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Co-integration and Causality Analysis in major Soybean Markets of Rajasthan and Madhya Pradesh

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Abstract

This paper tests integration and causality analysis of soybean in Rajasthan and Madhya Pradesh. Agricultural price movements have been a matter of serious concern for policy makers in our country as the behaviour of agricultural prices is affecting adversely to the steady economic development. Among other things, price plays a strategic role in influencing the cultivation of Oilseeds. The study has investigated co- integration across four major wholesale soybean markets of Rajasthan and Madhya Pradesh by adopting Johansen's multivariate co-integration approach and to examine the causality by granger causality tests and also captures the speed of adjustment to deviations in long run equilibrium in soybean markets by using Vector Error Correction Model (VECM). The data used in the co-integration analysis consists of monthly wholesale prices of four soybean dominated markets i.e Kota and Baran from Rajasthan and Ratlam and Ujjain from Madhya Pradesh for the period from 2003 to 2014. All the selected markets showed positive trend in prices. It was observed that all selected markets viz Baran, Kota, Ratlam and Ujjain were co-integrated. The pairwise granger's causality test for selected markets was significant at 1% level of significance which indicated mutual influence exerted by the markets on each other. The error correction model suggests that markets came to short run equilibrium as indicated that, Ujjain and Ratlam market 59 to 69 per cent of the disequilibrium got corrected in short run and influenced its own prices at two and three week lag and also the adjustment to deviations from equilibrium in the markets lead to a long-term equilibrium in most of the markets. All selected markets were co-integrated and extent of it was very high. Our results implies that public policies in selected market could play critical role in facilitating market integration and thereby, market efficiency through the development of agricultural market information systems and road infrastructure.

Keyword: Causality test, Wholesale Price, Soybean, VECM, Market, Co- integration

Introduction

The ups and downs in commodity prices have always been a major concern of the producers as well as the consumers as they affect their decision and planning process. Agricultural commodity prices are volatile in nature and the volatility itself changes over time depending on the demand and supply of the commodity. Changes in volatility can affect market variables by directly affecting the marginal value of storage. It also affect the total marginal cost of production and the opportunity cost of producing the commodity now rather than waiting for more price information (Pindyck 2004). Soybean is known as the "Golden Bean" of the twentieth century. Though soybean is a legume crop, yet it is widely used as oilseed. It is now the second largest oilseed in India after groundnut. It grows in varied agro-climatic conditions. It has emerged as an important commercial crop in many countries and international trade of soybean is spread globally.

Indian Government in its forth advance estimate has estimated the record Soybean production at 105.25 lakh tones in 2014-15. Madhya Pradesh and Rajasthan are the major soybean producing states of the country. These states cover more than 50 percent soybean production in the country.

Methodology

The secondary data on monthly wholesale prices (Rs/qtl) were collected for the period from January, 2003 to December, 2014 from the records maintained by the market committees of Kota and Baran markets from Rajasthan and Ujjain and Ratlam markets from Madhaya Pradesh. These markets are the major primary markets of soybean in the country.

Co -integration analysis

If two markets are said to be spatially integrated, prices in a given market adjust to the price shocks in other market. This price adjustment between markets may take place through the flow of goods from surplus to deficit areas. Such transfer usually occurs when

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the observed shocks are able to cover the transfer cost of goods from one market to the other. Even if prices in two markets are co-integrated some times one may not know a prior the direction of price adjustments taking place between these markets.

Co-integration is an analytical technique for testing for common trends in multivariate time series and modelling long-run and short-run dynamics. Two or more predictive variables in a time-series model are co-integrated when they share a common stochastic drift.

Granger causality test

When a co-integration relationship is present for two variables, a Granger Causality Test (Granger, 1969) can be used to analyze the direction of this co-movement relationship. As indicated earlier, Granger causality test could give a clue on the existence of potential causality and direction of causality between prices in different markets. Granger causality between prices of two markets A and B is specified as:

$$P_t^A = \sum_{i=1}^{k} \alpha_i P_{t-i}^A + \sum_{i=1}^{k} \beta_i P_{t-i}^B + \mu_{Ai}$$

and

$$P_t^B = \sum_{i=1}^{k} \mu_i P_{t-i}^B + \sum_{i=1}^{k} \tau_i P_{t-i}^A + \mu_{Bi}$$

Where P_t^A and P_t^B are prices at period t in markets A and B, respectively. m , b , a and t are parameters to be estimated. k is the maximum number of lagged prices included in the model. The null hypotheses to be tested in Granger causality is H_0 = 2 b =1 b: ...0= k b = for a situation where price in market B is expected to Granger cause price in market A, and H_0 = 2 t= 1 t: ... 0= k t= when price in market A is expected to Granger cause price in market B.

