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Market Integration and Price Transmission in Poultry Products Markets of Punjab, Pakistan

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Abstract

This study seeks to explore the degree of market integration and price transmission in poultry products markets of Punjab. Time series data of daily prices of poultry meat and eggs for 980 days were collected from Poultry Research Institute Rawalpindi (PRI). The data then manipulated in average weekly prices and converted into 140 observations for the time October, 2009 to May, 2012. Augmented Dickey Fuller (ADF) test was used to check the stationarity of data. ADF results showed that all variables were stationary at first difference. Johnson Cointegration and Granger Causality techniques were used to analyze the data. Augmented results revealed that markets of Lahore, Rawalpindi, Faisalabad and Multan were integrated with each other for price transmission and related physical arbitrage. The results of linear Granger Causality analysis led us to the conclusion that regardless of the sample considered, there was uni-directional relationship or in other words short-run uni-directional causality exists between the variables. It is suggested that government should regulate the prices of poultry products so that benefits could move from large businessman to small ones. Small businessman associations should be established who determine the prices of day-old chicks and eggs. In this regard, government should facilitate these associations in regulating their activities.

Key Words: *Market Integration, Cointegration, Granger Causality, Physical Arbitrage and Price Transmission.*

Introduction

Poultry is an important sub-sector of agricultural economy in Pakistan. About 1.5 million people are directly or indirectly engaged in this form of business. Its contribution to agriculture and livestock is 6.9 percent and 10.7 percent, respectively. This sector has contributed 1.4 percent in gross domestic product (GDP) at constant factor cost. Poultry meat contributes 30 percent of the total meat production in Pakistan. The poultry sector has exhibited a robust growth, ranged from 8-10 percent annually which shows its inherent potential (GOP, 2016).

No one can ignore the importance of balanced diet for good health and productive capabilities of the people. One of the important ingredients of balanced diet is protein which is mainly extracted from animals and plants sources. Milk, egg, beef and poultry meat are the main sources of animal protein whereas various vegetables also provide proteins. It is difficult for a common Pakistani to get protein from animal source. Thus, 66 percent population of Pakistan is facing the deficiency of protein. Against the required limit of protein i.e. 102.7 gram per head per day, the availability is only 69.6 gram per head per day, showing a gap of 33.1 grams per head per day (GOP, 2016).

In Pakistan, population is increasing at a rapid pace, thus the gap between production and requirement of protein of animal origin is widening with the passage of time. In this situation poultry products (eggs and meat) seems to have enough potential to bridge this gap both in terms of quality and quantity compared to the other sources of animal protein available in Pakistan. Since the last decade, poultry meat has become quite popular because it is not only providing nutritional value to customers but also a cheap source relative to red meat. Similarly, among the most important balanced foods, eggs are one of them which contain proteins, vitamins and minerals, necessary for good human health (Karthikeyan and Nedunchezhian, 2013). The total poultry meat and eggs production in Pakistan are more than 11 million and 16 million, respectively (GOP, 2016). Commercial farming in this sector has emerged as a major industry because it fulfills about 40 percent of the total domestic demand of meat. Heavy investment and incentives by the government resulted in the establishment of more than 28000 farms which are operating on commercial basis, more than 150 feed mills with approximate capacity to produce 2822 million tons of feed annually. Thus, poultry products production, has increased tremendously over the last couple of years (Ahmad, 2012).

Most of the poultry farms are situated in Mirpur Khas, Sukhar and Nawabshah in the province of Sindh, while Faisalabad, Lahore, Rahim Yar Khan, Multan, Mianwali and Rawalpindi are the major hubs of poultry business in Punjab province (Sheikh, 2012). The statistics indicates the potential of poultry industry in Pakistan which can help to fill the gap of total requirement of protein. The animal protein shortage can be managed by increasing poultry meat production at economical cost. In Pakistan, some local breeds are commonly used which are more adaptive to local environment and are highly productive. The production capacity of layers' farms varies from 2000 to 20000 birds while the capacity of broilers farms ranges up to 35000 birds in case of controlled shed poultry farms. High cost of poultry is related to increase in the price of different ingredients especially fishmeal.

