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Interest Rate: Futures and Cash Market Spill-over's in India

Hruda Ranjan Sahoo[1] & Pradiptarathi Panda[2]

Abstract:

The present study analyses the spill-over's effect between the interest rate cash and futures market in India. We use daily data of volumes, weighted average price, weighted average yield to represent cash market and number of contracts traded, values, open interest, settlement price to represent futures market from 4th August 2014 to 31st December 2015 with 337 (trading days) number of observations. We consider a single instrument (i.e. 08.40 GS 2024) which is most liquid, active and have contracts for a longer time period. All data are sourced from Clearing Corporation of India Ltd. (CCIL) and National Stock Exchange (NSE). We first presents descriptive statistics followed by stationarity test, Correlation, Regression, Granger Causality test and ARMA (1, 1), GARCH (1, 1) spill-over's model. The study finds cash market price is leading the futures market but the future settlement price has impact on the yield of the underlying security.

Key words*: Govt. Securities, Interest rate futures, NSE, CCIL*

JEL Classification: C 58, G 12, G 13

1. Introduction

Interest rate plays a significant role for stability, growth and development of an economy. Change in interest rate will affect the value of investment, cost of borrowing, cost of raising money from the securities market, value of the company, etc. therefore with the primary objective to hedge the interest rate risk, interest rate future were introduced like other financial derivatives. It is nothing but a future contract with the underlying an interest bearing instrument, which will be bought and sold on a predetermined future date, at a predetermined price and is also traded on the exchange

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platform. Mostly, the underlying in the interest rate future contracts are liquid treasury securities of different maturities.

Investors use interest rate derivative to hedge against interest rate risk. Among all derivative instruments, Interest Rate Futures (IRF) is the most popular derivative products available in the market across globe. Chicago Mercantile Exchange (CME) is the first exchange introduced IRF in the year 1981[3]. This particular product has gained interest in developed markets. The total turnover of IRF of all world exchanges is $4,576 billion under which North American exchanges, European exchanges, Asia/ pacific exchanges and other exchanges turnover is $3,175 billion (69%), $1135 billion (25%), $199 billion (4%) and $67 billion (2%) respectively (See Figure-1 & Figure- 2). But as a developing and emerging country like India, it is struggling since 2003. IRF has failed in the year 2003 and 2009. But in the third time as it is introduced in the year 2014 (MCX-SX introduced on 20th January 2014, NSE on 21st January 2014 and BSE on 28th January 2014), the volume in the NSE is high among all the three exchanges (Panda and Thiripalraju, 2015). A lot of debate arises among researchers, policy makers and market participants on whether future market leads cash market or cash leads futures market? Although several studies exists based on equity/commodity/index cash and futures market, there are no more studies exists considering interest rate cash and futures especially in respect to India. Considering commodity cash and futures market, studies find that futures market leads cash market {Oellermann & Farris (1985), Oellermann et al. (1989), Chaihetphon and Pavabutr (2010), Kumar and Arora (2011) & Arora and Kumar (2013)}. In case of equity cash and futures market, studies also find futures market leads cash market {Chan (1992), Raju and Karande (2003), Gupta and Singh (2007) & Gupta and Singh (2009)}. Hence this study takes an attempt further to examine the spill-over's effect between interest rate cash and futures market in India.

[3] Major exchanges issued IRF are- Chicago Mercantile Exchange/US, Korea Exchange/South Korea, Tokyo Stock Exchange/Japan, Australian Securities Exchnage/Australia, BM & F Bovespa/ Brazil, EUREX Exchange/Germany, Intercontinental Exchange/USA, NYSE Euronext/USA, NASDAQOMX/USA, Singapore Exchange/Singapore, South African Futures Exchange/ South Africa,

