RELATIONSHIP BETWEEN INFLATION MEASURED IN WHOLESALE PRICE INDEX (WPI) AND MOVEMENT IN INDIAN EQUITY MARKET

(Tapas Biswas[1] and Dr. Ajit Kumar Mishra[2])

ABSTRACT

This study is an attempt to understand the impact of Inflation (wholesale price index) on Indian capital market (BSE Sensex). For empirical estimation, this study has used monthly average data for the both the series for the period covering from April 2005 to March 2016. The study has used econometrics techniques such as Augmented Dickey Fuller Test, Johansen's Cointegration Test and Granger Causality Test. The findings of the empirical estimations suggest that there is a cointegrating relationship between WPI and BSE Sensex indicating a long-run relationship between both the variables. However, the Granger Causality test reveals that there is no causal relationship between BSE Sensex and WPI Inflation in the short run.

KEYWORDS: Growth Rates, Capital Market, Wholesale Price Index and BSE SENSEX

I. Introduction:

One of the strongest arguments for investing in stocks is that they provide protection against inflation. Market observers have often said that Federal Reserve chairman Paul Volcker's successful fight against US inflation in the late 1970s and early 1980s laid the groundwork for the huge Bull Run in the US stock markets in the 1990s.

The dilemma still remains that whether there is a similar correlation between inflation and the Indian stock market? Inflation based on wholesale price index (WPI) was at a very low 1.8% in March 2002, but that had no appreciable impact on the market—the Sensex was at 3,469 points at that time, marginally lower than in March 2001. During 1995-96, when the inflation rate had fallen to 4.5% by March 1996, after being as high as 16.9% a year earlier, but the Sensex only moved up from 3,260 to 3,366 between March 1995 and March 1996.

[1] Assistant General Manager, Reserve Bank of India, Bhubaneswar, Odisha.

[2] Assistant Professor, Department of Business Administration, Utkal University, Vani Vihar, Bhubaneswar, Odisha.

In March 1995, WPI inflation was at 16.9%, rising from 10.6% in the same month the previous year but the Sensex fell from 3,778 to 3,260 over the period. But between March 1993 and March 1994, the Sensex rallied 65%, although inflation increased from 7.1% to 10.6%. The above figures seem to indicate that the Sensex has little correlation with WPI inflation.

Does the kind of inflation make a difference? The argument that stocks are an inflation hedge is based on the premise that companies are able to raise prices during inflationary times, protecting their earnings. On the other hand, if input prices rise more than that for manufactured goods, then margins will be squeezed. On the contrary, fuel price inflation was at 10.4% in March 2005, but that had no appreciable impact on the Bull Run then. In 1993-94, in spite of big increases in inflation for primary articles and for fuel, the stock market rallied.

II. Review of Literature

Boucher (2006) examined the relationship between stock prices and inflation, by estimating the common long-term trend in the earning–price ratio and inflation. He found that the transitory deviations from this common trend exhibit substantial out-of-sample forecasting abilities for excess returns at short and intermediate horizons.

Alagidede and Panagiotidis (2012) examined the relationship between stock returns and inflation in the G7 countries (US, Canada, France, Germany, Italy, Japan and the UK). The findings of the study reveals that there are some positive coefficients in the distribution for Italy and the UK. A positive one-for-one relationship is found once a GARCH filter is employed in all cases except Canada.

Snowden and Munoz (2011) analysed portfolio equity inflows have been a feature of India's improved growth performance in recent years. This study examines a possible connection through the equity financing of capital formation by manufacturing firms. Emphasis is placed on the funding preferences of owner-controlled enterprises with the empirical results connecting equity issues to the management of gearing and the availability of internal funds. This context suggests strongly that equity and debt are complementary choices, although two channels of influence—macroeconomic and allocative—combine to encourage investment spending, with pro-cyclical implications.

Spierdijk and Umar (2015) examined that Inflation hedging is an important issue for long-term investors, even during prolonged periods of relatively low inflation. This study analyses the inflation-hedging properties of US stocks, bonds, and T-bills at the sub index level during the years 1983–2012. The analysis provides only partial confirmation of the hypothesis that, during the post-1980 period, the returns of cyclical stocks exhibit a more positive long-run relation with inflation than the returns of non-cyclical stocks. Stocks in both cyclical and non-cyclical industries have virtually no hedging ability until the fall of Lehman Brothers in September 2008. From that moment on, equity sub-indices particularly in the cyclical industries start to develop statistically significant but economically modest hedging ability, even in the short run. In contrast to T-bills, long positions in bonds turn out poor inflation hedges during the entire sample period, regard less of maturity, issuer, risk rating and investment horizon. Only short positions in long-term bond indices including Treasury bonds (with maturities of 10 years and longer) may have some long-run inflation hedging capacity.

