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# Price transmission and causality of onion markets in Karnataka

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**Abstract**
The present study was undertaken to analyze onion market integration in three major markets in Karnataka state, using monthly wholesale prices of onion during 2020 to 2022. Augmented Dickey-Fuller Unit root test indicated that the price series in each location are non-stationary at their levels, and stationary at their first differences. Co-integration results showed that the regional markets have price linkages and thus are spatially integrated. Johansen's multiple co-integration tests reveals that that their existence of only two co-integration equations for selected onion markets based on likelihood-ratio test. Granger causality test explain that, unidirectional relationship was found for the Bengaluru market, indicates that price of Bengaluru market influence the price of Hubballi market. Similarly, bidirectional causality was exerted on Bagalkot and Hubballi markets evidencing proximity, which indicated the price transmission happening in long run adjustments and the presence of short run equilibrium existed among the onion markets in Karnataka.

**Keywords:** Unit root, price transmission, co-integration and granger causality

## Introduction

Onion (*Allium cepa* L.) is one of the most popular vegetable that form the daily diet. China is the leading producer of onion followed by India (FAO, 2012). Onion produced by India and Pakistan are famous for their pungency and are available round the year. According to the United Nations Food and Agricultural Organizations at least 175 countries grow onion in the world. There are estimated 6.7 million acres in the world and onion production is 742.50 million tons which is composed by China 205.08 million tons, India 133.72 million tons, USA is 742.51 million tons, Egypt 22.08 million tons, Iran 19.23 million tons, Turkey 19.00 million tons, Pakistan 17.01 million tons, Brazil 15.56 million tons, Russia 15.36 million tons and Republic Korea 14.12 million tons (FAO, 2012). Onion is essential item in every kitchen as condiment and vegetable. It is used either in raw form and dehydrated form to add flavour and taste to food items and has a medicinal value used in some pharmaceutical preparation. Onion plays a part in preventing heart disease and other ailments.

It is also one of the important crops for household consumption and also for International exchange earning among the vegetables in India. Onion is considered as a most sensitive product due to sudden price fluctuation (Chengappa *et al.*, 2012) [1]. Among the agricultural products, prices of onions are more volatile in nature than those of the non-farm commodities due to inherently unstable production. India covers an area of around 1.28 Million hectare (Mha), with production of 23.262 Million tons (MT) and is the 2nd largest producer of onion, next to China. In India, Maharashtra (5.584 MT) is the largest onion producing state followed by Madhya Pradesh (3.701 MT), Karnataka (2.986 MT), Bihar (1.24 MT) and Andhra Pradesh (0.915 MT). Around 97% of the country's onion harvest is sold in 50 major onion market yards, regulated under the Agricultural Price Monitoring Act (APMC)-2003.The sudden increase in onion market price affects both producers as well as consumers through a spill over effect to the other onion markets which leads to high inflation in the economy. For the market participants, one of the important tasks is to know about price transmission mechanism which can spread instantaneously from one market to another market for price regulation and policy formulation. In this background, an attempt has been made to examine price transmission mechanism among major onion markets in Karnataka.

Marketing of onion in the state is characterised by poor market intelligence coupled with uncertainty in the future prices, has all through been a concern for producers and consumers. A reasonable idea about future prices to prevail at a future date could prove helpful for producers to rationalise their resources for profit maximization.

In this regard, market integration and price forecasting could help in stabilising the prices by removing the market imperfections, and attain market efficiency. In literature, Granger (1981, 1986) [2, 3], Granger and Weiss (1983) [2], Myers (1994) and others, established the basis for co-integration analysis in econometric modelling. Accordingly, more recent research on agricultural economics using this broad class of vector error correction (VEC) models has been producing important advances in overcoming the modelling faults and resulting forecast failures. Paul *et al.* (2015) [8] investigated structural breaks in price volatility and linkages between domestic & export prices of onion in India. Paul *et al.* (2016) [7] studied the effectiveness of integration in price forecasting for onion in selected markets of Delhi. Wani *et al.* (2015a, b, c) [8-10] reported that market integration can be defined as a measure of the extent to which demand and supply in one location are transmitted to another. The price transmission mechanism is well explained in major coffee markets of India by Paul and Sinha (2016) [7]

Cultivation of onion in India and also in Karnataka is undertaken mainly in high risk areas with uncertain returns on investment. In the past, little attention was paid to managing production, marketing and price risks involved in onion cultivation. The present crisis must be altered. The importance of identification and categorization of risks are essential along with the supply chain management has become increasingly apparent as stakeholders understand that successful risk management in production and marketing is critical for farmer's to continue production of onion.

