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Price discovery and market efficiency of cardamom in India

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Abstract

Purpose – Transparent and fair price discovery is essential to commodity market participants in the trade value chain for competitive benefit. The purpose of this paper is to investigate the price discovery of Indian cardamom at e-auction, spot and futures markets in addition to the existence of the day of the week effect at e-auction apart from exploring a novel price risk management framework.

Design/methodology/approach – This study used Johansen co-integration, vector error correction model, Granger causality and regression with dummy variables to understand a day of the week effect in high-value agri-commodity of cardamom e-auction prices. These price data were based on authenticated sources of Spices Board India and Multi Commodity Exchange of India Ltd.

Findings – The statistical results indicate price discovery exists in the e-auction market and it leads to spot and futures prices. cardamom e-auction prices are negatively related to cardamom futures and positively related to spot prices. It also finds the non-existence of the day of the week effect in the high-value cardamom e-auction system in India. The study revealed that a cardamom e-auction is more active in price discovery than a cardamom futures contract.

Research limitations/implications – These results shall facilitate policymakers to explore intervention of online forward market mechanism at the national level to ensure price discovery and market efficiency. However, the study did not explore reasons for the non-equilibrium of a cardamom futures contract with spot and e-auction market.

Practical implications – The results of this study are useful in understanding the price discovery of cardamom e-auction and its role in the spot and futures market. Cardamom price discovery depends upon the e-auction system; any change of auction policy shall be binding on Indian cardamom prices. The introduction of an online forward market mechanism as described in the paper shall facilitate price risk management apart from improving the efficiency of price discovery.

Originality/value – This is the first study considering cardamom e-auction, spot and futures prices in the price discovery process in India. Statistical results of a day of the week effect clearly show no significant volatility of cardamom prices during the week. Besides, this study did not find the role of cardamom futures contracts intended to serve the economic function of price discovery and price risk management. Hence, suggests policy intervention for implementing an online Forward Market mechanism for Indian cardamom to ensure market efficiency and manage price risk.

Keywords Market efficiency, Day of the week effect, Price discovery, Cardamom E-auction, Cointegration, Forward market

Paper type Research paper

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JEL classification – G13, G14, Q13

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1. Introduction

"Bhav Bhagwan Che" . . .! is a popular saying among traders in India, meaning "Price is God." The price discovery process is essential to ensure efficiency and transparency in a competitive market environment. It is the result of interaction among sellers and buyers considering market forces of demand and supply (Easwaran and Ramasundaram, 2008) in addition to factors of size, cost and location of the transaction. The price dissemination facilitates to stabilize spot price volatility (Tomek, 1980) and plays an important role in planning farm-level crop patterns in agriculture (Elumalai *et al.*, 2009). Price discovery through futures contract influences spot market transaction (Sehgal *et al.*, 2012) and reveals an asset's full information and value (Figuerola-Ferretti and Gonzalo, 2010). It observes and exhibits market information in the prices (Frijns *et al.*, 2018). In a static sense, price discovery indicates the existence of equilibrium prices whereas in a dynamic sense it describes the origin and transmission of price across the market (Yang and Leatham, 1999). A fair and efficient price discovery process facilitates all segments of the economy, wherein producers get an idea of the prices prevailing at future markets that facilitates market planning and minimizing price risk. Also, consumers get an idea about future prices of commodities, thus, assists in buying decisions (Shakeel and Purankar, 2014; Manogna and Mishra, 2020).

Scholastic studies on price discovery were seen mainly in developed countries focusing on securities, commodities and currency derivatives. Evidence on price discovery for agricultural commodity markets in emerging economies is limited. However, few of them emphasized evaluating the lead-lag association between spot and futures prices of commodity derivative contracts. Earlier studies of Elumalai *et al.* (2009), Easwaran and Ramasundaram (2008), Nirmala and Deepthy (2011), Ranganathan and Ananthakumar (2014), Inani (2016), Manogna and Mishra (2020) focused on the Indian perspective of commodities spot and future prices in evaluating price discovery. The price discovery function of commodity futures facilitates in predicting spot prices (Elumalai *et al.*, 2009; Nirmala and Deepthy, 2011; Manogna and Mishra, 2020) whereas, Inani (2016) finds a lead-lag relationship of commodity indexes. Ranganathan and Ananthakumar (2014) revealed the Indian soybean futures contracts are efficient and unbiased in the long run, however, inefficient in the short run. Similarly, Easwaran and Ramasundaram (2008) find futures contracts in pepper and soya are inefficient against price risk during volatility. The above scholastic evidences focused on prices of spot and futures markets in the price discovery process of selected commodities ignoring the e-auction market. This research gap motivated the author to consider the impact of spot, e-auction and futures market prices in the process of price discovery of high-value agri-plantation commodities.

