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Original Research Article

Effect of Oil Price, Exchange Rate and Interest Rate on Indian Stock Market: An ARDL Bounds Test Approach

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Abstract

This study investigates the effect of oil prices, exchange rate and interest rate on the Indian stock market with the help of ARDL Bounds test approach on monthly time series data from April 2000 to March 2024.The empirical results confirmed co-integration between the selected variables and the stock market, which is indicative of a long-run relationship. Further, the oil prices as well as the exchange rate were found to be significant and positively related to the stock market in the long run whereas interest rate was found to be significant and negatively related. The coefficient of error correction term was negative and significant which confirms convergence towards the long-run equilibrium.

Keywords: ARDL bounds test, co-integration, oil price, exchange rate, interest rate, stock market.

INTRODUCTION

The stock market is considered to be a vibrant and active component of the country's economic landscape. In India, it plays a critical role in shaping and reflecting economic conditions that prevail in the country. The interaction of different macroeconomic factors on stock market performance is a subject of major interest not only to investors but researchers and policymakers also. The macroeconomic factors such as oil price, exchange rate and interest rate were prominent among other factors due to their deep and interconnected effects on the financial market.

The relationship between crude oil prices and the stock market is multifaceted and influenced by a range of factors, movements in oil prices frequently play a key role in shaping market dynamics. Studies like Huang *et al.,* (1996) and Lardic and Mignon (2008) found that oil prices and the stock market are negatively association. However, studies like Aggarwal and Manish (2020), Alamgir and Amin (2021) found a positive relation between the said variables.

The stock market performance is also significantly influenced by exchange rate. Foreign trade dynamics and the trade balance play influential roles in shaping stock market outcomes. When the domestic currency depreciates relative to foreign currencies, investors are often enticed to allocate their investments into foreign assets, which can lead to a fall in domestic stock prices. In export-oriented countries, an appreciation of the domestic currency can diminish the competitiveness of exports, negatively impacting stock values and countries that rely heavily on imports, a stronger domestic currency reduces import costs, which can have a favorable effect on domestic stock prices. Research such as that conducted by Gay-Jr (2008) found that the exchange rate and stock prices were positively related whereas studies like Abugri (2008) found a negative relationship between the two variables. These differing findings underscore that the relationship between stock prices and exchange rates is empirical, varying across different studies.

Rate of interest is another one of the most extensively employed variable to determine stock prices. (Mukherjee & Naka, 1995 and Ray, 2012) used Call Money Rate as a proxy for interest rate. Interest rate and stock market are negatively related. Generally, when there is rise in interest rates, the borrowing costs for companies increase, which lead to decline in capital investment and lower corporate earnings, often resulting in a fall in stock prices. As explained by Maysami et al. (2004) when borrowings are used to buy stocks, a rise in rate of interest would make stock transactions costlier and since investors predict a higher rate of return from

investments, this causes the demand to fall and lead to depreciation in prices.

LITERATURE SURVEY

The literature on variables like oil prices, exchange rate and interest rate and its effect on the stock market is vast. However, some of them have been reviewed.

Basher, Haug and Sadorsky (2012) investigated the dynamic relationship between exchange rates, interest rate and oil prices and the stock markets in India by using structural vector auto regression monthly time series data. The findings revealed that the stock market was negatively related with oil prices and exchange rate in the short-run. Dey (2013) conducted a study that looked at the relationship between foreign currency reserves, foreign exchange rates, and the BSE Sensex return in India. The regression results revealed that the exchange rate has an impact on stock market returns. As per the Johansen co-integration test, the variables are not co-integrated and the Granger causality test confirmed that stock market returns are caused by the foreign exchange rate. Subburayan and Srinivasan (2014) studied the effects of exchange rate, interest rate and inflation on the CNX Bank index of the Indian stock market. Using monthly data co-integration and Granger causality test were used for the analysis and the findings suggest that bank stock returns had a long-run relationship with the selected variables. The effect of interest rate and exchange rate were found to be positive on the stock return. Abed and Zardoub (2019) used ARDL Bounds test to analyse the German stock market and its relation with certain macroeconomic variables and found that interest rate had a significant negative effect on the stock market however, oil and exchange rate were found to be insignificant. Demir (2019) used the ARDL bounds test to analyse the relation of macroeconomic variables and the stock market and observed that the price of crude oil and interest rate had a negative effect on the stock market whereas, the relative value of the domestic currency, i.e. exchange was positively related to the stock prices. Aggarwal and Manish (2020) applied the ARDL bounds test to check the long-run association among certain macro variables and found that changes in oil prices have a significantly positive effect on the stock market in the short as well as long run. Whereas, exchange rate has a positive relation but was insignificant.

