Testing the law of one price in gram, mash and masoor markets of Pakistan

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ABSTRACT

This study examines the market integration of three pulses explicitly known as gram, masoor and mash in Pakistan. The study develops a critical estimation of market integration in pulses market of Pakistan. Market integration provides valuable information about the dynamics of market adjustment and has implications for a sustainable agriculture development. The government intervention might be justified by market integration as this phenomenon raises a question whether there are present market imperfections. This study used the monthly wholesale price (Rs. /40kg) data from January 1991 to September 2010 of gram, mash and masoor in logarithmic form and empirically estimated the degree of integration in the markets of the three pulses. The study is employing an econometric technique of co-integration analysis. Co-integration results show that all gram, masoor and mash markets are highly co-integrated in the long run. The high degree of market integration observed in this case is consistent with the view that Pakistan's pulses markets are quite competitive and provide little justification for extensive and costly government intervention designed to improve competitiveness to enhance market efficiency.

Keywords: Market Integration, Co-Integration, Mash Markets, Gram Markets, Masoor Markets, Pakistan.

I- INTRODUCTION

In a decentralized economic system resource allocation take place through price signals transmitted by the markets. In developing economies like Pakistan, there are several impediments to the efficient functioning of markets, particularly of agricultural commodity markets. These includes inefficient transportation infrastructure, difficulties in accessing market information, government imposed restrictions on the movements of goods between regions, government monopoly over the marketing and distribution system. If markets are not integrated then price signals could be distorted which lead to inefficient allocation of resources and marketable surplus generated by the farmers, could results in depressed farm prices and diminishing income (Tahir and Raiz, 1997). Overall market performance may be evaluated in terms of price relationships. Co-integration test can be uses to examine the stability of price relationship. Although the larger markets that are better connected with the transportation and

communication network are expected to be well integrated; the same can not be said about the smaller, more remote markets.

Market integration refers to ‘co-movement of price and more generally, to the smooth transmission of price signals and information across spatially separated markets’. (Golettie, *et al.,* 1995). Market integration provides important information on how the markets work. Such information helps the government to decide the extent to which it should promote market development. If, for example locations A, B, C, and D are well integrated, then the government may think of withdrawing from, or al least reduce, its efforts to influence the price setting process in those locations. Degree of market integration has often been used as a gauge of the success of market efficiency and structural adjustment policies in developing countries. Market integration leads to price stabilization because of detailed transmission of incentives across the marketing chain. Government of Pakistan tries to stabilize by adapting different policies. If the markets are well integrated the government will stabilize the prices in one key market and rely on arbitrage to produce the similar outcome in other markets. This reduces the cost of stabilization considerably. The level of integration of agricultural markets is a critical determinant of agricultural price policy in developing countries (Raghbendra *et al.,* 2005).

Market integration is subjectively viewed as long-run phenomenon. It is present whenever a stable price relationship is established. This means that spatial prices can temporary deviate from each other in the short-run and still be consistent with the idea of an integrated market. The concept of spatial arbitrage is to visualize traders buying in price market, transferring the item to high price market, and reselling the purchased goods in different localities tend towards equality and move together with each other in integrated market. Markets that are not integrated tend to convey inaccurate price information that might distort production decision and contribute to inefficiencies in product market. In a market driven economy, the pricing mechanism is expected to transmit orders and direction to determine the flow of marketing activities. The pricing signal guide and regulate the production, consumption and marketing decision over time, form and place (Kohls and Uhl, 1998). Pulses are the dried edible seeds of cultivated legumes. Pulses contain more protein than any other plant. They serve as a low-cost protein to meet the needs of the large section of the people. They have, therefore, been justifiably described as 'the poor man's meat'. In general, pulses contain 20 to 28 per cent protein per 100 gm. Different pulses grown in Pakistan are mainly, gram or chickpea, mung, mash and masoor. The production of mash and

masoor in 2010 -2011 was 11.2 and 10.6 thousand tones from an area of 23.8 and 24.0 thousand hectares respectively (GOP, 2011). The production of mash increased 1.0 percent and the production of masoor decreased 2.7 percent from the previous year.

Much emphasis is given to area and production of gram, mash and masoor in Pakistan, while relatively little is known about how prices transmission takes place on the domestic pulses markets. Such information is important for the producers of gram, mash and masoor and other pulses value chain role players since it affects their marketing decision related to logistical matters and eventually profits realized. The main interest of studying price integration among local markets is to be able to identify sets of markets that lead other markets in price transmission process. The structure of paper is as follow: Section 2 discusses the empirical methodology; Section 3 discusses the data and results, while section 4 concludes.

