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Research Paper

Wheat price movement across major markets of Madhya Pradesh

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ABSTRACT : This paper has examined the market integration of wheat in Madhya Pradesh. Both market arrivals and prices of wheat have depicted increasing trends in almost all the selected markets of Madhya Pradesh. The present study aimed to study price movement of Wheat *i.e.* seasonal variation, price volatility and co-integration among the major wheat markets in Madhya Pradesh. For study purpose the data related to monthly average prices and arrivals of Wheat were collected from major markets from different markets in States *viz.*, Bhopal, Gwalior, Indore, and Ujjain for the period 2005-2016. Moving average method used to study seasonal variation. The econometric tools like ADF test, Johansen's multiple co-integration test, Granger Causality Test and ARCH-GARCH model were used to arrive at conclusion. The results of study showed that the prices of wheat were higher in the months from March to August in all selected markets. The cyclical variation observed in the prices of Wheat in the selected markets. For all selected markets the prices series are free from the consequences of unit root and were stationary at first difference. The selected markets show long run equilibrium relationship and co-integration between them. Most of the markets showed bidirectional influence on Wheat prices of each other. Bhopal, Gwalior, Indore and Ujjain recorded low price volatility in wheat prices.

KEY WORDS : Wheat, Market integration, Seasonality, Co-integration

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INTRODUCTION :

The spatial price relationships have been widely used to study market performance. The efficient functioning of markets provides profitable prices to the producers and fair prices to the consumers. Market integration and price transmission, in the case of a large producing and consuming country like India; depend on the geographical dispersion or concentration of production. While consumers are spread throughout the country, the production and marketed surplus are less spread-out, particularly for wheat. Apart from measures or incentives to increase food production (through technology, modern inputs, irrigation expansion, and infrastructure development), several polices too have impacts on market environment and their impacts are trailed over varying rates. The government intervention in the form of policies in market, *viz.*, announcement of minimum support prices (MSPs) and purchase of wheat grain at these prices, in the event of market prices falling below these levels; maintenance of food buffers for food security and price stability; and distribution of wheat to the consumers,

particularly to the vulnerable sections of the society, at affordable (subsidized) prices; regulation of traders' marketing practices through inter alia imposition of stocking limits and levies; and lastly regulation of imports and exports through canalization, licensing, imposition of trade tariffs, and minimum export prices (MEPs), with a view to maintain supplies and price stability in the market (Acharya *et al.*, 2012), generate market sentiments among stakeholders that are ultimately reflected in wheat price formation in the market. The major factors influencing on prices of Wheat are the arrivals in market, climatic conditions during the various growth stages, carry forward stocks, price movement over the period of time, crop condition throughout the country, export and import, global and domestic demand and supply, etc. Seasonal variations observed in prices of wheat. In the peak arrivals months the prices of wheat declined while in lean period they rises. The markets of wheat in Madhya Pradesh are co-integrated and they influences on prices of each other. For better marketing of any agricultural commodity the information regarding seasonality, seasonal variations, price volatility, price movement across the state and country, etc. is necessary. Analyzing the past trend in the price of commodities is also useful in understanding the present scenario and to formulate appropriate strategies to improve the marketing system. The study of seasonal variations is considered to be important as a guide to the producer to market his products and to the consumer to purchase his needs at the right time. It also serves as a guide to the Government to operate its policy measures (procurement and buffer release) at the appropriate time. The knowledge of cyclical variation help us in the insulating the economy against violent fluctuations. Therefore, the present study has undertaken with following specific objectives :

– To study seasonal variations and cyclical variations in prices of wheat.

– To assess the price volatility and co-integration among the major wheat markets in Madhya Pradesh.

MATERIALS AND METHODS :

For study purpose the major Wheat markets from the States were selected *viz.*, Bhopal, Gwalior, Indore, and Ujjain. As per the records available the time series data on monthly average prices and arrivals of wheat for the period from 2005 to 2016 was collected from official website of AGMARKNET for respective market.