On the basis of the literature survey, it may be stated that among the various macro-economic factors, oil prices, interest rate and exchange rate are important factors affecting the stock market conditions. Therefore, this research is conducted to investigate the effect of oil prices, interest rate and exchange rate on the Indian stock market using the Autoregressive Distributed Lag (ARDL) Bounds testing technique to co-integration.

DATA AND RESEARCH METHODOLOGY

On the basis of theoretical importance, uses and findings in the earlier empirical studies, the variables selected for the study are Crude Oil Prices, Exchange rate and Interest Rate.

This study attempts to analyse the effect of crude oil prices, exchange rate and interest rate on the stock market index (BSE Sensex) for which the following model has been undertaken:

BSE SENSEX = f (Oil prices, Exchange Rate, Interest Rate)

For the present study, time series data of monthly average values of BSE Sensex (BSE), monthly exchange rate (EXR) and call money rates, which is taken as a proxy for interest rate (INT) have been taken from Handbook of Statistics on Indian Economy as made available by the Reserve Bank of India. The data for crude oil prices has been taken from website of Index Mundi. The analysis has been carried out using monthly data from April 2000 to March 2024. All the variables, except interest rate, are transformed into natural logarithmic form, in order to account for expected non-linearities in relationships as well as to attain stationarity in variance. Thus, the following model is used to study the interaction between selected variables and stock market:

$$LnBSE = \beta_0 + \beta_1 LnOIL + \beta_2 LnEXR + \beta_3 INT + \varepsilon_t \ldots. \quad (1)$$

Where;
LnBSE is natural logarithm of monthly average values of BSE Sensex as a proxy for market index
LnOil is natural logarithm of monthly crude oil prices
LnEXR is natural logarithm of monthly exchange rate of Indian rupee against US dollar
INT is monthly values of call money rate (proxy for interest rate)

Model Used for Analysis

Auto Regressive Distributed Lag (ARDL) model has been used to study the long-run and short-run relationship between variables. Pesaran (1997), Pesaran and Shin (1999) and Pesaran *et al.*, (2001) developed the ARDL co-integration technique. This approach is particularly useful because it maintains the validity of long-term coefficient estimates, even when the variables are integrated at different levels, meaning they do not all need to be of the same order of integration. This flexibility allows for a more nuanced understanding of how variables interact over time, both in the short run and the long run.

To analyze the effects of oil prices, exchange rate and interest rate on the stock market, the Auto-Regressive Distributed Lag (ARDL) bounds test (Pesaran & Shin, 1999) has been used. The ARDL equation used in the study is as follows:

$$\Delta LnBSE = \alpha_0 + \sum_{i=1}^{p} \beta_1 \Delta LnBSE_{t-i} + \sum_{i=0}^{p} \beta_2 \Delta LnOIL_{t-i} + \sum_{i=0}^{p} \beta_3 \Delta LnEXR_{t-i} + \sum_{i=0}^{p} \beta_4 \Delta INT_{t-i} + \lambda_1 LnBSE_{t-1} + \lambda_2 LnOIL_{t-1} + \lambda_3 LnEXR_{t-1} + \lambda_4 INT_{t-1} + \varepsilon_t \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(2)$$

Where;
β_1 to β_4 represent short-run relationship
λ_1 to λ_4 represent the long-run relationship among variables
Δ is the first difference of variables
ε_t is the error term.

