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Is there Relationship between MIFOR and US-Interest Rate Swap Markets!

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ABSTRACT

An investigation into causal relationship between MIFOR and US Indian interest rate swap in post liberalization period have a royal importance in predicting or understanding the price movements in a financially globalized world. Here this paper empirically examined the basic objective of this study availing well established econometrics models. Johansen's co-Integration test, and Granger's Causality test is employed to measure long run and short run relationships respectively for the period of October 2002 to June 2016. This paper brought forward evidence for long run relationship in one and fifth year contracts and a trend of decreasing, "cause effect relationship" with increase in duration of contracts.

Key Words: *Interest Rate Swaps, Johanson's Co integration Test, Granger Causality, MIFOR, US-IRS.*

1. Introduction:

Global markets tend to be progressively incorporated. Such advances have been quickened by the innovation and globalisation in financial markets which are fully liberalized. Which gives us feeling that a jolt in one financial markets will be immediately reflected to other financial markets. An event in one market may or sometimes may not reflect in another market. If reflected the effect might be either for a shot period or for a long period over the time in different financial markets. The blend of such effects either long term or short term on one's financial market to another has often been discussed and tested using different methodologies by several researchers in different fields like in commodity markets; Ardeni, (1989) on various commodity prices among the countries like Australia, Canada, UK and USA; Karbuz & Jumah, (1995) on relationship between spot and futures between

New York CSCE and London Fox, with empirical evidence showing how the prices of such commodities move together over a period of time. Silvapulle & Moosa, (1999) on causal relationship between spot and futures prices of crude oil showing bidirectional effect; Ho Eom, Subrahmanyam, & Uno, (2002) on correlation between eleven future and spot prices with empirical results showing long-term symmetric relationships with significant two way flow of information between spot and futures markets, with futures being dominant.

Apart from commodities market several researchers like (Caporale, Pittis, & Spagnolo, 2006; Hamao, Masulis, & Ng, 1990; Karunanayake, Valadkhani, & O'BRIEN, 2010; Ke, Wang, & Murray, 2010; Koutmos & Booth, 1995; Savva, Osborn, & Gill, 2009; Shamiri & Isa, 2010; Singh, Kumar, & Pandey, 2010; Sinha & Sinha, 2010; Tanizaki & Hamori, 2009; Theodossiou & Lee, 1993; Weber, 2010) also focused on shocks of one equity market to other international equity markets.

The global Swaps market also witnesses few study on inter linkages among two or more countries like, (Ho Eom et al., 2002), and (In, Brown, & Fang, 2003). (In, Fang, & Brown, 2004) (Bhargava, Malhotra, Russel, & Singh, 2012), (Chatterjee, 2005). (Azad, Fang, & Hung, 2012) (Toyoshima & Hamori, 2012), (Ito, 2010). Few of the researchers have also considered interlinkage and volatility transmission between the markets like(Bhargava et al., 2012), (Azad, Batten, Fang, & Wickramanayake, 2015), (Renò* & Uboldi, 2005), (Pinho & Madaleno, 2013), (Lee et al., 2016). Using various approach like VAR, GARCH, TARCH, EGARCH, impulse response, variance decomposition, Granger-causality tests, co- integration and error correction like (Chortareas & Driver, 2001), (Edison & Pauls, 1993), (MacDonald & Nagayasu, 2000), (Coughlin & Koedijk, 1990), (Blundell-Wignall, Browne, & others, 1991) to see if there is any linkage within the markets and between the markets of different countries.

Global swaps market is become increasingly important and is witnessing a steady growth though the reason for its growth and importance is diversely explained by the researchers some point it as a result of comparative advantage, some mispricing of credit risk, while other regard it as hedging tool (Arak, Estrella, Goodman, & Silver, 1988; Bicksler & Chen, 1986; Litzenberger, 1992; Smith Jr, Smithson, & Wakeman, 1988; Wall & Pringle, 1989). Swap market in India is also witnessing an increasing trend, it has grown tremendously. The Indian swaps market at present uses four benchmark viz. (MIBOR) Mumbai Inter Bank Offer Rate, (MIFOR), MITOR, GOI, with different maturities, ranging from one to five years. Presence of increasing international relationship between the countries and its financial markets makes us to think that how much is it correlated with different countries so that better economic policies and investment strategy can be formulated (In, Brown, & Fang, 2003). But literature search reveals there are only few studies which have considered interlinkages among the countries with relate to interest rate swaps like (Azad, Fang, & Hung, 2012; Bhargava et al., 2012; Chatterjee, 2005; In et al., 2003; In, Fang, & Brown, 2004; Toyoshima & Hamori, 2012).