Method of moving average :

The method of moving average most widely used method of measuring seasonal fluctuations and the seasonal indices were obtained with following steps.

– Twelve month centered moving average value for given market arrivals and prices data were obtained.

– The original value as a percentage of centered moving average values for all months were expressed, except for first six month and six month at the end.

– The percentage was arranged according to the years and month. Primarily seasonal indices were obtained on eliminating the irregular component by averaging these percentages for each month. The average was taken over different year.

Cyclical indices :

The most commonly used method for estimating cyclical movement of time series is the residual method by eliminating the seasonal variation and trend. This is accomplished by dividing (Yt) by corresponding (S) for time't'. Symbolically,

$$\text{T.C.I.} = \frac{\text{T.C.S.I.}}{\text{T}}$$

Further, cyclical movements along with irregular fluctuations are calculated by detrending. Symbolically,

$$\text{C.I.} = \frac{\text{T.C.I}}{\text{T}}$$

Augmented dickey-fuller test (ADF) :

Before analyzing any time series data testing for stationarity is per-requisite. First the test for stationarity of time series data on wheat prices is conducted. An Augmented dickey-fuller test (ADF) is the test for the unit root in a time series sample. A stationary series is one whose parameters are independent of time, exhibiting constant mean and variance and having autocorrelations that are invariant through time. It the series is found to be non-stationary, the first differences of the series are tested for stationarity. The number of times (d) a series is differenced to make it stationary is referred to as the order of integration, I(d).

ADF unit root test are based on the following three regression forms:

Without constant and trend $\Delta Yt = \delta Yt\text{-}1 + ut$

With constant

$\Delta Yt = \alpha + \beta T + \delta Yt\text{-}1 + ut$

With constant and trend

the hypothesis is : H0: □= 0 (Unit root)

H0: □ ≠ 0

t* > ADF critical value then accept the Null hypothesis, *i.e.* unit root exists.

t* < ADF critical value then reject the Null hypothesis, *i.e.* unit root does not exists.

Johansen's multiple co-integration test:

Johansen's multiple co-integration test is employed to determine the long rum relationship between the price series. The test shows whether the selected wheat markets are integrated or not. Johansen (1988) has developed a multivariate system of equations approach, which allows for simultaneous adjustment of both or even more than two variables. The multivariate system of equations approach is more efficient than single equation approach *i.e.* it allows to estimate the co-integration vector with smaller variance. The second advantage of the multivariate approach is that in the simultaneous estimation it is not necessary to presuppose erogeneity of either of the variables.

Granger causality tests:

In order to know the direction of causation between the markets Granger causality test was employed. When a co-integration relationship is present for two variables, a Granger causality test (Granger, 1969) can be used to analysis the direction of this co-movement relationship. Granger causality tests come in pairs, testing weather variable xt Granger-causes variable yt and *vice versa*. All permutations are possible: univariate Granger causality from xt to yt or from yt to xt, bivariate causality or absence of causality. Formally, the Granger causality test analyses weather the unrestricted equation

$yt = \alpha 0 + \Sigma Ti = 1\ \alpha 1i\ yt\text{-}i + \Sigma Tj = 1\ \alpha 2i\ xt\text{-}j + \varepsilon t$ with $0 \leq i, j \leq T$

Yield better results than the restricted equation.

