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"EVALUATING THE 'GRANGER CAUSALITY' WITH REGARD TO MACRO-ECONOMIC VARIABLES AND STOCK PRICE TO ANALYZE THE RESULTANT INFLUENCE"

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In 1991, government of India has introduced a series of policy measures to liberalize its economy to cope up with the ongoing process of globalization all over the world. Relaxation of licensing rule, rationalization of tax structure, enhancement of the ceiling of foreign direct investment and private participation are some of the outcomes of liberalization which has resultant impact in the integration of Indian economy with rest of the economies and has also resulted in increased share in international trade and increased foreign reserve. Stock market assumes a urgent part in developing ventures and business of a nation that in the end influence economy. Its significance has been all around recognized in enterprises and investors viewpoints. Money markets benefit long haul cash-flow to recorded firms by pooling stores from various investors and enable them to extend in business and furthermore offers financial specialists contrasting options to put their surplus supports in. The investors precisely watch the execution of stock market by watching the composite market record, before contributing assets. The market record gives an authentic stock market execution, the measuring stick to analyze the execution of individual portfolios and furthermore gives financial specialist to estimating future patterns in the market.

In any case, not at all like develop stock markets of cutting edge nations, the stock markets of rising economies started to grow quickly just in the last two and half decades. While there have been various endeavors to create and settle the stock markets, the developing economies are described as the most unpredictable stock exchanges Moreover, the stock exchanges of rising economies are probably going to be touchy to variables, for example, changes in the level of monetary exercises, changes in the political and worldwide financial condition and furthermore identified with the progressions in other macroeconomic elements.

Financial specialists assess the potential monetary essentials and other firm particular elements/qualities to figure assumptions about the stock markets. In a productive capital market, stock costs alter quickly as indicated by the new data accessible. Thus, the stock costs mirror all data about the stocks. Additionally they reflect desires without bounds exhibitions of corporate

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houses. In the event that stock costs mirror these presumptions in genuine, at that point it ought to be utilized as a noteworthy marker for the financial exercises. Thusly, the dynamic connection between stock costs and macroeconomic factors can be utilized to make country's macroeconomic strategies.

With the successive waves of globalization ,capital market cannot be far behind .Therefore, several reforms in the capital market have also been initiated such as opening up of the stock markets to foreign investors, enhancement of the regulatory power of SEBI, trading in derivatives etc. which have resulted in remarkable development in the size and depth of stock markets in India A perception of the macro dynamics of Indian stock market can be helpful for traders, investors policy makers of the country.

Bombay Stock Exchange (BSE) Sensex have been considered as the proxy of the Indian stock market for present study. Bombay Stock Exchange Ltd., Mumbai, was established in 1875 as "The Native Share and Stock Brokers Association" (voluntary non-profit organization), has evolved over the years and is now one of premier exchange in the country.

OBJECTIVES OF THE STUDY:

In this study the major objective is to find out the causal relationship, if any, between stock market and real economic variables. It will shed light on the degree of integration of the two markets and how they affect each other. The specific sets of objectives of the study are as follow:

1. To study the causal relationship between Macro-economic variables i.e. Foreign Investment Inflow, Foreign Exchange rate, Gold prices, Crude oil prices, Interest rate and Index for Industrial Production on Stock prices.

2. To study the Bi-directional relationship Macro-economic variables and stock prices.

Research Methodology

Research is an unbiased, structured and sequential method of enquiry directed towards a clear implicit and explicit Objective.

Research Design

Exploratory Research: Exploratory research is research conducted for a problem that has not been clearly defined. It often occurs before we know enough to make conceptual distinctions or posit an explanatory relationship. Exploratory research helps determine the best research design, data collection method and selection of subjects.

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Causal Research: In this form of research the marketer tries to determine if the manipulation of one variable, called the independent variable, affects another variable, called the dependent variable. In essence, the marketer is conducting an experiment.

A Multiple regression model is designed to test the effects of Macroeconomic variables on Stock prices:

$$SP_t = \alpha + \beta 1\ GLD + \beta 2\ IIP + \beta 3\ OIL + \beta 4\ REER + \beta 5\ CMR + \beta 6 FII \quad \ldots\ldots(1)$$

Data collection and Explanatory Variables

1. **Stock Prices: -** The empirical investigation is carried out using Monthly data ranging from January 2004 to January 2014. The empirical investigation considers Bombay Stock Exchange (BSE) share price indices as proxy for Indian stock market.

2. **Macroeconomic variables**:- RBI's official website was used to get data from 2005 to 2014 for the following four macroeconomic variables:

- **Index for Industrial Production (IIP)**

  Index for Industrial production is utilized as intermediary to quantify the development rate in real part. Industrial production exhibits a measure of general monetary movement in the economy and influences stock prices through its effect on expected future money streams. Along these lines, it is normal that an expansion in Index for Industrial production is decidedly identified with stock prices. The IIP and stock prices are emphatically related in light of the fact that increase in IIP brings about increment in production of industrial sector that leads to increase in profit of industries and corporations. As profit expands, it brings about increment in share costs. In this way, it is relied upon to have positive connection amongst IIP and share prices as indicated by economic theory.

- **Crude oil Prices (OIL)**

  Crude oil is a crucial contribution for production and in this way, the cost of oil is incorporated as an intermediary for real monetary movement. India is to a great extent a shipper of crude oil and subsequently, oil value participates a basic part in Indian economy. It is clear that any key development in oil costs prompts vulnerabilities in the stock market which could convince investors to suspend or postpone their investments. In addition, increment in oil costs brings about higher transportation, generation and warming cost which have negative impact on corporate gaining. Rising fuel costs additionally raise caution about expansion and reduce purchasers optional spending. In this way, the financial danger of

investments increments when there is wide variance in oil cost. In this way for oil bringing in nations like India, an expansion in oil cost will prompt an increment underway expenses and subsequently to diminished future income, prompting a negative effect on money markets. In this manner, an expansion in oil costs in global market implies bring down real monetary movement in all divisions which will make stock prices fall.

- **Gold Price (GLD)**

  Gold is a substitute venture road for Indian investors. As the gold value rises, Indian investors have a tendency to put less in stock and more in gold to show signs of improvement returns. This outcomes in fall in stock prices. In this way, negative connection exists between gold cost and stock price.

- **Wholesale Price Index (WPI**)

  A record that measures and tracks the adjustments in cost of merchandise in the phases previously the retail level. Discount cost records (WPIs) report month to month to demonstrate the normal value changes of products sold in mass, and they are a gathering of the pointers that take after development in the economy.

Data Analysis

With a view to fulfill the stipulated set of targets of the investigation, diverse strategies have been embraced. As a matter of first importance, to satisfy the research objectives, Correlation is utilized to discover if any connection exist between stock market prices and macroeconomic variables. At that point the formal examination is done by looking at the stochastic properties of the factors by utilizing Unit Root Test to test the stationarity of the factors. In this unique circumstance, the generally utilized procedure is Augmented Dickey Fuller (ADF). In the event that the factors don't have unit root issue then Granger causality can be evaluated.

Augmented Dickey Fuller test (ADF) and Granger causality testing have been finished utilizing Eviews.

Unit Root Test

When managing time arrangement information, various econometric issues can impact the estimation of parameters utilizing OLS. Relapsing a period arrangement variable on some other time arrangement variable utilizing Ordinary Least Square (OLS) estimation can acquire a high R^2 in spite of the fact that there is no important connection between them. This circumstance mirrors the issue of spurious relapse between absolutely random factors created by a non-stationary process. The majority of the Macroeconomic information are non-stationary i.e. they tend to display

deterministic or/and stochastic pattern. Thusly, unit root test is directed to complete to test for the request of joining. An arrangement is said to be stationary if mean and fluctuation are time – invariant. A non stationary time arrangement will have a period subordinate mean and fluctuation i.e. information fluctuates with time. In this way, it is inferred that mean [(E (Yt)] and the fluctuation [Var (Yt)] of Y stays consistent after some time for all t. Since standard relapse investigation require that information arrangement be stationary, it is critical to decide if the arrangement utilized as a part of the relapse procedure is a distinction stationary or incline stationary.

Augmented Dickey-Fuller Model

Augmented Dickey-Fuller test is utilized to test the stationarity of data. The arrangement could be non stationary as a result of irregular walk or it takes after a particular pattern. To test the non stationarity it is basic to assess a regression that homes a mean, a loafer term (to test for distinction stationarity) and deterministic pattern term (to test for slant stationarity). Following condition checks the stationarity of time arrangement information utilized as a part of the examination:

$\Delta yt = \beta 1 + \beta 1t + \alpha\ yt\text{-}1 + \gamma\ \Sigma \Delta yt\text{-}1 + \varepsilon t$ Where t=1..... (2)

Where εt is the mistake term in the model of unit root test, with an invalid theory that variable has a unit root, i.e. variable is non-stationary. ADF relapse test for presence of the unit base of yt that speaks to all factor at day and age t. The test for unit root is directed on coefficient of yt-1 in the relapse. On the off chance that the coefficient is essentially not quite the same as zero (under zero) at that point the speculation that y contains a unit root is rejected. The invalid and elective theory for presence of unit root in factor yt is $H_0: \alpha = 0$ Versus $H_1: \alpha < 0$. Dismissal of the invalid theory indicates stationarity in the arrangement.

On the off chance that ADF test measurement (t-measurement) is less (in the total esteem) than the critical values of t, the invalid speculation of a unit pull can't be rejected for the time arrangement and subsequently, one can presume that the arrangement is a non-stationary at their levels. The unit pull test tests for the presence of a unit root in two cases: with capture just and with block and pattern to consider the effect of the pattern on arrangement.

Granger Causality Test

Causality is a sort of statistical feedback idea which is generally utilized as a part of working of anticipating models. Granger Causality test is a strategy for deciding if one time arrangement is noteworthy in anticipating another. The standard Granger test looks to decide if past estimations of variable predicts changes in another variable. Further, Granger Causality procedure measures the data given by one variable in clarifying the most recent estimation of another variable. What's more, it additionally says that variable Y is Granger caused by factor X if variable X helps with foreseeing

the estimation of variable Y. The invalid speculation that we test for this situation is that the X variable does not Granger cause variable Y and variable Y does not Granger cause variable X. In this manner, one variable (Xt) is said to granger cause another variable (Yt) if the slacked estimations of Xt can foresee Yt and the other way around.

Defining Granger Causality

Assume that we have three terms, Xt , Yt , and Wt , and that we first endeavor to gauge X t+1 utilizing past terms of X t and W t . We at that point endeavor to gauge X t+1 utilizing past terms of X t , Y t , and W t . On the off chance that the second gauge is observed to be more fruitful, as indicated by standard cost functions, at that point the past of Y seems to contain data helping in anticipating X t+1 that isn't in past X t or W t . Specifically, W t could be a vector of conceivable informative factors. In this manner, Y t would "Granger cause" X t+1 if (a) Y t happens before X t+1 ; and (b) it contains data helpful in anticipating X t+1 that isn't found in a gathering of other fitting factors.

..... (3)

where p is the most extreme number of lagged perceptions incorporated into the model, the framework A contains the coefficients of the model (i.e., the commitments of each slacked perception to the anticipated estimations of X 1 (t) and X 2 (t) , and E 1 and E 2 are residuals (forecast blunders) for each time arrangement. On the off chance that the change of E 1 (or E 2) is lessened by the incorporation of the X 2 (or X1) terms in the first (or second) condition, at that point it is said that X 2 (or X 1) Granger-(G)- causes X 1 (or X 2). At the end of the day, X 2 G-causes X 1 if the coefficients in A 12 are together altogether unique in relation to zero.

Hypothesis

In order to study granger causality between S&P BSE Sensex and Macroeconomic variables following hypothesis were formulated:

1. Null hypothesis (H_0) for evaluating existence of unit root (Augmented Dickey Fuller Test)

Let X be the macroeconomic variables which include Foreign exchange rate, crude oil prices, interest rate, gold prices, Index for Industrial Production, Foreign Investment Inflow and S&P BSE Sensex.

