Revisit the relationship between two inflation indicators: Case of Pakistan

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Abstract

This research paper determines the association between two inflation indicators, consumer price index and wholesale price index in three groups' i.e. general group, food group, and non-food group. The objective is to find out if the relationship is unidirectional or bidirectional between CPI and WPI in all groups. For this purpose monthly data from July 1971 to December 2019 has been used. Furthermore, Cointegration has been calculated via Johansen's cointegration test on time series data to discover if the long-run affiliation occurs between the variables. Before cointegration, it is essential to discover the stationarity of the variables for which the augmented dickey fuller test has been used at the first difference. Vector Error Correction Model (VECM) is also employed to check for the disturbances of divergence or convergence finally Granger causality/Block exogenity test is applied to discover causality between variables, it also specifies unidirectional relationship or bidirectional relationship. As a result, it is found that there is a significant co-integration equation which indicates that there is an existence of long-run association amongst variables. On the other hand, there is also an indication of the short-run relationship among variables. Finally, a two-way causal relationship is indicated by the granger causality test, between CPI and WPI in general and food group and one-way causal association between CPI and WPI in the non-food group.

Keywords: *Inflation indicators, CPI & WPI, Granger causality test,
co-integration, Pakistan*

JEL Classification*: E31, C22*

INTRODUCTION

Consumer Price Index (CPI) and Wholesale Price Index are two indexes usually considered to measure inflation. CPI is a collection of goods and services which is used to

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show the consumption expenditure while WPI is the price in the wholesale market (Index, 2012). According to the theoretical aspect, the change in wholesale price index (WPI) leads to a change in Consumer Price Index (CPI) says Hatanaka and Wallace (1979), Engle (1978) and Batura, (2008). Since the increase in price in the wholesale index is transmitted to the consumer price index with a lag. CPI is a basket of goods that is commonly purchased by urban consumers where their prices are measured on average. WPI is a basket of input that is purchased by producers where the prices are calculated on average. A change in WPI followed by a change in CPI usually takes place when the economy is facing cost-push inflation. WPI can help in estimating expected future inflation in the economy. That is one main reason why the central bank focuses on the CPI as an inflationary measure because in developing countries the phenomenon of Cost-push inflation is more prevalent than demand-pull inflation which affects the purchasing power of the middle income and lower-income class (Rao & Bukhari, 2011).

When the demand from the consumer side rises it is projected from CPI to WPI, this happens when the economy faces demand-pull inflation. Therefore it can be said that bidirectional causality is possible between WPI and CPI. This model has been investigated in studies by Colclough and Lange (1982), Silver and Wallace (1980), and Cushing and McGarvey (1990). A further possibility of simply no causal relationship also exists considering the components and complexities of the two variables hold due to certain reasons: 1) A difference in transmission mechanism from WPI to CPI when goods are intermediate or final. 2) The inclusion of Services in CPI but not in WPI and the extent of the share of imports in WPI compared to that of CPI (Arby & Ghauri, 2016).

Since the two variables can depict different behaviors in different economies and are vital in the estimation of inflationary pressures it is of utmost importance to identify the causality of both variables that an appropriate and applicable monetary policy can be designed to curb the source of inflation transmission concerning Pakistan.

Additionally considering the case of food inflation separately gives detail in our analysis as food is a necessity item and if the price of any necessity good decreases the purchasing power and real income of people (Joiya & Shahzad, 2013). As in many developing countries, aggregate inflation is lower than food inflation and the rise in food prices has a greater impact on CPI(Country, 2013).

Therefore this paper works on the main objective to identify the causal association between the two variables. Considering the case of Pakistan CPI consists of a basket of goods of 487 items which is collected from 40 cities while the WPI is consists of 463 items and the data is collected from 21 cities.

This paper aims to Investigate the dynamic and static causality between WPI(general)and CPI(general), WPI(food) and CPI(food),WPI(non-food)and CPI(non-food)and WPI(non-food)and CPI(food).

LITERATURE REVIEW

Many studies have been done in the past to investigate the link between the Wholesale Price Index (WPI) and the Consumer Price Index (CPI). This has been a source of interesting

conclusions. The tests used to investigate the link between these variables have usually been Johansen's co-integration for long-run relationship testing while granger causality is used for finding out if the variables are bidirectional or unidirectional but other tests have also been used at various occasions to strengthen the research process.