Heer and Sussmuth (2007) studied the effects of a permanent change in inflation on the distribution of wealth are analysed in a general equilibrium OLG model that is calibrated with regard to the characteristics of the US economy. Poor agents accumulate savings predominantly in the form of money, while rich agents participate in the stock market and accumulate equity. Higher inflation results in higher nominal interest rates and a higher real tax burden on interest income. Surprisingly, an increase in inflation results in a lower stock market participation rate; in addition, savings decrease and the distribution of wealth becomes even more unequal.

Castaneda (2006) presented a theoretical framework to analyse the implications on economic growth of a stock market that grows but is not well-developed in other aspects (concentrated ownership, low liquidity, poor legal and judiciary systems, and credit constraints). Family firms are modelled as consisting of risk-averse owners concerned with keeping the control of their firms while deciding to go public. It is suggested that in this type of economies there may be a non-linear relationship between stock market size and economic growth and that, in particular, the formation of an equity market may retard economic growth when institutions are weak.

Vu (2015) studied the time series and cross-sectional responses of output to variation in stock market volatility across 27 countries over 40 years, controlling for a number of country-specific characteristics. High levels of stock market volatility are detrimental to future output growth not only after financial crises as previously emphasized, but also in non-crisis periods. Output growth and interest rates react negatively to a random shock to volatility and revert to their means quickly thereafter. Moreover, these results are robust after controlling for economic policy uncertainty, the level of financial development, and the direction of the market.

Narayan, Narayan and Mishra (2013) used the common structural break test suggested by Bai et al. (1998) to test for a common structural break in the stock prices of the US, the UK, and Japan. On the basis of the structural break, each country's stock price series is divided into sub-samples and is investigated whether or not the structural break had slowed down the growth of stock markets. The main findings indicated that when stock markets are modelled in a trivariate sense, the common structural break slowed down, with the confidence interval including several episodes, such as the asset price bubble when housing prices and stock prices in Japan reached a peak in 1988/1989, the early 1990s recession in the UK, the business cycle peak of July 1990, the August 1990 Iraqi invasion of Kuwait and the March 1991 business cycle trough. Annual average growth rates suggest that the structural break has slowed down the growth rate of the US, the UK and Japanese stock markets.

Bekaert and Engstrom (2010) derived a Fed model, which postulates that the dividend or earnings yield on stocks should equal the yield on nominal Treasury bonds, or at least that the two should be highly correlated. In US data there is indeed a strikingly high time series correlation between the yield on nominal bonds and the dividend yield on equities. This positive correlation is often attributed to the fact that both bond and equity yields commove strongly and positively with expected inflation. Contrary to some of the extant literature, we show that this effect is consistent with modern asset pricing theory incorporating uncertainty about real growth prospects and habit-based risk aversion. In the US, high expected inflation has tended to coincide with periods of heightened uncertainty about real economic growth and unusually high risk aversion, both of which rationally raise equity yields.

Angelidis, Sakkas and Tessaromatis (2015) provided evidence using data from the G7 countries suggesting that return dispersion may serve as an economic state variable in that it reliably predicts time-variation in economic activity, market returns, the value and momentum premium and market volatility. A relatively high return dispersion predicts a deterioration in business conditions, a higher value premium, a smaller momentum premium and lower market returns. Dispersion based market and factor timing strategies outperform out-of-sample buy and hold strategies. The evidence are robust to alternative specifications of return dispersion and are not driven by US data.

Browna, Huanga and Wang (2016) illustrates a large sensitivity of stocks' earnings yield to inflation suggesting that the value of these stocks is highly influenced by inflation illusion. An inflation illusion factor is created by buying stocks with large earnings yield sensitivities on inflation and selling stocks with small earnings yield Sensitivities on inflation. This factor has a return of approximately 5% per year and is priced in the cross sectional asset returns. Low asset growth stocks have greater exposure to the inflation illusion factor than their counterparts, and they are also under priced at times of high inflation.

