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A STUDY ON INTEGRATION OF BLACK PEPPER (*PIPER NIGRUM* L.) IN DOMESTIC AND INTENATIONAL MARKET

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ABSTRACT

Market integration is one of the most important aspects that can be used to assess the impacts of market development and liberalization policies. This paper seeks to determine the existence of integration among the Domestic and International black pepper markets. By using Engle-Granger Test, examined the causality by Granger Causality tests and also captures the speed of adjustment to deviations in long run equilibrium by using Error Correction Model. Secondary data was obtained for average monthly prices of black pepper from January 2000 to December 2012.The result revealed that the Domestic and International markets were co-integrated. The Pairwise Granger causality test results were found that there exists unidirectional causality between the Domestic and International markets. Error correction coefficient was significant and its sign was negative, which implied that the domestic market price corrects to its previous period's disequilibrium by 14.63 per cent. Nowadays, market-based instruments such futures and options hedging, are advocated as efficient and effective alternative to mitigate the price instability. Besides of challenges such transaction costs, exchange rate risk, and the basis risk, arising when one attempt to use markets located in New York and London to hedge her outputs price from a developing country, there is a need to account for the role of changing macroeconomic policy.

Keyword: Co-integration**,** Granger Causality, Error Correction Model, Black pepper.

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Introduction

India is known as the "Home of Spices" and produces a wide variety of spices like black pepper, cardamom (small and large), ginger, garlic, turmeric, chilli, *etc*. It is the largest producer, consumer and exporter of spices and spice products. Out of the 109 spices listed by the ISO, India produces as many as 75 owing to its varied agro climatic regions. Almost all the States and Union Territories (UTs) of the country grow one or the other spices. In the World Spice Trade, India acquires 48 per cent of the global export volume and 44 per cent of the export value. They exports more than 0.40 million tonnes of spices annually. Over the years, imports of spices are steadily growing. All this shows that spice production in India holds a prominent position in the world spice production. Entrepreneurs from all over the world are exploring the opportunities in this area. The Government, both at the Centre and the State level, has undertaken several measures and initiatives for the sound development of the spices industry (Spices Fundamental Report, 2012).

Black pepper (*Piper nigrum* L.) famous as "Black Gold" and also known as "King of Spices" is one of the important agricultural commodities of commerce and trade in India since pre-historic period. India is one of the largest producers of black pepper, after China and Vietnam. Black pepper has played a pivotal role in India's International trade and it is said that the Europeans came to India primarily for this spice. A wide variety of black pepper is traded at an International level, with India as one of the top five exporters of black pepper, along with Vietnam, Indonesia, Brazil and Malaysia (Trade and Development Report, 2012). The black pepper price plays important role in black pepper export in India. It has been observed that India has hardly managed to export 9,500 tonnes of pepper during the January-June of 2014. The Indian price was higher by $3,000 per tonne than Vietnam's quotes which literally have drove India out of the International market of the spice this year. At the same time, Indian manufacturers of value added products depend mainly on imported pepper. North Indian markets also have sold imported pepper, as it has been cheaper compared to the local grades. During this year, Vietnam is reported to have a total production of around 1,50,000 tonnes while India's production confine to less than 35,000 tonnes. The leverage of large scale production and productivity help Vietnam growers to offer world's lowest price tags. U.S. market continues to be the largest importer of pepper from Vietnam with 22,632 tonnes during January - June period of the current year. According to Vietnam Pepper

Association Report, it has been found that Vietnam's pepper exports can fetch a record US$1 billion this year and it will export around 1,40,000 tonnes of the spices.

Market integration concept explains the relationship between the prices in the two or more markets that were spatially separated. When markets were integrated it implies that the markets in the system operate in unison, as a single market system. Markets which were spatially price efficient rules out the possibility of profits through arbitrage, as the profits gradually get absorbed because of competition. If two regions were engaged in trade in a commodity, the prices in each regions/markets will be same after necessary adjustments were made for transfer cost and if necessary exchange rate, then it considered that law of one price (LOP) was operating between markets. In the present study, co-integration analyses were employed to findout the nature of relationship between domestic and export market prices. Co-integration was regarded as the empirical counterpart of the theoretical notion of a long run relationship between two or more variables.

