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Correlation and causality between stock market and economy: Evidence from India

Sanjay Joshi

Abstract
Economic theory suggests that stock prices should reflect expectations about future corporate performance, and corporate profits generally reflect the level of economic activities. If stock prices accurately reflect the underlying fundamentals, then the stock prices should be employed as leading indicators of future economic activities, and not the other way around. Thus the purpose of the present study is to investigate the causal relationship persisting in India between macroeconomic variables, namely Wholesale Price Index (WPI), Exchange Rate (USD/INR), Index of Industrial Production (IIP), Foreign Institutional Investments (FIIs), M3 (Broad Money), Gold Prices, Crude Oil Prices and Stock prices of Bombay Stock Exchange (SENSEX) using monthly data after financial crisis from 2008-09 to 2013-14. Specifically, causality test has been used to measure the causal relationship between macroeconomic variables and stock prices using E-VIEWS software. Before testing causality, the study tested for VAR which gave lag structure and ADF Unit Root Test also performed to check the stationarity of data. The research will helpful to economic policy maker of the country and investor to predict the share prices of index.

Keywords: Regression, Causality Test, ADF test, Stationary Data

1. Introduction

Security prices are influenced by number of factors some are company specific, sector specific while some belong to the environment in which the company is operating. Movements of stock prices are seen to depend on macroeconomic factors; domestic and international economic, social or political events; market sentiments / expectations about future economic growth route, monetary and fiscal policy announcements etc. The stock market capitalizes the present and future values of growth opportunities while evaluating the growth of all sectors in the economy.

In a sense stock markets can really be regarded as the pulse of the economy as they reflect every action taken by the economic and political agents almost instantly. An efficient capital market is one in which security prices adjust rapidly to the arrival of new information and, therefore, the current prices of securities reflect all information about the security. Moreover, economic theory suggests that stock prices should reflect expectations about future corporate performance, and corporate profits generally reflect the level of economic activities. If stock prices accurately reflect the underlying fundamentals, then the stock prices should be employed as leading indicators of future economic activities, and not the other way around. Therefore, the causal relations among macroeconomic variables and stock prices are important in the formulation of the nation's macroeconomic policy. The relationship between macroeconomic factors and stock market movements has dominated the academic and practitioners' literature since long.

The analysis on stock markets has come to the force since this is the most sensitive segment of the economy and it is through this segment that the country's exposure to the outer world is most readily felt. The present study is an endeavor in this direction. It analyses the relationship between stock prices and macroeconomic variables in India with implications on efficiency of Indian stock market. The informational efficiency of major stock markets has been extensively examined through the study of causal relations between stock price indices and macroeconomic variables. If lagged changes in some macroeconomic variables cause variations in stock prices and past fluctuations in stock prices cause variations in the economic variable, then bi-directional causality is implied between the two series. In contrast, if changes in the economic variable neither influence nor are influenced by stock price fluctuations, then the two series are independent of each other and the market has informational efficiency.

2. Literature Review

Arestis Philip, Demetriades (2001), "Financial Development and Economic Growth: The Role of Stock Markets". The results support the view that, although both banks and stock markets may be able to promote economic growth, the effects of the former are more powerful. They also suggest that the contribution of stock markets on economic growth may have been exaggerated by studies that utilize cross-country growth regressions.

Deb S., Mukharjee J., (2008)., "Does Stock Market Development Cause Economic Growth? A Time Series Analysis for Indian Economy" Objective of this paper was to know the relationship between stock market and Indian economy. In this research paper variables used and those are WPI, IIP and EXR with BSE SENSEX. And this study reveals that Indian stock market is approaching towards informational efficiency at least with respect to two macroeconomic variables, viz. exchange rate and inflation (WPI). Limitation of the study is that major focus of this research paper was on demand of financial services rather than the economic growth of country.

Boubakari A., (2010), "The Role of Stock Market Development in Economic Growth: Evidence from Some Euronext Countries". Objective of the study was to find causality relationship between stock market proxies. Variables used in the study were Market Capitalization, Total trade volume, turnover ratio, Eco growth – FDI (Foreign Direct Investment) & GDP (Gross Domestic Product). Conclusion of the study was a positive links between the stock market and economic growth for some countries for which the stock market is liquid and highly active. However, the causality relationship is rejected for the countries in which the stock market is small and less liquid. And limitation of the study is that this study has defined that small stock markets which are having less liquidity cannot be the factor of economic growth but strong economic condition can develop stock markets.