Anggraeni & Irawan (2018), Amir Indrabudiman SE, (2015), Akçay, (2011), Ulke & Ergun, (2014) in their study investigated the relationship between CPI and WPI in Indonesia. However, Anggraeni & Irawan (2018) studied the relation in general, food and other groups. For this purpose they based on the model of VAR Granger causality has been applied. Monthly data has been used from January 2010 to August 2016. The results indicate the existence of the link from PPI to CPI which is a one-way link. Also, there is a bidirectional link between PPI and CPI in the food group furthermore there is a unidirectional relationship leading to PPI from CPI in the group of clothing and zero relationships between the two variables in the processed food group. While Amir Indrabudiman SE (2015) used quartile data from 2002 to 2012 and found the presence of both short-run and long-run link among the WPI and CPI, moreover one-way causality was found leading to WPI from CPI. Akçay (2011) used monthly data from August 1995 to December 2007 to find out the causality of various European countries using Toda and Yamamoto method. The tests concluded that a one-way link exists leading from PPI to CPI in the case of France and Finland. Furthermore, in the case of Germany two way the link is present between the variables while no causality is existent for the Netherland and Sweden. However Ulke and Ergun (2014) in their paper found a one-way link in the long run and causality leading to PPI from CPI while the presence of causality was not there in the short run in the case of Turkey.

Likewise, Tiwari (2012), Colclough & Lange (1982), Shahbaz, Wahid, & Haider (2010), Shahbaz, Kumar, & Iqbal, (2012), Arby & Ghauri (2016), Shahbaz (2013), Sethi, (2017) and Cerquera-Losada, Murcia-Arias, & Conde-Guzmán (2018) in their research investigated cointegration and causality and results vary according to different investigations. Tiwari (2012) finds CPI granger cause relationship in the short run, intermediate level, and long run. WPI granger causality was only found at the intermediate level. Colclough & Lange (1982) also attempts to find the causality between the given variables using the sims test as well as granger causality and explores that test results support the causality leading to producer prices from consumer prices which challenges the conventional notion that suggests that causality exists from producer to consumer price, therefore, the study suggest bidirectional causality. However Shahbaz, Wahid, & Haider (2010) used ARDL for co-integration and Toda Yamamoto for causality for Pakistan, and the conclusions show the presence of a relationship in the long run and bidirectional causality among CPI and WPI. Although it can be said that causality is stronger in the direction leading from WPI towards CPI compared to the case of vice versa situation for Pakistan. Moreover Shahbaz, Kumar and Iqbal (2012) show that causality exists at all levels from initial to intermediary and continuing in the long run directing towards WPI from CPI while it has been found that the causality in long run ceases to hold from WPI towards CPI. According to the research of Arby & Ghauri (2016) for Pakistan presence of long-run bidirectional link for WPI and CPI exists furthermore unidirectional relationship from WPI food to CPI food and long-run bidirectional link among CPI non-food and WPI nonfood is present. Shahbaz (2013) finds bi-directional causality among the variables for India. Moreover (Sethi, (2015) finds that both indexes have negative effects on the growth. Causality has been found using CPI and WPI individually with economic growth at different lag lengths.

Mixed results have been attained with the change of indexes as well as lag lengths (Cerquera-Losada, Murcia-Arias, & Conde-Guzmán (2018) uses Toda Yamamoto for causality in six countries of South America. In the case of Brazil, Columbia, Uruguay, and Ecuador causality is nonexistent between the two variables, but the conclusions for Paraguay and Peru are different from others.

Arshad (2012) results reveal co-integration between the two variables at 90% but the same result cannot be concluded at 95% or 99%. Mallick and Behera (2020) find the existence of non-linear cointegration additionally unidirectional causality is also found from CPI to WPI (Akdi, Berument and Mu (2006) have used the engle and granger test for single equation while for multivariate equations Johansen's cointegration and periodogram test has also been used. Engle granger and Johansen's co-integration provide mixed results but periodogram-based results show the insignificant presence of links in the long run among the two variables so it can be concluded that there is a lack of doing integration between the series.

Furthermore, Guthrie (2016) explores the link among the prices of producers and consumers which is described by the distributed lag model suggested by Solow. The methodology used is the Pascal distributed lag model. The result supports the hypothesis for the existence of a significant relationship between the two indexes. It is further suggested that although the relationship is significant it is not very strong but in recent years its strength has also improved.