The present study tries to focus on Relationship between US and Indian Interest Rates Swap Markets. We have considered US because it is the most advance country and has highest outstanding numbers of interest rate swaps. It will help us to know if interest rate swaps of emerging countries like India has any causal relationship with the advance country like US; contributing and extending the present literature in interlinkages in the context of US and India's interest rate swaps. The finding of the study is expected to throw a light on relationship between US and India's interest rate swaps. It will also

help the policy makers and investors to frame sound policy in line with advance countries like US and better investment strategy to those international portfolio holders.

Remaining of the paper is organised in several sections like section 2 consists of Data and Methodology, section 3 Analysis and interpretations followed by conclusion.

2. Data and Methodology:

The daily data of Mumbai Interbank Forward Offer Rate (MIFOR) & US-IRS is taken for this study. The study period is from October 2002 to June 2016, which consist of 1 year, 2 years, 3 years and 5 year MIFOR and US Interest Rate Swap; a total of 3339 observations. The raw data has been collected from Bloomberg database. The raw data were converted into continuously compounded rates as shown in Table No.1, below depicting the summary statistics for the (1, 2, 3, &5) year MIFOR and (1, 2, 3&5) year US – Interest rate swap. The data is analysed using Eviews software by various test such as unit root, Co-integration, causality tests were performed

First we considered running Unit Root Test to see whether out data series is stationary or not by applying a standard unit root test known as 'Augmented Dickey-Fuller' (ADF) and 'Phillips-Perron Test' to test if MIFOR & US-IRS are stationary or not. The null hypothesis for ADF test is that a unit root exists. The ADF and PP test are given below:

$$\Delta y_t = \alpha + \beta t + \gamma y_{t-1} + \delta_1 \Delta y_{t-1} + \cdots + \delta_{p-1} \Delta y_{t-p+1} + \varepsilon_t$$

Where,

△ = difference, t = time trend variable, α = constant, β = time coefficient, p = lag order and ε_t = white noise.

Regression for the Philips Perron Test:

$$\Delta y_t = p y_{t-1} + u_t$$

Next we use Johansen Co-Integration Test to know whether selected variables of non-stationary series are co-integrated or not and see if long run equilibrium exist between such group or is there any divergence in the short run from equilibrium. In short the equilibrium relationship between MIFOR and US-IRS value, which may be captured by co-integration vectors based on the error correction components, that indicates the proportion of disequilibrium from one period that is corrected in a latter period and the relative magnitude of adjustments in each market toward equilibrium, using VAR which can be written as follows:

$$y_1 = \mu + A_1 y_{t-1} + \cdots + A_p y_{t-p} + \varepsilon_t$$

$y_t = nx1$ *vectors of variable integrated at* $I(1)$ *and*

$\varepsilon_t = nx1$ *vector of innovations*

In order to test the number of co-integration vectors, to test viz. the maximal eigenvalue test and the trace test is used. Which is calculated as follows

$$\boldsymbol{\lambda_{max} = -T\, in\left(1-\hat{\lambda}_{r-1}\right)}$$

$$\boldsymbol{\lambda_{trace} = -T \sum_{i=r=1}^{k} in\,(1-\hat{\lambda}_1)}$$

Where, T = number of observation, λ_i = i^{th} largest canonical correlation

Than finally Granger, (1969) test is used to analyse the direction of causal relations between MIFOR and USD interest rate swaps. It helps us to tell about the number of times the past value of other variables describes the current value of one variable and whether adding lagged values of prior variable can improve the explanation or not. In order to test the H_0 = x does not cause y; Say if y and x are stationery, lagged vales of y is included in auto regression of y:

$$\boldsymbol{y_t = a_0 + a_1 y_{t-1} + a_2 y_{t-2} + \cdots + a_m y_{t-m} + error_t}$$

