TESTING THE LAW OF ONE PRICE: RICE MARKET INTEGRATION IN PUNJAB, PAKISTAN

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Regional market integration in many agricultural commodities has been extensively studied for the insight it provides into the functioning of such markets; such studies provide valuable information about the dynamics of market adjustments, and whether there exist market imperfections, which may justify government intervention. This study used Monthly wholesale prices (Rs. /40 kg) data from January 1995 to December 2003 of Basmati Rice (108 observations) in logarithmic form and empirically estimated the degree of integration in Rice (Basmati) markets of Pakistan's Punjab using the law of one price (LOP) framework and cointegration analysis. Cointegration Results show that all Rice markets are highly integrated in the long run. The high degree of market integration observed in this case is consistent with the view that Punjab's Rice 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, cointegration, rice prices, Punjab.

INTRODUCTION

In a decentralized economic system resource allocation takes place through price signals transmitted by the markets. In developing economies, there are several impediments to the efficient functioning of markets, particularly agricultural commodity markets. These includes poor transportation infrastructure, difficulties in access to market information, government-imposed restriction on movement of goods between regions, government monopoly over the marketing and distribution system, and poor enforcement of anti-trust regulation that result in price fixing and Oligopolistic market structures.

Overall market performance may be evaluated in terms of price relationships. Cointegration test can be used to examine the stability of price relationship. Although the larger markets that are better connected with the transport and communication network are expected to be well integrated; the same cannot be said about the smaller, more remote markets. Market integration refers to co-movements of prices and more generally, to the smooth transmission of price signals and information across spatially separated markets. Market integration provides important information on how markets work. Such information helps the government to decide the extent to which it should promote market development. If, for example locations A, B, and C are well integrated, then the government may think of withdrawing from, or at 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 liberalization and structural adjustment policies in developing countries. Market integration leads to market liberalization or price stabilization because of detailed transmission of incentives across the marketing chain. Government of Pakistan tries to stabilize the prices of Rice through price supports or producer subsidy. If 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.

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 temporarily 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 low priced market, transferring the item to a high priced market, and reselling the purchased good in different localities tend towards equality and move together with each other in integrated markets. Markets that are not integrated may convey inaccurate price information that might distort production decisions and contribute to inefficiencies in product markets.

Rice is considered as one of the most important food cash crops playing a vital role in uplifting the economy and providing food to large population of the country. Firstly, it is a secondary staple food after wheat and contributes two million tones to our food requirement. Secondly, it contributes significantly to foreign exchange earnings. Pakistan is among the large rice exporters with 5.5 percent share in global exports (APCOM, 2003-04). It is highly valued cash crop and is major non-traditional export item. It accounts for 5.4 percent in value added in agriculture and 1.3 percent in national income (GOP, 2003-04). In Pakistan, Punjab and Sindh provinces are two major producers of Rice. Punjab due to its suitable agro climatic and soil conditions is home to aromatic Basmati rice. It accounts for almost 95 percent of total basmati production in the country (GOP, 2001-02).

The main interest of studying price integration among local markets is to be able to identify sets of markets that lead other markets in the price transmission process. This study aims critically estimating the extent of market integration in rice markets of Punjab, Pakistan using the law of one price (LOP) framework. The structure of the paper is as follows: Section 2 discusses the LOP, Section 3 discusses the empirical approach, Section 4 discusses the data and results, while Section 5 concludes.

THE LAW OF ONE PRICE AND MARKET INTEGRATION

Richardson (1978) notes that the LOP is a test of market integration in period t and involves the regression:

$$\Delta P_{1t} = \beta_i + \beta_2 \Delta P_{2t} + u_t \quad t = 1,\ldots,n \quad (1)$$

where β_i and β_2 are parameters, Δ represents first difference where for example $\Delta P_{1t}=P_{1t}-P_{1t-1}$, and u_t is an error term with the usual properties. If the joint hypothesis that $\beta_i=0$ and $\beta_2=1$ is not rejected, the two prices are statistically identical and the LOP holds. Equation (1) can be estimated using the original price series or the series in logarithms. The former implies an absolute price difference as the maintained hypothesis while the latter implies a proportional price difference. Ravallion (1986) extends (1) by assuming that price adjustment between markets takes time, and using an error correction model, a nested test for short-run market integration is shown to be equivalent to a test of the LOP. The Granger-causality approach (Alexander and Wyeth, 1994) extends the Ravallion model and uses a single-equation error correction model to test causality between prices. The cointegration approach (Palaskas and Harriss-White, 1993, and Alexander and Wyeth, 1994) is based on the first step of the Engle and Granger (1987) two-step method. Estimating:

$$P_{1t} = \beta_i + \beta_2 P_{2t} + u_t \quad t = 1,\ldots,n \quad (2)$$

A test of long-run spatial market integration is equivalent to testing the stationarity of the residuals, u_t.