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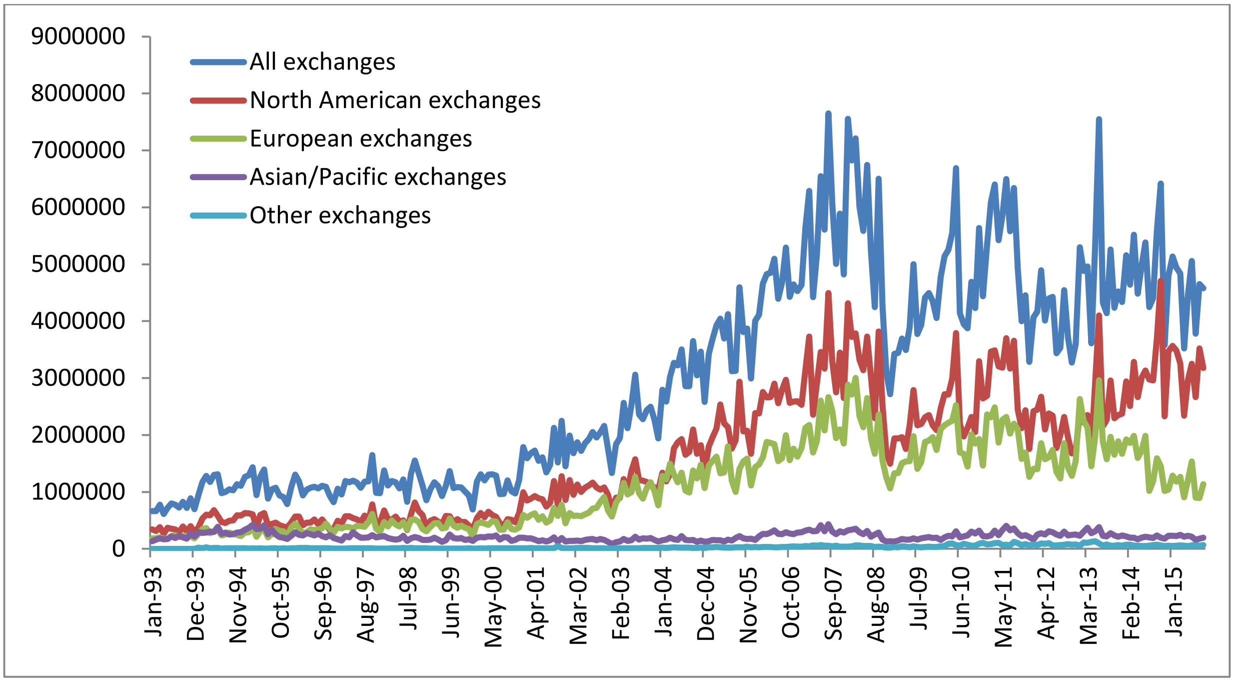
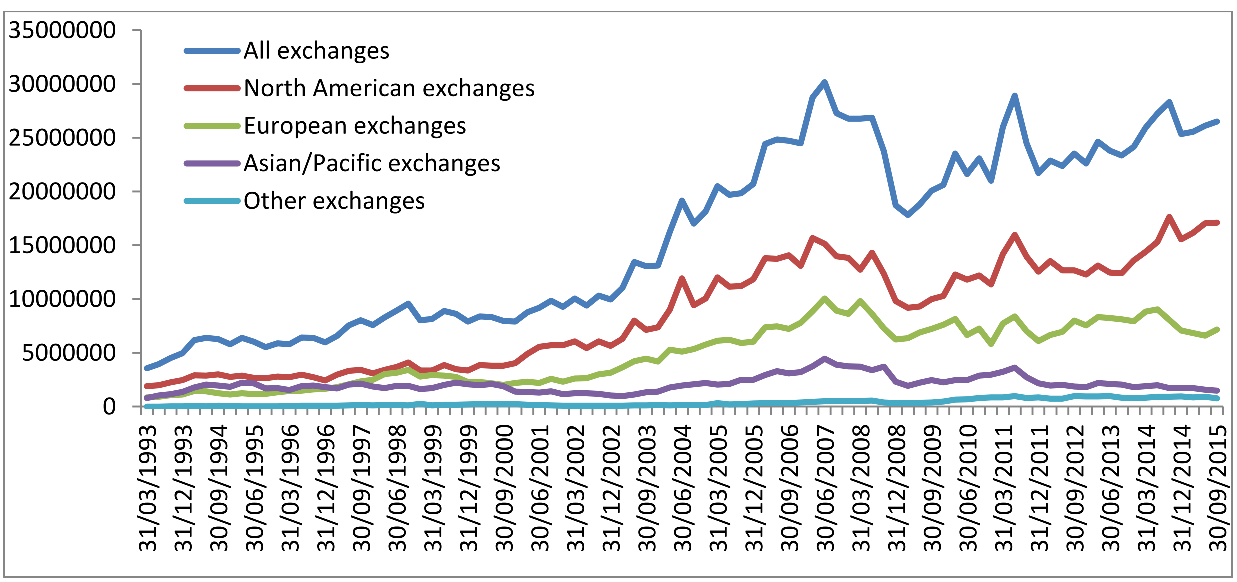
Fig 1: Notional Amount Turnover (USD Millions) of Interest Rate Derivative Contracts from Jan, 1993 to Sep, 2015.



