SBP Staff Notes
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The Relationship between Wholesale Price Index and Consumer Price Index

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I. Introduction

Central banks usually focus on consumer price index as a measure of inflation for monetary policy formulation. However, they also keep track of other prices, like producer prices, wholesale prices, asset prices, etc., to understand a general behavior of prices at different stages.

It is possible that changes in one kind of prices have implications for other prices. For example, shocks to producer prices have a spill over impact on consumer prices through a chain of transactions starting from producer to wholesaler to retailer. This can, particularly, be a case for cost-push shocks that initially affect cost of production and then may transmit to product prices at wholesale and retail stages. The extent of this transmission, however, depends upon the ability of producers and sellers to maintain their desired profit margins.

On the other hand, a demand-pull shock may directly affect consumer prices at the first stage, and then transmit to wholesale and producer prices. When retailers feel changes in the demand for their goods, they not only change the prices for consumers, but also alter their pattern of purchases from wholesalers and producers. The wholesalers and producers, in turn, can change their prices in response to demand from retailers. Moreover, a demand shock may also put an upward pressure on wages, leading to increase in the cost of production, and then to producer prices and wholesale prices.

Thus the direction of causality could be either way: from wholesale prices to consumer prices or vice versa. There is also a possibility of simply no causal relationship between the two, given the complexities of firms' pricing decisions.[1] Moreover, as a price index is an aggregation of hundreds of individual prices, the overall relationship among different kinds of price indices becomes complex. For example, the link between overall CPI and WPI may become tricky due to differences in their composition, as given below:

- WPI not only includes intermediate goods but also some finished goods. While changes in wholesale prices of intermediate goods may take a bit longer to transmit to consumer prices, those of finished goods may transmit quickly.
- CPI also includes services (which are produced and delivered at the same point of time and space), while WPI includes only goods.
- The share of imported goods (mostly raw material) is typically higher in WPI, compared with CPI. Thus WPI can be affected by global shocks more severely compared with CPI, as witnessed in Pakistan with recent slump in commodity and oil prices.

Thus, theoretically, there is no clear-cut answer to the question of the nature of relationship between WPI and CPI. Interestingly, the empirical studies on the subject also remain inconclusive.[2] This paper explores this relationship in the context of Pakistan. We are particularly interested to verify the general perception that WPI can predict changes in CPI.

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[1] There are number theories to explain price setting behavior of firms, like, mark-up pricing, Calvo pricing, menu cost, etc. It may, however, be noted that factors affecting price setting behavior at production stage and price pass-through behavior at retail stage may be different.

[2] For example, in case of USA, Jones (1986) finds a bi-directional causality between WPI and CPI (sample 1947-1983); Colclough (1982) finds uni-directional causality with CPI causing producer prices (sample 1945-1979); and Clark (1995) finds no relationship between the two indices (sample of 1959-1994). Caporale et al. (2002) find uni-directional relationship for France and Germany from PPI to CPI, for USA from CPI to PPI, and no feedback for Canada. In case of Pakistan, Shahbaz et al. (2010) find bi-directional relationship between CPI and WPI (sample 1992-2007). Similarly, Rao and Bukhari (2010) also find bidirectional causality between the two indices; however, they conclude that WPI is a leading indicator of CPI, which is contrary to their own findings of two way relationship.

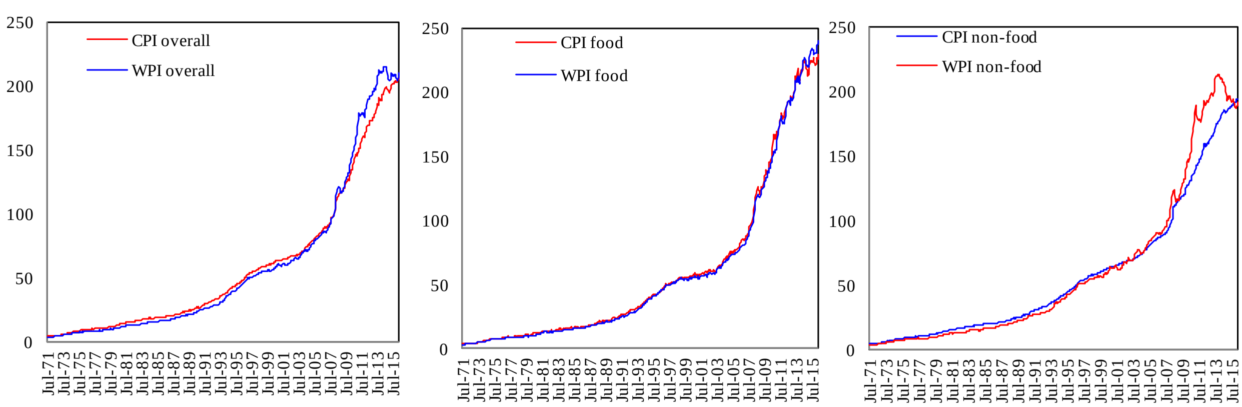
II. Data and methodology

We have taken CPI and WPI data for the period July 1971 to June 2016; and tested causality based on a vector error correction (VEC) model. We have also applied the test on food and non-food sub groups of the indices.

