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EVALUATING THE EFFICIENCY OF CHICKPEA MARKETS IN PUNJAB, PAKISTAN

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This paper examined the market integration through price signaling in selected chickpea markets of Punjab using Johnson Co-integration technique. The average monthly wholesale prices of seven Chickpea markets Sargodha, Faisalabad, Lahore, Multan, Layyah, Bhakhar, and Rawalpindi were used for analysis for the period January, 2007-November, 2018. The empirical results show that six major chickpea markets were integrated with each other i.e., there exist law of one price. Sargodha market emerged as the source market for other six markets – may be called as target markets. The Granger-Casualty results show, there exists bidirectional causality among all markets except Sargodha and Multan market, where exist Uni-directional causality. The study also verified the dynamic of price transmission by using vector autoregressive (VAR) i.e., a 10 percent increase in the price shock to Sargodha market transmitted to the all other chickpea markets. The findings of the study suggested, chickpeas markets in Punjab are working efficiently and there is no need of direct state intervention in markets to improve the efficiency.
Keywords: Agricultural markets, pulse crop, market integration, price signaling, price mechanism, trade policy.

INTRODUCTION

Under the decentralized economic system, price mechanism considered as one of the key factors to describe market efficiency. Price mechanism uses to control production, consumption and other market decision through supply and demand over time (Kohls and Uhl, 1998). In developing economies, structure of market systems contributes to market failure due of poor infrastructure, government-imposed restriction, and difficulties in access to market information particularly agricultural commodity markets. Although the large markets communication network and transport are well integrated, and prices are coordinate the actions of economic actors. On the other hand, the market driven economy price signals are an important tool to understand the flow of market actions, identifying the causes of these market imperfection in interregional markets. Price signaling provide an analytical tool to empirically estimate the marketing efficiency in long run.

Debate of the market integration started with the seminal contribution of Jasdanwala (1966), Farruk (1970), Jones (1973), Lele (1972) and Blyn (1973). They used the concept of correlation to estimate the market integration. Subsequently many authors like Dawson and Dey (2002), Ghosh (2003), Zahid *et al.* (2007) and Choi *et al.* (2008) criticized the correlation approach to estimate the market integration because of its static nature and high value of coefficients show the situation of physical discontinuities in the markets. Mushtaq *et al.* (2008) and Ghafoor *et al.* (2009, 2013) examined the market integration through the co-integration technique. More integrated markets yield lower price volatility (Ravallion, 1986, 1997; Sen, 1981). So, price signaling is a critical determinant for market integration and agriculture price policy in developing countries (Goodwin and Schroeder, 1991). These information's help governments for developing trade policy, subsequently for farmers that were trying to connect with larger international markets in developing world.

Chickpea one of the major pulse crop grown in Pakistan. It occupies nearly 76 percent of the total pulses area in Punjab (GOP, 2016). Chickpea provide multi functionality in term of high protein content source of nutrition, animal feed, soil fertility and cash income (Verkaart *et al.,* 2017). It is relatively common to study different dynamics of chickpeas production, while less attention was given to study the market dynamics of chickpea. This study was designed to empirically explore whether the chickpea markets are working and is there any state intervention is required in the chickpea markets of Punjab province to improve the efficiency.

DATA AND METHODS

To estimate the market integration through price signaling study uses the average monthly wholesale level price (Rs. /100 kgs) data in logarithmic form January, 2007 - November, 2018 of chickpea for seven markets (Sargodha (SARG), Faisalabad (FSD), Layyah (LYH), Bhakhar (BHKR), Multan (MULT), Lahore (LAHR), and Rawalpindi (RLP)) of Punjab

Province. Sargodha was selected as the central market as being indicated by different stakeholders during field survey. The data is retrieved form the Agricultural Market Information System (www.amis.pk).

