A STUDY OF INTERLINKAGES AMONG EXCHANGE RATE AND STOCK PRICE FOR INDIA

ABSTRACT

This paper is an attempt to examine the empirical relation between exchange rate and Indian stock price using the monthly time series data over the period 2011-2021. Johansen's cointegration test has been applied to test the long run relationship between exchange rate and stock price. Both the trace and Maximum Eigenvalue test statistic are less than the 0.05 critical values. Thus, the null hypothesis of no cointegration is accepted and no long run stable equilibrium relation was found to exist between exchange rate and stock price. The analysis further reveals the prevalence of unidirectional causal relationship from stock price to exchange rate by employing the Granger causality test. Thus, the study is found to support the Stock oriented model. So, regulators can predict the trends in exchange rate from the past values of stock prices which can induce profitable trading in the currency market. This study would be of immense importance for various stakeholders like investors, practitioners and policy makers to reduce the information symmetry owing to the volatile nature of the two variables.

Keywords: *Exchange Rate, Stock Price, Karl's Pearson Correlation Test, Johansen's cointegration test, Granger causality test*

1. INTRODUCTION

Exchange rate is defined as the value of one currency in terms of another thereby connecting the nation's price level with global prices. Commonly known as the traditional approach through which exchange rate operates, wherein depreciation of exchange rate brings about increasing export competitiveness and boosts the exports thus building up the Aggregate Demand and Gross Domestic Product of the economy. In India, long term correlation between inflation rate, interest rate, export, import, money supply, exchange rate and GDP are found along with short run relationship among the macroeconomic variables during 1990-2017 [1]. Stock market on the other hand, acts an impetus for

economic growth and development of a nation as it leads to mobilization of domestic savings, assist the businesses and corporate houses to acquire funds, thus ensuring liquidity in the market and efficient allocation of financial resources [2]. Market capitalization and Turnover ratio are two prominent indicators to gauge the development of the stock market which leads to increased economic activity in India [3]. According to RBI, it has been observed that post the 1990s economic reforms and gradual capital account liberalization post 1992 led to shift in composition from trade flows to capital flows. For instance, FPIs, FIIs and sovereign wealth funds flow substantially increased in India and further as a part of Financial sector reforms 1992, the restrictions on FIIs were relaxed in all securities available for trading on both the primary and secondary market. There is highly significant relation between FII and the Indian stock market and the exchange rate [4].

Exchange rate and stock market are key components of economy that impact other macroeconomic factors like rate of interest, inflation rate, money supply etc. that influence the growth and can even act as a channel of instability in the transmission mechanism of the economy. Owing to the significance of the two variables, they have been the centre of research and the empirical debate relating to the interlinkages between the exchange rate and stock market started post 1970-1980s when most countries around that time adopted flexible exchange rate regime and started opening their capital account.

