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Price Behaviour and Market Integration in Turmeric - Evidences from Empirical Analysis

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This paper provides an insight into the price behavior of turmeric in Tamil Nadu by analyzing the price data of 26 years (1986-2012) to trace the presence of price cycles using Bry-Boschan algorithm. Market integration in three major turmeric production and marketing centers of South India namely, Erode, Nizamabad and Duggirala was analysed by using Johansen's multiple co integration framework. The hypothesis of declining trend in prices was not found in turmeric price and in contrast , a positive trend was observed. Turmeric price exhibited a cyclical behavior with a length of 5 years approximately (peak to peak). Length of the price cycle was not dependent on the percentage change of price within a cycle. The time spent in slump was higher than the time spent in boom for turmeric. In this case, price cycles had a consistent shape, which provided scope for forecasting turmeric price. The study also found the existence of better integration between the three selected markets. Considering the price cycles and forecasted price, suitable guidelines could be formulated to minimize the loss to the farmers due to price fluctuations. Since all the selected markets exhibited market integration, the policies could be generalized for major production centers as well.

Keywords: Turmeric, Price cycle, Bry-Boschan, Co integration, policy

Turmeric is cultivated in 1.94 lakh hectares in India during 2010-11, which led to a total production of 8.92 lakh tonnes. Andhra Pradesh has been the leading producer among the States with an average area of 64000 ha (36 per cent) followed by Tamil Nadu with an area of 30,530 ha (16 per cent).The production was the highest in Andhra Pradesh (30.25 per cent) followed by Tamil Nadu (13.23 per cent) and Karnataka (6.22 per cent). Productivity of turmeric was the highest in Tamil Nadu, *viz*., 4.5 tonnes per ha (in terms of cured rhizomes). During 2011, India has exported about 67,000 tonnes of turmeric to the United Arab Emirates (UAE), United States of America, Bangladesh, Japan, Sri Lanka, UK, Malaysia, South Africa, The Netherlands and Saudi Arabia.

Turmeric is grown as a kharif crop in India and harvested during January and March. Price of turmeric prevailed during 1986-2012 is presented in Fig.1. The data indicates very wide fluctuation in prices. Erode, Duggirala and Nizamabad are the three major turmeric markets in India. More than 60 per cent of Indian turmeric production is traded in the above three markets. In November, 2010 the turmeric price per quintal was the maximum at Rs.15,800 and it dropped to Rs.4,800 during November, 2011 in Erode market. Coefficient of variation of turmeric price during 2010 and 2011 was 52 per cent and 22 per cent respectively. These sort of wide fluctuations would certainly affect the income of the farmers who have to take a greater risk in cultivation of the turmeric crop Hence, there is a need to study the price behavior of turmeric in respect to trend and cycle; and forecast the peak and trough periods, so as to minimize risk. Analyzing market integration across the major three markets will give an indication about the efficiency of markets with respect to turmeric prices.

Overall market performance may be evaluated in terms of price relationships. Co-integration test is used to examine the stability of price relationship among the major turmeric markets. Market integration is defined as co-movements of prices and more generally, to the smooth transmission of price signals and information across spatially separated markets. Market integration has led to market liberalization or price stabilization because of detailed transmission of incentives across the marketing chain. If markets would well integrate, then government can stabilize the price in one key market and rely on commercialization to produce a similar outcome in other markets, which ultimately reduce the cost of stabilization. Further, farmers would not be constrained by domestic fundamentals. Hence, a study to empirically verify the integration of turmeric markets in India would prove to be the tool for testing efficiency of turmeric markets, as well as the generalization of policy across markets.

To measure the amount of variation in commodity prices, it is essential to identify the phases (boom and slump) and measure the amplitude of the cycles

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(Cuddington et al., 1989). A cycle is an episode of absolute rise in prices followed by an absolute decline (Cashin et al., 2002). Trends and cycles are the two most dominant feature of a commodity price series. While, the trends represent permanent component of the price series, cycles are temporary deviations around it. Trends are a structural component of the price series and reflect the changing patterns of demand and supply in the country. An adequate understanding of the time-series properties of commodity prices is essential for risk management (Rahman,2012).

