Madras Agric. J., 105 (1-3): 99-108, March 2018

Cointegration between Domestic and International Market Prices of Beverage Crops in India

S. Lavanya[1*], U. Arulanandu[2] and S. Selvam[3]
[1]Department of Social Sciences
Anbil Dharmalingam Agricultural College and Research institute,
Tamil Nadu Agricultural University, Trichy-620027.

This study has been attempted to investigate market integration between the domestic and international market prices of the beverage crops viz. tea, arabica coffee, robusta coffee and cocoa in India. Attempts was also taken to determine the extent of integration between the markets. The coefficients of monthly price of tea, coffee and cocoa among all the selected markets were positive and negative and significant at five per cent level and indicates strong market integration. The results of VECM revealed that there was significant relationship in the short run and long run equilibrium between the market prices of tea and coffee whereas in case of cocoa there was only long run relationship. The findings revealed that tea and coffee had linkages between the domestic and international markets whereas cocoa remained independent and the suitable policies were formulated.

Key words: Beverage crops, ADF test, Johansen's cointegration, Vector error correction Mechanism.

Price transmission from the world to domestic markets play significant role in understanding the extent of the integration in the market process. The process of price transmission taking place all through upstream phases to the ultimate consumer, in the food sector, has been one of the most investigated areas in the agricultural economics literature for policy objectives (Palaskas, 1995). Tea, coffee and cocoa that categorized under beverage crops play a major role in foreign trade and economic development. India is the largest producer, exporter and consumer of tea and sixth largest Producer in coffee.

As markets become more integrated, it is expected that each market employs information from the others when forming its own price expectations and therefore bidirectional causality should be present (Arshad and Hameed, 2014). The degree to which consumers and producers would benefit, depends on how domestic markets are integrated with world markets and how different regional markets are integrated with each other (Gonzalo *et al*., 2012).

Thus, the beverage crops viz. tea, coffee and cocoa play major significant role in economic development and foreign trade. The price transmission of coffee from global to auction markets, auction to producers and global market to producers in the post reform, pre reform and pooled regression with structural breaks (Worako *et al*., 2008). The vertical integration of tea markets for the black tea, green tea and processors using the farm gate prices, marketing channels and processor prices. The results of the black tea marketing channels showed high cointegration and the granger causality test showed that there was a bi-directional pattern (Dang and Lantican, 2011). Thus the integration enlists the importance of the linkages in the domestic and international markets which makes the influence of one over the other determining the market efficiency. This in turn helps the farmers, organization and policy formulations to decide the effective marketing system and the lacunae in the current system.

*Corresponding author's email: lavanyasagunthala@gmail.com

Material and Methods

The present study includes the secondary data collected from various published sources viz. Tea Board of India, Coffee Board of India, ICO (International cocoa organization) and Indiastat.com, APEDA, World Bank and Agmarknet. In case of tea, the auction price was collected on the domestic markets viz. Cochin, Coonoor and Siliguri. The international markets of Mombasa and Colombo markets were also involved to study the impact of international markets at the same period. For Coffee arabica wholesale prices of the domestic markets viz. Chennai, Bangalore, Hyderabad and international market of New York and Bremen/Hamburg market price was collected. For Coffee robusta wholesale prices of the domestic and international markets viz. Chennai, Bangalore, Hyderabad and New York and Le Havre/Marseilles market price was collected. For cocoa, the wholesale price of domestic markets viz. Thodupuzha and the international markets viz. ICCO (International cocoa organization), New York futures price, London futures price and ICE (Intercontinental exchange) market price was collected. The monthly averages of domestic and International price were collected from January 2011 to December 2017 for coffee arabica and cocoa whereas for tea and coffee robusta the data from January 2013 to December 2017 were collected.

The market integration analysis consists in testing for the presence of unit root or Augmented Dickey Fuller test at the level and first difference, I (1), in each series, testing for the number of co-integrating vectors in the system, estimating and testing for the co-integrating relationship in the framework of a vector error correction model.

Test for unit root

The precondition of market integration was to test Augmented Dickey Fuller (Atkin and Blanford, 1982) test that the data should be stationary at the first difference and at the level it should be non-stationary. A stationary series is one whose parameters are independent of time, exhibiting constant mean and variance and having autocorrelations that are invariant through time. If the series is found to be non-stationary, the first differences of the series are tested for stationary. The number of times (d) a series is differenced to make it stationary is referred as the order of integration I (d). The ADF test considers the null hypothesis that a given series has a unit root i.e., it is non-stationary the test is applied by running the regression of the following form

$$\Delta y_t = (\rho - 1)y_{t-1} + u_t = \delta y_{t-1} + u_t \qquad (1)$$

Where, Δ is the first difference operator. This model can be estimated and testing for a unit root is equivalent to testing $\delta = 0$ (where $\delta = \rho - 1$). Since the test is done over the residual term rather than raw data, it is not possible to use standard t-distribution to provide critical values. Therefore this statistic has a specific distribution simply known as the Dickey – Fuller table.