He, Chen, Yao and Ou (2014) studied China's stock market with respect to financial liberalization and international market interdependence after its accession to the WTO in 2001. Using the multi-factor R-squared measure, they derived a normalized index to measure the impact of financial liberalization policies on stock market interdependence between China and the world. Some of China's financial liberalization measures, such as QFII and exchange rate reform, are found to have played an important role in increasing market interdependence. After the US credit crunch in 2007 and the world financial crisis in the following years, some anomalies were observed as China's stock market was more interdependent of the global market than the US stock market in some specific periods. These anomalies may have been related to the former's overreaction and economic overheating.

Apergisa, Artikisb and Kyriazis (2015) examined the relationship between stock market liquidity, with macroeconomic conditions. It was noticed that stock market liquidity contains strong and robust information about the condition of the economy for both the UK and Germany in the presence of well-established leading indicators. However, the empirical findings show that there is not any differential role of liquidity in explaining the course of macroeconomic variables between a capital market and a bank-oriented economy.

Chortareas and Noikokyris (2014) examine the implications of the Monetary Policy Committee (MPC) framework for the monetary policy–equity returns relationship in the UK. Using a standard event study methodology, no significant relationship was found between market-based policy surprises and equity returns. After controlling for joint response bias using Thornton's (in press) framework, it was found that unexpected policy rate changes enter the stock prices discovery process. Moreover, the impact of MPC policy decisions on equities was dependent upon the MPC members' voting record publication.

Pradhan, Arvin and Ghoshray (2015) examined the linkages between economic growth, oil prices, depth in the stock market, and three other key macroeconomic indicators: real effective exchange rate, inflation rate, and real rate of interest. The study used a panel vector autoregressive model to test Granger causality for the G-20 countries over the period 1961– 2012. A novel approach to this study is demarcation of the long-run and short-run relations between the economic variables. The results showed a robust long-run economic relationship between economic growth, oil prices, stock market depth, real effective exchange rate, inflation rate and real rate of interest. In the long run, real economic growth responded to deviation in the long-run equilibrium relationship that is found to exist between the different measures of stock market depth, oil prices, and the other macroeconomic variables. In the short run, a complex network of causal relationships was noticed between the variables. While the empirical evidence of short-run causality is mixed, there is clear evidence that real economic growth responds to various measures of stock market depth, allowing for real oil price movements and changes in the real effective exchange rate, inflation rate, and real rate of interest.

Alagidede and Panagiotidis (2010) analysed the extent to which the stock market provides a hedge to investors against inflation is examined for African stock markets. By employing parametric and nonparametric integration procedures, it was observed that the point estimates of the elasticities of stock prices with respect to consumer prices range from 0.015 for Tunisia to 2.264 for South Africa, evidence of a positive long-run relationship. Further, the time path of the response of stock prices to innovations in consumer prices exhibits a transitory negative response for Egypt and South Africa, which becomes positive over longer horizons, indicate that the stock market tends to provide a hedge against rising consumer prices in African markets.

Thus, the literature reviews undertaken broadly suggested that the relationship between the macro-economic variables with the Stock market is dynamic in nature and hence is interesting to be studied upon. Thus, the present study is an effort to find out the influence of the movement of inflation and the stock market indices in India. Since the subject is very vast, the study is mainly focused on identifying whether there is a relationship between movement of inflation and Indian capital market. It is mainly based on the data available in various websites. Other factors such as political, geographical, demographical factors governing that particular period could not be considered.

III. Objectives and Research Methodology

The objective of the study is to find out:

(a) To test the long-run relationship between BSE Sensex and WPI Inflation

(b) To know the direction of causality (uni-directional or bi-directional) between BSE Sensex and WPI Inflation.

This study has collected and used the data available from the secondary sources. Regarding the WPI, the data is collected from the website of the Office of the Economic Adviser, Ministry of Commerce & Industry, Govt. of India. The data of stock indices (as a representative of Indian equity market) are collected from the Bombay Stock Exchange Ltd. website. In case of BSE Sensex, the monthly data is calculated by taking the average of daily closing indices for better capturing the stock market movements during a month.

This study is empirical in nature and hence secondary data for the last fourteen years (1999-2013) is used to conduct the research.

IV. Hypotheses

Keeping in line with the above-mentioned objective of the study, it was intended to test the following hypotheses:

H0=There is no long run relationship between BSE Sensex and WPI inflation

H1=There is no causal relationship (neither uni-directional nor bi-directional) between BSE Sensex and WPI Inflation

V. Statistical Tools Used

Unit Root Test- A **unit root** is a feature of processes that evolve through time that can cause problems in statistical inference involving time series models. A linear stochastic process has a unit root if 1 is a root of the process's characteristic equation. Such a process is non-stationary. If the other roots of the characteristic equation lie inside the unit circle—that is, have a modulus (absolute value) less than one—then the first difference of the process will be stationary. The **first difference** of a time series is the series of changes from one period to the next. If Y_t denotes the value of the time series Y at period t, then the first difference of Y at period t is equal to Y_t-Y_{t-1}.