DATA AND METHODOLOGY

Data collection

In this research study, we investigated the relationship between inflation indexes CPI and WPI and their sub-indexes CPI food (CPIF) and non-food (CPINF), WPI food (WPIF), and non-food (WPINF). We have taken monthly data, July 1971 – December 2019 from the statistical bureau of Pakistan and SBP annual reports.

We have used the Log value of the Variables in this study to solve the issue of heteroscedasticity moreover in time series analysis generally, many economic series have a basic growth rate that may or may not be steady. These series are not stationary as the mean continues to rise; however, they are not integrated as they cannot be stationary by any amount of differentiation. It gives rise to one of the key motives for taking data logarithms before they are submitted to proper econometric study. By taking the log of a series that shows an average rate of growth, we can convert it into a series that follows a linear trend and is integrated.

Table 1: Trends of CPI and WPI in all groups

General Group	Food Group	Non-Food Group
LCPI	*LCPIF*	*LCPINF*
LWPI	*LWPIF*	*LWPINF*

The trend between CPI general and WPI general shows that till 2010 increase in CPI general is greater than that of WPI general but after 2010 there is a steep increase in both WPI and CPI where a change in WPI is greater than that of CPI.
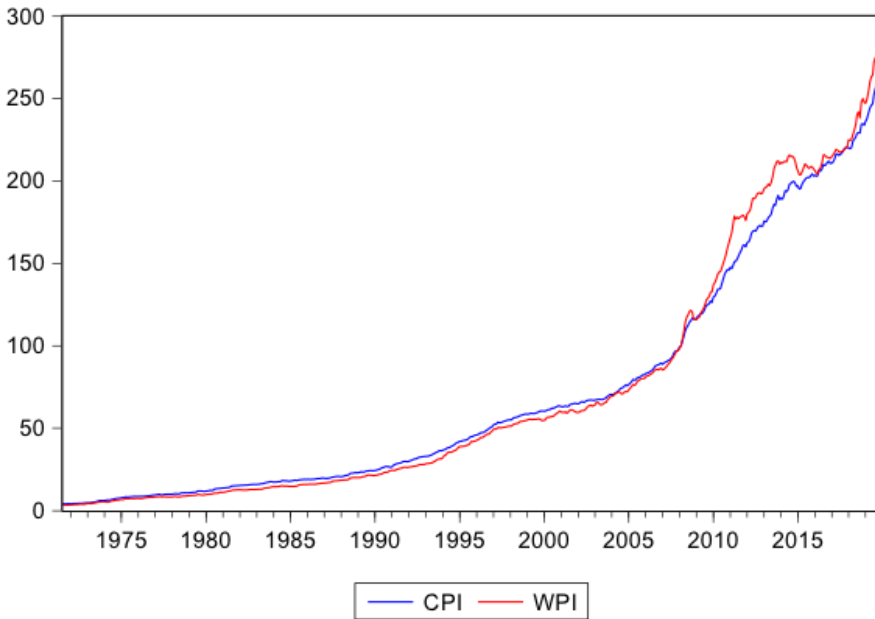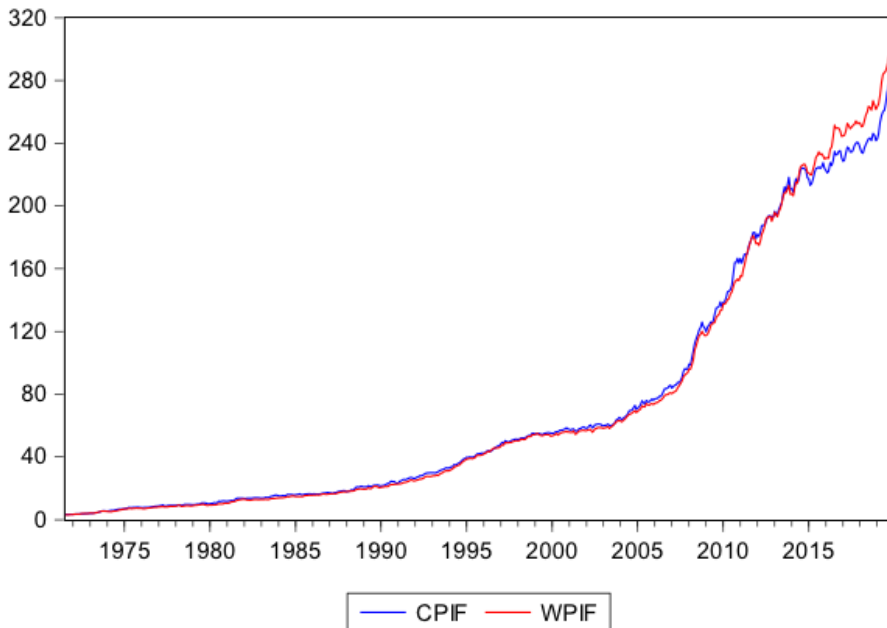
Figure 1: General group

