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RELATIONSHIP BETWEEN FUTURES AND WHOLESALE PRICE OF CASH-CROPS: EVIDENCE FROM INDIAN AGRICULTURAL COMMODITY MARKET

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Abstract

Agricultural commodities provide food, employment opportunities, and export earnings for the people involved in these activities. The stabilisation of commodity prices has an impact on the inflation of food articles which is exposed through Wholesale Price Index (WPI). WPI signifies the inflation factor for the agricultural commodities which are considered in this analysis. Data on monthly WPI and monthly near-month futures price for five cash-corps operated on two national-level commodity exchanges has been analysed with the purpose of reviewing the influence of inflation on the futures price of cash-crops. Futures price reacts from the change in the values of wholesale price of Castor, Cotton and Soyabean. However, wholesale price of Cardamom is shaped from the change in the futures price of it for the short-term. Although the volatility in futures price is entirely dependent on its own deviations in Turmeric.

Keywords: Agricultural commodity market, Futures contract, Wholesale price, Cash-crop, Cointegration

Introduction

Agricultural commodities are vital for emerging economies because they are the source of food grains/articles for the masses, establish income-generating prospects for the people largely participated in agriculture. Government interference has been witnessed at almost every stage of the marketing for major agricultural products in the form of Minimum Support Price (MSP) aimed at certain commodities. However, the government interference has considerably weakened after the beginning of liberalization and financial developments. The role of agricultural commodity can be seen in the steadying of Indian economy amid food items in the origin of the Wholesale Price Index (WPI) in India.

The futures market is a fundamental part of the economic engine of a nation. It plays an essential part in delivering the producers and consumers a domination over the future price of underlying asset or commodity. Without it, although the market would still operate, the price of the final good could vary and such variations can affect the viability of businesses, producers, and the consumers.

Review of Earlier Studies

Some prominent studies, both theoretical and empirical, that deal with the relationship between futures and wholesale price of cash-crops in Indian agricultural commodity market are analysed below.

Sahi and Raizada (2006) delved into the efficiency of the wheat futures market at National Commodity & Derivatives Exchange Ltd. (NCDEX) through the Johansen’s Co-integration approach. It indicated that the commodity futures market was not efficient in the short run and the growth in markets’ volume also had a significant impact on the inflation in the economy. It was seen that the commodity futures market did not come even in the category of weak efficiency for the short run. The social loss statistics indicated that the futures market did not contain the characteristic of price discovery. As the futures market matures, it can inculcate the characteristic of price discovery and reduce the inflationary impact on the economy.

Nath and Lingareddy (2008) detected that the disagreement of futures activity instigating an upsurge in price instabilities is discovered to be factual in the case of urad however sufficient statistical proof could not be located in case of gram. Even though there was a slight spill-over of instabilities from urad to food grains, the movement did not look to spread to all commodities. Hence, the proposal of futures trading sponsoring to rise in inflation (WPI) seems to have no merit, seeing the non-appearance of a straight causal association amid prices of pulses (urad and gram) and other goods.

Sen (2008) established that futures trading in India in the present exchange’s age had steered to an upsurge in instabilities in bulk of the mostly transacted commodities throughout the period of extra liquidity (in terms of their total market size). Moreover, a uni-directional surge in prices was also detected in the circumstances of commodities with minor market size and rare deliverable supplies in the marketplace. It shows the fact of the previous committees that under rare supply circumstances, futures trading may drive a rise in prices as everybody thinks prices to rise.

Sen and Paul (2010) recommended that future trading in agricultural goods and specially in food articles has neither caused in price detection nor less of instability in food prices. They detected a sheer rise in spot prices for key food articles alongside with a granger causal connection from future to spot prices for products on which futures are transacted. A pattern was seen which described that there was a link between the investment in stock market and commodity markets. It led to the financialisation of commodity market where the purpose of trading was speculation and it resulted into the unexpected or sudden change in the spot prices. It has an effect on the prices of commodities based on the cross-border trade and prices in international markets. A caution has to be taken to safeguard the interest of farmers in the case of commodity futures markets where the underlying asset can be the food article for consumption.

There is a vast amount of literature on this subject relating to the equity segment. There was not enough emphasis on the segment of cash-crops from the agricultural commodities even though they play a significant role in establishing the inflation in the country, as, the peasants are getting impacted by the inflation and it also causes somewhat the same effect of wage-price spiral on the economy. In such circumstances, the present study seeks to see the influence of futures contract on the underlying agricultural commodity market in India, mainly, considering cash-crops e.g., Cotton, Jute, Sugarcane, Oilseeds, Tobacco, Cardamom, Guar Gum, Guar Seed, Soyabean, Turmeric, etc.

Research Objective

The present study has been taken up to evaluate the relationship between futures prices and wholesale price index related to cash-crops in Indian agricultural commodity market.

Research Methodology and Analysis of Data

Scope of Study

The present study was conducted with respect to the Multi Commodity Exchange of India Limited (MCX) and National Commodity and Derivatives Exchange Limited (NCDEX). Owing to a great amount of agricultural commodities dealt in these exchanges and the substance they are acquiring lately. Cardamom, Castor, Cotton, Soyabean, Turmeric, Mentha Oil, Guar Gum and Guar Seed are cash crops which are traded actively in these two commodity exchanges. Cash crop is an agricultural produce which is produced to trade for profit. Cash crops are different for countries based on their geographical conditions and ability to produce crops with export value attached to them. There are many cash crops in India also, but only those commodities are selected which are traded actively in concerned exchanges and whose monthly data on WPI (Wholesale Price Index) and futures contract are also available separately for each commodity.

Sources of Data

The thorough data needed for the study was gathered from the secondary sources to achieve the objective of the study. The secondary data on monthly near-month futures price and monthly WPI was collected for each commodity separately from CMIE (Centre for Monitoring Indian Economy) Commodities database connected to commodities sector and Capitaline CSS database. The related statistics was acquired for a period of 10 years, beginning from September 2009 to August 2019. The precise period may differ for various commodities, dependent on the accessibility of trading information. If there are more than one trading prices, the last price or the closing price is well-thought-out for the study. If there is any absent observation, due to non-trading in any day, the usual routine is to eliminate that specific interval from the sample and it has been operated here also. The data has been analysed with the help of Eviews-10. By default, 5% level of significance is considered while applying the relevant statistical tools on the data.