H_0: Variable X has a unit root

H_1: Variable X does not have unit root

2. Null hypothesis for evaluating granger causality between Macroeconomic variables and S&P BSE Sensex.

Let X include macroeconomic variables (Foreign exchange rate, crude oil prices, interest rate, gold prices, Index for Industrial Production and Foreign Investment Inflow)

Y: S&P BSE Sensex

H_0: X does not granger cause Y

H_1: X granger causes Y

H_0: Y does not granger cause X

H_1: Y granger causes X

Granger Causality Analysis: Macroeconomic variables and BSE Sensex

The purpose of the present study is to study the relationship that exists between the Macroeconomic variables and the stock prices (S&P BSE Sensex).The study attempts to derive the causality between the macroeconomic variables using various statistical and econometric tools. These tools solve the purpose to represent a true sketch of all these variables which are regarded to be "indicators" of an economy and to demonstrate how they are interrelated and interlinked to each other. The primary purpose of the present study is to study the granger causality among the variables and stock prices. But prior to study of such a causal relationship there is a need to understand whether the variables under study are stationary or not which can be analyzed using Augmented Dickey Fuller test.

Unit Root Testing using Augmented Dickey Fuller (ADF) Test

When dealing with time series data, a number of econometric issues can influence the estimation of parameters using OLS. Regressing a time series variable on another time series variable using Ordinary Least Square (OLS) estimation can obtain a very high R^2 although there is no meaningful relationship between them. This situation reflects the problem of spurious regression between totally unrelated variables generated by a non- stationary process. Most of the Macroeconomic data are non-stationary i.e. they tend to exhibit deterministic or/and stochastic trend. Therefore, unit root test is conducted to carry out to test for the order of integration. A series is said to be stationary if mean and variance are time –invariant. A non-stationary time series will have a time dependent

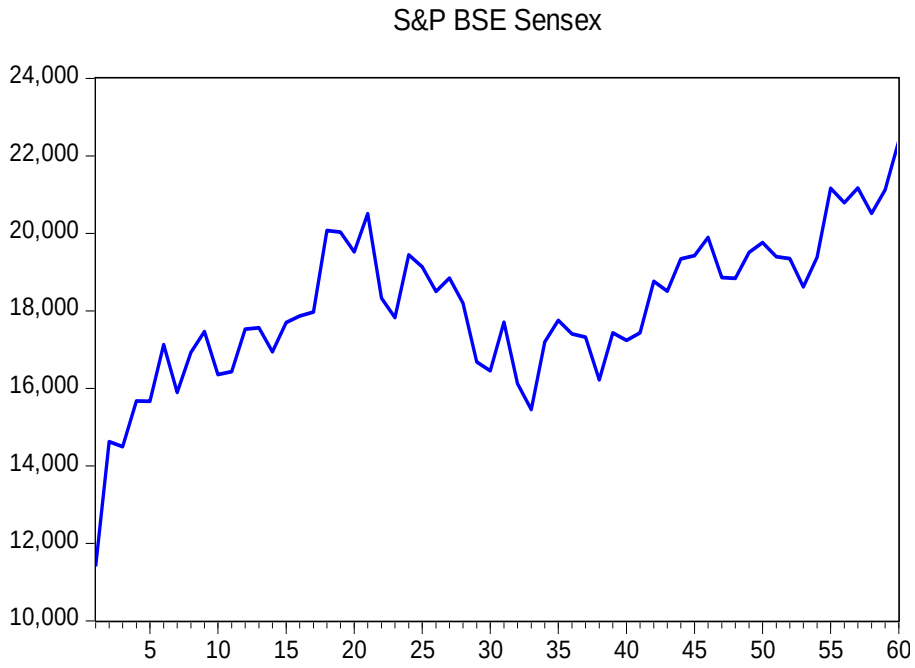
mean and variance i.e. data varies with time. Therefore, it is implied that mean [(E (Yt)] and the variance [Var (Yt)] of Y remains constant over time for all t. Since standard regression analysis require that data series be stationary, it is important to determine whether the series used in the regression process is a difference stationary or trend stationary.

In order to check whether the variables are stationary or not Augmented Dickey Fuller (ADF) test has been applied. Since, granger causality testing cannot be done on non-stationary variables

Data Analysis and Interpretation

1. **BSE Sensex**

The S&P BSE SENSEX (S&P Bombay Stock Exchange Sensitive Index), also-called the BSE 30 or simply the SENSEX, is a free-float market capitalization-weighted stock market index of 30 well-established and financially sound companies listed on BSE Ltd..



The above graph examines the pattern important for assumption in Augmented Dickey Fuller (ADF) test. The X-axis shows number of observation which is 60 while the Y-axis represents the BSE Sensex. The above figure shows an increasing trend in Sensex i.e. over a period of 5 years the Sensex have been rising. If a trend line is drawn form point '0' it can be observed that the values evolve around the trend line hence it can be proved that as time passes the observations trend upward and hence shows a time trend. On the other hand if we take the sample mean of BSE Sensex it come out to be18087. This value lies between 18,000 and 20,000 on Y-axis. If we draw a horizontal line from here we see that observations evolve around the mean. Thus it can be

concluded that the series evolve around a constant (Mean) and trend. Therefore, we need trend and a constant to check for stationary.

Assumption: To check whether BSE Sensex has a unit root or not we include trend and intercept.

Hypothesis (H_0): S&P BSE Sensex has a unit Root (non-stationary)

(H_1): S&P BSE Sensex does not have a unit root.

Case 1: Trend and Intercept (Level)

Null Hypothesis: SENSEX has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic - based on SIC, maxlag=10)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-3.923146	0.0170
Test critical values:	1% level	-4.121303	
	5% level	-3.487845	
	10% level	-3.172314	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(SENSEX)
Method: Least Squares
Date: 04/27/15 Time: 00:59
Sample (adjusted): 2 60
Included observations: 59 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
SENSEX(-1)	-0.333274	0.084951	-3.923146	0.0002
C	5597.708	1367.775	4.092564	0.0001
@TREND("1")	19.73597	9.143693	2.158425	0.0352

R-squared	0.219702	Mean dependent var	186.1529
Adjusted R-squared	0.191834	S.D. dependent var	991.5830
S.E. of regression	891.4137	Akaike info criterion	16.47300
Sum squared resid	44498629	Schwarz criterion	16.57864
Log likelihood	-482.9536	Hannan-Quinn criter.	16.51424
F-statistic	7.883725	Durbin-Watson stat	1.940855
Prob(F-statistic)	0.000962		

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On the basis of the graph, it was assumed that BSE Sensex follows a trend and evolve around a constant (Mean). Thus, we check for stationary using trend and intercept. Level represents that there is no difference in the variables. Comparing the critical values of t- statistic with actual values of t-statistic it can be observed that observed value of t- statistic i.e. -3.923146 is greater than the critical values at 1%, 5% and 10% level of significance. Hence it can be concluded that S&P BSE Sensex has a unit root i.e. data is non-stationary

Hence, H_0: S&P BSE Sensex has a unit root is accepted i.e. BSE Sensex observations are non-stationary. There are 1.70% chances of occurrence of an error. Therefore, we will check at first difference.

Case 2: Trend and Intercept (First Difference)

Null Hypothesis: D(SENSEX) has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 1 (Automatic - based on SIC, maxlag=10)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-7.207278	0.0000
Test critical values:	1% level	-4.127338	
	5% level	-3.490662	
	10% level	-3.173943	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(SENSEX,2)
Method: Least Squares
Date: 04/27/15 Time: 01:05
Sample (adjusted): 4 60
Included observations: 57 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(SENSEX(-1))	-1.469857	0.203941	-7.207278	0.0000
D(SENSEX(-1),2)	0.212456	0.125082	1.698529	0.0953
C	238.2240	261.4405	0.911198	0.3663
@TREND("1")	-1.176543	7.337342	-0.160350	0.8732

R-squared	0.617739	Mean dependent var	24.51860
Adjusted R-squared	0.596102	S.D. dependent var	1421.222
S.E. of regression	903.2294	Akaike info criterion	16.51742
Sum squared resid	43238641	Schwarz criterion	16.66079
Log likelihood	-466.7465	Hannan-Quinn criter.	16.57314

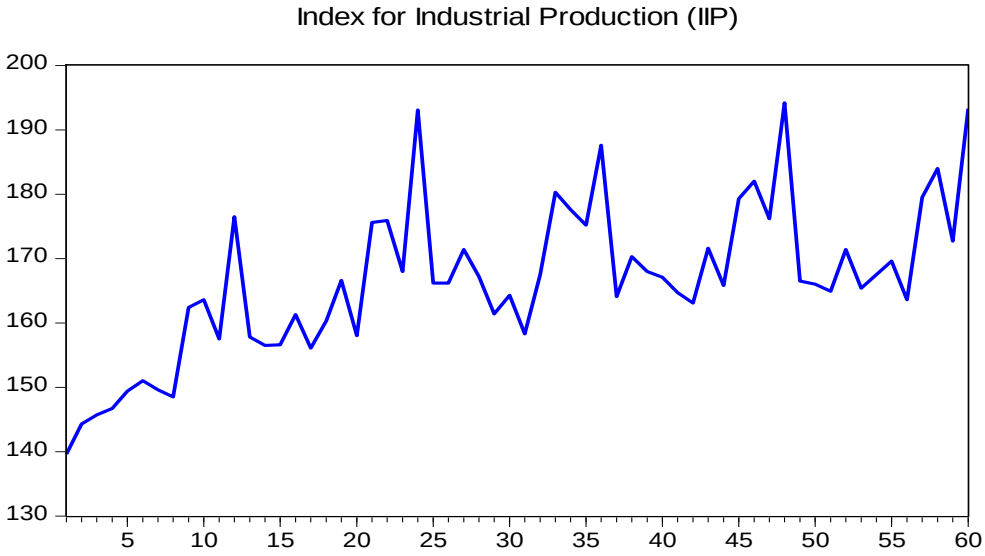
F-statistic	28.54957	Durbin-Watson stat	1.886286
Prob(F-statistic)	0.000000		

At first difference, it can be observed that observed value of t-statistic is less than the critical values of t-statistic. Hence, it can be concluded that S&P BSE Sensex does not have a unit root i.e. the observations of Sensex are stationary. The chance of committing an error is zero. Hence, H_0: S&P BSE Sensex has a unit root is rejected

Conclusion: H_0: S&P BSE Sensex has a unit root is rejected. Hence, it can be concluded that BSE Sensex observations are stationary.

Index for Industrial Production

Index of Industrial Production (IIP) is an abstract number, the magnitude of which represents the status of production in the industrial sector for a given period of time as compared to a reference period of time. IIP is a composite indicator that measures the short-term changes in the volume of production of a basket of industrial products during a given period with respect to that in a chosen base period.



The above graph examines the pattern important for assumption in Augmented Dickey Fuller (ADF) test. The X-axis shows number of observation which is 60 while the Y-axis represents the Index for Industrial Production. The above figure shows that initially there was a continuous increase and decrease in IIP. On the other hand if we take the sample mean of IIP it come out to be 166.6. This value ranges between 160-170 on Y-axis. If we draw a horizontal line from here we see

that observations evolve around the mean. Thus it can be concluded that the series evolve around a constant (Mean) and trend. Therefore, we need trend and a constant to check for stationary.

Assumption: To check whether Index of Industrial production has a unit root or not we include trend and intercept.

Hypothesis (H_0): Index for Industrial Production has a unit Root (non-stationary)

(H_1): Index for Industrial Production does not have a unit root.