$Yt = \beta 0 + \Sigma Ti = 1\ \beta\ 1i\ yt\text{-}i + \varepsilon t$ with $\Sigma Tj = 1\ \alpha 2j\ xt\text{-}j = 0$ (The Null hypothesis) *i.e.* if H0, in which $\alpha 21 = \alpha 22 = \ldots\ldots = \alpha 2T = 0$, is rejected then one can state "variable xt Granger causes variable yt"

ARCH-GARCH model :

To access the presence of price volatility the ARCH-GARCH analysis carried out. Autoregressive conditional heteroscedastcity (ARCH) models are specifically designed to model and forecast conditional variances. ARCH model introduced by Engle (1982) and generalized as GARCH by Bollerslev (1986). The ARCH model have two distinct specifications one for the conditional variance and the standerd GARCH (1,1) specification is presented below.

$$Yt = \gamma 0 + \gamma 1\ X1t + \ldots\ldots\ldots + \gamma\ k\ Xkt + e \quad (1)$$

$$\rho^2 t = \omega + \square\ e2t\text{-}1 + \beta\ \rho 2t\text{-}1 \quad (2)$$

Eq. (1) is the mean equation and equation (2) is the conditional variance equation. The ARCH component (□) indicate the lag of the squared residual from the mean equation and the GARCH term (β) the last period's forecast variance and the resultant sum of these co-efficient (□ + β) are presented. The sum of co-efficient very close to 1 would indicate that the volatility shocks are quite persistent in the series.

Vector error correction model :

Even if one demonstrates market integration through cointegration, there should be disequilibrium in the short run *i.e.* price adjustment across markets may not happen instantaneously. It may take some time for the spatial price adjustments. Error correction model can incorporate such short-run and long-run changes in price movement. A generalized ECM formulation to understand both the short-run and long-run behaviour of prices can be considered by first taking the autoregressive distributed lag (ADL). The generalized form of this equation for k lags and an intercept term is as follows.

$\Delta Yt = a00 + \Sigma\ ai1 \Delta Xt\text{-}1 + m0[m1Xt\text{-}k - Yt\text{-}k] + \varepsilon t$

where $m0 = (1\text{-}\Sigma ai2)$

The parameter m0 measures the rate of adjustment of the short-run deviations towards the long run equilibrium. theoretically, this parameter lies between 0 and 1. the value 0 denotes no adjustment and 1 indicate an instantaneous adjustment. A value between 0 and 1 indicate that any deviations will have gradual adjustment to the long-run equilibrium values.

RESULTS AND DATA ANALYSIS :

The results obtained from the present investigation as well as relevant discussion have been summarized under following heads :

Seasonal variation :

The arrivals of wheat start hitting in the market from the month of March and April. The peak period of arrivals is March to April. Due to large arrivals during this period the prices decline. The lean period is from December to

February. The prices were recorded higher from November to January. Most of the traders release the stored stock of wheat during this period in anticipation of making the profit. The seasonal indices of monthly average prices of wheat in Bhopal, Gwalior, Indore, and Ujjain markets were worked out to study seasonal variations, which are presented in Table 1.

From Table 1 it is observed that in selected markets the prices were higher from November to January. The prices of wheat recorded highest by 6.53, 4.21and 6.44 per cent during December in the Bhopal, Gwalior and Ujjain markets. The highest prices of wheat recorded highest by 72.96 per cent during November in the Indore market. Bhopal market recorded lower prices in the months from February to August. The lowest prices recorded by 6.37 per cent in the month of March in Bhopal. Gwalior and Ujjain market recorded lower prices in the month from March to September. The lowest prices recorded by 5.70 per cent and 6.30 per cent in the month of April and June in Gwalior and Ujjain Market, respectively. Lowest prices recorded by 1.03 per cent in the month of April in Indore market, during these months the arrivals starts which lowered down the prices. Chandrakala (2009) found that the prices of ground nut were higher in lean arrivals period.