Source: Bank for International Settlement (BIS)

Fig 2: Notional Amount Outstanding (OI) (USD Millions) of Interest Rate Derivative contracts of All Exchanges from March, 1993 to Sep, 2015.



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Source: Bank for International Settlement (BIS).

Table-1: IRF Volume in Indian Scenario (NSE)

Sl. No.	Period	Name of the Underlying	Future Market Value as a % of Cash Market Volume
1	21/01/14 to 30/10/14	883GS2023	5.46%
2	04/08/14 to 31/12/15	840GS2024	13.88%
3	29/05/15 to 31/12/15	772GS2025	14.73%
4	31/07/15 to 31/12/15	827GS2020	1.14%
5	31/07/15 to 31/12/15	788GS2030	3.57%

Source: Authors estimation/ CCIL/NSE

Table-1, presents IRF volume in Indian Scenario. During the period of our observation IRF contracts were mostly on these treasury securities 883GS 2023, 840GS2024, 772GS2025, 827GS2020 & 788GS2030. The trading volumes are mostly concentrated towards 10 year maturity horizon.

2. Review of Literature:

Studies based on interest rate futures are mostly on developed markets may be due to highest market share. The following are some literature on interest rate futures:

In a study, ***Poon et al. (1998)*** finds suspension of trading in Shanghai Treasury bond futures has a positive impact on the market liquidity of both A and B shares traded on both Shanghai and Shenzhen Stock Exchanges. ***Brewer et al. (2000)*** finds a positive relationship between the use of interest rate derivatives by banks and the growth in bank lending's (Commercial and industrial loans). ***Kuttner (2000)*** finds a strong relationship between surprise policy actions and market interest rates, but response to anticipated actions are small. Further, the response to surprise actions at the short end of the yield curve suggests that many of these surprises have more to do with timing of rate changes than with the level of rates and surprise target rate changes have virtually no effects on expectations of future Fed actions. ***Choi & Finnerty (2006)*** shows the market trading on the announcement day of Federal Open Market Committee (FOMC) is different from the market trading on a non-announcement for both the Eurodollar and T-Note futures market. The difference in autocorrelation structure exists at both markets, but the price level difference is not noticeable at T-Note market. There is strong correlation among the interest rates of T-Bonds and the federal funds rate. Further, despite of all the considerations, the difference in the maturity seems to have an effect on the magnitude of the FOMC impact. ***Zhou (2007)*** shows strong evidence that the movement of Eurodollar rates and the federal funds rate appears to be related to the way the Fed targets the funds rate. The study uses co-integration and vector error correction mechanism. The study finds that Fed may affect the market interest rates through a policy of changing the federal funds rate target by a fixed amount for the foreseeable future. ***Hyde (2007)*** finds in all four major European economies: France, Germany, Italy and the UK the industries are significantly exposed to both market risk and exchange rate risk. However, the sensitivity of stock returns at the industry level to interest rate risk was observed mainly in Germany and France. ***Purnanandam (2007)*** finds banks which usages derivatives for interest rate risk management are more comfortable during the events of external shocks. Usage of derivatives helps the banks to hedge their interest rate risk and also provides smooth cash flow to the bank and are unaffected in terms of their lending volume due to change in policy rates. ***Debasish (2009)*** finds no significant volatility Spill-over's from futures to spot market on NSE Nifty by using GARCH time series techniques. ***Park and Choi (2011)*** finds interest rate sensitivity of US property/liability insurer stock returns is time varying and is closely related to the underwriting cycle or performance of the insurance industry. The period of study was from 1992 and 2001. In Indian case ***Panda and Thiripalraju (2015)*** evaluates the rise and fall of interest rate futures (IRF) in Indian derivative market presenting three different cases like 2003, 2009 and 2014. The study uses the trend analysis of 2014 IRFs for three different exchanges like BSE, NSE and MCX-SX. The study finds NSE IRFs volume is higher in the Indian derivative market.