Case 1: Trend and Intercept (Level)

Null Hypothesis: IIP has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 3 (Automatic - based on SIC, maxlag=10)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-3.722284	0.0289
Test critical values:	1% level	-4.130526	
	5% level	-3.492149	
	10% level	-3.174802	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(IIP)
Method: Least Squares
Date: 04/26/15 Time: 22:59
Sample (adjusted): 5 60
Included observations: 56 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
IIP(-1)	-0.647281	0.173893	-3.722284	0.0005
D(IIP(-1))	-0.145114	0.175432	-0.827181	0.4121
D(IIP(-2))	0.137940	0.164722	0.837410	0.4063
D(IIP(-3))	0.379803	0.131438	2.889605	0.0057
C	101.2683	26.97776	3.753772	0.0005
@TREND("1")	0.240918	0.093606	2.573733	0.0131

R-squared	0.499204	Mean dependent var	0.832143
Adjusted R-squared	0.449125	S.D. dependent var	10.73475
S.E. of regression	7.967438	Akaike info criterion	7.089560
Sum squared resid	3174.003	Schwarz criterion	7.306562
Log likelihood	-192.5077	Hannan-Quinn criter.	7.173691

F-statistic	9.968230	Durbin-Watson stat	2.113926
Prob(F-statistic)	0.000001		

At level, observed value of t-statistic -3.722284 is greater than the critical values of t-statistic at 1%, 5% and 10% level of significance. Hence, null hypothesis that Index for Industrial production has a unit root is not rejected i.e. observations of crude oil prices is non-stationary. Moreover, there are 2.89% chances of occurrence of error. Therefore, we will check for stationary at first difference.

Case 2: Trend and Intercept (First Difference)

Null Hypothesis: D(IIP) has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 10 (Automatic - based on SIC, maxlag=10)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-9.361041	0.0000
Test critical values:	1% level	-4.161144	
	5% level	-3.506374	
	10% level	-3.183002	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(IIP,2)
Method: Least Squares
Date: 04/26/15 Time: 23:00
Sample (adjusted): 13 60
Included observations: 48 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(IIP(-1))	-10.86433	1.160590	-9.361041	0.0000
D(IIP(-1),2)	8.893611	1.096535	8.110653	0.0000
D(IIP(-2),2)	8.027583	0.982004	8.174693	0.0000
D(IIP(-3),2)	7.220389	0.861700	8.379237	0.0000
D(IIP(-4),2)	6.290487	0.769699	8.172659	0.0000
D(IIP(-5),2)	5.364074	0.670637	7.998480	0.0000
D(IIP(-6),2)	4.477504	0.563086	7.951722	0.0000
D(IIP(-7),2)	3.556384	0.467414	7.608641	0.0000
D(IIP(-8),2)	2.602881	0.380033	6.849088	0.0000
D(IIP(-9),2)	1.665799	0.255508	6.519557	0.0000
D(IIP(-10),2)	0.820348	0.117323	6.992219	0.0000
C	14.75262	2.858237	5.161440	0.0000

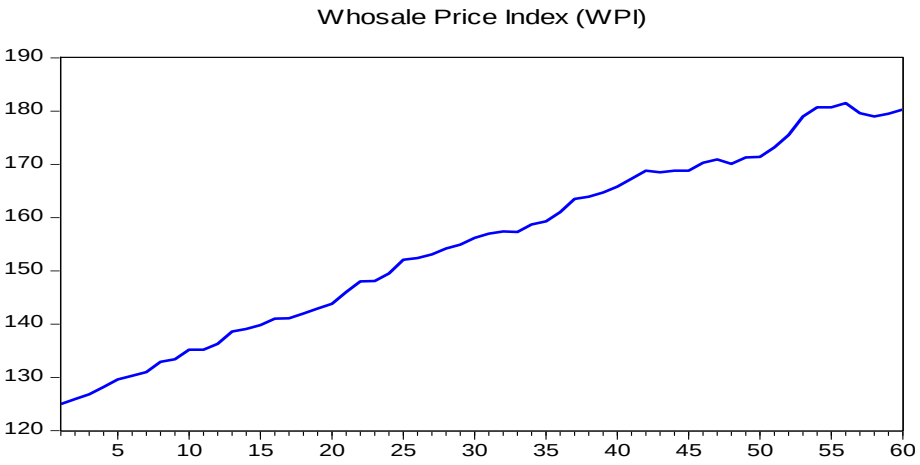
@TREND("1")	-0.294136	0.069020	-4.261578	0.0001
R-squared	0.946139	Mean dependent var		0.033333
Adjusted R-squared	0.927673	S.D. dependent var		19.26235
S.E. of regression	5.180366	Akaike info criterion		6.353442
Sum squared resid	939.2666	Schwarz criterion		6.860226
Log likelihood	-139.4826	Hannan-Quinn criter.		6.544956
F-statistic	51.23530	Durbin-Watson stat		1.993654
Prob(F-statistic)	0.000000			

At first difference, it can be observed that observed value of t-statistic is less than the critical values of t-statistic. Hence, it can be concluded that IIP does not have a unit root i.e. the observations of IIP are stationary. The chance of committing an error is zero. Hence, H_0: Index for Industrial Production has a unit root is rejected.

Conclusion: H_0: Index for Industrial Production has a unit root is rejected. The observations of Index for Industrial Production are stationary.

2. Wholesale price index

The Wholesale Price Index (WPI) is the price of a representative basket of wholesale goods. The wholesale price index (WPI) is based on the wholesale price of a few relevant commodities of over 240 commodities available. An index that measures and tracks the changes in price of goods in the stages before the retail level. Wholesale price indexes (WPIs) report monthly to show the average price changes of goods sold in bulk, and they are a group of the indicators that follow growth in the economy.



The above graph examines the pattern important for assumption in Augmented Dickey Fuller (ADF) test. The X-axis shows number of observation which is 60 while the Y-axis represents the Wholesale price index. The above figure shows that initially there was a continuous increase in WPI however maintained a consistent rise and hence the trend which can be noticed is increasing

one. On the other hand if we take the sample mean of WPI it come out to be155.1067. This value ranges between 150-160 on Y-axis. If we draw a horizontal line from here we see that observations evolve around the mean. Thus it can be concluded that the series evolve around a constant (Mean) and trend. Therefore, we need trend and a constant to check for stationary.

Assumption: To check whether Index of Industrial production has a unit root or not we include trend and intercept.

Hypothesis (H_0): Index for WPI has a unit Root (non-stationary)

(H_1): Index for WPI does not have a unit root.

Case 1: Trend and Intercept (level)

Null Hypothesis: WPI has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 1 (Automatic - based on SIC, maxlag=10)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.590526	0.2861
Test critical values:	1% level	-4.124265	
	5% level	-4.124265	
	10% level	-3.173114	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(WPI)
Method: Least Squares
Date: 04/26/15 Time: 22:40
Sample (adjusted): 3 60
Included observations: 58 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
WPI(-1)	-0.228904	0.088362	-2.590526	0.0123
D(WPI(-1))	0.305593	0.139021	2.198181	0.0322
C	29.50797	10.99793	2.683047	0.0097
@TREND("1")	0.218581	0.087636	2.494205	0.0157

R-squared	0.157404	Mean dependent var	0.937931
Adjusted R-squared	0.110593	S.D. dependent var	0.910721
S.E. of regression	0.858886	Akaike info criterion	2.600112
Sum squared resid	39.83504	Schwarz criterion	2.742212
Log likelihood	-71.40325	Hannan-Quinn criter.	2.655463

F-statistic	3.362546	Durbin-Watson stat	2.079323
Prob(F-statistic)	0.025185		

On the basis of the graph, it was assumed that WPI follows a trend and evolve around a constant (Mean). Thus, we check for stationary using trend and intercept. Level represents that there is no difference in the variables. Comparing the critical values of t- statistic with actual values of t-statistic it can be observed that observed value of t- statistic i.e. -2.518430 is greater than the critical values at 1%, 5% and 10% level of significance. Hence it can be concluded that WPI has a unit root i.e. data is non stationary

1% level of Significance= Observed value > Critical value -2.590526> -4.124265

5% level of significance= Observed value> Critical value -2.590526> -4.124265

10% level of significance= observed value> critical value -2.590526> -3.173114

Hence, H_0: WPI has a unit root is accepted i.e. WPI observations are non stationary. There are 28.61% chances of occurrence of an error. Therefore, we will check at first difference.

Case 2: Trend and Intercept (1st difference)

Null Hypothesis: D(WPI) has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic - based on SIC, maxlag=10)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-6.335360	0.0000
Test critical values:	1% level	-4.124265	
	5% level	-3.489228	
	10% level	-3.173114	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(WPI,2)
Method: Least Squares
Date: 04/26/15 Time: 22:45
Sample (adjusted): 3 60
Included observations: 58 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(WPI(-1))	-0.842957	0.133056	-6.335360	0.0000
C	1.026769	0.294114	3.491061	0.0010

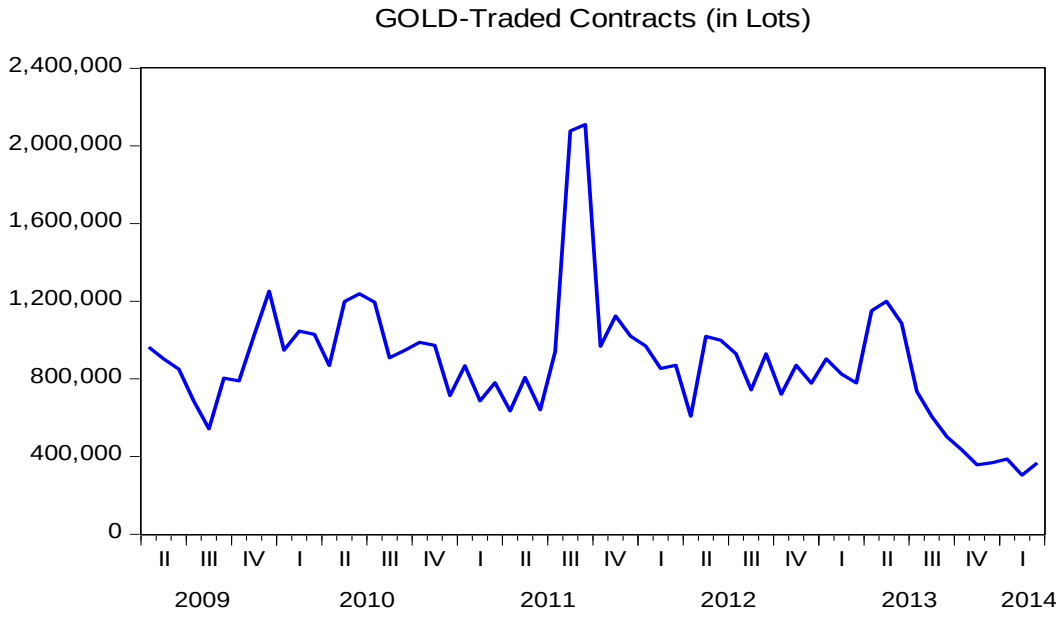
@TREND("1")	-0.007751	0.007174	-1.080355	0.2847
R-squared	0.421897	Mean dependent var		-0.001724
Adjusted R-squared	0.400875	S.D. dependent var		1.165813
S.E. of regression	0.902376	Akaike info criterion		2.682767
Sum squared resid	44.78553	Schwarz criterion		2.789342
Log likelihood	-74.80025	Hannan-Quinn criter.		2.724280
F-statistic	20.06939	Durbin-Watson stat		1.988339
Prob(F-statistic)	0.000000			

At first difference, it can be observed that observed value of t-statistic is less than the critical values of t-statistic. Hence, it can be concluded that WPI does not have a unit root i.e. the observations of WPI are stationary. The chance of committing an error is zero. Hence, H_0: WPI has a unit root is rejected

Conclusion: H_0: WPI has a unit root is rejected. Hence, it can be concluded that WPI observations are stationary.

3. Gold Prices

Of all the precious metals, gold is the most popular as an investment. Investors generally buy gold as a hedge or harbor against economic, political, or social fiat currency crises (including investment market declines, burgeoning national debt, currency failure, inflation, war and social unrest).