Econometric Tools and Techniques

For the purpose of accomplishing the objectives of the study, data was analysed using the following techniques.

Return

All the series of daily or monthly closing prices of commodities or value of WPI for each commodity transformed into continuous return series in the following manner:

$$R_{(S/F/WPI),\, t} = \ln [P_{(S/F/WPI),\, t}] - \ln [P_{(S/F/WPI),\, t-1}]$$

Where R_t is the return for the day t, ln is the natural log; P_t and P_{t-1} are the closing price of concerned commodity or closing value of WPI of each commodity for day or month t and its corresponding previous day or month t-1.

Stationarity

The correlation amid a series and its lagged values are expected to be determined by the length of the lag and not on when the series began. This property is known as stationarity and any series following this is called a stationary time series (Arora and Kumar, 2013). This test is important because regressing one non-stationary series on another may generate misleading inferences about the estimated parameters and degree of association (Wahab and Lashgari, 1993).

Augmented Dickey Fuller (ADF) examines whether a unit root is existed in an autoregressive model. It is christened after David A. Dickey and Wayne A. Fuller who expounded the test in the 1970s (Dickey and Fuller, 1981). ADF is the augmented form of the Dickey Fuller test to involve some form of serial correlation (Gujarati, 2004). If there is a time series named as y_t and unit root is to be tested on it. Then, ADF model tests unit root as follows.

$$\Delta y_t = \mu + \Omega y_{t-1} + \sum_{i=1}^{k} \beta_i \Delta y_{t-i} + e_t$$

Where,

Δy_t = first difference of y_t i.e., $y_t - y_{t-1}$

The H_0 of ADF is $\Omega = 1$ against H_1 of $\Omega < 1$. If H_0 is not rejected then the series is non-stationary whereas refutation denotes the series is stationary and no unit root is present.

Cointegration

For examining integration between two variables, cointegration technique is adopted. It means that the prices change in one market will be completely transferred to the other market. Markets that are not integrated may communicate incorrect price information that might mislead marketing decisions. Though it is assumed that the price series are stationary [I (1)], if their linear combination has been discovered to be non-stationary [I (0)] then the price series are stated to be cointegrated (Engle and Granger, 1987). Johansen (1988) and Johansen and Juselius (1990) developed improved cointegration model while considering weaknesses in Engel and Granger cointegration approach. Johansen (1988) version is widely accepted and used in econometric software. In this study, Johansen (1988) approach has been applied to test the cointegration in the below-mentioned manner.

$$\Delta Y_t = \sum_{j=1}^{n-1} \Gamma_j \Delta Y_{t-j} + \Pi Y_{t-1} + \mu_t$$

Johansen and Juselius (1990) presented that the coefficient matrix Π comprises the vital information about the relationship amid two variables. Specifically, if rank Π = 0 then Π is 2x2 zero matrix denoting that there is no cointegration amid them. In this case, Vector Error Correction Model (VECM) degrades to a Vector Auto Regression Model (VAR) in first difference. If rank Π = 2 then the appropriate technique is to assess VAR model in level. If rank Π = 1 then there is a single cointegrating relationship between them and ΠY_{t-1} is the error correction term. Johansen (1988) proposed the following two statistics to test for the rank of Π:

$$\lambda_{trace}(r) = -T \sum_{i=r+1}^{k} \ln(1-\hat{\lambda}_i)$$

$$\lambda_{max}(r, r+1) = -T \ln(1-\hat{\lambda}_{r+1})$$

Here $\hat{\lambda}_i$ signifies the eigenvalues attained from the assessment of the Π matrix and T is the number of usable observations. The λ_{trace} analyses the H_0 that there are at most r cointegrating vectors contrary to the H_1 that the number of cointegrating vectors is larger than r and the λ_{max} analyses the H_0 that the number of cointegrating vectors is r, alongside the H_1 of r+1. Critical values for the λ_{trace} and λ_{max} statistics are arranged by Osterwald-Lenum (1992). If the test statistic is more than the critical value, null hypothesis is turned down in favour of alternative hypothesis (Brooks, 2014).

Granger Causality

If the prices of two variables are cointegrated then causality must occur in at least one direction (Granger 1988). While cointegration provides the long run relationship amid variables and Granger causality puts light on the projecting proficiency of other variables. To determine the pattern of such relationship, Granger (1969) developed causality method. The simple model of Granger causality is as follows:

$$\Delta Y_t = \sum_{h=1}^{n} \varepsilon_h \Delta Y_{t-h} + \sum_{h=1}^{n} \lambda_h \Delta Xt_{-h} + \mu_{Y,t}$$

$$\Delta X_t = \sum_{h=1}^{n} \Omega_h \Delta X_{t-h} + \sum_{h=1}^{n} \pi_h \Delta Y_{t-h} + \mu_{X,t}$$

The H_0 in first equation above is $\lambda_h = 0$ which denotes that ΔX does not Granger cause ΔY. Similarly, the H_0 in second equation above is $\pi_h = 0$ and states that ΔY does not Granger cause ΔX. The dismissal or non-dismissal of H_0 is grounded on the F-statistics.

Impulse Response Analysis

It draws the impact of one standard deviation shock to one of the variables on current and future values of all the endogenous variables. A shock to any variable in the structure does not solitary influence that variable straightforwardly but it is also communicated to all of the endogenous variables throughout the dynamic structure of the VAR. It computes the time profile of the result of shock on the future states of a dynamical system (Sims 1980). Block F-test in VAR will neither disclose whether deviations in the worth of a variable have a positive or negative outcome on other variables in the system nor how long it would need for the consequence of that variable to work over the system. This can only be provided by the VAR's impulse response (brooks 2014).