Nazir M., Musarat M., Javed U., (2010)., "Relationship between economic growth and stock market development". Objective of this research paper was to know stock market development and economic growth. Variables used in this study are GDP Per Capita (Dependent) and FDI, HD Index, size of the market and liquidity prevalent. And this study concluded that economic growth can be attained by increasing the size of the stock markets of a country as well as the market capitalization in an emerging market like Pakistan. Limitation of the study is that, it is related to Pakistan, which may lead to country specific outcomes to be relied on.

Mitra Subrata Kumar (2010), "Relationships among Foreign Institutional Investments, Stock Returns and Currency Change-Over Rates in India". The study examined cause-effect relations and long term relations among the series. Most of the studies in Indian market reported that domestic stock returns attract foreign fund flows but foreign flows do not cause stock returns in India. The results of this study using data for past nine and half years however detected bidirectional causality.

Sharma G., Mahendru M. (2010). "Impact of Macro Economic Variables on Stock Prices in India" The paper analyzes long term relationship between BSE and macroeconomic variable. Results reveal that exchange rate and gold prices highly affect the stock prices and on the other hand the influence of foreign exchange reserves and inflation on the stock price is up to limited extend.

Kumar A., (2011). "An Empirical Analysis of Causal Relationship Between Stock Market And Macroeconomic Variables In India". Objective of the study is the causal relationship between stock prices and macroeconomic variables in India. Variables used in the study are Effective Eco Rate, FER, BOT, FDI, IIP, and WPI. And conclusion of the study is causal relationship between such macro economic variables having no co integration with nifty is not established. Nifty does not Granger Cause WPI and WPI also does not Granger Cause Nifty.

Reddy S., Gupta R., (2011)., "An Empirical Analysis of Stock Market Performance and Economic Growth : Evidence from India". Objective of the study was to investigate whether the stock market performance leads to economic growth or vice versa; study also examines short-run and long-run dynamics of the stock market. Variables used in this research are monthly Index of Industrial Production (IIP) and quarterly Gross Domestic Production (GDP) data, BSE and NSE Index data. This study reveals that The monthly results of Granger causality test suggest that there is a bidirectional relationship between IIP and Stock prices (BSE and NSE) and quarterly results reveal that there is no relationship between GDP and BSE but in the case of NSE and GDP there is a unidirectional relationship and that runs from GDP to NSE. The Engle-Granger residual based Cointegration test suggests that there is a long-run relationship between the stock market performance and economic growth.

Singh D. (2011)., "Causal Relationship between Macro-Economic Variables and Stock Market: A Case Study for India". Objective of the study is to explore the relation especially the causal relation between stock market index i.e. BSE SENSEX and three key macro economic variables of Indian economy by using correlation, unit root stationarity tests and Granger causality test. Variables used in the research are WPI, IIP and EXR with BSE (Causality Test). Conclusion of the study is, Indian stock market is approaching towards informational efficiency at least with respect to two macroeconomic variables, viz. exchange rate and inflation (WPI). Limitation of the study is, variables used in the research are undoubtedly good indicators of economic growth of the company. But the major variable must be included in the study while one is studying economic growth of a country i.e. GDP. And GDP is not included in this study and that may have limited the research.

Sahu N., Dhiman D., (2011)., "Correlation and Causality between Stock Market and Macro Economic Variables in India : An Empirical Study". Objective of study is to analyze the relationship and causality between Stock Market and Macro economic variables. Variables used in this research are SENSEX BSE Index and GDP rate. This research reveals that there is no causal relationship between stock market indicator i.e. SENSEX of Bombay stock exchange (BSE) and real gross domestic product of India despite they being highly co related. Therefore it is concluded in this paper that BSE SENSEX cannot yet be called as an "indicator" of India's growth and development. Limitation of the study is that, there is based on BSE Index and GDP rate only which do not help to

understand the exact situation or causal relationship between Stock Market of India and Economy.

