*Plant Archives* **Vol. 25, Special Issue (ICTPAIRS-JAU, Junagadh) Jan. 2025 pp. 627-632**
e-ISSN:2581-6063 (online), ISSN:0972-5210

**Plant Archives**

**Journal homepage: http://www.plantarchives.org**
**DOI Url : https://doi.org/10.51470/PLANTARCHIVES.2025.SP.ICTPAIRS-090**

# MARKET INTEGRATION AND PRICE TRANSMISSION IN FRUITS PRICE EXPORT FROM INDIA

**C.R. Bharodia*, C.D. Lakhlani, H.Y. Maheta and Kalpesh Kumar**

P.G. Institute of Agri - Business Management, Junagadh Agricultural university, Junagadh, Gujarat, India.
*Corresponding author E-mail : bharodia.chirag@gmail.com

**ABSTRACT**

Market integration and prices in major horticultural fruit crops such as Apple, Grapes, Pomegranate, Banana, Orange, Mango and Papaya play an important role in determining the production decisions of the farmers and diversification to high value crops. In this context, the study explores market integration and price transmission in major horticultural fruit crops export price using Johansen's multiple cointegration and Granger causality test. The outcomes of the study strongly buttressed to the co-integration and interdependence of major fruit crops export price. The result of Johansen's multiple cointegration indicated that presence of at least one cointegration equation at 5 per cent level of significance. Hence, both International and Domestic market have long run equilibrium for all fruits except grapes and papaya. The results of Granger causality indicated that International and Domestic market prices influenced each other and there existed bidirectional causality from international market price to Domestic market price and vice-versa for all major fruits.

***Key words :*** Market Integration, Price Transmission, Fruits, Johansen's multiple cointegration, Granger causality.

## Introduction

India is considered as the fruit and vegetable basket of the world. It being a residence of wide variety of fruits and vegetables, holds a unique position in production figures among all the countries. India is the second largest producer of fruits next only to China with an estimated production of 99.07 million tonnes, from an area of 6.66 million hectares in the year 2019 (Anonymous, 2019a). The vast production base offers, tremendous opportunities for export from India. India's total share of the exports of fruits and vegetables, in the global market is nearly one per cent only, but there is an increasing acceptance of horticultural produce from India due to development of cold storage infrastructure and quality assurance measures implemented by various government agencies in India. During 2018-19, India exported fruits and vegetables worth Rs. 10237 crore ($ 1,469 million) which comprised of fruits worth Rs. 4817 crore ($ 692 million) and vegetables worth Rs. 5419 crore ($ 777.25 million) (Anonymous, 2019b). Prices in horticultural crops play an important role in distributing the resources efficiently and signaling shortages and surpluses, which help the farmers to respond to dynamic market conditions (Haji and Gelaw, 2011). The form, time and place utilities regulate production, consumption and also help making efficient marketing decisions (Kohl and Uhl, 1998). These decisions are guided by price signals which determine the flow of marketing activities and provide directions for disposal of the supplies. A fundamental issue when analyzing trade policy reform in global agricultural markets is the extent to which domestic agricultural commodity markets in developing countries respond to changes in international prices. Price transmission from the world to domestic markets is central in understanding the extent of the integration of economic agents into the market process. Market integration shows the extent to which prices in different markets move together (Barret, 2001). The markets that are not integrated presents inaccurate picture about price information, which may distort production decisions of the producers and contribute to inefficiencies in agricultural markets, harm the ultimate consumers and lead to low production and sluggish growth (Mukhtar and Javed, 2008).

Timmer (1986), for example, argues that when markets are integrated, price intervention as a tool of public policy can be powerful, since, by operating on small amounts of easily controlled trade flows, governments or parastatal agencies could affect price structures for the commodity produced and consumed within the country through arbitrage, as low-priced commodities find their way to highpriced markets (Varela *et al.,* 2012). Market integration also plays a vital role in determining pattern and pace of diversification towards the high value crops (Sidhu *et al*., 2010). Chengappa *et al.* (2012) comprehend that weak supply chains and trade cartels often restrict the efficient functioning of the markets. In India, there exist several studies, which have analyzed market integration in food grain crops such as wheat, rice etc. (Ghosh, 2003; Ghosh, 2011; Ghoshray and Ghosh, 2011; Acharya *et al.*, 2012; Ghosh, 2012; Sekhar, 2012). The existing literature on market integration in horticultural crops is quite scanty (Basu, 2006; Beag and Singla, 2014; Wani *et al.*, 2015; Sendhil *et al.*, 2014 and Reddy *et al.*, 2012).