## Materials and Method

The study consist of monthly wholesale price (Rs./100 kg) data for three major onion markets namely, Bagalkote, Hubballi and Bengaluru for the period of January 2020 to March 2022 in logarithmic form. All the relevant data have been collected from Agmarknet and Krushimaratavahini during 2021-22. The markets are selected on the basis of their location in highest production areas of onion in Karnataka was selected to comprehend the price transmission and market integration among them.

### Tools and techniques used

Prices in spatially integrated markets are determined simultaneously in various locations, and information of any change in price in one market is transmitted to other markets [Gonzalez-Rivera and Helfand (2001)]. Markets that are not integrated may convey inaccurate price signal that might distort producers marketing decisions and contribute to inefficient product movement and traders may exploit the market and benefit at the cost of producers and consumers**.**

### Price transmission analysis

The output of price transmission analysis helps to understand the following points - Is there a long-term relationship between the two markets, Do prices in market 'A' influence those in market 'B', the reverse, or do they both influence each other, If the price in one market changes how much will it cause the other price to change in short run and if the price in one market changes how much will it cause the other price to change in the long run (Rivera, 2007). In the context of two domestic prices, it tells us whether market 'A' is influencing market 'B', or 'B' is influencing 'A', or if both are influencing each other. This causation analysis helps in understanding and describing trends in local prices.

### ADF test

Prior to testing for co-integration, the price series are first tested for their order of integration, since a necessary condition for co integration is that the series are integrated of the same order. The augmented Dickey- Fuller (ADF) test is used to test for the order of integration. To test unit root, the ADF test is conducted based on the following regression equation:

$$\Delta Y\ t = \beta 1 + \delta Y\ t\text{-}1 + \alpha i\ \Sigma\Delta\ Y\ t\text{-}1 + e_t$$

[t-1: 1 month lagged price and Δ: differenced series]

Yi denoted the price series of markets (Dewas, Ujjain, Amaravati, Latur, Bidar and Dharwad soybean price series).

### Engle-granger causality

An autoregressive distributed lag (ADL) model for the Granger-causality test was developed following Engle and Granger (1987) [4] specification provided below:

$Pt^1 = \alpha + \beta oT +$ □Jj-1βjP1 t-j+ □K k-1hk P2 t-k + □ t

Where T is the time trend, εt is the error term.

Lags for the ADL model were selected to minimize the Akaikes Information Criterion. Granger causality tests were specified as:

$$P_t^1 = \alpha + \beta_0 T + \Sigma^J_{j-1}\ \beta_j P^1_{t-j} + \Sigma^k_{k-1} h_k P^2_{t-k} + e_t$$

$$H_o: h_1 = h_2 = \ldots\ldots\ldots = h_t = 0$$

$$P^2_t = \delta + \Phi_0 T + \Sigma^J_{j-1} \Omega_j P^1_{t-j} + \Sigma^k_{k-1} \Phi_k P^2_{t-k} + \nu_t$$

$$H_o: \Phi_1 = \Phi_2 = \ldots\ldots\ldots = \Phi_k = 0$$

### Co-integration

Co-integration means that despite being individually nonstationary, a linear combination of two or more time series can be stationary. The series that satisfy this requirement are said to be co-integrated. Following Granger (1981) [2], a time series xt which has a stationary, invertible, non-deterministic ARMA representation after differencing d times is integrated of order d and is denoted by $x_t$ <~l(d). The components of the vector xt are said to be co integrated of order d, b, denoted CI (d,b), if all the components of xt are I(d); there exists a vector "$x_t$ is 1(d-b), b>0. The vector is then called a co integrating vector. A necessary condition for co integration is that the data series for each variable involved exhibit similar statistical properties, that is, to be integrated to the same order with evidence of some linear combination of the integrated series.

### Error correction model

Although price transmission analysis is a useful tool for understanding and predicting price trends, it only tells us about the relationship between two prices over time. It does not tell us why the price transmission is strong or weak, fast or slow (Engle and Granger, 1987) [4]. This interpretation can only be done with local knowledge of transportation routes, seasonal flows in staple foods, trade and agricultural marketing policies, the availability of foreign exchange and credit, the ease of obtaining permits, and the competition for overland freight, among other factors.