Paramati Sudharshan Reddy, Gupta Rakesh (2011), "An empirical analysis of stock market performance and economic growth: evidence from India". This study aims to investigate whether the stock market performance leads to economic growth or vice versa; study also examines short-run and long-run dynamics of the stock market. Results of this study provide evidence in favor of 'demand following' hypothesis for the Indian context in the short-run. Findings of the study suggest that the economic growth has been playing an important role in determining the stock price movements and economic growth also tends to be more likely to stimulate and promote stock market development by adopting appropriate reallocation of resources.

Patel Samveg (2012), "The effect of Macroeconomic Determinants on the Performance of the Indian Stock Market". He found the long run relationship between macroeconomic variables and stock market indices. The study also revealed the causality run from exchange rate to stock market indices to IIP and Oil Price.

Ray S. (2012). "Testing Granger Causal Relationship between Macroeconomic Variables and Stock Price Behavior: Evidence from India" A multiple regression model is designed to test the effects of macroeconomic variables on the stock prices and granger causality test is conducted to examine whether there exist any causal linkage between stock prices and macro economic variables. The multiple regression results of the study indicate that oil price and gold price have a significant negative effect on stock price, while balance of trade, interest rate, foreign exchange reserve, gross domestic product, industrial production index and money supply positively influence Indian stock price. On the other hand, inflation rate, foreign direct investment, exchange rate and wholesale price index do not appear to have any significant effect on stock price.

Srikanth Maram, Kishore Braj (2012), "Net FII Flows into India: A Cause and Effect Study". The research reviled that On the whole, it was observed that net FII inflows had a positive impact on the Indian stock market and foreign exchange reserves. Further, higher IIP and interest rates acted as catalysts for FII flows into India. Clearly, policy-makers are encouraged to continue the existing policy norms on portfolio investments from FIIs without any reservations.

Bayar Y., Kaya A., Yildirim M. (2013). "Effects of Stock Market Development on Economic Growth: Evidence from Turkey" they indicated that there is a long run relationship between economic growth and stock market capitalization, total value of stocks traded, turnover ratio of stocks traded and also there is unidirectional causality from stock market capitalization, total value of stocks traded and turnover ratio of stocks traded to economic growth.

Ezirim Chinedu, Michael Muoghalu (2013), "Macro-econometric Investigation of Stock Market Behavior in Nigeria". This study examines some specific economic factors that could offer further information on the way the Nigerian Stock market functions. It was also discovered that the individual variables do have the correct signs in their influence on the dependent variable and there is evidence that collectively they are significant in influencing stock prices.

Research Methodology

The purpose of the present study is to investigate the casual relationship between Indian economy which is represented by Wholesale Price Index (WPI), Exchange Rate (INR/USD), Index of Industrial Production (IIP), Foreign Institutional Investments (FIIs), M3 (Broad Money), Gold Price, Crude Oil Prices with Stock prices of National Stock Exchange (S&P CNX NIFTY) and Bombay Stock Exchange (BSE SENSEX) using monthly data that span from 2008-09 to 2013-14. Specifically, the study tested for causal relationship between macroeconomic variables and stock prices using Granger causality test. Before conducting Granger Causality test, ADF Unit Root Test and VAR Model used to know the stationarity of data and to obtain optimum lag order selection criteria. The necessary secondary data of Indian Economy has been sourced from Handbook Statistics of Reserve Bank of India and monthly observation of stock indices from yahoo finance. And rest of material from books, journals, and various other websites.

Tools of Analysis:

a. ADF Test
b. Correlation Coefficient
c. Granger's Causality Test

ADF Test:

Correlation is well known to everybody that it shows the linear relationship between two variables. We will see the technicality in Granger's Causality Test. The first step in causality test is to check whether the series considered are stationary or not at level and if it is non-stationary then to find out the order in which they are integrated, Augmented Dickey Fuller (ADF) test is widely used in literature, so the present study also revealed ADF test statistics. However, a series is said to be stationary if the mean and auto-covariance of the series do not depend on time. While performing ADF test we proceed by considering the three equations:

$\Delta Y_t = \gamma Y_{t-1} + \varepsilon_t$ (Pure Random Walk Model)..... (1)

$\Delta Y_t = a_o + \gamma Y_{t-1} + \varepsilon_t$ (An Intercept indicating the presence of drift)……. (2)

$\Delta Y_t = a_o + \gamma Y_{t-1} + a_2 t + \varepsilon$ (Drift and a linear time trend).... (3)

We test the null hypothesis H_o: $\gamma=0$ i.e. presence of unit roots for each of these equations. The test statistics against the critical values are checked and the null hypothesis is accepted or rejected if t-statistics is greater or less than the critical value respectively. Once we get the order of integration using the ADF test, we proceed with the method of causality to test the presence causal relationship between the Indian economy and stock market indices.