The above graph examines the pattern important for assumption in Augmented Dickey Fuller (ADF) test. The X-axis shows number of observation which is 60 while the Y-axis represents the Gold Prices. The above figure shows an increasing trend in Gold prices i.e. over a period of 5 years the gold prices have been rising. If a trend line is drawn form point '0' it can be observed that the values evolve around the trend line hence it can be proved that as time passes the observations trend upward and hence shows a time trend. On the other hand if we take the sample mean of Gold prices it come out to be 864102.517. This value lies between 800000 and 1200000 on Y-axis. If we draw a horizontal line from here we see that observations evolve around the mean. Thus it can be concluded that the series evolve around a constant (sample Mean) and trend. Therefore, we need trend and a constant to check for stationary.

Assumption: To check whether Gold Prices has a unit root or not we include trend and intercept.

Hypothesis (H_0): Gold Prices has a unit Root (non-stationary)

(H_1): Gold Prices does not have a unit root.

Case1: Trend and Intercept (Level)

Null Hypothesis: TRADED_CONTRACTS_IN_LOT has a unit root Exogenous: Constant, Linear Trend Lag Length: 0 (Automatic - based on SIC, maxlag=10)			
		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-3.563672	0.0419
Test critical values:	1% level	-4.121303	
	5% level	-3.487845	
	10% level	-3.172314	
*MacKinnon (1996) one-sided p-values.			

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(TRADED_CONTRACTS_IN_LOT)
Method: Least Squares
Date: 04/27/15 Time: 01:48
Sample (adjusted): 2009M05 2014M03
Included observations: 59 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
TRADED_CONTRACTS_IN_LOT(-1)	-0.379668	0.106539	-3.563672	0.0008
C	412209.3	129812.5	3.175421	0.0024
@TREND("2009M04")	-2828.347	1982.608	-1.426579	0.1593

R-squared	0.186742	Mean dependent var	-10114.05
Adjusted R-squared	0.157697	S.D. dependent var	270143.6
S.E. of regression	247929.8	Akaike info criterion	27.72919
Sum squared resid	3.44E+12	Schwarz criterion	27.83483
Log likelihood	-815.0111	Hannan-Quinn criter.	27.77042
F-statistic	6.429435	Durbin-Watson stat	1.803413
Prob(F-statistic)	0.003065		

At level, observed value of t-statistic -3.563672 is greater than the critical values of t-statistic. Hence, null hypothesis that Gold prices has a unit root is not rejected i.e. observations of Gold prices is non-stationary. Moreover, there are 4.19% chances of error which is huge chance of occurrence of error. Therefore, we will check for stationary at first difference.

Case 2: Trend and Intercept (First difference)

Null Hypothesis: D(TRADED_CONTRACTS_IN_LOT) has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 1 (Automatic - based on SIC, maxlag=10)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-7.186853	0.0000
Test critical values:	1% level	-4.127338	
	5% level	-3.490662	
	10% level	-3.173943	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(TRADED_CONTRACTS_IN_LOT,2)
Method: Least Squares
Date: 04/27/15 Time: 01:49
Sample (adjusted): 2009M07 2014M03
Included observations: 57 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(TRADED_CONTRACTS_IN_LOT(-1))	-1.381812	0.192269	-7.186853	0.0000
D(TRADED_CONTRACTS_IN_LOT(-1),2)	0.290014	0.131451	2.206251	0.0317
C	29746.96	76127.49	0.390752	0.6975
@TREND("2009M04")	-1358.778	2174.392	-0.624900	0.5347

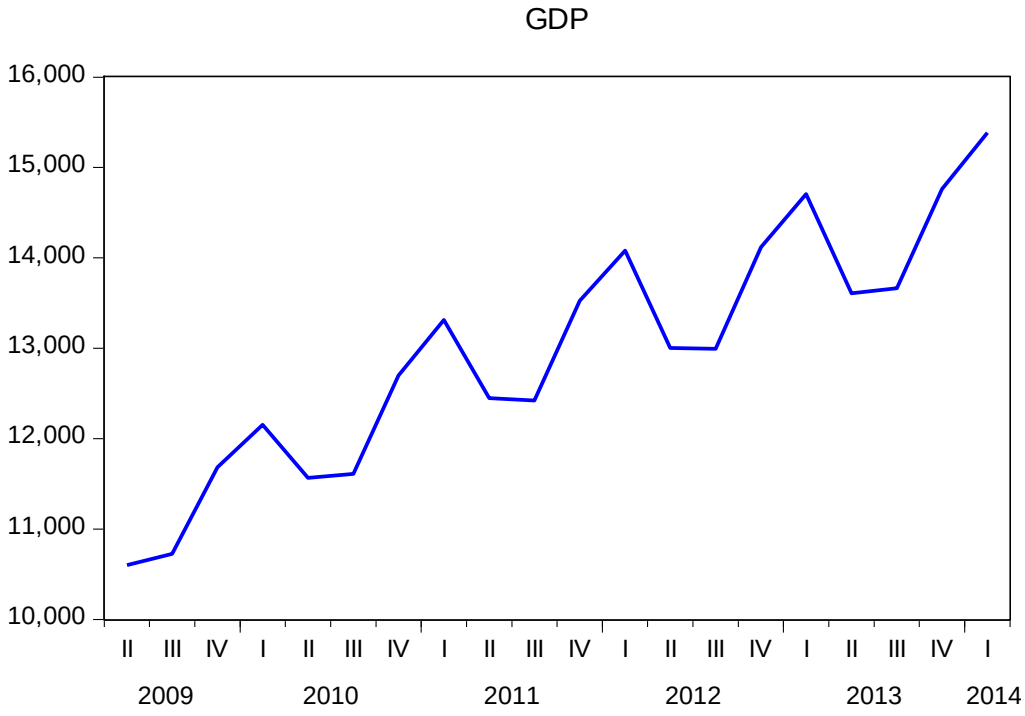
R-squared	0.574638	Mean dependent var	2039.930
Adjusted R-squared	0.550561	S.D. dependent var	401407.6
S.E. of regression	269104.6	Akaike info criterion	27.91118
Sum squared resid	3.84E+12	Schwarz criterion	28.05455
Log likelihood	-791.4686	Hannan-Quinn criter.	27.96690
F-statistic	23.86656	Durbin-Watson stat	2.062089
Prob(F-statistic)	0.000000		

At first difference, it can be observed that observed value of t-statistic is less than the critical values of t-statistic. Hence, it can be concluded that Gold prices does not have a unit root i.e. the observations of Gold prices are stationary. The chance of committing an error is zero. Hence, H_0: Gold prices have a unit root is rejected

Conclusion: H_0: Gold prices have a unit root is rejected. Hence, Gold prices observations are stationary.

4. GROSS DOMESTIC PRODUCT

The monetary value of all the finished goods and services produced within a country's borders in a specific time period, though GDP is usually calculated on an annual basis.



The above graph examines the pattern important for assumption in Augmented Dickey Fuller (ADF) test. The X-axis shows number of observation which is 20 while the Y-axis represents the Gross Domestic Product i.e. GDP. The above figure shows that there is a fluctuating but increasing

trend in GDP i.e. over a period of 5 years the GDP have been rising. If a trend line is drawn form point '0' it can be observed that the values evolve around the trend line hence it can be proved that as time passes the observations trend upward and hence shows a time trend. On the other hand if we take the sample mean of GDP it come out to be 12953.02. This value lies between 12000 and 13000 on Y-axis. If we draw a horizontal line from here we see that observations evolve around the mean. Thus it can be concluded that the series evolve around a constant (Mean) and trend. Therefore, we need trend and a constant to check for stationary.

Assumption: To check whether GDP has a unit root or not we include trend and intercept.

Hypothesis: (H_0): GDP has a unit Root (non-stationary)

(H_1): GDP does not have a unit root.

CASE 1: Trend and Intercept (level)

Null Hypothesis: GDP has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 4 (Automatic - based on SIC, maxlag=4)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-1.833089	0.6379
Test critical values:	1% level	-4.728363	
	5% level	-3.759743	
	10% level	-3.324976	

*MacKinnon (1996) one-sided p-values.
Warning: Probabilities and critical values calculated for 20 observations
and may not be accurate for a sample size of 15

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(GDP)
Method: Least Squares
Date: 04/26/15 Time: 23:17
Sample (adjusted): 6 20
Included observations: 15 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
GDP(-1)	-0.482769	0.263364	-1.833089	0.1041
D(GDP(-1))	-0.140626	0.291458	-0.482493	0.6424
D(GDP(-2))	-0.212939	0.274103	-0.776855	0.4596

D(GDP(-3))	-0.403826	0.257941	-1.565573	0.1561
D(GDP(-4))	0.608307	0.278001	2.188142	0.0601
C	5701.072	2906.787	1.961297	0.0855
@TREND("1")	75.53488	48.36845	1.561656	0.1570

R-squared	0.992410	Mean dependent var	254.6093
Adjusted R-squared	0.986717	S.D. dependent var	776.8409
S.E. of regression	89.53200	Akaike info criterion	12.13179
Sum squared resid	64127.84	Schwarz criterion	12.46222
Log likelihood	-83.98846	Hannan-Quinn criter.	12.12827
F-statistic	174.3313	Durbin-Watson stat	1.963399
Prob(F-statistic)	0.000000		

On the basis of the graph, it was assumed that GDP follows a trend and evolve around a constant (Mean). Thus, we check for stationary using trend and intercept. Level represents that there is no difference in the variables. By comparing the observed value of t- statistic with critical values of t-statistic it can be observed that observed value of t- statistic i.e. -1.833089 is greater than the critical values at 1%, 5% and 10% level of significance. Hence it can be concluded that GDP has a unit root i.e. data is non-stationary.

Hence, H_0: GDP has a unit root is accepted i.e. GDP observations are non-stationary. But there are 63.79% chances of occurrence of an error. Therefore, we will check at first difference.

CASE 2: Trend and Intercept (1st difference)

Null Hypothesis: D(GDP) has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 3 (Automatic - based on SIC, maxlag=4)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-1.352147	0.8318
Test critical values:	1% level	-4.728363	
	5% level	-3.759743	
	10% level	-3.324976	

*MacKinnon (1996) one-sided p-values.
Warning: Probabilities and critical values calculated for 20 observations
and may not be accurate for a sample size of 15

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(GDP,2)
Method: Least Squares

Date: 04/26/15 Time: 23:20
Sample (adjusted): 6 20
Included observations: 15 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(GDP(-1))	-1.531792	1.132859	-1.352147	0.2093
D(GDP(-1),2)	0.098142	0.868931	0.112945	0.9126
D(GDP(-2),2)	-0.265916	0.579836	-0.458605	0.6574
D(GDP(-3),2)	-0.714813	0.305436	-2.340303	0.0440
C	402.4794	344.9510	1.166773	0.2733
@TREND("1")	-11.13937	11.44699	-0.973127	0.3559

R-squared	0.994636	Mean dependent var	80.58933
Adjusted R-squared	0.991655	S.D. dependent var	1101.145
S.E. of regression	100.5890	Akaike info criterion	12.34914
Sum squared resid	91063.27	Schwarz criterion	12.63236
Log likelihood	-86.61852	Hannan-Quinn criter.	12.34612
F-statistic	333.7418	Durbin-Watson stat	1.586189
Prob(F-statistic)	0.000000		

By comparing the observed value of t- statistic with critical values of t- statistic it can be observed that observed value of t- statistic i.e. -1.352147 is greater than the critical values at 1%, 5% and 10% level of significance. Hence it can be concluded that GDP has a unit root i.e. data is non-stationary.

Hence, H_0: GDP has a unit root is accepted i.e. GDP observations are non-stationary. But there are 83.18% chances of occurrence of an error. Therefore, we will check at second difference.

