the growing capital requirements for the development of economy have significantly contributed to the developments, which took place in the Indian Capital market during the reforms. The prime motive for this change was to check the shortcomings of capital market viz. long delays, lack of transparency in procedures and vulnerability to price rigging and insider trading etc.

One of the contributions made by regulators, in this regard, with a view to meet international standards is the introduction of Derivatives in Indian capital market with the main objective to provide risk management and efficient market to the investors. Since then, the policymakers are more concerned about the impact of futures and options on the underlying spot market. The current study is an attempt to find whether the futures and options serve the purpose of efficient price discovery, for which these are introduced or not. In other words, the main objective of the study is to find out that specific market, which is efficient enough to act as the price discovery vehicle for the others and help traders to take arbitrage position in the underlying spot market so that they may obtain maximum returns while bearing minimum risk.

Data source and Time period

Index futures on S&P CNX nifty started trading on National Stock Exchange (NSE) in 2000 and options followed it in 2001. In this present Study, price discovery efficiency of index futures, index put options, index call options and Nifty index on S&P CNX Nifty has been examined. Daily closing quotes of index futures, index options (including both put and call) and S&P CNX Nifty are taken from July 2001 till July 2006. Returns are calculated as log of ratio of present day's price to previous day's price. Data are obtained from website of NSE (www.nseindia.com) for S&P CNX Nifty and Nifty Index Futures.

Methodology

When time-series data is used in econometrical analysis, several preliminary statistical steps must be undertaken. These steps include unit root testing and co integration testing. Given the nature of time-series data, it is necessary to test the stationary of each individual series. Unit root tests provide information about stationary of the data. Nonstationary data contains unit roots. The existence of unit roots makes hypothesis test results unreliable. Therefore, it becomes necessary to difference any nonstationary time-series before any economic analysis is conducted. One way to test for the existence of unit roots, and to determine the degree of differencing necessary to induce stationary, is to apply the Augmented Dicky-Fuller test or Phillip Perron test (PP). The results of ADF and PP determine the form in which the data should be used in any subsequent econometric analysis.

If each variable of a vector of time-series is found to be nonstationary, then there may exist a long run relationship among these variables. This possibility can be investigated within the cointegration testing framework. Cointegration analysis provides important information about the long run relationship among any group of time series data whose degree of integration is the same. Consequently, cointegration tests can determine whether there exists a stable long run relationship between Nifty Index futures,

Nifty options and Nifty Index in India. Table 3.1 and 3.2 discusses the cointegration results. Additionally, these tests provide important information on the type of testing framework appropriate for any subsequent causality testing of the data. Interpreting the existence of

cointegration as long run equilibrium, the evidence of cointegration allows for using Vector Error Correction Modeling (VECM) of the data to formulate the dynamics of the system.

VECM provides important information on the short run relationship between index futures, index options and index nifty. In general, it gives information on the state of the short run equilibrium. In other words, vector error correction estimation determines whether the system under consideration is in equilibrium or whether disequilibrium exists. Engle and Granger (1987) suggest that error correction models can determine if a part of the disequilibrium from one estimation period is corrected in the following period. Consequently, finding the evidence of disequilibrium within the vector error correction testing framework, it provides an important indication of the direction and size of the short run causality relationship between the three test variables. Therefore, vector error correction test results can provide empirical evidence on the short run causality between Nifty Index Futures and Nifty Index Options and nifty index.

According to Engle and Granger (1987), VCEM can be specified as follows for any two pairs of test variables, through equation (1) to (10), where F is the futures price, S is the cash market price, C is call option price and P is the put option price.

Nifty Index Futures and Nifty Index:

$$R_{f,t} = \alpha_{0f} + \alpha_{1f}(F_{t-1} - S_{t-1}) + \beta_{1f} R_{f,t-1} + \beta_{2f} R_{s,t-1} + \varepsilon_{f,t} \quad (1)$$

$$R_{s,t} = \alpha_{0s} + \alpha_{1s}(F_{t-1} - S_{t-1}) + \beta_{1s} R_{s,t-1} + \beta_{2s} R_{f,t-1} + \varepsilon_{s,t} \quad (2)$$