Ganger Causality Test:

If there is a lagged relationship between two variables, one of the test, which is applied to determine the direction of relation in terms of statistics, is Granger Causality test. Granger Causality test also gives information about the short-term relationship between the variables. Even there are different ideas about causality in terms of conception definition, this

concept makes a relation between causes and results were agreed upon.

After 1990s, Granger and Engle contributed to time series literature importantly. On these developments about time series analysis, some variations were done with Granger Causality test.

Although regression analysis deals with the dependence of one variable on other variables, it does not necessarily imply causation.

In other words, the existence of a relationship between variables does not prove causality or the direction of influence. But in regressions involving time series data, the situation may be somewhat different because, as one author puts it as…

"Time does not run backward. That is, if event A happens before event B, then it is possible that A is causing B. However, it is not possible that B is causing A. In other words, events in the past can cause events to happen today. Future events cannot".

This is roughly the idea behind the **Granger causality test**. But it should be noted clearly that the question of causality is deeply philosophical with all kinds of controversies. At one extreme are people who believe that "everything causes everything," and at the other extreme are people who deny the existence of causation whatsoever. The econometrician Edward Leamer prefers the term precedence over causality. Francis Diebold prefers the term predictive causality. As he writes: "The statement "yi causes yj" is just shorthand for the more precise, but long-winded, statement, yi contains useful information for predicting yj (in the linear least squares sense), over and above the past histories of the other variables in the system." To save space, we simply say that yi causes yj.

To explain the Granger test, we will consider the often asked question in macroeconomics: Is it GDP that "causes" the money supply M (GDP→ M) or is it the money supply M that causes GDP (M→GDP), where the arrow points to the direction of causality. The Granger causality test assumes that the information relevant to the prediction of the respective variables, GDP and M, is contained solely in the time series data on these variables. The test involves estimating the following pair of regressions:

$$GDP_t = \sum \alpha_i * M_{t-i} + \sum \beta_j * GDP_{t-j} + u_{1t} \ldots\ldots. (4)$$

$$M_t = \sum \lambda_i * M_{t-i} + \sum \delta_j * GDP_{t-j} + u_{2t} \ldots\ldots.....(5)$$

Where, it is assumed that the disturbances u_{1t} and u_{2t} are uncorrelated. In passing, note that, since we have two variables, we are dealing with bilateral causality. Equation (4) postulates that current GDP is related to past values of it as well as that of M, and equation (5) postulates a similar behavior for M. Note that these regressions can be cast in growth forms, ˙ GDP and ˙ M, where a dot over a variable indicates its growth rate. We now distinguish four cases:

1. **Unidirectional causality from M to GDP** is indicated if the estimated coefficients on the lagged M in equation 5 are statistically different from zero as a group (i.e., $\alpha i = 0$) and the set of estimated coefficients on the lagged GDP in equation 5 is not statistically different from zero (i.e., $\delta j = 0$).
2. **Conversely, unidirectional causality from GDP to M** exists if the set of lagged M coefficients in equation 4 is not statistically different from zero (i.e., $\alpha i = 0$) and the set of the lagged GDP coefficients in equation 5 is statistically different from zero (i.e., $\delta j = 0$).
3. **Feedback, or bilateral causality**, is suggested when the sets of M and GDP coefficients are significantly different from zero in both regressions.
4. **Finally, independence** is suggested when the sets of M and GDP coefficients are not statistically significant in both the regressions.

More generally, since the future cannot predict the past, if variable X (Granger) causes variable Y, then changes in X should precede changes in Y. Therefore, in a regression of Y on other variables (including its own past values) if we include past or lagged values of X and it significantly improves the prediction of Y, then we can say that X (Granger) causes Y. A similar definition applies if Y (Granger) causes X.