And again auto regression is improved by adding lagged values of x:

$$\boldsymbol{y_t = a_0 + a_1 y_{t-1} + a_2 y_{t-2} + \cdots + a_m y_{t-m} + b_p x_{t-p} + \cdots + b_q x_{t-q} + error_t}$$

Where p is the number of lags used for the variable. The significance level of hypothesis of causality test is based on an F-statistics given below:

$$\frac{(SSE_0 - SSE_1)/p}{SSE_1/(T-2p-1)}$$

Where SSE_0 & SEE_1 = sum of squares of residuals, p = No. of Lags and T = No. of observation. It is essential for us to understand that "X Granger causes Y" means; Y is not the effect caused by X because Granger causality is not a true causality.

3. Analysis and interpretations:

First let us plot the raw data to see the movements in interest rate swap prices between MIFOR and US. As the picture can tell a lot, we can notice that movement in both the markets are not identical specially after the crisis period. The US market showed declined in trend whereas MIFOR market showed a stochastic. So it will be interesting for us to know if there is any relationship between the markets.

Graph 1. MIFOR and US- Interest Rate Swap form 2000 to 2016 in values

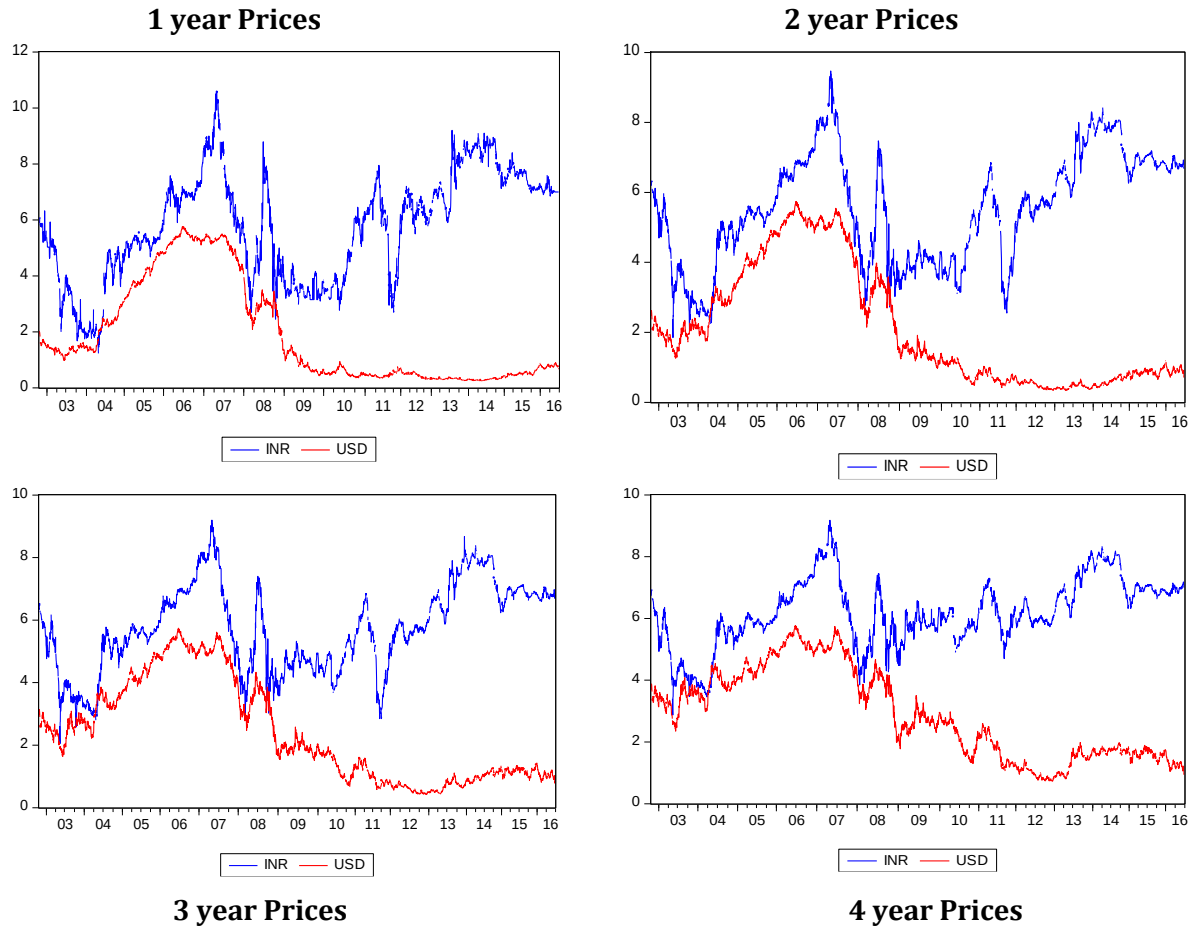

Table No. 1: Descriptive statistics of MIFOR and US interest rate swap

	1 year contract		2 years contract		3 years contract		5 years contract	
	MIFOR	**US**	**MIFOR**	**US**	**MIFOR**	**US**	**MIFOR**	**US**
Number of Observation = 3339								
Mean	5.76	1.88	5.54	2.10	5.73	2.38	6.19	2.88
Median	5.98	0.96	5.58	1.40	5.68	1.88	6.09	2.65
Maximum	10.60	5.76	9.47	5.74	9.20	5.74	9.18	5.77
Minimum	1.23	0.25	1.85	0.33	2.05	0.42	2.87	0.73
Std. Dev.	1.92	1.80	1.57	1.67	1.39	1.59	1.10	1.44
Skewness	-0.16	0.93	-0.07	0.77	-0.02	0.57	-0.16	0.28
Kurtosis	2.17	2.34	2.11	2.14	2.23	1.95	2.88	1.76

Sources: Calculated by authors'
*significant at 1% level

Table No. 1 shows the descriptive statistics of MIFOR and US-IRS market. If we look at the mean value, we can see that when compared to US interest rate swap market. The swap rate for MIFOR is higher for all the period considered under the study that is for maturity period of 1 year, 2 years, 3year and 5year respectively. The standard deviation