II_ MATERIALS AND METHODS

Testing For Unit Root

We begin by testing the presence of unit roots in the individual time series of each model using the Augmented Dickey Fuller (ADF) test Dickey and Fuller,1981), both with and with out a deterministic trend. The number of lags in the ADF-equation is chosen to ensure that serial correlation is absent using the Breusch-Godfery statistic. The ADF equation required for estimation by OLS is the following:

$$\Delta Y_t = \alpha_1 + \beta_{1t} + (\phi_1 - 1)\, Y_{t-1} + \sum 0_t\, \Delta\, Y_{t-1} + \mu_t$$

Where Yt is the series under investigation, *t* is a time trend and *ut* are white noise residuals. We do not know how many lagged values of the dependent variable to include on the right-hand side of above equation. There are several approaches but here Lagrange Multiplier (LM) test and was used.

Testing For Co-integration

The basic idea of Co-integration was to identify an equilibrium or a long-run relationship (s) between variable, if there exist a long-run relationship between variables; then divergence from the long-run equilibrium path was bounded, and the variable were co-integrated. In this case, two conditions must be satisfied. First, the series for at least two of the individual variables were integrated of the same order and linear combination of the variables exists which was integrated

to an order lower than the individual variables. For example, if the variables become stationary after differencing once, i.e. are I(1), then the error term from the co-integrated regression is stationary, i.e. I(1) , consider the co-integration regression :

$$Y_t = \alpha + \beta X_t + \mu_t$$

If the series were both I (1) and the error term was I (0), then the series were co-integrated of order I (1,0). In the equation below, β measures the equilibrium relationship between the series Y and X, and μ is the deviation from the long-run equilibrium path.

The economic interpretation for co integration is that if in the long-run two or more series Y_t and X_t are linked together to form an equilibrium relationship, then even though Y_t and X_t themselves are trended (i.e. non-stationary), they nevertheless move together closely over time and the difference between them is constant i.e. stationary. So the concept of co-integration implies the presence of long-run equilibrium to which an economic system move over time and μ_t may thus be interpreted as the disequilibrium error i.e. the extent to which the relationship deviate from equilibrium. Johansen's Full Information Maximum Likelihood (FIML) approach (Johansen, 1988; Johansen and Juselius, 1990) was used this study to test for co-integration. The Johansen maximum likelihood approach for multivariate co-integration is based on the following vector auto regression (VAR) model:

$$Zt = A_1 Z_{t-1} + \ldots + A_t Z_{t-k} + \mu_t$$

Where Zt is vector of I (1) variables (containing both endogenous and exogenous variable), A_I is an (nxn) matrix of parameter, μ_t is (nx1) vector of while noise. Equation 4 could be estimated by OLS because each in Z regressed on the lagged values of its own and other variables in the system. Johansen (1988) used the rank regression procedure to estimate the α and β- matrices and the trace test statistic was used to test the null hypothesis of most r co-integrating vectors against the alternative that it is greater then r.

III_ RESULTS AND DISCUSSIONS

Monthly wholesale price (Rs. /40 kgs) data from January, 1991 to September 2010 of gram, mash ,and masoor was used in the present study. The study analyzed price transmission in six selected gram,mash and masoor markets in Pakistan. The markets included in this study were Quetta, Lahore, Rawalpandi, Multan, Sukkhar and Hyderabad. The criterion for selecting these

markets was based on net market position (surplus or deficit), geographical distribution, data availability and the volume of trade or the importance of market to the national pulses trade flow.

The first step in testing for market integration, is to check whether, each series was stationary or non stationary. Augmented Dickey Fuller (ADF) unit root tests were used to determine whether each time series was stationary or not. The null hypothesis was that the variable observed had unit root, against the alternative (Table 1) reported the results of test of series in logarithms for unit root using ADF tests both with and with out linear trend for the three pulses separately.