Presently, the majority of the studies used the econometric techniques of time series to test the integration of the markets. The development of these techniques, which include the co-integration and the correction of errors models, became the standard tools to analyse the spatial relations of the markets, thus repalcing the old empirical tools, such as the regression and correlation coefficient. Although the time series models for the market integration analysis are criticised, it is significant to notethat they provide excellent results concerning the question of the integration of the markets and the transimission of the prices if a methodological framework of suitable test is used and correctly interpreted the results. Moreover, the models of the time series require less data compared to other econometric models, by considering only the series of price data easily available in the developing countries (Rapsomanikis *et al*. 2003).

The analysis of prices and market arrivals over time is important for formulating a sound pricing policy.Fluctuations in market arrivals argely contribute to the price instability of black pepper.The transition in commodity exchanges also plays an important role on the spot price of black pepper as it gives some indication of future price. In order to reduce the instability in price fluctuations of black pepper, there is a need to have a thorough understanding of the price behaviour over time and over space. The long run equilibriums between the market prices of black pepper are indicated by the Error Correction Model

(ECM) for the non-stationary individually with a long run relationship in the time series data. Hence, the present study was an attempt to assess the market integration of black pepper in

Data

The data relating to monthly prices of black pepper from January, 2000 to December, 2012 were taken for co-integration analysis which checked the integration of domestic market (Cochin) and International market (New York) prices.

Methodology

Market Integration

Eviews software was used for this study. Testing stationarity is a pre-requisite before analysing any time series data. Econometric relation between the time series has trend components. Augumented Dickey-Fuller (ADF) test involved testing for stationarity of the variables. 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 in the following form:

$$\Delta Y_t = \beta_0 + \beta_1 \Delta Y_{t-1} + e_t$$

ΔY_t predict the change in y at t from the level at t-1. Y_i denote the price series of Domestic and International black pepper prices (MG1 Cochin and MG1 New York).

If the coefficient β is not statistically different from zero, it implies that the series have a unit root, and therefore the series is non-stationary. To verify that the first differenced price series is indeed stationary, ADF unit root tests are used. The null hypothesis of non-stationary is used using a t-test. The null hypothesis is rejected if the estimated variable is significantly negative.

Co-integration

Co-intergation was said to exist between non-stationary variables if their linear combination, namely the residuals of the co-integrating regression were stationary (Hendry and David, 1986; Engle & Granger, 1987). The test for the order of integration of each variable in the model was to establish whether the time series was non-stationary and how many times the variable needs to be differenced to result in a stationary series. However, first differencing was not an appropriate solution to the non-stationarity problem and it prevents detection of the long run relationship that may be present in the data, i.e. the long-run information was lost, which was precisely the main question being addressed.The concept of

co-integration mimics the existence of a long-run equilibrium to which an economic system converges over time, and u_t defined above could be interpreted as the disequilibrium error (*i.e.* the distance that the system was away from equilibrium at time t).

An approach to testing for co-integration was to construct test statistics from the residuals of a co-integrating regression in levels mostly using Engle-Granger and Augmented Engle Granger tests. In testing for co-integration, the ADF test was applied to the residuals of the co-integrating regression rather than the level of the series. If the residuals of the bivariate or multivariate co-integrating regressions were found to be stationary, implying co-integration. The second step of the Engle-Granger two-step method was the error correction model.

Engle-Granger Co-integration test

Engel-Granger (1987), the co-integration regression between Y_t and X_t could be specified as:

$$Y_t = \alpha_0 + \alpha_1 X_t + \varepsilon_t \quad \ldots\ldots\ldots\ldots\ldots\ldots (1)$$

where Y_t and X_t were two price series in levels and ε_t was the residual term. Testing for co-integration implies testing stationarity of the residual term ε_t. In the current study, the dependent variable Y_t was domestic market prices of black pepper and the independent variable X_t was International market price. The residuals of the co-integration equation (1), $\varepsilon_t = (Y_t - \alpha_0 - \alpha_1 X_t)$ a linear difference of the non-stationary series (i.e., $Y_t - X_t$).

The ADF test equation based on the residuals was given as:

$$\Delta\hat{\varepsilon}_t = \varphi + \beta\hat{\varepsilon}_{t-1} + \sum_{i=1}^{j} \lambda\Delta\hat{\varepsilon}_{t-j} + \nu_t \quad \ldots\ldots\ldots\ldots\ldots\ldots (2)$$

The test statistic, as indicated earlier, was a t-ratio for $\beta = 0$. If this null hypothesis cannot be rejected against the alternative that $\beta < 0$, then the variables are not co-integrated, on the other hand if the null hypothesis was rejected then the conclusion would be that the estimated ε_t was stationary (i.e., does not have a unit root). In our estimation, bivariate co-integrating regressions were carried out between the domestic and International price of black

pepper to establish the existence of long-run co-integrating relationship. In the current study, the dependent variable Y_t is domestic price of black pepper and the independent variable X_t is International price.

