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Long run relationship between CPI and WPI: Evidence from Pakistan

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Abstract: The prime objective of this article is to judge the long-run/dynamic relationship between two widely used indexes i.e. Consumer Price Index (CPI) and the Wholesale Price Index (WPI) computed in Pakistan. Various statistical tests like Engle and Granger (1987) and Johansen's (1988) co integration tests have been employed for checking the long-run stability between these two indexes. The results reveal that both the series CPI and WPI are co integrated when we apply EG test for 90% but not for 95% and 99%. With the multivariate Johansen test the series are co integrated. The results are also checked for seasonally adjusted series and the findings are same. The results agree about the long run relationship between the series.

Keywords: Stationary, stability, Co-integration, Correlogram, Multivariate.

1. INTRODUCTION

Inflation always is a matter of great concern in almost every economy. Undoubtedly, this is the era of inflation. Every country, developed or developing, faces the inflationary pressures. Different critics argue differently and define numerous reasons of this current global inflation. Some of them blame high oil prices in the world market and others are of the view high growth in population, increasing need of food items, tight monetary policy, real exchange etc. whatever the reasons behind inflation becoming more and more popular all over the world. Some one rightly says "It runs in an economy like a blood in a body." It disturbs everybody business whether it is a country, a firm, an industry or even a layman if it is not under control. Most of the economies are trying to keep it under control like 2 to 3 percent, if it crosses this barrier many precautionary measures adopted like tight monetary policy by the central bank.

Pakistan has also experiencing the highest inflation of the history in these days. It reaches into two digit figures, government gives the numerous reasons of this shoot up in inflation likewise the fall out of the expansionary monetary policy pursued in the past years, supply shocks such as shortage of some food items like wheat (atta), enhancement of wheat support price, higher international price of crude oil, exchange rate depreciation and rising trend of real assets prices and consequently wealth effect on aggregate demand.

Khan and Schimmelpfennig (2006) pointed out that monetary factors (money supply, credit to the private sector) have played a dominant role in recent inflation, affecting inflation with a lag of about one year. Changes in the wheat support price influence inflation in the short run, but not in the long run. Furthermore, the wheat support price matters only over the medium term if accommodated by monetary policy. Central Banks always set their monetary policies by the movement of inflation. Friedman wrote that "Inflation is always and everywhere a monetary phenomenon."

In many countries, inflation is measured by percentage change in Consumer Price Index (CPI). In Pakistan, it covers 71 markets in 35 cities/urban centres of the country. Prices of 374 consumer items (both tradable and non-tradable) are taken for computation of this index on monthly basis. Another index known as Wholesale Price Index (WPI) also develops which measure the directional movements of prices for a set of selected items (tradable) in the primary and wholesale markets. Items covered in the series are those which could be precisely defined and are offered in lots by producers/manufacturers. Prices used in this index are generally those, which conform to the primary sellers realization at ex-mandi, ex-factory or at an organized wholesale level. The current series of WPI being computed are based on prices of 425 items which are soled in 18 main markets of the country.

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In literature, most of the studies are based either on CPI or on WPI or on both but no one certain which one is best indicator of prices. This uncertain situation opens the debate whether CPI and WPI behave equally or differently in the long-run. This judgment is also crucial for the central banks when they targeting inflation via monetary policy. The one purpose of this paper is to analyze the dynamic relationship between these two series directly rather than assessing the third variable effect on these two series. Hardly one or two examples can be found that some one has checked the direct long run relationship between these two like Akdi *et al.,* (2006) they have checked the direct relationship between the CPI and WPI and concluded that there is no longrun relationship between them whereas Katsouli *et al.,* (2002) concluded that a long-term equilibrium relationship exist between the two price indexes.

To portraying these indexes here because most of the studies commonly/widely used to asses the affect of other variables on these. Some researchers like, Murphy et al (1989) have used technology shocks and increasing return to scale; Basu (1995) has used different stickiness of intermediate product prices; others like Clark (1999) uses tight monetary policy; Doroodian and Boyd (2003) use oil price shocks; and Kim (2004) uses real exchange rates affect on prices.

