World Black Tea price volatility, Market Linkages among global tea auction markets

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Abstract
The primary determinant of the growth of the global tea economy is demand for the commodity. Tea auction markets refer to market leaders to discover prices and market behaviour. The purpose of the study was to evaluate the degree of integration between the world markets price measured by FAO composite price index and black tea auction markets around the world. The study captures tea price dynamics and evolution of tea prices at the major tea auction markets around the world. The study utilizes monthly tea auction data from 2003 to 2009 to investigate tea price dynamics in order to capture price evolution and volatility .The study found that multivariate cointegration test suggests one common stochastic trend driving all the tea prices, indicating volatility in the prices. Granger causality interestingly shows that most of the tea auction prices have a significant trend and cyclical components. Volatility seems to spill across all tea markets with markets experiencing common shocks, rather than being isolated from each other. The findings of the study indicate that tea agribusiness firms refer to Sri -Lanka prices to make decisions on markets behaviour and are likely to incorporate world price information into planting decisions which will create significant challenges whose implications will lead to oversupply if world consumption of tea does not improve in tandem with increased production. The study uses the current novel methods of testing price cointegration on commodity markets

Keywords: tea price volatility, tea auction markets, Granger causality, Cointegration,

Introduction

Governments in tea exporting countries acknowledge the significance of the tea industry. The sector is a source of export earnings, job creation, infrastructural development and income generation in tea producing countries. Tea processing factories located in rural areas contribute to control of migration to urban areas. A high price of tea creates opportunities for better well-being of millions of farmers and tea agribusiness companies worldwide. Meanwhile according to United Nations food and agricultural Association (FAO, 2010, Tanui., et al.), the increase in export earnings in 2009 at the global level, positively affected rural incomes in all tea producing countries(Tanui., et al. 2012). In 2008, the world experienced a dramatic surge and volatility in the tea prices in the main markets(FAO,2010), the increase was the highest in nearly 30 years. The tea prices later plummeted to the lowest during the world economic crisis in 2008(FAO, 2010; Minot, 2011). It was the period when the tea industry entered a "meltdown" after the auction prices dropped by nearly 60% from the previous prices in September in the same year (Tanui et al., 2012). Recently international tea prices, as measured by the FAO Tea Composite price, increased consistently until 2012.The main determinant of the growth of the global tea economy is demand for the commodity(FAO,2015).

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Global tea prices have recently become an increasingly important topic, according to United Nations food and agricultural Association (FAO, 2010), after long periods of sustained growth, tea production declined, by 0.64 percent, between 2007 and 2009 (FAO, 2010). Consequently, the FAO composite price jumped from 154 US cents/kg in 2003 to 238 US cents in 2008 and peaked at 318 cents/kg in September 2009, the highest price since the FAO Tea Composite price creation in 1989. In fact, after many years of declining in real terms, the price of tea more than doubled between 2003 and 2010. In 2013 the average price fell by 2.5 percent to 279 US cents/kg and further dropped by 5.3 percent in 2014 to 265US Cents/ kg (FAO, 2015). The FAO Tea Composite Price, which is an indicative price for black tea, increased significantly from 2006 to 2012 (FAO,2015), since then FAO report that it has declined to US cents 265 / kg averaged in 2014, which is still considerably higher than prices averaged in the previous two decades.High tea prices are partially disguised risks in volatility in recent years; driven by soaring demand from the emerging economies of China and India(Tanui., et al., 2012). It would take little to tip prices to rollercoaster back down again. In fact, warnings of danger surfaced towards the end of 2008 when tea prices dropped in all the auction markets in the world forcing massive withdrawals of tea and boycotts by buyers. Previous attempts to control supplies of tea through trade and policy interventions at the global level over the years had proved ineffective (FAO, 2005). Planting of tea takes about four years for tea bushes to achieve commercial harvest, this makes it expensive to maintain during the unproductive periods. Apart from increases in China and India, consumption has remained virtually unchanged in other major tea consuming countries.

