Testing the Integration in Pulses Market: Empirical Evidence from Major Lentil Wholesale Markets in India

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Abstract -This study has tested the long-run market integration across the four major wholesale lentil markets from the two leading Lentil producing states, Madhya Pradesh, and Uttar Pradesh. Two major wholesale markets, Attara and Banda are selected from Uttar Pradesh, and another two wholesale markets, Jabalpur and Raisen are selected from Madhya Pradesh based on the availability of data on prices and arrival. The empirical results have confirmed the presence of long-run price connections across the selected markets. Johansen's cointegration test has shown that even though the selected Lentil markets in India are geographically isolated and spatially segmented, they are well-connected in terms of prices of Lentil and have long-run price linkage between them. Granger Causality Test shows that there are unidirectional causalities between Attara and Jabalpur markets which implies that a price change in the former market in each pair granger causes the price formation in the latter market, whereas the price change in the latter market is not feedbacked by the price change in the former market in each pair. However, out of six cases, bi-directional causality is observed in two cases i.e., Attara-Banda, Banda-Attara and Jabalpur-Raisen, Raisen-Jabalpur, thus, indicating there is a perfect price transmission mechanism between these market pairs.

Keywords: ADF test, Granger causality test, Johansen co-integration Test, Lentil, Market integration.

I. INTRODUCTION

India is the largest producer, consumer, and importer of pulses. Although it is the world's second-largest pulses producer, there is still a huge shortage of pulses and, the prices are not affordable to a large section of consumers (Reddy et al., 2013). According to different studies and reports, despite being the second largest producer in the world, the price of pulses witnesses spatial variations in India. Dealing with such issues has become a foremost challenge for the country. Thus, the present study identifies the most influential pulses markets in India. Lentil is one of the main pulses which is consumed by every class of people, either rich or poor and is comparatively more affordable to the common man than other pulses. Madhya Pradesh and Uttar Pradesh are the leading Lentil-producing states in India. In the present study, market integration across the major wholesale markets of these two leading states has been checked.

II. REVIEW OF LITERATURE

Knowledge about the extent of market integration is useful for understanding the functioning of markets and for designing successful agricultural price stabilization policies. Properly integrated and efficient food markets should ensure effective trade between food-deficit and food-surplus locations and can therefore lead to a major source of economic growth. On the other hand, if prices are not properly transmitted, localized scarcities and surpluses can hurt both consumers and producers and lead to increased price volatility (Tamru, 2013). The most important factor with which markets can be integrated is the price of the product. Thus, the principle of market integration is based on the "Law of One Price" (LOP). Thus, the Law of One Price is a market principle that states that under perfect competition conditions, all prices within markets will be uniform after the costs of adding place, time, and form utility. The law of One Price assumes that if markets are integrated, price changes in one market will be transmitted to other markets instantaneously and the law of one price is very useful in determining the size of a market, forecasting price changes within a market, and assessing the pricing efficiency of a market. As the correct price signals are transmitted smoothly to all the markets, producers will be able to take appropriate

decisions on input purchase, production, sale, storage, etc. Consumers will also be benefited, as the well-integrated market ensures the availability of food and stability in prices at the regional level (Ghosh, 2011). Also, the price stability will lower the risk premium for traders and other intermediaries, and consequently, the retail price spread of agriculture will shrink, and the market needs to become more efficient (Kustiari, 2017).

Various studies have been empirically done using time series data and cointegration techniques to investigate market integration, price volatility, and price transmission across different regions taking agricultural commodities (Wani et al., 2015; Ifejirika et al., 2013; Zakari et al., 2014; Patil et al., 2014; Habte, 2017; Kustiari, 2017; Betty et al., 2017; S.O et al., 2003; Sanusi et al., 2017) and thus this study investigates empirically the market integration in the pulses markets particularly in the lentil wholesale markets because such studies are rare in numbers. The study by Wani et al. (2015) has revealed that the selected markets are strongly cointegrated and converge on the long-run equilibrium. However, in the short run, market prices do deviate from their equilibrium but converge in a few weeks. On the other hand, Ghosh (2011) has found that the extent of spatial integration of food grain markets has improved during the post-reform period, as the regional markets, which were either segmented or poorly integrated during the pre-reform period, are found to be strongly integrated. Further, the study by Kustiari (2017) has reported that the co-integration models provide evidence for a well-integrated market, and in the study by Patil et al., (2014); it has been seen that the multiple co-integration depicted the selected markets having long-run equilibrium relationship and their exist co-integration between them and there were bidirectional influences.