Variance Decomposition Analysis

Its breakdowns the variance of the forecast error into components that can be attached to each of the endogenous variables. It delivers a dissection of the variance of the n-step ahead forecast errors of variable X which is reported by the innovations in variable Y in the VAR. It provides the share of the activities in the dependent variables that are due to their own shocks, versus shocks to the other variables. A shock to the variable will sincerely affect that variable of course, but it will also be spread to all of the other variables in the system through the dynamic structure of VAR (brooks 2014). To some extent, impulse response and variance decomposition offer very similar information. The inherent shocks to the VAR model are orthogonalised by means of the Cholesky decomposition of the variance-covariance matrix of the errors. In general, it depends on the succession of the variables in the VAR. The dilemma of the reliance on the ordering of variables in the VAR is overpowered through the generalised impulse response method (Pesaran and Shin 1998).

Lag Structure Criteria

Picking correct lag length is vital in VAR modelling (Enders, 2013). Optimal number of lags can be designated by utilising existing lag length selection criteria. Lag length has been determined on the basis of Akaike Information Criterion (AIC) and Schwartz Information Criterion (SIC or SC). AIC rewards model that achieves a high goodness of fit score and penalises if model become overly complex. It has the ability to strike a balance with its data set and it also avoids over fitting of the data set (Akaike 1973). The formula of the AIC is as follows:

$$AIC = 2K - 2\ln(l)$$

Where,

K= number of parameters

l = highest value of the likelihood function of the model

SIC practices a role of the residual sum of squares (RSS) collectively with a penalisation for big number of parameters. It reduces the expression: T*log (RSS) + K*log (T), where T is the amount of observations and K is the number of regressors (Gupta and Singh 2007).

Result and Discussion

Castor

Lag Inclusion Criteria in Castor

There is total 32 observations from January, 2017 to August, 2019. VAR lag order selection criteria is adopted in table 1 to find out the number of lags. The AIC is adopted because data is not large enough and this criterion selects six as the desired number of lags.

Table 1: Lag Order Selection Criteria for Castor

Dependent var.s: LOGFUTURESPRICE LOGWPI				Independent var.: C	
Lags	L.R.	F.P.E.	A.I.C.	S.C.	H.Q.
0	NA	2.84e-05	-4.793887	-4.695148	-4.769054
1	63.71260	1.67e-06	-7.631691	-7.335475	-7.557193
2	4.087108	1.90e-06	-7.510926	-7.017233	-7.386764
3	0.315084	2.71e-06	-7.182793	-6.491622	-7.008965
4	8.474504	2.20e-06	-7.440288	-6.551641	-7.216796
5	6.130154	2.03e-06	-7.603308	-6.517183	-7.330151
6	14.69030*	7.53e-07*	-8.724513*	-7.440911*	-8.401690*
7	1.037311	1.15e-06	-8.506350	-7.025271	-8.133863
8	2.614868	1.47e-06	-8.594336	-6.915779	-8.172183
9	1.063434	2.79e-06	-8.512368	-6.636334	-8.040551

Test for Stationarity in Castor

A statistical tool named as ADF is adopted to find out the nature of stationarity in Castor. Table 2 is reproducing the same result of accepting the non-stationarity in log futures price and log WPI. Based on the t-statistic and probability value, there is no reason to reject the null hypothesis in the table. After first differencing, the return futures price and return WPI have become stationary and it can be seen from t-statistic and probability value.

Table 2: ADF on Log Futures Price for Castor

H_0: LOG FUTURES PRICE is non-stationary H_0: LOG WPI is non-stationary H_0: RETURN FUTURES PRICE is non-stationary H_0: RETURN WPI is non-stationary Independent: Constant Size of Lags: 0 (on the basis of A.I.C., max. lags=6)		
	t-Statistics	Probability Value
ADF [LOG FUTURES PRICE]	-1.335412	0.6003
ADF [LOG WPI]	-1.359987	0.5887
ADF [RETURN FUTURES PRICE]	-6.038065	0.0000
ADF [RETURN WPI]	-4.295625	0.0021
1%	-3.661661	
5%	-2.960411	
10%	-2.619160	

Test for Cointegration in Castor

Table 3 outlines about the status of cointegration between log futures price and log WPI for Castor. Johansen Cointegration Test (JCT) is used to find out the relationship between them. Trace statistic and Maximum Eigen Value both are not rejecting the null hypothesis of having at most one cointegration equation based on the value of statistic and its probability value. So, it represents some kind of relationship between log futures price and log WPI in Castor.

Table 3: Johansen Cointegration Test for Castor

From 2017M07 to 2019M08 Total Ob.s: 26 following adaptations Trend: Nil (restricted constant) LOGFUTURESPRICE LOGWPI Lag size (after one difference): 1 to 5 Trace Value				
Hypothesised No. of Cointegration eq.	Eigen value	Trace Statistics	5% Critical Value	Probability Value
Nil	0.775273	40.58280	20.26184	0.0000
Maximum 1	0.065747	1.768215	9.164546	0.8232
Max. EigenValue				
Hypothesised No. of Cointegration eq.	Eigen value	Max. Eigen Statistics	5% Critical Value	Probability Value
Nil	0.775273	38.81458	15.89210	0.0000
Maximum 1	0.065747	1.768215	9.164546	0.8232

Cotton

Lag Inclusion Criteria in Cotton

Table 4 paints about the presence of desired number of lags in Cotton. VAR lag order selection criteria is applied for this. There are 89 observations from April, 2014 to August, 2019. Based on the number of observations, AIC is selected which generates three as the number of lags for this commodity.