CASE 3: Trend and Intercept (2nd difference)

Null Hypothesis: D(GDP,2) has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 2 (Automatic - based on SIC, maxlag=4)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-29.22434	0.0001
Test critical values:	1% level	-4.728363	
	5% level	-3.759743	
	10% level	-3.324976	

*MacKinnon (1996) one-sided p-values.
Warning: Probabilities and critical values calculated for 20 observations
and may not be accurate for a sample size of 15

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(GDP,3)
Method: Least Squares
Date: 04/26/15 Time: 23:21
Sample (adjusted): 6 20
Included observations: 15 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(GDP(-1),2)	-4.240396	0.145098	-29.22434	0.0000
D(GDP(-1),3)	2.166786	0.083015	26.10111	0.0000
D(GDP(-2),3)	1.117628	0.070134	15.93552	0.0000
C	-52.01793	80.65592	-0.644936	0.5335
@TREND("1")	1.957657	6.347873	0.308396	0.7641

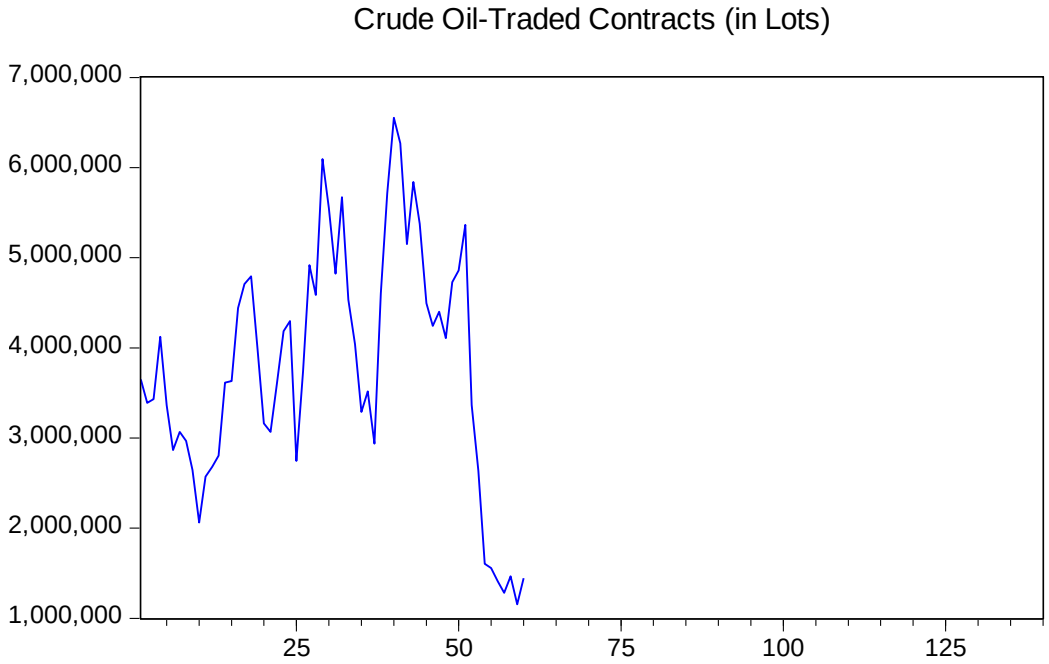
R-squared	0.997088	Mean dependent var	38.69600
Adjusted R-squared	0.995923	S.D. dependent var	1639.217
S.E. of regression	104.6720	Akaike info criterion	12.40074
Sum squared resid	109562.3	Schwarz criterion	12.63676
Log likelihood	-88.00557	Hannan-Quinn criter.	12.39823
F-statistic	855.8805	Durbin-Watson stat	1.866224
Prob(F-statistic)	0.000000		

At second difference, it can be observed that observed value of t-statistic is less than the critical values of t-statistic. Hence, it can be concluded that GDP does not have a unit root i.e. the observations of Sensex are stationary. The chance of committing an error is zero.

Therefore, H_0: GDP has a unit root is rejected. Hence, it can be concluded that GDP observations are stationary.

5. Crude Oil Prices

A naturally occurring, unrefined petroleum product composed of hydrocarbon deposits. Crude oil can be refined to produce usable products such as gasoline, diesel and various forms of petrochemicals. The fluctuation in the price of crude oil has bearing on inflation as increase in price of crude oil cause prices of petrol, diesel etc to rise thereby raising the cost of transportation and hence have trickledown effect on various industries.



The above graph examines the pattern important for assumption in Augmented Dickey Fuller (ADF) test. The X-axis shows number of observation which is 60 while the Y-axis represents the crude oil prices. The above figure shows trend in crude oil prices. If a trend line is drawn form point '0' it can be observed that the values evolve around the trend line hence it can be proved that as time passes the observations trend upward and downward hence shows a time trend. On the other hand if we take the sample mean of crude oil prices it come out to be 3786794.217. This value lies between 3000000-4000000 on Y-axis. If we draw a horizontal line from here we see that observations evolve around the mean. Thus it can be concluded that the series evolve around a constant (sample Mean) and trend. Therefore, we need trend and a constant to check for stationary. Assumption: To check whether Crude oil Prices has a unit root or not we include trend and intercept.

Hypothesis (H_0): Crude oil Prices has a unit Root (non-stationary)

(H_1): Crude oil Prices does not have a unit root.

Case 1: Trend and Intercept (Level)

Null Hypothesis: TRADED_CONTRACTS_IN_LOT has a unit root Exogenous: Constant, Linear Trend Lag Length: 0 (Automatic - based on SIC, maxlag=10)		
	t-Statistic	Prob.*

Augmented Dickey-Fuller test statistic		-1.751322	0.7155
Test critical values:	1% level	-4.121303	
	5% level	-3.487845	
	10% level	-3.172314	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(TRADED_CONTRACTS_IN_LOT)
Method: Least Squares
Date: 04/27/15 Time: 01:37
Sample (adjusted): 2009M05 2014M03
Included observations: 59 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
TRADED_CONTRACTS_IN_LOT(-1)	-0.125886	0.071881	-1.751322	0.0854
C	572179.7	332838.4	1.719092	0.0911
@TREND("2009M04")	-4262.624	5493.996	-0.775869	0.4411

R-squared	0.061868	Mean dependent var	-37402.20
Adjusted R-squared	0.028363	S.D. dependent var	729029.0
S.E. of regression	718616.0	Akaike info criterion	29.85755
Sum squared resid	2.89E+13	Schwarz criterion	29.96319
Log likelihood	-877.7978	Hannan-Quinn criter.	29.89879
F-statistic	1.846531	Durbin-Watson stat	1.837352
Prob(F-statistic)	0.167262		

At level, observed value of t-statistic-1.751322 is greater than the critical values of t-statistic at 1%, 5% and 10% level of significance. Hence, null hypothesis that crude oil prices has a unit root is not rejected i.e. observations of crude oil prices is non-stationary. Moreover, there are 71.55% chances of occurrence of error. Therefore, we will check for stationary at first difference.

Case 2: Trend and Intercept (First Difference)

Null Hypothesis: D(TRADED_CONTRACTS_IN_LOT) has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic - based on SIC, maxlag=10)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-7.351958	0.0000

Test critical values:	1% level	-4.124265
	5% level	-3.489228
	10% level	-3.173114

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(TRADED_CONTRACTS_IN_LOT,2)
Method: Least Squares
Date: 04/27/15 Time: 01:37
Sample (adjusted): 2009M06 2014M03
Included observations: 58 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(TRADED_CONTRACTS_IN_LOT(-1))	-0.992744	0.135031	-7.351958	0.0000
C	117574.6	203374.5	0.578119	0.5655
@TREND("2009M04")	-4944.329	5870.073	-0.842294	0.4033

R-squared	0.495655	Mean dependent var	9483.483
Adjusted R-squared	0.477315	S.D. dependent var	1027829.
S.E. of regression	743089.0	Akaike info criterion	29.92536
Sum squared resid	3.04E+13	Schwarz criterion	30.03193
Log likelihood	-864.8354	Hannan-Quinn criter.	29.96687
F-statistic	27.02614	Durbin-Watson stat	1.994152
Prob(F-statistic)	0.000000		

At first difference, it can be observed that observed value of t-statistic is less than the critical values of t-statistic i.e. -7.351958 is less than the critical values at 1%, 5% and 10% level of significance. Hence, it can be concluded that Crude oil prices does not have a unit root i.e. the observations of crude oil prices are stationary. The chance of committing an error is zero. Hence, H_0: Crude oil price has a unit root is rejected.

Conclusion: H_0: Crude oil price has a unit root is rejected. Thus observations of Crude oil Prices are stationary.

Existence of unit root in Macroeconomic variables and stock prices

Trend and Intercept/ Intercept							
Macroeconomic variables and stock prices	**Level (t-statistic)**	**p-value**	**Decision**	**First difference OR Second difference (t-statistic)**	**p-value**	**Decision**	**Existence of Unit root or not**
S&P BSE Sensex	-3.923146	0.0170	Accept	-7.207278 (1^{st} diff.)	0.0000	Reject	S&P BSE Sensex does not have a unit root
Wholesale Price Index	-2.590526	0.2861	Accept	-6.335360 (1^{st} diff.)	0.0000	Reject	Wholesale Price Index does not have a unit root
Gross Domestic Product	-1.833089	0.6379	Accept	-29.22434 (2^{nd} diff.)	0.0001	Reject	Gross Domestic Product does not have unit root
Index for Industrial Production	-3.722284	0.0289	Accept	-9.361041 (1^{st} diff.)	0.0000	Reject	Index for Industrial Production does not have unit root
Gold price	-3.260474	0.0214	Accept	-7.200408 (2nd diff.)	0.0000	Reject	Gold price does not have unit root
Crude oil	-1.751322	0.7155	Accept	-7.351958	0.0000	Reject	Crude oil price does not have unit root

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Granger Causality Test

Granger Causality test is a system for deciding if one time arrangement is huge in guaging another. The standard Granger test tries to decide if past estimations of variable predicts changes in another variable. Further, Granger Causality procedure measures the data given by one variable in clarifying the most recent estimation of another variable. Likewise, it additionally says that variable Y is Granger caused by factor X if variable X helps with foreseeing the estimation of variable Y. The invalid speculation that we test for this situation is that the X variable does not Granger cause variable Y and variable Y does not Granger cause variable X. In this way, one variable (Xt) is said to granger cause another variable (Yt) if the slacked estimations of Xt can anticipate Yt and the other way around.

Concept of Granger causality

Assume that we have three terms, X t , Y t , and W t , and that we first endeavor to gauge X t+1 utilizing past terms of X t and W t . We at that point endeavor to figure X t+1 utilizing past terms of X t , Y t , and W t . In the event that the second figure is observed to be more fruitful, as indicated by standard cost capacities, at that point the past of Y seems to contain data helping in estimating X t+1 that isn't in past X t or W t . Specifically, W t could be a vector of conceivable logical factors. Consequently, Y t would "Granger cause" X t+1 if (a) Y t happens before X t+1 ; and (b) it contains data helpful in determining X t+1 that isn't found in a gathering of other proper factors.

where p is the most extreme number of slacked perceptions incorporated into the model, the framework A contains the coefficients of the model (i.e., the commitments of each slacked perception to the anticipated estimations of X 1 (t) and X 2 (t) , and E 1 and E 2 are residuals (expectation mistakes) for each time arrangement. On the off chance that the difference of E 1 (or E 2) is decreased by the consideration of the X 2 (or X1) terms in the first (or second) condition, at that point it is said that X 2 (or X 1) Granger-(G)- causes X 1 (or X 2). At the end of the day, X 2 G-causes X 1 if the coefficients in A 12 are mutually altogether not the same as zero

1. **Index of Industrial Production and S&P BSE Sensex**

   Research problem: Whether Index of Industrial Production causes S&P BSE Sensex or/and S&P BSE Sensex causes Index of Industrial Production.