Hence, the present study was conducted to analyze the operation of price cycles to identify the peaks and troughs, integration among the selected turmeric markets and to suggest policy measures to protect the farmers from the risks emanating from turmeric markets.

Materials and Methods

To study the market integration, monthly price data of turmeric for a period of 18 years was collected from three markets. Monthly price data of turmeric for a period of 26 years (1986-2012) was collected from Erode regulated market in Tamil Nadu for analyzing the cyclical behaviour. The data series had undergone two base year revisions in 1993-94 and 1999-00. All the series had converted at 1993-94 base year with the help of splicing method to link series with two different base years (Rahman,2012).

The data were divided into two periods ie., 26 years (January, 1986 to December,2012) monthly price and 24 years (January, 1986 to October,2010) monthly price to check for the abnormal price variation during November, 2010. The existence of price cycles was analysed using Bry-Boschan algorithm. MATLAB software was used to run the Bry-Boschan algorithm and the codes used by Rahman (2012) were utilized to analyse the price cycles in turmeric. The trend in turmeric price was analysed using regression model. Market integration was analysed by using Granger Causality test and Johansen co-integration test.

Bry - Boschan algorithm

The Bry-Boschan algorithm helped to identify turning points in the time series and indicated the dates when the series would hit a peak or a trough. Movement of peak and trough is always alternating, which would complete one cycle. The amount of time which a series would take to go from peak to trough or vice-versa is called as a phase and two such phases would constitute a cycle. In order to identify a turning point (peak or a trough), not every change is taken as a turning point, rather a local maxima or minima is selected based upon a criteria that a certain number of points after the selected point follow the same pattern. From the identified dates, the duration spent in each state and the percentage change in the phase known as, the amplitude would be calculated.

The Bry- Boschan algorithm is used to confirm the operation of price cycles besides the length of the cycle. The algorithm used in MATLAB is as given below.

Step 1: Make first pass at dating peaks and troughs

The algorithm picks an initial selection of peaks and troughs, where a peak is located at the highest point in the series using a window two months either side of the point, and vice versa for troughs.

Step 2: Enforce alteration of peaks and troughs

The algorithm checks that none of the peak dates and trough dates are shared.

Step 3 : Censor dates

1. The algorithm enforces the restriction that cycles are atleast 24 months long.
2. The algorithm censors the dates at the end of the series by eliminating turns within 12 months of both ends of the series, and by eliminating peaks (troughs) at both ends, which are lower than values closer to the end.
3. The algorithm again checks the restriction that cycles (peak-peak and trough-trough) are at least 24 months long.
4. The algorithm eliminates phases whose duration is less than 12 months long.

Step 4: Statement of final turning points

The algorithm selects the final peak and trough dates.

This algorithm was utilized by many authors in analyzing the business cycles of industrial products and macroeconomic indicators (Everts, 2006; Harding and Pagan, 2005; Michael, 2003), but only very few used for analyzing the agricultural commodity cycles. Research done by *Raveendaran*, et al.,(1989) checked the presence of cycles in turmeric price of Tamil Nadu using graphical method. The length of the export price cycle varied from three to seven years.

The price cycle in selected food products showed a symmetry in the duration spent in boom and slump and price cycle does not have a consistent shape (Rahman, 2012). The study did not provide any policy implications to safeguard the farmers from wide fluctuations in price.

Granger Causality Test

The Granger test is based on a promise that if forecasts of some variable, say X, obtained by using both the past values of X and the past values of another variable Y, is better than the forecasts obtained using past values of X alone, Y is then said to cause X. The model proposed by Granger (1969) was:

$$Y_i = a_i Y_{t-i} + b_i X_{t-i} + e_i \quad (1)$$

$$X_i = c_i Y_{t-i} + d_i X_{t-i} + v_i \quad (2)$$

Where, X_i and Y_i are two stationary time series with zero mean: e_i and v_i are two correlated series, m is assumed to be finite and shorter than the time series considered. Since the series of the variable are usually non-stationary and integrates of order I (1), first difference of the variable is normally taken, which is stationary. The optimal lag length of the variables is determined by minimizing Akaike's Information criterion. Based on the equations 1 and 2, unidirectional causation from one variable X to Y (*i.e.* X Granger causes Y) is observed, if the estimated coefficient on the lagged X variable in equation (1) is statistically non-zero as a group, and the set of lagged Y coefficient is zero in equation (2)Similarly, unidirectional causation from Y to X (i.e. Y Granger causes X) is implied if the estimated coefficient on the lagged Y in equation (2) are statistically different from zero as a group and the set of estimated coefficient on the lagged X variable in equation (1) is not statistically different from zero. Feedback or mutual causality (bi-directional) would occur when the set of coefficients on the lagged X variable in equation (1) and on lagged variable Y in equation (2) are statistically different from zero. Finally, independence exists when the coefficients of both X and Y variables are equal to zero.