The formulation of valid study on the market integration and price transmission in fruits has potential application for the development of agricultural markets. Against this backdrop, the formulation of valid study on the market integration in major fruits exported from India has potential application for the development of agricultural markets. The existing study analyses market integration in fruits and its price transmission analysis of major fruits exported from India.

## Materials and Methods

### Study area

India also known as the Republic of India is a country in South Asia. It is the seventh largest country by area and with more than 1.3 billion people, it is the second most populous country as well as the most populous democracy in the world. India lies to the North of the equator between 8°4' and 37°06' North latitude and 68°07' and 97°25' East longitude. India's coastline measures 7,517 km in length. It has achieved all-round socio-economic progress during the last 72 years of its Independence. India has become self-sufficient in agricultural production and is now the tenth industrialized country in the world and the sixth nation to have gone into outer space to conquer nature for the benefit of the people. India accounts for a meagre 2.4 per cent of the world surface area of 3287263 sqkm. Yet, it supports and sustains a whopping 16.7 per cent of the world population.

### Nature and Source of data

Based on major share in world export of different fruits from India, 7 major fruits *viz*., (1) Apple, (2) Grapes, (3) Pomegranate, (4) Banana, (5) Orange (6) Mango and (7) Papaya were selected for the study. The importing countries has changed over time, so the countries were selected based on average of the country's export quantity and the top five countries were selected for analysis. The data pertaining to objectives of the study were collected from the Agricultural and Processed Food Products Export Development Authority (APEDA), Export–Import Data of India and Director General of Foreign Trade. The commodity wise export data were collected for the year 2000-2001 to 2020-2021.

### Determinants of Trade

Cointegration is defined as a situation where linear combinations of non-stationary time series are stationary. This implies the existence of a long-run equilibrium between the variables. Therefore, tests of cointegration were used for price mechanism between domestic and international market. Cointegration test make sure that the series were non-stationary and hence integrated of order 1. For testing time series data the Augmented Dickey Fuller (ADF) tests on the series and the differenced series to confirm that the series was indeed I (1) and it was used the Schwartz Information Criterion (SIC) for lag selection as it seems to be the criterion of choice in most studies.

The ADF test is as follows:

$$\Delta Y_t = \alpha + \phi Y_{t-1} + u_t + \sum_{j=1}^{k} d_j \Delta Y_{t-j} + \varepsilon_t \tag{1}$$

Where, $\alpha$ is a constant, $\mu$ the coefficient on a time trend and k the lag order of the autoregressive process. The unit root test was carried out under the null hypothesis $\phi = 0$ against the alternative hypothesis of $\phi < 0$.

### Market Co-integration Technique

Consider X, Y both I(1), then

$$X_t = \beta\, Y_t + \nu_t \tag{2}$$

$$\Delta Y_t = e_t \tag{3}$$

Even though both are non-stationary there is a combination of the two which is created by the first equation which is stationary. Both are driven by the common stochastic trend $\sum_{i=0}^{t} e_i$ e.i. and the cointegrating vector is (1, -β). The components of the vector X are said to be cointegrated of order d, b denoted as

$$X \sim CI(d,b) \quad (4)$$

If X is I(d) and there exists a non-zero vector such that

$$\beta' X_t \sim I(d-b),\ d, b > 0 \quad (5)$$

Then x is cointegrated and β is the cointegrating vector. If X has n components then there may be up to r cointegrating vectors, r is at most n-1. This implies the presence of n-r common stochastic trends. When n>1, then β is n × r and r is the cointegrating rank of the system.

### The Granger representation theorem

This important theorem defines some of the basic properties of cointegrated systems (Granger, 1969).