Figure 2: Food Group

The trend in the food group shows there is a sharp increase in WPI and CPI till 2010 while the increase in WPI is greater than that of CPI since 2015.
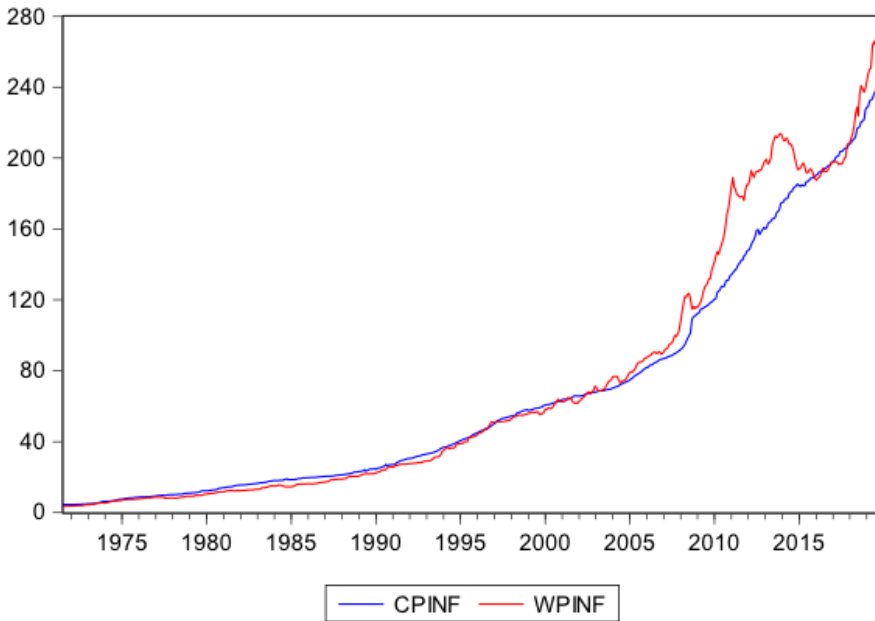
Figure 3: Non-food Group

The graph above shows that till 2010 CPINF and WPINF are quite close to each other but in the next five years till 2015, the rise in WPINF is greater than that of CPINF.

Table 2: Descriptive Information of Six Variables

Statistics	CPI	WPI	CPIF	WPIF	CPINF	WPINF
Mean	70.84	71.50	72.77	72.87	67.57151	71.32
Average	12.1	12.28	12.50	12.52	11.6	12.25
Median	44.90	41.78	41.95	41.00	43.68	42.64
Maximum	262.82	279.44	285.87	299.77	248.94	267.36
Minimum	4.07	3.26	3.30	2.98	4.42	3.48
Std. Dev.	70.25	75.74	78.10	81.28	65.14	72.95
Skewness	1.13	1.16	1.19	1.29	1.12	1.07
Kurtosis	3.00	2.98	3.00	3.31	3.07	2.80
Jarque-Bera	123.65	129.78	137.54	163.57	122.15	112.53
Probability	0.00	0.00	0.00	0.00	0.00	0.00
Observations	582	582	582	582	582	581

The table above summarizes the descriptive information of six variables for 48 years on monthly basis. The mean of the logs is in the same range except for CPI non-food. In a total of these 582 observations, the average of CPI was 12.1%, WPI 12.28%, CPI food is 12.5%, WPI food is 12.52%, CPI non-food is 11.6% and WPI non-food is 12.25% which indicate that the average of WPI is above the CPI in all inflation index groups but significantly in non-food index group. The standard deviation is not very small which indicates variability around the mean. However, WPI food has the largest standard deviation among the six variables depicting higher volatility in comparison to other variables. The skewness of all variables is close to one. Jarque-Bera test shows that (p<0.05) which confirms the normal distribution.