Nifty Index Futures and Nifty Index Call Options:

$$R_{f,t} = \alpha_{0f} + \alpha_{1f}(F_{t-1} - C_{t-1}) + \beta_{1f} R_{f,t-1} + \beta_{2f} R_{c,t-1} + \varepsilon_{f,t} \quad (3)$$

$$R_{c,t} = \alpha_{0c} + \alpha_{1c}(F_{t-1} - C_{t-1}) + \beta_{1c} R_{c,t-1} + R_{f,t-1} + \varepsilon_{c,t} \quad (4)$$

Nifty Index Futures and Nifty Put Options:

$$R_{f,t} = \alpha_{0f} + \alpha_{1f}(F_{t-1} - P_{t-1}) + \beta_{1f} R_{f,t-1} + \beta_{2f} R_{p,t-1} + \varepsilon_{f,t} \quad (5)$$

$$R_{p,t} = \alpha_{0p} + \alpha_{1p}(F_{t-1} - P_{t-1}) + \beta_{1p} R_{p,t-1} + \beta_{2p} R_{f,t-1} + \varepsilon_{p,t} \quad (6)$$

Nifty Index and Call Options:

$$R_{s,t} = \alpha_{0s} + \alpha_{1s}(S_{t-1} - C_{t-1}) + \beta_{1s} R_{s,t-1} + \beta_{2s} R_{c,t-1} + \varepsilon_{s,t} \quad (7)$$

$$R_{c,t} = \alpha_{0c} + \alpha_{1c}(S_{t-1} - C_{t-1}) + \beta_{1c} R_{c,t-1} + \beta_{2c} R_{s,t-1} + \varepsilon_{c,t} \quad (8)$$

Nifty Index and Put Options:

$$R_{s,t} = \alpha_{0s} + \alpha_{1s}(S_{t-1} - P_{t-1}) + \beta_{1s} R_{s,t-1} + \beta_{2s} R_{p,t-1} + \varepsilon_{s,t} \quad (9)$$

$$R_{p,t} = \alpha_{0p} + \alpha_{1p}(S_{t-1} - P_{t-1}) + \beta_{1p} R_{p,t-1} + \beta_{2p} R_{s,t-1} + \varepsilon_{p,t} \quad (10)$$

The focus of vector error correction analysis is on the lagged terms. These lagged terms are the residuals from the previously estimated cointegration equations. In the current case the residuals from two lagged specifications of the cointegration equations were used in the vectors error correction estimates. Lagged terms provide an explanation of the short run deviations from the long run equilibrium for the two test equations. Lagging these terms means that the disturbance of last period will impact the current time period. Statistical significance tests are conducted on each of the lagged terms in these equations. In general, finding a statistically insignificant coefficient of the term implies that the system under investigation is in the short run equilibrium as there are no disturbances present. If the coefficient of the term is found to be statistically significant, then the system is in the state of the short run disequilibrium. In such a case the sign of the term gives an indication of the causality direction between the three test variables. The results of these equations are summarized in Table 4.1 and 4.2.

IV- Empirical Analysis

Empirical Analysis of the data is segregated under this part. The unit root test results are elaborated in Table 1.1 (put, cash and futures) and 1.2 (call, cash and futures). Table 2.1 and 2.2 discuss the Johansen's Cointegration results and the causality results are discussed in Table 3.1 and 3.2. Figures in this section show the lead lag pattern among three indices.

It can be observed from Table 1.1 and 1.2 that options, futures and cash prices are non-stationary at levels but are stationary at first log difference. Thus for further analysis we will use returns of series instead of their level prices. If all series are non-stationary at levels it means that these series should be integrated of some order. Since first log difference is stationary, so Nifty Futures Returns, Nifty Options Returns and Nifty Stock Returns contain unit roots and these series should be integrated of order one. Johansen's Cointegration test helps to verify that whether long run relationship exists between

futures, options and cash markets. λ_{max} and λ_{Trace} tests results in Table 2.1 and 2.2 show that Nifty Index, Nifty options (put & call) and nifty futures are integrated of order one and thus there exists a stable long run relationship between them. It can be concluded here that any change occurred in these three markets have long run impact upon each other.

It can also be observed from Table 3.1 and 3.2 that there is bilateral causality among three markets i.e., from Futures to Cash & Cash to Futures, Options to Cash & Cash to Options and Options to Futures & Futures to Options.