In their research, Bathla & Srinivasulu (2011), Ifejirika et al., (2013), and Habte (2017), they have analyzed the degree and determinants of market integration across different markets for different commodities and found the possible causes. The identified determinants are such as supply shortages due to deceleration in yield, weak infrastructure, price information gaps, government controls and regulations on private trade in wholesale markets, Non-competitive market structure, transportation cost, toll fee, processing cost, and storage can significantly affect the level of market integration. And they have suggested that to improve the level of market integration; transportation, processing, storage, communication, and credits facilities should be provided. Also, the government should create conducive policy environments that improve the good flow of price information, and work on infrastructural accessibility and institutional arrangement to reduce transaction costs.

III. DATA SOURCES AND METHODOLOGY

The objective of the present study is to analyze the long-run market integration among the major wholesale markets of lentils in India. The selected markets are the major wholesale markets of two different top lentil-producing states of India i.e., Uttar Pradesh and Madhya Pradesh. This study used purposive sampling to select the markets. The selection criteria for the market are based on the volume of production and availability of data. The top two producers of Lentils based on their average production (000 Tons) over 18 years (2000-2017)[1] are Uttar Pradesh (417.3 '000 tons) and Madhya Pradesh (269.3'000 tons). The study used the average monthly price of lentils covering the period January 2013-Dec 2017.

Three methods have been followed to analyze the time series data:

The first step in dealing with time series data is to test for the presence of a unit root in the individual time series of each model. There are several methods to test the unit root hypothesis but this study has used Augmented Dickey-Fuller (Dickey and Fuller 1979) on testing for a unit root in time series. ADF Test is performed to check the order of integration which is shown below in the model (1):

$$\Delta Y_t = \alpha + \delta T + \beta_1 Y_{t-1} + \sum^{p}_{i=1} \beta_1 \Delta Y_{t-1} + \varepsilon_t \quad \ldots\ldots\ldots\ldots\ldots\ldots (1)$$

Where, $\Delta Y_t = Y_t - Y_{t-1}$, $Y_{t-1} = Y_{t-1} - Y_{t-2}$ and $Y_{t-2} = Y_{t-2} - Y_{t-3}$. ε_t = white noise term, α is the constant term, 't' is

[1] Author's own calculation by taking State wise Lentil's yearly production data from CMIE and India Stat

the time trend effect, and 'p' is the optimal lag value, selected based on the Akaike information criterion (AIC) or the Schwartz Information Criterion (SBC). Null hypothesis: $\beta 1$, the coefficient of $Y_t - 1$ is zero, and alternative hypothesis: $\beta 1 < 0$. Now, the non-rejection of the null hypothesis will suggest that the time series under consideration is non-stationary.

The second step is Co-integration Test. The basic idea of co-integration is to identify the long-run relationship between variables, then divergence from the long-run equilibrium path is bounded, and the variables are co-integrated. For cointegration, two conditions must be satisfied. First, the series for at least two of the individual variables are integrated of the same order and second, a linear combination of the variables exists which is integrated to an order lower than the individual variables (Johansen, 1990).

$\Delta Y_t = \mu + \sum^{p-1}_{i=1} \Gamma_i Y_{t-1} + \Pi Y_{t-1} + \varepsilon_t$……. (2)

Where Γ and Π are matrices of parameters, p is the number of lags (selected based on the Schwarz information criterion), and ε_t is an (n × 1) vector of innovations. The presence of at least one cointegrating relationship is necessary for the analysis of the long-run relationship of the prices to be plausible. To detect the number of co-integrating vectors, Johansen proposed two likelihood ratio tests: trace test and maximum eigenvalue test.

The third step is Granger Causality Test. When two price series are stationary of the same order and co-integrated, a causality test can be carried out on the series. The Granger causality test is used to test the existence and the direction of the long-run causal price relationship between the markets (Granger, 1969). It is an F-test of whether changes in one price series affect another price series.

IV. RESULTS AND DISCUSSION

Summary Statistics of Monthly Prices from the year 2013-2017 of Lentil in the Major Wholesale Markets of Uttar Pradesh and Madhya Pradesh are presented below.