Cyclical variation :

The cyclical variation observed in the prices of wheat in the selected markets. The higher prices recorded during the year 2007, 2011 and 2014. It was observed that at the start of decade during the year 2007 the price of wheat was higher by 8.35 and 11.37 per cent in Gwalior and Ujjain market, respectively. During the year 2011 by 11.75 and 66.97 per cent in Bhopal and Indore market, respectively. The rise in prices attributed to less production due to bad weather conditions. The wheat

Table 1 : Seasonal index for wheat prices and arrivals in different markets of Madhya Pradesh

Months	Bhopal		Gwalior		Indore		Ujjain	
	Arrivals	Prices	Arrivals	Prices	Arrivals	Prices	Arrivals	Prices
Jan	45.73	102.26	17.20	107.39	20.74	96.45	11.82	104.03
Feb	46.24	96.60	16.75	102.43	41.22	91.98	22.17	99.25
Mar	111.52	96.37	25.80	98.14	220.21	89.79	145.09	98.41
Apr	366.60	97.34	427.96	95.70	396.74	91.03	499.35	98.26
May	225.58	99.73	377.77	96.42	231.24	91.30	266.04	97.28
Jun	90.74	97.88	146.16	97.04	66.65	89.83	88.33	96.30
Jul	64.02	98.95	52.80	98.18	52.87	92.96	40.39	98.67
Aug	48.55	99.22	27.97	99.14	31.69	94.07	27.56	99.41
Sep	46.67	100.48	37.71	98.85	37.17	93.98	31.61	96.45
Oct	40.07	99.63	28.24	100.60	30.33	95.67	17.21	101.42
Nov	55.27	105.01	23.59	101.90	38.55	172.96	23.86	104.08
Dec	59.02	106.53	18.04	104.21	32.59	99.98	26.58	106.44

Table 2 : The cyclical index for wheat prices in different markets of Madhya Pradesh was worked out for the period 2005-2016

Years	Bhopal	Gwalior	Indore	Ujjain
2005	97.569	95.82	94.51	97.59
2006	92.505	88.37	85.93	90.40
2007	102.342	108.85	101.92	111.37
2008	98.391	103.02	90.87	95.40
2009	98.922	107.12	93.61	100.45
2010	105.361	102.77	98.71	105.48
2011	111.756	102.69	166.97	105.09
2012	91.747	88.08	83.38	88.63
2013	101.012	97.39	93.87	101.59
2014	107.375	105.99	103.82	109.75
2015	99.867	105.69	95.97	101.53
2016	93.151	94.22	90.46	92.72

prices raised again by 7.37, 5.99, 3.82 and 9.75 during the year 2014 in Bhopal, Gwalior, Indore and Ujjain market, respectively (Chandrakala, 2009).

Augmented dickey-fuller test (ADF) :

The Augmented dickey fuller (ADF) based unit root test procedure is done to check weather wheat prices are stationary in the markets under study.

From Table 3 it is observed that at level with lag 1, the ADF values are more than critical values at 1 per cent level of significance indicating the existence of unit root implied that the prices series in all markets are non-stationary. This implied that the Wheat prices series are non-stationary at level. The table further showed that in first difference with lag 1, the ADF values are lower than the critical values at 1 per cent level indicated that the prices series are free from the consequences of unit root. This implied that the prices series are stationary at 1st difference level. Ghosh (2011) found the prices rice and wheat were non-stationary in levels but stationary in first-differences implied that all the series of rice and wheat prices contain a single unit root and are integrated of order one, I(1) for both the period.

Johansen's multiple co-integration tests :

Johansen's multiple co-integration test is employed to determine the long rum relationship between the price series. The test shows whether the selected soybean markets are integrated or not.

To test whether the selected wheat markets are integrated or not, Johanson multiple co-integration test conducted by using E-views software and the results presented in Table 4. The results of Co-integration test showed at least one co-integration equations at 5 per

Table 3 : ADF test results of wheat prices

Markets	Level	First difference	Critical value (1%)
Bhopal	-3.465868	-14.74361	
Gwalior	-3.833528	-15.11122	-4.018349
Indore	-3.31941	-10.28323	
Ujjain	-3.013231	-14.21219	