Let X be a vector of n I(1) components and assume that there exists r cointegrating combinations of X. Then there exists a valid ECM representation.

$$\Phi(L)(1-L)X_t = -\pi X_{t-k} + \mu + \varepsilon_t \quad (6)$$

Further there also exists a moving average representation,

$$(1-L)X_t = C(L)(\varepsilon_{t+\mu}) = C(1)(\varepsilon_{t+\mu}) + C^*(L)\Delta(\varepsilon_{t+\mu}) \quad (7)$$

Where, C(1) has rank n-r

### Estimating the cointegrating vectors

The original suggestion made by Engle and Granger was simply to employ a static regression, *e.g.*; in the bivariate case,

$$Y_t = \alpha X_t + e_t \quad (8)$$

Where, it is assumed that X and Y cointegrate so that e is I (0),

$$\hat{\alpha} = \sum_{t=1}^{T} X_t Y_t \left(\sum_{t=1}^{T} X_t^2\right)^{-1} = \alpha + \sum_{t=1}^{T} X_t e_t \left(\sum_{t=1}^{t} X_t^2\right)^{-1} \quad (9)$$

As e is I(0), by the assumption of cointegration and X is I(1)

$$T^{-1}\sum_{t=1}^{T} X_t^2 \sim O_p(T)$$

$$T^{-1}\sum_{t=1}^{T} X_t e_t \sim O_p(1)$$

So,

$$T(\hat{\alpha} - \alpha) \sim O_p(1)$$

$$(\hat{\alpha} - \alpha) \sim O_p(T^{-1})$$

This is the super consistency property of static regression.

### Testing cointegration

For the above estimation procedures to be valid we need to establish that the variables do cointegrate. In a single equation context this amounts to checking that the residuals of the following regression are I(0).

$$\hat{\mu}_t = Y_t - \hat{\beta} X_t \quad (10)$$

This is simply a matter of checking a series for stationarity. But the error process is a constructed series from estimated parameters so the tests have different distributions. Main tests are the Cointegrating Regression Durbin Watson (CRDW), the (Augmented) Dickey-Fuller tests and the Phillips non-parametric tests.

### The Dickey-Fuller test

$$\Delta\hat{\mu}_t = \rho\hat{\mu}_{t-1} + \text{dynamics} + v_t \quad (11)$$

Same distribution as the ADF. The distribution of these tests varies with T and n, the number of X variables.

## Results and Discussion

### Market integration and Price Transmission

### Market integration

In order to check the stationarity of price of major fruits the Augmented Dickey Fuler based unit root test procedure was done. The results is given in Table 1. From the table, it could be inferred that Augmented Dickey Fuller test values are above the critical value (i.e. 1%) given by MacKinnnon statistical tables at levels implying that the series are non-stationary at their levels indicating the existence of unit root. After taking first difference, all the series become stationary which can be observed from the calculated values for both the markets are less than the critical value (1%) and are free from unit root except international series of grapes and International & Domestic series of pomegranate, which become stationary at second level difference.

### Johansen's multiple cointegration analysis

Based on Johansen's multiple cointegration procedure, the integration between International and domestic market was analyzed using E-views software. The result is presented in Table 2. The result indicated that presence of at least one cointegration equation at 5 per cent level of significance. Hence, both International and Domestic market have long run equilibrium for all fruits except grapes and papaya.

### Granger Causality Test

In order to know the direction of causation between

**Table 1 :** ADF test result of Major fruits.

| Fruit Crop | Market | Level | First Difference | Second Difference | Critical Value (1%) |
|---|---|---|---|---|---|
| Apple | International | -2.235 | -8.543 | - | -3.831 |
| | Domestic | -0.312 | -4.118 | - | |
| Banana | International | -1.560 | -4.589 | - | |
| | Domestic | -0.958 | -4.650 | - | |
| Grapes | International | -1.119 | -2.150 | -9.975 | |
| | Domestic | -0.331 | -8.550 | - | |
| Mango | International | -1.027 | -7.253 | - | |
| | Domestic | -0.996 | -6.609 | - | |
| Orange | International | -2.360 | -5.513 | - | |
| | Domestic | -0.287 | -5.516 | - | |
| Papaya | International | -1.344 | -4.104 | - | |
| | Domestic | 0.753 | -6.090 | - | |
| Pomegranate | International | -1.280 | -3.431 | -5.389 | |
| | Domestic | -1.155 | -3.784 | -5.147 | |

*Significant at 1 per cent level.