2. MATERIAL AND METHODS

Data Description and Methods

In this study we used monthly data from July 1991 to September 2008 for both CPI and WPI with base 2000-01. The data has been collected from Federal Bureau of Statistics (FBS).

Usually time series data dealt with a common assumption that variables are stationary. A time series is said to be stationary if it has a constant mean, a constant variance and a covariance which depends only on the time between the lagged observations**.** Various tests are available in literature for checking stationarity like graphical, correllogram and unit root. We will employ all of these.

Graph gives us initial clue about the stationarity. A simple test of stationarity is based on autocorrelation function (ACF). Autocorrelation, $\hat{\rho}_k$, plot against number of lags, , k is known as correlogram and a series is stationary if the correlogram has one or two, and certainly very few significant spikes at very small lags and then cuts off drastically or dies down very quickly.

In applying any co-integration technique, the first exercise is to judge the degree of integration of each variable in the model. The integrated property of each series will be investigated by Augmented Dickey and Fuller's tests (ADF) or Phillipe- Perron test (PP). ADF unit root test developed by Dickey and Fuller. They consider three different regression equations with a random walk, random walk with drift and random walk with drift and trend that can be used to test for the presence of unit root in the time series values, says Y_t, with the null hypothesis H_0: Y_t has a unit root.

CO-INTEGRATION

Concept of co-integration applies in a variety of economic models. The equilibrium relationship among a set of nonstationary variables means that their stochastic trends must be linked i.e. variables cannot move independently of each other. Co-integration describes the long-run linear relationship between groups of variables which exhibit an equilibrium relationship with each other. So, the long-run relationship between WPI and CPI will be checked with the help of co-integration technique advocated by Engle and Granger, Johansen, Stock and Watson etc. All of them proposed the null hypothesis is of no co integration.

By Engle and Granger (EG) Method, we will apply unit root test to check integrated property of same order of all variables then regress one variable on the rest and save the residuals, say $\{e_t\}$ and lastly apply unit root test on $\{e_t\}$ and test $H_0 : e_t$ has a unit root or variables are not co integrated, if the residuals are stationary, then we can conclude that the series are co integrated.

OLS is not suitable for identifying different cointegration vectors which may exist within multivariate framework. **Johansen** developed a more powerful test of the components of cointegration vector usually known as Johansen Likelihood Ratio or Trace test.

Johansen procedure performs two functions that are:

1. To identify the cointegration vectors in a group of time series.
2. To provide the maximum likelihood estimations of the co integration vectors and the speed of adjustment vectors.

The appropriate estimation procedure of Johansen's approach is:

Step 1: Determining the co integrating rank

Step 2: Determining the factorization $\prod = \alpha\beta'$: Estimating the matrix of co integrating vectors, β and the weighting matrix α .

Step 3: Estimating the VAR, incorporating the co integrating relations from the previous step.

3. RESULTS AND DISCUSION

Fig. 1 is a combined graph of both the series after taking logarithms. By inspection of the graph we found that both the series increasing with upward trend and the mean of both series may be changed over period of time.

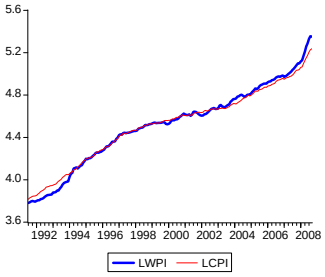


Fig. 1 Graph of CPI and WPI

The correlation between the variables in log levels is examined in order to get the general understanding of the overall relationships between them. In brief, a high positive strong correlation (0.998503) between the examined variables was found. So, there is a chance that these two variables behave equally in the long-run. It is also worth mentioning that the correlation coefficient is only meaningful when two time series are stationary.

Fig. 2 and 3 are the graphs and correlograms of the log levels of series CPI and WPI. Graphs showing persistence upward trends whereas sample partial autocorrelations dies down slowly which indicate of non-stationary series and hence unit root is the possible candidate for each series.