Literature review

Tea has grown from a medicinal crop in China introduced five thousand years ago to command a multi-billion dollar industry and a critical component of international trade. It is the most famous beverage in the highly populated countries of China and India making tea the second important drink in the world after water (FAO, 2008, Hicks,2009)). Although there are a growing number of countries that produce teas there exist essentially three main types of tea, these are Green, 'Oolong' and Black (Hicks, 2009 Tanui.., et al. 2012). The difference lies in the fermentation process during processing. Green tea is mostly unfermented, Oolong tea is partially fermented, and Black tea is fully fermented(Hicks,2009, Tanui.., et al. 2012). Black tea represents the majority of tea traded internationally and takes about 80% of global tea market (Tanui et al., 2012). Tea is sold primarily in auction markets where prices are quoted in each of these markets at least on a weekly basis. These quotes are prices per kilogram and reflect demand for and supply of various types of tea and different quality characteristics Dharmasena, Senarath and Bessler, David, 2004). Prices may also reflect government interventions. Governments use trade policy instruments such as export taxes, import tariffs, and import quotas in apparent attempts to influence the price and consumption of tea. Such regulations may introduce inefficiencies into the tea market, which in turn may give false signals to producers in future periods. Tea is usually exported after initial processing (drying and bulk packaging) while at retail level tea is sold as a blend from different countries(Tanui.., et al.). The degree to which changes in world tea prices are transmitted to export markets is critical to smallholder farmers, tea estates, agribusiness firms and governments in these countries. Market participants in these countries get anxious when these markets are volatile and unpredictable. Fluctuations in world tea prices happen when price changes in the global

market transmit to domestic markets. Highly unstable and unpredictable prices are detrimental to the health of a sector, as volatility inhibits investment and adjustment to market conditions. It also destabilizes income and savings, thus resulting in reduced capital accumulation and losses in efficiency.

Table 1 Tea production and export in metric tons

Production in Metric Tons					Exports Metric tons				Type of Tea
Country	2010	2011	2012	2013	2010	2011	2012	2013	
China	1475	1633	1790	1925	303.2	322.6	321.8	329.7	Green
India	971	1120	1129	1200	182.7	205.3	199.1	209.2	Black
Kenya	403.3	383	373	436	362.3	347.3	349.9	415.9	Black
Sri Lanka	331	328	328	343	305.8	303.2	306.1	311	Black
Bangladesh	60.0	59.6	63	66.2	0.9	1.5	0.6	0.5	Black
Indonesia	157	151	151	153	87.1	75.5	70.1	70.5	black
Malawi	52	47	43	47	48.9	44.9	41.8	40.5	black
World	4364	4627	4784	5062	1683	1674	1684	1768.5	

Methods

Data sources

Prices for Malawi and Kenya tea markets are obtained from Limbe and Mombasa tea auction centers respectively. Sri Lankan, Bangladesh, and Indonesian and India prices are the average prices of all Indian auctions (

Methodology

If a global tea markets were to be integrated, the prices charged by major exporters of that tea would be expected to move together over time (Goshray, 2010). From an econometric point of view, this would imply that prices of the tea should be cointegrated. Standard cointegration techniques, used in the literature on spatial integration of agricultural product markets, have been criticized because of the grounds that they ignore the potentially important role played by transactions costs by estimating linear models, which are inconsistent with discontinuous trade (Baulch, 1997). The coefficient of variation (CV) and standard deviation are the most common measure of volatility. On market integration using time series data on prices of tea, we use the following relationship:

$$lnP1_t=\alpha+\beta lnP2_t+\varepsilon_t \qquad (1)$$

Where $P1_t$ and $P2_t$ are the logarithms of prices, ε_t is a white noise error term, α represents an intercept which includes the differences between the prices expressed in levels and β is the price transmission elasticity

. This study employs the Augmented Dickey-Fuller (ADF) test for unit roots (Dickey and Fuller, 1981). ADF test was to test the null hypothesis that p_t is non-stationary by calculating the t – statistic for $\beta=0$ in the following relationship.

$$\Delta Pt=\alpha+\beta P_{t-1}+\gamma_t+ \delta\Delta P_{t-k}+\varepsilon_t \qquad (2)$$

Where $\Delta P_t = P_t-P_{t-1}$: $P_{t-k} - P_{t-k-1}$; k = 2,3,...,n; P_t is the price at time t; α, β, γ, and δk are parameters to be estimated, and ε_t is the error term. If the ADF statistic is less than critical values, it shows that p_t is stationary. If non-stationary, the next step is to determine whether Pt is stationary in the first difference {that is, to test $'P_t-'P_t-1 \sim I(1)$}. If the ADF test fails for the null hypothesis, for $P_t \sim I(1)$, then the second step of testing for cointegration is undertaken.