For the proposed study, X_i denoted turmeric prices where i=1, (1-Erode) and Yi denoted i =1, 2 (1=Duggirala, 2= Nizamabad) ; and lead-lag relationship among turmeric markets were analysed using Granger causality test.

For the present study based on Akaike's Information Criterian (AIC) criterion 1 month lag for turmeric market was selected in the Vector Auto Regression (VAR) framework.

Johansen multiple co-integration test

The co-integration test was first introduced by Engel and Granger (1987); then, developed and modified by Johansen (1988) and Johansen, and Juselius (1990).The Johansen's co-integration tests are very sensitive to the choice of lag length. Firstly, a VAR model is fitted to the time series data in order to find an appropriate lag structure. The Schwarz Criterion (SC) and the Likelihood Ratio (LR) test are used to select the number of lags required in the co-integration test. The laggted terms are included to ensure that the errors are uncorrelated. The number of lagged difference terms to be included can be chosen based on t-test, F-test or the Akaike's Information Criterion (AIC) (Greene 1993). If the estimated value of error term exceeds critical values at 1, 5 and 10 per cent levels of significance, the conclusion would be that the residual term is stationary and hence the two individual series, though non-stationary are co-integrated in the long run.

Before analysing any timeseries data, testing for stationarity is a prerequisite since econometric relation between the timeseries has trend components. It involved testing for stationarity of the variables using the Augmented Dickey-Fuller (ADF) test. 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:

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

[t-1: 1 month lagged price, Δ : differenced series] Y_t denoted the price series of Erode, Duggirala and Nizamabad turmeric markets.

If the coefficient δ 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 test was used. The null hypothesis of non-stationary is tested using a t-test. The null hypothesis is rejected if the estimated variable is significantly negative.

Results and Discussion

The estimated regression equation revealed that turmeric price showed positive trend over the years. The results are in consistent with the results obtained by Rahman (2012), who observed positive trend for spice price over years. It could be concluded that theory of declining food prices not holds true in the case of turmeric.

Alston *et al.* (2009) found that there is a trend decline in the price of food and feed products. They attributed the reason for this decline in prices to increase in agricultural productivity. The results are often mixed with no consensus on whether we should expect a positive or negative trend.

Cyclical features of the real price (Bry-Boschan algorithm)

Bry-Bosch algorithm was used to estimate the cycle length and turning points. The results are presented in Table.3. In total, 5 cycles were observed in price data of 26 years with a mean cycle length of 58 months (4.83 years). There was a consistent shape in the turmeric price cycles, which enabled prediction based on occurrence of boom and slump, and also helped in formulating policies. Wang (2010) examined the phases of cereal price cycles in China using Bry- Boshan algorithm and concluded that types of cereals used for direct consumption had relatively long price cycles compared to those used for livestock feed and bio-fuel materials.

The results for the price data of two periods (the whole 26 years; the month until abnormal price variation) did not show any difference to the length of the price cycle. In both the periods, the average length of price cycle was 4.8 years. This would have happened because of the unexpected rise and decline happened within a year, which did not have impact on cycle length.

Similarly, if we look at amplitude during booms and slump; in slump, on an average, price got reduced to 60 percentage where as in boom the prices got doubled (121 percentage). From peak stage it took 23 months to attain a trough; and from trough, it took 31 months to attain a peak. The time spent in trough was higher than the time spent in peak. In line with Cashin et al. (2002), who found that the commodity prices had spent greater time in slump than in boom, our results confirmed that the duration spent in slump is higher than in boom. The results are presented in Table 1.