The methodology involves five steps: (1) applying unit test on individual series to determine their level of integration; (2) estimating unrestricted vector autoregressive (VAR) models to determine appropriate lags;[3] (3) applying Johansen Cointegration tests with appropriate lags; (4) estimating VEC (given the existence of Cointegration) with appropriate lags; and (5) applying VEC Granger Causality/Block Exogeneity Wald Tests. Both the VAR and VEC included seasonal dummies.

We have also introduced three structural dummies to control (i) wide fluctuation in prices during early 1970s mainly due to oil price shock, (ii) global financial crisis of FY08 and resulting hike in commodity prices, and (iii) oil price shock of FY14.[4] While the first two periods witnessed very high inflation due to adverse external shocks, the third period witnessed very low inflation due to a favorable oil price shock.
Average inflation in Pakistan, excluding periods of these shocks, has been 8.4 percent in case of CPI and 8.9 percent in case of WPI, which means both the indices have increased overtime by almost the same pace.[5] It has also been observed that WPI generally remained below CPI. However, this pattern was reversed in FY08 due to sharp increase in commodity prices resulting from global crisis. As argued by SBP 3rd Quarterly Report for FY08, this increase in international commodity prices affected WPI more than CPI.[6] As a result, WPI overshot CPI (Figure 1). On the other hand, the reduction in global oil prices during FY14 helped WPI to come back to its long run path.

Figure 1: Trend of CPI and WPI



Source: Pakistan Bureau of Statistics

III. Results and discussion

The results are summarized in Table 1 (detail results are given in the Annexure). We have found that CPI and WPI are cointegrated, i.e., have a long-run relationship with each other. It implies if a variable deviates from

[3] We have determined appropriate lags by applying Lag Exclusion Wald test on VAR model.
[4] The first dummy variable (dum70s) has value 1 for months of May 1973 to July 1975 (the period of YoY inflation of more than 20 percent) and 0 otherwise; the second dummy for global crisis (dum08) has value 1 for September 2007 to September 2008 (IMF global all commodity price index showed YoY increase of more than 40 percent during this period); and the third dummy (dum14) has value 1 for October 2014 to December 2015 (the period from start of decline in international oil price to the new equilibrium of low price; IMF index of crude oil price showed YoY decline of more than 40 percent during this period). While we have selected these dates for dummy variables on the basis of economic history of Pakistan, Bai-Perron tests of multiple breakpoints also detect December 2007 as a break point. This test cannot identify other two breakpoints because both of them are almost end periods of our sample.
[5] Average inflation, without excluding shocks period, was 9.4 percent in case of CPI and 10.2 percent in case of WPI.
[6] CPI basket contains house rent index and services, which are less affected by global commodity prices.

its long run path due to a shock, it will come back to its equilibrium after some time. The results show that: if CPI deviates from its long run trend, it comes back to its equilibrium path in 3 years. Adjustment in WPI is further slow, as it requires 46 months.

Interestingly, food index is very fast to adjust as compared to non-food index. Especially WPI food group adjusts back to its equilibrium very quickly – in 14 months, while CPI food takes 18 months to come back to its equilibrium. As food prices are usually affected by seasonal factors, it makes sense that the impact of these factors is short-lived. On the other hand, non-food group of both CPI and WPI take longer time to adjust: 53 months and 33 months respectively.

VEC Granger Causality (Block Exogeneity Wald Test) shows that two-way causality exists between overall CPI and WPI, i.e., both the indices cause each other. Similar is the result in case of non-food groups of CPI and WPI. However, in case of food group, there is only one-way causality: WPI food index affects CPI food index, and CPI food does not (statistically) affect WPI food. It implies if consumer prices of food items change (due to, for example, seasonal demand), it may not necessarily lead to changes in their wholesale prices. This may be due to the fact that such seasonal demand shocks to consumer prices have very short life, and may die out before transmitting to wholesale prices. On the other hand, the impact of seasonal supply shocks, which directly affect wholesale prices of food, may last longer. Therefore, changes in WPI food can be transmitted to consumer prices.