Granger Causality Test

Co-integration between two variables implied that the existence of causality between them in at least one direction (Granger, 1988). Co-integration itself cannot be used to make inferences about the direction of causation between the variables. The Granger causality test provides additional evidence for the presence and as direction of price transmission occurring between two series. If two markets were integrated, the price in one market, P_D, would be found to granger cause the price in the other market, P_I and/or vice versa. The test involves estimating the following pair of regressions

$$P_{Dt} = \sum_{i=1}^{n} \alpha_i P_{I\,t-i} + \sum_{j=1}^{n} \beta_j P_{D\,t-j} + u_{1t} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots.. (3)$$

$$P_{It} = \sum_{i=1}^{n} \lambda_i P_{I\,t-i} + \sum_{j=1}^{n} \delta_j P_{D\,t-j} + u_{2t} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots. (4)$$

Unidirectional causality from P_{It} to P_{Dt} was indicated if the estimated coefficients on the lagged P_{It} in the first regression were statistically different from zero as a group and the set of estimated coefficients in lagged P_{Dt} in (3) was not statistically different from zero. Conversely, unidirectional causality from P_{Dt} to P_{It} existed if the set of lagged P_{It} in the first regression was not statistically different from zero and the set of lagged P_{Dt} coefficients in (3) were statistically different from zero. Bilateral causality was suggested when the sets of P_{It} and P_{Dt} coefficients were statistically different from zero in both the regressions. When the sets of both the coefficients were not statistically significant in both the regressions, independence is suggested.

Error correction Mechanism (ECM)

An Error Correction Model (ECM) was a neat way of combining the long run, co-integrating relationship between the level variables and the short run relationship between the first differences of the variables. It also had the advantage that all the variables in the

estimated equation were stationary; hence there was no problem with spurious correlation. The last step in co-integration analysis involved application of error-correction mechanism. Since the procedure of differencing results in loss of valuable long-run information in the data, an error correction (EC) term was introduced in the theory of co-integration that integrated short run dynamics of a series to its long run value. The residuals obtained from the linear equation were introduced as explanatory variable into the system of variables in level. The error correction term, thus captured the adjustment towards long-run equilibrium.

Engle and Granger (1987) demonstrated that once a number of variables were found to be co-integrated, then there exist a corresponding error correction model relationship, which implied that changes in the dependent variable were a function of the level of disequilibrium in the co-integrating relationship (captured by the error correction term) as well as changes in other variables.

If the price series were I (1), then one could run regression in their first differences. However, by taking first differences we lose the long run relationship that was stored in the data which implied that use of variables in levels as well. Advantage of error correction methodology was that it incorporates variables both in their levels and first differences. By doing this, ECM captures the short run equilibrium situations as well as the long run equilibrium adjustments between prices. Even if one demonstrates market integration through co-integration, there could be disequilibrium in the short run. i.e., price adjustment across markets might not happen instantaneously. It might take some time for the spatial price adjustments. ECM can incorporate such short run and long run changes in the price movements. A generalized ECM formulation to understand both the short run and long run behaviour of prices could be considered by first taking the Autoregressive Distributed Lag (ADL) equation as follows:

$$Y_t = a_{01}X_t + a_{11}X_{t-1} + a_{12}Y_{t-1} + \varepsilon_t$$

By adding and deleting Y_{t-1}, $a_{01} X_{t-1}$, rearranging terms and using the difference operator, the above equation could be written in the ECM format as follows:

$$\Delta Y_t = a_{01}\Delta X_t + (1-a_{12})\left[\frac{a_{01}+a_{11}}{1-a_{12}}X_{t-1} - Y_{t-1}\right] + \varepsilon_t$$

The generalized form of this equation for k lags and an intercept term was as follows:

$$\Delta Y_t = a_{00} + \sum_{i=0}^{k-1} a_{i1}\Delta X_{t-1} + \sum_{i=1}^{k-1} a_{i2}\Delta Y_{t-1} + m_0[m_1 X_{t-k} - Y_{t-k}] + \varepsilon_t$$

$$\text{where, } m_0 = (1 - \sum_{i=1}^{k} a_{i2}) \qquad \text{and} \qquad m_1 = \frac{\sum_{i=0}^{k} a_{i1}}{m_0}$$