Commodities are essential for the survival of living beings. India is a commodity-based economy and is considered as a production hub for agri-plantation crops such as pulses, wheat, tea, coffee, cardamom and pepper (Rajib, 2015). Among these, spices contribute significantly to Indian agri-exports and foreign exchange reserves. Indian spices are largely traded agri-commodities across the globe due to their quality (Thomas and Sanil, 2019). Cardamom is one of the high-value spices used as a flavoring agent in Asian cuisines, cordials, liquors in perfumery and also in ayurvedic medicines. It is also known as "Green Gold" and "Queen of spices" because of its commercial value, aroma and quality (Rani *et al.*, 2018). Until 2002, India used to be the leading producer of cardamom and thereafter Guatemala took over the first position followed by Sri Lanka, Tanzania, El Salvador, Vietnam, Laos, Thailand, Cambodia, Honduras and Papua and New Guinea. Indian Cardamom cultivation is concentrated mainly at the Western Ghats and is generally identified as cardamom hills of the nation. India produced 12,940 metric tonnes in an area of

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69,132 hectares during 2018–2019 (SBoI, 2020). The prices of cardamom have been fluctuating in the Indian market at shorter intervals in the spot and e-auction markets resulting in high price volatility. The cardamom e-auction is being conducted by licensed auctioneers on a specified day and time of the week under the supervision of the Spices Board. However, there is an absence of research studies focusing to understand the day of the week effect on the cardamom e-auction system of India.

The study considering research gap and high price volatility of small cardamom have four motives to address, first the dearth of research considering the impact of e-auction prices on spot and futures, second, inadequate research focusing on cardamom prices being a high value largely traded agri-commodity in India, the third, price discovery and market efficiency of Indian cardamom and fourth, to understand the volatility with a day of the week effect in cardamom e-auction. Moreover, this study to the best of the author's knowledge shall be first to consider all three market prices of cardamom i.e. spot, e-auction and futures in India. This prompted the researcher to explore price discovery and market efficiency of Indian cardamom to add fresh insights into the existing domain of scholastic literature apart from contributing to the policy dimension of price risk management to facilitate cardamom market participants. The remainder of this paper is organized in the following sections - Section 2 provides a conceptual framework, Section 3 describes a scholastic review, Section 4 explains methodology and data, Section 5 presents results and analysis, Section 6 portrays policy dimensions and, finally, Section 7 concludes with findings and future scope of research.

2. Conceptual framework

Price is a subjective phenomenon that depends upon several factors of demand, supply, expected benefit and realizable value in the future. Marginal buyers and sellers determine the price of an asset or commodity during trade interactions. Price discovery determines a common price agreed among market participants at a particular time or period. A fair, transparent and efficient price discovery mechanism is essential to facilitate trade. Agri-commodities are traded largely at spot/physical markets by farmers in India and experience price risk and other infrastructural challenges (Vijayakumar, 2020). Commodities Board as a part of the government mechanism acts for regulating and developing market activities for their respective commodities as specified in governing regulations. Commodity Boards such as Tea Board, Spices Board and Tobacco Board, facilitate price discovery through the E-auction system to market participants. The physical market of commodities facilitates stakeholders and firms with the processing, storage and marketing of agri-commodities (Figuerola-Ferretti and Gonzalo, 2010). A market that provides lower transaction costs, greater liquidity and fewer market restrictions plays a significant role in the price discovery process (Tse, 1999). The function of price discovery implies that prices of the future and spot market are systematically related in the short run or long run (Zhong *et al.*, 2004). Similarly, commodity exchanges through a futures contract facilitate the function of transparent price discovery and risk management. In India, we have two popular commodity exchanges in operations for agri-plantation commodities, namely, National Commodities and Derivatives Exchange Limited (NCDEX) and Multi-Commodities Exchange of India Limited (MCX). Competitive price discovery is a major economic function and creates the economic benefit of futures trading (Easwaran and Ramasundaram, 2008). Supply and demand, trader's attitude to take the risk, price volatility, accessibility to information and market mechanisms are major determinants in assessing commodities prices at derivatives exchange. Figure 1 portrays modes of price discovery.

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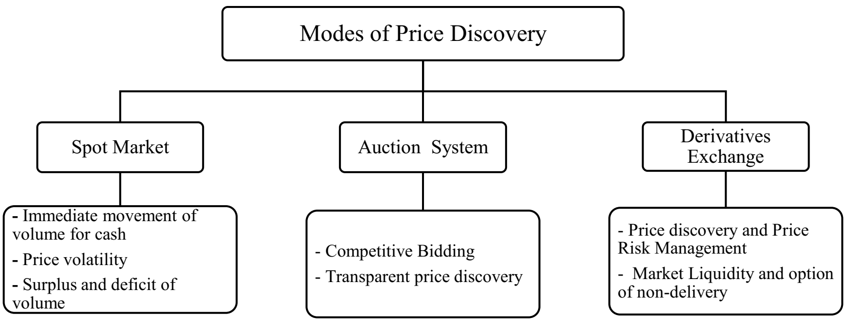
- *Spot market* – The spot market offers market participants to buy and/or sell commodities at a prevailing price with a condition of immediate settlement of a transaction. Cardamom is sold at different spot markets across the country including New Delhi, Kanpur and Mumbai. However, the market of Vandanmedu (Kerala) is considered a spot market price for Cardamom in India.
- *E-auction system* – The E-auction process assists producers, traders, exporters in real-time visibility of bids and ask's prices in a controlled environment managed by an auctioneer with a license. Seller will have the flexibility to accept or not to accept buyer offer price. Similarly, buyers have an opportunity to know the transparent bidding process and access information on winning a bid at an instant response. Cardamom in India is being sold at e-auction centers licensed by the Spices Board, Government of India, subject to the regulation of Cardamom (Licensing and Marketing) Rules. The major e-auction trading centers of cardamom are Vandanmedu, Kumily, Nedumkanadm and Puliyanmala (Kerala), Bodinayakanur (Tamil Nadu).
- *Derivatives Exchange* – Commodity derivatives exchange plays a crucial role in the price discovery and price risk management process through derivatives instruments of futures and options. In India, the selected number of commodity futures contracts is traded due to lack of awareness and other technical reasons among commodities sector stakeholders. Futures contracts facilitate hedging commodity price risk, liquidity and transparent price discovery, as well as price stabilization. The Securities and Exchange Board of India, as a market regulator has been taking several steps to promote commodity derivatives along with derivative exchanges for higher participation, however, trading volumes are not encouraging. The Multi-commodity Exchange of India Limited has been offering Cardamom futures contracts for facilitating the economic function of price discovery and risk management in the Indian commodity ecosystem.