ADF Test of Unit Root

Before conducting any time series analysis, the basic procedure is to conduct the basic properties of the time series data – stationary or non-stationary. There are various methods to test the stationary properties of the data. Among them the one most popular and rigorous method of testing the stationary property of the data is Augmented Dickey-Fuller test.

The Dickey-Fuller (DF) test (Dickey and Fuller 1979) is based on the independently and identically distributed (*iid*) errors. The test examines the null hypothesis that the series X_t (independent or dependent variable) contains a unit root, *i.e*., $\alpha=1$

It can be determined empirically as to how many lagged difference terms are required to be included. The basic purpose is to include enough lagged terms so as to make the error term serially uncorrelated.

Johansen's Cointegration Test

There are various techniques for conducting Cointegration analysis for determining the long-run relationship among various time series. Two popular approaches in this area are the residual-based approach proposed by Engel and Granger (1987) and the maximum likelihood approach proposed by Johansen and Juselius (1990) and Johansen (1992). While the Engel-Granger approach can determine only one cointegrating relationship, the maximum likelihood approach of Johansen-Juselius can determine if there exists more than one cointegrating relationship. With 'n' number of variables, there can be 'n-1' number of cointegrating relationships. The Johansen and Juselius Cointegration approach and the Vector Error Correction Model (VECM) framework are used to determine both long-run and short-run relationships respectively among variables. However, both the above approaches require that the variables should be of same order of integration. Johansen (1995) developed a maximum likelihood estimation procedure based on the *reduced rank* *regression method.* It takes into account the short-run dynamics of the 'system' whilst estimating the cointegrating vectors.

Granger Causality Test

Once the stationary properties and possible existence of long-run relationship of the variables are checked, this study has used the Granger Causality test to explore the underlying relationship. C.W.J. Granger (1969) had made the first attempt at testing for the direction of causality among the variables. The logic behind the said test is quite simple and straight forward. If between two variables, X Granger causes Y but Y does not Granger cause X, then it may be inferred that the past values of X should help in predicting future values of Y but not the vice versa. The test statistics is the standard Wald F-statistics.

Granger causality really means only a temporal correlation between the current value of one variable and the past values of others; it does not mean that movements of one variable cause movements of another.

In the case of Granger Causality test, the important things to be noted are enumerated below:

1) It is assumed that the two concerned variables are stationary.
2) The number of lagged terms to be introduced in the causality test is an important practical question. The direction of causality may depend critically on the number of lagged terms included.
3) It is assumed that the error terms entering the causality test are uncorrelated. If this is not the case, appropriate transformation may be done.
4) Since the interest here is in testing for causality, one need not present the estimated coefficient of the models explicitly as just the results of the F-test will suffice.

VI. Results of the Empirical Analysis

Unit Root Test

As discussed in the methodology section, the Augmented Dickey-Fuller (ADF) tests is used to determine the stationary properties of the data. The results the ADF test suggests that both the BSE Sensex and WPI inflation Index is non-stationary at level (there is a presence of unit root in the series). When the ADF test after taking the first difference of both the series was undertaken, it is found that both of them are stationary in nature (has no unit root) as the values of the variables in the unit root test is more than the critical values (Table 2). Therefore, the ADF test found that both the series are I (1) [Integrated at first difference].

Table 1: Unit Root Tests of the Variables

Variables	ADF Test	
	Level	First Difference
LBSE	-2.316	-5.034*
LWPI	-1.664	-4.994*
Critical Values		
1%	-3.482	-3.482
5%	-2.881	-2.884

Note: "H_0: The series under consideration has a unit root"; "H_1: The series under consideration is stationary". The maximum number of lags included in Augmented Dickey Fuller (ADF) tests is 10. For the ADF tests, the lag length is based on the SC, The test include a constant (intercept).* Significant at 1% level.

Johansen's Cointegration Test

Since all the variables are I(1), the possibility of existence of a cointegrating relationship is examined under the maximum likelihood approach of Johansen-Juselius. The results have been presented in Table 2. The trace and max tests (Table 2) suggests that there is a cointegrating relationship between WPI and BSE Sensex since both the Trace-Statistic and Max-Eigen statistic values are lesser than their respective critical values at first difference.