Table 1.1

Unit Root Test Results

Variables	ADF (Augmented Dickey fuller test)			PP (Philip Perron test)		
	Without Constant	With constant	Constant & Trend	Without Constant	With constant	Constant & Trend
AT LEVELS						
PUT OPTIONS	0.6051	-0.4351	-1.3586	-2.73	-22.04	-35.01
FUTURES	1.8866	0.4409	-2.0728	1.09	0.46	-9.22
CASH	1.9689	0.5321	-2.0179	1.11	0.52	-8.76
AT FIRST LOG DIFFERENCE						
PUT OPTIONS	-8.4797*	-8.4909*	-8.5309*	-1120.75*	-1119.84*	-1117.07*
FUTURES	-6.2461*	-6.5237*	-6.5979*	-1341.05*	-1297.33*	-1286.38*
CASH	-6.3555*	-6.6525*	-6.7326*	-1220.48*	-1177.49*	-1166.87*

*Statistically 1% significant, **Statistically 5% significant

Table 1.2

Variables	ADF (Augmented Dickey fuller test)			PP (Philip Perron test)		
	Without Constant	With constant	Constant & Trend	Without Constant	With constant	Constant & Trend
AT LEVELS						
CALL OPTIONS	-0.3137	-1.9761	-3.6493*	-1.75	-16.16	-46.54
FUTURES	1.8866	0.4409	-2.0728	1.09	0.46	-9.22
CASH	1.9689	0.5321	-2.0179	1.11	0.52	-8.76
AT FIRST LOG DIFFERENCE						
CALL OPTIONS	-7.6215*	-7.6400*	-7.6369*	-1045.68*	-1044.47*	-1044.51*
FUTURES	-6.2461*	-6.5237*	-6.5979*	-1341.05*	-1297.33*	-1286.38*
CASH	-6.3555*	-6.6525*	-6.7326*	-1220.48*	-1177.49*	-1166.87*

*Statistically 1% significant, **Statistically 5% significant

Table 2.1
Johansen's Cointegration Results

Variable	Vector	λ max	λ trace	λ max	λ trace
Put Option Futures	0	39.8*	43.6*	16.7	18.10
	1	3.8	3.8	3.8	3.8
Futures Cash	0	61.2*	67.7*	19.20	25.4
	1	6.5	6.5	23.5	12.5
Put Option Cash	0	40.5*	44.3*	16.7	18.10
	1	3.7	3.7	3.8	3.8

*Statistically 1% significant, **Statistically 5% significant

Table 2.2

Variable	Vector	λ max	λ trace	λ max	λ trace
Call Option Futures	0	37.7*	40.6*	15.8	20.2
	1	2.9	2.9	9.1	9.1
Futures Cash	0	61.2*	67.7*	19.20	25.4
	1	6.5	6.5	23.5	12.5
Call Option Cash	0	34.8*	37.8*	15.8	20.2
	1	3.0	3.0	9.1	9.1

*Statistically 1% significant, **Statistically 5% significant

Table 3.1
Pair wise Granger Causality Tests

Null Hypothesis:	Obs	F-Statistic	Probability
FUTURE does not Granger Cause CASH	1251	5.32512*	7.5E-05
CASH does not Granger Cause FUTURE		9.87298*	2.9E-09
PUT OPT does not Granger Cause CASH	1251	2.62438**	0.02274
CASH does not Granger Cause PUT OPT		9.51008*	6.5E-09
PUT OPT does not Granger Cause FUTURES	1251	3.61337*	0.00300
FUTURES does not Granger Cause PUT OPT		9.02782*	1.9E-08

*Statistically 1% significant, **Statistically 5% significant

Table 3.2

Null Hypothesis:	Obs	F-Statistic	Probability
CASH does not Granger Cause CALL OPT	1252	0.34934	0.84460
CALL OPT does not Granger Cause CASH		2.35463	0.05205
FUTURES does not Granger Cause CALL OPT	1252	0.31790	0.86611
CALL OPT does not Granger Cause FUTURE		3.32138	0.01022
FUTURES does not Granger Cause CASH	1252	2.71639	0.02858
CASH does not Granger Cause FUTURES		9.37607	1.8E-07