3. Review of literature

This paper reviewed scholastic evidence on price discovery and its mechanisms in ABDC, Web of Science and Scopus indexed databases. Empirical studies of Iyer and Pillai (2010), Nirmala and Deepthy (2011), Arora and Kumar (2013) focused on commodities of precious metals, copper, aluminum and studied the role of a futures market in price discovery.



Source: Author's conceptualization

Figure 1. Modes of price discovery

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Similarly, Dash (2019) investigated the price discovery of 12 commodities in the spot and futures market and its impact on macroeconomic variables. The findings unravel that inflation had a significant effect on price volatility. Adämmer and Bohl (2018) examined the influence of the European agricultural futures contract of canola, wheat and corn on price discovery to analyze the impact on commodity markets during price volatility and rise in trading activity. The effect of access to price information on agri-commodities traded at Ethiopian commodity exchange increased output share and induced small farmers to increase supply explored by Belay and Ayalew (2020). On the same line, Andersson *et al.* (2016) found that institutional intervention on market efficiency enables the reduction of price volatility among small-scale farmers. Zhong *et al.* (2004) initiated that the futures market in Mexico is considered as a suitable price discovery vehicle and a source of instability for the spot market. The studies of Bohmann *et al.* (2018), Bohl *et al.* (2019) examined the role of speculation in the price discovery process and found that speculation is a significant element in commodity derivatives to manage price instability. Yang *et al.* (2001) prompted that asset storability may not affect the co-integration of the futures market in predicting cash prices, but it may affect the magnitude of bias of futures market estimates. Agri-commodity futures contracts are efficient in improving market efficiency and unbiasedness in forecasting spot market prices and price discovery function (Soni, 2014; Ranganathan and Ananthakumar, 2014; Inoue and Hamori, 2014). Besides, Leath and Garcia (1983), Zapata *et al.* (2005), Arnade and Hoffman (2015) focusing on corn, sugar and soybean futures, respectively, found relative efficiency of the futures market in price discovery.

The research studies on the price discovery process of agri-commodities in the Indian context were found to be limited as compared to international studies. The study of Easwaran and Ramasundaram (2008) evaluated the efficiency of castor, cotton, pepper and soya traded in future contracts and found an inefficient hedge against volatile price risk. Also, it is found the lack of awareness on futures market functioning mechanism among farmers, poor grading and standardization of commodities, under-developed infrastructure at physical markets and lack of active participation of trading members resulted in inefficiency. The evidence on price discovery and spillover effects was investigated by Srinivasan (2012) on four spot and future indices and Manogna and Mishra (2020) on the nine most liquid agricultural spot and future commodity markets. The results of these studies revealed that price discovery and spillover effects are imperatives indicators and assimilation of prices reflected in the spot market. Inani (2017) evidenced that future markets are more efficient and impound information more rapidly than the spot market. The price discovery in futures and spot market for pepper, chana and guar seeds was analyzed by Elumalai *et al.*(2009) and found an influence of agri-commodity futures contract on spot prices indicating better hedge efficiency for producers to manage their price risk in derivatives exchange platform. Further, the long-run association between spot and futures prices of various agri-commodities was examined by Ali and Gupta (2011) and found that there is a lack of co-integration between commodities because of exploitation from large traders concerning market manipulation. On the same note, Peri *et al.* (2013), Inoue and Hamori (2014) opined rapid reaction of futures market due to unpredicted information than the spot market. Nambiar and Balasubramanian (2016) studied a rubber futures contract and highlighted the price discovery process during a post-recession period that facilitating traders to manage price risk. The studies on the weekend effect of commodities were focused on crude oil, natural gas and gold (Nelson *et al.*, 2019), crude oil (Yu and Shih, 2011; Gorska and Krawiec, 2015) and corn, coffee, cotton, rough rice and soybeans (Musunuru, 2011). However, studies focusing on the day of the week effect on cardamom prices remain scarce. The aforementioned scholastic shreds of evidence on price discovery, market efficiency and

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agri-commodities clearly indicate a research gap on the cardamom price discovery process considering spot, e-auction and future prices. It is, therefore, there is a need for extended study beyond existing scholastic literature for understanding the lead-lag relationship of spot and futures prices. Moreover, it is also pertinent to policymakers to explore alternate strategies for price risk management of cardamom to ensure remunerative price in advance apart from the existing market mechanism and declining volume of the cardamom futures contract.