Table 2: Johansen's Cointegration Test Result

No. of observations: 130 after adjustments
Trend assumption: No deterministic trend (restricted constant)
Series: LWPI LBSE
Lags interval (in first differences): 1 to 1

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.115290	25.01766	20.26184	0.0102
At most 1	0.067558	9.093290	9.164546	0.0516

Trace test indicates 1 cointegrating equations at the 0.05 level. * denotes rejection of the hypothesis at the 0.05 level. **MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)				
Hypothesized No. of CE(s)	**Eigenvalue**	**Max-Eigen Statistic**	**0.05 Critical Value**	**Prob.****
None *	0.115290	15.92437	15.89210	0.0494
At most 1	0.067558	9.093290	9.164546	0.0516
Max-eigenvalue test indicates 1 cointegrating equations at the 0.05 level. * denotes rejection of the hypothesis at the 0.05 level. **MacKinnon-Haug-Michelis (1999) p-values				

Granger Causality Test

As discussed above, in the next stage of empirical analysis, the study conducts the Granger Causality Test between the BSE Sensex and WPI Inflation. The estimates F-statistics of the causality test are reported in the ***Table 3***. The results of F-statistics suggest that there is no causality relationship between BSE Sensex and WPI Inflation in the short run.

Table 3: Bivariate Granger Causality Test

Null Hypothesis: No Causality	Lags	F-Statistics	Probability
DLWPI→ DLBSE	1	0.00011	0.9915
DLBSE→ DWPI		1.31159	0.2543
DLWPI→ DLBSE	2	0.32060	0.7263
DLBSE→ DWPI		1.67174	0.1921
DLWPI→ DLBSE	3	0.23226	0.8738
DLBSE→ DWPI		1.26895	0.2882
DLWPI→ DLBSE	4	2.32244	0.0607
DLBSE→ DWPI		1.13536	0.3433
DLWPI→ DLBSE	5	1.86169	0.1064
DLBSE→ DWPI		0.84926	0.5177
'D' before the variables denotes first difference of these variables. 'L' for Log.			

VII. Conclusions

The detailed test results from the Augmented Dickey Fuller Test, Johansen Cointegration Test and Granger Causality Test is presented in the Annex. Augmented Dickey Fuller test concludes that the first difference of both the series are stationary in nature. The trace and max tests suggests that there is a cointegrating relationship between WPI and BSE Sensex since both the Trace-Statistic and Max-Eigen statistic values are lesser than their respective critical values at first difference. However, the results of F-statistics by Granger Causality Test between the BSE Sensex and WPI

Inflation concludes that there is no causality relationship between BSE Sensex and WPI Inflation in the short run even after taking five lags.

VIII. Further scope of the Study

There could be several macroeconomic factors (both domestic and international factors) which could be the reason behind the change in the movements in Indian equity price which could be further explored through an expansive research attempt.

The study is an analysis of the past fourteen year's data available from the Office of the Economic Adviser, Ministry of Commerce& Industry, Govt. of India and BSE websites. Other factors such as political, geographical, demographical factors governing that particular period could not be considered. Further, extending the study to other geographical/demographical locations of other countries or indices can also be explored.

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ANNEX

RESULTS OF VARIOUS TESTS

Unit Root Test

Null Hypothesis: LBSE has a unit root

Exogenous: Constant

Lag Length: 3 (Automatic - based on AIC, maxlag=12)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.316327	0.1684
Test critical values:	1% level	-3.482035	
	5% level	-2.884109	
	10% level	-2.578884	

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

Augmented Dickey-Fuller Test Equation

Dependent Variable: D(LBSE)

Method: Least Squares

Date: 06/13/16 Time: 16:48

Sample (adjusted): 2005M08 2016M03

Included observations: 128 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LBSE(-1)	-0.035140	0.015171	-2.316327	0.0222
D(LBSE(-1))	0.341768	0.086495	3.951315	0.0001

Null Hypothesis: D(LBSE) has a unit root

Exogenous: Constant
Lag Length: 2 (Automatic - based on AIC, maxlag=12)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-5.033876	0.0000
Test critical values:	1% level	-3.482035	
	5% level	-2.884109	
	10% level	-2.578884	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LBSE,2)
Method: Least Squares
Date: 06/13/16 Time: 16:48
Sample (adjusted): 2005M08 2016M03
Included observations: 128 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LBSE(-1))	-0.625320	0.124222	-5.033876	0.0000
D(LBSE(-1),2)	-0.024326	0.105340	-0.230927	0.8178
D(LBSE(-2),2)	-0.212013	0.087983	-2.409711	0.0174
C	0.002523	0.002236	1.128479	0.2613