Based on the above literature, we find most of the research on interest rate derivatives have been done in developed markets. But as per our knowledge, in case of emerging markets like India the study on IRF are a few. As in India IRF failed two times and this is the third time (from 2014 onwards), the IRF market is growing, we find only one study Panda and Thiripalraju (2015) consider 2014 data. But they have not examined the inter-linkages between Interest rate cash and futures market. This study empirically examines the spill-over between interest rate cash and futures market in respect to India.

3. Data Sources and Methodology

Data Sources:

For our analysis we have considered the most liquid treasury security in the 10 year maturity horizon i.e. 840 GS 2024. All futures market data are sourced from National Stock Exchange (NSE) and all cash market data are obtained from Clearing Corporation of India Ltd. (CCIL). The period of our study covers form- 4th August 2014 to 31st December 2015 with total number of 337 daily observations (trading days). We considered four variables from the futures market such as daily settlement price, number of contracts traded, value of contracts traded and open interest and three variables from the cash market such as weighted average price, volume and weighted average yield for our analysis. The detailed of variables used and their codes are presented in Table- 2.

Table-2: **Codes used in this study**

Futures	rsp	Natural log return of daily settlement price
Market	rcon	Natural log Return of number of contracts traded on daily basis
Variables	rval	Natural log Return on total value of contracts traded on daily basis
	roi	Natural log return of total open interest on daily basis
Cash Market	rwap	Natural log return of daily weighted average price
Variables	rvol	Natural log return on total daily volume
	rway	Natural log return on daily weighted average yield

For futures market, we considered the daily settlement price of the near month contracts as those contracts are more liquid and active. The number of contracts traded, value of contracts traded and open interest are the gross value on daily basis. Each contract consists of 2000 units of the underlying security.

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Methodology:

To normalize the data, all data series were converted to natural logarithm by formula – $\boldsymbol{ln(P_t/P_{t-1})*100}$

Where -

P_t represents settlement price/ contracts traded/total value of contracts traded/open interest/ weighted average price/ total volume/weighted average yield, etc. on the same day.

P_{t-1} represents settlement price/ contracts traded/total value of contracts traded/open interest/ weighted average price/ total volume/weighted average yield, etc. on the previous day.

We proceed further by representing descriptive statistics of the variables and checked the stationarity by Augmented Dickey Fuller Test (ADF) of Dickey and Fuller (1979), Philips and Perron test of Philips and Perron (1988) and Kwiatkowski-Phillips-Schmidt-Shin (KPSS) test of Kwiatkowski-Phillips-Schmidt-Shin (1992).

To check the relationship among variables, we present correlation matrix among variables. Subsequently, we run ordinary least square with the variables by considering different dependent and independent variables. The equations are as under:

$$rwap = a_0 + \beta_1 rvol + \beta_2 rcon + \beta_3 roi + \beta_4 rsp + \beta_5 rway + \varepsilon_i \ldots\ldots\ldots\ldots\ldots\ldots\ldots.(i)$$

$$rway = a_0 + \beta_1 rvol + \beta_2 rcon + \beta_3 roi + \beta_4 rsp + \beta_5 rwap + \varepsilon_i \ldots\ldots\ldots\ldots\ldots\ldots\ldots.(ii)$$

$$rsp = a_0 + \beta_1 rwap + \beta_2 rcon + \beta_3 roi + \beta_4 rvol + \beta_5 rway + \varepsilon_i \ldots\ldots\ldots\ldots\ldots\ldots\ldots.(iii)$$

$$rcon = a_0 + \beta_1 rwap + \beta_2 sp + \beta_3 roi + \beta_4 rvol + \beta_5 rway + \varepsilon_i \ldots\ldots\ldots\ldots\ldots\ldots\ldots.(iv)$$

Further we checked VAR lag length criteria and we find most of the criteria are satisfied with 4th lag order. After lag order selection we applied Granger Causality test of Granger (1969, 1980) to know about the cause and effect relationship among variables.

The Granger causality test checks the causality between two variables. If there are two variables say X and Y then the causality result between these two variables may come in 4 possible cases.