Table 4: Lag Order Selection Criteria for Cotton

Dependent var.s: LOGFUTURESPRICE LOGWPI				Independent var.: C	
Lags	L.R.	F.P.E.	A.I.C.	S.C.	H.Q.
0	NA	2.01e-05	-5.136820	-5.077698	-5.113099
1	223.5433	1.27e-06	-7.903994	-7.726627	-7.832832
2	18.06440	1.10e-06	-8.042918	-7.747307*	-7.924315*
3	9.850149*	1.07e-06*	-8.077262*	-7.663407	-7.911218
4	2.044194	1.14e-06	-8.006889	-7.474789	-7.793403
5	2.527192	1.22e-06	-7.944226	-7.293882	-7.683299
6	2.083226	1.31e-06	-7.876096	-7.107508	-7.567728
7	2.199760	1.40e-06	-7.810660	-6.923827	-7.454851
8	0.204079	1.55e-06	-7.715084	-6.710006	-7.311833

Test for Stationarity in Cotton

Stationarity is checked through a statistical tool named as ADF. Table 5 is sketching about the presence of stationarity or not in log futures price and log WPI for Cotton. The null hypothesis of having unit root is considered for both the series based on t-statistic and probability value. So, there is non-stationarity in log futures price and log WPI for Cotton. ADF test is also representing the presence of stationarity in return futures price and return WPI in the table. After first differencing of log futures price and log WPI, there is a presence of unit root in both the series based on their t-statistic and probability value.

Table 5: ADF on Log Futures Price for Cotton

H_0: LOG FUTURES PRICE is non-stationary H_0: LOG WPI is non-stationary H_0: RETURN FUTURES PRICE is non-stationary H_0: RETURN WPI is non-stationary Independent: Constant Size of Lags: 0 (on the basis of A.I.C., max. lags=3)		
	t-Statistics	Probability Value
ADF [LOG FUTURES PRICE]	-2.061549	0.2607
ADF [LOG WPI]	-1.731748	0.4118
ADF [RETURN FUTURES PRICE]	-8.530985	0.0000
ADF [RETURN WPI]	-7.409112	0.0000
1% 5% 10%	-3.506484 -2.894716 -2.584529	

Test for Cointegration in Cotton

Table 6 reproduces the status of relationship between log futures price and log WPI. The null hypothesis of having at most one cointegration equation is not rejected based on the Trace statistic and Maximum Eigen Value. The value of these statistic and its corresponding probability value is also illustrating this for Cotton.

Table 6: Johansen Cointegration Test for Cotton

From 2012M07 to 2019M08 Total Ob.s: 86 following adaptations Trend: Nil (restricted constant) LOGFUTURESPRICE LOGWPI Lag size (after one difference): 1 to 2 Trace Value				
Hypothesised No. of Cointegration eq.	Eigen value	Trace Statistics	5% Critical Value	Probability Value
Nil	0.179959	21.92127	20.26184	0.0293
Maximum 1	0.054931	4.858743	9.164546	0.2993
Max. EigenValue				
Hypothesised No. of Cointegration eq.	Eigen value	Max. Eigen Statistics	5% Critical Value	Probability Value
Nil	0.179959	17.06253	15.89210	0.0326
Maximum 1	0.054931	4.858743	9.164546	0.2993

Soyabean

Table 7 illustrates selection of lag (s) for Soyabean. VAR lag order selection criteria is adopted for this purpose. There is total 89 observations form April, 2012 to August, 2019. As per AIC, one lag is the desired number of lags for Soyabean.

Lag Inclusion Criteria in Soyabean

Table 7: Lag Order Selection Criteria for Soyabean

Dependent var.s: LOGFUTURESPRICE LOGWPI				Independent var.: C	
Lag	LR	FPE	AIC	SC	HQ
0	NA	3.90e-05	-4.476409	-4.417287	-4.452688
1	206.5462*	3.05e-06*	-7.025672*	-6.848305*	-6.954510*
2	2.745514	3.24e-06	-6.963031	-6.667420	-6.844428
3	8.263828	3.24e-06	-6.975939	-6.562084	-6.809895
4	4.343632	3.33e-06	-6.937502	-6.405402	-6.724017
5	2.703408	3.55e-06	-6.877357	-6.227013	-6.616430
6	3.197465	3.74e-06	-6.825613	-6.057024	-6.517245
7	4.624999	3.86e-06	-6.796923	-5.910090	-6.441114
8	7.008937	3.84e-06	-6.807672	-5.802595	-6.404422

Test for Stationarity in Soyabean

Table 8 is depicting the nature of stationarity in log futures price and log WPI for Soyabean. ADF is applied as a statistical tool for this purpose. Both the series are not rejecting the null hypothesis of having unit root which result into the presence of non-stationarity in these series. It can also be seen through the value of t-statistic and its probability value. This table also outlines ADF for return futures price and return WPI for Soyabean. Both the series are illustrating the presence of non-stationarity by rejecting null hypothesis of having unit root.

Table 8: ADF on Log Futures Price for Soyabean

H_0: LOG FUTURES PRICE is non-stationary H_0: LOG WPI is non-stationarity H_0: RETURN FUTURES PRICE is non-stationary H_0: RETURN WPI is non-stationarity Independent: None Size of Lags: 0 (on the basis of A.I.C., max. lags=1)		
	t-Statistics	Probability Value
ADF [LOG FUTURES PRICE]	0.040798	0.6932
ADF [LOG WPI]	0.070778	0.7027
ADF [RETURN FUTURES PRICE]	-8.342005	0.0000
ADF [RETURN WPI]	-6.613493	0.0000
1% 5% 10%	-2.591505 -1.944530 -1.614341	

Test for Cointegration in Soyabean

Table 9 paints towards the estimation of relationship between the log futures price and log WPI for Soyabean through JCT. Trace statistic and Maximum Eigen Value are not rejecting the hypothesis of having at most one cointegrating equation which is based on their value as compare to critical value and their corresponding probability value. So, there is a presence of relationship between these two series for this commodity.