Several Things Need To Be Noted:

1. 1. It should be clear that the two variables, GDP and M, are stationary. Sometimes taking the first differences of the variables makes them stationary.
2. The number of lagged terms to be introduced in the causality tests is an important practical question. As in the case of the distributed lag models, we may have to use the Akaike or Schwarz information criterion to make the choice. But it should be added that the direction of causality may depend critically on the number of lagged terms included.
3. We have assumed that the error terms entering the causality test are uncorrelated. If this is not the case, appropriate transformation, may have to be taken.

Since our interest is in testing for causality, one need not present the estimated coefficients of models (4) and (5) explicitly; just the results of the F test will suffice.

Scope and Future Directions

Since ambiguous results were found in this research analysis therefore it itself gives us a scope for further research where various other variables can also be worked out which affect the stock market index. The working of this integrated and interrelated mechanism needs to be known that how real economy and stock market works and shape up each other. If this working is discovered and explored, it could be of immense help to the policy makers as it would be easy for them to manipulate these markets through each other and also derive the expected results in these markets and curb unnecessary volatility in them.

Empirical Results:

Table Number 1 Correlation Matrix						Source: E-Views Output			
	BSE	NSE	M3	IIP	GOLD	FIIS	ER	CRUDE	CPI
BSE	1.000								
NSE	0.999	1.000							
M3	0.665	0.685	1.000						
IIP	0.667	0.679	0.769	1.000					
GOLD	0.593	0.617	0.958	0.750	1.000				
FIIS	0.453	0.467	0.279	0.296	0.281	1.000			
ER	0.280	0.304	0.713	0.410	0.681	0.433	1.000		
CRUDE	0.544	0.549	0.599	0.526	0.597	-0.045	0.205	1.000	
CPI	0.692	0.710	0.994	0.767	0.949	0.285	0.702	0.599	1.000

The above table represents the correlation among selected economic indicators and stock markets. As such BSE and NSE shows high positive correlation (0.999) which indicates both are moving in almost same direction. Further low positive correlation is found in BSE with Exchange Rates (0.20) and Foreign Institutional Investments (0.453). The same situation we can see in
NSE with Exchange Rates (0.304) and Foreign Institutional Investments (0.467). Almost all variables are positively correlated with each other but Foreign Institutional Investments and crude is having negative correlation (-0.045) and which also very low.

ADF Test statistics

Table Number 2 ADF Test Statistics				
Variables	Levels		First Difference	
	Test Stat	Prob.	Test Stat	Prob.
BSE	-2.7112	0.2355	-7.8993	0.0000
NSE	-2.8307	0.1915	-8.1043	0.0000
CPI	-1.9479	0.6177	-6.8191	0.0000
Crude Oil	-2.2097	0.4766	-5.5001	0.0001
ER	-0.532	0.9796	-6.0447	0.0000
FIIs	-4.6925	0.0018	-8.1043	0.0000
Gold	-0.6653	0.9711	-7.098	0.0000
IIP	-5.7026	0.0001	-13.537	0.0000
M3	-3.1028	0.1145	-9.103	0.0000

Source: E-Views Output

The above table indicates that all variables are non-stationary except FIIs and IIP at level data because all ADF test statistics are higher than ADF critical value in rest of all variables. On the contrary, all probability values are also greater than 0.05 expect FIIs and IIP. So we fail to reject null hypothesis and interpret that all variables have unit root and have stationarity problem. However, unit root tests reject the same null hypothesis in the first-differenced form of the series which indicate that in first differenced form, all the series are stationary. Therefore, each variable is integrated in order one, or I (1). So the Granger causality test which strongly demands that all variables must be in same order.
Now if all variables are in ordered, we can definitely test for causal relationship pair wise. But another thing which needs to take care of while testing for ganger causality is identify appropriate lag value. To identify the appropriate lag structure, the study used AIC: Akaike Information Criterion, SC: Schwarz Information Criterion, HQ: Hannan-Quinn Information Criterion. Followings are the results of lag length criteria obtained by applying VAR model.