That are-

a. Unidirectional causality: X granger cause Y
b. Unidirectional causality: Y granger cause X
c. Bidirectional causality: if causality exists from X to Y and Y to X
d. No Granger Causality: No causality exists from either X to Y or Y to X

To test causal relations between two stationary series X_t and Y_t (in bi-variate case) can be based on the following two equations:

$$Y_t = \alpha_0 + \sum_{i=1}^{4} \alpha_i Y_{t-i} + \sum_{j=1}^{4} \beta_j X_{t-j} + \varepsilon_t \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(v)$$

$$X_t = \gamma_0 + \sum_{i=1}^{4} \gamma_i X_{t-i} + \sum_{j=1}^{4} \theta_j Y_{t-j} + \nu_t \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(vi)$$

Here Y_t and X_t denotes respective variables. The disturbance term ε_t and ν_t are assumed to be un-correlated.

a. Unidirectional Granger causality form X to Y will exist if $\sum_{j=1}^{4} \beta_j \neq 0$ and $\sum_{j=1}^{4} \theta_j = 0$

b. Unidirectional Granger causality from Y to X will exists if $\sum_{j=1}^{4} \beta_j = 0$ and $\sum_{j=1}^{4} \theta_j \neq 0$

c. Bidirectional causality will exist if $\sum_{j=1}^{4} \beta_j \neq 0$ and $\sum_{j=1}^{4} \theta_j \neq 0$

d. No causality exists between X and Y if $\sum_{j=1}^{4} \beta_j = 0$ and $\sum_{j=1}^{4} \theta_j = 0$

Finally, we run Volatility spill-over's effect among the variables like- rsp & rwap; rsp & rway; and rval & rvol by AR (1) MA (1)-GARCH (1,1) spill-over's model. The respective equations are given below:

$$R_{cashmarket} = \alpha_0 + \alpha_i AR(1) + \beta_j MA(1) + \varepsilon_t \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(vii)$$

$$R_{futurmarket} = \alpha_0 + \alpha_i AR(1) + \beta_j MA(1) + \varepsilon_t \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(viii)$$

We run AR (1) MA (1) for variables of cash markets (rwap, rway & rvol) and futures market (rsp & rval). In each run, we capture residual of the particular equation and square it. Further we employ the squared residual in other variable's variance equation of GARCH model of Bolleserve (1986) to capture the spill-over's effect between the variables. The GARCH (1, 1) spill-over's model in each case are given below:

$$h_{t\,(\text{futures market})} = \alpha_1 + \beta_1 \mathcal{E}_{t-1}^2 + \beta_2 h_{t-1} + \phi\,(\text{sqresid}_{\text{ cash market}})\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ (ix)$$

$$h_{t\,(\text{cash market})} = \alpha_1 + \beta_1 \mathcal{E}_{t-1}^2 + \beta_2 h_{t-1} + \phi\,(\text{sqresid}_{\text{ futures market}})\ldots\ldots\ldots\ldots\ldots\ldots\ldots(x)$$

Here-

$\alpha_1 > 0$, $\beta_{1>=}0$, $\beta_{2>=}0$

h_t = the conditional variances of both futures market and cash market respectively. It is function of mean α_1.

The news about volatility from the previous period is measured as the lag of the squared residual from the mean equation ($\mathcal{E}_{t-1}^2$), previous periods forecast variance (h_{t-1}) and the squared residual of futures market and cash market respectively in both the above equations.

4. Empirical Results:

We first present descriptive statistics in Table-3 to know the nature of data series under consideration. Descriptive statistics describes the nature of data in quantitative terms. Mean is the average of a data series and indicates where the values are centred. Over the period of time mean of contracts, open interest, settlement price, value & weighted average prices is positive and volume & weighted average yield are negative. From the standard deviation we observe that contracts, value and volumes are more volatile but settlement price, weighted average price and weighted average yield are less volatile. From the skewness we find open interest & weighted average yield is positively skewed and rest of the variables are negatively skewed. Kurtosis tells us the distribution is less or more peaked than a normal distribution. Here all value of kurtosis are positive and more than three indicates the distribution is leptokurtic and more peaked distribution than normal distribution. From the probability value of Jarque- Bera test, we find all data series are non-normal.