If the coefficient d is not statistically different from zero, it implies that the series have a unit root, and therefore the series is non-stationary, the determination of order of integration of each variable is required for any time series analysis and more importantly, for error correction equations, because each variable involved in the estimation of these models must be first differently stationary series. Augmented-Dickey fuller (ADF) unit root test are used. The null hypothesis of non-stationary is tested using a t-test. The null hypothesis is rejected if estimated variable is significantly negative.

The critical values for this test are negative and larger than the standard t values. If the computed value (at level) is smaller than the critical't' statistics, accept the null hypothesis of non-stationary series. In this case, the individual series may be integrated of order 1or 2, i.e., I (1) (or) I (2) and may be more than this order. Once the variable are checked for stationary and are of same order, integration between them can be tested using methods such as Augmented Dickey Fuller test (or) Johansen Maximum likelihood test in a bivariate as well as multivariate frame work of the estimated value of error term exceeds critical values at one per cent, five per cent and 10 per cent levels of significance, the conclusion would be that the residual term is stationary and hence the two individual series, through non-stationary are co-integrated in the long run.

Johansen's cointegration test

It is possible that individual time series of the commodity prices may be non-stationary on levels, but a linear combination of them may be stationary indicating a long-run equilibrium relationship between them (Engle and Granger, 1987). If a linear combination of the two non-stationary series is stationary then the two series are considered to be co integrated. To test whether or not the residual term of the regression between the two time series in question is stationary, co integration test start with the promises that for a long-run equilibrium relationship to exist between two variables it is necessary that they should have the same inter temporal characteristics.

The ADF test is supplemented by Johansen Juselius Maximum likelihood method. This test is considered to be better than other co-integration approaches as it address erogeneity and simultaneity problems being faced in other methods in bivariate models. Also, it is important when co integration is tested between more than two variables. In the technique, the hypothesis of presence of co-integration vector is formulated on group of non-stationary series, as the hypothesis of reduced rank of the long-run impact matrix likelihood ratio and maximum likelihood test are applied to derive test statistics for the hypothesis of given number of co integration vectors and their weights inference concerning linear restrictions on the co-integration vectors and their weights is performed using usual chi square methods (Johnsen and Juselius,1990) and (Johansen,1988). First, the order of integration is the same for each time series of prices, and then test for co integration. Only variables of the same order of integration qualify for the pair wise co integration relationships the specific linear combination tested are the residual from a static co integration regression such as

$$Y_t = \beta_1 + \beta_2 X_1 + Z_t \qquad (2)$$

Where Y_1 and X_1 are two price series in levels and Z_t is the residual term Testing for co integration implies testing stationarity of the residual term Z_t.

The (Johansen, 1991) defined two different test statistics for cointegration under the Johansen's method: (i) Trace Test and (ii) Maximum Eigen value Test. The Trace test is a joint test that tests the null hypothesis of no cointegration (H_0: r = 0) against the alternative hypothesis of cointegration (H_1: r > 0).

For Trace test based on the log-likelihood ratio test:

$$\text{i. e. } \ln\left[\frac{\text{L max(r)}}{\text{L max(k)}}\right] \forall\, \text{r} = \text{k} - 1, \text{k} - 2, \ldots .1,0. \qquad (3)$$

The Null hypothesis is H_o: Co-integration rank is r and the alternative hypothesis is H_1: Co-integration is k

And for Maximum Eigen value test based on the log-likelihood test:

$$\text{i.e } \ln\left[\frac{\text{L max(r)}}{\text{L max(r+1)}}\right] \quad \forall\, \text{r} = 0,1, \ldots \ldots \ldots \text{k} - 1. \qquad (4)$$

The Null hypothesis is H_o: Cointegration rank is r and the alternative hypothesis is H_1: Cointegration rank is r+1

The Maximum Eigen value test were conducted separately on each eigenvalue. It tests the null hypothesis that the number of cointegrating vectors is equal to r against the alternative hypothesis of r+1 cointegrating vectors. (Chris Brooks, 2008)

$$\lambda_{\text{trace (r)}} = -\text{T}\sum_{\text{i=r+1}}^{\text{g}} \ln(1 - \hat{\lambda}_{\text{i}}) \qquad (5)$$

$$\lambda_{\max}(\text{r}, \text{r}+1) = -\text{T}\ln\left(1 - \hat{\lambda}_{\text{r+1}}\right) \qquad (6)$$

Where, r = is the number of cointegrating vectors and $\hat{\lambda}_i$ = estimated i^{th} ordered Eigen value from α β' matrices. The presence of the non-zero Eigen value indicates a significant cointegrating vector.