$$\Delta P_t=\alpha+\Phi D_t+ \Gamma i \ \Delta P_{t-1} +\Pi P_{t-n}+\varepsilon_t, \qquad t=1,2\ldots\ldots T \qquad (3)$$

Where $\Gamma i=-I+\Pi 1+...+\Pi I$, for i = 1... n-1, $\Pi=-I+\Pi 1+...+\Pi n$, I a (k x k) identity matrix, ΦD_t is a vector of dummy variables, and α is a vector of intercepts. Therefore, Π contains the possible long-run equilibrium relationship(s) of equation 2. The number of cointegration relationships provided by the rank of the matrix Π (r), and is determined by two asymptotically similar tests: the Trace test and the Maximum eigenvalue test.

The Johansen procedure allows tests on the coefficients α and β, by the use of likelihood ratio (LR) tests (Johansen and Juselius, 1994).

Results

Descriptive statistics

Table 2. Summary of descriptive statistics for tea prices and FAO composite price

	Sri Lanka	Bangladesh	FAO	India	Indonesia	Kenya	Malawi
Mean	221	132	195	149	130.0	184	118
Median	194	118	181	139	124	165	108
Maximum	376	214	318	230	226	299	197
Minimum	143	73.8	144	100	84.9	139	83.0
Std. Dev.	61.2	33.7	44.2	34.7	33.3	41.5	27.5
Skewness	0.72	0.95	1.07	0.59	1.01	1.09	0.90
Kurtosis	2.1	3.0	3.1	2.2	3.5	3.2	2.8
Jarque-Bera	9.10	12.7	16.1	7.40	15.6	16.9	11.5
Probability	0.01	0.001	0.00	0.02	0.00	0.00	0.00
	84	84	84	84	84	84	84

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Observation
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Table 2 provides the summary of descriptive statistics for the prices of the world auction tea markets and FAO composite price. The maximum price during this period was 375 US cents in Sri Lanka for September 2009, followed by FAO composite price at 318 USD for the same period 2009. The largest spread in tea prices is in Sri Lanka with a standard deviation of 61.2, then FAO composite price with 42.99. Both show a high degree of variability in prices and possible volatility while the spread in Malawi, Bangladesh, India and Indonesia spread is lower. It is worth noting that statistical characteristics of the small exporters of tea may suggest that influence on tea prices and price formation is minimal. Positive skewness dominates the results for all tea auction markets, In general, a high positive skewness means episodes of high prices dominate the series. Kurtosis varies from 3.5 to 2.1 for Sri Lanka. A few extreme events explain a possible interpretation of high kurtosis and variability. It could also be a measure of uncertainty.

Table 3. Ranking of Mean, Coefficient of Variation (CV) and Standard deviation (SD)

Country	Mean	Ranking	CV%	Ranking	SD	Ranking
Sri Lanka	221	1	27.7	1	61.2	1
Bangladesh	132	5	25.7	2	33.7	5
FAO	195	2	22.6	5	44.2	2
India	149	4	23.3	3	34.7	4
Indonesia	130	6	25.7	2	33.3	6
Kenya	184	3	22.5	6	41.5	3
Malawi	118	7	23.2	4	27.5	7

In Table 3 we discuss the behavior of each price using the Mean, standard deviation and the Coefficient of variation. Regarding mean, Sri Lanka is leading followed by Kenya, an indication that prices of tea are high and the tea is of good quality in these two main world exporters of tea. All prices except Sri Lanka are below the FAO composite price which is the world reference price for tea. Regarding the standard deviation (SD) and coefficient of variation (CV), Sri Lanka market ranks number. FAO price is number two regarding SD but ranks no five on CV; Similarly, Kenya is number three in SD and number six in CV. Sri Lanka market is leading regarding price volatility. The weakness of using the above summary statistics in the analysis is that they do not incorporate the time series properties of the underlying price series.