Fig 1: Factors affecting exchange rate and its impacts

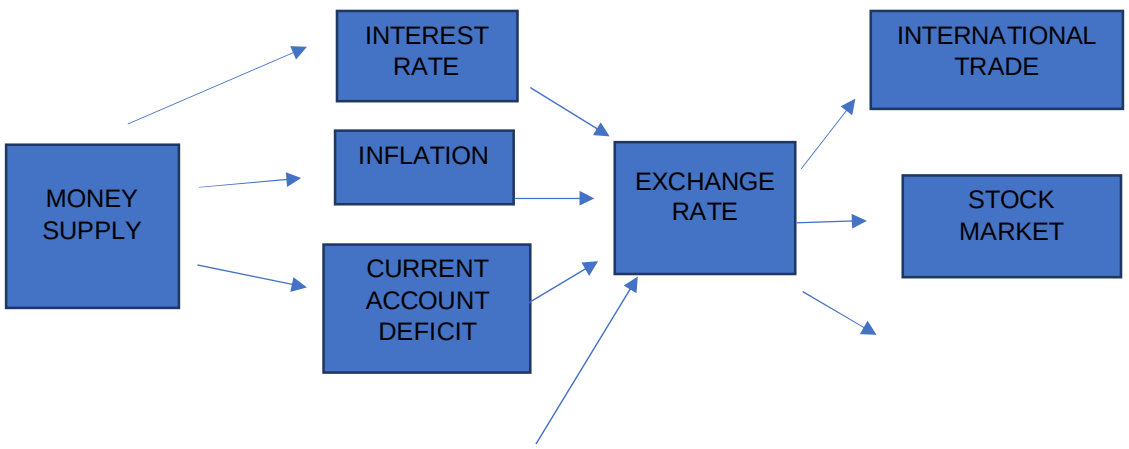
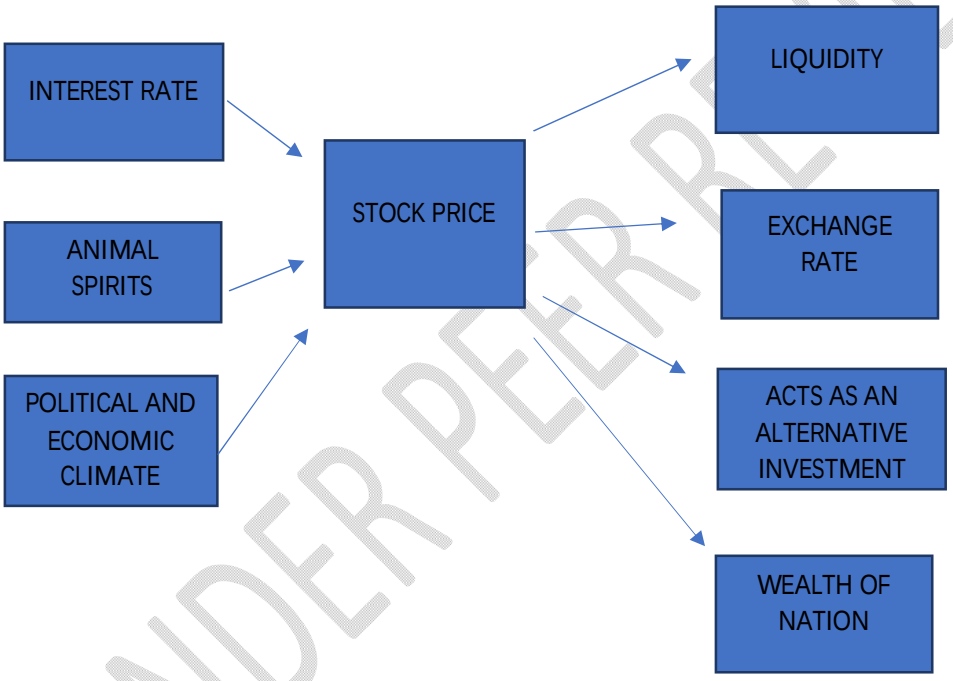


Fig 2: ***Factors affecting stock price and its impacts***



There are two main theories that explain the theoretical relationship between Exchange Rate and Stock price. On one hand, we have the traditional approach also called the Flow Oriented Model given by (Dornbusch and Fischer, 1980) [5] which focused on current account to explain that as exchange rate changes it affects the firms expected cash flows and thus its revenues and profit margin, further leading to a change in its stock price. Pan et al. (2007) [6] for Hongkong, Japan, Malaysia and Thailand while Smyth and Nandha (2003) [7] for India and Pakistan found support for the Flow oriented theory. On the other hand, Stock Oriented Model or Portfolio Balance Model discussed

by Branson et al. (1977) [8] who acknowledged the role of capital account transactions to explain how change in stock price change affects exchange rate. As stock prices rise, the demand for domestic currency increases due to capital inflows thus appreciating the exchange rate. Also, stock prices increase implies a rise in the wealth accompanied by increasing demand for money as well which leads to increase in the domestic interest rate vis-à-vis its foreign counterparts leading to capital inflow and thus appreciating exchange rate again. Further, studies like Ajayi et al. (1998) [9] for USA, Korea and Malaysia and Huy (2016) [10] for Vietnam advocated the Stock Oriented theory.

The following are the literature reviews that empirically test the theoretical relationship between the exchange rate and stock price nexus. The study by Frank and Young (1972) [11] was one of the earliest researches which found no association between the two variables. Nieh and Lee (2001) [12] empirically searched the relation between exchange rate and stock prices in G-7 countries using daily data over the period 1993-1996 by employing the standard Johansen's and Engle Granger cointegration techniques to find that no co-movement exists in the long run. The time series estimation supports the findings of Bahmani-Oskooee and Sohrabian (1992) [13] for USA using S&P index and effective dollar exchange rate. Further, Kutty (2010) [14] found same result for Mexico using weekly closing index of Mexico's stock market and Mexican Peso.