   Regression Model for checking Granger causality between two variables is as follow:

   - Regression model for IIP causes S&P BSE Sensex

     BSE Sensext=A_{11} IIP (t-j) + A_{12} BSE (t-j) + E (t)

   - Regression model for S&P BSE granger causes IIP

$$\mathbf{IIPt = A_{21}\ IIP\ (t\text{-}j) + A_{22}\ BSE\ (t\text{-}j) + E\ (t)}$$

Where, t-j is lagged values or the lag period

E (t): Residual value or the error term

A_{11}, A_{12}, A_{21}, A_{22} are the coefficients

Case 1: Index for Industrial production does not granger cause S&P BSE Sensex

Hypothesis (H_0): IIP does not granger cause S&P BSE Sensex

(H_1): IIP granger cause S&P BSE Sensex

Null Hypothesis	Lag Values	Observations	F-statistic	Prob.(p value)	Decision
Index for Industrial production does not granger cause BSE Sensex	1	59	7.11405	0.9310	Accept
Index for Industrial production does not granger cause BSE Sensex	2	58	0.05014	0.9511	Accept

According to above table, for lag values ranging from 0 to 2 p-values are always greater than 0.05. Therefore, null hypothesis that index for industrial production does not granger cause S&P BSE Sensex is accepted and IIP does not help in predicting Sensex.

H_0: Index for Industrial Production does not granger cause S&P BSE Sensex is accepted.

Case 2: S&P BSE Sensex does not granger cause Index for Industrial production

Hypothesis (H_0): S&P BSE Sensex does not granger cause Index for Industrial production

(H_1): S&P BSE Sensex granger causes Index for industrial production.

Null Hypothesis	Lag Values	Observations	F-statistic	Prob.(p value)	Decision
S&P BSE Sensex does not granger cause Index for Industrial production	1	59	7.11405	0.0100	Reject

S&P BSE Sensex does not granger cause Index for Industrial production	2	58	2.09950	0.1326	Accept

According to above table, at lag1 'p'-value is 0.0100 which is less than 0.05. Hence, it can thus be interpreted that S&P BSE Sensex granger cause IIPi.e. IIPcan be predicted using S&P BSE Sensex.

H_0: S&P BSE Sensex does not granger cause Index for Industrial production is rejected.

Values calculated using Eviews

AT LAG 1

Pairwise Granger Causality Tests
Date: 04/28/15 Time: 17:15
Sample: 2009M04 2014M03
Lags: 1

Null Hypothesis:	Obs	F-Statistic	Prob.
IIP does not Granger Cause SENSEX	59	0.00757	0.9310
SENSEX does not Granger Cause IIP		7.11405	0.0100

AT LAG 2

Pairwise Granger Causality Tests
Date: 04/28/15 Time: 17:15
Sample: 2009M04 2014M03
Lags: 2

Null Hypothesis:	Obs	F-Statistic	Prob.
IIP does not Granger Cause SENSEX	58	0.05014	0.9511
SENSEX does not Granger Cause IIP		2.09950	0.1326

Conclusion: It can be concluded that there exist unidirectional relationship between IIP and BSE Sensex. Since in Case 1 null hypothesis that S&P BSE Sensex does not granger cause IIP is accepted but in case 2 null hypothesis that IIP does not granger cause BSE Sensex is rejected. Therefore, it can be concluded that there exist a relationship between two variables.

2. Wholesale price index and Sensex

Research problem: Whether Wholesale price index causes S&P BSE Sensex or/and S&P BSE Sensex causes Wholesale price index.

Regression Model for checking Granger causality between two variables is as follow:

- Regression model for WPI causes S&P BSE Sensex

$BSE\ Sensex_t = A_{11}\ WPI\ (t-j) + A_{12}\ BSE\ (t-j) + E\ (t)$

- Regression model for S&P BSE granger causes IIP

$WPI_t = A_{21}\ WPI\ (t-j) + A_{22}\ BSE\ (t-j) + E\ (t)$

Where, t-j is lagged values or the lag period

E (t): Residual value or the error term

A_{11}, A_{12}, A_{21}, A_{22} are the coefficients

Case 1: WPI does not granger cause S&P BSE Sensex.

Hypothesis (H_0): WPI does not granger cause S&P BSE Sensex

(H_1): WPI granger cause S&P BSE Sensex

Null Hypothesis	Lag Values	Observations	F-statistic	Prob.(p value)	Decision
Wholesale Price Index does not granger cause BSE Sensex	1	59	3.71840	0.0589	Accept
Wholesale Price Index does not granger cause BSE Sensex	2	58	2.93378	0.0619	Accept
Wholesale Price Index does not granger cause BSE Sensex	4	56	1.03494	0.3992	Accept
Wholesale Price Index does not granger cause BSE Sensex	10	50	0.57929	0.8172	Accept
Wholesale Price Index does not granger cause BSE Sensex	14	46	0.81556	0.6461	Accept

Wholesale Price Index does not granger cause BSE Sensex	16	44	0.58408	0.8407	Accept

According to the above table from lag 1 to lag 16, P-values are more than 5% significant level. Which means that the null hypothesis i.e. WPI does not granger cause BSE Sensex is accepted.

Case 2: S&P BSE Sensex does not granger cause WPI.

Hypothesis (H_0): S&P BSE Sensex does not granger cause Wholesale Price Index

(H_1): S&P BSE Sensex granger causes Wholesale Price Index.

Null Hypothesis	Lag Values	Observations	F-statistic	Prob.(p value)	Decision
S&P BSE Sensex does not granger cause Wholesale Price Index	1	59	0.00713	0.9330	Accept
S&P BSE Sensex does not granger cause Wholesale Price Index	2	58	0.12101	0.8863	Accept
S&P BSE Sensex does not granger cause Wholesale Price Index	4	56	0.66427	0.6200	Accept
S&P BSE Sensex does not granger cause Wholesale Price Index	10	50	0.81202	0.6194	Accept
S&P BSE Sensex does not granger cause Wholesale Price Index	14	46	0.94041	0.5405	Accept
S&P BSE Sensex does not granger cause Wholesale Price Index	16	44	2.06834	0.1125	Accept

According to above table, from lag 1 to 16, P-values are more than 0.05. Therefore, the null hypothesis is accepted. Therefore, we can say that Sensex does not help in predicting WPI.

In simple words, H_0: S&P BSE Sensex does not granger cause Wholesale Price Index is accepted.

Values calculated using Eviews

AT LAG 1

Pairwise Granger Causality Tests
Date: 04/28/15 Time: 17:18
Sample: 2009M04 2014M03
Lags: 1

Null Hypothesis:	Obs	F-Statistic	Prob.
WPI does not Granger Cause SENSEX	59	3.71840	0.0589
SENSEX does not Granger Cause WPI		0.00713	0.9330

AT LAG 2

Pairwise Granger Causality Tests
Date: 04/28/15 Time: 17:18
Sample: 2009M04 2014M03
Lags: 2

Null Hypothesis:	Obs	F-Statistic	Prob.
WPI does not Granger Cause SENSEX	58	2.93378	0.0619
SENSEX does not Granger Cause WPI		0.12101	0.8863

AT LAG 3

Pairwise Granger Causality Tests
Date: 05/01/15 Time: 01:55
Sample: 2009M04 2014M03
Lags: 4

Null Hypothesis:	Obs	F-Statistic	Prob.
SENSEX does not Granger Cause WPI	56	0.66427	0.6200
WPI does not Granger Cause SENSEX		1.03494	0.3992

AT LAG 4

Pairwise Granger Causality Tests
Date: 05/01/15 Time: 01:56
Sample: 2009M04 2014M03
Lags: 10

Null Hypothesis:	Obs	F-Statistic	Prob.
SENSEX does not Granger Cause WPI	50	0.81202	0.6194
WPI does not Granger Cause SENSEX		0.57929	0.8172

AT LAG 5

Pairwise Granger Causality Tests
Date: 05/01/15 Time: 01:57
Sample: 2009M04 2014M03
Lags: 14

Null Hypothesis:	Obs	F-Statistic	Prob.
SENSEX does not Granger Cause WPI	46	0.94041	0.5405
WPI does not Granger Cause SENSEX		0.81556	0.6461

AT LAG 6

Pairwise Granger Causality Tests
Date: 05/01/15 Time: 01:59
Sample: 2009M04 2014M03
Lags: 16

Null Hypothesis:	Obs	F-Statistic	Prob.
SENSEX does not Granger Cause WPI	44	2.06834	0.1125
WPI does not Granger Cause SENSEX		0.58408	0.8407

Conclusion: It can be concluded that there exist neither bi-directional nor unidirectional relationship between WPI and BSE Sensex. Since in Case 1 null hypothesis that WPI does not granger cause BSE Sensex is accepted and similarly in case 2 null hypothesis that S&P BSE Sensex

does not granger cause WPI is accepted. Therefore, it can be concluded that there exist no relationship between two variables.

3. Gross Domestic Product and Sensex

Research problem: Whether GDP causes S&P BSE Sensex or/and S&P BSE Sensex causes GDP.

Regression Model for checking Granger causality between two variables is as follow:

- Regression model for IIP causes S&P BSE Sensex

  BSE Sensext=A_{11} GDP(t-j) + A_{12} BSE (t-j) + E (t)

- Regression model for S&P BSE granger causes IIP

  GDPt= A_{21} GDP (t-j) + A_{22} BSE (t-j) + E (t)

Where, t-j is lagged values or the lag period

E (t): Residual value or the error term

A_{11}, A_{12}, A_{21}, A_{22} are the coefficients.

Case 1: GDP does not granger cause S&P BSE Sensex

Hypothesis (H_0): GDP does not granger cause S&P BSE Sensex

(H_1): GDP granger cause S&P BSE Sensex

Null Hypothesis	Lag Values	Observations	F-statistic	Prob.(p value)	Decision
GDP does not granger cause S&P BSE Sensex	1	19	0.11745	0.7363	Accept
GDP does not granger cause S&P BSE Sensex	2	18	0.53932	0.5956	Accept
GDP does not granger cause S&P BSE Sensex	6	14	4909.03	0.0109	Reject

According to above table, at lag1and 2 'p' values is greater than 5% therefore H_0 is accepted. However, when lag value is increased to 6 p-value is 0.0257 which is less than 0.05. Hence, it can thus be interpreted that GDP granger cause S&P BSE Sensex i.e. BSE Sensex can be predicted using GDP.

H_0: GDP does not granger cause S&P BSE Sensex is rejected.

Case 2: S&P BSE Sensex does not granger GDP.

Hypothesis (H_0): S&P BSE Sensex does not granger cause GDP.

(H_1): S&P BSE Sensex granger causes GDP.

Null Hypothesis	Lag Values	Observations	F-statistic	Prob.(p value)	Decision
S&P BSE Sensex does not granger cause GDP.	1	19	1.23706	0.7363	Accept
S&P BSE Sensex does not granger cause GDP.	2	18	0.53932	0.5956	Accept
S&P BSE Sensex does not granger cause GDP.	6	14	0.67196	0.7317	Accept

According to above table, for lag values ranging from 0 to 6. P-values are always greater than 0.05. Therefore, null hypothesis that S&P BSE Sensex does not granger cause GDP is accepted and Sensex does not help in predicting GDP.

H_0: S&P BSE Sensex does not granger cause GDP is accepted.

Values calculated using Eviews

AT LAG 1

Pairwise Granger Causality Tests
Date: 04/28/15 Time: 17:22
Sample: 2009M04 2014M03
Lags: 1

Null Hypothesis:	Obs	F-Statistic	Prob.
GDP does not Granger Cause QUATERLY_SENSEX	19	0.11745	0.7363
QUATERLY_SENSEX does not Granger Cause GDP		1.23706	0.2825

AT LAG 2

Pairwise Granger Causality Tests
Date: 04/28/15 Time: 17:21
Sample: 2009M04 2014M03
Lags: 2

Null Hypothesis:	Obs	F-Statistic	Prob.
GDP does not Granger Cause QUATERLY_SENSEX	18	0.53932	0.5956
QUATERLY_SENSEX does not Granger Cause GDP		0.31845	0.7328

AT LAG 6

Pairwise Granger Causality Tests
Date: 04/30/15 Time: 19:59
Sample: 2009M04 2014M03
Lags: 6

Null Hypothesis:	Obs	F-Statistic	Prob.
SENSEX does not Granger Cause GDP	14	0.67196	0.7317
GDP does not Granger Cause SENSEX		4909.03	0.0109

Conclusion: It can be concluded that there exist unidirectional relationship between S&P BSE Sensex and GDP. Since from case 1 null hypothesis the GDP does not granger cause S&P BSE Sensex is rejected i.e. accepted. Hence, it can be concluded that GDP do not cause SENSEX. On the other hand in case 2 null hypothesis that S&P BSE Sensex does not granger cause GDP is

rejected hence SENSEX help in GDP .Therefore, there exist unidirectional relationship between S&P BSE Sensex and GDP.