*Statistically 1% significant, **Statistically 5% significant

The figures 1 to 10, depicts the results of impulse response analysis. It shows the affect of changes in one market on the other one with reference to the time period. As Figure 1 shows that any change in the future market effect the cash market by 9 days while Figure 2 depicts that Cash market changes influence the Futures market for 7 days only. Hence, from Fig. 1 & Fig. 2, it can be said that Futures market leads the cash market. Figure 3 shows that changes in Futures Market have an effect on the trading mechanism of Put Options for 7 days. Fig 4 displays that any change occurred in the Put Options affect the Futures market for 6days. Thus, Fig.3 & Fig.4 shows the result that Futures market leads the Options market as in this case also Options market follows the Futures market. Figure 5 depicts that the changes occurred in the Put Options affect the Cash market for 6 days. However Fig 6 Shows that any change comes in the Cash market affect the Put Options for 8 days. Thus, from Fig.5 & Fig.6, it can be concluded that the Cash market leads the Put Options by 2 days. Fig 7 and 8 illustrate futures market's leading role on the call options by 1 day. Also the Fig. 9 and Fig. 10 demonstrate that the call options lead the cash market by 2 days.

Impulsive Response Analysis

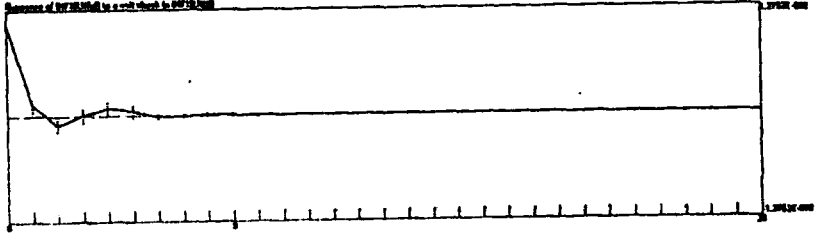

Figure-1 : FUTURES TO CASH

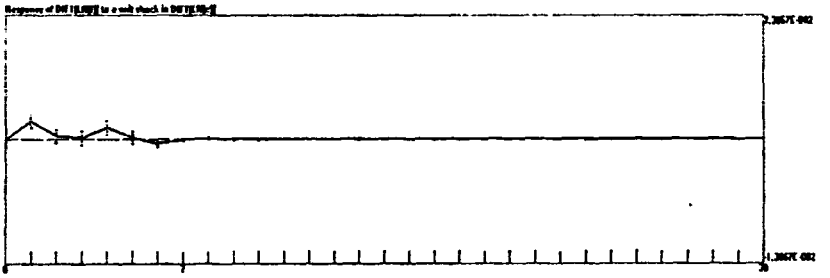

Figure-2 : CASH TO FUTURES

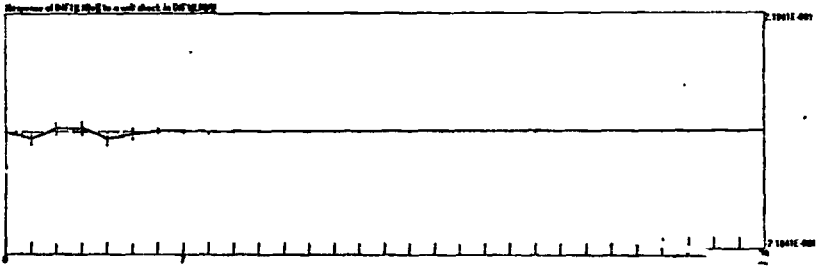

Figure-3 : FUTURES TO PUT OPTIONS

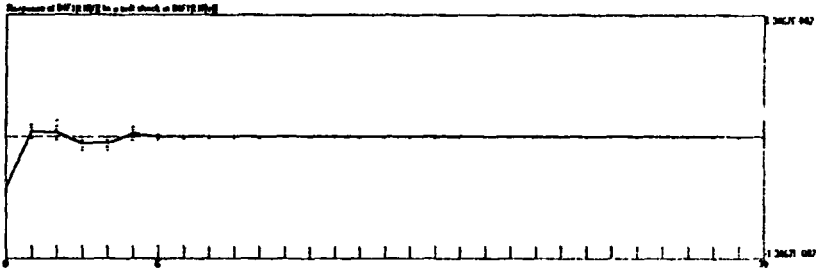

Figure-4 : PUT OPTIONS TO FUTURES

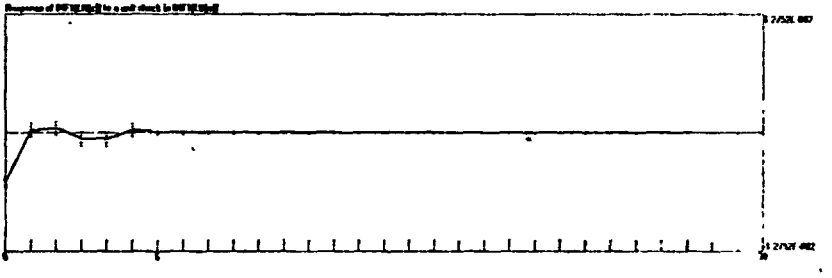

Figure-5 : PUT OPTIONS TO CASH

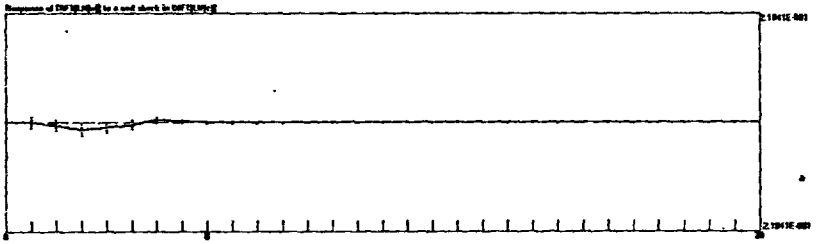

Figure-6 : CASH TO PUT OPTIONS

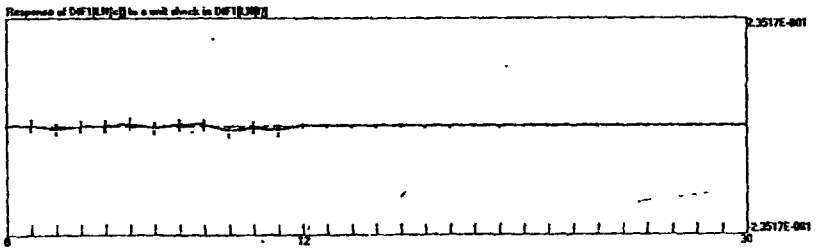

Figure-7 : FUTURES TO CALL OPTIONS

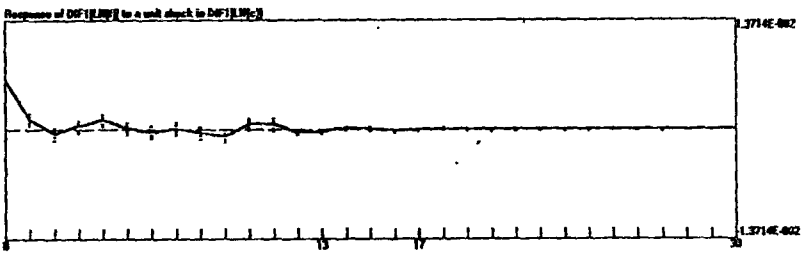

Figure-8 : CALL OPTIONS TO FUTURES

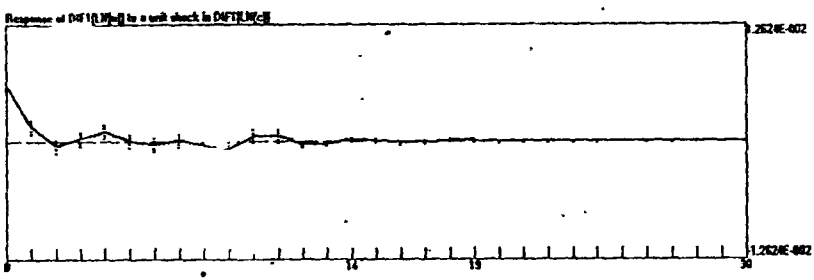

Figure-9 : CALL OPTIONS TO CASH

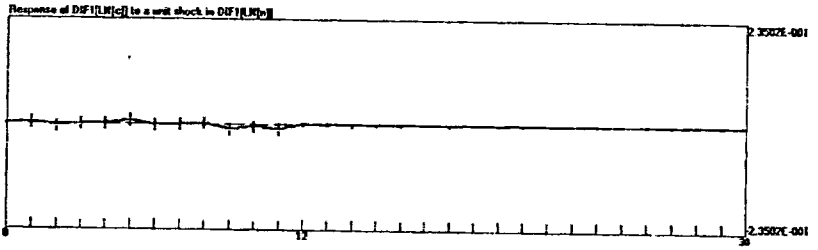

Figure-10 : CASH TO CALL OPTIONS

V- Conclusion

The present paper is an attempt to bring the evidence about the Price Discovery Efficiency of Indian equity Futures, Options and Cash market. From the results of ADF and PP it has been monitored that all series are non-stationary at levels and are integrated of order one which specifies that there exists long run relationship between these variables. The bilateral causality among the three markets is found with the application of Granger causality tests. Finally, by representing the data in graphical form, the lead lag relationship between the three markets can be examined even at a glance.