The efficiency of agricultural markets is instrumental in improving performance of any sector. One of the measures of market efficiency is the level of market integration and price transmission in regional wholesale markets. Markets are said to be integrated if the prices in two markets move together and thus physical arbitrage adjust any disequilibrium. Markets that are not integrated may convey inaccurate price information which might distort producer-making decisions and contribute to inefficient product movements. The main interest of studying price integration among local markets is to identify set of markets that lead other markets in the price transmission process (Javed *et al*., 2015 and Ghafoor and Aslam, 2012). Government policies cause market integration in a variety of ways. Price stabilization policy, trade restrictions, credit and transport regulations are different public interventions affecting the

marketing system. The unpredictability of government intervention is often supposed as one of the major obstacle to the integration of markets. It is possible, however, that some degree of volatility of government intervention may contribute to improving the process of price transmission. Considering above facts, the existing poultry and its products marketing system has been functioning without concrete planning. So, it seems necessary to investigate the status and level of integration among agricultural markets of Pakistan.

Recent progress in the time series analysis, particularly those related to studies in market cointegration have led to an explosion in the literature in many countries e.g. (Schroedu and Godwin, 1991; Pendell and Schroeder, 2004; Mari and Lohano, 2005; Saran and Bangwar, 2008; Sendhil *et al.,* 2013) and in Pakistan such as (Mushtaq *et al.*, 2007; Zahid *et al*., 2007; Hussain, 2010; Mehmood, 2010; Ghafoor and Aslam, 2012; Ali *et al*., 2016 Imran *et al*., 2017 and Ali *et al*., 2017). Most of the studies are related to market integration of food grains, cotton, tomato etc. But, the issue concerning market cointegration in respect of poultry products has not been dealt with adequately. Therefore, this study focused on investigating the level of market cointegration and causality between pairs of poultry products (meat and eggs) markets in the Punjab province of Pakistan and suggested remedial measures for their improvement.

Methodology

This study was conducted to estimate market integration of poultry products markets in Punjab. Daily time series price data of poultry products (poultry meat and eggs) for about 980 days were collected from Poultry Research Institute Rawalpindi (PRI). The data then manipulated in average weekly prices and converted into 140 observations. The study covered the sample period of October, 2009 to May, 2012.

The first step in any time series analysis is to test for the presence of unit roots among the data series if present, then cointegration analysis is used to test long-run equilibrium relationships among the series. A series is supposed to be stationary if its mean and variance remain constant over the entire data series, while covariance between the two-time periods depends only on the lag between two time periods (Gujrati, 2005). Cointegration analysis and Granger causality was used to analyze the data.

Unit Roots

The most commonly used approach to test unit root hypothesis is known as Augmented Dickey-Fuller (ADF) test (Dickey and Fuller, 1981) If Y_t is data series ADF-test takes the following form:

$$\Delta Y_t = \alpha_2 + \beta_{3t}(\Phi_3 - 1)Y_{t-1} + \sum X_1, \ldots, X_n \theta_t \Delta Y_{t-1} + \mu_t \quad (1)$$

It is not known that how many lagged values of the dependent variable to include on the right-hand side of (1). There are several ways but the Lagrange multiplier (LM) test (Holden and Perman, 1994) was employed. The ADF-statistic has the same asymptotic distribution as the DF-statistic, so the same critical values can be used as previously (Dickey and Fuller, 1981).

Testing for Cointegration

Two recognized approaches are commonly used to test for Co-integration. One is residual-based ADF-approach proposed by Engle and Granger (1987), and the second is the Johannsen's Full Information Maximum Likelihood (FIML) approach (Johansen, 1988; Johansen and Juselius, 1990).

The Johansen's Full Information Method permits the estimation of all possible co-integrating relationships and develops a set of statistical tests to test hypothesis about how many co-integrating vectors exist and how they work in the system. Estimation of the number of cointegrating vector is important because both

under or over-estimation have potentially serious consequence for estimation and inference. Under-estimation implies the missing of empirically relevant error-correction terms and over-estimation implies that the distribution of statistics is non-standard. The Johansen Maximum Likelihood approach for multivariate Cointegration is based on the following vector autoregressive (VAR) model:

$$Z_t = A_t Z_{t-1} + \ldots + A_k Z_{k-1} + \mu_t \quad (2)$$

Where Z_t is an (nx1) vector of *I(1)* variables (containing both endogenous and exogenous variables), A_i is an (nxn) matrix of parameters, μ_t is (nx1) vector of white noise errors. Equation (2) can be estimated by OLS because each variable in Z_t regressed on the lagged values of its own and all other variables in the system.

Two likelihood ratio (LR) tests are constructed for detecting the presence of a single cointegrating vector. The first is the trace test statistics which tests the null hypothesis of at most r co-integrating vectors against the alternative that it is greater than r. The second is the maximal-eigenvalue test, which tests the null hypothesis of r cointegrating vectors against the alternative that it is r +1. The critical values for these tests have been derived by Monte Carlo simulations and tabulated by Johansen (1988) and Osterwald-Lenum (1992). The trace test shows more robustness to skewness than maximum eigenvalue test.