In order to investigate the co-integration between the selected variables, the ARDL Bounds test is used and F- test is used to test the null hypothesis (there is no co-integration) and alternate hypothesis (co-integration exists) as suggested by Pesaran *et al.*, (2001). The following are the null (H_0) and alternate (H_1) hypotheses:

$H_0: \lambda_1 = \lambda_2 = \lambda_3 = \lambda_4 = 0$
$H_1: \lambda_1 \neq \lambda_2 \neq \lambda_3 \neq \lambda_4 \neq 0$

If the variables are co-integrated, then the coefficients of each variable may be estimated using the Error Correction Model (ECM) which is as follows:

$$\Delta LnBSE = \alpha_0 + \sum_{i=1}^{p} \beta_1 \Delta LnBSE_{t-i} + \sum_{i=0}^{p} \beta_2 \Delta LnOIL_{t-i} + \sum_{i=0}^{p} \beta_3 \Delta LnEXR_{t-i} + \sum_{i=0}^{p} \beta_4 \Delta INT_{t-i} + \delta ECT_{t-1} + \varepsilon_t \quad \ldots\ldots\ldots\ldots\ldots\ldots (3)$$

Where ECT stands for the error correction term, while the parameter δ represents the speed at which adjustments occur. A negative and significant δ indicates the movement towards equilibrium.

RESULTS AND DISCUSSION

Unit Root Analysis

Before applying the ARDL test, it is necessary to test the stationarity of the variables. Augmented Dickey-Fuller (ADF) test as proposed by Dickey and Fuller (1979) was applied at level and first difference. It is important to note here that the null hypothesis states that the variable is non-stationary (has a unit root). The results of unit root analysis are shown in Table 1. According to the results of ADF test, the variables are found to be stationary at first difference except interest rate which is found to be stationary at level. Therefore, all the variables are found to be integrated either at level, i.e. I(0) or at first difference, i.e. I(1) and none are integrated at second order, i.e. I(2). Hence, ARDL Bounds test can be applied.

Table 1: Unit Root Test for Stationarity

Variables	ADF (Level)	ADF (Ist Difference)
LnBSE	-2.564	-12.94***
LnOil	-3.110	-12.638***
LnEXR	-2.117	-12.691***
INT	-4.575***	-

Source: Author's own work
Note: *** denotes significance at 1 per cent

Lag Selection

Since the lag order in time series analysis is very receptive to the results, thus it is critical to choose an acceptable criterion for lag duration. In order to choose the optimal lag length, the VAR lag length criteria is used and the results suggest that the optimal lag length is 2 based on Akaike Information Criterion (AIC).

ARDL Bounds Test

Table 2 shows the results of ARDL Bounds Test. The optimal model identified is ARDL (3,1,1,2). The calculated F-statistic is 6.831, which surpasses the upper critical values at the1%, 5% and 10% significance levels according to Pesaran *et al.*, (2001). This signifies rejection of the null hypothesis of no co-integration, suggesting a long-run relationship exists between the variables.

Table 2: Results of ARDL Bounds Test

Optimal lag length:	ARDL (3,1,1,2)	
F-statistic	**6.831852**	
	Critical Value Bounds	
Significance	I (0) Bound	I (1) Bound
10%	2.37	3.20
5%	2.79	3.67
1%	3.65	4.66

Source: Author's own work

Short-Run and Long-Run Analysis

Now that the existence on co-integration among variables is certain, it is feasible to estimate the co-integration form of the model and short-run and the long-run coefficients to find out how individual explanatory variables affect the stock market.

Table 3: Short-run Estimates

Variable	Coefficient	Std. Error	t-Statistic	Prob.
ΔLnBSE (-1)	0.212286	0.050620	4.193761	0.0000***
ΔLnBSE (-2)	-0.087998	0.048828	-1.802214	0.0726
ΔLnOIL	0.103377	0.027460	3.7646228	0.0002***
ΔLnEXR	-1.513462	0.159299	-9.500764	0.0000***
ΔINT	-0.005731	0.002916	-1.965429	0.0500**
ΔINT (-1)	0.005480	0.002787	1.966190	0.0503
CointEq (-1)	-0.025807	0.004214	-5.887099	0.0000***

Source: Author's own work

Note: *** denotes significance at 1 per cent; ** denotes significance at 5 per cent

Table 3 shows the short-run coefficients of the model. The results reveal that the variables are significant at 1 and 5 per cent level of significances. Oil prices are positively related to the stock market. However, exchange rate and interest rate are found to be negatively related. The coefficient of the error correction term (ECT) is -0.025, which has negative sign and is highly significant. This means that the speed of adjustment towards long-run equilibrium will be only 2.5 per cent monthly.