Table 9: Johansen Cointegration Test for Soyabean

From 2012M05 to 2019M08 Total Ob.s: 88 following adaptations Trend: Nil LOGFUTURESPRICE LOGWPI Lag size (after one difference): Nil Trace Value				
Hypothesised No. of Cointegration eq.	Eigen value	Trace Statistics	5% Critical Value	Probability Value
Nil	0.509933	62.77532	12.32090	0.0000
Maximum 1	0.000143	0.012591	4.129906	0.9269
Max. EigenValue				
Hypothesised No. of Cointegration eq.	Eigen value	Max. Eigen Statistics	5% Critical Value	Probability Value
Nil	0.509933	62.76273	11.22480	0.0000
Maximum 1	0.000143	0.012591	4.129906	0.9269

Cardamom

Lag Inclusion Criteria in Cardamom

Table 10 drafts about the number of lags for Cardamom. There is total 84 observations from April, 2012 to March 2019. VAR lag order selection criteria pertain about the lags in it. As per AIC, three is the desired number of lags for Cardamom.

Table 10: Lag Order Selection Criteria for Cardamom

Dependent var.s: LOGFUTURESPRICE LOGWPI				Independent var.: C	
Lags	L.R.	F.P.E.	A.I.C.	S.C.	H.Q.
0	NA	0.000325	-2.357288	-2.293550	-2.331941
1	241.8493	1.04e-05	-5.801219	-5.610007	-5.725180
2	39.17508*	6.41e-06	-6.282105	-5.963418*	-6.155373*
3	8.272290	6.31e-06*	-6.298684*	-5.852521	-6.121259
4	1.913990	6.86e-06	-6.216878	-5.643241	-5.988761
5	2.643610	7.36e-06	-6.148262	-5.447150	-5.869452
6	0.373362	8.22e-06	-6.042024	-5.213437	-5.712521
7	4.582345	8.51e-06	-6.011175	-5.055113	-5.630980
8	7.061731	8.41e-06	-6.029272	-4.945735	-5.598384
9	2.695167	9.01e-06	-5.968426	-4.757414	-5.486845
10	1.483616	9.88e-06	-5.885422	-4.546936	-5.353148
11	1.480851	1.09e-05	-5.803597	-4.337636	-5.220631
12	8.044206	1.03e-05	-5.865795	-4.272359	-5.232136
13	6.648465	1.01e-05	-5.904221	-4.183309	-5.219869

Test for Stationarity in Cardamom

Table 11 reproduces ADF on log futures price and log WPI for Cardamom. In this table, the null hypothesis is not rejected, based on the t-statistic and probability value, which is representing the presence of non-stationarity in log futures price and log WPI for Cardamom. It also outlines the nature of stationarity in return futures price and return WPI for Cardamom. Return futures price and return WPI are sketching the presence of stationarity in themselves by rejecting the null hypothesis and the nature of stationarity is changed after first differencing of log futures price and log WPI for Cardamom.

Table 11: ADF on Log Futures Price for Cardamom

H_0: LOG FUTURES PRICE is non-stationary H_0: LOG WPI is non-stationary H_0: RETURN FUTURES PRICE is non-stationary H_0: RETURN WPI is non-stationary Independent: Constant Size of Lags: 3 (on the basis of A.I.C., max. lags=3)		
	t-Statistics	Probability Value
ADF [LOG FUTURES PRICE]	-1.332286	0.6110
ADF [LOG WPI]	-1.474172	0.5417

ADF [RETURN FUTURES PRICE]	-6.535605	0.0000
ADF [RETURN WPI]	-4.436214	0.0006
1% 5% 10%	-3.514426 -2.898145 -2.586351	

Test for Cointegration in Cardamom

Table 12 pictures about the status of cointegration between log futures price and log WPI for Cardamom through JCT. Trace statistic and Maximum Eigen Value are not rejecting the null hypothesis of having no cointegration equation between them. So, there is no relationship between them for Cardamom.

Table 12: Johansen Cointegration Test for Cardamom

From 2012M07 to 2019M03 Total Ob.s: 81 following adaptations Trend: Linear LOGFUTURESPRICE LOGWPI Lag size (after one difference): 1 to 2 Trace Value				
Hypothesised No. of Cointegration eq.	Eigen value	Trace Statistics	5% Critical Value	Probability Value
Nil	0.078787	11.94594	15.49471	0.1595
Maximum 1	0.063323	5.298746	3.841466	0.0213
Max. EigenValue				
Hypothesised No. of Cointegration eq.	Eigen value	Max. Eigen Statistics	5% Critical Value	Probability Value
Nil	0.078787	6.647194	14.26460	0.5317
Maximum 1	0.063323	5.298746	3.841466	0.0213

Table 13 portrays the Granger Causality between return futures price and return WPI for Cardamom. With return futures price as dependent variable, null hypothesis of excluding return WPI cannot be rejected. It says that three lags of return futures price have an impact on return WPI in short run. In short run, return futures price leads return WPI i.e., in short term, there is unidirectional causality from return futures price to return WPI. It also interprets that there is correlation between current value of return WPI and past values of return futures price in short run.

Table 13: VAR Granger Causality for Cardamom

From 2012M04 to 2019M03 Total Ob.s: 80			
Endogenous var.: RETURNFUTURESPRICE			
Rejected	$\chi 2$	Degree of freedom	Probability Value
RETURNWPI	0.328931	3	0.9545
All	0.328931	3	0.9545
Endogenous var.: RETURNWPI			

Rejected	χ2	Degree of freedom	Probability Value
RETURNFUTURESPRICE	53.12013	3	0.0000
All	53.12013	3	0.0000

Figure 1 depicts about the impulse response for return futures price and return WPI for Cardamom. First and third line are showing 95% confidence interval and the middle line is for impulse response. Return futures price, in response to its own shocks, decreases from period 1 to 4 and becomes negative, but it increases afterwards. Return futures price, in response to the shocks of return WPI, does not get affected from it.

Return WPI, in response to the shocks of return futures price, starts increasing from period 1 to 2 and then it decreases till period 5 and becomes negative. Afterwards, it again increases and becomes positive from period 7 onwards. In response to its own shocks, it decreases from the beginning and becomes negative till period 5. After that, it increases again and becomes static from period 7.