Granger Causality

Cointegration between two variables did not specify the direction of a causal relation, if any, between the variables. Economic theory guarantees that there is always Granger Causality in at least one direction. Granger causality is a statistical method based on the direction estimation from one variable to other. This test is applied on appropriate lagged values of variables. Granger causality measures whether one thing happens before another thing and helps predict it. This test predicts direction of causal relation e.g. If Y is responsible for the change in Z, and then changes in Z is followed by the change in Y. Causal relationship between time series variables was checked by Granger causality test, introduced by Granger (1969). In the context of this analysis the Granger method involves the estimation of following equation:

$$X = \beta_1 + \sum_{l=1}^{L} \alpha_{1,l} X_{i,t-l} + \sum_{l=1}^{L} \mu_{1,l} Y_{I,t-1} + \varepsilon_{1,t} \quad (3)$$

$$Y = \beta_2 + \sum_{l=1}^{L} \alpha_{2,l} X_{i,t-l} + \sum_{l=1}^{L} \mu_{2,l} Y_{I,t-1} + \varepsilon_{2,t} \quad (4)$$

In these equations X stands for Lahore market and Y stands for Rawalpindi, Faisalabad and Multan markets. As per these equations there are four possibilities: Firstly, there is uni-directional causality from Y to X if all $\mu_{1,}$ are non-zero in first equation and all $\alpha_{2,}$ are zero in second equation. Secondly, there is uni-directional causality from X to Y if all $\alpha_{2,}$ are non-zero in second equation and all $\mu_{1,}$ are zero in first equation. Thirdly, there is bidirectional causality between X and Y if all $\mu_{1,}$ and all $\alpha_{2,}$ are non-zero in two equations. Lastly, no causality between X and Y if all μ_1 and all α_2 are zero in equations. There is a need to determine the appropriate maximum lag length for the Granger causality by using the usual information criteria, such as AIC, SIC.

Results and Discussion

Unit Root test

The results of unit root test of poultry meat and egg prices over study period are presented is Table 1. Table shows that in both the models i.e. Non-Trended and Trended Models, the absolute value of the ADF statistics for all poultry products markets are well below the 95 percent critical value of the test and hence the null hypothesis is accepted which implies that there exists a unit root or the prices data are non-stationary.

Table 1: ADF Test for Unit Roots at Level Series

Variables	Test Statistics for Non-Trended Model		Test Statistics for Trended Model	
	Egg	Poultry	Egg	Poultry
Lahore	-2.6479	-2.6479	-3.0986	-3.0986
Rawalpindi	-2.7831	-2.7831	-3.2503	-3.2503
Faisalabad	-2.7725	-2.7725	-3.0184	-3.0184
Multan	-2.8171	-2.7930	-3.1490	-3.1490
CV at 5%	**-2.8828**		**-3.4435**	

Source: Author Own Calculations
Note: Results are at 95 percent confidence interval

Table 2 shows that after taking first difference of the price data series, the unit root test was again applied and the results disclosed that now the data series was stationary in both the models as their statistical values were higher than critical values at 95 % level of significance. Based on these results, the null hypothesis of unit root was rejected. This means that all the four series have unit roots. Therefore, it can be concluded that all the data series had become stationary after first differencing, representing by *I*(1).

Table 2: ADF Test for Unit Roots at First Differenced Series

Variables	Test Statistics for Non-Trended Model		Test Statistics for Trended Model		Remarks
	Egg	Poultry	Egg	Poultry	
Lahore	-8.7335	-8.7335	-8.7011	-7.2811	*I*(1)
Rawalpindi	-8.1141	-8.1141	-8.0840	-8.0840	*I*(1)
Faisalabad	-7.0918	-8.4616	-7.0641	-8.4254	*I*(1)
Multan	-7.6087	-7.6087	-7.5795	-7.5795	*I*(1)
CV at 5%	**-2.8830**		**-3.4437**		

Source: Author Own Calculations
Note: Results are at 95 percent confidence interval

The first step in Johansen's procedure is the selection of order of VAR. Adjusted LR-Test on the Vector Auto Regressive (VAR) with a maximum four lags has been carried out. The results indicated that the AIC and SBC selected the order of the VAR to be 4 and 1, respectively. (Because the value of AIC at fourth order was maximum i.e. 1169.4 and the value of SBC was maximum at first order i.e. 1133.4). The adjusted LR Test rejected order zero but did not reject VAR of the order one. Since study had a reasonable number of observations and to avoid over parameterization researcher choose the order of VAR to be 1 and the results are presented in Table 3.

