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LONG-RUN ASSOCIATION OF CRUDE OIL PRICE, CONSUMER PRICE INDEX AND EXCHANGE RATES WITH SENSEX

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Abstract: This study examines the long-run relationship between three important macroeconomic variables in terms of crude oil price, consumer price index, and exchange rates and Sensex. On account of insufficient crude oil reserve, India's import bill is increasing day by day; consequently a huge pressure can be felt on foreign exchange reserve. Nonetheless, inflation rates have been increased. These ultimately hit the India's stock market. Time series data has been collected from the RBI database for the period from April 1, 2014 to March 31, 2022. While analyse the data, correlation analysis, unit root test, Johansen cointegration test and vector autoregression model have been used. Correlation test results show that crude oil price influences Sensex very meagerly, exchange rates influences Sensex moderately, and consumer price index influences Sensex negatively. From vector autoregression analysis it is found that crude oil price, consumer price index, and exchange rates do not influence the Sensex in the long run.

Keywords: Crude oil price, consumer price index, exchange rates, Sensex, India, vector autoregression.

1. INTRODUCTION

Crude oil is inevitable in the modern day scenario. Due to several reasons fluctuation in the price of crude oil is observed. Fluctuation in the production of crude oil, Covid-19 pandemic and war between Russia and Ukraine has impacted the crude oil price in recent times. Consumption of crude oil has been increasing over the years in India. India is not self sufficient for the need of crude oil from its own reserve. India has to import huge amount of crude oil from different countries. As a result of that huge pressure can be felt on foreign exchange reserve in India. So any fluctuation in exchange rates can impact Indian economy hugely. If exchange rate fluctuates

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negatively for Indian rupee, that leads to increase in crude oil price in India. As a result of that price of consumer products increases which leads to increase in consumer price index. It is often believed that crude oil price has an impact on the stock price (Bhunia, 2012). It is also found that sometimes other macroeconomic variables namely consumer price index and exchange rate also influences the stock price (Tabash *et al.*, 2022). Although some others believe that there is an insignificant linkage between macroeconomic variables and stock prices (Chang *et al.*, 2021). The present study will judge the impact of these macroeconomic factors on the Indian stock market.

2. LITERATURE REVIEW

Doong *et al.* **(2005)** examined the relationship between stock prices and exchange rates for six Asian countries (Indonesia, Malaysia, Philippines, South Korea, Thailand, and Taiwan) for a period from 1989 to 2003. They concluded that financial variables are not co-integrated. The result of Granger causality test shows that bidirectional causality is detected in Indonesia, Korea, Malaysia, and Thailand. On the other hand there is a significantly negative relation between the stock returns and the change in the exchange rates for all countries except Thailand. **Pescatori (2008)** at the International Monetary Fund (IMF), attempted to measured changes in the S&P 500 as an alternative for stock prices and crude oil prices. He revealed his variables only occasionally moved in the same direction at the same time, but even then, the relationship was weak. He concluded that no correlation exists at 5% level of significance. **Mahunta (2011)** examined the long-term relationship between CNX NIFTY-50 index of National stock exchange and crude oil price by using different econometric test like descriptive test, correlation test, unit root test, co-integration test and pair wise granger causality test for a period from January, 2010 to December, 2014. He concluded that there was a co-integrated long-term relationship between CNX index and crude oil price. Granger causality results describe that there is unidirectional causality exists and crude oil price causes NSE but NSE does not cause oil price. **Chittdi (2012)** investigated the long run relationship between oil prices and stock prices in India over a period from April, 2000 to June, 2011 using Auto Regressive Distributed Lag (ARDL) model. He found that volatility of stock prices in India has a significant impact on the volatility of oil prices but a change in the prices does not have impact on stock prices. **Bhunia (2012)** enlightened on Association between Crude Price and Stock Indices Empirical Evidence from Bombay Stock Exchange for a period from 2001 to 2011 by using Unit root, co-integration and causality test. He found that one way causality relationship exists from all index of the stock market to crude price, but crude price was