R-squared	0.392543	Mean dependent var	-3.83E-05
Adjusted R-squared	0.377847	S.D. dependent var	0.031062
S.E. of regression	0.024501	Akaike info criterion	-4.549455
Sum squared resid	0.074437	Schwarz criterion	-4.460329
Log likelihood	295.1651	Hannan-Quinn criter.	-4.513243
F-statistic	26.70993	Durbin-Watson stat	2.014087
Prob(F-statistic)	0.000000		

Null Hypothesis: LWPI has a unit root

Exogenous: Constant
Lag Length: 4 (Automatic - based on AIC, maxlag=12)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-1.664346	0.4469
Test critical values:	1% level	-3.482453	
	5% level	-2.884291	
	10% level	-2.578981	

*MacKinnon (1996) one-sided p-values.
Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LWPI)
Method: Least Squares
Date: 06/13/16 Time: 16:49
Sample (adjusted): 2005M09 2016M03
Included observations: 127 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LWPI(-1)	-0.005245	0.003151	-1.664346	0.0986
D(LWPI(-1))	0.410998	0.087461	4.699199	0.0000
D(LWPI(-2))	0.059107	0.092963	0.635816	0.5261
D(LWPI(-3))	0.211135	0.096457	2.188895	0.0305
D(LWPI(-4))	-0.261405	0.090701	-2.882063	0.0047
C	0.012334	0.006836	1.804395	0.0737

R-squared	0.286068	Mean dependent var	0.001768
Adjusted R-squared	0.256567	S.D. dependent var	0.003302
S.E. of regression	0.002847	Akaike info criterion	-8.838902
Sum squared resid	0.000981	Schwarz criterion	-8.704531
Log likelihood	567.2703	Hannan-Quinn criter.	-8.784308
F-statistic	9.696807	Durbin-Watson stat	2.036197
Prob(F-statistic)	0.000000		

Null Hypothesis: D(LWPI) has a unit root

Exogenous: Constant

Lag Length: 3 (Automatic - based on AIC, maxlag=12)

	t-Statistic	Prob.*

Augmented Dickey-Fuller test statistic		-4.994342	0.0000
Test critical values:	1% level	-3.482453	
	5% level	-2.884291	
	10% level	-2.578981	

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

Augmented Dickey-Fuller Test Equation

Dependent Variable: D(LWPI,2)

Method: Least Squares

Date: 06/13/16 Time: 16:50

Sample (adjusted): 2005M09 2016M03

Included observations: 127 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LWPI(-1))	-0.549976	0.110120	-4.994342	0.0000
D(LWPI(-1),2)	-0.024848	0.115183	-0.215731	0.8296
D(LWPI(-2),2)	0.042788	0.105520	0.405501	0.6858
D(LWPI(-3),2)	0.258376	0.091338	2.828796	0.0055
C	0.000970	0.000325	2.981785	0.0035

R-squared	0.332332	Mean dependent var	6.52E-06
Adjusted R-squared	0.310441	S.D. dependent var	0.003453
S.E. of regression	0.002868	Akaike info criterion	-8.832015
Sum squared resid	0.001003	Schwarz criterion	-8.720039
Log likelihood	565.8329	Hannan-Quinn criter.	-8.786520
F-statistic	15.18140	Durbin-Watson stat	2.028222
Prob(F-statistic)	0.000000		

Date: 06/13/16 Time: 16:52
Sample: 2005M04 2016M03
Included observations: 130
Series: LWPI LBSE
Lags interval: 1 to 1

Selected (0.05 level*) Number of Cointegrating Relations by Model

Data Trend:	None	None	Linear	Linear	Quadratic
Test Type	No Intercept No Trend	Intercept No Trend	Intercept No Trend	Intercept Trend	Intercept Trend
Trace	2	1	0	0	0
Max-Eig	2	1	0	0	0

*Critical values based on MacKinnon-Haug-Michelis (1999)