Table 1: Summary Statistics of Monthly Prices of Lentils in the Major Wholesale Markets of Uttar Pradesh and Madhya Pradesh (Rs. per Ton)

	ATTARA	BANDA	JABALPUR	RAISEN
Mean	4257.69	3097.58	3125.17	4457.37
Median	3756.00	3300.00	3450.00	4750.00
Maximum	8000.00	6145.00	6145.00	8000.00
Minimum	1500.00	560.00	560.00	2400.00
Std. Dev.	1185.64	1247.54	1245.71	1299.92

Source: Directorate of Marketing & Inspection (DMI), Ministry of Agriculture and Farmers Welfare, Government of India

The descriptive statistics of monthly wholesale prices of Lentil spanning from Jan 2013 to Dec 2017 for the four major wholesale markets are presented in Table 1. Two major markets, Attara and Banda were taken from Uttar Pradesh, and another two markets, Jabalpur and Raisen were taken from Madhya Pradesh. These markets were selected based on the availability of data on prices and arrival and they are also the major wholesale markets of respective states. From the result, it is seen that the minimum price of the lentil in Attara is Rs.1500 per ton while in Banda the minimum price is Rs.560 per ton. Again, in Jabalpur, the minimum price is Rs. 560 and in Raisen Rs.2400. Result is contradicted in this case. Prices are not the same within the states. Similarly, maximum prices vary from Rs. 8000 per ton in the Attara market to Rs. 6145 per ton in the Banda market during the same period.

The average prices were found to be Rs.4257.69 per ton in the Attara market, Rs.3097.58 per ton in the Banda market, Rs.3125.17 per ton in the Jabalpur market, and Rs.4457.37 per ton in the Raisen market. The standard deviation in prices was found to be minimum in the Attara market (Rs.1185.64 per ton) and maximum in the Raisen market (Rs.1299.92 per ton) which indicates that there is slight instability in Lentil in all the selected markets but the highest in the Raisen market during the period Jan 2013-Dec 2017 and which might be due to fluctuation in arrivals.

Unit Root Test:

To check the stationarity of the price series data, a unit root test has been done by performing an ADF test. The results are presented in the table below:

Table 2: Results of ADF Stationary Test in the Price of Lentil

Market	Stage	ADF		Remarks
		t-stat	Prob<0.05	
Attara	level	-1.82	0.364	Non-stationary
	1st Difference	-3.89	0.0000	Stationary
Banda	level	-2.123	0.2369	Non-stationary
	1st Difference	-3.82	0.0007	Stationary
Jabalpur	level	-4.723	0.182	Non-stationary
	1st Difference	-3.39	0.0206	Stationary
Raisen	level	-3.469	0.568	Non-stationary
	1st Difference	-3.17	0.0323	Stationary

Source: Author's calculation using EViews Software

The ADF values of all the series were found to be non-significant at a 5 percent level of significance (Table 2) which indicated the existence of unit root in the series and which implies the non-stationary nature of the data. But at the first difference level, the ADF values for all the series were found to be significant at a 5 percent level of significance, implying that these price series are free from the unit root problem which means the price series are stationary at first difference. Or in other words, the results of the unit root test did not reject the null hypothesis of the presence of unit root when the series was considered at the level. The first differenced series were found to be stationary, i.e., these are integrated of order one I (1). Now Johansen's cointegration test will be conducted since all the price series are in the same order I (1).

Johansen's Co-integration Test:

To determine the long-run relationship between the price series from four major wholesale markets of lentils, Johansen's co-integration test has been employed and the results are presented below in Table no.3:

Table 3: Johansen Test Results for Integration of Lentil Major Wholesale Markets

Unrestricted Co-integration Rank Test (Trace)				
Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.0500 Critical Value	Prob.**
None*	0.620857	53.98565	47.85613	0.0119**
At most 1*	0.507659	29.79991	27.79707	0.0435**
At most 2*	0.195570	8.668178	15.49471	0.3970
Trace test indicates 2 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				
Unrestricted Co-integration Rank Test (Maximum Eigenvalue)				
Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.0500 Critical Value	Prob.**
None*	0.620857	27.18574	26.58434	0.0346**
At most 1*	0.507659	19.13173	21.13162	0.0931
At most 2*	0.195570	5.875782	14.26460	0.6292
Max-eigenvalue 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				

Source: Author's calculation using EViews Software

The co-integration analysis using the Johansen test is conducted by comparing the value of trace statistic (TS) and Maximum Eigen-value (ME) against statistics. If the value of TS and ME exceeds the t-statistic value, then the null hypothesis is rejected, and this implies that the prices are mutually co-integrated. From above Table 3, it seems that both the TS and ME values are significantly higher than the 5% t-statistics. The results based on the TS value show that there are two co-integration equations at the 5% level and based on the ME value there is one co-integration equation at the 5% level. This integration suggests that some co-integrated equations increase the stability of price linkages between markets. These three prices have a long-term equilibrium relationship, and there is a strong integration between the major wholesale

markets of Lentil. Both tests (Trace and Max-Eigen tests) confirmed that all the selected Lentil markets had 3 cointegrating vectors out of 4 cointegrating equations which indicates that they are efficient, well integrated, and price signals are transferred from one market to another market. Thus, the Johansen cointegration test has shown that even though the selected Lentil markets in India are geographically isolated and spatially segmented, they are well-connected in terms of the prices of Lentils and have long-run price linkage between them.