not the causal of each of the three indexes. **Suriani** *et al.* **(2015)** examined the impact of exchange rate on stock market in Pakistan for a period from January, 2004 to December, 2009. They used ADF test and Granger causality test for the analysis. They found that there is no relationship exists between exchange rate and stock price and both the variables are independent of each other. **Tawfeeq** *et al.* **(2019)** explored the linkage between crude oil prices and stock indices for seven Middle East countries using vector auto regression (VAR) model and vector error correction model (VECM) using daily data for a period from 2001 to 2015. They found that there is a positive relationship between crude oil prices and stock indices value for three countries and there is a short-run causality for two countries running from oil price to the stock market. **Akbar** *et al.* **(2019)** scrutinized the relationship among exchange rate, gold prices, stock indices, and interest rate by using vector auto regressive (VAR) and Bayesian VAR model for the period 2001–2014 taking monthly data series. They found that bilateral relationship exists between exchange rate and stock value with downward movement of both Pak rupee and stock prices in case of economic downturns. **Ji** *et al.* **(2020)** examined the impact of supply-side and demand-side shocks in oil prices on the currency rates of export- oriented and import-oriented economies by using the structural VAR framework. They found that supply-side oil price shocks lead to the depreciating trend in the exchange rate of the export-oriented economy. However, the prevalence of the transmission of oil price shocks toward the exchange rate has become more powerful after the financial crisis of 2008. **Aggarwal & Manish (2020)** studied the impact of oil prices on the Indian stock market using the ARDL model for a period January 2000 to November 2018 data obtained from Bombay Stock Exchange (BSE) and World Bank and they concluded that oil prices significantly and positively affect the Indian stock market both in the short and long run. **Chang** *et al.* **(2021)** investigated the impact of macroeconomic variables on stock prices, both in the short and long term period, using quantile ARDL model and monthly data series. They also considered the impact of three crises that occurred between 2005 and 2009. They remarked that there is an insignificant relationship between macroeconomic variables and stock prices in the long run. However, in short run, stock prices asymmetrically affected all the macroeconomic variables. **Zaighum** *et al.* **(2021)** used an asymmetrical quantile-based autoregressive distributed lag (ARDL) framework for examining the non-linear linkage between the world's Islamic stock indices and energy prices. They proposed that the practical implications for longer-term investors that they should invest in Islamic stock market at the times of increasing oil prices and stock market bullish behavior. **Tabash** *et al.* **(2022)** analysed the trilateral relationship between macroeconomic variables

namely oil prices, stock market index, and exchange rate to express their behavior and inter-relationship in the economy of Pakistan for a period from 4 January 2016 to 30 April 2021 by using a Vector Autoregressive (VAR) model. They found that oil prices changes, and stock index have an insignificant direct relationship both in pre-COVID-19 and overall sub-periods of study while a positive and statistically significant relationship during the COVID-19 period. **Iqbal** *et al.* **(2022)** examined whether the sustainable investment stock market indices are affected by different categories of international risk factors like unpredictability in the economy, fluctuations in the stock market, health-related uncertainty factors, and the US treasury market fluctuations by employing the connectedness time and frequency methodology of Diebold and Yilmaz (2012) for a period from January 2005 to March 2021. They found that there is more intra-regional connectedness among the Asian countries than inter-regional connectedness. Negative returns promulgate more strongly than positive ones, and this situation is considerably boosted during crises, including the Covid-19.

There are lots of research work has been done to see the impact of macroeconomic variables on stock market. But there is no such research work is done to see the impact or influences of Crude Oil Price (COP), Consumer Price Index (CPI) and Exchange Rate (ER) on Sensex. This paper is an attempt to assess the influence of these three macroeconomic variables on Sensex.

Based on the above, the research question obviously arises: Are crude oil price, consumer price index, and exchange rates influenced the Sensex in the long-run?

3. DATA AND METHODOLOGY

Data used in the research COP, CPI, ER and SENSEX which are secondary in nature. Out these COP, CPI and ER are independent variable whereas SENSEX is dependent variable. Data relating to COP, CPI, ER and SENSEX have been collected from RBI database. Data for the research work has been collected for the period from April 1, 2014 to March 31, 2022. For the purpose of the analysis Eviews 7 package program has been used for arranging the data and conducting econometric analyses using correlation analysis, Augmented Dickey-Fuller (ADF) unit root test, Johansen cointegration test and Vector Autoregression (VAR) model. Studying correlations allows us to understand the extent of the integration between SENSEX and three macroeconomic variables taken for the study.

The Augmented Dickey-Fuller (ADF) unit root test has been used to check the stationarity of the time series data used for the study and to find

the order of integration between them. The ADF unit root test has been performed by estimating regression model $\Delta y_t = cy_{t-1} + \sum_{i=1}^{p} b_i y_{t-i} + e_t$

The ADF unit rest is based on the null hypothesis (H_0): unit root is present in y_t. This indicates that y_t is not *I(0)*,i.e.; y_t is not integrated of order 0 which implies y_t is non-stationary. If the calculated ADF test statistics is less than the critical value of the test in a specified significance level, then the null hypothesis is rejected, otherwise null hypothesis is accepted. If the data is found non-stationary at level, the ADF test is to be performed to the first difference of the data is used for testing a unit root. In this case, the data is said to be co-integrated of order one, *I(1)*.