Information Criteria by Rank and Model

Data Trend:	None	None	Linear	Linear	Quadratic
Rank or No. of CEs	No Intercept No Trend	Intercept No Trend	Intercept No Trend	Intercept Trend	Intercept Trend
	Log Likelihood by Rank (rows) and Model (columns)				
0	865.3987	865.3987	871.2440	871.2440	873.0336
1	871.3577	873.3609	876.3087	878.2543	879.8097
2	874.4792	877.9075	877.9075	879.8811	879.8811
	Akaike Information Criteria by Rank (rows) and Model (columns)				
0	-13.25229	-13.25229	-13.31145	-13.31145	-13.30821
1	-13.28243	-13.29786	-13.32783	-13.34237	-13.35092*
2	-13.26891	-13.29088	-13.29088	-13.29048	-13.29048
	Schwarz Criteria by Rank (rows) and Model (columns)				
0	-13.16406	-13.16406	-13.17910*	-13.17910*	-13.13175
1	-13.10596	-13.09934	-13.10725	-13.09974	-13.08622
2	-13.00421	-12.98207	-12.98207	-12.93755	-12.93755

Johansen's Cointegration Test

Date: 06/13/16 Time: 16:54
Sample (adjusted): 2005M06 2016M03
Included observations: 130 after adjustments
Trend assumption: No deterministic trend (restricted constant)
Series: LWPI LBSE
Lags interval (in first differences): 1 to 1

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.115290	25.01766	20.26184	0.0102
At most 1	0.067558	9.093290	9.164546	0.0516

Trace test indicates 1 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**

None *	0.115290	15.92437	15.89210	0.0494
At most 1	0.067558	9.093290	9.164546	0.0516

Max-eigenvalue test indicates 1 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegrating Coefficients (normalized by b'*S11*b=I):

LWPI	LBSE	C
0.499788	3.559496	-17.08176
-18.18301	11.84788	-10.43636

Unrestricted Adjustment Coefficients (alpha):

D(LWPI)	-0.000817	0.000474
D(LBSE)	-0.005270	-0.005069

1 Cointegrating Equation(s): Log likelihood 873.3609

Normalized cointegrating coefficients (standard error in parentheses)

LWPI	LBSE	C
1.000000	7.122013	-34.17802
	(3.34673)	(14.1613)

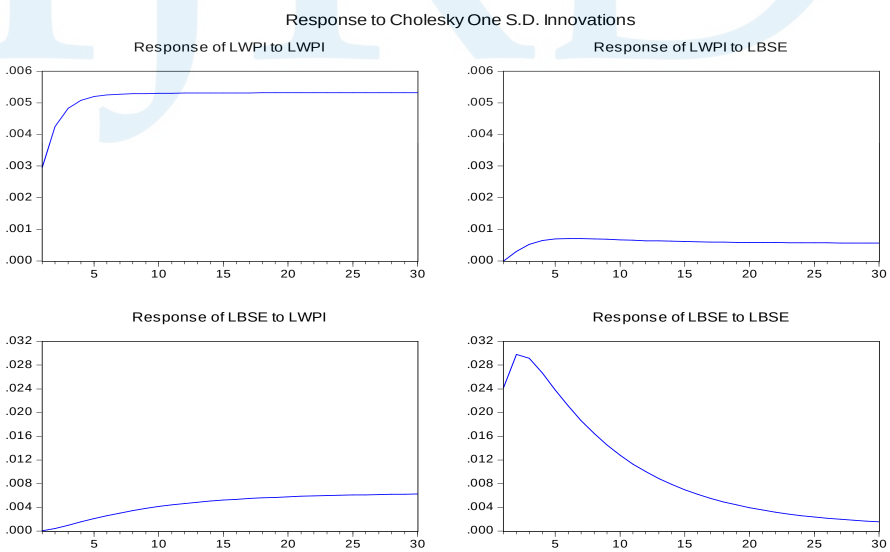
Adjustment coefficients (standard error in parentheses)

D(LWPI)	-0.000409
	(0.00013)
D(LBSE)	-0.002634
	(0.00108)

Vector Error Correction Estimates
Date: 06/13/16 Time: 16:55
Sample (adjusted): 2005M06 2016M03
Included observations: 130 after adjustments
Standard errors in ( ) & t-statistics in [ ]

Cointegrating Eq:	CointEq1	
LWPI(-1)	1.000000	
LBSE(-1)	-0.833818	
	(0.14924)	
	[-5.58714]	
C	1.365462	
Error Correction:	D(LWPI)	D(LBSE)
CointEq1	-0.001218	0.096276
	(0.00369)	(0.03030)
	[-0.32998]	[3.17788]