Table 4 : Results of multiple co-integration analysis

Domestic wheat market	Eigen value	Trace statistics value (5%)	Critical no. of CE(s)	Hypothesized	No. of co-integration equation
Bhopal	0.196659	72.98852	63.87610	None *	One
	0.112576	39.92318	42.91525	At most 1	
	0.074560	21.88882	25.87211	At most 2	
	0.065247	10.18837	12.51798	At most 3	

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

Table 5 : Results of pair-wise granger causality test

Null hypothesis	Obs	F-Statistics	Prob.
Gwalior does not Granger Cause Bhopal	154	3.35001	0.0377
Bhopal does not Granger Cause Gwalior		10.5724	5.E-05
Indore does not Granger Cause Bhopal	154	0.05143	0.9499
Bhopal does not Granger Cause Indore		7.51017	0.0008
Ujjain does not Granger Cause Bhopal	154	10.1924	7.E-05
Bhopal does not Granger Cause Ujjain		5.71524	0.0041
Indore does not Granger Cause Gwalior	154	0.47035	0.6257
Gwalior does not Granger Cause Indore		5.96196	0.0032
Ujjain does not Granger Cause Gwalior	154	12.6657	8.E-06
Gwalior does not Granger Cause Ujjain		0.72209	0.4874
Ujjain does not Granger Cause Indore	154	7.10047	0.0011
Indore does not Granger Cause Ujjain		1.20580	0.3024

Sample: 2003M01 2015M10 Lags: 2

cent level of significance indicated that the selected wheat markets having long run equilibrium relationship and there exists co-integration between them. Mukim *et al.* (2009) found the wholesale prices of wheat were co-integrated in the long run. Similar results recorded by Gandhi and Koshy (2006) and Ghosh (2011).

Granger causality tests :

In order to know the direction of causation between the markets Granger causality test was employed. When a co-integration relationship is present for two variables, a Granger causality test (Granger, 1969) can be used to analysis the direction of this co-movement relationship.

Table 6 : Results of ARCH-GARCH analysis

Parameter	Bhopal	Gwalior	Indore	Ujjain
Alpha (α)	1.035510	1.081981	0.680419	1.008802
Beta (β)	-0.697898	-0.253323	-0.010491	-0.667665
Sum of α and β	0.337612	0.828658	0.669928	0.341137

Table 7 : Results of vector error correction model

Error correction	D (Bhopal)	D (Gwalior)	D (Indore)	D (Ujjain)
Coint Eq1	0.005410	0.026206	1.114880	-0.002970
	(0.01365)	(0.01425)	(0.16235)	(0.01283)
	[0.39641]	[1.83923]	[6.86716]	[-0.23155]
D (Bhopal(-1))	-0.343301	0.112260	-0.983027	0.126282
	(0.08802)	(0.09189)	(1.04706)	(0.08272)
	[-3.90021]	[1.22162]	[-0.93884]	[1.52660]
D (Bhopal(-2))	-0.178574	0.069513	-0.695659	0.066306
	(0.08759)	(0.09144)	(1.04192)	(0.08232)
	[-2.03877]	[0.76018]	[-0.66767]	[0.80552]
D (Gwalior(-1))	0.040044	-0.296626	2.696625	-0.008546
	(0.09077)	(0.09476)	(1.07976)	(0.08530)
	[0.44115]	[-3.13015]	[2.49742]	[-0.10018]
D (Gwalior(-2))	-0.039870	-0.179564	1.288305	-0.129934
	(0.08754)	(0.09140)	(1.04138)	(0.08227)
	[-0.45543]	[-1.96469]	[1.23711]	[-1.57931]
D (Indore(-1))	0.003481	0.016165	-0.020965	0.000653
	(0.00979)	(0.01022)	(0.11649)	(0.00920)
	[0.35549]	[1.58108]	[-0.17997]	[0.07097]
D (Indore(-2))	0.005772	0.011033	-0.005063	0.011212
	(0.00702)	(0.00733)	(0.08353)	(0.00660)
	[0.82199]	[1.50504]	[-0.06062]	[1.69898]
D (Ujjain(-1))	0.359982	0.151839	-2.048972	-0.194581
	(0.10315)	(0.10769)	(1.22702)	(0.09694)
	[3.48992]	[1.41000]	[-1.66988]	[-2.00726]
D (Ujjain(-2))	0.244087	0.105549	-1.932910	0.049539
	(0.11019)	(0.11503)	(1.31071)	(0.10355)
	[2.21525]	[0.91755]	[-1.47470]	[0.47840]
C	7.945252	6.001862	11.46034	5.178938
	(6.55815)	(6.84673)	(78.0129)	(6.16329)
	[1.21151]	[0.87660]	[0.14690]	[0.84029]
R-squared	0.153953	0.135662	0.501519	0.099801
Adj. R-squared	0.100705	0.081263	0.470146	0.043145
Akaike AIC	11.67534	11.76147	16.62767	11.55115
Schwarz SC	11.87341	11.95953	16.82574	11.74922