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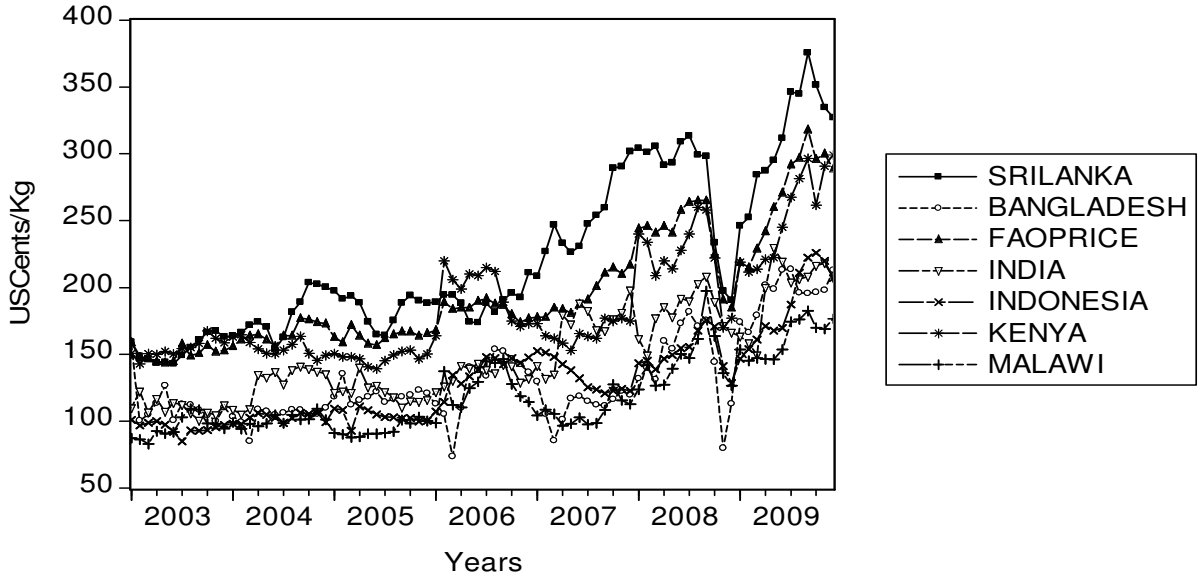

Figure 1. Evolution of Monthly average price for world tea markets for the period 2003 to 2009

During the period under examination, figure 1, tea prices experienced slow growth, for the tea auction export markets from 2003 to 2005 together with some fluctuation up to around 2006.Sri Lanka, FAO, and Kenya are higher than rest of the exporting countries and tend to move together. Prices, Kenya, India, Malawi, Indonesia, and Bangladesh, lie below FAO composite price /world reference prices an indication that prices in the tea auction are below the world reference price. The graph suggests that sale prices for most auction prices in exporting countries under study co-move with the FAO composite reference price. The figure also reveals that prices of tea plummeted towards the end of 2008. Based on FAO composite price fluctuation of tea was maintained through 2003 to 2005 however it picked in 2006 and fell in the first quarter. After that, there was an accelerated growth rate in prices during the 2008 and 2009 period to reach a record 318USdollars in September 2009. The graph shows Bangladesh tea prices wavering from 2006 to 2008. Towards the end of 2008, tea prices dropped drastically; s during the world economic "meltdown."

Table 4. Pairwise correlation matrix between the prices of tea in world tea auction markets

	Sri Lanka	Bangladesh	FAO	India	Indonesia	Kenya	Malawi
Sri Lanka	1.00	0.73	0.95	0.89	0.83	0.82	0.77
Bangladesh	0.73	1.00	0.82	0.70	0.80	0.80	0.80
FAO	0.95	0.82	1.00	0.89	0.90	0.93	0.88
India	0.89	0.70	0.89	1.00	0.83	0.76	0.76
Indonesi	0.83	0.80	0.95	0.89	1.00	0.89	0.88

a			0	3			
Kenya	0.81	0.81	0.93	0.76	0.89	1.00	0.93
Malawi	0.77	0.80	0.88	0.76	0.879	0.93	1.00

Correlation coefficients measure the linear relationship between a pair of tea prices. Results of correlation coefficients show that all tea markets are highly related, with FAO, Sri Lanka and Kenya seemingly showing unyielding high correlation. Malawi and Kenya also demonstrate that they are highly correlated.

Univariate Time Series Properties

The study applied standard augmented Dickey–Fuller (ADF) (Dickey and Fuller 1981) to the data in levels and first differences. Summary of the unit root tests shown in Table 5. For each data set, we cannot reject the null of a unit root though dismissed in first differences. All the unit root tests confirm that the price series are non-stationary I (1).

