Testing precedence relationship between Stock markets and Interest rates: Evidence from India

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Abstract

This paper investigates the relationship between interest rates and stock market performance by using weekly time series data from 2003 to 2015. We use Johansen cointegration test to check the long-term relationship between interest rates of different duration (short-term to long-term) and different equity indices (narrow-based and broad-based) of Indian stock market. We find no evidence of long-term relationship between the two variables. We also use the Granger causality test to check the precedence of one variable over the other. Contrary to our assumption and popular belief, we find that stock market performance has precedence over interest rates, i.e. equity indices Granger cause interest rates.

Keywords: Indian stock market, Interest rate, Johansen cointegration, Granger causality, Long-term relationship

Introduction

The decision of policy makers and investors depend on the interactions between macroeconomic variables and financial strength indicators. Interest rates are considered a key economic variable as the growth of the economy depends on the rate at which businesses can borrow money. The level of stock market is generally considered barometer for the financial strength and growth of the economy. Movements in interest rates impact the future cash flows of firm along with changes in the discount rates used to arrive at the present value of the cash flows.

Any relationship other than a coincidental one, will have implications on the efficiency of stock and bond market, as it would make either of the two variables predictive. In this study we test the long-term relationship between interest rates and stock markets, along with an examination of the precedence among the two variables. Section two briefly discusses the literature that examines the relationship between these two variables. Section three describes the data and methodology used to test the relationship. Section four discussed the results and finally section five concludes.

Literature Review

Literature related to relationship between stock markets and macroeconomic variables is in abundance. However, there is no consensus regarding the results. Stone (1974) develops a two-index model with one index consisting of the equity market risk and the other index included for debt market risk. The author explains that individual stock returns exhibit varying degrees of sensitivity to changes in interest rate, therefore an index that captures the debt market risk is necessary. Chan, Norrbin and Lai (1997) study the cointegration between stock and bond prices to find no evidence of long-term relationship

between the two. Rahman and Mustafa (1997) investigate the long-run relationship and Granger causality between US stock market and short-term US corporate bond market. They find long-run relationship between the two, with the precedence of short-term US bond market over US stock market. Kim (2003) applies Johansen cointegration test on monthly data of US interest rate and US stock market to find that stock prices are negatively related to interest rates. The author also performs variance decomposition which indicates that innovations in interest rate considerably drive stock prices. Ryan and Worthington (2004) test the sensitivity of Australian bank stock returns to market risk, interest rate risk and foreign exchange rate risk to find that short-term and medium-term interest rates are an important determinant of bank stock returns, whereas they do not find long-term interest rates to have a significant impact on stock returns. Ahmed and Osman (2007) investigate the relationship between various macroeconomic variables and stock markets to find some evidence of influence of interest rates on stock market return. They also find evidence of precedence of interest rates over stock markets, thereby implying informational inefficiency in Bangladesh stock market.

Data and Methodology

The data set consists of weekly data for four different equity indices of Bombay Stock Exchange (BSE) and interest rates for different durations from April 2003 to May 2015, collected through Bloomberg terminal. We had four different stock indices, namely SENSEX (Index1), BSE100 (Index2), BSE200 (Index3) and BSE500 (Index4) Index that represent a move from narrow-based to broad-based stock index. The four different interest rates for different durations were Government of India's generic treasury bill/ bond rates for durations of 3 months (Interest1), 6 months (Interest2), 1 year (Interest3) and 10 years (Interest4). Initially, we converted the weekly data into weekly log returns as follows,

$$\textit{Return } R_t \textit{ at time t is given by } R_t = lnP_t - lnP_{t-1}$$

where P_t is the closing price for day t.

Then we performed the preliminary analysis of the descriptive statistics of the return series by analyzing the first four moments (mean, standard deviation, skewness and kurtosis). Independent Identical Distributional (IID) properties of the all the series was tested. Normality was tested by using Jarque-Bera test. The Ljung Box test was used to check the independence of the series.

Augmented Dickey Fuller (ADF) Test was used to test the stationarity of the series, after which, the Schwarz Information Criteria (SIC) was used to estimate the appropriate lag length for the autoregressive process. The lag length which minimized the SIC was selected, which came out to be one. This lag length was used for carrying out Johansen's cointegration test. The Johansen's Cointegration test was applied to combinations of interest rates of different durations and different stock indices to test the presence of any long-run equilibrium relationships between combinations of the two variables. In the context of interest rate and indices, the equation for Johansen cointegration test can be written as follows:

$$Y_t = \alpha 1 + \beta 1\, X_t + \epsilon 1_t \text{ ----------} \quad (1)$$

or

$$X_t = \alpha 2 + Y2\ Ft + \epsilon 2_t, \text{ ----------} \quad (2)$$

where Yt is the interest rates of different durations and Xt are the different equity indices at time t.