4.Gold Prices and S&P BSE Sensex

Research Problem: Whether Gold prices granger causes S&P BSE Sensex or/and S&P BSE Sensex granger causes Gold prices.

Regression Model for checking Granger causality between two variables is as follow:

- Regression model for Gold prices causes S&P BSE Sensex

  BSE Sensext=A_{11} GLD (t-j) + A_{12} BSE (t-j) + E (t)

- Regression model for S&P BSE granger causes Gold prices

  GLDt= A_{21} GLD (t-j) + A_{22} BSE (t-j) + E (t)

Where, t-j is lagged values or the lag period

E (t): Residual value or the error term

A_{11}, A_{12}, A_{21}, A_{22} are the coefficients

Case 1: Gold prices does not granger cause S&P BSE Sensex

Hypothesis (H_0): gold prices does not granger cause S&P BSE Sensex

(H_1): gold prices granger cause S&P BSE Sensex

Null Hypothesis	Lag Values	Observations	F-statistic	Prob.(p value)	Decision
Gold prices does not granger cause S&P BSE Sensex	1	59	1.81763	0.1830	Accept
Gold prices does not granger cause S&P BSE Sensex	2	58	0.86745	0.4259	Accept
Gold prices does not granger cause S&P BSE Sensex	6	54	1.11282	0.3717	Accept

Gold prices does not granger cause S&P BSE Sensex	8	52	1.51110	0.1889	Accept
Gold prices does not granger cause S&P BSE Sensex	10	50	1.46855	0.2014	Accept
Gold prices does not granger cause S&P BSE Sensex	14	46	1.20030	0.3559	Accept
Gold prices does not granger cause S&P BSE Sensex	16	44	1.08094	0.4590	Accept
Gold prices does not granger cause S&P BSE Sensex	18	42	1.10409	0.5011	Accept

According to above table, at lag0 to18 'p' value is greater than 5% therefore H_0 is accepted. H_0: Gold prices does not granger cause S&P BSE Sensex is Accepted.

Case 2: S&P BSE Sensex does not granger cause Gold Prices

Hypothesis (H_0): S&P BSE Sensex does not granger cause Gold prices

(H_1): S&P BSE Sensex granger causes Gold prices.

Null Hypothesis	Lag Values	Observations	F-statistic	Prob.(p value)	Decision
S&P BSE Sensex does not granger cause Gold prices	1	59	0.70188	0.4057	Accept
S&P BSE Sensex does not granger cause Gold prices	2	58	0.79675	0.4561	Accept
S&P BSE Sensex does not granger cause Gold prices	6	54	0.85074	0.5388	Accept
S&P BSE Sensex does not granger cause Gold prices	8	52	1.30010	0.2755	Accept
S&P BSE Sensex does not	10	50	0.98998	0.4738	Accept

granger cause Gold prices					
S&P BSE Sensex does not granger cause Gold prices	14	46	0.56589	0.8564	Accept
S&P BSE Sensex does not granger cause Gold prices	16	44	0.54272	0.8707	Accept
S&P BSE Sensex does not granger cause Gold prices	18	42	0.47725	0.8868	Accept

Values calculated using Eviews

AT LAG 1

Pairwise Granger Causality Tests
Date: 04/28/15 Time: 17:35
Sample: 1 140
Lags: 1

Null Hypothesis:	Obs	F-Statistic	Prob.
TRADED_CONTRACTS__IN_LOT does not Granger Cause SENSEX	59	1.81763	0.1830
SENSEX does not Granger Cause TRADED_CONTRACTS__IN_LOT		0.70188	0.4057

AT LAG 2

Pairwise Granger Causality Tests
Date: 04/28/15 Time: 17:24
Sample: 1 140
Lags: 2

Null Hypothesis:	Obs	F-Statistic	Prob.
SENSEX does not Granger Cause TRADED_CONTRACTS__IN_LOT	58	0.86745	0.4259
TRADED_CONTRACTS__IN_LOT does not Granger Cause SENSEX		0.79675	0.4561

AT LAG 6

Pairwise Granger Causality Tests
Date: 05/01/15 Time: 18:36
Sample: 1 140
Lags: 6

Null Hypothesis:	Obs	F-Statistic	Prob.

TRADED_CONTRACTS__IN_LOT does not Granger Cause SENSEX	54	1.11282	0.3717
SENSEX does not Granger Cause TRADED_CONTRACTS__IN_LOT		0.85074	0.5388

AT LAG 8

Pairwise Granger Causality Tests
Date: 05/01/15 Time: 18:37
Sample: 1 140
Lags: 8

Null Hypothesis:	Obs	F-Statistic	Prob.
TRADED_CONTRACTS__IN_LOT does not Granger Cause SENSEX	52	1.51110	0.1889
SENSEX does not Granger Cause TRADED_CONTRACTS__IN_LOT		1.30010	0.2755

Conclusion: It can be concluded that there exist neither bi-directional nor unidirectional relationship between Gold prices and BSE Sensex. Since in Case 1 null hypothesis that Gold price does not granger cause S&P BSE Sensex is accepted and similarly in case 2 null hypothesis that S&P BSE Sensex does not granger cause Gold price is accepted. Therefore, it can be concluded that there exist no relationship between two variables.

5. Crude Oil prices and S&P BSE Sensex

Research Problem: Whether crude oil prices granger causes S&P BSE Sensex or/and S&P BSE Sensex granger causes crude oil prices.

Regression Model for checking Granger causality between two variables is as follow:

- Regression model for IIP crude oil prices causes S&P BSE Sensex

$$\textbf{BSE Sensext} = A_{11}\,\textbf{OIL (t-j)} + A_{12}\,\textbf{BSE (t-j)} + \textbf{E (t)}$$

- Regression model for S&P BSE granger causes crude oil prices

$$\textbf{OILt} = A_{21}\,\textbf{OIL (t-j)} + A_{22}\,\textbf{BSE (t-j)} + \textbf{E (t)}$$

Where, t-j is lagged values or the lag period

E (t): Residual value or the error term

A_{11}, A_{12}, A_{21}, A_{22} are the coefficients

Case 1: S&P BSE Sensex does not granger cause crude oil prices

Hypothesis (H_0): S&P BSE Sensex does not granger cause crude oil prices

(H_1): S&P BSE Sensex granger causes crude oil prices.

Null Hypothesis	Lag Values	Observations	F-statistic	Prob.(p value)	Decision
S&P BSE Sensex does not granger cause crude oil prices	1	59	0.41297	0.5231	Accept
S&P BSE Sensex does not granger cause crude oil prices	2	58	0.41090	0.6651	Accept

The base for acceptance or rejection of null hypothesis is comparing the p values with 5% level of significance. If p value is greater than 5% level of significance then null hypothesis is accepted and if 'p' value is less than 5% level of significance then null hypothesis is rejected.

In the above table when lag value is increased from lag 1 to lag 8 it can be observed that p values are significantly higher than the 5% or 0.05, therefore null hypothesis have been accepted or not rejected in all the cases.

H_0: S&P BSE Sensex does not granger cause crude oil prices is not rejected. Thus, S&P BSE Sensex doesn't help in predicting the crude oil prices.

Case 2: Crude oil prices does not granger cause S&P BSE Sensex

Hypothesis (H_0): crude oil prices does not granger cause S&P BSE Sensex

(H_1): crude oil prices granger cause S&P BSE Sensex

Null Hypothesis	Lag Values	Observations	F-statistic	Prob.(p value)	Decision
S&P BSE Sensex does not granger cause crude oil prices	1	59	0.54213	0.4646	Accept
S&P BSE Sensex does not granger cause crude oil prices	2	58	0.15038	0.8607	Accept

According to above table, at lag o to 2 'p' value is greater than 5% therefore H_0 is accepted.

H_0: Crude oil prices does not granger cause S&P BSE Sensex is Accepted.

Values calculated in Eviews

AT LAG 1

Pairwise Granger Causality Tests
Date: 04/28/15 Time: 17:41
Sample: 1 140
Lags: 1

Null Hypothesis:	Obs	F-Statistic	Prob.
SENSEX does not Granger Cause TRADED_CONTRACTS__IN_LOT	59	0.41297	0.5231
TRADED_CONTRACTS__IN_LOT does not Granger Cause SENSEX		0.54213	0.4646

AT LAG 2

Pairwise Granger Causality Tests
Date: 04/28/15 Time: 17:40
Sample: 1 140
Lags: 2

Null Hypothesis:	Obs	F-Statistic	Prob.
SENSEX does not Granger Cause TRADED_CONTRACTS__IN_LOT	58	0.41090	0.6651
TRADED_CONTRACTS__IN_LOT does not Granger Cause SENSEX		0.15038	0.8607

Conclusion: It can be concluded that there exist neither bi-directional nor unidirectional relationship between Crude oil and BSE Sensex. Therefore, it can be concluded that there exist no relationship between two variables.

Existence of Granger Causality and Relationship between variables

The table given below is the summary of granger causality test. Table reflects the acceptance and/or rejection of granger causality between variables and the kind of relationship (bi-directional, unidirectional) that exist between the variables.

Null Hypothesis	Lag Values	F-statistic	Prob.(p value)	Decision	Bi-direction/ unidirectional relationship
S&P BSE Sensex does not granger cause Index for Industrial production	1	7.11405	0.0100	Reject	Uni-directional
Index for Industrial Production does not granger cause S&P BSE Sensex	2	0.05014	0.9511	Accept	
S&P BSE Sensex does not granger cause WPI	16	2.06834	0.1125	Accept	No Relationship
WPI does not granger cause S&P BSE Sensex	16	0.58408	0.8407	Accept	
S&P BSE Sensex does not granger cause GDP	6	0.67196	0.7317	Accept	Unidirectional
GDP does not granger cause S&P BSE Sensex	6	4909.03	0.0109	Reject	
S&P BSE Sensex does not granger cause Gold prices	18	0.47725	0.8868	Accept	No Relationship
Gold prices does not granger cause S&P BSE Sensex	8	1.10409	0.5011	Accept	
S&P BSE Sensex does not granger cause crude oil prices	1	0.41090	0.6651	Accept	No Relationship
Crude oil prices does not granger cause S&P BSE Sensex	2	0.15038	0.8607	Accept	

Findings and Limitations

5.1 Findings

The primary motive of the present study was to analyze whether there exist granger causality between Macroeconomic variables and BSE Sensex. However, before undertaking this analysis it was essential to check whether the variables under study are stationary or not i.e. whether their mean and variance are invariant with time or show a specific trend. The analysis for checking stationarity or existence of unit root was done using Augmented Dickey Fuller test. The results were as follow:

- All variables including GDP, gold prices, crude oil prices, WPI, BSE Sensex and Index for Industrial production when plotted on graph showed trend and their observations were evolving around a constant called sample mean (Mean value of all the observations) therefore this suggested that stationarity be check at trend and intercept.