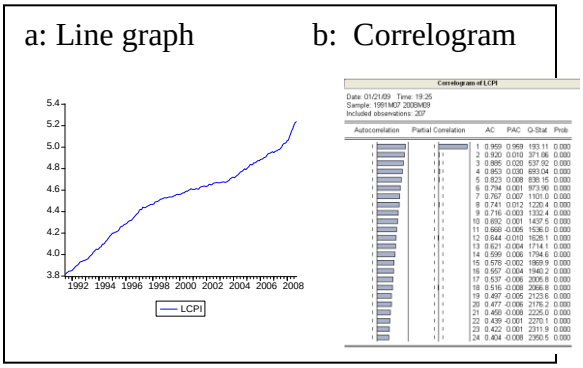


Fig. 2 CPI Series

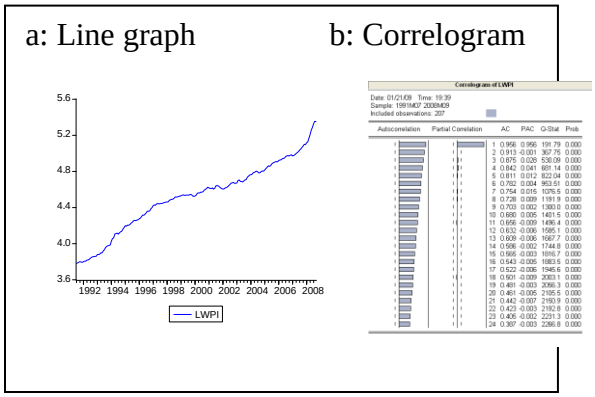


Fig. 3 WPI Series

The results of ADF and PP tests under the null that there is unit root are reported in **(Table 1)**. The choice of lag length is based on the minimum Akaik Information Criterion (AIC).

Table 1: Tests for Unit Root

Series	In Levels				In 1st Differences	
	With trend and drift		With drift		With drift	
	ADF	PP	ADF	PP	ADF	PP
LCPI	-1.065844	-1.156086	0.323780	-0.026830	-4.548475	-11.30983
LWPI	-1.460174	-0.768670	0.354658	0.543029	-9.452706	-9.544396
5%C.V	-3.45		-2.88		-2.88	

The results clearly indicate that the null hypothesis is rejected in differences but not in levels. Hence both series are first difference stationary i.e. LCPI~I(1) and LWPI~I(1) or DLCPI~I(0) and DLWPI~I(0).

Table 2: Tests for Unit Root (Seasonally adjusted)

Series	In Levels				In 1st Differences	
	With trend and drift		With drift		With drift	
	ADF	PP	ADF	PP	ADF	PP
LCPI_SA	-1.2816	-1.1625	0.2535	-0.0511	-3.7056	-11.3569
LWPI_SA	-0.7730	-0.8525	0.4577	0.4686	-9.0187	-9.1810
5%C.V	-3.45		-2.88		-2.88	

Table 2 exhibits results of both series after seasonally adjusted. We use Census X-12 approach for seasonal adjustment. Table 2 shows the same scenario as portrayed in table 1 i-e presence of unit root in levels but not in differences.

It is confirmed from the above tests that both series whether seasonally adjusted or not are integrated of order 1, next we determine the equilibrium relationship by using the Engle and Granger (1987) test. For this test we run OLS regression by taking each variable as a dependent variable and save the residuals of each regression. The results of two regression equations along with t-values in parentheses and 'd' is the Durbin-Watson statistics are given below:-