Table 1: Results of CPI and WPI Causality Tests

	Unit Root		Cointegration			
	Level	1st diff	Existence	Adjustment period (in months)		VEC Granger Causality
				CPI	WPI	
CPI	Yes	No				
CPI-food	Yes	No				
CPI-non food	Yes	No				
WPI	Yes	No				
WPI-food	Yes	No				
WPI-non food	Yes	No				
CPI and WPI			Yes	35	46	
CPI-food and WPI-food			Yes	18	14	
CPI-non food and WPI-non food			Yes	53	33	
CPI causes WPI						Yes
WPI causes CPI						Yes
CPI-food causes WPI-food						No
WPI-food causes CPI-food						Yes
CPI-non food causes WPI-non food						Yes
WPI-non food causes CPI-non food						Yes

We have also explored possible relationship between CPI food and WPI non-food as well as CPI non-food and WPI food. The second pair was found cointegrated with two way causality. The impact of WPI food inflation on CPI non-food can be explained through expectations. For example, when support price of wheat is increased, it not only affects CPI food inflation but also non-food inflation.[7] On the other hand, explaining the impact of non-food CPI inflation on WPI food inflation is not straightforward: a possible explanation is the impact of consumer prices of fuel and transport charges (both are part of CPI non-food) on WPI food price.

[7] The impact of wheat prices on CPI inflation has also been found earlier by Khan and Schimmelpfennig (2006).

Summarizing the results, we have found that both the CPI and WPI cause each other, as against the general perception that only CPI follows WPI. However, in case of food group, we can expect consumer prices of food items to follow changes in wholesale prices, i.e., WPI food index can be a predictor of CPI food index.

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Annexure: Detail Results

(1) Unit Root Test (All variables in log form)

A. Level

	Augmented Dickey-Fuller Test			Phillips-Perron test statistic		
	Lags	ADF t-statistics	Probability	Bandwidth	Adj. t-Stat	Probability
CPI	12	-1.6535	0.45	6	-2.6153	0.09
CPI-food	12	-1.2817	0.64	3	-1.7868	0.39
CPI-non food	6	-2.7512	0.07	9	-2.7036	0.07
WPI	1	-2.0533	0.26	10	-2.1229	0.24
WPI-food	1	-1.5347	0.52	8	-1.6652	0.45
WPI-non food	1	-2.0945	0.25	8	-2.0911	0.25

B. 1st diff

	Lags	ADF t-statistics	Probability	Bandwidth	Adj. t-Stat	Probability
CPI	11	-3.3282	0.01	4	-19.4968	0.00
CPI-food	11	-4.0416	0.00	4	-20.6270	0.00
CPI-non food	11	-6.8151	0.00	9	-21.6617	0.00
WPI	0	-16.1779	0.00	7	-16.2916	0.00
WPI-food	0	-18.3703	0.00	6	-18.3843	0.00
WPI-non food	0	-17.0930	0.00	4	-17.2172	0.00

Conclusion: All variables are I (1).

(2) Johansen Unrestricted Cointegration Rank Test (Trace)

Series (log form):	Overall CPI and WPI	Food group of CPI and WPI	Non-food group of CPI and WPI
Sample (adj.):	1973M06 to 2016M06	1973M08 2016M06	1973M06 2016M06
Included obs.:	517	515	517
Lags (in first diff.):	1, 3, 9, 14, 19, 22	1, 3 to 5, 7, 8, 11 to 14, 24	1, 8, 12, 22
Hypothesis: No cointegration equation:			
Eigenvalue	0.033	0.050	0.036
Trace Statistic	17.45	26.73	20.07
Probability*	0.03	0.00	0.01
Hypothesis: At most 1 cointegration equation:			
Eigenvalue	0.000	0.000	0.001
Trace Statistic	0.11	0.15	0.92
Probability*	0.74	0.70	0.34
Adjustment coefficients (Speed of adjustment in months):			
D(LP)#	-0.029 (34.5)	-0.055 (18.2)	-0.019 (52.6)
D(LW)#	0.022 (45.5)	0.072 (13.9)	0.030 (33.3)

Note: (i) Linear deterministic trend is assumed for all cointegrating equations; and (ii) seasonal dummies were included as exogenous variables in all equations.
#: LP is CPI in log form; LW is WPI in log form; D is 1st difference operator.
*MacKinnon-Haug-Michelis (1999) p-values

(3) **VEC based Test of Causality**

VEC Granger Causality/Block Exogeneity Wald Tests

Overall indices				Food group				Non-food group			
Dependent variable: D(LP)				Dependent variable: D(LPF)				Dependent variable: D(LPNF)			
Excluded	Chi-sq	df	Prob.	Excluded	Chi-sq	df	Prob.	Excluded	Chi-sq	df	Prob.
D(LW)	24.279	6	0.00	D(LWF)	26.772	11	0.01	D(LWNF)	21.309	4	0.00
All	24.279	6	0.00	All	26.772	11	0.01	All	21.309	4	0.00
Dependent variable: D(LW)				Dependent variable: D(LWF)				Dependent variable: D(LWNF)			
Excluded	Chi-sq	df	Prob.	Excluded	Chi-sq	df	Prob.	Excluded	Chi-sq	df	Prob.
D(LP)	10.515	6	0.10	D(LPF)	14.528	11	0.21	D(LPNF)	9.049	4	0.06
All	10.515	6	0.10	All	14.528	11	0.21	All	9.049	4	0.06