- On the basis of above findings augmented dickey fuller test was applied some variables were stationary at first difference and some at 2nd difference i.e. when there is difference between the values and not at level i.e. when there is no difference between the values. Since, all the variables were stationary therefore it can be interpreted that mean and variance for all these variables were time invariant. These findings can be briefly explained in table given below:

- **UNIT ROOT**

Null hypothesis	**t-statistic**	**P value**	**Decision**
S&P BSE Sensex has a unit root	-7.207278	0.0000	Reject
Wholesale Price Index has a unit root	-6.335360	0.0000	Reject
Gross Domestic Product has a unit root	-29.22434	0.0001	Reject
Index for Industrial Production has a unit root	-9.361041	0.0000	Reject
Gold price has a unit root	-29.22434	0.0000	Reject
Crude oil has a unit root	-7.351958	0.0000	Reject

Since it was proved through above analysis that all the variables are stationary; so granger causality test was applied. The data undertaken for the present study was a monthly data ranging from 2009-14 therefore the lag values could range between 1 to 18. The findings of granger causality are depicted in following table:

- **GRANGER CAUSALITY**

Null Hypothesis	**F-statistic**	**Prob.(p value)**	**Findings**
S&P BSE Sensex does not granger cause Wholesale Price Index	2.06834	0.1125	Accept(i.e. stock prices does not help in predicting the Wholesale price index and does not causes WPI to fluctuate)
Wholesale Price Index does not granger cause S&P BSE Sensex	0.58408	0.8407	Accept(i.e. WPI does not help in predicting the stock prices and does not causes stock prices to fluctuate)
Gross Domestic Product does not granger cause S&P BSE Sensex	4909.03	0.0109	Reject (GDP causes BSE Sensex and hence help in predicting the future trend of stock prices).
S&P BSE Sensex does not granger cause Gross Domestic Product	0.67196	0.7317	Accept (BSE Sensex does not cause GDP).
S&P BSE Sensex does not granger cause Index for Industrial production	7.11405	0.0100	Reject (Sensex help in predicting or it causes IIP).
Index for Industrial Production does not granger cause S&P BSE Sensex	0.00757	0.9310	Accept (IIP do not help in predicting stock price and hence does not cause stock prices to fluctuate).
S&P BSE Sensex does not granger cause Gold price	1.30010	0.2755	Accept (BSE Sensex does not cause gold price).
Gold price does not granger cause S&P BSE Sensex	1.51110	0.1889	Accept(i.e. gold price does not help in predicting the stock prices and does not causes stock prices to fluctuate)
S&P BSE Sensex does not granger cause Crude oil	0.41090	0.6651	Accept (BSE Sensex does not cause crude oil).
Crude oil does not granger cause S&P BSE Sensex	0.15038	0.8607	Accept(i.e. crude oil does not help in predicting the stock prices and does not causes stock prices to fluctuate)

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Granger causality is used to unravel the nature of causal relationship (unidirectional or bidirectional causality) that exists between the stock market and Macroeconomic variable. The findings are as follow:

1. **IIP AND SENSEX:** It can be concluded that there exist unidirectional relationship between IIP and BSE Sensex. Since in Case 1 null hypothesis that S&P BSE Sensex does not granger cause IIP is accepted but in case 2 null hypothesis that IIP does not granger cause BSE Sensex is rejected. Therefore, it can be concluded that there exist a relationship between two variables.

2. **WPI AND SENSEX:** It can be concluded that there exist neither bi-directional nor unidirectional relationship between WPI and BSE Sensex. Since in Case 1 null hypothesis that WPI does not granger cause BSE Sensex is accepted and similarly in case 2 null hypothesis that S&P BSE Sensex does not granger cause WPI is accepted. Therefore, it can be concluded that there exist no relationship between two variables.

3. **GDP AND SENSEX:** It can be concluded that there exist unidirectional relationship between S&P BSE Sensex and GDP. Since from case 1 null hypothesis the GDP does not granger cause S&P BSE Sensex is rejected i.e. accepted. Hence, it can be concluded that GDP do not cause SENSEX. On the other hand in case 2 null hypothesis that S&P BSE Sensex does not granger cause GDP is rejected hence SENSEX help in GDP .Therefore, there exist unidirectional relationship between S&P BSE Sensex and GDP.

4. **GOLD PRICE AND SENSEX:** It can be concluded that there exist neither bi-directional nor unidirectional relationship between Gold prices and BSE Sensex. Since in Case 1 null hypothesis that Gold price does not granger cause S&P BSE Sensex is accepted and similarly in case 2 null hypothesis that S&P BSE Sensex does not granger cause Gold price is accepted. Therefore, it can be concluded that there exist no relationship between two variables.

5. **CRUDE OIL AND SENSEX:** It can be concluded that there exist neither bi-directional nor unidirectional relationship between Crude oil and BSE Sensex. Therefore, it can be concluded that there exist no relationship between two variables.

5.2 LIMITATIONS

Since only 5 years have been undertaken for study therefore, their exist no relationship between some variables under study.

Conclusion

The key objective of the present study was to explore the impact of different macroeconomic variables on the stock prices in India using monthly data from period 2009 to 2014. In this study; the S&P BSE Sensitive index was used as a proxy for the Indian stock prices. The vital macroeconomic variables included in the study are Gross domestic product (GDP), Whole price index (WPI), Gold prices (GLD), Crude oil prices (OIL) and Index for Industrial Production (IIP).

The primary purpose of the present study was to check for existence of granger causality between Macroeconomic variables and S&P BSE Sensex .However, prior to study of such a relationship it was essential to check whether the variables undertaken for the study are stationary or not. A variable is said to be stationary if the mean and variance are time-invariant i.e. mean [E (Yt)] and the variance [Var (Yt)] of Y remains constant over time for all t. Therefore, a formal test of stationary i.e. Augmented Dickey Fuller test (ADF) was used to test for unit root. Graphical representation of each variable was used to analyze whether the variables depicted any trend or not and whether the observations evolve around constant called sample mean. Variables which depicted existence of both trend and whose observations evolved around mean were studied using trend and intercept. All variables including Gross domestic product, Gold prices, crude oil prices, Whole price index and Index for Industrial production evolved around mean and were following a particular trend.

After it was analyzed using graph whether to undertake the analysis using trend and intercept the econometric model was applied. Results showed stationary of all the variables at first difference and 2^{nd} difference and not at level. Since analysis of all the variables depicted stationarity therefore granger causality test could be applied.

Granger causality test is a technique for determining whether one time series is significant in forecasting another i.e. whether past values of variables help to predict changes in another variable. If there are two variables X and Y, then variable Y is granger caused by X if variable X assists in predicting the value of variable Y. The null hypothesis that we test in this case is that X does not granger cause Y and Y does not granger cause X.

The estimates of multivariate granger causality indicate that there exists unidirectional causality between Gross Domestic Product and BSE Sensex i.e. GDP causes BSE Sensex and not vice versa, Index for Industrial Production and BSE Sensex i.e. BSE Sensex causes IIP and not vice versa. There exist no causal relationship between BSE Sensex and Wholesale Price Index (WPI).On the other hand, that there exists neither bi-directional nor unidirectional relationship between Crude oil prices (OIL) nor Gold prices.

The results have implication on domestic as well as foreign investors, stock market regulators, policy makers and stock market analysts. Investors and stock market analysts could forecast stock

prices using mix of all the variables and hence can undertake buying or selling decision. The quantitative data analyzed in present study well relates with the perception of investors in the stock market and the qualitative data that is being presented in the news and media. The relationship between BSE Sensex and Macroeconomic variable could be well seen when we come across newspaper headlines of bullish and bearish market. Hence, it could be concluded that both Quantitative and Qualitative data depicts relationship between macroeconomic variable and BSE Sensex.

ANNEXURE

Annexure-1

Month	SENSEX	WPI	IIP	Gold Prices	Crude Oil Prices
9-Apr	11403.25	125	139.6	962913	3650692
9-May	14625.25	125.9	144.3	903509	3389258
9-Jun	14493.84	126.8	145.7	849566	3430757
9-Jul	15670.31	128.2	146.7	685993	4122330
9-Aug	15666.64	129.6	149.4	543199	3364276
9-Sep	17126.84	130.3	151.0	803479	2867974
9-Oct	15896.28	131	149.6	789597	3066007
9-Nov	16926.22	132.9	148.5	1021794	2968273
9-Dec	17464.81	133.4	162.4	1251544	2645063
10-Jan	16357.96	135.2	163.6	947665	2063651
10-Feb	16429.55	135.2	157.5	1045816	2572046
10-Mar	17527.77	136.3	176.5	1028942	2681569
10-Apr	17558.71	138.6	157.8	868194	2805302
10-May	16944.63	139.1	156.5	1198652	3614835
10-Jun	17700.9	139.8	156.6	1238228	3631230
10-Jul	17868.29	141	161.3	1194175	4442937
10-Aug	17971.12	141.1	156.1	908343	4707162
10-Sep	20069.12	142	160.3	947163	4794548
10-Oct	20032.34	142.9	166.6	988028	3992584
10-Nov	19521.25	143.8	158.0	972574	3162530
10-Dec	20509.09	146	175.6	714445	3068659
11-Jan	18327.76	148	175.9	867610	3608627
11-Feb	17823.4	148.1	168.0	687189	4186136
11-Mar	19445.22	149.5	193.1	779570	4296271
11-Apr	19135.96	152.1	166.2	634910	2743996
11-May	18503.28	152.4	166.2	807443	3740719
11-Jun	18845.87	153.1	171.4	640531	4918000

11-Jul	18197.2	154.2	167.2	940393	4585496
11-Aug	16676.75	154.9	161.4	2077107	6093396
11-Sep	16453.76	156.2	164.3	2109999	5550545
11-Oct	17705.01	157	158.3	967808	4824491
11-Nov	16123.46	157.4	167.5	1123501	5672910
11-Dec	15454.92	157.3	180.3	1019699.00	4533071
12-Jan	17193.55	158.7	177.6	969584.00	4040734
12-Feb	17752.68	159.3	175.2	853450.00	3290426
12-Mar	17404.2	161	187.6	869808	3516882
12-Apr	17318.81	163.5	164.1	607578.00	2937083
12-May	16218.53	163.9	170.3	1019039.00	4604948
12-Jun	17429.98	164.7	168.0	998315.00	5716827
12-Jul	17236.18	165.8	167.1	928965	6553550
12-Aug	17429.56	167.3	164.7	743139	6269479
12-Sep	18762.74	168.8	163.1	928681	5150314
12-Oct	18505.38	168.5	171.6	721539	5839258
12-Nov	19339.9	168.8	165.8	869663	5376066
12-Dec	19426.71	168.8	179.3	777848	4494662
13-Jan	19894.98	170.3	182.0	902974	4243535
13-Feb	18861.54	170.9	176.2	824977	4399400
13-Mar	18835.77	170.1	194.2	778512	4108995
13-Apr	19504.18	171.3	166.5	1150782	4728631
13-May	19760.3	171.4	166.0	1199863	4859413
13-Jun	19395.81	173.2	164.9	1085950	5363444
13-Jul	19345.7	175.5	171.4	735041	3366422
13-Aug	18619.72	179	165.4	606174	2636952
13-Sep	19379.77	180.7	167.5	501510	1603410
13-Oct	21164.52	180.7	169.6	433728	1555800
13-Nov	20791.93	181.5	163.6	357385	1410618
13-Dec	21170.68	179.6	179.5	367707	1281549
14-Jan	20513.85	179	184.0	387238	1464598
14-Feb	21120.12	179.5	172.7	303851	1155354
14-Mar	22386.27	180.3	193.3	366184	1443962

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Annexure-2

YEAR	GDP(Quaterly)	SENSEX (Quaterly)
2009-10		
Q1	10601.26	14493.84
Q2	10725.12	17126.84
Q3	11682.51	17464.81
Q4	12151.82	17527.77
2010-11		
Q1	11564.66	17700.9
Q2	11608.79	20069.12
Q3	12698.77	20509.09
Q4	13313.08	19445.22
2011-12		
Q1	12447.06	18845.87
Q2	12421.35	16453.76
Q3	13525.51	15454.92
Q4	14081.36	17404.2
2012-13		
Q1	13002.21	17429.98
Q2	12994.61	18762.74
Q3	14117.85	19426.71
Q4	14706.45	18835.77
2013-14		
Q1	13607.57	19395.81
Q2	13664.41	19379.77
Q3	14762.12	21170.68
Q4	15383.8	22386.27