No doubt, the long run relationship has been observed between futures, option and spot market in India, but futures market is proved to be more efficient price discovery tool other than options and cash market and thus it leads the options as well as cash market. However, it can also be rightly said that various frictions might cause one market to lead the other ones. In order to deal with the options, investors also have to pay some advance money as premium, which makes its trading mechanism somewhat complex for traders as comparison to futures and stock market. Also the transaction cost in the futures market is lesser than the options as well as stock market. Moreover informed traders like to trade in the futures market rather than the cash market as it enabled the traders to arbitrage effectively, which ultimately leads to maximize the trading volume in the futures market.

The study emphasized on price discovery of markets and its lead lag pattern can be considered significant and helpful for traders as well as regulatory bodies. With the help of analysis conducted regarding the three markets by taking the data for the time period of five years, it can be concluded in this study that the price movements in the

futures markets systematically lead price movements of the underlying index in the stock as well as options market but the relationship between the options and cash market is just opposite as cash market found to be efficient market as price discovery vehicle than the options market in India. Thus, the traders in India can arbitrage effectively in futures market by taking favourable position. In short, it makes the hedging possible for them by bearing minimum risk and that too with getting maximum returns in the leading market. The study is also helpful for the regulatory bodies and policymakers to frame the policies regarding capital market by taking into consideration that vary market where price innovations take place first and which is able to predict the arrival of new information in the other market or markets as well.

REFERENCES

Allen, Franklin and Douglas Gale, 1992, Stock Price Manipulation. *Review of Financial Studies*, 5(3), 503-529.

Abhayankar, Abhay, H., 1995, Return and Volatility Dynamics in the FT-SE 100 Stock Index and Stock Index Futures Markets, *Journal of Futures Markets*, 15, 457-488.

Anthony, Joseph H., 1988, The Interrelation of Stock and Options Market Trading Volume Data, *Journal of Finance*, 43, 949-964.

Bhattacharya, Mihir, 1987, Price Changes of Related Securities: The Case of Call Options and Stocks, *Journal of Financial and Quantitative Analysis*, 22, 1-15.

Bollen, Nicolas P.B., and Robert E. Whaley, 1998, A Note on the Impact of Options on Stock Return Volatility, *Journal of Banking and Finance*, 22, 1181-1191.

Boyle Phelim P., Byoun S. and Park Hun Y., 1999, Temporal Relation Between Stock Option Market: A Bias Of Implied Volatility in Option Price, *Working Paper Series*, OFOP, Paper No. 99-07.

Chan K.C. and G. Andrew Karoyli, Chan, Kolak, 1991, Intraday Volatility in the Stock Index and Stock Index Futures Market, *Review of Financial Studies*, 4, 657-684.

Chan, Kalok, 1992, A Further Analysis of the Lead Lag Relationship Between the Cash Market and Stock Index Futures Market, *Review of Financial Studies*, 5, 123-152.

Chan, Kalok, Y. Peter Chung and Herb Johnson, 1993, Why Option Prices Lag Stock Prices: A Trading-Based Explanation, *Journal of Finance*, 48, 1957-1967.

Choi, Hong and Avanidhar Subrahmanyam, 1994, Using Intraday Data to test for Effects of Index Futures on the Underlying Stock Markets , *Journal of Futures Markets*, 14, 293-322.

De Jong, Frank and Monique W.M. Donders, 1997, Intra day Lead-Lag Relationship between the Futures, Options and Stock Market, *Working Paper*, Tilburg University.

De Jong, Frank and Theo Nijman, 1997, High Frequency Analysis of Lead Lag Relationship between Financial Markets, *Journal of Empirical Finance*, 4, 259-277.

Engle, R.F. and Granger, C.W., 1987, Co-integration and Error Correction Representation, Estimation, and Testing, *Econometrica*, 55, 251-276.

Easley,David, O'Hara and P.S. Srinivas, 1998, Option Volume and Stock Prices: Evidence on where Informed Traders Trade. *Journal of Finance*, 53, 431-465.

Finucane, Thomas J., 1999, A New Measure of the Direction and Timing of Information Flow between Markets, *Journal of Financial Markets*, 2, 135-151.