4. Methodology and data

Prices of commodities absorb market information in an efficient market system maintaining equilibrium. The emotional behavior and perceived value of an asset shortly move the direction of prices upward, downward or sideways. These movements shall be causing volatility in the long and short run at different market forums. This paper considering three different prices at spot, e-auction and futures markets of cardamom explores price discovery and market efficiency. This study with the causal research method used daily price data of spot, e-auction and futures of cardamom traded in India from publically available domains of Spices Board and Multi Commodity Exchange of India Limited. The monthly average E-auction prices with effect from January 2017 were available to this study from Spice Board sources. It is, therefore, to bring uniformity in data analysis the prices of spot and future from MCX were also considered from the same date. The study, in total, considered 2,286 observations from 1st January 2017 to 19th March 2020 of all trading days excluding public holidays up to the announcement of COVID-19 lockdown. This data has been subjected to statistical analysis with the R – Statistical package. At first, we convert the variables into log-returns and test for stationarity, as well as administer a co-integration test for understanding long-run association. Then, the spot, e-auction and futures prices data shall be subjected to vector error correction model (VECM) and Granger Causality tests and finally with the help of regression using dummy variables on e-auction prices test the existence of volatility with the day of the week effect considering cardamom as high-value agri-commodity.

4.1 Test of stationarity and lag order criteria

The variables in original converted into log-returns and tested for stationarity with Augmented Dickey-Fuller test (ADF). The optimal lag order for co-integration and VECM has been considered from Akaike Information Criteria (AIC) (Dickey and Fuller, 1981). Johansen co-integration test has been used for the testing long-run association of spot, e-auction and future prices of cardamom as proposed by Johansen and Juselius (1990). Trace and Max Eigen test critical values are considered to test the null hypothesis at most r co-integrating vector. These tests are represented as under

$$J_{trace} = -T \sum_{i=r+1}^{n} ln\left(1 - \hat{\lambda}_i\right) \tag{1}$$

$$J_{max} = -T \; ln\left(1 - \hat{\lambda}_{r+1}\right) \tag{2}$$

4.2 Vector error correction model and Granger causality

This study administered the VECM model after confirming the existence of co-integration among the selected variables as per the cost of carrying relationship.

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$$\Delta A_t = C_A + \lambda_1 \ \ Z_{t-1} + \sum_{i=1}^{k} \alpha_{A,i} \Delta A_{t-1} + \sum_{i=1}^{k} \beta_{A,i} \Delta FS_{t-1} + \varepsilon_{A,t} \quad (3)$$

$$\Delta F_t = C_F + \lambda_2 \ \ Z_{t-1} + \sum_{i=1}^{k} \alpha_{F,i} \Delta F_{t-1} + \sum_{i=1}^{k} \beta_{F,i} \Delta S_{t-1} + \varepsilon_{F,t} \quad (4)$$

$$\Delta S_t = C_S + \lambda_3 \ \ Z_{t-1} + \sum_{i=1}^{k} \alpha_{S,i} \Delta S_{t-1} + \sum_{i=1}^{k} \beta_{S,i} \Delta F_{t-1} + \varepsilon_{S,t} \quad (5)$$

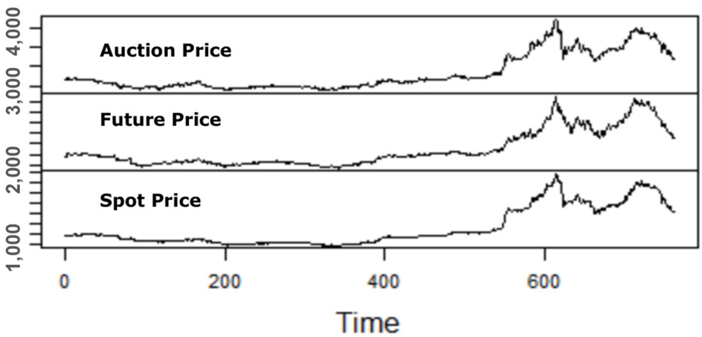
Here, ΔA = E-auction price, ΔF = Futures price, ΔS = Spot price considering respective lags, co-integrating vectors, short-term adjustments and error terms. This model helps to understand the existence of long and short-run causality among selected variables of market efficiency. Granger causality test has been administered to explore causal impact among e-auction's, futures and the spot price of cardamom to understand interrelated effects. Besides, the regression with dummy variable of the day is also used to understand the day of the week effect in high-value cardamom e-auction trade.

5. Results and analysis

The study interpreted empirical findings based on results of statistical tools and techniques as under.

5.1 Descriptive statistics

The variables of e-auction, spot and futures price movements over a study period have been portrayed in Figure 2. The prices are moving in trend at different time frames. Table 1 depicts descriptive statistics of selected variables under the study such as mean, median, standards deviation, kurtosis and skewness. The mean value of the spot price is higher than e-auction and future prices indicating the existence of a price gap. Generally, higher spot prices are observed for processed cardamom as compared to unprocessed at e-auction system. This instability in prices of cardamom at e-auction and spot markets has been indicated at kurtosis value.