METHODOLOGY

The methodology involves the following step: Step one is to define the level of integration of each inflation index using the Augmented Dickey-Fuller unit root test. Step two is to determine appropriate lags by estimating the lag exclusion test in the unrestricted VAR model. Step three is to check the long-run association between indexes with help of the application of Johansen's co-integration test depending on the level of integration. Step four is to estimate convergence, divergence, and speed of equilibrium by applying the Vector Error Correction Model (VECM) with appropriate lags after determining that there is the incidence of long-run association. Finally, determine causal nexus between variables by using VEC Granger Causality/Block Exogeneity Wald test.

ADF Unit Root Test

It is very essential to verify the unit root of the series because hocks will be transitory in stationary time series, and their impacts will be removed over time as the series returns to its long-run mean values. In comparison, non-stationary time series may typically comprise lasting components. The dilemma with non-stationary data is that standard procedures for OLS regression will easily lead to wrong conclusions which lead to trouble of spurious. For this purpose, we applied the widely used Augmented Dickey-Fuller test suggested by (Taylor, Dickey, Fuller, Dickey, & Fuller, 2012) Dickey and Fuller in 1979, 1981.

$$\Delta y_t = \alpha_0 + \alpha_1 y_{t-1} + \sum_{i=1}^{n} \alpha \Delta y_t + e_t$$

Johansen's Co-integration Test

In time series examination it is essential to find out that the time series of the model is truly integrated or not because sometimes stochastic trends make them integrated falsely or there is a chance of occurrence of the spurious problem. For this purpose, the co-integration test is crucial in the time series model using non-stationary time series data. In this investigation, we have applied widely used Johansen's Co-integration tests for multiple equations at level i.e. I (0). The general form of the equation is written below.

$$Z_t = A_1 Z_{t-1} + A_2 Z_{t-2} + \cdots + A_k Z_{t-k} + u_t$$

VECM

If there is a long-run association between series and the two variables are co-integrated that indicates that there is disequilibrium in the short-run. Moreover, there is a certain adjustment process to equilibrium that prevents long-term affiliation errors from becoming higher. ECM is the method suggested by Engle and Granger (2007)to indicate the period and pace of correction from short-run disequilibrium to long-run equilibrium. ECM also has some other importance in time series analysis that is formulated in terms of first difference which tends to solve the problem of spurious by eliminating trends in series. The general form of the equation is written below.

$$\Delta Z_t = r_1 \Delta Z_{t-1} + \cdots + r_{k-1} \Delta Z_{t-k-1} + \alpha(\beta Z_{t-1} \mu_1 1 \quad \delta_1 t) + \mu_2 + \delta_2 t + u_t$$

Granger causality/block erogeneity

If it is found that the variables of the model are co-integrated that means there is a long-term association among them so it is crucial to find out which variable affects another variable. For this determination granger causality test GRANGER (1969) is used to recognize the ability of a variable to predict another variable which can be bi-directional or uni-directional. Granger causality can be expressed in subsequent equations.

$$y_t = a_1 + \sum_{i=1}^{n} \beta_i \, x_{t-i} + \sum_{j=1}^{m} \gamma_j \, y_{t-j} + e_{1t}$$

$$x_t = a_2 + \sum_{i=1}^{n} \theta_i \, x_{t-i} + \sum_{j=1}^{m} \delta_j \, y_{t-j} + e_{2t}$$

RESULTS AND DISCUSSION

After applying 1st step we found that all indexes and sub-indexes are stationary at the level of integration of 1st difference which is a pre-requisite of the Johansen co-integration test so we applied Johansen's co-integration and we found a long-term nexus between CPI and WPI also between sub-indexes. After we found the existence of long-run affiliation we applied VECM and found that there is the convergence of some indexes and divergence of some indexes from equilibrium which means there is short-run disequilibrium. Finally, we found the existence of Granger causality between inflationary indexes of different groups.

Augmented Dickey-Fuller Unit root test

1st step is to find the stationarity of inflation indexes by using the ADF test which is crucial to evade the dilemma of spurious in which two variables seem to associate with each other due to coincidence or presence of a third variable. This false association can become an obstacle in determining true and significant relationships; results are shown in Table 3.