Table 4: Long-run Estimates

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LnOIL	1.273628	0.248075	5.134055	0.0000***
LnEXR	1.577410	0.577348	2.732165	0.0067***
INT	-0.229391	0.086827	-2463064	0.0144**
C	-5.060663	2.054621	-2.463064	0.0144**

Source: Author's own work

Note: *** denotes significance at 1 per cent; ** denotes significance at 5 per cent

The long-run estimates of the model are shown in Table 4. The result shows that oil prices and exchange rate are significant at 1 per cent level of significance and the slope coefficient is positive, which suggests that they are positively related with stock market. The positive coefficients of oil prices and exchange rate denote that a 1 per cent increase in oil prices and exchange rate will push up the stock market by 1.27 and 1.57 per cent, respectively. Further, interest rate is significant at 5 per cent level of significance and the slope coefficient is negative, which implies that it is negatively related with the stock market. The negative coefficient of interest rate suggests that a 1 per cent increase in the interest rate will bring down the stock market by 0.22 per cent.

Serial Correlation Test and Stability Test

The Breusch-Godfrey serial correlation LM test was applied to check the existence of serial correlation and the result suggests absence of serial correlation as the p-value is greater than 5 per cent level of significance, implying acceptance of the null hypothesis of no serial correlation. To test the stability of the short-run and long-run coefficients, the Cumulative Sum of Recursive Residuals (CUSUM) and the Cumulative Sum of Squares of Recursive Residuals (CUSUMSQ) tests were applied. The results as shown in Figure 1 and 2, indicate that both (CUSUM and CUSUMSQ) lie within the critical levels at 5 per cent level of significance, thereby suggesting that the model is structurally stable.

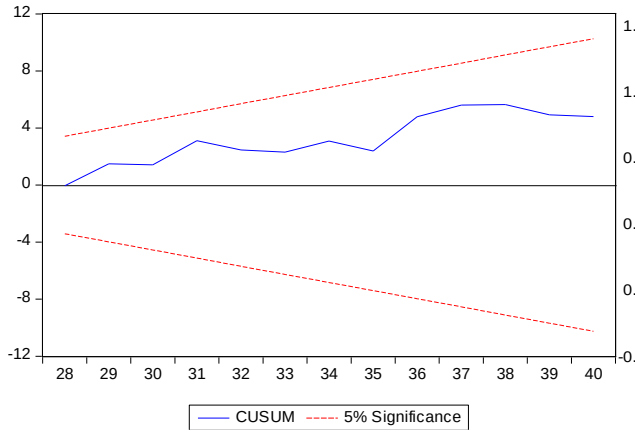

Figure 1: CUSUM Test

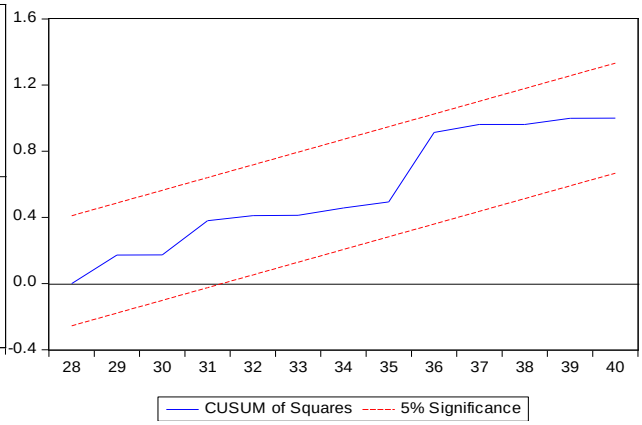

Figure 2: CUSUMSQ Test

Source: Author's own work

CONCLUSION

In an attempt to investigate the effect of selected variables on the stock market, the ARDL Bounds testing method was used to examine co-integration among the variables. The results obtained confirmed that there exists co-integration between the selected variables and stock market.

Oil prices are found to be significant and positively related to the stock market in the short-run as well as in the long-run. Exchange rate is found to be significant in both- the short as well as long-run. However, it is negatively related to the stock market in the short-run but positively related in the long-run. Further the interest rate is statistically significant in the short-run as well as in the long-run and is found to be negatively related with the stock market. The coefficient of the error correction term (ECT) is -0.025, which has negative sign and is highly significant. This means that the speed of adjustment towards long-run equilibrium will be only 2.5 per cent monthly.

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