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RESEARCH ARTICLE

Structure and efficiency of onion market in Karnataka

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ABSTRACT

Farmers in Karnataka face high levels of distress due to low price realization and lower productivity. The marketing system plays a crucial role in addressing this issue, especially for onion, which covers 67% of the area under vegetables in the state. The Lorenz curve and Gini coefficient were used to assess competitiveness, while the Toda-Yamamoto (T-Y) method examined price integration and efficiency. The findings showed that Bengaluru, which accounted for over 65% of onion arrivals, had a high concentration of traders, with just 3% of traders handling 50% of onions in 2017-18. This indicates an extremely high level of concentration, with farmers becoming price takers. Integration and efficiency analyses showed that most markets had two-way Granger causality and were interdependent with Bengaluru. However, the high concentration of traders meant that price discovery was inefficient, leaving farmers as mute spectators. To address this issue, market intervention through information, innovations, and institutions is necessary. The government must provide institutional support and access to information, better marketing infrastructure, and innovative marketing techniques. This will help improve price discovery, reduce market concentration, and provide better market access to farmers. Farmers should also be encouraged to diversify their crops, utilize modern technology, and receive better credit facilities. These measures will help reduce the farmers' dependence on a single crop, mitigate price fluctuations, and increase productivity. In conclusion, a competitive and efficient marketing system is critical to alleviating the distress faced by farmers in Karnataka.

Keywords: Market conduct, market efficiency, market structure, onion market, Gini, Lorenz curve

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INTRODUCTION

The distress among farmers in Karnataka due to low price realization for their crop output is a major issue that needs to be addressed. Economic policy can potentially address this issue, but an efficient market is a crucial prerequisite for better price realization and poverty alleviation among the farming community. The structure conduct and performance paradigm (SCP) suggests that the structure of the market, i.e., the number and size of competitors, determines how they behave and affects the efficiency and performance of the market. A perfect competition, with large numbers of competitors, free flow of information, and free entry and exit, leads to better market performance.

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Efficient markets are especially important for vegetable crops, as small and marginal farmers produce over half of the country's fruits and vegetables (Subramanyam et al., 2004; Birthal et al., 2011). In Karnataka, this group forms 76% of farmer households and cultivates 40% of the land (GoK, 2013). Onion is a major vegetable crop in Karnataka, with 67% of the area under vegetable crops dedicated to onion alone. This study aims to empirically investigate the efficiency of markets for onion, which has implications for whether or not farmers receive remunerative prices based on market dynamics. As such, it is an important step towards understanding the structure and efficiency of these markets in Karnataka and improving the livelihoods of farmers.

MATERIALS AND METHODS

The study relies on secondary data provided by the Department of Agricultural Marketing and Karnataka State Agricultural Marketing Board. This data includes information on the number of traders operating in major agricultural produce markets, daily quantity handled by the traders, daily arrivals, and modal prices for important markets in Karnataka. To collect this data, the daily quantity handled by traders was recorded for one year, from 1st July 2017 to 30th June 2018. Additionally, data on onion arrivals into the Agricultural Produce Marketing Committee (APMC) markets and prices were collected for a period of three years, from 1st July 2015 to 30th June 2018. Based on the arrivals during these periods, major markets in Karnataka and Nagpur market from Maharashtra were selected for further analysis. This data provides an important foundation for investigating the efficiency and performance of onion markets in Karnataka and the factors that may be contributing to the distress among farmers in the state.

Market Competitiveness

The competitiveness of the markets was analyzed using the Lorenz curve and Gini coefficient. The Lorenz curve is a graphical representation that shows the distribution of a parameter of interest (Lorenz, 1905). Meanwhile, the Gini coefficient is a numerical measure of the inequality of the distribution based on the Lorenz curve. This coefficient is a ratio where the numerator represents the area between the Lorenz curve of the distribution and the uniform distribution line, while the denominator represents the area under the uniform distribution line. The value of the Gini coefficient ranges from 0 to 1, where 0 indicates perfect equality, while 1 indicates perfect inequality (Gini et al., 1921). Therefore, lower concentration levels in the market indicate higher competitiveness, while higher concentration levels imply lower competitiveness.

Market Integration and Efficiency

In a scenario where markets are spatially separated, there can be three types of relationships with respect to price. Price leadership implies that the price in one market influences the price in the other market, indicating a one-way causation. Interdependence suggests a two-way causation, indicating the free flow of information. Independence indicates that the price in one market does not affect the price in the other market, indicating that the markets are operating in isolation. Inefficient markets are characterized by price leadership and independence, whereas interdependence indicates market efficiency.