Augmented Dickey-Fuller (ADF) test (Dickey and Fuller, 1981) was applied to study the unit root properties of data. Breusch-Godfrey statistic (Greene, 2000) was used to select the number of lags in the ADF-equation to avoid serial correlation. The following equation was estimated.

$$\Delta Y_t = \alpha_3 + \beta_{3t} + (\phi_3 - 1)\, Y_{t-1} + \sum \theta_t \Delta Y_{t-1} + \mu_t \quad (1)$$

Where Y_t is to be estimated and μ_t is the white noise error term.

Johansen's (1988) maximum likelihood estimation procedure (Eq. 2) was applied to test for the long run relationship between the series if these are integrated of the same order.

$$\Delta z_t = \delta + \Gamma_1 \Delta z_{t-1} + \Gamma_2 \Delta z_{t-2} + \cdots + \Gamma_{p-1} \Delta z_{t-p+1} + \pi z_{t-p} + \Psi x_t + u_t \quad (2)$$

Trace and maximum eigenvalue statistics are applied to estimate number of co-integrating vectors. Equation 2 can be rewritten as:

$$\Delta SARG_t = \alpha + \sum_{i=1}^{m} \beta_{1i} FSD_{t-i} + \sum_{i=1}^{m} \beta_{2i} LYH_{t-i} + \sum_{i=1}^{m} \beta_{3i} MULT_{t-i} + \sum_{i=1}^{m} \beta_{4i} BHKR_{t-i} + \sum_{i=1}^{m} \beta_{5i} LAHR_{t-i} + \sum_{i=1}^{m} \beta_{6i} RLP_{t-i} + \sum_{i=1}^{m} \beta_{7i} SARG_{t-i} + \sum_{i=1}^{m} \beta_{8i} V FSD_{t-i} + \sum_{i=1}^{m} \beta_{9i} V LYH_{t-i} + \sum_{i=1}^{m} \beta_{10i} V MULT_{t-i} + \sum_{i=1}^{m} \beta_{11i} V BHKR_{t-i} + \sum_{i=1}^{m} \beta_{12i} V LAHR_{t-i} + \sum_{i=1}^{m} \beta_{13i} V RLP_{t-i} + \sum_{i=1}^{m} \beta_{14i} V SARG_{t-i} + \varepsilon_t \quad (3)$$

Even if equilibrium was established in the long run, prices takes time to adjust in the short run. Therefore, short run adjustment equation is given as:

$$\Delta SARG_t = \alpha + \sum_{i=1}^{m} \beta_{1i} V FSD_{t-i} + \sum_{i=1}^{m} \beta_{2i} V LYH_{t-i} + \sum_{i=1}^{m} \beta_{3i} V MULT_{t-i} + \sum_{i=1}^{m} \beta_{4i} V BHKR_{t-i} + \sum_{i=1}^{m} \beta_{5i} V LAHR_{t-i} + \sum_{i=1}^{m} \beta_{6i} V RLP_{t-i} + \sum_{i=1}^{m} \beta_{7i} V SARG_{t-i} + \beta_{8i} ECM_{t-1} + \nu_t \quad (4)$$

Granger (1988) assumes the existence of causality among markets i.e., what is the direction of price transmission between two markets. The model is represented by the following equations.

$$\Delta P_{it} = \alpha_0 + \sum_{t=1}^{n} \beta_i \Delta P_{(t-1)i} + \sum_{t=1}^{n} \beta_j \Delta P_{(t-1)j} + \delta ECT_{t-1} + \mu_t \quad (5)$$

$$\Delta P_{jt} = \varphi_0 + \sum_{t=1}^{n} \sigma_j \Delta P_{(t-1)j} + \sum_{t=1}^{n} \sigma_i \Delta P_{(t-1)i} + \lambda ECT_{t-1} + \varepsilon_t \quad (6)$$