Figure 1: Impulse Response for Cardamom

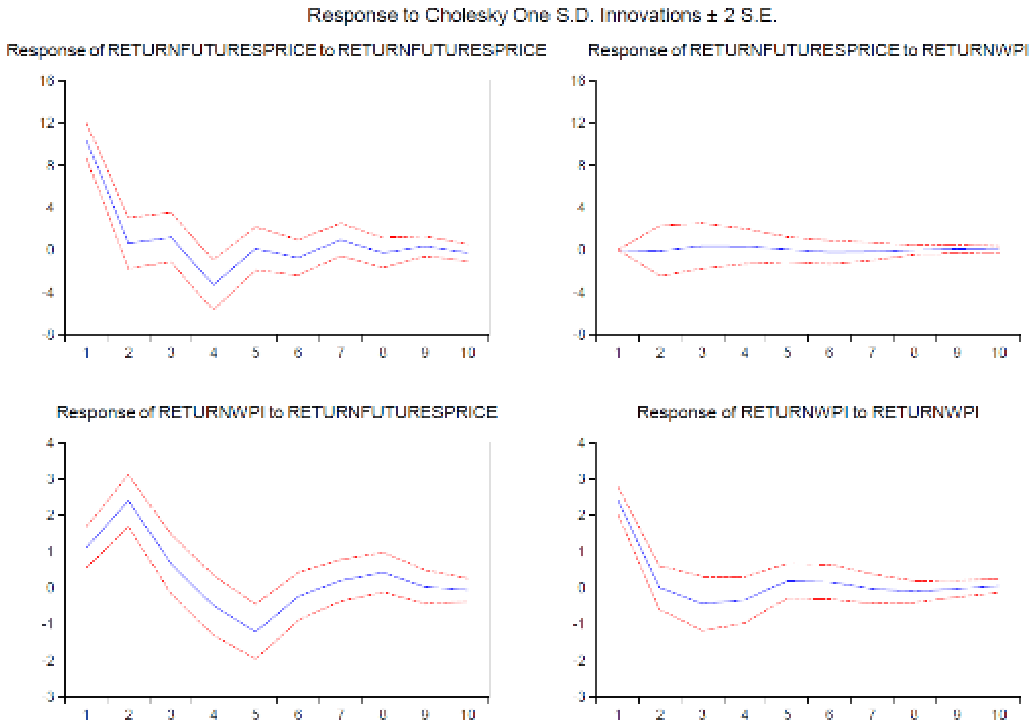
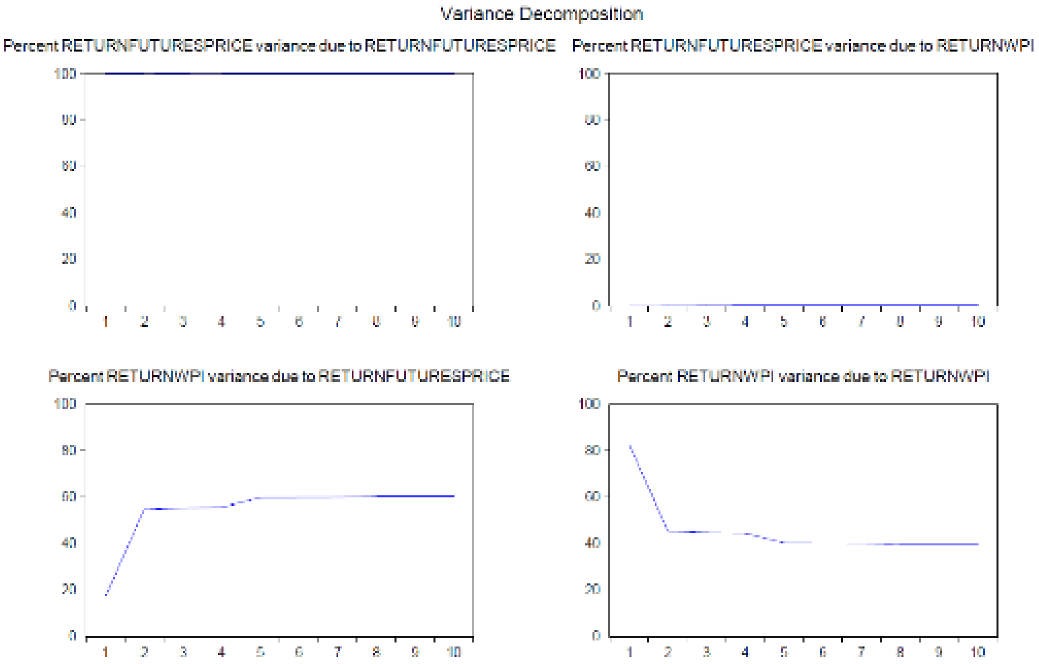


Figure 2 outlines about the variance decomposition between return futures price and return WPI for Cardamom. Return futures price is showing 100% responsiveness to its own shocks and it is unresponsive from the shocks of return WPI. It can also be seen from the two graphs in the first row.

Return WPI responds to the shocks of return futures price from 20% to 60% from period 1 to 3 and after that it becomes static at 60% from the shocks of return futures price. In other words, it gets affected 80% from its own shocks from period 1, but this reduces to 40% from period 3 which is also present in the two graphs of second row.

Figure 2: Variance Decomposition for Cardamom



Turmeric

Lag Inclusion Criteria in Turmeric

Table 14 represents required number of lags for Turmeric. VAR lag order selection criteria is adopted for this purpose. There is total 80 observations from January 2013 to August 2019. As per AIC, four is the desired number of lags for Turmeric.

Table 14: Lag Order Selection Criteria for Turmeric

Dependent var.s: LOGFUTURESPRICE LOGWPI				Independent var.: C	
Lags	L.R.	F.P.E.	A.I.C.	S.C.	H.Q.
0	NA	5.47e-05	-4.137950	-4.075197	-4.112942
1	217.4015	2.73e-06	-7.134096	-6.945839	-7.059072
2	17.68298	2.35e-06	-7.284550	-6.970789*	-7.159511*
3	1.394444	2.57e-06	-7.196089	-6.756823	-7.021034
4	12.99983*	2.35e-06*	-7.289623*	-6.724852	-7.064552
5	4.112535	2.45e-06	-7.246365	-6.556089	-6.971278
6	5.138957	2.52e-06	-7.222425	-6.406645	-6.897323
7	0.596416	2.80e-06	-7.123119	-6.181834	-6.748001

Test for Stationarity in Turmeric

Table 15 outlines about the status of stationarity in log futures price and log WPI for Turmeric through a statistical tool named as ADF. The null hypothesis of having a unit root is not rejected in both the tables. It represents that there is non-stationarity in log futures price and log WPI for Turmeric. It also paints about the presence of stationarity in return futures price and return WPI for Turmeric. The null hypothesis of having unit root is rejected in both the return series based on the t-statistic and probability value.