EMPIRICAL PROCEDURE

The approach adopted here is based on the LOP in (2) but follows the Sims' (1980) vector autoregressive (VAR) methodology, unlike single-equation methods, the exogeneity of one price is not imposed *ex ante*; long-run market integration is examined using Johanson's (1988) cointegration procedure. This approach incorporates important features of previous models. First, both prices are determined by their current and past values. Second, the null hypothesis of no cointegration between two prices is a test of the LOP which holds if the null is rejected. Given cointegration, the null of perfect market integration is tested where a price change in one market leads to an equivalent price change in the other; imperfect market integration occurs if the relationship is not strictly proportional.

A price series is often trended and can be made stationary by first-differencing, that is it is integrated of order one, or I(1). In general, the OLS regression in (2) is spurious since it is based on the assumption that both series are stationary (Harris, 1995, p.14). The exception is when (2) is cointegrated where the prices move together so that a stable relationship between them is maintained. Any short-run disturbance away from this relationship induces changes in the prices so that the relationship is maintained in the long run. In this sense, cointegration implies that a meaningful long-run equilibrium exists (Granger, 1988). Since a cointegrating relationship cannot exist between two prices which are integrated of a different order, it is necessary to test for their order of integration. The subsequent test for cointegration is a formal test of the long-run equilibrium relationship between pair-wise prices.

We begin by testing for 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 without a deterministic trend. The number of lags in the ADF-equation is chosen to ensure that serial correlation is absent using the Breusch-Godfrey statistic (Greene, 2000, p.541). If two prices are integrated of the same order, Johansen's (1988) procedure can then be used to test for the LOP between them. The procedure is based on maximum likelihood estimation of the vector error correction model (VECM):

$$\Delta z_t = \delta + \Gamma_1 \Delta z_{t-1} + \Gamma_2 \Delta z_{t-2} + \cdots + \Gamma_{p-1} \Delta z_{t-p+1} + \pi z_{t-p} + \Psi x_t + u_t \quad (3)$$

where z_t is a vector of I(1) endogenous variables, $\Delta z_t=z_t-z_{t-1}$, x_t is vector of I(0) exogenous variables, and π and Γ_i are (n×n) matrices of parameters with $\Gamma_i=-(I-A_1-A_2-\ldots-A_i)$, $(i=1,\ldots,k-1)$, and $\pi=I-\pi_1-\pi_2-\ldots-\pi_k$. This specification provides information about the short-run and long-run adjustments to the changes in z_t through the estimates of $\hat{\Gamma}_i$ and $\hat{\pi}$ respectively. The term πz_{t-k} provides information about the long-run equilibrium relationship between the variables in z_t. Information about the number of cointegrating relationships among the variables in z_t is given by the rank of the π-matrix: if π is of reduced rank, the model is subject to a unit root; and if $0<r<n$, where r is the rank of π, π can be decomposed into two (n×r) matrices α and β, such that $\pi=\alpha+\beta'$ where $\beta' z_t$ is stationary. Here, α is the error correction term and measures the speed of adjustment in Δz_t and β contains r distinct cointegrating vectors, that is the cointegrating relationships between the non-stationary variables. Johansen (1988) uses the reduced rank regression procedure to estimate the α- and β-matrices and the trace test statistic is used to test the null hypothesis of at most r cointegrating vectors against the alternative that it is greater than r.

RESULTS AND DISCUSSION

Monthly wholesale prices (Rs./40 kg) data from January, 1995 to December, 2003 of Basmati Rice (108 observations) in logarithmic form were used. The study was confined to six major Rice (Basmati) markets of Punjab province that is; Faisalabad, Lahore, Multan, Gujranwala, Sargodha and Rawalpindi. Table 1 reports the unit root results using ADF tests both with and without linear trend. In Trended model, the absolute values of ADF statistics for Faisalabad, Multan, Rawalpindi and Gujranwala markets were well below the 95 percent critical value of test statistics (-3.45) and thus theses markets have unit roots whereas for Lahore and Sargodha were above 95 percent critical value which means these markets have no unit roots. In non-trended model, the absolute values of ADF statistics for all six markets were well below the 95 percent critical value of test (2.89) and hence the null hypothesis that all the six variables have unit roots was firmly accepted. We carried out an additional test called the Φ_3 test. The null hypothesis in Φ_3 test was that the variable observed have unit root with no trend against the alternative that the variables were trend stationary. The values of F-statistics for all six variables were below the 95 percent critical value of the Φ_3 test (6.34); therefore we reject the alternative and accept the null hypothesis that means all six price series have unit root and no trend.

