International Journal of Statistics and Applied Mathematics 2024; SP-9(3): 104-107

International Journal of Statistics and Applied Mathematics

ISSN: 2456-1452
Maths 2024; SP-9(3): 104-107

https://www.mathsjournal.com
Received: 27-02-2024
Accepted: 05-04-2024

SR Padavi
Department of Agricultural Economics, Navsari Agricultural University, Navsari, Gujarat, India

Narendra Singh
Professor and Head, Department of Agricultural Economics, Navsari Agricultural University, Navsari, Gujarat, India

YA Garde
Assistant Professor, Department of Agricultural Statistics, Navsari Agricultural University, Navsari, Gujarat, India

Corresponding Author:
SR Padavi
Department of Agricultural Economics, Navsari Agricultural University, Navsari, Gujarat, India

Market integration of okra in wholesale market in South Gujarat

SR Padavi, Narendra Singh and YA Garde

Abstract
The present study was done in four major okra wholesale markets in South Gujarat, namely Surat, Navsari, Tapi and Bharuch markets. The study period involves the eighteen years data of okra wholesale prices (January 2006 to December 2023). The study was majorly based on the prices of okra obtained through secondary source. These data were collected from various portals such as FAO, Agmarknet and APMC. The current study employs co-integration analysis of wholesale monthly okra prices in selected market places to determine the degree of market integration. The Trace and Maximum Eigen-value tests results showed that the okra prices in South Gujarat moves together in the long run equilibrium. The direction of information flow was determined by using Granger Causality test. It was found that in markets pairs, price transmissions were uni-directional.

Keywords: Granger causality, Price transmission, Uni-directional, Multivariate test, ADF test

Introduction
Okra, known for its versatile applications, serves as a valuable food, non-food, and medicinal resource. Its dry seeds boast high oil content (18-20 %) and protein levels (20-23 %). Widely cultivated and consumed across India, okra stands out for its nutritional richness, offering an abundance of nutrients including protein, minerals, and notably high levels of Vitamins A, B, C, and K. Rise in the area under okra was observed in South Gujarat during the period 2022-23. The increase in area, production and productivity under okra crops were recorded 37.56 thousand ha, 500.38 thousand tonnes and 13.32 tonnes per ha, respectively.

Methodology
Market integration is an alternative strategy for resource allocation, price stabilization, and correction of market imperfections such as entrenched monopsonies or monopolies and insufficient and expensive information transmission. Co- integration is a way to define the long-term relationship between a group of time series variables. Co-integration indicates to a linear combination of non-stationary time series that result in a stationary time series in the presence of co-integration among the variables. The first step in implementing co-integration analysis is to use the enhanced Dickey-Fuller unit root test to examine stationarity of price series to ensure robust regression results are obtained.

Techniques and tools used
Augmented Dickey Fuller test
Co-integration test is used to examine in the study whether or not two markets are co-integrated. Before performing the co-integration test, however, the data must be verified whether it is stationary or not, because the lack of stationarity makes the relationship spurious as well as meaningless. A statistical test for stationarity or unit root has been proposed by Dickey and Fuller (1979) [1].

A stochastic process is said to be stationary if its mean & variance are constant over time and the value of the covariance between the two periods depends only on the distance or gap or lag between the two time periods and not the actual time with which the covariance is computed.

Such a stochastic process is called covariance stationary, weak stationary or second order stationary *etc*.,

Mean: $(Y_t) = \mu$

$$\text{Var } (Y_t) = (Y_t - \mu)^2 = \sigma^2$$

Covariance (auto covariance) = $[(Y_t - \mu)((Y_{t+k} - \mu)] = \gamma_k$

The null hypothesis of the test is that the price series has unit root present in it. If unit root is present in the data, it means the data is non-stationary. Therefore, the presence of unit root at the level of the data directs the data to be transformed into first differences where the unit root test is repeated again and the stationarity is checked for further analysis. ADF test consist of estimating the following regression.

$$\Delta Y_t = \beta_1 + \beta_2 t + \delta Y_{t-1} + \sum_{i=1}^{p} \alpha_i \Delta Y_{t-i} + \varepsilon_t$$

Where,
Y_t = Price of okra market at time t
ε_t is a pure white noise error term

$\Delta Y_{t-1} = (Y_{t-1} - Y_{t-2})$, $\Delta Y_{t-2} = (Y_{t-2} - Y_{t-3})$, (t–i – lagged prices & Δ is differenced series)

α is the drift parameter
t is the time trend effect, β_i, δ_i and b_i is coefficients p is the optimal lag value which is selected on the basis of Akaike Information Criterion (AIC) and Schwartz Basic Criteria (SBC).
The null hypothesis that, $\delta = 0$; signifying unit root, states that the time series is non-stationary, while the alternative hypothesis, $\delta < 0$, signifies that the time series is stationary, thereby rejecting the null hypothesis.