Table-3 : Descriptive Statistics

	RCON	ROI	RSP	RVAL	RVOL	RWAP	RWAY
Mean	0.390	0.830	0.011	0.401	-0.693	0.011	-0.022
Median	1.954	0.255	0.006	1.868	0.796	0.005	0.000
Maximum	219.022	109.205	0.676	219.644	208.811	0.632	1.524
Minimum	-239.436	-32.450	-0.971	-239.505	-135.824	-0.811	-1.293
Std. Dev.	66.669	9.994	0.216	66.683	44.707	0.180	0.354
Skewness	-0.330	4.003	-0.451	-0.329	-0.018	-0.166	0.072
Kurtosis	4.163	47.339	5.431	4.166928	4.152	4.820	4.772
Jarque-Bera	25.064	28421.070	94.207	25.16067	18.585	47.949	44.249
Probability	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Observations	336	336	336	336	336	336	336

Table 4 presents stationarity of data series. To check stationarity of data series, we employ ADF test, PP test and KPSS test. KPSS test find stationarity in opposite way. That means if probability value of coefficients in KPSS test is insignificant then the series is stationary. In case of KPSS test, the series is stationary at level and intercept but in 3 cases of trend and intercept it is non stationary. We find over-all data series are stationary at level in both intercept & trend and intercept.

Table 4: Result of Stationarity Test at Level

	ADF		**PP**		**KPSS**	
	Intercept	Trend and intercept	Intercept	Trend and intercept	Intercept	Trend and intercept
RCON	-1.621	-1.622	-1.364	-1.363	0.391	1.979
	(0.089)*	(0.089)*	(0.051)*	(0.051)*	(3.637)	(7.268)

ROI	-0.769	-0.796	-0.768	-0.796	0.830	-0.023
	(0.043)*	(0.429)*	(0.043)*	(0.043)*	(0.546)	(0.006)*
RSP	-1.139	-1.156	-1.011	-1.016	0.011	0.038
	(0.077)*	(0.077)*	(0.055)*	(0.055)*	(0.012)	(0.024)
RVAL	-1.622	-1.623	-1.363	-1.364	0.401	2.017
	(0.089)*	(0.089)*	(0.051)*	(0.051)*	(3.638)	(7.269)
RVOL	-1.513	-1.519	-1.313	-1.314	-0.693	1.435
	(0.089)*	(0.089)*	(0.053)*	(0.052)*	(2.438)	(4.873)
RWAP	-0.972	-0.987	-0.834	-0.841	0.011	0.037
	(0.694)*	(0.069)*	(0.054)*	(0.054)*	(0.009)	(0.020)***
RWAY	-0.988	-1.000	-0.849	-0.854	-0.023	-0.069
	(0.070)*	(0.070)*	(0.054)*	(0.054)*	(0.019)	(0.038)***

Note:

- *, **&*** represents significant at 1%, 5% and 10 % respectively;
- Numbers in the parenthesis are standard errors.

Table-5 represents the correlation among variables of both future and cash markets. It is observed that there is a high degree of positive correlation between number of contracts traded in futures market and total traded value in futures market (0.999) & daily settlement price in futures market and the daily weighted average price in cash market (0.778). There is a high degree of negative correlation between daily settlement price in futures market and daily weighted average yield in the cash market (-0.762) & the daily weighted average price in cash market and daily weighted average yield in the cash market (-0.988). The rest of the variables are less correlated.

Table-5: Correlation Matrix

	rcon	rval	roi	rsp	rvol	rwap	rway
rcon	1.000						
rval	0.999	1.000					
roi	0.254	0.254	1.000				

rsp	-0.003	-0.001	-0.199	1.000			
rvol	0.410	0.411	0.001	0.270	1.000		
rwap	0.083	0.086	-0.146	0.778	0.271	1.000	
rway	-0.091	-0.094	0.124	-0.762	-0.278	-0.988	1.000

Further we run regression in 4 different equations. The regression result is given in table-6. In equation-*i*, we consider the impact of volume, contract, open interest, settlement price and weighted average yield on weighted average price. We find no significant impact from volume and contract on weighted average price. The impact from open interest, settlement price and weighted average yield to weighted average price is negative and significant. Among all the variables the weighted average yield impacts more on the weighted average price. In equation-*ii*, we regressed weighted average yield with volume, contracts, open interest, settlement price and weighted average price. In this case we find only open interest and weighted average price negatively impacts weighted average yield significantly and rest of the variables impact is insignificant. The weighted average price impacts more on the weighted average yield. In equation- iii, we regress settlement price with weighted average price, contracts, open interest, volume and weighted average yield. We find significant positive impact exists from weighted average price and volume to settlement price and significant negative impacts from contracts and open interest. Weighted average price impacts more on settlement price. For equation - *i, ii & iii* the R squared value is high and the Durbin Watson statistics is more than two, indicates the model is good fit. The equation-*iv* regress contract with weighted average price, settlement price, open interest, volume and weighted average yield. Although significant negative impact shown from settlement price and significant positive impact shown from open interest and weighted average yield to contract; the R squared is very low.