Table 3: Augmented Dickey-Fuller Unit root test Null hypothesis: Ho: series has a unit root (series is non-stationary)

Series	Order of Integration I(1)	p-value of ADF Test	Result
LCPI	1ST Difference	0.0090	REJECT H0
LCPIF	1ST Difference	0.0009	REJECT H0
L CPINF	1ST Difference	0.0035	REJECT H0
LWPI	1ST Difference	0.0000	REJECT H0
LWPIF	1ST Difference	0.0000	REJECT H0
LWPINF	1st difference	0.0002	REJECT H0

Since the p-value of the ADF test of all the series is less than 0.05 hence they all are stationary at 1st difference.

Johansen's Co-integration Test:

Since all series are stationary at the same integration of 1st difference so we used Johansen co-integration test for determination of long-run association between general CPI and WPI and also between sub-indexes food and non-food. We required appropriate lag to apply Johansen co-integration test for this we used the VAR lag exclusion test. Results are presented in Table 2.

Table 4: Johansen's co-integration test Ho: there is no co-integration

GENERAL GROUP	Hypothesized Number of co-integration equations	Eigen values	Trace statistics	0.05(5%) critical value (p-value)	Max-Eigen statistics	0.05(5%) critical value (p-value)
LCPI LWPI	None *	0.0277	17.2150	15.4947 (0.0273)	16.0504	14.2646 (0.0258)
	At most 1*	0.0020	1.1646	3.8415 (0.2805)	1.1646	3.8415 (0.2805)

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

Adjustment coefficients (Monthly Speed of adjustment)

DLCPI	–0.0372	(–26.91)
DLWPI	–0.0167	(–59.84)

FOOD GROUP	Hypothesized Number of co-integration equations	Eigen values	Trace statistics	0.05(5%) critical value (p-value)	Max-Eigen statistics	0.05(5%) critical value (p-value)
LCPIF LWPIF	None *		16.4125	15.4947 (0.0363)	14.9066	14.2646 (0.0395)
	At most 1*	0.0026	1.5059	3.8415 (0.2198)	1.5059	3.8415 (0.2198)c

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

Adjustment coefficients (Monthly speed of adjustment)

D(LCPIF)	–0.0669	(14.95)
D(LWPIF)	–0.0067	(148.63)

NON-FOOD GROUP	Hypothesized Number of co-integration equations	Eigen values	Trace statistics	0.05(5%) critical value (p-value)	Max-Eigen statistics	0.05(5%) critical value (p-value)
LCPINF LWPINF	None *	0.0311	20.9476	15.4947 (0.0068)	18.1549	14.2646 (0.0115)
	At most 1*	0.0048	2.7927	3.8415 (0.0947)	2.7927	3.8415 (0.0947)

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

Adjustment coefficients (Monthly speed of adjustment)

D(LCPINF)	–0.0204	(49.14)
D(LWPINF)	–0.0020	(488.99)

Table 4 indicate the result of Johansen's co-integration test in which the trace test specify 1 co-integration equation at the significance level of 0.05 and the Max-Eigen test shows the robustness by indicating the same results therefore there is a long-term link between inflation indexes as well as between sub-indexes which is similar to the results of ,Akçay (2011), Ulke and Ergun (2014), Tiwari (2012), Colclough and Lange (1982), Shahbaz, Wahid and Haider, (2010), Shahbaz, Kumar and Iqbal, (2012), Arby & Ghauri (2016), Arshad, (2012), Mallick and Behera (2020) and Shahbaz (2013).

Vector Error Correction Model:

Since Johansen's co-integration test specified equilibrium or long-run association between series so there must be disequilibrium in the short-run thus it is crucial to apply the vector error correction model to find out divergence and convergence and its rate of amendment towards equilibrium in long-run. Results are shown in Table 5.

Table 5: Vector Error Correction Model 3

Variables	Error correction Coefficients	Standard error	t-stats
General Group			
D(LCPI)	−0.03716	(0.0094)	[−3.9546]
D(LWPI)	−0.0167	(0.0110)	[−1.5170]
Food Group			
D(LCPIF)	−0.0669	(0.0204)	[−3.2808]
D(LWPIF)	−0.0067	(0.0180)	[−0.3729]
Non–Food Group			
D(LCPINF)	−0.0203	(0.0048)	[−4.2431]
D(LWPINF)	−0.0020	(0.0086)	[−0.2367]

As the theory suggests that if the variable was deviated from long-run equilibrium and move above the equilibrium level, it is negative therefore in the following period the error term will diminish to its equilibrium level while if the variable deviates below the equilibrium level it is positive therefore in the following period the trajectory of the error term will move upwards towards the equilibrium. The pace at which alteration takes place is defined by the error correction coefficient's value.