Table I Augmented Dickey – Fuller unit root test results for gram, mash, and masoor Market in Pakistan

Variables	Trended Model (gram)	Non Trended Model(gram)	Trended Model (mash)	Non Trended Model (mash)	Trended Model (masoor)	Non Trended Model (masoor)
Peshawar	-2.75	-2.18	-2.62	-2.17	-2.16	-2.13
Rawalpindi	-2.31	-1.96	-2.10	-1.87	-2.41	-1.43
Lahore	-2.60	-2.49	-2.43	-2.56	-2.70	-2.57
Multan	-2.98	-2.63	-2.53	-2.33	-2.53	-2.89
Sukkhar	-3.21	-2.85	-3.62	-2.45	-3.11	-2.26
Hayderabad	-3.24	-1.08	-3.16	-1.62	-3.72	-1.76
Quetta	-2.69	-2.13	-2.18	-2.56	-2.54	-2.89
CV 5 at Percent	-3.43	-2.87	-3.65	-3.43	-3.46	-3.45

Both model indicated that null of unit root could not be rejected for all the price series, as absolute values of ADF statistics were well below the 95 percent critical value of test statistics. Thus it could be concluded that all the price series were non- stationary. The results are in accordance with (Mushtaq, *et al.,* 2008) who conducted work on market integration of apple in Pakistan using co-integration analysis.

After testing for unit root, the next step is to test for co-integration. Johansen procedure had been applied to pulses prices. The first step in Johansen's procedure was the selection of the order of Vector Auto Regressive (VAR). We tried the Akaike Information Criterion (AIC) and Schwarz Bayesian Criterion (SBC) to select the lag length. Both AIC and SBC select

the lag length because values of both AIC and SBC are maximum for gram at first order i.e. 1132.3 and 1056.4 respectively. So VAR with order one was select. The same pocedure was also performed for mash and masoor (Table 2).

Table II Adjusted LR Test on VAR with maximum of five lags

(a) Gram

Order	AIC	SBC	Adjusted LR Test
5	1042.8	663.82	---------
4	1064.1	760.96	43.43 (0.697)
3	1090.8	863.43	78.49 (0.926)
2	1115.5	963.85	116.77 (0.969)
1	1132.2	1056.40	167.49 (0.931)
0	-125.3	-125.33	2219.4 (0.000)

AIC = AKaike Information Criterion
SBC: Schwarz Bayesian Criterion

(b) Mash

Order	AIC	SBC	Adjusted LR Test
5	1046.5	763.97	---------
4	1051.5	660.96	44.41(0.657)
3	1099.7	863.43	76.49 (0.884)
2	1111.8	854.44	119.99 (0.844)
1	1177.3	1100.40	168.41 (0.842)
0	-123.3	-122.33	2199.4(0.000)

(c) Maoor

Order	AIC	SBC	Adjusted LR Test
5	1048.5	666.82	---------
4	1098.8	722.91	44.43 (0.888)
3	1010.8	861.43	79.49 (0.826)
2	1567.4	916.85	114.77 (0.911)
1	1082.9	1056.40	144.33 (0.912)
0	-124.31	-134.33	2117.4 (0.000)

The second step in Johansen's procedure was to test the presence of number of co-integration vectors among the series in each model. (Table 3) presents Johansen's co-integration results for

gram, mash and masoor separately.

Table 111 Co- integration results

(a) Co-integration of Gram-Trace test

Equ. Tested	Null Hypothesis	Alternative Hypothesis	Statistics	95 % CV
Quetta	r =0	r =1	247.77	132.45
Rawalpindi	r < = 1	r =2	156.07	102.56
Lahore	r < = 2	r =3	104.30	75.98
Peshawar	r < = 3	r =4	58.30	53.48
Hyderabad	r < = 4	r =5	26.38	34.87
Multan	r < = 5	r =6	11.40	20.18
Sukkhar	r < = 6	r =7	4.41	9.16

(b) Co-integration results for Mash-Trace test

Equ. Tested	Null Hypothesis	Alternative Hypothesis	Statistics	95 % CV
Quetta	r =0	r =1	233.44	141.45
Rawalpindi	r < = 1	r =2	167.07	111.56
Lahore	r < = 2	r =3	110.30	79.98
Peshawar	r < = 3	r =4	59.41	55.48
Hyderabad	r < = 4	r =5	25.33	38.11
Multan	r < = 5	r =6	10.22	21.18
Sukkhar	r < = 6	r =7	4.48	8.16

(c) Co-integration results for Masoor-Trace test

Equ. Tested	Null Hypothesis	Alternative Hypothesis	Statistics	95 % CV
Quetta	r =0	r =1	241.66	131.46
Rawalpindi	r < = 1	r =2	152.11	101.21
Lahore	r < = 2	r =3	111.30	74.99
Peshawar	r < = 3	r =4	56.30	54.41
Hyderabad	r < = 4	r =5	27.38	31.86
Multan	r < = 5	r =6	12.40	21.18
Sukkhar	r < = 6	r =7	4.45	8.88