$$LWPI = -0.432154 + 1.095929 * LCPI + e_{wc} \quad \text{--------(1)}$$

(-22.74525) (261.3530) d= 0.135154 R^2=0.997008

$$LCPI = 0.406664 + 0.909737 * LWPI + e_{cw} \quad \text{---------(2)}$$

(25.76189) (261.3530) d= 0.134788 R^2 = 0.997008

Below are the OLS regressions for seasonally adjusted series

$$LWPI_SA = -0.429451 + 1.095336 * LCPI_SA + e_{wcsa} \quad \text{--------(3)}$$

(-23.03021) (266.1454) d= 0.118257 R^2= 0.997114

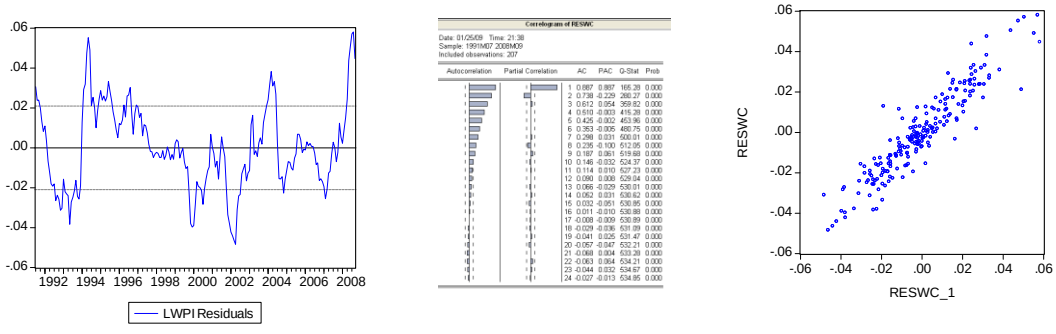
$$LCPI_SA = 0.403978 + 0.910327 * LWPI_SA + e_{cwsa} \quad \text{--------(4)}$$

(26.04440) (266.1454) d= 0.117921 R^2=0.997114

Where e_{wc} , e_{cw}, e_{wcsa} and e_{cwsa} are the residuals of equations1,2,3 and 4 respectively. After saving the residuals of each equation we check them for stationary by using Dickey Fuller test. The critical values for this special application are different than those for the usual DF test because the above test is applied to the residuals of the estimated models rather than on raw data or in other words values of '*e'* are not "observed" but "estimated".

Before proceeding we first analyze the residuals of each equation which will help us for determining whether residuals are correlated among each others or not, if the residuals are correlated they are violating the assumptions of ordinary least squares and the estimates are inconsistent.