Table 5 Unit root test

Price	Levels	First difference
Sri Lanka	-1.21	-7.13**
Bangladesh	-1.87	-8.39**
FAO	-0.22	-7.59**
India	-1.47	-7.83**
Indonesia	-0.06	-7.20**
Kenya	-0.77	-8.55**
Malawi	-1.50	-8.52**
SriLanka	-1.21	-7.13**

** And * denote rejection of the null hypothesis at the 1% and 5% significance levels. The results of the ADF test, considering the suggested lag lengths in Table 5, show that at the 1% and 5% critical values of -3.49 and -2.88, the null hypothesis of a unit root. We conclude that all seven log Tea price series are non-stationary.

Cointegration test of log world tea prices between 2003 and 2009

Table 6a Results from bivariate Trace and Maximum eigenvalues

	Trace Test		Max eigen	
Price relationships	H=0	H=1	H=0	H=1
Bangladesh-FAO Price	12.4	0.43	11.9	0.43
Bangladesh-India	9.69	0.32	9.35	0.32
Bangladesh-Indonesia	16.7*	0.23	16.5*	0.23
Bangladesh--Kenya	14.4	0.02	14.4	0.02
Bangladesh-Malawi	17.1*	0.05	17.1*	0.05
Bangladesh-Sri Lanka	9.33	1.00	8.32	1.00
FAO-India	18.9*	0.59	18.3*	0.60
FAO-Indonesia	5.89	6.03E-10	5.88	6.03E-10
FAO-Kenya	11.2	3.13	8.09	3.13
FAO-Malawi	9.07	0.88	8.19	0.88
FAO-Sri Lanka	10.1	1.61	8.49	1.60
India-Indonesia	9.17	0.07	9.03	0.07
India-Kenya	9.57	0.12	9.44	0.12
India -Malawi	9.69	0.59	9.10	0.59
India –Sri Lanka	26.5**	0.72	25.8**	0.72
Indonesia -Kenya	8.19	0.26	7.926	0.26
Indonesia -Malawi	9.57	0.05	9.52	0.05
Indonesia-Sri Lanka	6.30	0.05	6.26	0.05
Kenya -Malawi	17.5*	0.02	17.4*	0.02
Kenya-Sri Lanka	10.7	2.41	8.25	2.41
Malawi-Sri Lanka	8.62	1.26	7.35	1.26

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*Indicates rejection at the 5% level
** Indicates rejection at the 1% level
Note: 1. For the trace test:
At H_0 (r=0), the 5% critical value is 15.49 and the 1% critical value is 19.94
At H_0 (r≦1), the 5% critical value is 3.84, and the 1% critical value is 6.63
2. For the maximum eigenvalue test,
At H_0 (r=0), the 5% critical value is 14.26 and the 1% critical value is 18.52
At H_0 (r≦1), the 5% critical value is 3.84, and the 1% critical value is 6.63

Table 6b. Multivariate cointegration test
Cointegration Rank Test (Trace)
Ho:no cointergration

	Max Eigen value	Trace Statistic	0.05 Value	Critical Value	Prob.**
None *	0.457772	152.1371	125.6154		0.0004
At most 1 *	0.336201	102.5595	95.75366		0.0157

Regarding bivariate cointegration test, results indicate that pairs of Bangladesh and Malawi, Bangladesh, and Indonesia, FAO and India, Kenya and Malawi, are all integrated at 5% level, only India, and Sri Lanka pair show cointegration at 1%levels. Furthermore, multivariate cointegration test in Table 6 b suggests one cointegrating equation for both trace test none for maximum eigenvalue at 5% level. Suggesting that there is one common stochastic trend driving all the tea prices which are probably volatility in the current prices and by extension implies that in the long run, the prices converge to equilibrium. We can infer from the results that there is no long-run cointegration relationship between FAO composite price and most tea auction prices except for Indian pair, confirming that FAO composite index does not seem fully integrated with auction tea prices.

Granger causality test
Table 7 Tests of Granger-causality on tea prices, 2003 to 2009
H0: no causality, 2 lag, N=43

Exogenous	Endogenous	F-statistics	Probability
Bangladesh	SriLanka	0.34	0.709
SriLanka	Bangladesh	2.70	0.073*
FAO	SriLanka	0.626	0.537
SriLanka	FAO	2.71	0.072*
India	SriLanka	1.891	0.157
SriLanka	India	11.96	3.0E-05*
Indonesia	SriLanka	0.609	0.546
SriLanka	Indonesia	12.48	2.0E-05*
Kenya	SriLanka	1.68	0.192