Finally Vector Autoregressive Estimates were calculated for all the markets. The VEC (Vector Error Correction) estimates provide the short term co-integration with in the markets and between the markets which were expressed in percentage. The T-statistics were calculated to know the significance of the markets within them and also between markets, which decided on the basis of T- statistics value. If the T- statistics values are greater than 2.0 then the integration values were considered as significant, otherwise non-significant and were not considered for drawing the inferences.

Results and Discussion

Trend represents the general direction of change in prices over a period of time. Trend component is affected by changes in demand such as change in population, income, habits, customs, establishment of processing industries, *etc.* Price trend is also affected by adjustment in supply arising out of development of cold storage and marketing facilities, production technology and market arrivals over long period. The estimated parameters of trend values for price (P) of soybean crop for selected markets are given in Table 1. All the selected markets showed positive trend in prices showing rise in prices over time.

Table 1: Trend equations of soybean price in selected markets

Market	Price Trend equations for Markets
Kota	P= 771.92 + 18.8549*t
Baran	P= 779.22 + 18.8104*t
Ujjain	P= 813.21 + 18.6195*t
Ratlam	P= 805.93 + 18.3606*t

Co-integration Analysis

Based on the Johansen multiple co-integration procedure, the integration between the markets was analyzed by E-views software. Unrestricted co-integration rank tests (Trace and Maximum Eigen value) indicated the presence of at least four co-integrating equation at 5% level of significance as depicted in Table 2. Hence markets were having long run equilibrium relationship. These findings are also supported by Burark et al (2013) on coriender and Khatkar et al (2013) on mustard crops.

Table 2: Johansen's multiple co-integration analysis for monthly whole sale prices of soybean in selected markets

Hypothesized No. of CE(s)	Eigen Value	Trace Statistic	0.05 Critical Value	Prob.**
None*	0.232579	90.05433	55.24578	0.0000
At most 1*	0.155465	52.99357	35.01090	0.0003
At most 2*	0.144302	29.33786	18.39771	0.0010
At most 3*	0.052301	7.520524	3.841466	0.0061

Trace test indicates 4 cointegrating eqn(s) at the 0.05 level
*denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Vector Error Correction Model

The error correction term indicates the speed of adjustment among the variables before converging to equilibrium in the dynamic model. The coefficients show how quickly variables return back to equilibrium. The Table 3 clearly shows that any disturbance in price was get corrected in about 21 days in Ratlam market and around 17 days in Ujjain markets came to short run equilibrium as indicated by the level of significance and the rapid speed of adjustment. In long run, Baran market prices were influenced by Kota market and Ujjain market price with one month lags to the extent of 28 and 55%, respectively. Kota market prices were influenced by its own two month lag prices were to extent of 42%. Ratlam soybean market prices were influenced by Baran market

Table 3: Vector error correction model for monthly wholesale prices of soybean in selected markets