Vector autoregressive (VAR) mechanism can also further be used to verify the price transmission mechanism among selected chickpea markets. The matric form of the Vector autoregressive model is given as:

$$\begin{pmatrix} SARG_t \\ FSD_t \\ LYH_t \\ MULT_t \\ BHKR_t \\ LAHR_t \\ RLP_t \end{pmatrix} = \begin{pmatrix} \beta_{11} & \beta_{12} \\ \beta_{21} & \beta_{22} \\ \beta_{31} & \beta_{32} \\ \beta_{41} & \beta_{42} \\ \beta_{51} & \beta_{52} \\ \beta_{61} & \beta_{62} \end{pmatrix} \begin{pmatrix} SARG_{t-1} \\ FSD_{t-1} \\ LYH_{t-1} \\ MULT_{t-1} \\ BHKR_{t-1} \\ LAHR_{t-1} \\ RLP_{t-1} \end{pmatrix} + \begin{pmatrix} \varepsilon_{SARG,t} \\ \varepsilon_{FSD,t} \\ \varepsilon_{LYH,t} \\ \varepsilon_{MULT,tt} \\ \varepsilon_{BHKR,t} \\ \varepsilon_{LAHR,t} \\ \varepsilon_{RLP,t} \end{pmatrix}$$

Each market in the model depend on its lagged values, and error term ε_t are white noise.

RESULTS AND DISCUSSION

Table 1 and 2 depict the ADF unit root results and we concluded that all price series are non-stationary at level form and become stationary at first-difference form.

Table 1. Augmented Dickey-Fuller (ADF) unit root test results at level.

Variables	Log Level Form		Log Level Form		Conclusion
	Without Trend	Pro	With Trend	Pro	
SARG	-2.341	0.161	-2.852	0.182	I(0) Non- Stationary
LYH	-2.230	0.197	-2.401	0.378	I(0) Non- Stationary
LAHR	-1.926	0.320	-2.220	0.475	I(0) Non- Stationary
FSD	-1.667	0.446	-2.262	0.452	I(0) Non- Stationary
BHKR	-1.702	0.428	-2.719	0.231	I(0) Non- Stationary
MLT	-1.880	0.341	-2.648	0.260	I(0) Non- Stationary
RLP	-1.917	0.324	-2.750	0.219	I(0) Non- Stationary

Table 2. Augmented Dickey-Fuller (ADF) unit root test results at 1st difference.

Variables	First Difference Form				Conclusion
	Without Trend	Pro	With Trend	Pro	
SARG	-13.293	0.000	-13.293	0.000	I(I) Stationary
LYH	-10.317	0.000	-10.341	0.000	I(I) Stationary
LAHR	-11.117	0.000	-11.141	0.000	I(I) Stationary
FSD	-10.729	0.000	-10.710	0.000	I(I) Stationary
BHKR	-10.128	0.000	-10.107	0.000	I(I) Stationary
MLT	-8.817	0.000	-8.806	0.000	I(I) Stationary
RLP	-9.157	0.000	-9.162	0.000	I(I) Stationary

After investigating the order of the stationarity of the price series of all markets, next step was to estimate the co-integration among the selected markets, using the Johnson co-integration technique. Before apply the Johnson co-integration technique for long run relationship between price series of selected markets of Punjab, it is precondition to select the lag length for each variable used in the estimation, using vector autoregressive (VAR) model. Table 3 presents the estimated results of the VAR Lag Selection Criteria. Study select the lag order one on the bases of Schwarz information criterion.

Table 3. VAR Lag selection criteria.

VAR Lag order selection criteria				
Lag	**LR**	**AIC**	**SC**	**HQ**
1	NA	-20.7055	**-19.5162***	**-20.2230***
2	**89.0186***	**-20.7389***	-18.3602	-19.7738
3	56.3782	-20.4834	-16.9154	-19.0357
4	63.9357	-20.3695	-15.6122	-18.4393
5	60.7799	-20.2839	-14.3372	-17.8711
6	43.1781	-20.0257	-12.8897	-17.1304
7	38.3339	-19.7592	-11.4338	-16.3813
8	51.2341	-19.7991	-10.2844	-15.9387