Vector error correction mechanism

It is quite possible for random walks to be related to each other so that a regression of one random walk on the other has a stationary error term. For example

$$\Delta X_1 = \varepsilon$$
$$\Delta Y_1 = \mu$$

let

and let y_t+x_t be stationary. The simplest example is that $y_t = -x_t+v$. That is, let one random walk be the negative of the other- along allowing for some error. Then the sum is simply a random error with no unit root or autocorrelation.

If the combination of unit root variables is not unit root then there must be some relation between them. This is true if and only if statement. If you find co integration then a relationship exists, if not it does not. Therefore if you are interested in establishing that a relationship exists between unit root variables, this is equivalent to establishing co integration. That relationship is called the co integrating vector, which for our example is (1, 1) since the sum is stationary.

The equations can be written in the following form to capture all relationships and avoids unit roots.

$$\Delta X_t = \alpha_1(\beta_1 Y_{t-1} + \beta_2 X_{t-1}) + \varepsilon_t + \vartheta_t \qquad (7)$$

$$\Delta Y_t = \alpha_2(\beta_1 Y_{t-1} + \beta_2 X_{t-1}) + \mu_t + \vartheta_t \qquad (8)$$

This is called a vector error correction model. The error comes from the co integrating relationship. The betas contain the co integrating equation and the alphas the speeds of adjustment. The Johansen's cointegration test were performed using the Statistical software E-views version 7.

Results and Discussion

ADF test of tea, arabica, robusta and cocoa

The precondition to perform the cointegration test that the data should be non-stationary at level and stationary at the first difference. Thus the unit root test was performed for the selected beverage crops viz. tea, coffee arabica, coffee robusta and cocoa. It is evident from the Table 1 that all the markets showed unit root at level and Stationarity at the first difference with one per cent significance.

Table 1. Results of the ADF test of selected crops

Crop	Markets	Level	1st difference	P value
Tea	Cochin	-2.8107(0.0628)***	-7.07231(0.0000)	-3.5441(0.01)
	Coonoor	-2.0388(0.2699)***	-7.1412(0.0000)	-2.9109(0.05)
	Mombasa	-1.2325(0.6548)***	-5.6512(0.0000)	-2.5930(0.10)
	Colombo	-2.6003(0.0985)***	-5.6559(0.0000)	
Coffee arabica	Chennai	-2.5613(0.1052)***	-8.4614(0.000)	-3.5113(0.01)
	Bangalore	-2.0879(0.2501)***	-10.4023(0.000)	-2.8968(0.05)
	Hyderabad	-1.4565(0.5506)***	-7.2575(0.000)	-2.5856(0.10)
	New York	2.4473(0.1323)***	-7.4720(0.000)	
Coffee robusta	Chennai	-2.3749(0.1530)***	-7.7617(0.0000)	-3.5441(0.01)
	Bangalore	-2.5297(0.1137)***	-8.4752(0.0000)	-2.9109(0.05)
	Hyderabad	-2.0794(0.2536)***	-6.7765(0.0000)	-2.5931(0.10)
	New York	-1.6269(0.4628)***	-6.1747(0.0000)	
Cocoa	Thodupuzha	-2.2688(0.1845)***	-10.9186(0.0000)	-3.5113(0.01)
	ICCE	-1.2629(0.6434)***	-8.0288(0.0000)	-2.8968(0.05)
	ICO	-0.9163(0.7785)***	-7.2816(0.0000)	-2.5856(0.10)
	US futures	-2.1736(0.2174)***	-14.8134(0.0001)	
	London Futures	-1.6297(0.4630)***	-5.3987(0.0000)	

Note: *** indicates significance at 1% level. P indicates Mackinnon one-sided p-values

The results of the ADF test of domestic and international market price viz. Cochin, Coonoor, Mombasa and Colombo confirmed the presence of unit root at the level and Stationarity at first difference with one per cent significance. The results of the ADF test of domestic and international market of arabica coffee viz. Chennai, Bangalore, Hyderabad and New York markets confirmed the presence of unit root at the level and Stationarity at first difference with one per cent significance. The results of the ADF test of domestic and international market price of robusta coffee viz. Chennai, Bangalore, Hyderabad and New York markets confirmed the presence of unit root at the level and Stationarity at first difference with one per cent significance. The results of the ADF test of domestic and international market price viz. Thodupuzha, ICE, ICCO, US futures and London futures markets confirmed the presence of unit root at the level and Stationarity at first difference with one per cent significance.