In the next step, the Johansen's cointegration test has been applied to detect whether any short run equilibrium relation exists between the variables. This test is useful to check cointegration among several, say k *I(1)* time series. The Johansen approach to cointegration test is based on two test statistics, namely, the trace test statistic, and the maximum eigenvalue test statistic. The trace test statistics can be specified as $\lambda_{trace}(r) = -\mathrm{T}\sum \log(1-\lambda_i)$ where λ_i is i^{th} largest eigen value of cointegration matrix $\prod$ and T is the number of observations. In the trace test, the null hypothesis (H_0) is that the number of distinct co-integrating vector(s) $r = r_1 < k$ against the alternate hypothesis (H_1) $r = k$ .The maximum eigenvalue test statistics can be specified as $\lambda_{\max} = -\mathrm{T}\log(1-\lambda_{r+1})$ where $\lambda_{\max}$ is the $(\mathrm{r+1})^{\mathrm{th}}$ largest squared eigen value. In the maximum eigenvalue test, the null hypothesis (H_0) $r = r_1 < k$ is tested against the alternate hypothesis (H_1) $r = r_1 + 1$.

4. EMPIRICAL RESULTS AND ANALYSIS

4.1. Correlation analysis

Table 1: Correlation Analysis

	COP	*CPI*	*ER*	*SENSEX*
COP	1			
CPI	0.41	1		
ER	-0.39	-0.40	1	
SENSEX	0.01	-0.36	0.66	1

From table 1 shows the association of Sensex with COP, CPI and ER. It is clear that COP (0.01) and ER (0.66) positively related to the Sensex and CPI is associated with Sensex (-0.36) negatively. But the correlation analysis does not talk about the cause and effect of the relationship of Sensex with COP, CPI and ER.

4.2. ADF Unit Root Test Results

Table 2: ADF Unit Root Tests

Variable	*At Level*			*At 1st Differenced*		
	t-stat	*C.V. at 0.05*	*Remarks*	*t-stat*	*C.V. at 0.05*	*Remarks*
COP	-2.82	-2.90	NS	-5.65	-2.90	S
CPI	-2.55	-3.47	NS	-6.15	-3.47	S
ER	-1.25	-2.90	NS	-7.08	-2.90	S
Sensex	-0.82	-2.90	NS	-8.30	-2.90	S

Before carrying on further analysis, a stationarity test is required as the data is time series. It is necessary to check whether the data is stationary at first differenced or not. Augmented Dickey-Fuller (1979) is conducted in order to test the survival of unit root. Table 2 exhibits the results of the ADF unit root test. The results show that all the variables are stationary at I(1). As the time series data was stationary at the first difference, it is obvious that regular regression will produce false results. So, the Johansen cointegration test has been conducted on whether the long-run relationship among the variables or not.

4.3. Johansen Cointegration Test Results

This test is a commonly used technique in error correction models, which is used to make out long-run relationships between time series data. That's why; this test to examine the interrelationship of independent variables COPS, CPI, ER and dependent variable SENSEX. A lag length 2 has been identified above. In the cointegration test, a critical value of a 5 percent level has been used. The null hypothesis of the test is that COP, CPI and ER do not influence SENSEX and the alternative hypothesis is that COP, CPI and ER influence SENSEX.

Table 3 reveals the Johansen cointegration test results. In this table, two likelihood ratios of the maximum-eigenvalue statistics and trace statistics have been measured. The results illustrate that both trace statistic (41.51) and maximum eigenvalue (25.28) are lower than its C.V. at 5%. Trace statistic and Max-eigenvalue test indicates no cointegration at the 0.05 level. This denotes rejection of the null hypothesis at the 0.05 level.