To study market efficiency, the price series in the major four markets of Karnataka (Bengaluru, Hubballi, Belagavi, and Mysuru) were analyzed. However, the analysis excluded the Hassan market due to a lack of regular and consistent data. Nagpur market prices were also used to study price movement and integration.

The T-Y Granger Causality model (T-Y) was used to study market efficiency. The literature on spatial commodity market integration often relies on the Granger Causality model to draw conclusions on the lead-lag price relationship. However, this methodology has two major limitations: it is sensitive to model specification and the number of lags, and when the variables

are integrated, the F-test procedure is not valid, as the test of statistics does not have a standard distribution (He, 1999; Enders, 2004; Gujarati, 2006; Ali, 2011). Therefore, the Toda-Yamamoto (1995) procedure was used to examine the causal relation for the selected variables. This procedure requires the estimation of an "augmented" Vector Autoregression (VAR) even when there is cointegration, which guarantees the asymptotic distribution of the Modified Wald (M Wald) statistic. The Toda-Yamamoto (1995) procedure involves the MWALD test in an augmented VAR model and does not require pretesting for the cointegration properties of the system. The idea underlying the T-Y test is to artificially augment the true lag length (say, p) of the VAR model by the maximal order of integration (m) identified using Augmented Dicky Fuller (ADF) and Kwiatkowski–Phillips–Schmidt–Shin (KPSS) tests that might occur in the process. Then, one can estimate the VAR model with a (p+m) order, ignoring the coefficients of the last m lagged vectors, and test the linear or nonlinear restrictions on the first k coefficient matrices by the standard Wald test.

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Consider the following VAR(p) model:

$Y_t = \gamma + A_1 Y_{t-1} + \ldots\ldots\ldots\ldots\ldots\ldots + A_p Yp_{-1} + \varepsilon$

where, Y_t, and $\varepsilon \sim (0, W)$ are n-dimensional vectors and Ak is an n x n matrix of parameters for lag k. To implement the T-Y test the following augmented VAR(p+m) model to be utilized for the test of causality is estimated,

$Y_t = \gamma \text{ hat} + A_1 \text{ hat} Yt_{-1} + \ldots\ldots\ldots\ldots\ldots\ldots + A_p \text{ hat } Yp_{-1} + \varepsilon \text{ hat}$

The order p of the process is assumed to be known, and m is the maximal order of integration of the variables. Since the true lag length p is rarely known in practice, it can be estimated by some consistent lag selection criteria. The j^{th} element of Y_t does not Granger-cause the i^{th} element of Y_t, if the following null hypothesis is not rejected:

H0 : the row i; column j element in Ak equals zero for k = 1,……., p

The null hypothesis is tested by a Wald test which is termed as MWALD test in case of the augmented VAR outlined above.

RESULTS AND DISCUSSION

Onion Markets overview in Karnataka

Bengaluru was found to have the highest share of total arrivals, accounting for over 65 percent during the study period, among all APMC markets in Karnataka. The top five markets, as shown in Table 1, accounted for 90 percent of the total arrivals. The table also presents the important varieties in each market. For the purpose of analyzing market integration and efficiency, the prices of Local variety in Bengaluru and Hubballi, Pusa-Red in Belagavi, and other variety in Mysuru markets were used.

Table 1: Annual Average quantity of Onion arrivals in the markets (2015-2018) ***(in lakh Qtls.)***