The study by Richards et al. (2009) [15] on daily Australian data of closing prices of stock index and exchange rate over the period 2003-2006 was an enriching one as the researchers applied OLS regression along with checking for the presence of ARCH effect to find that variability in level data series depends on its past values. Besides, the study finds existence of cointegrating equations and unidirectional causality that runs from stock price to exchange rate for the variables. Luqman and Kouser (2019) [16] examined the short run and long run association between exchange rate and stock price of 14 countries (G-8 countries and 5 emerging market economies along with Pakistan) to find the presence of long run and short run in all countries by employing the Johansen's cointegration test and VECM. The study further empirically confides with the Flow oriented model for Japan and Stock oriented model for Brazil, USA, India. Gokmenoglu et al. (2020) [17] employed Quantile-on-Quantile approach on monthly data over the

period 1994 to 2019 for ten most prominent emerging market economies of China, India, Brazil, Russia, Mexico, Indonesia, Turkey, Thailand, South Africa and Malaysia as samples and resulted that disturbance in the currency market can influence the equity market only when market is bearish.

The following are the studies in the Indian context that show the association between exchange rate and stock price. Mishra (2004) [18] made a slightly different study and tried to investigate the relationship between four macroeconomic variables for India; interest rate, demand for money, exchange rate return and stock return for the period April 1992-March 2002 and used the Granger causality test and VAR Technique in a four variable system where all the variables are considered to be endogenous. Growth rate of broad money, call money, return on stock price i.e. BSE Sensex, Rupees vis –a-vis Dollar is taken a proxy for demand for money, interest rate, stock return and exchange rate return respectively. As there are greater than two variables so granger causality would not be effectively able to capture causal relation that is why VAR Modelling is used. The study concludes that though unidirectional causality runs from exchange rate return to interest rate and demand for money but no causal relationship exists between exchange rate return and stock return.

Singh (2015) [19] took the period Jan 2007-March 2014 to examine the exchange rates-stock price relations for India. The empirical results use pair-wise granger causality test to give Bidirectional causality (Feedback effect) between stock price and exchange rate implying that both exchange rate and stock price are significant in affecting one another. Kotha and Sahu (2016) [20] studied the interconnection between various macroeconomic factors like exchange rate, WPI, money supply, interest rate and BSE Sensex returns considering 2001-2015 as the sample period to find that long run relation exist between the all the financial variables. In addition, bidirectional causality exists between exchange rate and Sensex. Similar causality result was also found by Bhuvaneshwari and Ramya (2017) [21] for the period 2006-2015, but concluded no long run association between Indian stock market and exchange. The study further employed the chow's test to find that no structural break existed due to the Global financial crisis of 200708.

Continuing the same line of research, studies from the emerging and developing South Asian economies are demonstrated. Employing the Asian flu data, Granger et al. (2000) [22] examined the causality over the period January 1986 to June 1998. The data for Indonesia and Japan suggested no causality and bidirectional causality was discovered for Hongkong, Singapore, Malaysia and Thailand. However, unidirectional causality from exchange rate to stock price for South Korea but for Philippines reverse causation from stock price to exchange rate was found. Muhammad and Rasheed (2002) [23] employed monthly stock price indices and spot exchange rates from the financial markets of Bangladesh, India, Pakistan and Srilanka from 1994-2000 to examine exchange rates-stock price relations using techniques like cointegration, error correction model and granger causality tests. According to results of the study, no long run and no way causal relation was found for India and Pakistan but significant relation exists for Bangladesh and Srilanka. However, all the four countries found consensus on no short run associations between the variables. Similar work was done by Rahman and Uddin (2009) [24] for three emerging South Asian markets of Bangladesh, India and Pakistan using monthly data for the period of 2003-2008 which traced no long run and causal relation between exchange rate and stock prices in the countries. Similar results were obtained by Kalaithan et al. (2017) [25] for Srilanka during the period 2005-2016.

Pan et al. (2007) [6] studied the causality issue between exchange rate and stock prices of seven East Asian countries over the period 1988-1998. The empirical results detected unidirectional causality from exchange rates to stock prices for Japan, Malaysia and Thailand and causality running from opposite direction for Korea and Singapore. However, existence of dual causality for Hongkong before the East Asian crisis of 1997. Bidirectional causality was also detected by Ayedmir and Demirhan (2009) [26] for Turkey between exchange rate and stock market taking financials, industrials, national100, services, technology indices as stock price indices for the period February 2001 to January 2008 using MWALD Test. Another study by Amin and Janor (2016) [27] used multivariate time series technique for examining the relationship between exchange rate, interest rate, stock price index of export and import based industry for Malaysia for the period of March 1994 to December 2013. The study finds unidirectional causality

from exchange rate to stock price, with exchange rate having more impact on import based industry rather than export based industry.