*indicates lag order selected by the criterion; LR: sequential modified LR test statistic (each test at 5% level); FPE: Final prediction error; AIC: Akaike information criterion; SC: Schwarz information criterion; HQ: Hannan-Quinn information criterion

Johnson results are presented in Table 4. Trace and Max-eigenvalue test indicates six co-integrating equations. The empirical results indicate, there exist long run equilibrium in the six out of seven selected chickpea markets in Punjab. The seventh equation also co-integrated at 10 percent level of significance. In other words, estimated results suggested that six out of seven selected chickpea markets in Punjab are fully co-integrated and confirm the existence of law of one price (LOP). These results are in-line with the findings by Mushtaq *at al*. (2008) and Ghafoor *et al.* (2009).

The estimated results in Table 5 illustrate the pair wise co-integration of selected chickpea markets in Punjab. Empirical results of pair wise co-integration show Faisalabad, Layyah, Bhakhar, Multan, Lahore, and Rawalpindi are co-integrated with Sargodha market.

After estimation of pair-wise co-integration study also report the pair wise long run elasticities of the all selected markets with Sargodha markets. Table 6 shows empirical results of long run pair wise elasticities of the all the selected chickpea markets are near to one, therefore, verified the hypothesis that law of one price holds true in selected chickpea markets in Punjab.

The price transmission is the long run phenomena as cited in the literature. This shows price adjustment take time to attain the equilibrium across markets, it may not happen instantaneously. Table 7 reports the empirical results of the pair wise short run speed of adjustment of each market with Sargodha market. Results show that 59 percent convergence

Table 4. Johnson Co-integration Rank Test results.

Co-integration Rank Test (Trace)				
Hypothesized No. of CE(s)	**Eigenvalue**	**Trace Statistic**	**0.05 Critical Value**	**Prob.****
r = 0*	0.497	267.903	125.615	0.000
r ≤ 1*	0.335	178.610	95.754	0.000
r ≤ 2*	0.273	125.632	69.819	0.000
r ≤ 3*	0.231	84.234	47.856	0.000
r ≤ 4*	0.200	50.106	29.797	0.000
r ≤ 5*	0.126	21.063	15.495	0.007
r ≤ 6	0.027	3.576	3.841	0.059
Co-integration Rank Test (Maximum Eigenvalue))				
Hypothesized No. of CE(s)	**Eigenvalue**	**Max-eigenvalue Statistic**	**0.05 Critical Value**	**Prob.****
r = 0*	0.497	89.294	46.231	0.000
r ≤ 1*	0.335	52.977	40.078	0.001
r ≤ 2*	0.273	41.398	33.877	0.005
r ≤ 3*	0.231	34.128	27.584	0.006
r ≤ 4*	0.200	29.043	21.132	0.003
r ≤ 5*	0.126	17.487	14.265	0.015
r ≤ 6	0.027	3.576	3.841	0.059

Trace and Max-eigenvalue test indicates 6 co-integrating eqn(s) at the 0.05 level. * denotes rejection of the hypothesis at the 0.05 level. Alternative hypothesis of trace statistics r=k, while Alternative hypothesis of Max-eigenvalue statistics r=r*+1. **James *et al.* (1999) p-values

Table 5. Pair-wise Johnsen Co-integration results.

Markets Pair	Pair-wise Co-integration Rank Test (Trace)				
	Hypothesized		Trace	0.05	
	No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
Sargodha _Layyah	r = 0*	0.198	32.977	15.495	0.000
	r ≤ 1*	0.034	4.516	3.841	0.034
Sargodha-Faisalabad	r = 0*	0.184	30.105	15.495	0.000
	r ≤ 1	0.023	3.115	3.841	0.078
Sargodha _MULT	r = 0*	0.225	36.324	15.495	0.000
	r ≤ 1	0.025	3.238	3.841	0.072
Sargodha _LAHR	r = 0*	0.190	31.756	15.495	0.000
	r ≤ 1	0.028	3.780	3.841	0.052
Sargodha _BHKR	r = 0*	0.244	40.889	15.495	0.000
	r ≤ 1	0.027	3.658	3.841	0.056
Sargodha _RLP	r = 0*	0.133	22.733	15.495	0.003
	r ≤ 1	0.028	3.792	3.841	0.052

* denotes rejection of the hypothesis at the 0.05 level. Alternative hypothesis of trace statistics r=k, while Alternative hypothesis of Max-eigenvalue statistics r=r*+1, ** James *et al.* (1999) p-values

Table 6. Pair Wise Long run elasticities.