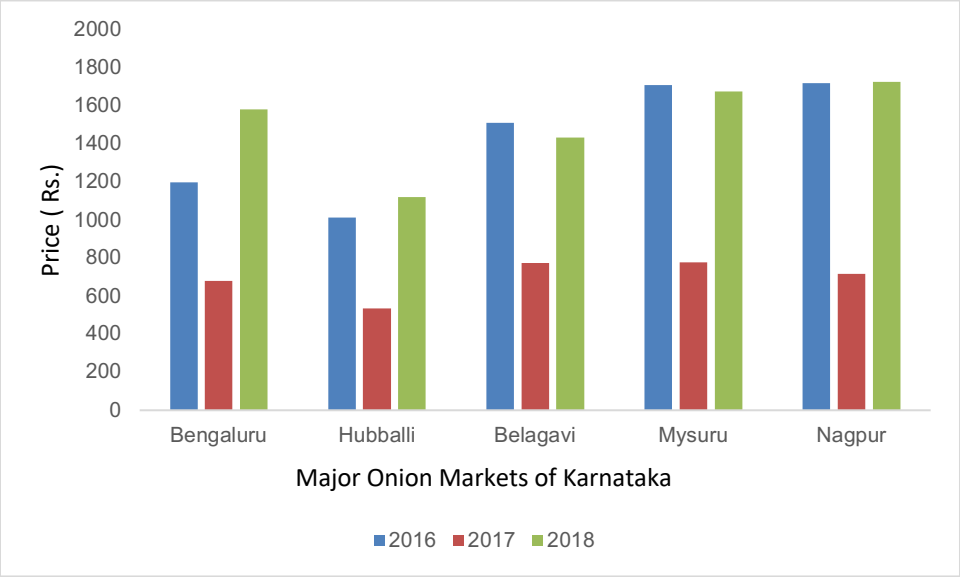
Markets/ Varieties	2016	2017	2018	Total
Bengaluru	**84.03 (67.16)**	**96.15 (66.98)**	**65.82 (64.62)**	**246.00 (66.39)**
Local	31.55	37.53	31.13	100.21
Puna	26.66	32.85	34.62	94.13
Onion	20.08	19.91	0	39.98
Bangalore Small	5.74	5.87	0.08	11.68
Hubballi	**15.31 (12.24)**	**17.40 (12.12)**	**10.92 (10.72)**	**43.63 (11.78)**
Local	7.35	10.2	4.63	22.18
Puna	4.29	4.49	3.67	12.45
Telagi	3.66	2.71	2.62	9
Other	0.01	0	0	0.01
Belagavi	**9.05 (7.24)**	**11.28 (7.86)**	**9.33 (9.16)**	**29.66 (8.01)**
Pusa-Red	8.16	10.71	9.06	27.93
White	0.89	0.57	0.27	1.73
Hassan	**4.04 (3.23)**	**4.20 (2.93)**	**3.39 (3.33)**	**11.64 (3.14)**
Other	4.04	4.2	3.39	11.64
Mysuru	**2.03 (1.62)**	**3.48 (2.43)**	**5.26 (5.16)**	**10.77 (2.91)**
Other	2.03	3.48	5.26	10.77
All Markets	**125.12 (100)**	**143.54 (100)**	**101.87 (100)**	**370.53 (100)**

Source: http://krishi-vishleshana-phalaka.com

Fig. 1 shows the average prices of the selected varieties in Bengaluru, Hubballi, Belagavi, Mysuru, and Nagpur markets. The prices were found to be generally higher in Mysuru and Belagavi markets compared to other markets. This is likely due to

lower arrivals and the use of different varieties in these markets. The prices in Nagpur market were also higher than those in Bengaluru and Belagavi markets.

Fig. 1: Average onion prices in major markets (2016-2018)



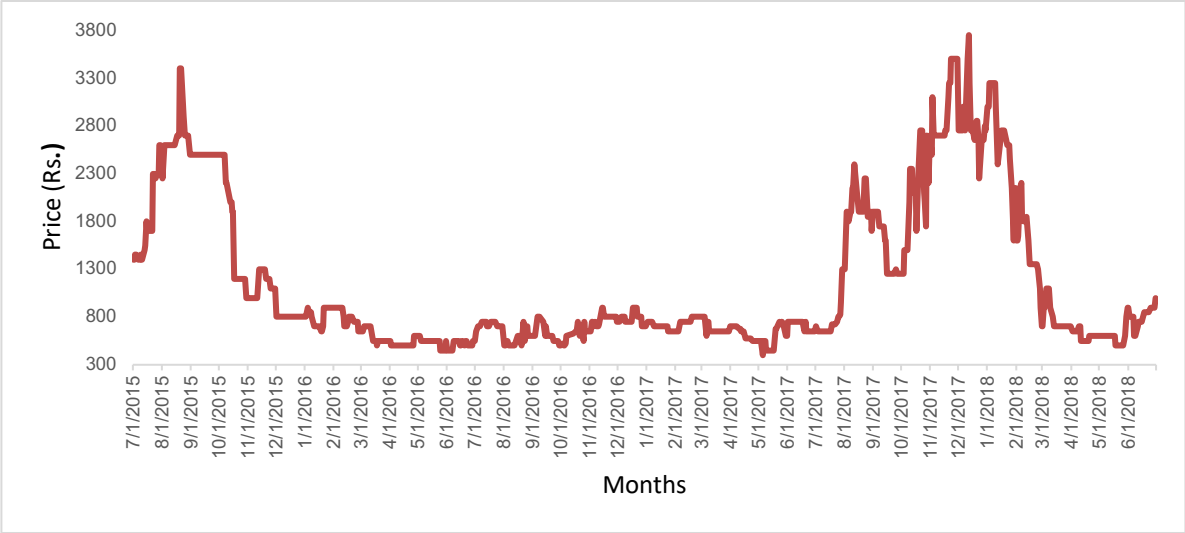
Source: http://krishi-vishleshana-phalaka.com & agmarknet.gov.in