## Results and Discussion

### Market Integration

To verify level and second differenced price series were indeed stationary, Augmented Dickey-Fuller (ADF) unit root test was used. The ADF test results are presented for the period Jan 2020 to March 2022 (Table 1). The equations were estimated with an intercept and time trend. The results are presented in Table 1 for Augmented Dickey-Fuller (ADF) unit root tests for each series. The null hypothesis of non-stationary was tested based on the critical values reported by MacKinnon. All the price series appeared non stationary in the levels, but all the series were stationary after taking second differences. After confirming the currency exchange rates were stationary in their second differences, co integration between the commodity futures was tested using Johansen s maximum likelihood procedure. The bivariate co-integration technique of Engle and Granger was also tested for the presence of long run relationship existing between onion prices in different states.

### Granger casualty test

The causal relationship among the markets price of major onion markets in Karnataka were analysed through Grangers Causality technique and presented in Table 2. It could be seen that existence of mostly unidirectional causality as well as bidirectional causality among onion selected markets. The unidirectional relationship was found for the Bengaluru market, indicates that price of Bengaluru market influence the price of Hubballi market. Similarly, bidirectional causality was exerted on Bagalkot and Hubballi markets evidencing proximity of inter market price transmission within the state (Fig.1).These results are similar to the findings of Murulidhar *et al*. (2018) [5] and Sangeetha, *et al*. (2017) [6].

### Results of Jahansen's multiple co-integration analysis

Since all the price series are non-stationary at level form and stationary at second difference level, Johansen co-integration test can be applied to analyze the long run equilibrium among the onion markets. The results of the analysis shown that, there is at least two co-integration equations at 5 per cent level of significant (Table 3). Hence it is concluded that the long run equilibrium exists among the three major markets in Karnataka. Any stocks in these markets would affect the prices of the other markets.

**Table 1:** ADF unit root test for onion in selected markets of Karnataka

| Variable | Level | P-Value | First difference | P-Value |
|---|---|---|---|---|
| Bagalkot | -1.530107 | 0.183077 | -8.357737 | 0.000 |
| Hubballi | -0.988478 | 0.193941 | -5.096788 | 0.000 |
| Bengaluru | -2.504603 | 0.520535 | -4.811597 | 0.000 |

**Table 2:** Pair wise granger causality test for onion Markets in Karnataka

| Null Hypothesis | F-statistic | P-Value |
|---|---|---|
| BGK does not Granger Cause HUB | 4.03580** | 0.0337 |
| HUB does not Granger Cause BGK | 5.20880** | 0.0151 |
| BGK does not Granger Cause BNG | 0.78724$^{NS}$ | 0.4687 |
| BNG does not Granger Cause BGK | 2.30716$^{NS}$ | 0.1254 |
| HUB does not Granger Cause BNG | 0.22379$^{NS}$ | 0.8015 |
| BNG does not Granger Cause HUB | 5.78386** | 0.0104 |

**Note:** **significant at 5 per cent level; Ns- Non significant

**Table 3:** Johansen's multiple co-integration analysis for onion in selected markets unrestricted co-integration rank test (trace)

| No. of CE(s) | Eigen value | Statistic | Critical value | Probability |
|---|---|---|---|---|
| None | 0.584637 | 42.32115*** | 29.79707 | 0.0011 |
| At most 1 | 0.356011 | 20.35609*** | 15.49471 | 0.0085 |
| At most 2 | 0.312140 | 9.354258*** | 3.841466 | 0.0022 |

**Note:** Critical values based on MacKinnon (1999); LR test indicated 2 Co-integration equations
***significant at 1 per cent level

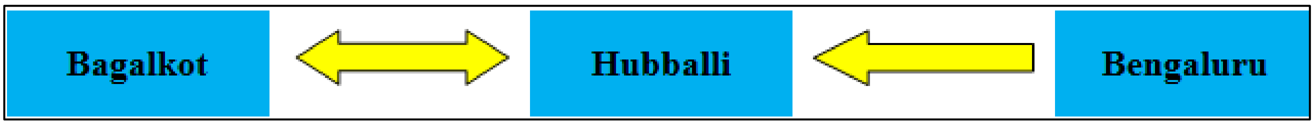


**Fig 1:** Pair wise granger causality of onion markets in Karnataka

### Conclusion

Onion plays a vital role in the world economy particularly in India. The considerable increase in production of onion due to adoption of improved/ high yielding verities and wider adoptability of crop for different agro-climatic conditions across the country, also increase in demand for onion in domestic as well as international markets owing to favourable value chain access by many stakeholders. The domestic onion markets are highly integrated. Price transmission among domestic onion market is improved since it had long run association with the domestic markets. Results of the time series econometric analyses confirmed that domestic onion markets were integrated with intercontinental onion market and the world prices are transmitted to the domestic markets. Results of Johansen's multiple co-integration tests revealed that the domestic onion markets of Bagalkot, Hubballi and Bengaluru, are integrated with at least two co-integration vectors.

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