Fleming, Jeff, Barbara Ostdiek and Robert E. Whaley, 1996, Trading Costs and Relative Rates of Price Discovery in Stock, Futures, and Option Markets, *Journal of Futures Markets*, 16, 353-387.

Frino A. et al., 2000, The Lead Lag Relationship Between Equities And Stock Index Futures Markets Around Information Releases, *Journal Of Futures Markets*, 20(5), 467-487.

Ghosh A., 1993, Cointegration and Error Correction Models: Intertemporal Causality Between Index and Futures Prices, *Journal Of Futures Market*, 13, 193-198.

Granger, C. W., 1969, Investigating Casual Relations by Econometric Models and Cross Spectral Methods, *Econometrica*, 37, 423-438.

Grossman, S.L. and Miller, M.H., 1988, Liquidity and Market Structure, *Journal of Finance*, 43, 617-633.

Gupta Kapil, Singh Balwinder, 2006, Price Discovery and Causality in the Spot and Futures Market in India, *Journal of Derivative Markets*, 3(1), 30-41.

Harris L., 1989, The October 1987 S&P 500 Stock Future Basis, *Journal of Finance*, 44, 77-99.

Illueca M. and Lafuente J.A., 2003, The effect of spot and futures trading on stock index volatility: A non-parametric approach, *Journal of Futures Markets*, 23(9), 841-858.

Karoyli, Andrew G., 1996, Stock Market Volatility around Expiration Days in Japan, *Journal of Derivatives*, 4, 23-43.

Kawaller, Ira G., Paul D. Koch and Timothy W. Koch, 1987, The Temporal Price Relationship between S&P 500 Futures Prices and the S&P 500 Index, *Journal Of Finance*, 5, 1309-1329.

Kawaller, Ira G., Paul D. Koch and Timothy W. Koch, 1993, Intraday Market Behavior and the Extent of Feedback between S&P 500 Futures Prices and the S&P 500 Index, *Journal Of Financial Research*, 16, 107-121.

Mukherjee, K.N. and R. K. Mishra, 2006, Lead-Lag Relationship and It's Variation around Information Release: Empirical Evidence from Indian Cash and Futures Markets. Available at SSRN: http://ssrn.com/abstract=931098

Kyriacou, K. & L. Sarno, 1999, The Temporal relationship between derivatives trading and spot market volatility in the UK: An empirical investigation, *Journal of Futures Markets*, 19, 245-270.

Gupta, L.C., 1998, Report of the Committee on Derivatives, *Securities and Exchange Board of India*, 1-53

MacKinlay, C., and K. Ramaswamy, 1988, Index-Futures Arbitrage and the Behavior of Stock Index Futures Prices, *Review of Financial Studies*, 137-158.

Manaster, Steven and Richard J. Rendlemen Jr., 1982, Option Prices as Predictors of Equilibrium Stock Prices, *Journal of Finance*, 37, 1043-1057.

Pan, J., and A. Poteshman, 2005, The Information in Option Volume for Future Stock Prices, *Review of Financial Studies*, 19 (3), 871-908

Raju, M. T. and Karande, K., 2003, Price Discovery and Volatility on NSE Futures Market, *SEBI Working Paper No. 7*, 1-17.

Ross, S., 1989, Information and Volatility: The No-arbitrage Approach to Timing and Resolution of Irrelevance, *Journal of Finance*, 44, 1 – 17.

Stephan, Jens A. and Robert E. Whaley, 1990, Intraday Price Changes and Trading Volume Relation-ships in the Stock and Stock Options Markets, *Journal of Finance*, 45, 191-220.

Stoll, H.R., and Whaley, R.E., (1990), The dynamics of stock index and stock index futures returns, *Journal of Financial and Quantitative Analysis*, 25 (4), pp. 441-468.

Stoll, Hans R. and Robert E. Whaley, 1997, Expiration-Day Effects of the All Ordinaries Share Price Index Futures: Empirical Evidence and Alternative Settlement Procedures, *Australian Journal of Management*, 22, 139-174.

Sung C. Bae, Taek Ho Kwon, and Jong Won Park (2004). "Futures trading, spot market volatility, and market efficiency: The case of the Korean index futures markets." *Journal of Futures Markets*, 24 (12), 1195

Wahab, Mahmoud and Malek Lashgari, 1993, Price Dynamics and Error Correction in Stock Index and Stock Index Futures Markets, A Cointegration Approach, *Journal of Futures Markets* ,13, 711-742.