Table-6: Regression Result

	Equation-i	Equation-ii	Equation-iii	Equation-iv
Variable	Coefficient	Coefficient	Coefficient	Coefficient
a_0	7.751	-0.000	0.003	-0.478

	(0.001)	(0.003)	(0.007)	(3.206)
	-3.971	-9.731	1.218	79.796
β_1	(3.731)	(7.541)	(0.269)*	(121.178)
	1.641	1.071	-0.000	-57.109
β_2	(2.501)	(5.051)	(0.000)**	(23.840)**
	-0.000	-0.001	-0.001	0.627
β_3	(0.000)**	(0.000)**	(0.001)***	(0.075)*
	-0.048	0.026	0.001	12.705
β_4	(0.011)*	(0.022)	(0.000)*	(59.985)
	-0.481	-1.965	0.165	1.601
β_5	(0.006)*	(0.026)*	(0.137)	(0.328)*
R^2	0.979	0.977	0.625	0.245
AR^2	0.978	0.977	0.620	0.234
DW	2.887	2.897	2.871	2.592

Note:

- *, ** & *** indicates level of significance at 1%, 5% & 10%.
- Numbers in the parenthesis are standard errors.
- R^2= R Squared, A R^2= Adjusted R Squared, DW= Durbin-Watson stat

Before running Granger causality test, we run VAR lag order selection criteria (See Table 7). We find most of the conditions like LR, FPE and AIC has been satisfied at lag 4. So we consider lag 4 for granger causality test.

Table-7: VAR Lag Order Selection Criteria

Endogenous variables: rcon, roi, rsp, rval, rvol, rwap, rway

Exogenous variables: C

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-3133.359	NA	0.488	19.148	19.229	19.18083
1	-2917.774	420.653	0.177	18.132	18.780*	18.391*

2	-2836.683	154.766	0.145	17.937	19.151	18.421
3	-2780.450	104.922	0.139	17.893	19.673	18.604
4	-2725.152	100.817*	0.134*	17.855*	20.202	18.791
5	-2691.158	60.524	0.148	17.946	20.860	19.109
6	-2655.385	62.168	0.161	18.026	21.508	19.415
7	-2616.280	66.287	0.171	18.087	22.134	19.702
8	-2586.804	48.706	0.195	18.206	22.820	20.047

* indicates lag order selected by the criterion, LR: sequential modified LR test statistic (each test at 5% level), FPE: Final prediction error, AIC: Akaike information criterion, SC: Schwarz information criterion, HQ: Hannan-Quinn information criterion

Table -8 presents pair wise granger causality between variables. We find bidirectional causality exists between volume and contracts traded, settlement price and open interest, open interest and weighted average yield & volume and value. Unidirectional causality exists from open interest to value and weighted average price, weighted average price to volume and weighted average yield & weighted average yield to volume. For rest of the variables causality does not exist.

Table-8 : Pair wise Granger Causality Test

Lags: 4

H_0: Does not Granger Cause

H_0	F-Statistic	H_0	F-Statistic
RSP $\rightarrow$ RCON	0.987	RVOL $\rightarrow$ RSP	1.041
RCON $\rightarrow$ RSP	0.960	RSP $\rightarrow$ RVOL	1.149
RVOL $\rightarrow$ RCON	2.143***	RWAP $\rightarrow$ RSP	1.026
RCON $\rightarrow$ RVOL	3.869*	RSP $\rightarrow$ RWAP	14.728
RWAP $\rightarrow$ RCON	1.088	RWAY $\rightarrow$ RSP	1.196
RCON $\rightarrow$ RWAP	0.725	RSP $\rightarrow$ RWAY	15.453
RWAY $\rightarrow$ RCON	1.018	RVOL $\rightarrow$ RVAL	2.125***