Table 1. The Unit Root Results

Prices	Trended Model	Non-Trended Model	Φ_3 test
Faisalabad	-3.05	-2.12	4.39
Lahore	-4.08	-1.96	5.11
Sargodha	-3.68	-1.43	4.23
Multan	-2.57	-1.36	4.40
Rawalpindi	-2.29	-2.51	3.68
Gujranwala	-3.24	-2.06	4.90
Critical Value (95% confidence level)	-3.45	-2.89	6.34

The first step of the Johansen procedure is to select the order of the VAR for each price relationship. We used the LR-statistic, adjusted for small samples (Sims, 1980), to test the null hypothesis that the order of the VAR was k against the alternative that it was five where k=0, 1, 2,..., 5 and for all cases, k=1. Johansen's cointegration results are presented in Table 2. The trace test results suggested that these six price series are strongly cointegrated and converge to long run equilibrium in the sense that Punjab rice (Basmati) market system is stationary in four directions and non-stationary in two directions. In other words, four prices can be expressed in terms of the other two prices means that prices in six rice (Basmati) markets are fully cointegrated as law of one price (LOP) holds. It suggests that even though the regional markets are geographically dispersed, and therefore, spatially segmented, spatial pricing relationships reveal that the prices are linked together indicating that all the Rice (Basmati) exchange locations are in the same economic market.

Table 2. Cointegration Results–Trace Statistics

Equation Tested	Null	Alter-native	Statistics
Faisalabad, Lahore, Sargodha, Multan, Rawalpindi and Gujranwala.	r=0 r≤1 r≤2 r≤3 r≤4 r≤5	r≥1 r≥2 r≥3 r≥4 r≥5 r≥6	182.4609 (102.56) 120.7829 (75.98) 71.9733 (53.48) 37.2692 (34.87) 14.8957 (20.18) 2.5239 (9.16)

Note: Critical values (95% confidence level) in parentheses.

Table 3 reports the pair wise cointegration relationship between the markets. As the result indicates we reject the null of no cointegration and accept the alternative. Hence, pair-wise cointegration relationships indicate that all major rice markets of Punjab province are perfectly integrated i.e., price signals are fully transmitted across spatially separated markets.

Table 3. Pair-wise Cointegration Results–Trace Statistics

Equation Tested	Null	Alternative	Statistics
Lahore- Faisalabad	r=0 r≤1	r≥1 r≥2	47.43 (20.18)* 6.56 (9.16)
Lahore-Sargodha	r=0 r≤1	r≥1 r≥2	38.65 (20.18)* 5.70 (9.16)
Lahore- Multan	r=0 r≤1	r≥1 r≥2	25.76 (20.18)* 7.00 (9.16)
Lahore-Gujranwala	r=0 r≤1	r≥1 r≥2	40.90 (20.18)* 6.38 (9.16)
Lahore- Rawalpindi	r=0 r≤1	r≥1 r≥2	18.90 (17.88)** 4.40 (7.53)
Faisalabad- Sargodha	r=0 r≤1	r≥1 r≥2	32.00 (20.18)* 6.7957 (9.16)
Faisalabad- Multan	r=0 r≤1	r≥1 r≥2	25.12 (20.18)* 7.47 (9.16)
Faisalabad-Gujranwala	r=0 r≤1	r≥1 r≥2	40.66 (20.18)* 6.77 (9.16)
Faisalabad-Rawalpindi	r=0 r≤1	r≥1 r≥2	23.48 (20.18)* 4.06 (9.16)
Sargodha- Multan	r=0 r≤1	r≥1 r≥2	23.64 (20.18)* 6.9856 (9.16)
Sargodha- Rawalpindi	r=0 r≤1	r≥1 r≥2	18.79(17.88)** 3.01 (7.53)
Sargodha- Gujranwala	r=0 r≤1	r≥1 r≥2	23.37 (20.18)* 6.04 (9.16)
Multan- Rawalpindi	r=0 r≤1	r≥1 r≥2	18.14 (17.88)** 2.61 (7.53)
Multan- Gujranwala	r=0 r≤1	r≥1 r≥2	19.57(17.88)** 7.2061 (7.53)
Rawalpindi-Gujranwala	r=0 r≤1	r≥1 r≥2	19.25 (17.88)** 4.99 (7.53)

Note: *, **indicates significant at 95 and 90 percent confidence level.

CONCLUSIONS

In the present study an effort was made to assess the degree of market integration in major Rice (Basmati) markets of Punjab province, Pakistan. Cointegration techniques were applied to the monthly wholesale prices data of Rice markets. The results indicated that these markets are strongly cointegrated and converge to long run equilibrium in the sense that Punjab rice marketing system is stationary in four directions and non-stationary in two directions. In other words, four prices can be expressed in terms of the other two prices means that prices in six Rice markets are fully cointegrated as law of one price (LOP) holds. The high degree of market integration observed in this case is consistent with the view that Punjab's Rice markets are quite competitive and provide little justification for extensive and costly government intervention designed to improve competitiveness to enhance market efficiency. The results also indicate that pair wise markets are also well integrated with each other. The integration among these markets can further be improved through the promotion of price information and communication facilities.

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