SriLanka	Kenya	3.61	0.03*
Malawi	SriLanka	1.150	0.32
SriLanka	Malawi	3.00	0.05*
FAO	Bangladesh	3.612	0.031*
Bangladesh	FAO	0.400	0.67
India	Bangladesh	2.928	0.059*
Bangladesh	India	0.763	0.46
Indonesia	Bangladesh	2.89	0.06*
Bangladesh	Indonesia	4.50	0.01*
Kenya	Bangladesh	2.31	0.105
Bangladesh	Kenya	1.66	0.195
Malawi	Bangladesh	2.14	0.123
Bangladesh	Malawi	5.38	0.006*
India	FAO	2.01059	0.140
FAO	India	7.12626	0.001*
Indonesia	FAO	0.056	0.945
FAO	Indonesia	16.94	8.0E-07*
Kenya	FAO	2.126	0.126
FAO	Kenya	4.726	0.011*
Malawi	FAO	3.57	0.032*
FAO	Malawi	9.00	0.0003*
Indonesia	India	4.17	0.018*
India	Indonesia	1.46	0.237
Kenya	India	2.43	0.094*
India	Kenya	4.50	0.014*
Malawi	India	1.34	0.266
India	Malawi	4.85	0.010*
Kenya	Indonesia	9.69	0.0001*
Indonesia	Kenya	1.18	0.311
Malawi	Indonesia	4.63	0.012*
Indonesia	Malawi	2.16	0.121
Malawi	Kenya	0.78	0.458
Kenya	Malawi	12.50	2.0E-05*

The results of Granger causality test reported in Tables 7 reveal that there are real significant volatility causality from the Sri Lanka to Bangladesh market and not vice versa. Results indicate co-movement information flows from Sri Lanka market to Bangladesh tea auction market between prices. Similarly, there is positive volatility transmission from Sri Lanka to Kenya and not vice versa. Further results also confirm that there is no reverse volatility from Sri Lanka to India, Indonesia and Malawi suggesting that volatility is transmitted to these countries and not vice versa. Granger causality results also indicate that FAO volatility influences India, Kenya, Malawi, Indonesia and Bangladesh auction markets and not vice versa, there was no volatility between Kenya and Bangladesh. We have bidirectional between FAO and Malawi and between Kenya and Malawi and also between Indonesia and Bangladesh. Overall, these results indicate that Colombo auction market in Sri Lanka and FAO prices are exporting their volatility to all auction markets. Finally volatility in the African markets of Mombasa in Kenya and Limbe in

Malawi tend to be bi-directional, supporting the fact that most of the Tea from Malawi is sold in Mombasa auction as opposed to Limbe auction centre Malawi (Tanui et al., 2012) Using monthly data, the results indicate that nearly all commodities have significant trend and cyclical components. Volatility seems to spill across all tea markets with markets experiencing common shocks, rather than being isolated from each other.

Conclusions, Implications, and Limitation for the tea industry

Results from the study suggest that transmission of volatility is evident in all tea markets under study either of the international tea price or across linkages in the integrated tea auction markets, especially from Sri Lankan market. Granger causality can be interpreted to suggest that the market side facing the greatest level of uncertainty is likely to produce the exogenous price (Schroeter and Azzam, 1991). In the tea industry, supply is the natural candidate for such uncertainty, the variability in supply, subject to many substitutes with cheaper tea products. Tea can be considered as having a share of the soft drink/beverages market, as well as having functional food potential. On the demand side, tea occupies a small proportion of the consumer's budget. Up to a certain level of demand, tea is sensitive to changes in price and income. Superimposed on this there may be a tendency to shift from common to better quality teas as income increases. However, consumer preferences for beverages are somewhat fixed and switching from one beverage to the other may take place over an extended period. The ability to vary output in the short run is an important feature of tea production, which distinguishes it from other plantation crops. When prices reach rock bottom, the output control should be encouraged through resorting to plucking high-quality raw material for processing.High prices, on the other hand, encourage coarser plucking. This relatively high short-run price elasticity implies that producers can react more quickly to situations of overproduction and excesses in stocks. It is through this instrument that the efforts at price control have sought to operate. On the demand side, a concerted effort through marketing increase consumption. Exchanging information and views between producers and consumers, as well as public and private sectors, could promote greater market transparency. Some of the main reasons for limited production of orthodox tea are the inadequate capacity to produce and higher cost of production of orthodox tea vis-à-vis CTC tea. Tea Boards in the respective countries should balance the production of the two types of tea through the introduction of Orthodox Subsidy Schemes. Tea related organizations in black tea producing countries should work toward the realization of production of high-quality tea as well as expand production bases of orthodox teas. The main limitations of the study are that we covered only tea producing countries with functional tea auction markets. Other famous tea producing countries, such as China, Vietnam, Argentina, and Turkey among others also produce tea in large quantities but do not have auction markets and were therefore not included, the other limitation related to econometric procedures applied highlighted in each methodology used.