VECM table shows that the error correction coefficient of inflation index LCPI and its sub-indexes LCPIF and LCPINF are negative but significant because their t-values are greater than 2 and up to the benchmark. Hence negative value means that they are above the equilibrium and move downward to its equilibrium while the rate of adjustment in percentage form is the value of error correction coefficients. However error correction coefficient of LWPI and its sub-indexes LWPIF and LWPINF are also negative which means they are also above the equilibrium and move downward to its equilibrium with the pace of adjustment defined by the value of error correction coefficients. DLCPI adjust downward to its equilibrium in 27 months, DLWPI adjusts upward towards its equilibrium in 60 months, DLCPIF adjusts downward to its equilibrium in 15 months, DLWPIF adjusts upward toward its equilibrium in 149 months, DLCPINF adjusts downward toward its equilibrium in 49 months and DLWPINF adjusts upward toward its equilibrium in 489 months. It is found that CPI adjusts more quickly than

WPI in all groups. On the other hand, the food group adjusts fast as compare to the non-food group which adjusts slowly.

Table 6: VEC Granger Causality/ Block Exogeneity Wald Test

Dependent variable	Excluded	Chi-sq	df	Prob.	Ho	Causality
General Group						
DLCPI	*DLWPI*	*33.0599*	*05*	*0.0000*	*reject*	*Two-way causality between DLCPI and DLWPI*
DLWPI	*DLCPI*	*16.9994*	*05*	*0.0045*	*reject*	
Food Group						
DLCPIF	*DLWPIF*	*34.2607*	*07*	*0.0000*	*reject*	*Two-way causality between DLCPIF and DLWPIF*
DLWPIF	*DLCPIF*	*17.6578*	*07*	*0.0136*	*reject*	
Non–Food Group						
DLCPINF	*DLWPINF*	*50.2988*	*03*	*0.0000*	*reject*	*One-way causality from DLWPINF to DLCPINF*
DLWPINF	*DLCPINF*	*3.6120*	*03*	*0.3065*	*accept*	

Ho: No granger causality toward the variable.
At the significant level of 5%

Table 6 shows VEC Granger causality test results which indicate the existence of two-way causality between CPI and WPI in the general group as well as in food group inflation indexes that mean they both cause each other in general and food group and these findings are parallel to the findings of Anggraeni and Irawan (2018) and Arby & Ghauri (2016). However, in the non-food group, there is one-way causality from WPI to CPI which shows that only WPI defines CPI in a non-food group of the inflation index.

CONCLUSION:

In this study, we examine causality between CPI and WPI in three groups' i.e. general, food, and non-food group, and it is concluded that all inflationary indexes and sub-indexes are stationary at first difference which leads to applying Johansen's co-integration test and it indicates the existence of a long-run association between DLCPI and DLWPI in all groups. Furthermore, equilibrium or long-run association leads us to VECM which indicate direction and speed of correction of inflationary indexes towards equilibrium in long-run then VEC Granger causality confirmed that there is two-directional causality between DLCPI and DLWPI in general and food group that means both inflation indexes can define each other while unidirectional causality in the non-food group from DLWPI to DLCPI that means DLWPI can explain DLCPI in a non-food group at the significance level of 5%.

EMPIRICAL FINDINGS FOR ASSOCIATION BETWEEN CPI AND WPI:

Inflation Index	ADF Unit root test		Johansen's Co-integration		VEC Granger Causality
	(Level of integration for Stationarity)		Existence	Adjustment period in months	
	Level 1st	diff	CPI	WPI	
CPI	*No*	*Yes*			
CPI food	*No*	*Yes*			

CPI non-food	*No*	*Yes*			
WPI	*No*	*Yes*			
WPI food	*No*	*Yes*			
WPI non-food	*No*	*Yes*			
CPI and WPI			*Yes*	*27*	*60*
CPI food and WPI food			*Yes*	*15*	*149*
CPI non-food and WPI non-food			*Yes*	*49*	*489*
CPI cause WPI					*Yes*
WPI cause CPI					*Yes*
CPI food cause WPI food					*Yes*
WPI food cause CPI food					*Yes*
CPI non-food cause WPI non-food					*No*
WPI non-food cause CPI non-food					*Yes*

Source: Author's calculations

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