Granger Causality Test:

Now, after determining cointegration among different Lentil markets, a test of Causality is important to perform to know the direction of price transmission between two markets. Therefore, in the present study, the test of causality is conducted by using the Granger method. The result of the Granger Causality Test is presented below.

Table 4: Granger Causality Test Results of Lentil Major Wholesale Markets

Null Hypothesis:	F-Statistic	Prob.
Banda does not Granger Cause Attara	0.302	0.044**
Attara does not Granger Cause Banda	2.476	0.010**
Jabalpur does not Granger Cause Attara	0.19999	0.8202
Attara does not Granger Cause Jabalpur	3.17666	0.0314**
Raisen does not Granger Cause Attara	0.12241	0.8854
Attara does not Granger Cause Raisen	1.17553	0.3273
Jabalpur does not Granger Cause Banda	0.27868	0.7594
Banda does not Granger Cause Jabalpur	0.17556	0.8401
Raisen does not Granger Cause Banda	0.49638	0.6154
Banda does not Granger Cause Raisen	2.45814	0.1088
Raisen does not Granger Cause Jabalpur	0.42660	0.046**
Jabalpur does not Granger Cause Raisen	2.83376	0.008**

Source: Author's calculation using EViews Software Note: ** indicates significance level at 5%

Granger Causality Test (Table 4) shows that not all the F-statistics are statistically significant. Hence the null hypothesis of no granger causality is accepted in many cases, indicating that neither the former in each market pair granger causes the price formation in the latter, nor the latter in each market pair granger causes the price formation in the former. In other words, there is no long-run price association between these market pairs. There are unidirectional causalities between these market pairs: Attara-Jabalpur which implies that a price change in the former market in each pair granger causes the price formation in the latter market, whereas the price change in the latter market is not feedbacked by the price change in the former market in each pair.

Out of six market pairs, only in two pairs, F-statistics is found to be statistically significant which implies that the null hypothesis has been rejected in those cases. Bi-directional causality is observed in two cases i.e., Attara-Banda, Banda-Attara and Jabalpur-Raisen, Raisen-Jabalpur, thus, indicating there is a perfect price transmission mechanism between these market pairs. The reason behind this bi-directional causality might be due to the distance between the markets. The markets, Attara and Banda are from the same State Uttar Pradesh and the markets Jabalpur and Raisen are from Madhya Pradesh.

V. CONCLUSION AND POLICY IMPLICATIONS

In the present study, the wholesale price of Lentil from the two leading Lentil producing states has been taken and analyzed to check whether, in the long run, these major markets are integrated or not. Two major markets, Attara and Banda are taken from Uttar Pradesh, and another two markets, Jabalpur and Raisen are taken from Madhya Pradesh are selected for the present study these markets are selected based on the availability of data on prices and arrival and they are also the major wholesale markets of respective states. Monthly wholesale prices of Lentil spanning from Jan 2013 to Dec 2017 for the four major wholesale markets are taken. Monthly data for five years (2013-17) made enough datasets for performing time series analysis. Thus, the study performed the Johansen Unit root Test, Co-integration test, Granger Causality Test, and other descriptive tests to check the integration between the selected wholesale markets of Lentil.

The empirical results show that there is slight instability in the prices of Lentil in all the selected markets but highest in the Raisen market during the period Jan 2013-Dec 2017 and which might be due to fluctuation in arrivals. Again, all the selected Lentil markets had 3 cointegrating vectors out of 4 cointegrating equations which indicates that they are efficient, well integrated, and price signals are transferred from one market. Thus, the Johansen cointegration test has shown that even though the selected Lentil markets in India are geographically isolated and spatially segmented, they are well-connected in terms of the prices of Lentils and have long-run price linkage between them. Granger Causality Test shows that there are unidirectional causalities between these market pairs: Attara-Jabalpur which implies that a price change in the former market in each pair granger causes the price formation in the latter market, whereas the price change in the latter market is not feedbacked by the price change in the former market in each pair. However, out of six cases, bi-directional causality is observed in two cases i.e. Attara-Banda, Banda-Attara and Jabalpur-Raisen, Raisen-Jabalpur, thus, indicating there is a perfect price transmission mechanism between these market pairs. Hence, it can be concluded that the lentil markets of the selected markets are efficiently functioning and the prices of Lentil in the selected markets are cointegrated in the long run.

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