References

Alexander, C., and Wyeth, J. (1994). Cointegration and market integration: An application to the Indonesian rice market. *Journal of Development Studies,* Vol.30 No,2, pp.303-334.

Bacon, C. (2005). Confronting the Coffee Crisis: Can Fair Trade, Organic and Specialty Coffee Reduce Small-Scale Farmer Vulnerability in Northern Nicaragua? *World Development*, Vol. 33 No3, 497-511.

Dickey, D.A. and W.A. Fuller. (1981). Likelihood ratio statistics for autoregressive time series with a unit root. *Econometrica* ,Vol.49,pp. 1057-72.

Engle, R.F., and C.W.J. Granger. (1987). Cointegration and error correction: Representation, estimation, and testing. *Econometrica,* Vol.49 No2pp. 251-76.

Fackler, P. L., and Goodwin, B. K. (2001). Spatial price analysis. *Handbook of agricultural economics,* Vol. 1 pp. 971-1024.

FAO. 2012. Report of the nineteenth session of the intergovernmental group on tea' Colombo, Sri Lanka, Current situation and medium outlook retrieved March 16th, 2017 from http://www.fao.org/economic/est/est-commodities/tea/tea-meetings/teaigg20/en/;

FAO. 2005. Committee on commodity problems, an intergovernmental group on tea "Tea market studies." Retrieved March 16th, 2017, from http://www.fao.org/unfao/bodies/ccp/tea/2004/tea04_en.ht

FAO. 2008. Committee on commodity problems, an intergovernmental group on tea "Current situation and medium outlook." Retrieved March 16th, 2017, from ftp://ftp.fao.org/docrep/fao/meeting/013/k1755e.pdf

FAO. 2010. Committee on commodity problems, an intergovernmental group on tea, "Market development and outlook." Retrieved March 16th, 2017, from http://www.fao.org/docrep/meeting/018/K7503E.pdf

FAO. 2015. Committee on commodity problems, an intergovernmental group on tea, Retrieved 16th March 2017,"Market development and outlook: http://www.fao.org/3/a-i4480e.pdf

Ghoshray, A. (2010). The extent of the world coffee market. *Bulletin of Economic Research*, Vol. 62No1, pp. 97-107.

Ghoshray, A. and M. Ghosh. (2011). How integrated is the Indian wheat market? *Journal of Development Studies*Vol. 47 No10,pp .1574-94

Hicks, A. (2001). Review of Global Tea Production and the Impact on Industry of the Asian Economic Situation. : Asian Int. Tea Conf. '98, Singapore, 1-2 October 1998.

Johansen, S., and Juselius, K. (1994). Identification of the long-run and the short-run structure an application to the ISLM model. *Journal of Econometrics,* Vol. 63 No1, pp. 7-36.

Johansen, S., and Juselius, K.(1990). Maximum likelihood estimation and inference on cointegration-with applications to the demand for money. *Oxford Bulletin of Economics and Statistics,* Vol.52 No2,pp.169-210.

Knetter, M. M. (1992). International comparisons of pricing to market behavior. Cambridge, MA: National Bureau of Economic Research.

Krugman, P.R., and M. Obstfeld. 2009. International Economics: Theory and Policy. 4 ed: Addison-Wesley.

Mackinnon, J.G., A.A. Haug and L. Michelis. (1998). Numerical distribution functions of likelihood ratio tests for cointegration. *Journal of Applied Econometrics,* Vol 14, pp. 563-57.

Minot, N. (2011). Transmission of world food price changes to markets in sub-Saharan Africa. Washington, IFPRI 34

Srilanka tea board reports .2010. Retrieved March 16th, 2017, fromhttp://www.pureceylontea.com

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Tanui, J., W. Fang, W. Feng, P. Zhuang and X. Li. (2012). World black tea markets: Relationships and implications for the global tea industry, *Journal of International Food and Agribusiness Marketing*. Vol. 24,pp.1–21