Table 3: Johansen Cointegration Test

Unrestricted Cointegration Rank Test (Trace)				
Hypothesized No. of CE(s)	*Eigenvalue*	*TraceStatistic*	*0.05 Critical Value*	*Prob.***
None	0.31	41.51	47.85	0.17
At most 1	0.17	16.23	29.79	0.69
At most 2	0.05	3.45	15.49	0.94
At most 3	3.01	0.01	3.84	0.96
Unrestricted Cointegration Rank Test (Maximum Eigenvalue)				
Hypothesized No. of CE(s)	*Eigenvalue*	*Max-EigenStatistic*	*0.05 Critical Value*	*Prob.***
None	0.31	25.28	27.58	0.09
At most 1	0.17	12.78	21.13	0.47
At most 2	0.05	3.44	14.26	0.91
At most 3	3.01	0.00	3.84	0.96
Trace statistic and Max-eigenvalue test indicates no cointegration at the 0.05 level				

* denotes rejection of the hypothesis at the 0.05 level

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

4.4. Vector Autoregression Results

Table 4: Vector Autoregression Estimates

	COP	*CPI*	*ER*	*SENSEX*
COP(-1)	1.15	-0.01	0.00	64.35
S.E.	(0.12)	(0.01)	(0.02)	(31.57)
t-value	[8.98]	[-0.58]	[0.13]	[2.03]
Prob.	0.00	0.55	0.89	0.04
COP(-2)	-0.31	-0.00	-0.01	-28.79
S.E.	(0.11)	(0.01)	(0.01)	(28.58)
t-value	[-2.70]	[-0.23]	[-0.82]	[-1.00]
Prob.	0.00	0.81	0.40	0.31
CPI(-1)	0.381	1.14	-0.29	293.81
S.E.	(0.92)	(0.11)	(0.15)	(228.63)
t-value	[0.41]	[9.59]	[-1.83]	[1.28]
Prob.	0.68	0.00	0.06	0.20
CPI(-2)	0.25	-0.27	0.48	-548.59
S.E.	(1.05)	(0.13)	(0.18)	(259.62)
t-value	[0.24]	[-2.02]	[2.67]	[-2.11]
Prob.	0.80	0.04	0.00	0.03
ER(-1)	-0.16	0.21	1.04	-2.31
S.E.	(0.77)	(0.09)	(0.13)	(190.96)

contd. table

	COP	*CPI*	*ER*	*SENSEX*
t-value	[-0.21]	[2.12]	[7.81]	[-0.01]
Prob.	0.82	0.03	0.00	0.99
ER(-2)	-0.11	-0.25	-0.170	117.19
S.E.	(0.77)	(0.09)	(0.13)	(191.46)
t-value	[-0.14]	[-2.51]	[-1.27]	[0.61]
Prob.	0.88	0.01	0.20	0.54
SENSEX(-1)	0.00	0.00	2.36	0.84
S.E.	(0.00)	(7.60)	(0.00)	(0.14)
t-value	[0.52]	[2.21]	[0.23]	[5.82]
Prob.	0.59	0.02	0.81	0.00
SENSEX(-2)	-1.66	-0.01	8.40	0.03
S.E.	(0.00)	(7.5)	(0.00)	(0.14)
t-value	[-0.02]	[-1.88257]	[0.82]	[0.20]
Prob.	0.97	0.06	0.40	0.83
C	15.73	3.02	5.33	-4364.56
S.E.	(16.05)	(2.05)	(2.76)	(3959.17)
t-value	[0.97]	[1.46]	[1.92]	[-1.10]
Prob.	0.32	0.01	0.05	0.27
R^2	0.91	0.83	0.95	0.95
Adj. R^2	0.90	0.81	0.94	0.95
F-statistic	80.29	37.03	142.13	161.94

Johansen cointegration test results above showed that three-macroeconomic variables and stock market indexes were not cointegrated in the same order. As a result, vector autoregression (VAR) model based on the AIC test with lag length 2 is useful to determine the equilibrium relationship.

Table 4 illustrates the results of VAR tests. The VAR test results show that Sensex has no association with COP and CPI as the coefficient vales of COP and CPI are zero at first lag, this is significant in case of CPI but it is insignificant for COP. On the other hand, at the first lag Sensex is positively associated with ER (2.36) which is statistically insignificant. But Sensex is negatively associated with COP (-1.66) and CPI (-0.01) at the second lag and both are statistically insignificant. Whereas Sensex is positively associated with ER (8.40) and which is also statistically insignificant. The VAR test results confirm that the Indian stock market has no association with COP, CPI, and ER during the study period.

5. CONCLUSION

This paper intended to find out the influences of COP, CPI and ER on Sensex in the long-run. Correlation test results show that COP and ER positively

related to Sensex and CPI is associated with Sensex negatively. Johansen cointegration test results show that there does not exist any long run relationship amongst the selected variables. From VAR analysis, it is found from the results that there is no long-run causality running from COP, CPI, and ER to Sensex or vice versa.

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