Johansen Co-integration Test
Johansen co-integration test was given by the Johansen and Juselius (1990) to test the long run relationship among the price series. The co-integration approach to market integration is intuitively appealing and straight forward in application. Integrated markets are those where prices are determined interdependently. This has generally been supposed to mean that the price changes in one okra or brinjal market will be fully transmitted to the other okra markets. Markets those are not integrated may convey inaccurate price information that might distort marketing decisions and contribute to inefficient movements of products.
The Johansen technique examines a Vector Auto Regression (VAR) model of Yt, an (n x 1) vector of variables that are integrated of the order one - I time series.
This VAR can be expressed as equation

$$\Delta Y_t = \mu + \sum_{i=1}^{p-1} \Gamma_i Y_{t-1} + \Pi Y_{t-1} + \varepsilon_t$$

Where, Γ and Π are matrices of parameters, p is the number of lags (selected on the basis of Schwarz Information Criterion), ε_t is an (n × 1) vector of innovations. The presence of at least one co-integrating relationship is necessary for the analysis of long-run relationship of the prices to be plausible. To detect the number of co-integrating vectors, Johansen proposed two likelihood ratio tests: Trace test and Maximum Eigen value test, shown in equations.

$$J_{trace} = -T\Sigma_{i=r+1}^{p} \text{In } (1 - \hat{\lambda}_i)$$

$$J_{max} = -T \text{ In } (1 - \hat{\lambda}_I + 1)$$

Where,
T is the sample size and
$\hat{\lambda}_I$ is the I^{th} largest canonical correlation.
The trace test examines the null hypothesis of r co-integrating vectors against the alternative hypothesis of n co-integrating vectors. The Maximum Eigen value test, on the other hand, tests the null hypothesis of r co-integrating vectors against the alternative hypothesis of r +1 co-integrating vectors.

Granger Causality Test
The price series P_{1t} can cause P_{2t} ($P_{1t} \rightarrow P_{2t}$) or the price series P_{2t} can cause P_{1t} ($P_{2t} \rightarrow P_{1t}$), and the arrows show the direction of causality. The granger causality test assumes that the information relevant to the prediction of the respective variables, P_{1t} and P_{2t}, is contained in the time series data of these variables under study. The test involves estimating the following pair of regressions:

$$P_{1t} = \alpha + \sum_{i=1}^{m} \beta_i p_{it-1} + \sum_{j=1}^{m} y_j p_{2t-j} + u_{1t}$$
$$P_{2t} = \alpha' + \sum_{i=1}^{m} \theta_i p_{1t-i} + \sum_{j=1}^{m} \Phi_j p_{2t-j} + u_{2t}$$

It is assumed that the disturbances u_{1t} and u_{2t} are uncorrelated and based on the significance of the lagged coefficients the causality is determined (Gujarati, 2003).

Result and Discussion
Unit root test
The Augmented Dickey-Fuller (ADF) test was employed to examine the stationarity of the price series at their current levels and after taking their differences. The estimated test statistics from the ADF test for okra market prices in levels and first-differences are presented in Table 1. The test was conducted on both the level and first-differenced price series. The null hypothesis in this test is that the observed variable has a unit root, while the alternative hypothesis is that it does not have a unit root. The null hypothesis of a unit root was rejected at the level for all price series. Therefore, we can conclude that the price series were non-stationary at the level, while became stationary after the first differentiation.

Table 1: Results of unit root test for okra markets prices of South Gujarat

Market	ADF Test (τ)	
	At level	At first difference
Surat	2.001^{NS}	-7.210**
Navsari	0.822^{NS}	-8.567**
Tapi	0.375^{NS}	-8.658**
Bharuch	0.628^{NS}	-8.126**

Note: $p < 0.05$ indicate significance, * Significant at 5% level, ** Significant at 1% level

Johansen co-integration test

Table 2: Johansen co-integration test for integration – trace statistics of okra markets

Unrestricted co-integration rank test (trace)				
Hypothesized no. of CE(s)	Eigen value	Trace statistic	Critical Value at 5%	P value**
None*	0.234	143.304	63.876	0.000
At most 1*	0.198	86.904	42.915	0.000
At most 2*	0.134	40.010	25.872	0.001

Trace test indicates 3 co-integrating eqn(s) at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values
*denotes rejection of the hypothesis at the 0.05 level
CE(s)- Co-integration equations

Table 3: Johansen co-integration test for integration – Maximum eigenvalue of okra markets

Unrestricted co-integration rank test (maximum eigenvalue)				
Hypothesized no. of CE(s)	**Eigen value**	**Max-eigen statistic**	**Critical Value at 5%**	**P value****
None*	0.234	56.401	32.118	0.000
At most 1*	0.198	46.893	25.823	0.000
At most 2*	0.134	30.573	19.387	0.001

Max-eigen value test indicates 3 co-integrating eqn(s) at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values
*denotes rejection of the hypothesis at the 0.05 level
CE(s)- Co-integration equations

Table 2 and Table 3 provide the outcome of this analysis, which helps identify the existence and strength of long-term relationships among the market variables. Both tables indicate the presence of three co-integration equations at a significance level of 5 per cent. This implies that the markets under consideration exhibit a long-run equilibrium connection. The strength of this co-integration is determined by the number of co-integrating equations identified. In summary, the results from Table 2 and Table 3 provide strong evidence of the existence of a long-term equilibrium relationship between the markets, as indicated by the rejection of the null hypothesis and the identification of three co-integration equations.