	Pair Wise Long run Elasticities					
Relationship of SARG with other markets	**LYH**	**FSD**	**MULT**	**LAHR**	**BHKR**	**RLP**
Coefficient	0.960	0.881	0.916	0.899	0.908	0.842
Stander error	0.031	0.036	0.028	0.037	0.028	0.050
T-Statistics	31.090	24.139	32.764	24.036	32.193	16.706

take place among the Sargodha and Multan market in one month i.e., economic equilibrium among these markets is established in two months. Table 8 present the pairwise causality results. The estimated results show, five markets, i.e., Faisalabad, Layyah, Lahore, Bhakhar, and Rawalpindi, there exists bidirectional granger causality. In case of Sargodha and Multan there exist Uni-directional causality from Sargodha to Multan.

Table 7. Pair Wise Short-Run Speed of adjustment.

Pairwise Speed of Adjustment			
Relationship with Sargodha	**Coef.**	**T-value**	**P-value**
Layyah	-0.493	-3.829	0.000
Faisalabad	-0.393	-3.649	0.000
Multan	-0.593	-4.948	0.000
Lahore	-0.352	-3.367	0.001
Bhakhar	-0.558	-4.307	0.000
Rawalpindi	-0.278	-3.026	0.003

Table 8. Pairwise Granger Causality results.

Pairwise Granger Causality	F-statistics	P-value	Direction
SARG → LYH	9.870	0.000	Bi-Directional
LYH → SARG	7.087	0.000	
SARG → FSD	16.543	0.000	Bi-Directional
FSD → SARG	12.919	0.001	
SARG → MULT	37.017	0.000	Uni-Direction
MULT→ SARG	0.183	0.670	
SARG → LAHR	14.210	0.000	Bi-Directional
LAHR → SARG	16.168	0.000	
SARG → BHKR	29.677	0.000	Bi-Directional
BHKR→ SARG	8.083	0.005	
SARG → RLP	10.866	0.001	Bi-Directional
RLP→ SARG	6.684	0.011	

Figure 1 reports the dynamic of price signaling through the shock to the Sargodha market prices which transmitted directly to the other selected chickpea markets of the Punjab. Through VAR forecasted the prices of the selected chickpeas markets from 2007 to 2020. Then given the shock of 10 percent increase in the price of Sargodha market and again estimate the all series through VAR. The depicted results show shock to the Sargodha market prices was transmitted directly to the other selected chickpea markets. The prices of the all other markets also shift upward. This further verified the presence of law of one price in the selected chickpea markets in Punjab.

***Conclusions*:** The paper investigated the degree of market integration in the selected Chickpea markets in Punjab using the Johnson co-integration analysis and monthly wholesale prices data from January, 2007 - November, 2018. The empirical results show six out of seven chickpeas markets are strongly co-integrated, and there exist law of one price. The study also verified the analysis of Johnson co-integration technique through the VAR. Shock to the Sargodha market prices transmitted to the other selected chickpea markets