Lag Order Selection:

Table Number 3 VAR Lag Order Selection Criteria						
Endogenous variables: BSE NSE CPI CRUDE ER FIIS GOLD IIP M3						
Lag	Log L	LR	FPE	AIC	SC	HQ
0	-3398.69	NA	1.19E+39	115.515	115.832	115.6388
1	-2931.28	776.3843	2.51E+33	102.4162	105.5854*	103.6533
2	-2846.74	114.6297	2.67E+33	102.2963	108.3176	104.6467
3	-2748.16	103.5890*	2.51E+33	101.7004	110.574	105.1643
4	-2611.62	101.8287	1.30E+33	99.81762	111.5434	104.3949
5	-2402.74	92.04734	2.79e+32*	95.48282*	110.0608	101.1735*
* 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: E-Views Output

Above table represents the lag order selection criteria obtained from applying Vector Auto Regression (VAR) model. Among all criterions, lag length is ranging from 1 to 5. So we can include maximum lag of 5 for these sets of data. To perform this, first all variables are considered as endogenous and then pair wise VAR model is obtained. And further these gave the pair wise lag to be included for each pair. Followings are the obtained lag length and ganger causal test result pair wise.

Granger Causality Test

Table Number 4 Pair Wise Granger Causality Tests					
Null Hypothesis:	**Lag Order**	**Obs.**	**F-Statistic**	**Prob.**	**Decision**
NSE does not Granger Cause BSE	1	71	0.0155	0.9014	Accept
BSE does not Granger Cause NSE	1		0.1916	0.6629	Accept
CPI does not Granger Cause BSE	1	63	4.0270	0.0493	Reject
BSE does not Granger Cause CPI	1		1.7432	0.1918	Accept
CRUDE does not Granger Cause BSE	2	68	0.4817	0.6200	Accept
BSE does not Granger Cause CRUDE	2		5.3137	0.0074	Reject
ER does not Granger Cause BSE	5	63	2.5702	0.0375	Reject
BSE does not Granger Cause ER	5		8.9407	0.0000	Reject
FIIS does not Granger Cause BSE	1	63	1.4368	0.2354	Accept
BSE does not Granger Cause FIIS	1		0.0001	0.9915	Accept
GOLD does not Granger Cause BSE	1	63	3.3768	0.0711	Accept
BSE does not Granger Cause GOLD	1		0.0350	0.8523	Accept
IIP does not Granger Cause BSE	1	63	0.8928	0.3485	Accept
BSE does not Granger Cause IIP	1		10.1942	0.0022	Reject
M3 does not Granger Cause BSE	1	64	3.8800	0.0534	Accept
BSE does not Granger Cause M3	1		0.2847	0.5956	Accept

Source: E-Views Output

The above table shows the pair wise ganger causality test with different lag values which is obtained from leg length criteria. BSE does not ganger cause NSE, FIIs, Gold and M3 and vice a versa. That means their coefficients are not statistically significant. These variables are having no causal relation either a way. Moreover we can say that they are independent to each other.

Further we can see that unidirectional relationship is there between BSE and CPI means CPI does granger cause BSE but BSE does not granger cause CPI. Moreover, BSE does granger cause Crude Oil but Crude Oil does not granger cause BSE. Again BSE does granger cause IIP but IIP does not granger cause BSE.

Lastly, bi-directional causality is there between BSE and Exchange Rates as they are statistically significant in both the regressions. In other words, BSE does granger cause Exchange Rates and Exchange Rates does ganger cause BSE.

Conclusion:

The study concludes from the correlation statistics that almost all economic variables have positive relation with Indian stock market except Exchange rates and Foreign Institutional Investments. ER and FIIs is having low positive relations. Moreover, negative correlation is found between Crude Oil prices and Foreign Institutional Investments. Actually, the purpose of the study is to find the causality between Indian Stock Market and Indian macro-economic variables. So from causality test, it is concluded that BSE does not granger cause NSE, FIIs, Gold, M3, CPI while BSE does granger cause Crude Oil, Exchange Rates and Index of Industrial Production.

So, Indian Stock Market is not strong enough to influence the Indian Economy because majority of studies variables (expect Crude Oil, ER and IIP) does not influence by BSE. Indian Stock Market is still an under developed area of economy that contributes very less in development of Indian Economy.

The research suggest to Indian investors and policy maker to consider their investment policy by considering crude oil, exchange rates and index of industrial production because these are affected by stock market (BSE). On the other hand, Exchange rates and consumer price index also influence the stock market. So investors should consider these two variables while preparing their investment policy.

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