Source: Author's calculation based on secondary data

Figure 2.
Time series plot

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Particulars	Auction price	Spot price	Futures price
Number of observation	762	762	762
Minimum	764.08	938.30	843.70
Maximum	4,454.00	4,390.00	42,46.70
1. quartile	963.68	1,103.47	1,088.55
3. quartile	2,416.79	2,631.82	2,304.70
Mean	1,657.16	1,783.49	1,718.16
Median	1,242.21	1,392.70	1,414.80
Sum	1,262,757.84	1,359,022.50	1,309,238.10
SE mean	33.89	33.36	30.77
LCL mean	1,590.62	1,718.00	1,657.75
UCL mean	1,723.69	1,848.98	1,778.56
Variance	875,359.93	848,165.11	721,458.16
Std. deviation	935.60	920.95	849.38
Skewness	1.13	1.123736	1.20
Kurtosis	−0.13	−0.18	0.25

Source: Authors' calculation based on secondary data

Table 1. Basic statistics

5.2 Results of stationarity test

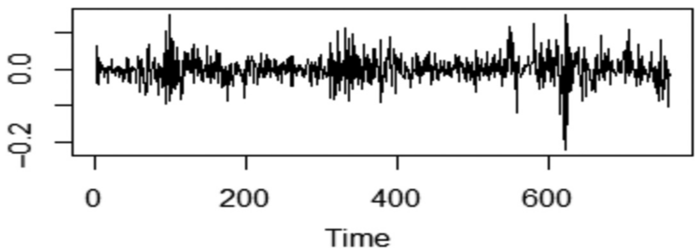
The study with the Augmented Dickey-Fuller test (ADF) diagnosed stationarity of original data and log series. Table 2 presents ADF test results at the levels of variables indicating stationarity with P values.

The diagrammatical representations of log-returns of e-auction's, futures and spot prices are shown in Figures 3 to 5 indicating stationarity.

	Primary at level		Log returns at the level	
Variable	Statistics	*p*-value	Statistics	*p*-value
Auction price	−2.3956	0.4109	−8.2349	0.01
Spot price	−2.155	0.5127	−7.317	0.01
Future price	−2.435	0.3942	−7.8795	0.01

Source: Authors' calculation based on secondary data

Table 2. Test of stationarity (ADF)



Source: Author's calculation based on secondary data

Figure 3. Log return e-auction price

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5.3 Johnsen co-integration test results

The study considering log-returns of e-auction, spot and futures prices administered the Johansen Co-integration test as per the AIC lag length of 10 (−2.278099e + 01). The variables are found to be co-integrated by referring to the Trace and Max Eigenvalue statistics at a 5% level of significance as shown in Table 3. Accordingly, calculated values at zero co-integrating vector are greater than critical values at 5%, hence, it indicates a long-run association among cardamom e-auction, futures and spot prices.

5.4 Vector error correction model and causality

VECM model under the VAR environment has been administered considering the existence of co-integration among cardamom prices at different markets. VECM under maximum

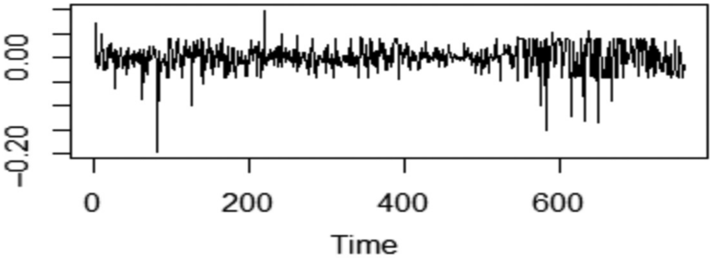

Figure 4. Log return futures price

Source: Author's calculation based on secondary data

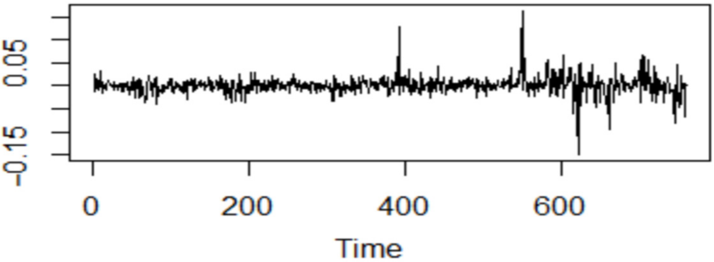

Figure 5. Log return spot price

Source: Author's calculation based on secondary data

Table 3. Co-integration vector statistics

Particulars	Zero co-integrating vector ($r = 0$) Trace	Max Eigen	One co-integrating vector ($r = 1$) Trace	Max Eigen	Two co-integrating vectors ($r = 2$) Trace	Max Eigen
Test statistics	274.36	119.52	154.85	109.06	45.79	45.79
Critical Values						
10%	32.00	19.77	17.85	13.75	7.52	7.52
5%	34.91	22.00	19.96	15.67	9.24	9.24
1%	41.07	26.81	24.60	20.20	12.97	12.97

Source: Authors' calculation based on secondary data

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likelihood finds cardamom e-auction prices are negatively associated with futures (−2.512776) and positively associated with spot price (1.771471). The statistical outputs shown in Table 4 describes the long and short-run causal effect of cardamom e-auction prices derived from futures contract and spot prices. The error correction term showing a significant long-term causal effect of e-auction price to the extent of 45.15% derived from both futures and spot prices.

5.4.1 Short-term causal effect. In addition to long-term causality, Table 4 also describes the short-term causal effect of e-auction prices derived from previous prices of its own, futures and spot. The cardamom e-auction prices are deriving short-term causal effect from its previous prices of 6 out of 10ten days.