shows higher in case of US interest rate swaps for 2 years, 3 years and 5years. The probability value of 'Jarque–Bera' test has been taken to check the goodness of fit that is whether data taken have the skewness and kurtosis matching a normal distribution or not. In this case we find that it is normally distributed at 1% significant level.

Next we test to check if the data taken for the study has a unit roots because unit root is the serious problem in case of time series data as it may lead to non-sense regression. In order to determine the unit roots it is whether it is stationary or not, unit root testing is applied.

Table No. 2: unit root test result for MIFOR

	ADF				PP			
	level		I(1)		At level		I(1)	
	t-stat	p-value	t-stat	p-value	t-stat	p-value	t-stat	p-value
1 year	-2.087	0.250	-37.033	0.000	-2.203	0.205	-64.392	0.000
2 year	-1.956	0.307	-62.365	0.000	-2.018	0.279	-62.235	0.000
3 year	-2.341	0.159	-60.615	0.000	-2.248	0.189	-60.634	0.000
5 year	-2.584	0.096	-58.119	0.000	-2.504	0.115	-58.148	0.000

Sources: Calculated by authors'
**1% & *5% level significant

Table No. 3: unit root test result for US-IRS

	ADF				PP			
	level		I(1)		At level		I(1)	
	t-stat	p-value	t-stat	p-value	t-stat	p-value	t-stat	p-value
1 year	-0.483	0.892	-52.631	0.000	-0.570	0.875	-53.212	0.000
2 year	-0.739	0.835	-43.109	0.000	-0.678	0.850	-58.000	0.000
3 year	-0.895	0.791	-43.527	0.000	-0.807	0.816	-59.112	0.000
5 year	-0.940	0.776	-44.264	0.000	-0.961	0.769	-59.579	0.000

Sources: Calculated by authors'
significant level at 1%

The (ADF) and (PP) are used to check the Unit Root for MIFOR and US-IRS as given above in Table No. 2 and 3. The test results from both the test reveals that both variables that is MIFOR and US-IRS is having a unit root problem because the test statistics is not significant for different period considered under this study viz. 1year, 2 years, 3 years, and 5years. As unit root is must to proceed further we tried using first difference. The result of 1st difference shows that data is stationery stationary as the test statistics is statistically significant. Therefore, we can say that MIFOR and US-IRS are stationary at order one or I(1).