Table 3: LR-Test on VAR with a maximum of four lags

List of variables included in the unrestricted VAR: LLHR LRWP LFSD LMUL				
List of Deterministic/Exogenous Variable: A				
Order	**AIC**	**SBC**	**Adjusted LR Test**	**P. Value**
4	1169.4	1076.2	------	------
3	1165.8	1095.9	34.5776	0.005
2	1168.4	1121.8	58.2344	0.003
1	1156.7	1133.4	107.1217	0.000
0	564.2472	564.2472	1180.9	0.000

Source: Author Own Calculations

AIC=Akaike Information Criterion SBC=Schwarz Bayesian Criterion,

The second step in the Johansen procedure after the selection of VAR (order one has been selected) is to test the presence and number of Co-integration vectors among the series in each model. Johansen's procedure consists of two tests for Co-integration i.e. maximum eigenvalue and the trace test. The results of maximum eigenvalue test are indicated in Table 4 which depict that there exist one co-integrating vector at 95 percent critical value because statistical values are greater than critical values.

Table 4: Maximal Eigenvalue Test

List of variables included in the co-integrating vector: LLHR LRWP LFSD LMUL Intercept							
Null		**Alternative**		**Statistics**		**95 percent**	
Egg	**Poultry**	**Egg**	**Poultry**	**Egg**	**Poultry**	**Egg**	**Poultry**
r=0	r=0	r=1	r=1	33.8840	33.8840	28.2700	28.2700
r<=1	r<=1	r=2	r=2	24.9581	24.9581	22.0400	22.0400
r<=2	r<=2	r=3	r=3	15.8700	13.2341	13.8100	15.8700
r<=3	r<=3	r=4	r=4	7.1600	4.4926	7.5300	9.1600

Source: Author Own Calculations

Table 5 shows the results of trace test. The results indicated that there is one co-integrated vectors in both products markets at 95 percent critical value. The presence of co-integrated vectors showed that markets converge towards long-term equilibrium. It suggests that even though the regional poultry and egg markets were geographically dispersed but spatial pricing relationship revealed that the prices in these markets were linked together implying that all the poultry exchange locations were in the same economic market. Or in other words these markets in Punjab are well connected with each other and transmit price signals from each other.

Pair wise Granger Causality Results of Poultry Meat

Tables 5 and 6 provide the results of pair wise analysis. Significant F-Statistic values denote rejection of the null hypothesis. This study rejected the null hypothesis if the F-Statistic is more than 2. The causality test also tested between two independent variables.

Table 6 reveals that there is almost unidirectional relationship between all pairs except Faisalabad and Lahore markets which shows no relationship. While the Casual relationship of the base market Lahore with Rawalpindi and Multan markets is found unidirectional at 95 percent significant level. In other cases, the causality between Multan and Rawalpindi and Multan & Faisalabad is also unidirectional. It means that Multan followed its mature counterparts (Rawalpindi and Faisalabad) in the short-run that there exists a lead lag relationship between them. It also implies that past values of Rawalpindi and Faisalabad had a productive ability to determine the present values of Multan. Similarly, the past values of Rawalpindi and Lahore had a productivity ability to determine the present values of Lahore and Multan, respectively.

Table 5: Trace Test

List of variables included in the co-integrating vector: LLHR LRWP LFSD LMUL Intercept							
Null		Alternative		Statistics		95 percent	
Egg	Poultry	Egg	Poultry	Egg	Poultry	Egg	Poultry
r=0	r=0	r=1	r=1	33.8840	76.5689	28.2700	53.4800
r<=1	r<=1	r=2	r=2	24.9581	42.6849	22.0400	34.8700
r<=2	r<=2	r=3	r=3	15.8700	17.7268	13.8100	20.1800
r<=3	r<=3	r=4	r=4	7.1600	4.4926	7.5300	9.1600