While futures and spot prices of the previous 5 out of 10 days are influencing e-auction prices. In total, e-auction prices in the short run are deriving from their own previous prices rather than futures and spot.

5.5 Granger causality test

The statistical outputs of Granger Causality showing the lead-lag relationship of prices at different market environments of cardamom are presented in Table 5. The test results with F-statistics and P values showing cardamom e-auction prices leading to futures and spot prices. Similarly, future prices causing e-auction and spot prices and vice-versa.

5.6 Day of the week effect

Cardamom being a high-value agri-planation commodity of India widely fluctuates in real market environments. The cardamom e-auction system is being organized by the Spices Board through licensed auctioneers on a specified day of the week. However, the prices of cardamom are subjected to high volatility. The study, therefore, explored day of the week effect of cardamom e-auction prices using a dummy variable of the day with a regression analysis. Accordingly, the statistical output in Table 6 portrays the return from cardamom e-auction prices are higher on day3 (Wednesday), however, it is not significant. Besides, the F-statistic with a p-value of regression model suggests not to reject the null hypothesis of the non-existence of day of the week effect associated with the present e-auction system. Hence, this study did not find the existence of the day of the week effect in e-auction trade among licensed auctioneers. It indicates that the e-auction system is not subjected to volatility associated with auctioneers in a week. However, there may be a possibility of fluctuations in e-auction prices in a month. Further, it can also be implied that the cardamom e-auction system as a price discovery mechanism is more active as compared to other market environments of spot and futures as analyzed in this study.

6. Policy dimension – price risk management model

Cardamom e-auction system monitored by the Spices Board India has been facilitating price discovery and playing an important role in cardamom trade. However, the trade operations are limited to specific geographic locations by replacing the open outcry system with e-auction. The price risk and limited participants have inherited issues of concern in the system. Even, cardamom futures trading at the Indian commodity exchange is not popular for its role in price discovery and risk management due to unknown reasons. It is, therefore, it is essential to have an appropriate mechanism for managing price risk to improve market efficiency, transparent price discovery and to absorb price factors of cardamom. In this dimension, this study proposes a viable price

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Table 4.
VECM model output

Full sample size: 761, end sample size: 750 AIC −16,948.62, BIC −16,495.85, SSR 1.654678					
	ECT	Intercept	RAP-1	RFP-1	RSP-1
Equation RAP	−0.4515 (0.0922)***	0.0001 (0.0013)	−0.6646 (0.0950)***	−0.7157 (0.2189)**	0.9536 (0.1813)***
Equation RFP	0.3675 (0.0683)***	−0.0005 (0.0010)	−0.2018 (0.0704)**	0.0276 (0.1623)	−0.7246 (0.1344)***
Equation RSP	−0.1871 (0.0484)***	4e-05 (0.0007)	0.3409 (0.0499)***	−0.3215 (0.1149)**	−0.6953 (0.0952)***
RAP-2	RFP-2	RSP-2	RAP-3	RFP-3	RSP-3
−0.7100 (0.1055)***	−0.5093 (0.2046)*	0.7672 (0.1998)***	−0.7760 (0.1178)***	−0.4443 (0.1900)*	0.7384 (0.2132)***
−0.1040 (0.0782)	−0.0159 (0.1516)	−0.7889 (0.1481)***	−0.1016 (0.0873)	−0.0662 (0.1408)	−0.7530 (0.1581)***
0.4188 (0.0554)***	−0.2716 (0.1074)*	−0.8043 (0.1049)***	0.3976 (0.0619)***	−0.2146 (0.0997)*	−0.7453 (0.1119)***
RAP-4	RFP-4	RSP-4	RAP-5	RFP-5	RSP-5
−0.7462 (0.1286)***	−0.3115 (0.1740)	0.7282 (0.2197)***	−0.5123 (0.1352)***	−0.2859 (0.1576)	0.4554 (0.2171)*
−0.0362 (0.0953)	−0.0764 (0.1290)	−0.6384 (0.1628)***	0.0370 (0.1002)	−0.1009 (0.1168)	−0.6671 (0.1609)***
0.3943 (0.0675)***	−0.1988 (0.0913)*	−0.6059 (0.1153)***	0.4164 (0.0710)***	−0.1788 (0.0828)*	−0.5814 (0.1140)***
RAP-6	RFP-6	RSP-6	RAP-7	RFP-7	RSP-7
−0.3624 (0.1340)**	−0.1898 (0.1414)	0.3007 (0.2083)	−0.2045 (0.1228)	−0.1769 (0.1240)	0.1836 (0.1909)
0.0571 (0.0993)	−0.0968 (0.1048)	−0.5528 (0.1544)***	0.0709 (0.0910)	−0.1330 (0.0919)	−0.5198 (0.1415)***
0.3792 (0.0703)***	−0.0876 (0.0742)	−0.5281 (0.1094)***	0.3416 (0.0644)***	−0.0816 (0.0651)	−0.4063 (0.1002)***
RAP-8	RFP-8	RSP-8	RAP-9	RFP-9	RSP-9
−0.1128 (0.1054)	−0.1415 (0.1047)	−0.0169 (0.1645)	0.0496 (0.0815)	−0.1833 (0.0831)*	−0.0974 (0.1296)
0.1340 (0.0781)	−0.0743 (0.0776)	−0.4679 (0.1219)***	0.1171 (0.0604)	−0.1003 (0.0616)	−0.2891 (0.0961)**
0.2666 (0.0553)***	−0.0221 (0.0550)	−0.2970 (0.0864)***	0.2084 (0.0428)***	−0.0534 (0.0436)	−0.1964 (0.0680)**
RAP-10	RFP-10	RSP-10			
0.1119 (0.0506)*	−0.1536 (0.0583)**	−0.1216 (0.0879)		RAP = auction price	
0.0543 (0.0375)	−0.0795 (0.0432)	−0.0934 (0.0651)		RFP = futures price	
0.0899 (0.0266)***	−0.0374 (0.0306)	−0.0199 (0.0461)		RSP = spot price	