D(LWPI(-1))	0.442909	0.029474
	(0.07911)	(0.64949)
	[5.59831]	[0.04538]
D(LBSE(-1))	0.011214	0.310365
	(0.01001)	(0.08218)
	[1.12020]	[3.77655]
C	0.000949	0.003072
	(0.00030)	(0.00244)
	[3.20006]	[1.26134]
R-squared	0.208293	0.154668
Adj. R-squared	0.189443	0.134541
Sum sq. resids	0.001096	0.073838
S.E. equation	0.002949	0.024208
F-statistic	11.04991	7.684630
Log likelihood	574.9983	301.3103
Akaike AIC	-8.784589	-4.574005
Schwarz SC	-8.696357	-4.485773
Mean dependent	0.001779	0.004484
S.D. dependent	0.003275	0.026021
Determinant resid covariance (dof adj.)		5.10E-09
Determinant resid covariance		4.79E-09
Log likelihood		876.3087
Akaike information criterion		-13.32783
Schwarz criterion		-13.10725



Variance Decomposition of LWPI: Period	S.E.	LWPI	LBSE
1	0.003215	100.0000	0.000000
2	0.004517	99.93032	0.069681

3	0.005500	99.77960	0.220397
4	0.006316	99.55992	0.440081
5	0.007027	99.28222	0.717781
6	0.007661	98.95634	1.043655
7	0.008239	98.59107	1.408930
8	0.008771	98.19416	1.805845
9	0.009267	97.77242	2.227581
10	0.009732	97.33181	2.668189
11	0.010170	96.87749	3.122512
12	0.010586	96.41390	3.586102
13	0.010981	95.94484	4.055155
14	0.011359	95.47357	4.526432
15	0.011720	95.00280	4.997197
16	0.012067	94.53484	5.465156
17	0.012400	94.07160	5.928401
18	0.012721	93.61464	6.385362
19	0.013031	93.16524	6.834759
20	0.013329	92.72443	7.275566

Variance Decomposition of LBSE:

Period	S.E.	LWPI	LBSE
1	0.025329	0.060556	99.93944
2	0.034681	0.081638	99.91836
3	0.041159	0.106338	99.89366
4	0.046093	0.134633	99.86537
5	0.050021	0.166476	99.83352
6	0.053230	0.201801	99.79820
7	0.055899	0.240522	99.75948
8	0.058145	0.282536	99.71746
9	0.060053	0.327725	99.67227
10	0.061688	0.375957	99.62404
11	0.063096	0.427087	99.57291
12	0.064315	0.480962	99.51904
13	0.065375	0.537417	99.46258
14	0.066302	0.596286	99.40371
15	0.067115	0.657394	99.34261
16	0.067830	0.720566	99.27943
17	0.068461	0.785624	99.21438
18	0.069020	0.852394	99.14761
19	0.069517	0.920699	99.07930
20	0.069960	0.990370	99.00963

Cholesky Ordering: LWPI LBSE

Granger Causality Test

Pairwise Granger Causality Tests

Date: 02/09/17 Time: 15:16

Sample: 2005M04 2016M03

Lags: 1

Null Hypothesis:	Obs	F-Statistic	Prob.
DLWPI does not Granger Cause DLBSE	130	0.00011	0.9915

DLBSE does not Granger Cause DLWPI		1.31159	0.2543

Pairwise Granger Causality Tests
Date: 02/09/17 Time: 15:17
Sample: 2005M04 2016M03
Lags: 2

Null Hypothesis:	Obs	F-Statistic	Prob.
DLWPI does not Granger Cause DLBSE	129	0.32060	0.7263
DLBSE does not Granger Cause DLWPI		1.67174	0.1921

Pairwise Granger Causality Tests
Date: 02/09/17 Time: 15:17
Sample: 2005M04 2016M03
Lags: 3

Null Hypothesis:	Obs	F-Statistic	Prob.
DLWPI does not Granger Cause DLBSE	128	0.23226	0.8738
DLBSE does not Granger Cause DLWPI		1.26895	0.2882

Pairwise Granger Causality Tests
Date: 02/09/17 Time: 15:17
Sample: 2005M04 2016M03
Lags: 4

Null Hypothesis:	Obs	F-Statistic	Prob.
DLWPI does not Granger Cause DLBSE	127	2.32244	0.0607
DLBSE does not Granger Cause DLWPI		1.13536	0.3433

Pairwise Granger Causality Tests
Date: 02/09/17 Time: 15:17
Sample: 2005M04 2016M03
Lags: 5

Null Hypothesis:	Obs	F-Statistic	Prob.
DLWPI does not Granger Cause DLBSE	126	1.86169	0.1064
DLBSE does not Granger Cause DLWPI		0.84926	0.5177