The above equation can be rewritten in terms of residuals as follows:

$$Y_t - \alpha 1 - \beta 1 Xt = \hat{e}1_t \ldots\ldots\ldots\ldots \quad (3)$$

or

$$X_t - \alpha\ 2 - \beta 2\ Yt = \hat{e}2_t, \ldots\ldots\ldots\ldots \quad (4)$$

where $\hat{e}_t$ represents the white noise residual term. If either of the residual terms, $\hat{e}1_t$ or $\hat{e}2_t$, is stationary, then it means that one of them is I(0) and there exists at least one cointegrating vector that that leads to a long run relationship between Y_t and X_t. Finally the direction of precedence was confirmed through Granger's causality test on each of the combinations discussed above.

Results

Key statistics from the tests that were performed during analysis are represented in the following tables.

Table 1: Descriptive Statistics of Return series of different indices and interest rates

	INDEX1	INDEX2	INDEX3	INDEX4	INTEREST1	INTEREST2	INTEREST3	INTEREST4
Mean	38.79169	12.01652	4.951749	15.51758	0.004785	0.004656	0.004630	0.003677
Median	69.94000	22.02000	9.790000	32.26000	0.005500	0.004900	0.003800	0.000000
Maximum	1713.730	592.9500	246.7400	790.9900	2.347500	1.768000	1.132800	0.898000
Minimum	-1998.470	-638.4700	-261.7900	-836.3500	-1.373100	-1.202800	-0.879200	-0.644000
Std. Dev.	454.0013	141.7689	57.49192	181.2309	0.227823	0.205689	0.165531	0.146098
Skewness	-0.281341	-0.288665	-0.320695	-0.360181	1.997125	0.882807	0.526590	0.276878
Kurtosis	4.668929	4.927546	4.992744	5.165916	33.35684	19.90439	15.46558	9.935467
Jarque-Bera	81.29656	106.1108	114.8557	136.5484	24570.09	7570.951	4101.599	1260.608
Probability	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
Sum	24399.97	7558.390	3114.650	9760.560	3.009800	2.928700	2.912300	2.298000
Sum Sq. Dev.	1.29E+08	12621811	2075741.	20626431	32.59529	26.56948	17.20751	13.31904
Observations	629	629	629	629	629	629	629	625

The above descriptive statistics provide evidence of skewness and kurtosis, along with the rejection of null hypothesis of normality for Jarque-Bera test.

Table 2 a: Test of Stationarity for Indices

	At Level		At First Difference	
	t-statistic	p-value	t-statistic	p-value
Index1	-0.8104	0.8151	-24.649	0
Index2	-0.7939	0.8197	-24	0
Index3	-0.7265	0.8377	-15.464	0
Index4	-0.782	0.823	-15.255	0

Table 2 b: Test if Stationarity for Interest rates

	At Level		At First Difference	
	t-statistic	p-value	t-statistic	p-value
Interest1	-2.0684	0.2578	-14.871	0
Interest2	-1.9391	0.3143	-14.896	0
Interest3	-1.8687	0.3472	-14.383	0
Interest4	-2.1755	0.2156	-26.867	0

The ADF test shows presence of unit root at level for all of the eight data series under consideration. These data series are integrated to the order one, indicating that they exhibit stationarity at first difference.

We modeled the different combinations of the two variables to estimate the appropriate lag length to be used in Johansen's test. SIC criteria as used to pick the lag length of one.

Table 3 a: Results of Johansen's Cointegration Test for Index1

	Trace Statistic		Maximum Eigen value		Lag length#	
	r=0	r=1	r=0	r=1	r=0	r=1
Interest1_Index1	10.53198	0.864051	9.667928	0.864051	1	1
	0.242	0.3526	0.2347	0.3526		
Interest2_Index1	10.08751	0.859133	9.228377	0.859133	1	1
	0.274	0.354	0.2676	0.354		
Interest3_Index1	10.52549	0.897307	9.628185	0.897307	1	1
	0.2424	0.3435	0.2375	0.3435		
Interest4_Index1	8.063181	0.391877	7.671303	0.391877	1	1
	0.4587	0.5313	0.4131	0.5313		

Table 3 b: Results of Johansen's Cointegration Test for Index2

	Trace Statistic		Maximum Eigen value		Lag length#	
	r=0	r=1	r=0	r=1	r=0	r=1
Interest1_Index2	10.60368	0.882843	9.720836	0.882843	1	1
	0.2371	0.3474	0.2309	0.3474		
Interest2_Index2	10.20157	0.880577	9.320989	0.880577	1	1
	0.2656	0.348	0.2604	0.348		
Interest3_Index2	10.65071	0.925407	9.725299	0.925407	1	1
	0.2339	0.3361	0.2306	0.3361		
Interest4_Index2	7.955779	0.272398	7.683381	0.272398	1	1
	0.4701	0.6017	0.4118	0.6017		