If all the variables were I (1), i.e., they were integrated of order 1, they were stationary in first difference. Therefore, all the summation in the above equations were also stationary. Moreover, if the variables were co-integrated, the ECM term *i.e.* the linear combination of variables represented in parentheses was also stationary. The a_{ij} coefficients captured the short run effects and m_j coefficients represent the stationary long run impacts of the right hand side variables. The parameter m_0 measures the rate of adjustment of the short run deviations towards the long run equilibrium. Theoretically, this parameter lies between 0 and 1. The value 0 denoted no adjustment and 1 indicated an instantaneous adjustment. A value between 0 and 1 indicated that any deviations will have gradual adjustment to the long run equilibrium values. The black pepper prices were assumed to be integrated because of Indian black pepper market was integrated with global market. In view of that, the price linkages between the domestic market price and the International market price of black pepper were studied through co-integration and ECM approach.

Results and Discussion

Market Integration

The Augmented Dickey Fuller (ADF) based unit root tesrt procedure was done to check whether the price series of black pepper in MG1 Cochin and MG1 New York markets are stationary.It could be inferred that the p-values for the coefficient of the price of black pepper in the domestic and International market were insignificant at 5per cent level of significance. The null hypothesis of unit root was therefore accepted. The price of black pepper in two markets therefore had a unit root. The result indicated that the price of black pepper in two markets was not stationary and that the price of the previous period influenced the current price of black pepper. However, the Augmented Dickey Fuller (ADF) test statistics for the first differences of the price series for all markets were significant at 99 per cent confidence level. This showed that differencing the price data once made it stationary. Hence it was said to be integrated of order one process, denoted as I(1). It was inferred from

the Table 1 that the coefficients of the first difference of the price of black pepper in two markets (domestic and International) were significant at five per cent significance level. Therefore, the null hypothesis of unit root was rejected since the difference was significantly different from zero. The first difference of the price of black pepper in two markets was stable. The stability of the price of black pepper in two markets at first differentials explained that the price series was autoregressive integrated of order one process. The first difference of the price of black pepper in the two markets was therefore used to conduct co-integration analysis since they were stable. Stationarity test for the first difference of the price of black pepper in two markets indicated that the first difference of the price were stationary.

Table 1. Stationarity test for the first difference of black pepper price

Dependent Variable : $\Delta(\Delta MGC_t)$				
Markets	**Variables**	**β**	**Std.Error**	**t-Statistics**
MG1 Cochin	Constant	0.9325	0.9784	0.9531
	ΔMGC_{t-1}	-0.8929**	0.0812	-11.0008
Dependent Variable : $\Delta(\Delta MGN_t)$				
MG1 New York	Constant	0.6648	1.0488	0.6339
	ΔMGN_{t-1}	-0.7156**	0.0778	-9.1962

Note: * Significant at 5 per cent, **significant at 1 per cent
$\Delta(\Delta MGC_t)$ –Second difference of lagged MG1 Cochin price
$\Delta(\Delta MGN_t)$– Second difference lagged MG1 New York price

Engle-Granger co-integration test

In the co-integration approach, Engle Granger and Augmented Engle Granger tests were used to construct test statistics from the residuals of a co-integrating regression in the levels. It was inferred from the Table 2 that the coefficient of the lagged residual of domestic price with respect to International price was significant at one per cent level of significance.

Table 2. Estimates of co-integration test between Domestic and International price of black pepper

Variables	**β**	**Std.Error**	**t-Statistics**	**Decision**
Constant	0.115501	0.725038	0.159304	Co-integrated
ε_{t-1}	-0.195203**	0.048712	-4.007333	

** Significant at 1 per cent

Since the coefficient of the lagged residuals (ε_{t-1}) was significant at one per cent significance level, the null hypothesis of a unit root was rejected. According to Engle and Granger (1987), the presence of co-integration between the two series was indicative of non-segmentation between the two series. The first step yielded the result of non-stationarity of the price of black pepper in both domestic and International markets. Whereas the second step resulted in the absence of the unit root in the residuals of regression between the domestic and International price of black pepper.

In nutshell, monthly data pertaining to domestic (Cochin) and International (New York) market price of MG1 garbled black pepper were taken for the period from January, 2000 to December, 2012 in co-integration analysis. It was concluded that these two markets were co-integrated.