The daily price movement of Bengaluru market is presented in Fig. 2. During the year 2016, onion growers experienced a difficult period as the prices were at their lowest until mid-2017. Despite the prices being higher during late 2015 and early 2018, the market experienced significant volatility. This inconsistency, with lower prices during some periods and higher volatility associated with higher prices during others, does not benefit the farmers.

During the period from July 1, 2017, to June 30, 2018, a total of 51 markets in Karnataka marketed 12 varieties of onions. Bengaluru had the highest share of onion arrivals, accounting for 65% of the total arrivals in the state. This highlights the market's competitiveness and its importance for farmers in the state who seek better prices for their produce. According to data from the board, 637 licensed traders participated in onion purchase in Bengaluru market during this period. However, only 3% of the traders handled over 50% of the quantity, indicating that very few traders control the onion market in Karnataka.

Market concentration analysis was performed only for Bengaluru market, as it was the leading market in Karnataka. The Lorenz curve (Fig. 3) was used to plot the cumulative frequencies of the number of traders and the arrivals. The x-axis represents the cumulative percent of arrivals, while the y-axis represents the cumulative percent of traders. The curve shows that the distribution line is far from the line of equality, indicating a highly concentrated onion market. The Gini coefficient obtained from the Lorenz curve was 0.82, which is close to one and indicates a highly concentrated market. With such extreme concentration, farmers are likely to be price takers and passive observers, making it unlikely for them to receive a remunerative price for their produce.

Fig. 2: Daily prices (Rs.) of Onion at Bengaluru market (01.07.2015 – 30-06-2018)



Market Efficiency

This section discusses the price integration and transmission between the markets, which was analyzed using the T-Y Granger Causality model. To determine the order of Integration, an augmented Dicky Fuller (ADF) and Kwiatkowski–Phillips–Schmidt–Shin (KPSS) unit root tests were conducted and the results are presented in Table 2.

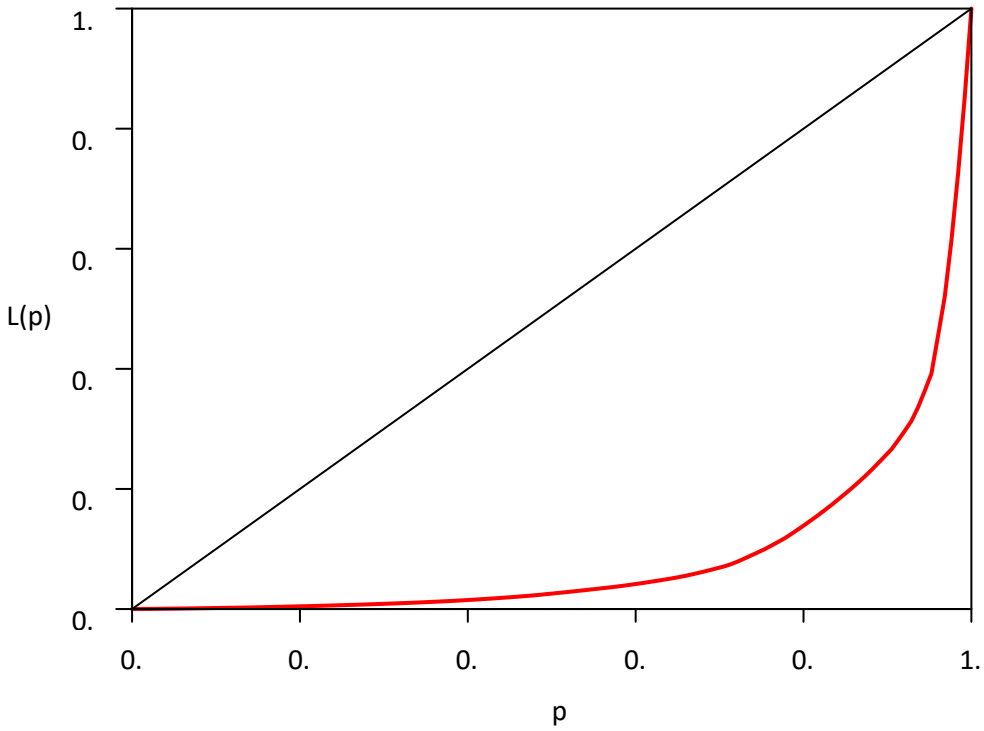
To check for stationarity, the ADF test was applied to the series at the level, which revealed that all the markets were non-stationary. However, after differencing the series once, all the markets became stationary. Thus, the maximum order of integration for any pair of series is one. The results were further verified using the KPSS test, which produced the same results.