The importance of the study lies in the fact that though several studies have been done to investigate the dynamic relation between exchange rate and stock market but these studies have shown diverse and mixed results and have not arrived to any conclusion. Also, the centre of attraction of the immense literature has been on the currency and equity markets of developed countries. India is one of the emerging markets which has enormous importance for the global economy as it is on the path to achieve internalization of financial markets via full capital account convertibility. Thus, there is opportunity for investors worldwide to make use of the untapped potential offered by India. So, there is a need for more extensive study in the same direction as it of immense importance for various stakeholders like investors, practitioners and policy makers to reduce the information asymmetry due to highly volatile nature of the two variables.

2. METHODOLOGY

The study uses monthly time series data of the exchange rate and stock market price for the period of January 2011 to December 2021. Price of the Nifty 50 index is considered as a proxy for stock price as it is one of the robust indices of Indian stock market while USD-INR exchange rate is considered as an indicator of the exchange rate. The data for CNX Nifty price is downloaded from money control site and the data for USD-INR exchange rate is taken from FRED Economic Data. The study make use of 'EViews' for the analysis of data.

As we know that working with time series the variables should be stationary which implies that though the series could change over time but the statistical properties of the data generating process do not change over time. In this study we make use of Dickey and Fuller (1979) [28] Test for checking the stationarity and it requires the following equation to be estimated.

$$\Delta Y_t = \alpha_0 + \alpha 1\ t + \delta Y_{t-1} + \sum_{i=1}^{k} \beta t \Delta Y_{t-1} + \mu t$$

Where, α_0 is intercept, α_1 denotes the parameter of time trend while k is the lag order of the AR(k) autoregressive process. The null hypothesis of the above indicates the presence of unit root i.e. the timeseries is non-stationary.

Johansen's cointegration technique (Johansen and Juselius,1991) [29] is used to establish the long run relationship by identifying the number of cointegrating vectors. This method can be applied only when series are integrated of the same order. Since the cointegration test could be sensitive to the lag length, we choose an appropriate lag order using VAR lag order selection criterion before applying the Johansen's Test.

The test describes the Trace statistic and the Maximum Eigenvalue statistic to test the number of cointegrating vectors r.

$$\lambda_{trace(r)} = -T \sum_{i=r+1}^{n} \ln(1-\lambda_1)$$

$$\lambda_{\max(r,r+1)} = -T \ln(1-\lambda_{r+1})$$

If no cointegration relation exists between the two variables, implying no existence of long run equilibrium relationship, then we examine the causal relation between the two financial time series variables.

Granger Causality test is a statistical analysis quite relevant for time series variables and is applied to establish whether one time series helps in predicting the other series. Granger (1969) [30] defines causality between two stationary series in terms of predictability. If past values of Y_t help in forecasting X_t, then series Y_t is said to granger cause series X_t. The equation of the standard bivariate granger causality test is as follows:

$$Y_t = \alpha + \beta 1\, Y_{t-1} + \text{----------} + \beta n\, Y_{t-n} + \zeta 1\, X_{t-1} + \text{--------} + \zeta n\, X_{t-m} + \mu t$$

H_O: X_t DOES NOT granger cause Y_t

$$X_t = \theta + \Omega_1 X_{t-1} + \text{----------} + \Omega_p X_{t-p} + \prod_1 Y_{t-1} + \text{---------} + \prod_q Y_{t-q} + \eta_t$$

H_O: Y_t DOES NOT cause X_t.

3. RESULTS AND DISCUSSIONS

Table 1 shows the descriptive statistics (Measures of central tendancy, Measures of dispersion and Measures of Normality) for the two study variables. The average value of stock price and exchange rate over the period 2011-2021 is 9058.68 and 63.88 respectively. A high value of Standard Deviation for stock price reflects that the stock market is quite volatile i.e. there is high dispersion of stock price from the average stock price. Further, the Coefficient of Variation is calculated which is a relative measure of degree of variation in relation to means of the respective samples. C.V. for stock price comes out to be 34.77 % and 13.1% for exchange rate which implies that stock price is more volatile than exchange rate over the period 2011-2021. Skewness measures the degree of asymmetry in the data series. A positive value of skewness for stock price is indicative of long right tail and more higher values in contrast to a negatively skewed distribution for exchange rate. Besides that, Kurtosis value for stock price is greater than 3 (Leptokurtic) which shows a higher degree of peak for stock price while a negative kurtosis for exchange rate (Platykurtic) which indicates for a flatter curve for exchange rate. The Jarque-Bera probability values reveal that the data series of both the variables are not normally distributed.