Table 2. Results of trace test on domestic and international markets of tea

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.429756	59.44188	47.85613	0.0028
At most 1	0.240804	25.74041	29.79707	0.1367
At most 2	0.113026	9.210730	15.49471	0.3463
At most 3	0.033015	2.014355	3.841466	0.1558

Note: Trace test indicates 1 cointegrating eqn(s) at the 0.05 level * denotes rejection of the hypothesis at the 0.05 level, **MacKinnon-Haug-Michelis (1999) p-values.

Table 3. Results of trace test on domestic and international markets of coffee arabica

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.284282	53.92201	47.85613	0.0121
At most 1 *	0.193333	26.83006	29.79707	0.1059
At most 2	0.080487	9.427659	15.49471	0.3273
At most 3	0.031958	2.630893	3.841466	0.1048

Note: Trace test indicates 1 cointegrating eqn(s) at the 0.05 level, * denotes rejection of the hypothesis at the 0.05 level, **MacKinnon-Haug-Michelis (1999) p-values.

Table 4. Results of trace test on domestic and international markets of coffee robusta

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.362413	57.53814	47.85613	0.0048
At most 1 *	0.234439	30.53424	29.79707	0.0411
At most 2	0.165776	14.50545	15.49471	0.0701
At most 3	0.058710	3.630265	3.841466	0.0567

Note: Trace test indicates 2 cointegrating eqn(s) at the 0.05 level, * denotes rejection of the hypothesis at the 0.05 level, **MacKinnon-Haug-Michelis (1999) p-values

Johansen's cointegration test

In this study the trace test were considered for all the market series because it performs more robust than the Max-Eigen value Statistic. It is evident from the table 2 that there were one cointegrating equations among the tea market prices.

Table 5. Results of trace test on domestic and international markets of cocoa

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.382394	74.19020	69.81889	0.0214
At most 1	0.173881	35.15599	47.85613	0.4398
At most 2	0.123338	19.68366	29.79707	0.4445
At most 3	0.061473	9.021284	15.49471	0.3634
At most 4 *	0.046800	3.882373	3.841466	0.0488

Note: Trace test indicates 1 cointegrating eqn(s) at the 0.05 level,* denotes rejection of the hypothesis at the 0.05 level, **MacKinnon-Haug-Michelis (1999) p-values

From table 2, it could be noted that coffee arabica markets are integrated with one cointegrating equation and coffee robusta markets are integrated with two cointegrating equations. In case of cocoa, there were one cointegrating equations. The similar results were also obtained by (Ajjan *et al*., 2012).

Table 6. Results of the vector error correction mechanism for the domestic and international markets of tea

Error Correction	D(Cochin)	D(Coonoor)	D(Colombo)	D(Mombasa)
CointEq1	-0.361998***	-0.329415***	0.030379	0.004401
	(0.08130)	(0.07453)	(0.12729)	(0.16107)
	[-4.45283]	[-4.41974]	[0.23866]	[0.02733]
D(Cochin(-1))	0.260522	0.322934***	0.032309	-0.025992
	(0.14002)	(0.12837)	(0.21924)	(0.27742)
	[1.86060]	[2.51564]	[0.14737]	[-0.09369]
D(Cochin(-2))	-0.128856	0.203174	-0.226196	-0.034838
	(0.14732)	(0.13506)	(0.23068)	(0.29189)
	[-0.87466]	[1.50427]	[-0.98057]	[-0.11936]
D(Coonoor(-1))	-0.025324	-0.035931	0.395949	-0.039757
	(0.15464)	(0.14178)	(0.24214)	(0.30639)
	[-0.16376]	[-0.25344]	[1.63522]	[-0.12976]
D(Coonoor(-2))	-0.010032	-0.369559***	0.174474	-0.352641
	(0.14765)	(0.13536)	(0.23119)	(0.29253)
	[-0.06794]	[-2.73013]	[0.75469]	[-1.20548]
D(Colombo(-1))	-0.124990	-0.141502	0.433704***	-0.110157
	(0.10404)	(0.09538)	(0.16290)	(0.20612)
	[-1.20142]	[-1.48356]	[2.66241]	[-0.53442]
D(Colombo(-2))	-0.206477	-0.046808	-0.169028	0.149733
	(0.10368)	(0.09505)	(0.16234)	(0.20541)
	[-1.99157]	[-0.49246]	[-1.04123]	[0.72894]
D(Mombasa(-1))	-0.096302	-0.036232	-0.133172	0.304768***
	(0.07323)	(0.06713)	(0.11466)	(0.14508)
	[-1.31513]	[-0.53970]	[-1.16148]	[2.10066]
D(Mombasa(-2))	0.110980	0.052389	0.042964	-0.013272
	(0.07227)	(0.06625)	(0.11315)	(0.14318)
	[1.53571]	[0.79072]	[0.37969]	[-0.09269]
C	0.792949	0.872712	0.285843	-0.235470
	(0.70684)	(0.64804)	(1.10678)	(1.40046)
	[1.12182]	[1.34670]	[0.25827]	[-0.16814]

Note: ( ) indicates Standard error, [ ] indicates the t statistic, ***Significant at 5 per cent.