Next we go for co-integration test or see if there is any association between the variables in the long run.

Table No. 4: Co-integration result between MIFOR & US-IRS

	Hypothesis	Trace Statistic		Max-Eigen Statistic		Integration
		$\lambda trace$	P-Value	λmax	P-Value	
1 year	H_0: r = 0	4.395134	0.0692***	4.215000	0.0360**	Co-integrated
	H_0: r ≤ 1	0.180134	0.6713	0.180134	0.6713	
2 year	H_0: r = 0	4.388664	0.8698	4.077704	0.8511	Not Co- Integrated
	H_0: r ≤ 1	0.310959	0.5771	0.310959	0.5771	
3 year	H_0: r = 0	5.604066	0.7417	5.138093	0.7243	Not Co- Integrated
	H_0: r ≤ 1	0.465973	0.4948	0.465973	0.4948	
5 year	H_0: r = 0	6.790415	0.0621***	6.331487	0.0711***	Co-integrated
	H_0: r ≤ 1	0.458928	0.4981	0.458928	0.4981	

Sources: Calculated by authors'
showing *1%, **5% and ***10% at level significant

The Table No. 4, presents results of Johansen co-integration test. The MIFOR and US-IRS market shows no co-integration in the second and third year which is identified with the help of Trace statistics and Max-Eigen statistics p-value. While in the first year and fifth year the US and Indian interest swap market shows Co-integration if we look at the significance level. Thus it can be concluded that there is a long term relationship between MIFOR and US-IRS only for first and fifth year, but not in case of second and third year as it is not found to be significant.
Next we move on for granger causality to see if direction of relationship between the two variables.

Table No. 5: Granger Causality Test result between MIFOR & US-IRS

Year	Null Hypothesis	F-Statistic	Direction	Relationship
1	US-IRS 'does not Granger Cause' MIFOR	35.1063***	Bi-directional	US↔MIFOR
	MIFOR 'does not Granger Cause' US-IRS	2.61343**		
2	US-IRS 'does not Granger Cause' MIFOR	42.9591***	Uni-directional	US→MIFOR
	MIFOR 'does not Granger Cause' US-IRS	0.46542#		
3	US-IRS 'does not Granger Cause' MIFOR	41.0007***	Uni-directional	US→MIFOR
	MIFOR 'does not Granger Cause' US-IRS	0.50108		
5	US-IRS 'does not Granger Cause' MIFOR	50.8889***	Uni-directional	US→MIFOR
	MIFOR 'does not Granger Cause' US-IRS	0.62342#		

Sources: Calculated by authors'
at level significant level at ***1%, **5% and #not significant

The Granger causality tests as shown in table No. 5, above gives the direction of relationship among the series. The test results reveals that one-year Interest rate swap for MIFOR and US is having bi-directional relationship (i.e. USD↔MIFOR). Whereas two, three and five years Interest rate swap for MIFOR and US shows uni-directional relationship i.e. (US→MIFOR). Therefore, US Interest rate

swap instability has an influence on MIFOR but, MIFOR inflow does not cause US interest rate swap except in case of 1year maturity period.

Conclusion:

This study concentrated on relationship between MIFOR and US interest rate swap in post liberalization period, using Econometric tools like Johansson's co-integration test and Granger's Causality. Unit root test were done using 'Augmented Dickey-Fuller' (ADF test) and 'Phillips-Perron' (PP test). The findings show the presence of long run relationship in case of 1 year and 5th year, but not in case of 2nd year and 3rd year. Further the Granger Causality test reveals that only the 1 year shows bi directional relationship whereas rest of all were unidirectional. We can conclude that only one-year maturity contract has influence on each other while in other case only the US-IRS market has influence on the MIFOR. So indirectly hinting the international investors to refer to US-IRS market in case of investment decision for more than one-year maturity period.

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