Table 15: ADF on Log Futures Price for Turmeric

H_0: LOG FUTURES PRICE is non-stationary H_0: LOG WPI is non-stationary H_0: RETURN FUTURES PRICE is non-stationary H_0: RETURN WPI is non-stationary Independent: Constant, Linear Trend Size of Lags: 4 (on the basis of A.I.C., max. lags=4)		
	t-Statistics	Probability Value
ADF [LOG FUTURES PRICE]	-2.446403	0.3534
ADF [LOG WPI]	-2.287765	0.4353
ADF [RETURN FUTURES PRICE]	-4.818298	0.0011
ADF [RETURN WPI]	-4.843967	0.0009
1% 5% 10%	-4.085092 -3.470851 -3.162458	

Test for Cointegration in Turmeric

Table 16 renders in relation to cointegration between log futures price and log WPI for Turmeric. JCT is applied for this purpose. Trace statistic and Maximum Eigen Value are indicating towards the presence of no cointegration equation, but it is also not rejecting the hypothesis of having at most one cointegrating equation.

Table 16: Johansen Cointegration Test for Turmeric

From 2013M05 to 2019M08 Total Ob.s: 76 following adaptations Trend: Linear (restricted) LOGFUTURESPRICE LOGWPI Lag size (after one difference): 1 to 3 Trace Value				
Hypothesised No. of Cointegration eq.	Eigen value	Trace Statistics	5% Critical Value	Probability Value
Nil	0.103372	12.86816	25.87211	0.7484
Maximum 1	0.058427	4.575473	12.51798	0.6580
Max. EigenValue				
Hypothesised No. of Cointegration eq.	Eigen value	Max. Eigen Statistics	5% Critical Value	Probability Value
Nil	0.103372	8.292689	19.38704	0.7945
Maximum 1	0.058427	4.575473	12.51798	0.6580

Table 17: VAR Granger Causality for Turmeric

From 2013M01 to 2019M08 Total Ob.s: 75			
Endogenous var.: RETURN FUTURES PRICE			
Rejected	χ2	Degree of freedom	Probability Value
RETURN WPI	10.03494	4	0.0398
All	10.03494	4	0.0398
Endogenous var.: RETURN WPI			
Rejected	χ2	Degree of freedom	Probability Value
RETURN FUTURES PRICE	12.23232	4	0.0157
All	12.23232	4	0.0157

Table 17 renders about short-term relationship between return futures price and return WPI for Turmeric. Block Exogeneity Wald test has been applied on both the return series of Turmeric. Null hypothesis of exclusion of return WPI and return futures price both are rejected at 5% level of significance. So, it can be said that there is bi-directional feedback relationship between return futures price and return WPI for Turmeric in short-run.

Figure 3 communicates about the impact of shocks from other variables through the application of Cholesky Impulse Response test. Return futures price and return WPI are considered for this impulse response in Turmeric. In terms of its own shocks, return futures price is decreased from period 1 to 4 and it starts increasing from there to next period i.e., 5. From 6th period onwards, it fluctuates around base line. In relation to return WPI, it is moving around base line except for period 5 where it takes a dip. So, return futures price is not impacted too much from its own shocks or shocks from return WPI.

Return WPI starts decreasing till period 4 in terms of its own shocks. Although, it is negative till period 9 but increased a little bit and follows the base line from period 9 onwards. In terms of shocks from return futures price, it is increased from period 1 to 2 and then starts decreasing till period 6. Afterwards, it increases but remain in the negative portion till period 10 and after that it merges in the base line. So, it is also not impacted from its own shocks or shocks from return futures price. It can also be seen from VAR Granger Causality in table 17.

Figure 4 exhibits about variance decomposition of return futures price and return WPI for Turmeric. It explains the role of its own shocks in the variable. Return futures price gets affected from its own shocks completely in period 1 and after that it starts decline till the last period which explains the role of return WPI in it, but it is still affected almost 80% from its own shocks. Return WPI is mostly affected from the shocks of itself, but this magnitude is decreased a bit after period 1 and it becomes static from period 3 at 60%. So, both the return series are mostly affected from its own shocks only.