VECM

The Error correction model shows that all the markets adjust to prices changes toward long-run equilibrium (Ahmed *et al*., 2015). The reflection during the sudden shocks would enable to know the changes in the market. The results of the VECM model and the estimates of the short run are presented in the Table 6 to 13. The short run and the long run equilibrium adjustments indicates the external and the internal forces.

VECM of tea

The results of VECM were presented in the Table 6 and t statistics values greater than 2.00 were considered as significant. It reveals that, in the long run Cochin market had no significant coefficients values and the market was independent. In case of Coonoor market, the coefficients of two months (-0.369559) lagged by its own market price was negative and significant at 5 per cent level. It reveals that, in the long run Coonoor market price was influenced by its own market price. In case

Table 7. Estimates for short run price integration in the selected Tea markets

Cointegrating Eq	CointEq1
Cochin(-1)	1.000000
Coonoor(-1)	0.491354
	(0.26152)
	[1.87885]
Colombo(-1)	-0.466457
	(0.10652)
	[-4.37898]
Mombasa(-1)	0.094373
	(0.06977)
	[1.35266]
C	-50.08627

of Colombo market, the coefficients of one month (0.433704) lagged by its own market price was positive and significant at 5 per cent level. It reveals that in the long run, Colombo market was influenced by its own market price. In case of Mombasa market, the coefficients of one month (0.304768) lagged by its own market price was positive and significant at 5 per cent level. It reveals that in the long run, Mombasa market was influenced by its own market price. Finally the results can be consolidated and interpreted that the Coonoor market linked with its own and Cochin market. Hence as Coonoor market was considered as the lead market. Whereas other markets are linked by only one market.

Table 8. Results of vector error correction mechanism for domestic and international markets of arabica coffee

Error Correction	D(Bangalore)	D(Chennai)	D(Hyderabad)	D(New York)
CointEq1	0.021402	0.100447***	-0.003163	-0.000156
	(0.01532)	(0.02614)	(0.02091)	(0.01684)
	[1.39664]	[3.84327]	[-0.15129]	[-0.00926]
D(Bangalore(-1))	-0.252122	-0.079099	0.338076	0.086702
	(0.14670)	(0.25020)	(0.20015)	(0.16124)
	[-1.71867]	[-0.31614]	[1.68909]	[0.53773]
D(Bangalore(-2))	0.026224	-0.017182	0.293024	-0.083299
	(0.13921)	(0.23742)	(0.18993)	(0.15300)
	[0.18839]	[-0.07237]	[1.54278]	[-0.54443]
D(Chennai(-1))	0.290906***	0.326206***	-0.027902	0.121361
	(0.09370)	(0.15982)	(0.12785)	(0.10299)
	[3.10458]	[2.04113]	[-0.21824]	[1.17837]
D(Chennai(-2))	0.143477	0.178947	0.032342	-0.007511
	(0.09474)	(0.16158)	(0.12926)	(0.10413)
	[1.51449]	[1.10749]	[0.25021]	[-0.07213]
D(Hyderabad(-1))	-0.195576	-0.190062	-0.423003***	-0.241585***
	(0.10971)	(0.18711)	(0.14968)	(0.12058)
	[-1.78271]	[-1.01576]	[-2.82596]	[-2.00350]
D(Hyderabad(-2))	-0.156901	-0.273220	-0.222602	-0.072732
	(0.10602)	(0.18082)	(0.14465)	(0.11652)
	[-1.47997]	[-1.51101]	[-1.53891]	[-0.62417]
D(New York(-1))	0.433880***	0.284034	0.165875	0.190438
	(0.12225)	(0.20850)	(0.16679)	(0.13436)
	[3.54923]	[1.36227]	[0.99449]	[1.41733]
D(New York(-2))	0.192322	0.214484	0.112517	0.124106
	(0.13143)	(0.22416)	(0.17932)	(0.14445)
	[1.46335]	[0.95685]	[0.62747]	[0.85915]
C	-0.463979	0.115916	0.414788	-0.750216
	(1.44835)	(2.47027)	(1.97614)	(1.59191)
	[-0.32035]	[0.04692]	[0.20990]	[-0.47127]

Note: ( ) indicates Standard error, [ ] indicates the t statistic, ***Significant at 5 per cent.