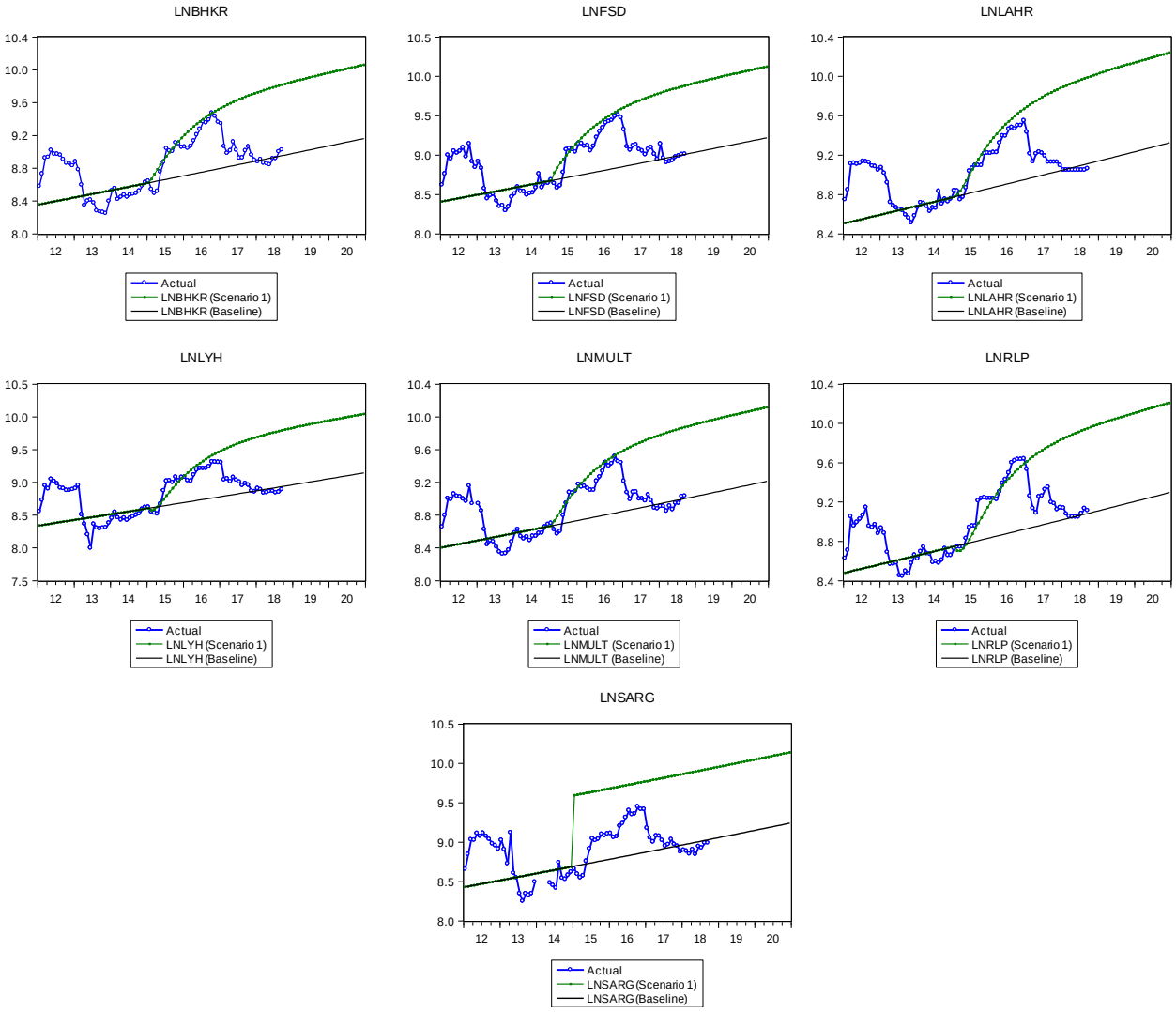

Figure 1. Shock to Sargodha market.

(Layyah, Faisalabad, Multan, Lahore, Bhakhar and Rawalpindi).

The long run pairwise elasticities are near to one, verified the hypothesis the existence of the low of one price in the selected markets of the chickpea. The pairwise elasticities also confirmed, market price linkages are important in economic analysis. The results of pairwise granger casualty shows direction of price formation between the selected Chickpea markets in Punjab. The findings of the study suggested, chickpeas markets in Punjab are working efficiently and there is no need of direct state intervention in markets to improve the efficiency.

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