Notes: Figures in parentheses are probability values; The asterisks indicate the following level of significance: ***1%, **5% and *10%
Source: Authors' calculation based on secondary data

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risk management model as shown in Figures 6 and 7 for the benefit of Indian cardamom stakeholders. Under this proposed model, the Spices Board should play a facilitator role by setting up of Online Cardamom Forward Market (CFM) platform.

In this process, CFM should have an electronic trade terminal to enlist bid and ask prices from buyers and sellers with a specified expiry date of a compulsory deliverable contract of 7 or 14 days with specified quality parameters and settlement conditions after the expiry. Buyers should be allowed to quote their bid prices for an expected future delivery contract against the ask prices of sellers of cardamom on the trading platform. The CFM should announce the deal price every day at a specified time for this forward contract of cardamom. During this process, CFM can register traders (buyers and sellers) interest against the fulfilment with small margin money of the total contract value to manage counterpart risk. Subsequently, one/two days prior to the expiry of the contract CFM should assess the delivery interest of both buyers and sellers to collect trade value from the buyer and quality-quantity assurance from the seller. On the date of delivery, CFM should ensure the transfer of ownership from the seller to the buyer against full trade settlement value to the seller. This centralized cardamom forward platform shall facilitate mitigating price risk to market participants and results in assuring agreed prices for a definite period of the contract. This forward contract mechanism is in practice in other countries and informally in practices among the traders in India. The monitored and centrally controlled cardamom forward market shall bring trade discipline and facilitate price risk management apart from bringing market efficiency.

Sl. No.	Null hypothesis	F-statistic	Probability	Direction
1.	RAP does not granger cause RFP	2.4127	0.007962**	RAP → RPF
2.	RFP does not granger cause RAP	6.3768	1.911e−09***	RFP → RAP
3.	RAP does not granger cause RSP	8.0984	1.76e−12***	RAP → RSP
4.	RSP does not granger cause RAP	2.5575	0.004849**	RSP → RAP
5.	RFP does not granger cause RSP	6.3388	2.228e−09***	RFP → RSP
6.	RSP does not granger cause RFP	2.5450	0.005064**	RSP → RFP

Note: The asterisks indicate the following level of significance: ***1%, **5% and *10%
Source: Authors' calculation based on secondary data

Table 5. Granger causality test

Days	Estimate	Std. error	*t*-value	Pr (>I*t*I)
Monday	0.005489	0.295356	0.019	0.9852
Tuesday	0.278014	0.419822	0.662	0.5080
Wednesday	0.772071	0.417004	1.851	0.0645
Thursday	−0.159203	0.413660	−0.385	0.7004
Friday	−0.214243	0.416320	−0.515	0.6070
Saturday	1.137095	1.644471	0.691	0.4895

Multiple R-squared: 0.01042 Adjusted R-squared: 0.003871
F-statistic: 1.591 on 5 and 755 DF p-value: 0.1603

Source: Authors' calculation based on secondary data

Table 6. Day of the week effect on cardamom E-auction

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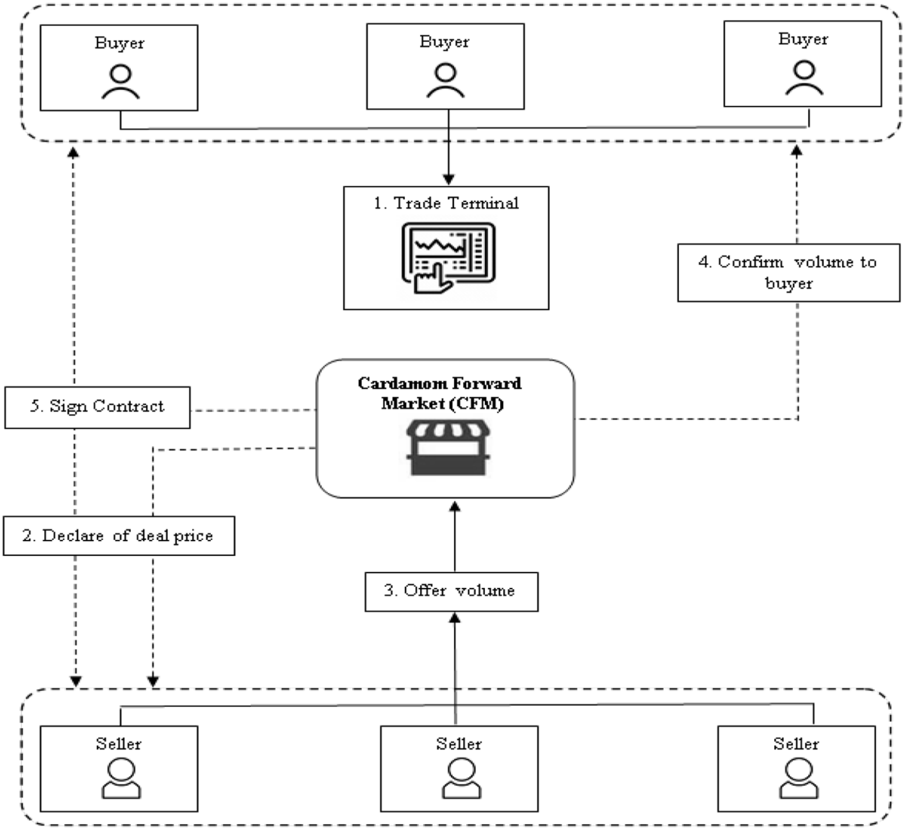