a Graph of residuals b: Correlogram c:current vs. lag residual



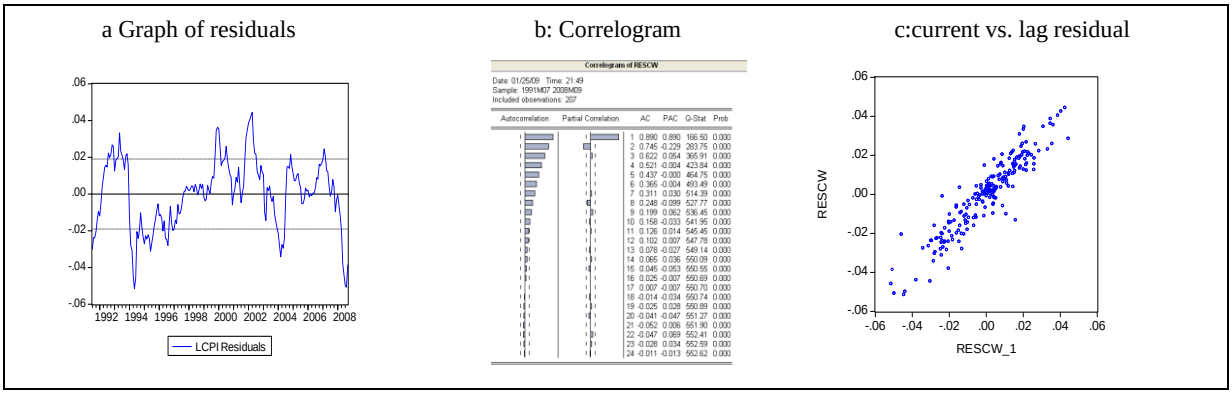


Figure: 5 Graph of residuals for equation 3 and 4

Figs. 4 and 5 are the graphs of residuals obtained from equation (1) and (2) respectively. The graphs show some discernible pattern of cyclical type and plots of current versus lagged residuals shown that most of the residuals are bunched in the second and fourth quadrants, suggesting a strong positive correlation in the residuals. Hence we say that residual is a candidate of serial correlation. The same is confirmed by using Durbin-Watson d statistics the value of d for the equation 4 is 0.135154 and for 5 is 0.134788 which is close to zero along with high R^2 and high t-values or F-value greater the evidence of positive serial correlation. Also whenever 'd' is less than adj R^2, there is a good chance that the estimated regression is spurious. One can also use Run/LM test to check/detect the serial correlation in the residuals. Residuals of seasonally adjusted equations (3) and (4) also been examined. The graphs of these equations also indicate the same results.

We use Augmented Dickey-Fuller test of unit root for checking stationary by keeping in mind of avoiding serial correlation in residual series as the same is confirmed after diagnostic checking. We incorporate 1lag in the test which is suggested by AIC, results produced in **Table 3 and Table 4.**

Table 3: ADF test for unit root of residuals

Regressions	No lags	1 lag (AIC)
LCPI on LWPI	-2.538320	-3.299572
LWPI on LCPI	-2.464113	-3.256888
Critical values	-3.12 for 10%, -3.41 for 5% and -3.96 for 1%	

Table 4: ADF test for unit root of residuals (seasonally adjusted)

Regressions	No lags	1 lag (AIC)
LCPI_SA on LWPI_SA	-2.355862	-3.196716
LWPI_SA on LCPI_SA	-2.281988	-3.149781
Critical values	-3.12 for 10%, -3.41 for 5% and -3.96 for 1%	

Table 3 and 4 depict that the series are not co integrated at 95% and 99% but co integrated at 90% and both regressions yield the same conclusion.

Johansen multivariate co integration test has been employed for seasonally adjusted and not adjusted series. **Table 5 and 6** report the results of Trace and Maximum Eigen Value tests. In table 5, value of trace statistics (20.38245) and Max. Eigen Value statistics (20.21289) exceed the 5% C.V., it means to reject the null hypothesis of no cointegration vector and accept the alternative of cointegrated vector. The same results can be found in table 6 for seasonally adjusted series.

Table 5: Johansen's Cointegration Test Results (seasonally not adjusted)

Hypothesized No. of CE(s)	Eigen value	Trace Statistic	Max-Eigen Statistic	0.05 C.V. trace **	0.05 C.V. Max**
r=0*	0.095220	20.38245	20.21289	15.49471	14.26460
r=1	0.000839	0.169552	0.169552	3.841466	3.841466

Table 6: Johansen's Co integration Test Results(seasonally adjusted)

Hypothesized No. of CE(s)	Eigen value	Trace Statistic	Max-Eigen Statistic	0.05 C.V. trace **	0.05 C.V. Max**
r=0*	0.105872	22.85083	22.60505	15.49471	14.26460
r=1	0.001216	0.245780	0.245780	3.841466	3.841466

* indicates rejection of null hypothesis
**MacKinnon-Haug-Michelis (1999) p-values

4. CONCLUSION

The prime objective of this paper was to judge the long-run dynamic relationship between two widely used indexes i.e Consumer Price Index (CPI) and Wholesale Price Index (WPI) computed in Pakistan. Various statistical tests like Engle and Granger (1987) and Johansen's (1988) co integration tests have been employed for checking the long-run stability between these two indexes. The results reveal that both the series CPI and WPI are co integrated when we apply EG test for 90% but not for 95% and 99%. With the multivariate Johansen test the series are cointegrated. The results are also checked for seasonally adjusted series and the findings are same. The results are opposite to Y. Akdi et al (2006) but in line with E. Katsouli *et al.,* (2002) Hence we conclude that two indexes (the wholesale and consumer price index) drift together irrespective that these time series individually non-stationary i.e. they tend to upwards or downwards overtime. This common drifting of series makes linear relationships between these over long period of time.

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