According to trace test for gram there are four co-integrating vectors and two common trends at 95 percent critical values because first four statistical values of trace test (205.94, 137.35, 83.78 and 41.38) are greater then their respective 95 percent values (102.56, 75.98, and 53.48 and 34.87). The remaining two statistical values of trace test (20.22 and 4.69) are less then their respective 95 percent values (20.18 and 9.16). The same four statisitical values of trace test for mash and masoor are found greater than their repective 94 percent values and the remaing two values for mash and gram are lesser than their 95 percent values.

The results of the test for gram, mash and masoor suggest that these six price are strongly co-integrated and converge to long run equilibrium in the sense that Pakistan's gram mash and masoor market system is stationary in four directions and non- stationary in two directions. In other words, four prices can be expressed in terms of two prices means that prices in six markets are fully co-integrated as law of one price (LOP) holds. The results are in accordance with (Mushtaq, *et al.,* 2008) who conducted work on market integration of apple in Pakistan using co-integration analysis.

It suggested that even though the regional markets are geographically dispersed and spatially segmented, spatial pricing relationships reveal that the prices are linked together indicating that all pulses markets are highly integrated.

IV - CONCLUSION AND POLICY IMPLICATIONS

This paper has examined the degree of spatial market integration in the regional pulses markets of Pakistan using co-integration analysis and monthly wholesale price data from January, 1991 to September 2010. The results indicated that theses pulses markets are highly co-integrated and converge to long-run equilibrium in the sense that Pakistan gram, masoor and mash market system is stationary in four, three, four directions and non- stationary in three, two and two directions respectively. It means that prices in pulses markets are fully co-integrated as law of one price (LOP) holds. The study confirmed that market price linkages and the interrelationship among the spatial markets are important in economics analysis. Inter-market price linkages and speed of adjustment to shocks show that transportation costs have significant impact in determining the degree of market integration. Pulses markets in Pakistan are quite competitive and provide little justification for the government intervention designed to improve competitiveness or to enhance market efficiency. The results of the study reveals that certain market are not well integrated with each other, and order to achieve the goal of integration government should promote information and develop communication with in the markets. To enhance integration among the markets, infrastructure facilities should be provided by the government to targeted markets.

References

Dickey, D.A., and M.A. Fuller (1981). Likelihood Ration Statistics for Auto Regressive Time Series with a Unit Root, Econometrica, 49: (1057-1072).

Fredoun, Z. and A. Esfahani. (2006). Testing the Law of One Price in Chinese Wholesales Food Market. *Agribusiness*, 22(4) : (569-589).

Golettie, F. and S. Babu (1994). Market Liberalization and Integration of Maize Markets in Malawi. *Agricultural Economics*, 11(3): (311-324).

Govt. of Pakistan (GOP, 2008). Economics Survey (2007-08) of Pakistan. Finance division, Economic Advisor's Wing, Islamabad.

Govt. of Pakistan (GOP, 2007). Agriculture Statistics of Pakistan. The Ministry of Food, Agriculture Livestock, Economic Wing, Islamabad.

Johansen, S. and K. Juselius (1990). Maximum Likelihood and Estimation and Inference and Co-Integration with Application to the Demand for Money. Oxford, *Bulletin of Econometric and Statistics*, 52: (170-207).

Johansen, S. (1988). Statistical Analysis of Co-Integration of Vectors. *Journal of Economic Dynamic and Control*, 12: (231-254).

Kohl, S.R.L and J.N Uhl (1998). *Marketing of Agricultural Produces*. Fifith Edition, Macmillan publication, New York.

Mushtaq, K, F. Abbas, Abedullah and A. Ghafoor (2007). Testing the Law of One Price: Rice Market Integration in Punjab Pakistan. Pakistan Journal of Agricultural Sciences 43(3-4).

Mushtaq, K, A. Ghafoor and M.Dad (2008). Apple Market Integration: Implication for Sustainable Development. The Lahore Journal of Economics 13:1 (Summer 2008): 129-138.

Raghbendra, j., K. V. B. Murthy and A. Sharma (2005). Market Integration in Wholesale Rice Markets in India. ASARC Working Paper 2005.

Tahir, Z. and K. Riaz (1997). Integration of Agricultural Commodity Market in Punjab. The Pakistan Develoment Review 36 (3): (241-262).