It could be evident from the Table 6 that the tea markets viz. Cochin, Coonoor markets came to short run equilibrium as indicated by significant coefficients with the rapid speed of adjustment. All the tea market

Table 9. Estimates for the short run price integration in the selected arabica coffee markets

Cointegrating Eq:	CointEq1
Bangalore(-1)	1.000000
Chennai(-1)	-6.724063 (1.25848) [-5.34299]
Hyderabad(-1)	4.387842 (1.19189) [3.68140]
New York(-1)	1.103323 (0.77336) [1.42665]
C	45.87877

price series under the study were of monthly price. The results revealed that in the short run, any shock in the price of Cochin market adjusted with 36 percent and Coonoor market got adjusted with 32 per cent that were indicated by the coefficient values. In a similar study, (Masih & Masih, 2001) the long term and short

Table 10. Results of vector error correction mechanism for domestic and international markets of robusta coffee

Error Correction	D(Bangalore)	D(Chennai)	D(Hyderabad)	D(New York)
CointEq1	-0.356287	0.362309	0.294013	0.388814***
	(0.18560)	(0.23197)	(0.19161)	(0.18091)
	[-1.91970]	[1.56191]	[1.53442]	[2.14918]
D(Bangalore(-1))	0.186856	-0.097354	0.042996	-0.104997
	(0.17426)	(0.21780)	(0.17991)	(0.16987)
	[1.07226]	[-0.44698]	[0.23898]	[-0.61811]
D(Bangalore(-2))	0.090058	-0.167266	-0.085495	-0.021787
	(0.15176)	(0.18967)	(0.15668)	(0.14793)
	[0.59343]	[-0.88186]	[-0.54568]	[-0.14728]
D(Chennai-1))	0.329646***	-0.290472	0.000135	0.046146
	(0.15588)	(0.19483)	(0.16093)	(0.15195)
	[2.11475]	[-1.49094]	[0.00084]	[0.30370]
D(Chennai(-2))	0.006474	0.002204	0.179663	-0.207513
	(0.14409)	(0.18009)	(0.14876)	(0.14045)
	[0.04493]	[0.01224]	[1.20773]	[-1.47744]
D(Hyderabad(-1))	-0.386237***	0.463370	-0.003924	0.087066
	(0.19086)	(0.23854)	(0.19704)	(0.18604)
	[-2.02372]	[1.94253]	[-0.01991]	[0.46799]
D(Hyderabad(-2))	-0.110789	-8.33E-05	-0.142801	-0.019058
	(0.15989)	(0.19984)	(0.16507)	(0.15585)
	[-0.69291]	[-0.00042]	[-0.86509]	[-0.12228]
D(New York(-1))	0.055428	0.262322	0.083232	0.356668***
	(0.17945)	(0.22428)	(0.18527)	(0.17492)
	[0.30888]	[1.16960]	[0.44926]	[2.03903]
D(New York(-2))	0.180274	0.164717	0.156432	0.229709
	(0.17853)	(0.22313)	(0.18432)	(0.17402)
	[1.00977]	[0.73820]	[0.84871]	[1.31998]
C	-0.349315	0.039113	-0.190903	-0.124410
	(0.78510)	(0.98126)	(0.81055)	(0.76529)
	[-0.44493]	[0.03986]	[-0.23552]	[-0.16257]

Note: ( ) indicates Standard error, [ ] indicates the t statistic, ***Significant at 5 per cent.

term price transmission among the stock markets were also obtained. In the long run, the significant VECM estimates of the selected markets exhibited both positive and negative coefficients. The estimates of the short run price integration were presented in the Table 7.

VECM of arabica coffee

In the long run the price series with negative and positive coefficients converged to the long run equilibrium. The t statistics values greater than 1.99 were marked as significant. As indicated from the Table 8 in case of Bangalore market, the coefficient of one month (0.29091) lagged price of Chennai market was positive and significant and the coefficient of the one month (0.43388) lagged price of New York market was positive and significant at 5 per cent level of significance.

Table 11. Estimates for the short run price integration in the selected robusta coffee markets

Cointegrating Eq	CointEq1
Bangalore(-1)	1.000000
	0.233689
Chennai(-1)	(0.16312)
	[1.43265]
	-0.658228
Hyderabad(-1)	(0.21489)
	[-3.06309]
	-0.867167
New York(-1)	(0.06852)
	[-12.6554]
C	45.53904

It reveals, that the Bangalore market was influenced by Chennai market and New York market. For Chennai market, the coefficient of one month (0.32621) own lagged price was positive and significant and the coefficients of Hyderabad market one month (-0.42300) own lagged price was negative and significant at 5 per cent level. It reveals that the Chennai market was influenced by Hyderabad market. The current price of New York market, was influenced by one month (-0.24159) lagged price of Hyderabad market with 24 per cent to bring about the equilibrium. The consolidated results showed that Bangalore market as lead market because it was only linked with Chennai and New York market. Whereas other markets are linked by only one market.