Table 3 c: Results of Johansen's Cointegration Test for Index3

	Trace Statistic		Maximum Eigen value		Lag length#	
	r=0	r=1	r=0	r=1	r=0	r=1
Interest1_Index3	10.86786	0.824981	10.04288	0.824981	1	1
	0.2197	0.3637	0.2091	0.3637		
Interest2_Index3	10.49245	0.826222	9.66623	0.826222	1	1
	0.2447	0.3634	0.2348	0.3634		
Interest3_Index3	11.00442	0.876251	10.12817	0.876251	1	1
	0.2112	0.3492	0.2037	0.3492		
Interest4_Index3	7.85386	0.180706	7.673154	0.180706	1	1
	0.4812	0.6708	0.4129	0.6708		

Table 3 d: Results of Johansen's Cointegration Test for Index4

	Trace Statistic		Maximum Eigen value		Lag length#	
	r=0	r=1	r=0	r=1	r=0	r=1
Interest1_Index4 Index	11.19248	0.964221	10.22826	0.964221	1	1
	0.2	0.3261	0.1974	0.3261		
Interest2_Index4 Index	10.81865	0.965311	9.853342	0.965311	1	1
	0.2229	0.3259	0.2217	0.3259		
Interest3_Index4 Index	11.35634	1.019346	10.33699	1.019346	1	1
	0.1905	0.3127	0.1907	0.3127		
Interest4_Index4 Index	8.025573	0.190665	7.834907	0.190665	1	1
	0.4627	0.6624	0.3957	0.6624		

Results of Johansen's cointegration test do not provide any evidence of long-run equilibrium relationship between the two variables even after considering all the combinations of the two variables.

Table 4 a: Results of Granger Causality Test for Index1

Interest(i)		Index1 does not granger cause Interest(i)	Interest(i) does not granger cause Index1	Lag length#
Interest1	F-Statistic	5.29427	0.77578	1
	p-value	(0.0217)*	0.3788	
Interest2	F-Statistic	5.5248	0.92195	1
	p-value	(0.0191)*	0.3373	
Interest3	F-Statistic	5.99854	1.42571	1
	p-value	(0.0146)*	0.2329	
Interest4	F-Statistic	3.97171	0.05395	1
	p-value	(0.0467)*	0.8164	

Table 4 b: Results of Granger Causality Test for Index2

Interest(i)		Index2 does not granger cause Interest(i)	Interest(i) does not granger cause Index2	Lag length#
Interest1	F-Statistic	5.30402	0.79461	1
	p-value	(0.0216)*	0.3731	
Interest2	F-Statistic	5.60217	0.95279	1
	p-value	(0.0182)*	0.3294	
Interest3	F-Statistic	6.1386	1.49243	1
	p-value	(0.0135)*	0.2223	
Interest4	F-Statistic	3.91705	0.01237	1
	p-value	(0.0482)*	0.9115	

Table 4 c: Results of Granger Causality Test for Index3

Interest(i)		Index3 does not granger cause Interest(i)	Interest(i) does not granger cause Index3	Lag length#
Interest1	F-Statistic	5.44937	0.98713	1
	p-value	(0.0199)*	0.3208	
Interest2	F-Statistic	5.78542	1.16757	1
	p-value	(0.0164)*	0.2803	
Interest3	F-Statistic	6.37406	1.7647	1
	p-value	(0.0118)*	0.1845	
Interest4	F-Statistic	3.82431	0.00045	1
	p-value	0.051	0.9831	

Table 4 d: Results of Granger Causality Test for Index4

Interest(i)		Index4 does not granger cause Interest(i)	Interest(i) does not granger cause Index4	Lag length#
Interest1	F-Statistic	5.62171	1.08135	1
	p-value	(0.018)*	0.2988	
Interest2	F-Statistic	6.00887	1.26566	1
	p-value	(0.0145)*	0.261	
Interest3	F-Statistic	6.64821	1.87064	1
	p-value	(0.0102)*	0.1719	
Interest4	F-Statistic	3.9763	0.00214	1
	p-value	(0.0466)*	0.9631	

Even though no long-term relationship between the two variables was detected, we performed Granger's causality test to check the order of precedence of variables under consideration. Contrary to our expectations and popular belief, stock markets were found to have precedence over interest rates of different durations, thereby implying that stock market anticipate the interest rates much more efficiently and incorporate them much more quickly into the prevalent market prices.

Conclusion

Through the results of Johansen cointegration, we decipher that there is no long-term relationship between the two variables under consideration, whereas, results demonstrate that stock markets Granger-cause interest rates. This means that in terms of anticipating the interest rates, the stock markets are efficient. These results have implications for policy makers in the sense that they cannot infuse confidence into the markets by changes in interest rates as these changes are already being reflected in the prevalent stock prices. This undermines their ability to control the financial system. The stock market has now become such a well functioning body that is no longer just a proxy or barometer of financial strength of an economy in an indirect manner, but it is very true in its reflection of the financial progress of an economy,.

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