RCON $\rightarrow$RWAY	0.850	RVAL $\rightarrow$RVOL	3.886*
RSP $\rightarrow$ROI	1.988***	RWAP $\rightarrow$RVAL	1.098
ROI $\rightarrow$RSP	3.257**	RVAL $\rightarrow$RWAP	0.724
RVAL $\rightarrow$ROI	1.025	RWAY $\rightarrow$RVAL	1.022
ROI $\rightarrow$RVAL	1.933***	RVAL $\rightarrow$RWAY	0.848
RVOL $\rightarrow$ROI	3.458	RWAP $\rightarrow$RVOL	3.250**
ROI $\rightarrow$RVOL	1.386	RVOL $\rightarrow$RWAP	0.320
RWAP $\rightarrow$ROI	0.962	RWAY $\rightarrow$RVOL	3.511*
ROI $\rightarrow$RWAP	4.391*	RVOL $\rightarrow$RWAY	0.342
RWAY $\rightarrow$ROI	0.835*	RWAY $\rightarrow$RWAP	0.510
ROI $\rightarrow$RWAY	4.332*	RWAP $\rightarrow$RWAY	2.144***
RVAL $\rightarrow$RSP	0.960		
RSP $\rightarrow$RVAL	0.999		

Notes-

- *, ** & *** indicates level of significance at 1%, 5% & 10%.
- H_0 is the Null Hypothesis

Volatility is the fluctuation in a variable over a period of time. It results unpredictability, uncertainty and risk. It affects investors wealth and increases the bid ask spread which signifies the importance of risk management (Beg and Anwar, 2012). Engel (2004) in his Nobel lecture rightly posits that volatility is an important issue in financial econometrics. It is associated with the concept of risk. Table -9 presents volatility Spill-over's across variables. Here β_1, β_2 and ϕ represents ARCH (volatility persistence), GARCH (volatility clustering) and volatility spill-over's effect between the variables respectively. The β_1 i. e. ARCH term is insignificant in all cases except value to volume. This indicates absence of volatility persistence. The β_2 i.e. volatility clustering is significant in all cases. We find ϕ i. e. volatility spill-over's effect is significant in all cases indicates existence of volatility spill-over's effect.

Table-9. Examination of Volatility Spill-over's

AR(1) MA(1)-GARCH(1,1)

Parameters	RSP & RWAP		RSP & RWAY		RVAL & RVOL	
	rsp $\rightarrow$ rwap	rwap $\rightarrow$ rsp	rsp $\rightarrow$ rway	rway $\rightarrow$ rsp	rval $\rightarrow$ rvol	rvol $\rightarrow$ rval
α_0	0.006	0.015	-0.015	0.015	-0.940	-0.550
	(0.006)	(0.008)***	(0.012)	(0.008)***	(2.082)	(3.127)
α_1	0.000	-0.136	-0.015	-0.140	-0.344	-0.389
	(0.049)	(0.059)**	(0.052)	(0.055)**	(0.049)*	(0.049)*
β_0	0.001	0.005	0.004	0.005	-2.613	5.251
	(0.001)***	(0.001)*	(0.003)	(0.001)*	(13.403)	(51.773)
β_1	-0.018	0.014	0.009	0.022	-0.051	0.019
	(0.049)	(0.039)	(0.050)	(0.043)	(0.013)*	(0.025)
β_2	0.361	0.141	0.363	0.116	0.977	0.907
	(0.080)*	(0.060)**	(0.083)*	(0.054)**	(0.020)*	(0.034)*
ϕ	0.463	1.108	1.759	0.313	0.039	0.182
	(0.098)*	(0.207)*	(0.373)*	(0.054)*	(0.008)*	(0.077)**
$LM(1)$	0.339	0.405	0.115	0.970	2.424	1.354

5. Conclusion

The study finds over the period of time contracts, open interest, settlement price, value and weighted average prices mean is positive and volume and weighted average yield are negative.-We observe high degree of positive correlation between daily settlement price in futures market and the daily weighted average price in cash market and a high degree of negative correlation between daily settlement price in futures market and daily weighted average yield in the cash market. From regression result, we find impact from open interest, settlement price and weighted average yield to weighted average price is negative and significant and weighted average yield impacts more on the weighted average price. We find only open interest and weighted average price negatively impacts weighted average yield and are significant. Further significant positive impact exists from weighted average price to settlement price. Bidirectional causality exists between volume and contracts traded, open interest and weighted average yield & volume and value; unidirectional causality exists from open interest to weighted average price as proved from Granger causality test. We find absence of volatility persistence among the variables. Volatility clustering and volatility spill-over's exists from cash markets to futures markets and from futures markets to cash markets. Significant spill-over impact exists from weighted average price to settlement price and from settlement price to weighted average yield. Thus, cash market price is leading the futures market but the future settlement price has impact on the yield of the underlying security.

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