Table 2: ADF and KPSS unit root tests on onion prices

Market Price Series	ADF		KPSS	
	I (0)	I (1)	I (0)	I (1)
Bengaluru	-1.97	-08.55*	1.24*	0.07
Belagavi	-1.89	-08.47*	1.44*	0.06
Hubballi	-1.95	-09.03*	1.33*	0.1
Mysuru	-2.02	-12.22*	1.72*	0.04
Nagpur	-1.79	-10.82*	1.46*	0.05

Note: * indicates significant at 1 per cent level

Fig. 3: Lorenz curve for Onion trade in Yeshwantpur market in Bengaluru, Karnataka



In order to determine the appropriate lag length, a Vector Auto Regressive (VAR) model was established based on the levels of the data. The lag was determined by evaluating Akaike's Information Criterion (AIC) and Schwarz Criterion (SC) statistics. Then, the model was tested for autocorrelation in errors using the Portmanteau test. If the null hypothesis of no autocorrelation was rejected, the next higher order lag was chosen and subjected to the Portmanteau test. The lag length thus identified is shown in Table 3 along with the results of the Portmanteau test. The chi-square statistic for the Portmanteau test demonstrated that there was no autocorrelation in the VAR errors at the lags presented in the table.

Subsequently, the MWald test was used to examine the Granger non-causality, where the non-rejection of the null hypothesis indicates no causality, and the rejection supports the existence of Granger causality. The results of the T-Y Granger Causality tested for each pair of markets are presented in Table 4. The null hypothesis was rejected for all the markets that were tested with Bengaluru as the leading market and vice versa, indicating two-way causation in those markets. This suggests that the movement of prices in Bengaluru market Granger causes the prices in all other markets and vice versa. The chi-square statistics for the MWald test were found to be highly significant at a 1% level of significance. However, the MWald test was not applied for other pairs of markets as there existed a serial correlation in the VAR errors even at extremely higher lag orders. The existence of two-way causation in the onion price movement in major markets of Karnataka and with Nagpur markets highlights the presence of an efficient market system in the state.

Table 3: The lag identified by VAR and the results of serial correlation test

Market Price Series	VAR (p)	Portmanteau Test Value
Bengaluru - Hubballi	11	27.7
Bengaluru - Belagavi	15	20.4
Bengaluru - Mysuru	9	29.3
Bengaluru - Nagpur	10	32.2

Table 4: Modified Wald test of T-Y Granger Causality test

	Bengaluru	Hubballi	Belagavi	Mysuru	Nagpur
Bengaluru		25.1*	36.9*	31.9*	14.4*
Hubballi	24.8*				
Belagavi	58.2*				
Mysuru	47.8*				
Nagpur	16.8*				

Note: * indicates $\chi 2$ statistic is at 1 per cent level of significance

CONCLUSION

The study evaluated the level of market competitiveness and efficiency using the daily prices and trading data over the past three years in the APMC markets. To measure market competitiveness, the Lorenz curve and Gini coefficient were used, revealing extreme concentration of the market in the hands of a few traders. This concentration can negatively impact farmers' earnings due to the lack of competitiveness and near monopoly of the market. The study suggests that efforts should be made to increase competition and transparency in the trade, provide marketing information and intelligence to ensure greater symmetry of information, and implement market reforms to increase competitiveness.

The major onion markets were found to be well integrated, with two-way Granger causality with the Bengaluru market indicating the free flow of information about prices in different markets. While the results indicate an existence of a price efficient market in terms of movement of information, the price discovery process is inefficient due to market concentration. The study recommends innovative interventions to increase competitiveness and improve the price discovery system.

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