Table 1: Descriptive Statistics

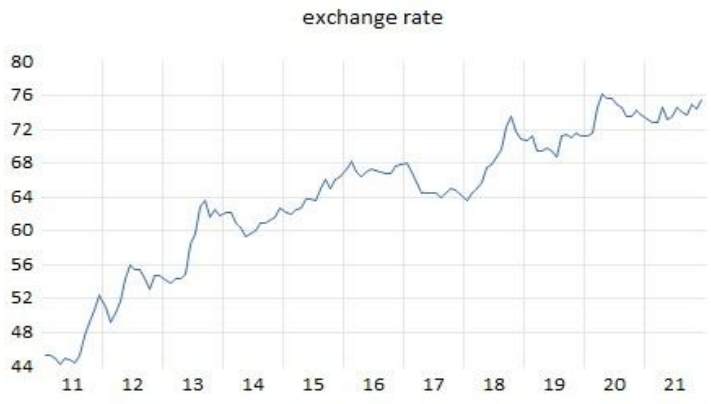
	STOCK PRICE	EXCHANGE RATE
Mean	9058.683	63.88440
Median	8574.775	65.03095
Standard Deviation	3150.121	8.403886
Coefficient of Variation (%)	34.77	13.1
Skewness	0.774662	-0.694825
Kurtosis	3.188681	2.704900
Jarque-Bera	13.39801	11.10016

Probability	0.001232	0.003887
Sum	1195746	8432.741
Sum Sq. Dev	1.30E+09	9251.915
Observations	132	132

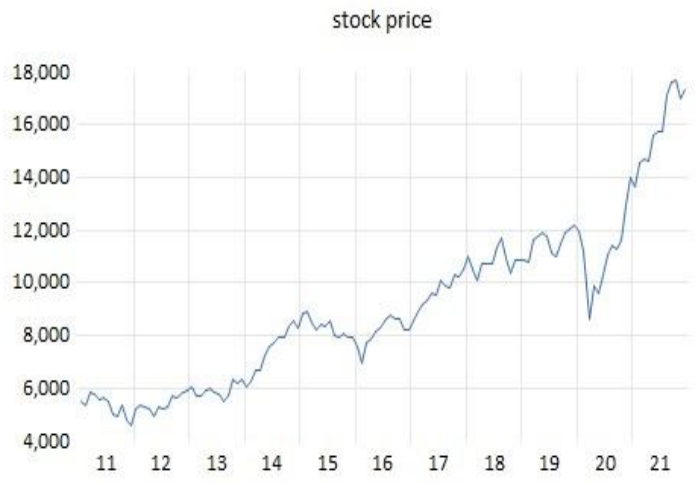
***Source**: Author's own estimation.*

The Karl Pearson correlation coefficient between exchange rate and stock price was found to be 0.81 which implies a significant and positive relation between the two study variables and calls for an extended analysis to examine the relationship between the two variables.

The graphical representation of the two variables over the period of 2011-2021 is presented below which shows the presence of an increasing time trend in the two financial time series which indicates the possibility of non- constant mean and thus non-stationarity at level.



***Source**: Author's plot using FRED Economic Data*



***Source**: Author's plot using Moneycontrol.com*

Augmented Dickey Fuller Test is applied to confirm the presence of unit root. The results are presented in Table 2.

Table 2: ADF Test Results

EXCHANGE RATE

(At Level) (At First Difference)

		t-Statistic	Prob.*			t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-1.800285	0.3791	Augmented Dickey-Fuller test statistic		-9.068539	0.0000
Test critical values:	1% level	-3.481217		Test critical values:	1% level	-3.481217	
	5% level	-2.883753			5% level	-2.883753	
	10% level	-2.578694			10% level	-2.578694	

STOCK PRICE

(At Level) (At First Difference)

		t-Statistic	Prob.*			t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		0.855864	0.9946	Augmented Dickey-Fuller test statistic		-11.35293	0.0000
Test critical values:	1% level	-3.480818		Test critical values:	1% level	-3.481217	
	5% level	-2.883579			5% level	-2.883753	
	10% level	-2.578601			10% level	-2.578694	

At all the significance level; 1%, 5%, 10% the null hypothesis of presence of unit root at level cannot be rejected for both the variables. Thus, both exchange rate and stock price are nonstationary at level. On contrary when converted to first difference, the null hypothesis is rejected for both variables (at all significance level) and they become integrated of order one i.e. the variable become stationary.