Figure 3: Impulse Response for Turmeric

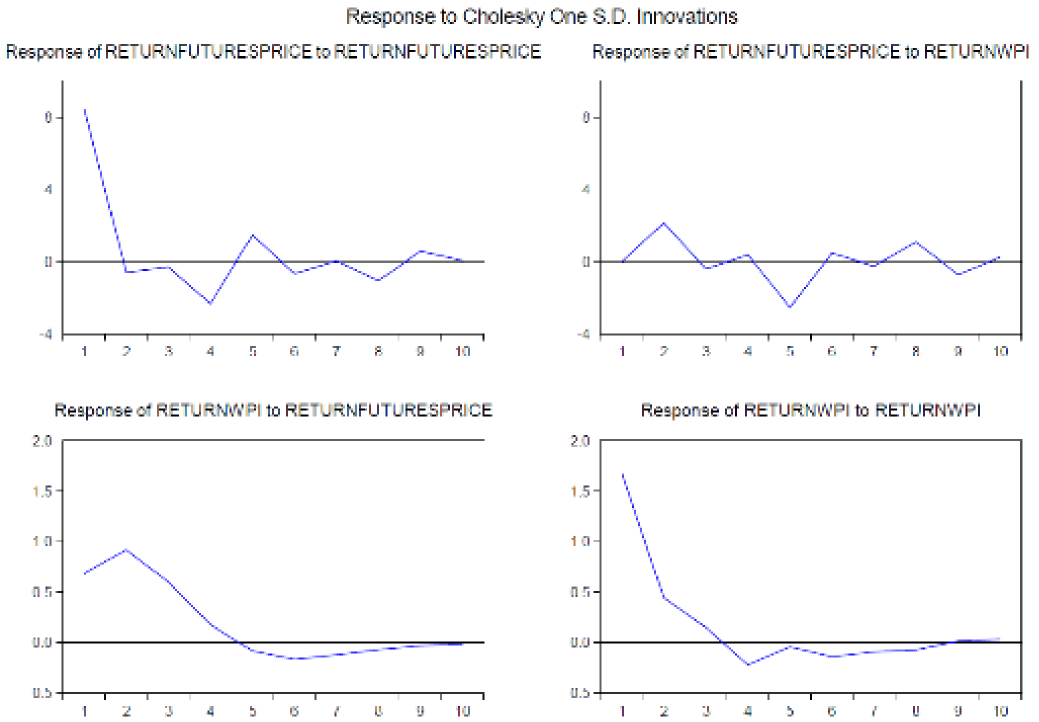
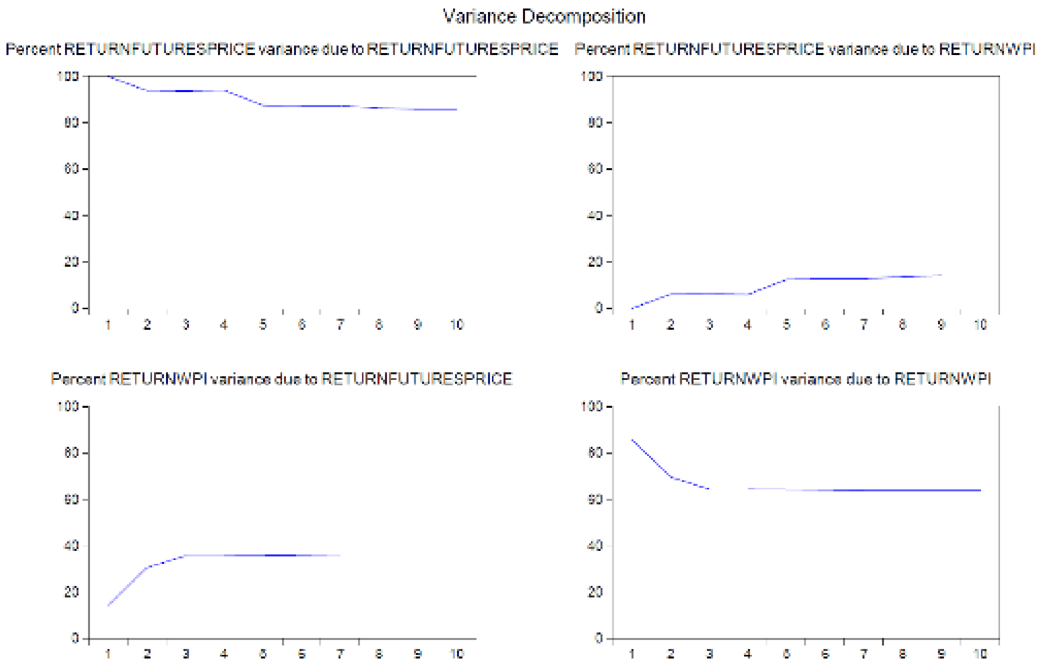


Figure 4: Variance Decomposition for Turmeric



Conclusion

Data on monthly WPI and monthly near-month futures price for each cash-corps operated on MCX and NCDEX has been analysed with the intention of assessing the effect of inflation on the futures price of cash-crops. WPI implies the inflation factor for the agricultural commodities which are studied in this exploration. All the five cash-crops are considered for this objective, namely, Castor, Cotton, Soyabean, Cardamom, and Turmeric, pose non-stationarity in their data set.

Castor, Cotton, and Soyabean depict the cointegration between their monthly near-month futures prices and monthly wholesale price which elucidates the long-term relationship between them. As a result, information flows from both the monthly near-month futures prices and monthly wholesale price simultaneously. On the basis of this, rise in the wholesale price can also be pursued through futures price or the determining factor for the futures price in the exchange can be based on the price of these commodities in the wholesale market, but the arbitrage process attempts to equate these prices altogether to achieve long-term equilibrium. Cardamom and Turmeric are portraying no cointegration between their monthly near-month futures price and monthly wholesale price. Therefore, there is no long-term relationship between them. Short-term relationship is studied through Block Exogeneity Wald Test between these two data sets.

In Cardamom, return futures price leads to return wholesale price for three lags of it in short-term. That is previous three month's futures price have an impact on current month's wholesale price. If futures price is low for the last three months, the wholesale price for current month can be lower in short run. So, the rate of inflation can be regulated in short-run through the past three month's futures price of the commodity. As a result, the players in the futures market may also involve in wholesale market to decide about the future wholesale price of the commodity. The regulatory authorities can verify if there is any correlation between the investors in futures market and wholesale market for Cardamom. Impulse response and variance decomposition are drafting the same result. Futures price does not react from the change in the values of wholesale price of it, but wholesale price of Cardamom is shaped from the change in the futures price of it for the short-term. Volatility, sudden change in price, in WPI of Cardamom is mainly because of the variation in futures price. Although the volatility in futures price is entirely dependent on its own deviations, volatility and sudden change in price in WPI of Cardamom is mainly because of the variation in futures price.

In Turmeric, there is no lead-lag relationship between futures price and wholesale price in the short-run. These two prices pursue bi-directional feedback relationship. It can also be witnessed through impulse response and variance decomposition where futures price is volatile due to its own shocks and same goes with the wholesale price of Turmeric. Therefore, there is no intrusion from one data set into other for generation of price in short-term. As a result, the price of futures contract and wholesale price of Turmeric have no bearing on each other at any level of magnitude.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this article.

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