**Table 2 :** Results of Johansen's multiple cointegration analysis for major fruits market unrestricted Co-Integration Rank Test (Trace).

| Fruit Crop | Hypothesized No. of CE(s) | Eigen Value | Trace Statistic | 0.05 Critical value | Prob.** |
|---|---|---|---|---|---|
| Apple | None * | 0.729251 | 25.46727 | 15.49471 | 0.0012 |
| | At most 1 | 0.033253 | 0.642560 | 3.841466 | 0.4228 |
| Banana | None * | 0.606423 | 18.20251 | 15.49471 | 0.0191 |
| | At most 1 | 0.025224 | 0.485411 | 3.841466 | 0.4860 |
| Grapes | None | 0.314093 | 6.932438 | 15.49471 | 0.5855 |
| | At most 1 | 0.008090 | 0.146211 | 3.841466 | 0.7022 |
| Mango | None * | 0.574619 | 16.84935 | 15.49471 | 0.0311 |
| | At most 1 | 0.078088 | 1.463501 | 3.841466 | 0.2264 |
| Orange | None * | 0.699920 | 23.01648 | 15.49471 | 0.0031 |
| | At most 1 | 0.007657 | 0.146034 | 3.841466 | 0.7023 |
| Papaya | None | 0.131383 | 3.261210 | 15.49471 | 0.9538 |
| | At most 1 | 0.030320 | 0.584999 | 3.841466 | 0.4444 |
| Pomegranate | None * | 0.590635 | 20.65197 | 15.49471 | 0.0076 |
| | At most 1 * | 0.275066 | 5.468462 | 3.841466 | 0.0194 |

Trace test indicates cointegration eqn at the 0.05 per cent level
*denotes rejection of the hypothesis at the 0.05 per cent level
**MacKinnon-Haug-Michelis(1996) p-values.

the market Granger Causality test was carried out. The results are presented in Table 3. The results indicated that International and Domestic market prices influenced each other and there existed bidirectional causality from international market price to Domestic market price and vice- versa for all major fruits.

**Table 3 :** Pairwise Granger Causality Test results.

| Fruit Crop | Null Hypothesis | Obs. | F-statistics | Probability |
|---|---|---|---|---|
| Apple | INTERNATIONAL does not Granger Cause DOMESTIC | 20 | 3.05086 | 0.0987 |
| | DOMESTIC does not Granger cause INTERNATIONAL | | 5.43489 | 0.0323 |
| Banana | INTERNATIONAL does not Granger Cause DOMESTIC | 20 | 5.61005 | 0.0300 |
| | DOMESTIC does not Granger cause INTERNATIONAL | | 1.52416 | 0.2338 |
| Grapes | INTERNATIONAL does not Granger Cause DOMESTIC | 20 | 0.05049 | 0.8249 |
| | DOMESTIC does not Granger cause INTERNATIONAL | | 3.20807 | 0.0911 |
| Mango | INTERNATIONAL does not Granger Cause DOMESTIC | 20 | 5.26122 | 0.0348 |
| | DOMESTIC does not Granger cause INTERNATIONAL | | 4.58702 | 0.0470 |
| Orange | INTERNATIONAL does not Granger Cause DOMESTIC | 20 | 0.42867 | 0.5214 |
| | DOMESTIC does not Granger cause INTERNATIONAL | | 5.16557 | 0.0363 |
| Papaya | INTERNATIONAL does not Granger Cause DOMESTIC | 20 | 0.06603 | 0.8003 |
| | DOMESTIC does not Granger cause INTERNATIONAL | | 0.63278 | 0.4373 |
| Pomegranate | INTERNATIONAL does not Granger Cause DOMESTIC | 20 | 1.89013 | 0.2056 |
| | DOMESTIC does not Granger cause INTERNATIONAL | | 2.77832 | 0.1021 |

** indicates significant the 1 per cent level.

## Conclusion

The present study analyzed market integration and price transmission in seven major fruits exported from India using Johansen's cointegration and Granger causality test. Johansen's multiple cointegration procedure indicated that presence of at least one cointegration equation at 5 per cent level of significance. Hence, both International and Domestic market have long run equilibrium for all fruits except grapes and papaya. The results indicated that international and domestic market prices influenced each other and there existed bidirectional causality from international market price to Domestic market price and vice- versa for all major fruits.

## Acknowledgement

Junagadh Agril. University, Junagadh, India.