Before applying the cointegration test it is imperative to select the appropriate lag order using the Lag length criterion as Johansen's Test is sensitive to the lag length.

Table 3: Lag order selection criteria

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-1519.690	NA	1.56e+08	24.54339	24.58888	24.56187
1	-1105.454	808.4281	209179.1	17.92668	18.06315	17.98212
2	-1095.201	19.68025*	189122.5*	17.82582*	18.05326*	17.91821*
3	-1094.753	0.844413	200306.1	17.88312	18.20153	18.01247
4	-1091.700	5.662473	203444.9	17.89839	18.30779	18.06470
5	-1090.348	2.464827	212410.9	17.94110	18.44147	18.14436
6	-1088.722	2.910919	220837.2	17.97939	18.57074	18.21961
7	-1088.517	0.360976	234971.6	18.04059	18.72292	18.31777
8	-1085.044	5.993373	237237.5	18.04910	18.82240	18.36323

* 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

***Source**: Author's own estimation*

From table 3, we can make out that at lag 2, AIC is minimized. Thus, we choose lag length of 2 for estimating the Johansen's cointegration test. This method is applied to check for the long run relation and results of both the trace test statistic and Maximum Eigenvalue test statistic are summarized below in Table 4 and 5.

Table 4: Trace test statistic

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 critical value	Prob**
None	0.070928	10.11947	15.49471	0.2717
Atmost 1	0.004865	0.629126	3.841465	0.4277

Trace test indicates no cointegration at 0.05 level

**MacKinnon-Haug-Michelis(1999) p-values

***Source**: Author's own estimation*

Table 5: Maximum Eigenvalue Test statistic

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 critical value	Prob**
None	0.070928	9.490341	14.26460	0.2476
Atmost 1	0.004865	0.629126	3.841465	0.4277

Max-eigenvalue test indicates no cointegration at 0.05 level **MacKinnon-Haug-Michelis(1999) p-value.

***Source**: Author's own estimation*

From the above tables 4 and 5, it can be observed that the values of both the trace and Maximum Eigenvalue test statistic are less than the 0.05 critical values. Thus, we have to accept the null hypothesis of no cointegration and thus no long run stable equilibrium relation between exchange rate and stock price. Kalaithan et al. (2017) [25] for Srilanka and Tabak (2006) [31] for Brazil.

Since, no cointegration relationship has been established so we now check for the presence causal relation if there is any, using the Pairwise granger causality test and results are shown in table 6.

Table 6: Granger causality Test

Null Hypothesis	Obs.	F-statistic	Prob	Decision
Exchange rate does not granger cause stock price	130	1.90589	0.1530*	Accept
Stock price does not granger cause exchange rate		5.83908	0.0038*	Reject

*at 0.05 level of significance

***Source**: Author's own estimation*

The result table above indicates that causality exists and the direction of causality runs from stock price to exchange rate for the period 2011-2021. Huy (2016) [10] for Vietnam and Kutty (2010) [14] for Mexico collaborated the same findings. So past values of stock prices are able to explain the future values of exchange rate but not vice-versa. So, regulators can predict the trends in exchange rate which can induce profitable trading in the currency market.

4. CONCLUSION

This study examined the associations between the currency and equity markets of India,both of which are quite volatile in nature like that of markets in other developing countries. To conclude, the paper finds no long run equilibrium relation between exchange rate and stock price in the indian context. One of the probable reasons for this could the omission of other important macroeconomic variables like interest rate, inflation rate etc. [32]. On the other hand, the study found support for the Stock oriented Model as it indicated unidirectional relationship that runs from stock price to exchange rate. So, policy makers should undertake reforms in the capital market precisely as any change in the equity market could have short run effect on exchange rates. There is scope for future studies in the same direction; firstly impact of crisis and shocks can also be included which can act as potential structural break. Secondly, use of daily, weekly or fortnightly data could be used for more robust results owing to the highly volatile variables. Thirdly, the timeseries can be divided into different periods depending upon different phases of business cycle, to get more substantive and detailed results on the relationship amongst the variables.

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