Error Correction	D(BR)	D(KT)	D(RTM)	D(UJ)
CointEq1	0.021497	0.331822	0.690598	0.598228
	(0.21129)	(0.27127)	(0.21639)	(0.20943)
	[0.10174]	[1.22322]	[3.19149]	[2.85652]
D(BR(-1))	-0.403905	-0.284160	-0.343984	-0.265355
	(0.20877)	(0.26804)	(0.21381)	(0.20693)
	[-1.93466]	[-1.06015]	[-1.60883]	[-1.28233]
D(BR(-2))	0.016698	-0.004019	-0.197116	-0.058049
	(0.19315)	(0.24798)	(0.19781)	(0.19145)
	[0.08645]	[-0.01621]	[-0.99647]	[-0.30321]
D(BR(-3))	-0.271975	-0.007711	-0.293183	-0.302756
	(0.14045)	(0.18032)	(0.14384)	(0.13921)
	[-1.93649]	[-0.04276]	[-2.03832]	[-2.17484]
D(KT(-1))	0.113521	-0.239730	0.419758	0.514776
	(0.09953)	(0.12779)	(0.10193)	(0.09866)
	[1.14053]	[-1.87599]	[4.11790]	[5.21792]
D(KT(-2))	0.000221	-0.429107	0.136249	0.225798
	(0.12398)	(0.15917)	(0.12697)	(0.12289)
	[0.00178]	[-2.69584]	[1.07307]	[1.83746]
D(KT(-3))	0.213695	-0.220792	0.210486	0.298967
	(0.11958)	(0.15353)	(0.12247)	(0.11853)
	[1.78698]	[-1.43809]	[1.71868]	[2.52230]
D(RTM(-1))	0.126106	0.267623	0.395856	0.703028
	(0.34963)	(0.44889)	(0.35807)	(0.34655)
	[0.36068]	[0.59619]	[1.10553]	[2.02865]
D(RTM(-2))	0.071747	-0.044842	0.168838	0.329561
	(0.32533)	(0.41769)	(0.33318)	(0.32247)
	[0.22053]	[-0.10736]	[0.50674]	[1.02200]
D(RTM(-3))	0.450299	0.392708	0.446205	0.596214
	(0.27824)	(0.35722)	(0.28495)	(0.27578)
	[1.61840]	[1.09934]	[1.56590]	[2.16190]
D(UJ(-1))	0.553985	0.402538	0.056221	-0.406807
	(0.27082)	(0.34769)	(0.27735)	(0.26843)
	[2.04561]	[1.15773]	[0.20271]	[-1.51552]
D(UJ(-2))	-0.232746	0.358313	-0.327942	-0.705842
	(0.29219)	(0.37513)	(0.29924)	(0.28961)
	[-0.79656]	[0.95517]	[-1.09593]	[-2.43722]
D(UJ(-3))	-0.374105	-0.263977	-0.202371	-0.465309
	(0.26161)	(0.33588)	(0.26793)	(0.25931)
	[-1.42999]	[-0.78593]	[-0.75532]	[-1.79444]

price in three months lagged price to the extent 29 per cent and Kota market prices were one month lagged to extent of 41%. Ujjain market were influenced by one month back prices of Kota market and Ratlam market prices were to the extent of 45 and 24%, respectively and three months legged price of Baran, Kota and Ratlam Markets to the extent of 30, 29 and 59%, respectively.

Pair wise Granger Causality Test

In order to know the direction of causation between the markets, Granger Causality test was employed. When a co-integration relationship is present for two variables, a Granger Causality Test (Granger, 1987) can be used to analyse the direction of this co-movement relationship. It was observed that there was a bidirectional influence on soybean prices of Ratlam and Baran as well as Ujjain and Baran as shown in Table 4 implying mutual influence of prices in these markets. Baran soybean price shows unidirectional causality with Kota. Ratlam market prices were influenced by Kota market prices. The prices at Ujjain market were influenced by the prices of Kota market shows unidirectional causality in markets. Since in all these cases the probability value was less than 0.05.Thus, different markets of soybean were closely linked with each other for the movement of soybean prices.

Table 4: Pair wise granger causality tests results for soybean wholesale prices.

Null Hypothesis	Obs	F-Statistic	Prob.
KT does not Granger Cause BR	142	7.96793	0.0005
BR does not Granger Cause KT		2.92246	0.0572
RTM does not Granger Cause BR	142	15.9950	6.E-07
BR does not Granger Cause RTM		5.79188	0.0038
UJ does not Granger Cause BR	142	20.2820	2.E-08
BR does not Granger Cause UJ		4.65543	0.0011
RTM does not Granger Cause KT	142	2.02904	0.1354
KT does not Granger Cause RTM		17.7631	1.E-07
UJ does not Granger Cause KT	142	3.38183	0.0368
KT does not Granger Cause UJ		22.4076	4.E-09
UJ does not Granger Cause RTM	142	1.71052	0.1846
RTM does not Granger Cause UJ		1.01702	0.3644

KT=Kota, BR= Baran, RTM= Ratlam and UJ= Ujjain

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