Table 12. Results of the vector error correction mechanism for the domestic and international markets of cocoa

Error Correction	D(ICE)	D(ICCO)	D(London futures)	D(Thodupuzha)	D(US futures)
CointEq1	0.128040	0.000141	-0.163779	-3.31E-05	-0.059702
	(0.08826)	(7.9E-05)	(0.10208)	(2.2E-05)	(0.12975)
	[1.45074]	[1.78728]	[-1.60445]	[-1.49770]	[-0.46014]
D(ICE(-1))	-1.051778***	-0.000413	0.050023	4.44E-05	-0.124451
	(0.26525)	(0.00024)	(0.30679)	(6.6E-05)	(0.38995)
	[-3.96518]	[-1.73524]	[0.16305]	[0.66772]	[-0.31915]
D(ICE (-2))	-0.328604	-3.09E-05	-0.075958	-3.37E-05	-0.139204
	(0.34807)	(0.00031)	(0.40258)	(8.7E-05)	(0.51170)
	[-0.94406]	[-0.09893]	[-0.18868]	[-0.38629]	[-0.27204]
D(ICCO(-1))	952.2078***	0.402031	-303.1557	-0.072562	390.9664
	(392.222)	(0.35153)	(453.637)	(0.09827)	(576.603)
	[2.42773]	[1.14365]	[-0.66828]	[-0.73837]	[0.67805]
D(ICCO (-2))	327.1175	0.011027	-66.89108	0.034307	43.31280
	(368.779)	(0.33052)	(426.524)	(0.09240)	(542.140)
	[0.88703]	[0.03336]	[-0.15683]	[0.37130]	[0.07989]
D(London futures(-1))	0.216488	0.000288	-0.138837	6.00E-05	0.153703
	(0.18954)	(0.00017)	(0.21922)	(4.7E-05)	(0.27865)
	[1.14215]	[1.69801]	[-0.63331]	[1.26274]	[0.55160]
D(London futures(-2))	0.235499	0.000373***	0.347501	-4.09E-05	0.388863
	(0.20007)	(0.00018)	(0.23140)	(5.0E-05)	(0.29412)
	[1.17709]	[2.07740]	[1.50176]	[-0.81608]	[1.32213]
D(Thodupuzha(-1))	470.3376	0.072476	-190.3614	-0.191564	259.5776
	(478.517)	(0.42888)	(553.445)	(0.11989)	(703.464)
	[0.98291]	[0.16899]	[-0.34396]	[-1.59777]	[0.36900]
D(Thodupuzha(-2))	61.98341	0.155488	-426.9039	-0.049991	147.9493
	(475.535)	(0.42620)	(549.996)	(0.11915)	(699.081)
	[0.13034]	[0.36482]	[-0.77619]	[-0.41958]	[0.21163]
D(US futures(-1))	0.046355	-8.25E-05	0.348691	2.83E-06	-0.388825
	(0.29979)	(0.00027)	(0.34673)	(7.5E-05)	(0.44071)
	[0.15463]	[-0.30703]	[1.00567]	[0.03768]	[-0.88227]
D(US futures(-2))	0.043122	-0.000144	0.062800	2.57E-05	-0.117726
	(0.20799)	(0.00019)	(0.24055)	(5.2E-05)	(0.30576)
	[0.20733]	[-0.77413]	[0.26106]	[0.49411]	[-0.38503]
C	-401429.4	-811.5905	-497451.1	-244.7124	-790106.9
	(925345.)	(829.350)	(1070238)	(231.849)	(1360343)
	[-0.43382]	[-0.97859]	[-0.46480]	[-1.05548]	[-0.58081]

Note: ( ) indicates Standard error, [ ] indicates the t statistic, ***Significant at 5 per cent.

From the Table 8. In the short run, the arabica coffee markets of the Chennai markets came to short run equilibrium as indicated by level of significance with the rapid speed of adjustment. Any disturbance in the price would get corrected with 10 per cent of the Chennai market. From the Table 9 the estimates of the short run price integration are presented.

VECM of robusta coffee

In the long run, the significant values of the Vector Error correction estimates of the selected markets exhibits both the positive and negative coefficients. The t statistics greater than 2.00 were considered significant. In the case of the Bangalore market, from the Table 10 showed that the coefficient of the one month (0.329646) lagged Chennai market price was positive and significant and the coefficients of the one month (-0.386237) lagged Hyderabad market price was negative and significant. It reveals that, in the long run Bangalore market price was influenced by one month lag of Chennai market price and one month lag of Hyderabad market price. In case of Chennai market, the coefficient values were not significant and the market was independent. In case of Hyderabad market the coefficients values were also not significant and remained independent. In case of the New York market, the coefficients of the one month (0.356668) lagged by its own price was positive and significant. It reveals that, in the long run the New York market was influenced by its own market price. The consolidated results showed that Bangalore market as lead market because it was only linked with Chennai and Hyderabad. Whereas other markets are linked by only one market.