Source: Author Own Calculations

Table 6: Granger Causality Test for Poultry Products Markets

Null Hypothesis	F-Statistic	Probability	Result
FSD did not Granger Cause RWP RWP did not Granger Cause FSD	0.664 6.723	0.61775 6.1E-05	**Unidirectional**
LHR did not Granger Cause RWP RWP did not Granger Cause LHR	0.325 3.901	0.862 0.005	**Unidirectional**
FSD did not Granger Cause LHR LHR did not Granger Cause FSD	1.261 1.215	0.289 0.308	**Neutral**
MUL did not Granger Cause LHR LHR did not Granger Cause MUL	0.279 2.829	0.891 0.028	**Unidirectional**
MUL did not Granger Cause RWP RWP did not Granger Cause MUL	0.828 11.583	0.509 4.8E-08	**Unidirectional**
MUL did not Granger Cause FSD FSD did not Granger Cause MUL	0.603 6.664	0.661 6.7E-05	**Unidirectional**

Source: Author Own Calculations

Pair wise Granger Causality Results of Egg Markets

Table 6 results revealed that there exists uni-directional causality in all the causes. It has been found that Rawalpindi granger cause Faisalabad, Lahore and Multan at 95 percent significance level which implying that past values of Rawalpindi had a productivity ability to determine the present values of Faisalabad, Lahore and Multan.

Table 6: Granger Causality Test for Faisalabad and Rawalpindi Markets

Null Hypothesis	F-Statistic	Probability	Result
FSD did not Granger Cause RWP RWP did not Granger Cause FSD	0.308 9.166	0.872 6.7E-06	**Unidirectional**
LHR did not Granger Cause RWP RWP did not Granger Cause LHR	0.142 2.687	0.966 0.034	**Unidirectional**
FSD did not Granger Cause LHR LHR did not Granger Cause FSD	3.901 0.323	0.005 0.862	**Neutral**
MUL did not Granger Cause LHR LHR did not Granger Cause MUL	0.754 13.65	0.558 6.2E-09	**Unidirectional**
MUL did not Granger Cause RWP RWP did not Granger Cause MUL	0.756 13.08	0.559 6.3E-09	**Unidirectional**
MUL did not Granger Cause FSD FSD did not Granger Cause MUL	9.27 0.318	1.7E-05 0.863	**Unidirectional**

Source: Author Own Calculations

In other causes Faisalabad Granger Cause Lahore, Lahore Granger Cause Multan and Multan Granger Cause Faisalabad, which determines that Lahore, Multan and Faisalabad followed their mature counterparts i.e. Faisalabad, Rawalpindi and Multan respectively in the short-run and there exists a lead lag relationship between them.

Conclusions and Recommendation

The prime objective of the study was to explore degree of market integration and price transmission in major poultry and egg markets of Punjab using co-integration technique. Much emphasis is given to rearing and production of poultry both for meat and egg in Pakistan, while relatively little is known about how price transmission takes place on the domestic egg markets. Such information are important for poultry farm holders since it affects their marketing decisions (buying and selling), which in turn affects decision related to logistical and eventually profits realized.

The study confirmed that market price linkages and the interrelationship among spatial markets are important in economic analysis. The high degree of market integration observed in this case is consistent with view that egg markets in Pakistan are linked with each other for price transmission and related physical arbitrage. As such, it is concluded that policies designed to govern working of poultry products markets in Pakistan are good enough to ensure efficiency as such leave little justification for government intervention (Ghafoor and Aslam, 2012).

The results of linear Granger Causality analysis led us to the conclusion that regardless of the sample considered, there was uni-directional relationship or in other words results showed that the short-run uni-directional causality existed between the variables. Following policy implications, relevant to Punjab's egg marketing policy, can be derived from these findings.

The increased government regulation in poultry products markets shall encourage cross market movements. This in turn shall promote the integration of markets and will benefit both poultry products demanding and supplying regions. More integrated these products markets will help producers and consumers to realize the gains from these markets reforms, as correct price signals can be transmitted down the marketing chain. Consequently, consumers in some markets will not have to pay higher prices, and poultry products dealers will be able to specialize as per their comparative advantages that will lead to more efficient use of resources.

In integrated markets where there exists interdependence of prices changes across spatially separated locations in the long-run, the government may increase its market regulations. The results of the co-integration tests support the view that the government intervention in poultry products markets can be rationalized in these established and integrated markets without significantly decreasing market integration. But this integration does not imply that markets are working fully efficiently because for market efficiency we need to investigate market dynamics of egg as well. It also seems imperative to consider some major factors affecting market efficiency and integration among these products markets like transportation cost and nature of competition.

So market integration analysis considering all above mentioned facts should be carried out at national level in Pakistan to draw further inferences about market efficiency. Government should regulate these prices of poultry products so that benefits could move from big guns to small growers. Small grower's associations should be established who determine the prices of products. In this regard, government should facilitate these associations in regulating their activities.

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