Source: Author's conceptualization

Figure 6.
Forward contract – initiation

7. Findings, conclusion and implications

This study focusing on cardamom as a high-value agri-plantation commodity ascertained price discovery and market efficiency considering three different market forums of spot, e-auction and futures. The statistical analysis finds the existence of a long-run association among the three aforementioned markets with the help of the Johansen Co-integration test. Besides, the VECM model revealed the long-term causality of cardamom e-auction derived from the spot and futures market, whereas, in the short term e-auction prices derive from their own previous prices. Granger causality tests find causal relationships among the cardamom prices of e-auctions, futures and spot. The study finds lower price realization of cardamom at e-auction as compared to spot and futures. Generally, farmers bring the ungraded commodity to e-auction resulting to realize lower prices. It is also observed the existence of arbitrage opportunity in cardamom futures and e-auction prices resulting to store, process and sell for competitive price realization by trade participants. The Spices

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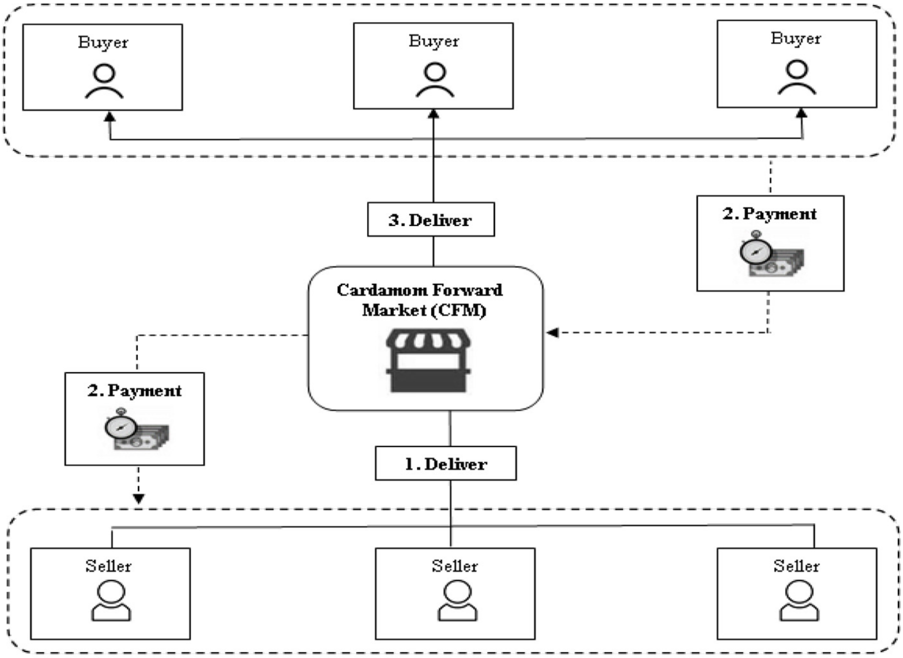

Source: Author's conceptualization

Figure 7.
Forward contract – delivery and settlement

Board promoted the cardamom e-auction system as playing an important role in a limited capacity for the price discovery process. The theoretical findings of Soni (2014), Ranganathan and Ananthakumar (2014), Inoue and Hamori (2014) referring to the role of commodity futures contracts in price discovery are not found in the Indian cardamom market. However, farmers and traders are actively participating in the cardamom e-auction system to discover and realize price benefits. This auction system limited to specific geographic locations of Kerala and Tamil Nadu is not only restricting major traders, exporters, processors, etc. but also posing a challenge for competitive bidding directly from different locations in the price discovery process. It is, therefore, essential to broaden the scope of the existing e-auction on-site system by converting it into an online auction system to encourage trade participants from different locations. This delivery-based online e-auction should have contract specifications to facilitate accessing trade information and encourage more participation. This process shall facilitate competitive bidding, liquidity, and turnover, etc., to ensure market efficiency and price discovery. Besides, the study recommends policy intervention of introducing Cardamom Forward Market System to enable market participants for price risk management. Therefore, this study brings a new dimension to the existing cardamom e-auction system in price discovery as it was never considered in Indian scholastic literature. Future research studies may explore the viability of online trading mechanisms and price discovery with a special emphasis on agri-planation commodities. Besides, studies may explore reasons for non-equilibrium of futures market with e-auction and spot.

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