The result implies that the price series in our model move together in the long run in conformity with the concept of market integration. However, this result by its own doesn't provide sufficient information regarding the cause and effect relationship among the variables, except that it assures at least a unidirectional causality.

Granger causality test

Before performing Market integration test, it is necessary to know the causal relationship existing between the markets. Here causality implies Granger causality, it means to ascertain the lead market between the markets because there is a strong relationship between the Granger causality and cointegration i.e. atleast one market Granger causes other markets in an integrated markets. This Granger causality test find out which market should be regressed on and regressed by other market. It is Before performing Market integration test, it is necessary to know the causal relationship existing between the markets. Here causality implies Granger causality, it means to ascertain the lead market between the markets because there is a strong relationship between the Granger causality and cointegration i.e. atleast one market Granger causes other markets in an integrated markets. This Granger causality test find out which market should be regressed on and regressed by other market. It is performed between the pair of market and the result is given under the following sections.

Table 4: Pair wise Granger causality tests with okra market

Null Hypothesis	Obs.	F-Statistic	Prob.	Direction
NAVSARI does not Granger Cause SURAT	215	0.58344	0.4458	Unidirec.
SURAT does not Granger Cause NAVSARI		4.72820*	0.0308	
TAPI does not Granger Cause SURAT	215	7.00271**	0.0087	Unidirec.
SURAT does not Granger Cause TAPI		2.15696	0.1434	
BHARUCH does not Granger Cause SURAT	215	1.02414	0.3127	Unidirec.
SURAT does not Granger Cause BHARUCH		21.4780**	6.E-06	
TAPI does not Granger Cause NAVSARI	215	16.1220**	8.E-05	Unidirec.
NAVSARI does not Granger Cause TAPI		0.16374	0.6861	
BHARUCH does not Granger Cause NAVSARI	215	0.91955	0.3387	Unidirec.
NAVSARI does not Granger Cause BHARUCH		13.6563**	0.0003	
BHARUCH does not Granger Cause TAPI	215	2.37934	0.1244	Unidirec.
TAPI does not Granger Cause BHARUCH		27.0078**	5.E-07	

Note: * and ** indicates of Significant at 5% and 1% level of significance, respectively. Unidirec. = Unidirectional and Bidirec. = Bidirectional

Conclusion

The results of the Augmented Dickey–Fuller test for stationarity revealed that all price series were non-stationary at the level data, although the test was significant for all price series at first differentiation. This indicated the presence of stationarity in the price series.Johansen co-integration test for integration indicated the presence of at least four co-integration equations at 5 per cent level of significance. As a result, markets were in long-run equilibrium relationship.

Whereas price in Surat market exhibited unidirectional causality with Navsari market and Bharuch market. It means price discovery occurred in Surat market was transmitted to Navsari market and Bharuch market. Whereas price in Tapi market exhibited unidirectional causality with Surat market, Navsari market and Bharuch market. While price in Navsari market exhibited unidirectional causality with Bharuch market. There was no causality observed for okra market price of Navsari and Surat, Surat and Tapi, Bharuch and Surat, Navsari and Tapi, Bharuch and Navsari, Bharuch and Tapi markets.

References

1. Dickey, David, Fuller, Wayne. Distribution of the estimators for autoregressive time series with a unit root. Journal of the American Statistical Association. 1979;74:427-431.
2. Engle RF, Granger CWJ. Co-integrtaion and error correction: representation, estimation and testing. *Econometrica*. 1987;55(1):251-276.
3. Kumar RR, Jha GK, Choudhary K, Mishra DC. Spatial integration and price transmission among major potato markets in India. Indian Journal of Agricultural Science. 2020;90(3):581-585.
4. Mohapatra S, Singh J. Co-integration of major potato markets in Punjab. An International Refereed, Peer Reviewed & Indexed Quarterly Journal in Science, Agriculture & Engineering. 2020;10(33):618-621.
5. Mohapatra S, Singh J, Kumar S. Cointegration among major cauliflower markets in Punjab. Indian Journal of Economics and Development. 2018;14(2):330-335.

6. Sendhil R, Sundaramoorthy C, Venkatesh P, Thomas L. Testing market integration and convergence to the law of one price in Inidan onions. African Journal of Agricultural Research. 2014;9(40):2975-2984.
7. Tingre AS, Bhopale AA. Price Stability and Co-integration Analysis of Tomato for Major Markets of Maharashtra. International Journal of Pure and Apllied Bioscience. 2019;7(3):510-514.
8. Vasanthi C, Patil KK, Manjunatha GR, Chinnappa B. Spatio-temporal integration of tomato markets in Karnataka state: an econometric analysis. Journal of Crop and Weed. 2017;13(2):45-51.