## References


Acharya, S.S., Chand P.R., Birthal S.K. and Negi D.S. (2012). Market integration and price transmission in India: A case of rice and wheat with special reference to the world food crisis of 2007/08. Rome: Food and Agriculture Organization.

Anonymous (2019a). *Status of Indian fruits production*. Available at <www.thehindbusinessline.com >Accessed on: 19th December, 2020.

Anonymous (2019b). *Agricultural Processed Food Export Development Agency database*. Available at <www.apeda.gov.in> Accessed on: 23rd December, 2020.

Barrett, C.B. (2001). Measuring integration and efficiency in international agricultural markets. *Rev. Agricult. Econ.*, **23(1)**, 19-32.

Basu, J.P. (2006). Cointegration and market integration: An application to the potato markets in rural West Bengal, India. In 2006 Annual Meeting, August 12-18, 2006, Queensland, Australia (No. 25705). *International Association of Agricultural Economists*.

Beag, F.A. and Singla N. (2014). Cointegration, causality and impulse response analysis in major apple markets of India. *Agricult. Econ. Res. Rev.*, **27(2)**, 291-298.

Chengappa, P.G., Manjunatha A.V., Vikas D. and Khalil S. (2012). Competitive assessment of onion markets in India. Institute for Social and Economic Change. Competition Commission of India, pp. 1-86.

Ghosh, M. (2003). Spatial integration of wheat markets in India: Evidence from cointegration tests. *Oxford Development Studies*, **31(2)**, 159-171.

Ghosh, M. (2011). Agricultural policy reforms and spatial integration of food grain markets in India. *J. Econ. Develop.-Seoul*, **36(2)**, 15-37.

Ghosh, M. (2012). Market integration in agricultural commodities in India: A study on impact of movement in international prices on household welfare (SANEI Working Paper Series: No 12-02). Retrieved from South Asian Network of Economic Research Institutes. Available at < website: http://www.saneinetwork.net/Files/3008201204081612_02. NGhosh.pdf.>

Ghoshray, A. and Ghosh M. (2011). How integrated is the Indian wheat market? *J. Develop. Stud.*, **47(10)**, 1574-1594.

Granger, C.W. (1969). Investigating causal relations by econometric models and cross-spectral methods. *Econometrica: J. Econometric Society*, **37(3)**, 424-438.

Haji, J. and Gelaw F. (2011). Agricultural marketing and price analysis. In : Kassa, B. (Ed.), Review of the Economic Role of Prices and Approaches to the study of Agricultural Marketing Ethiopia: Alemaya University Press; pp. 15 -21.

Kohl, S.R.L. and Uhl J.N. (1998). *Marketing of agricultural product*. Fifth edition, Macmillan, New York.

Mukhtar, T. and Javed M.T. (2008). Market integration in wholesale maize markets in Pakistan. *Regional and Sectoral Economic Studies*, **8(2)**, 85-98.

Reddy, B.S., Chandrashekhar S.M., Dikshit A.K. and Manohar N.S. (2012). Price trend and integration of wholesale markets for onion in metro cities of India. *J. Econ. Sustain. Develop.*, **3(70)**, 120-130.

Sekhar, C.S.C. (2012). Agricultural market integration in India: An analysis of select commodities. *Food Policy*, **37(3)**, 309-322.

Sendhil, R., Sundaramoorthy C., Venkatesh P. and Thomas L. (2014). Testing market integration and convergence to the law of one price in Indian onions. *Afr. J. Agricult. Res.*, **9(40)**, 2975-2984.

Sidhu, R.S., Kumar S., Vatta K. and Singh P. (2010). Supply chain analysis of onion and cauliflower in Punjab. *Agricult. Econ. Res. Rev.*, **23**, 445-453.

Timmer, C.P. (1986). *Getting prices right: The scope and limits of agricultural price policy*. Ithaca: Cornell University Press.

Varela, G., Aldaz-Carroll E. and Iacovone L. (2012). Determinates of market integration and price transmission in Indonesia. *J. Southeast Asian Econ*., **30 (1)**, 19-44.

Wani, M.H., Paul R.K., Bazaz N.H. and Manzoor M. (2015). Market integration and price forecasting of apple in India. *Indian J. Agricult. Econ.*, **70(2)**, 169-181.