Error Correction Model for Black Pepper Price

The Error Correction Mechanism (ECM) was used to estimate the acceleration speed of the short-run deviation to the long-run equilibrium. The results were furnished in the Table 3. The advantage of ECM as that it allowed for the short-run dynamics as well as an assessment for the degree towards the long-run relation as shown by co-integration.

Table 3. Error Correction Model (ECM) for domestic and International black pepper price

Dependent Variable: ΔMGC_t			
Variable	**Coefficient**	**Std. Error**	**t-Statistic**
C	0.3851	0.6609	0.5827
ΔMGN_t	0.6741**	0.0501	13.4668
ε_{t-1}	-0.1463**	0.0451	-3.2429
R-squared		0.544724	
Adjusted R-squared		0.538733	
Durbin-Watson		1.859377	

Note: **significant at 1 per cent
ΔMGC_t-Difference of MG1 Cochin price
ΔMGN_t– Difference of MG1 New York price

It was further observed that the price of black pepper in domestic market was found crucial in determining the price of black pepper in International market. As shown, the

coefficient of the first difference of the price of black pepper in domestic market was significant at one per cent level of significance. Consequently, the residual was also significant at one per cent significance level. The residual was therefore included as an extra explanatory variable in the model due to its significance. The constant was insignificant indicating that the price as well as the demand of black pepper in the two markets (domestic and International) did not in any occasion throughout the study hit the zero level. No zero monthly price of black pepper was recorded. The coefficients of the error-correction estimate indicated the speed of adjustment at which the price series returns to the equilibrium. The error correction coefficient -0.1463 was significant and its sign was negative, which implied that the domestic market price corrects to its previous period's disequilibrium by 14.63 per cent. It is also evident from the analysis that the absolute value of error correction term had been higher indicating that the price had the tendency to find equilibrium at a faster rate in the long-run. The ECM for the domestic and International black pepper price was then specified as follows:

$$\Delta MGC_t = 0.3851+0.6741\Delta MGN_t -0.1463\,\varepsilon_{t-1}$$

where ΔMGC_t and ΔMGN_t are the first difference of the price of black pepper in domestic and International market respectively, whereas ε_{t-1} is the lagged residuals. From equation 1, it could be explained that a unit rise of the price of black pepper in domestic market was explained by 0.6741 percent rise in the price of black pepper in International market.

Pair-wise Granger causality test

Granger causality was also estimated between pairs of domestic and International markets of black pepper. Granger causality tests provided additional evidence as to whether and in which direction, price transmission is occuring between two price series. The co-integration analysis proved that the markets are integrated and that there is granger causality atleast in one direction.

Granger causality test results were furnished in the Table 4. It was found that there existed unidirectional causality. The test for black pepper proved that the MG1 Cochin ganger caused the MG1 New York which suggested causality from domestic to International market for Malabar garbled black pepper**.**

Table 4. Pair-wise Granger causality test for black pepper price

Null Hypothesis:	F-Statistic	Prob.	Direction
MG1 New York does not Granger Cause MG1 Cochin	0.39555	0.5303	Unidirectional
MG1 Cochin does not Granger Cause MG1 New York	5.67764	0.0184	

Conclusion

Results of Engle-Granger co-integration tests revealed that the Domestic and International markets of black pepper were integrated of order one. From the results of the Error Correction Model, the coefficients of the error-correction estimate indicated the speed of adjustment at which the price series returns to the equilibrium. The pairwise Granger Causality Test for Domestic and International markets has unidirectional causality. The test for black pepper proved that the MG1 Cochin ganger caused the MG1 New York which suggested causality from domestic to International market for Malabar garbled black pepper**.** In the 1970's, International commodity agreements and marketing boards have unsuccessfully attempted to stabilize the black pepper price. Nowadays, market-based instruments such futures and options hedging, are advocated as efficient and effective alternative to mitigate the price instability. Besides of challenges such transaction costs, exchange rate risk, and the basis risk, arising when one attempt to use markets located in New York and London to hedge her outputs price from a developing country, there is a need to account for the role of changing macroeconomic policy. Formation of Pepper FPOs will provide them to explore the alternate marketing options like online marketing or through commodity exchanges for better price realization. Thus the black pepper industry will help the country to achieve its goal of more than 10 per cent growth rate in GDP and to sustain the same**.**

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