Table 13. Estimates for the short run price integration in the selected cocoa markets

Cointegrating Eq	CointEq1
ICE(-1)	1.000000
	-4625.825
	(590.988)
ICCO(-1)	[-7.82728]
	0.385846
	(0.15723)
London futures(-1)	[2.45398]
	345.4069
	(330.254)
Thodupuzha(-1)	[1.04588]
	3.321442
	(0.55008)
US futures(-1)	[6.03814]
C	6105608

In the short run, as indicated from the Table 10 indicated that the New York market came to equilibrium as indicated by the level of significance and the speed of the adjustment. From the table 10 it is indicated that any disturbances in the price would be corrected with 38 per cent of New York market as indicated by the coefficients values of the cointegration equation. And the estimates of the short run were presented in the Table 11.

VECM of cocoa

In the long run, the VECM estimates of the selected markets show both positive and negative coefficients values. The t statistics values greater than 1.99 were considered as significant coefficients. As it is obvious from the table 12 that in case of ICE price, the coefficient of one month (-1.051778) lagged by its own price of ICE price was negative and significant and the coefficient of one month (952.2078) lagged price of ICCO was positive and significant. It reveals, that in the long run ICCO were influenced by its own price one month lagged price and ICCO of one month lag. In case of ICCO price, the coefficient of two months (0.000373) lagged price of London futures price showed positive and significant at 5 per cent level. It reveals that in the long run ICCO price was influenced by two months lagged price of London futures price. In case of London and US market, the coefficients were not significant and remained independent. In case of Thodupuzha market the coefficients were not significant and remained independent.

For cocoa, it could be evident from the Table 12 that the coefficients of the markets of cocoa viz. ICE, ICCO, US futures, London futures and Thodupuzha markets showed no significant short run equilibrium.

Conclusion

From the present study the price transmission between domestic and international markets were studied and the following inferences were brought out. The tea auction price of domestic and international markets indicate that there is linkages between them and it can be improved further by considering the retail prices and farm gate prices. The coffee markets of Chennai, Hyderabad and New York markets are linked because it may be due to the presence of Coffee Board in Bangalore. Further the speed of adjustment of the market prices determines the transport time and distance. Cocoa production should be increased to compete to the international markets such as by adopting Post-harvest technology for Re-export of the cocoa beans and price formation process. And also for cocoa marketing system to be well performed, an effective integrated plan should be evolved for getting the biggest profits through the export for India.

References

Ahmed, U.I., Ying L., Bashir M.K., Iqbal M.A., Rizwan M., Mazhar M., Qamar M.R., and Nazeer A., 2015. Spatial Price Transmission in Pakistan: The Case of Wheat and Rice Markets, *Pakistan Journal of Agricultural Research.,* **28(4):** 254-262.

Ajjan, N., Murugananthi D., and Raveendran N., 2012. An econometric analysis of maize and poultry market

integration in India, *Madras Agricultural Journal.,* **99(46)**:397-402.

Akaike, 1973. Maximum likelihood identification of Gaussian autoregressive moving average models. *Biometrika.,* **60(2)**:255-265.

Arshad, F.M. and Hameed, A. 2014. Price transmission in selected malaysian fruits markets. *American Journal of Applied Sciences,* **11(3)**:347-355.

Atkin, M., and Bladford D., 1982. Structural changes in import market shares for apples in the United Kingdom. *European Review of Agricultural Economics.,* **9(3)**:313-326.

Dang, N.V., and Lantican F.A., 2011. Vertical integration of tea markets in vietnam. *J. ISSAAS.,* **17(1):** 208-222.

Gonzalo, V., A.C.Enrique and I.Leonardo. 2012, *Determinants of market integration and price transmission in Indonesia*: The World Bank.

Gujarati, D.N., 2009. Basic econometrics (4-Ed) Tata McGraw-Hill Education, p-1002.

Rumi, M., and Masih A.M., 2001. Long and short term dynamic causal transmission amongst international stock markets. *Journal of international Money and Finance.,* **20(4):**563-587.

Palaskas, T.B., 1995. Statistical analysis of price transmission in the European Union. *Journal of Agricultural Economics.,* **46(1)**:61-69.

Sahito, J.G., 2017. Market Integration of Wheat in Pakistan. *Journal of Agricultural Research.,* **55(3)**:545-556.

Sundaramoorthy, C., Mathur V.C. and Jha G.K., 2014. Price Transmission along the Cotton Value Chain. *Agricultural Economics Research Review.,* **27(2):**177-186.

Worako, T., Schalkwyk H.V., Alemu Z. and Ayele G. 2008. Producer price and price transmission in a deregulated Ethiopian coffee market. *Agrekon.,* **47(4).**

Received : January 17, 2018; Revised : February 26, 2018; Accepted : March 19, 2018