Note: Standard errors in ( ) and t-statistics in [ ].

Theoretically, a variable is said to Granger-cause another variable, if the current value is conditional on the past value.

The casual relationship between the price series of selected wheat markets where approached through Granger causality technique. The results of the analysis showing the relationship between selected wheat markets are presented in Table 5. Gwalior and Bhopal market exhibited unidirectional causality and prices of Bhopal market affected Gwalior market. Ujjain and Bhopal market showed bidirectional causality Similarly Ujjain and Gwalior market. So the influence of Bhopal prices played a significant role over the other market prices and the influence is so strong that F- Stat. values happened to be significant at 1 per cent level. Thus a strong market integration of the four markets, Bhopal, Gwalior, Indore and Ujjain are established through the results of the analysis. Similar results found by Ajjan *et al.* (2009).

Price volatility:

To assess the presence of price fluctuations in the prices of wheat in Bhopal, Gwalior, Indore and Ujjain market ARCH-GARCH analysis is carried out and presented in Table 6.

It was observed that among the markets, the sum of Alpha and Beta is not nearer to 1 *i.e.* 0.337612, 0.828658, 0.669928 and 0.341137 for Bhopal, Gwalior, Indore and Ujjain markets, respectively, indicated that the absence of price fluctuations in wheat prices during the study period.

Vector error correction model :

Since the Johansen's multiple co-integration test result showed that the selected Wheat market having long run equilibrium relationship and there exists co-integration between them. Hence the Vector error correction model (VECM) is employed to know the speed of adjustments among the wheat markets for long run equilibrium. The results of VECM showed in Table 7.

The estimates of Vector error correction model revealed that Bhopal, Gwalior, Indore and Ujjain markets came to equilibrium in long run. Bhopal market one month and two month lag price is affecting current prices of their own market. Gwalior market one month lag price is affecting current prices of their own market and also Indore market. Ujjain market one month lag price is affecting current prices of their own market and also Bhopal market. Ujjain market two months lag prices is affecting current of Bhopal market. Indore market attains short run equilibrium rapidly.

Conclusion :

The study examined the price movement of wheat across the major markets in major wheat producing Districts of Madhya Pradesh. In selected markets the Wheat prices were higher from November to January. The cyclical variation observed in the prices of wheat in the selected markets. The higher prices of wheat recorded during the year 2007, 2011 and 2014.The results of ADF test showed that all the markets having the ADF values lower than the critical values at 1 per cent level indicated that the price series are stationary at first difference level. The analysis of multiple co-integration depicted that the selected markets having long run equilibrium relationship and their exists co-integration between them. There was bidirectional influences on wheat prices of Ujjain and Bhopal, Ujjain and Gwalior and the influence of Bhopal prices played a significant role over the other market prices. As the sum of Alpha and Beta worked out is not nearer to 1 for Bhopal, Gwalior,Indore and Ujjain market, this indicated low price volatility in wheat prices in these markets.

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