Table 1. Results of cyclical features of the real price

Parameters	Unit
Number of cycles	5
Mean cycle duration (months)	58
Amplitude of the phase (percentage change in the prices during each of the phase) Slump	-60
Amplitude of the phase (percentage change in the prices during each of the phase) – Boom	121
Number of months spent – Peak –Trough	23
Number of months spent – Trough-peak	31

If turmeric price would increase in the current year, the area under the crop would certainly increase and add to the next year arrival and cause the price to decline to a certain extent. Since turmeric is a storable commodity, a larger section of the farmers can store the commodity in anticipation of better price. Hence, the decrease in prices not reaches the bottom rock levels because of limited sale in spite of maximum arrivals. At the end of second year, fresh arrivals would start flowing into market and along with the existing stock; the total stocks would become too huge. Also, turmeric is a commodity which is inelastic (Shinoj, 2006) with respect to price and income; since, it is both an essential commodity and required regularly in meager quantities in the households. Exports also could not be expanded to a greater extent; since mostly, required for domestic consumption. All these make the prices to fall at the end of the second year or at the beginning of the third year.

At this time only farmers would start reducing the area under crop and by the end of the third year or beginning of the fourth year, the prices would start increasing. Even though prices would start increasing, farmers would still reduce the area under turmeric in the fourth year also, since prices may not be remunerative, which may result in very less production and arrivals to the market, and with a constant demand prices would reach the maximum. Thus, turmeric prices exhibited a cyclical behavior with a length of 5 years approximately (peak-peak), as evidenced in the present study, the length of the cycle are bound to change with pest and disease attack, and problems in irrigation during that period.

Since turmeric farmers were not aware of the trough and peak periods and the length of the price cycles; they were incurring losses during trough periods. Our analysis revealed that the next peak will be in March, 2014 and hence, the farmers who harvested turmeric in the current year would store the product and sell it during peak price period.

Results of Market integration

Augmented Dickey Fuller test was done for Erode, Duggirala and Nizamabad markets and the results are presented in Table 2.

Table 2. ADF Test Results of Turmeric Prices

Market	Level	First diff	Critical Value (1%)
Erode	3.241	-6.305	
Duggirala	3.242	-6.305	-3.49*
Nizamabad	-0.697	-6.305	

* MacKinnon critical values for rejection of hypothesis of a unit root.

It could be inferred that at level, the critical value was lesser than calculated ADF value and series are non stationary and in first difference, the critical value was higher than ADF value and the series was made stationary and free from unit root for further co movement analysis.

Granger Casuality Test

When a co-integration relationship is present for two variables, a Granger causality test (Granger,1969) can be used to analyze the direction of this co-movement relationship. Theoretically, a variable is said to Granger-cause another variable, if the current value of it conditions on the past values. The results From the Table 3.

Table 3. Results of multiple co integration analysis

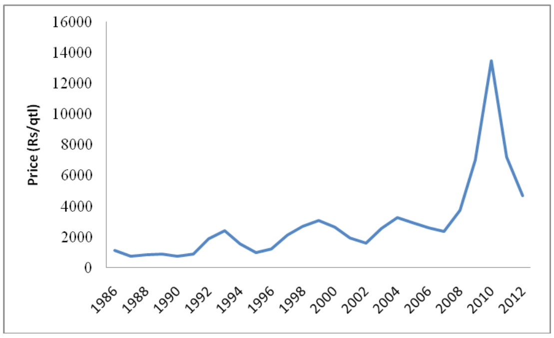
Eigenvalue	LR Ratio	5%Critical Value	1%Critical Value	No. of CE(s)
0.349274	106.5819	47.21	54.46	None **
0.216792	58.45926	29.68	35.65	At most 1 **
0.202085	31.09132	15.41	20.04	At most 2 **
0.050526	5.806917	3.76	6.65	At most 3 *

* denotes rejection of the hypothesis at the 0.05 level
****MacKinnon-Haug-Michelis (1999) p-values**

From the results, it is inferred that Erode market prices influence the prices at Nizamabad market, but not vice versa. There is a bidirectional influence on the prices of Duggirala and Nizamabad markets, whereas Duggirala price is found to influence Erode market price also.

Johansen's multiple co-integration test was employed to determine the long run relationship between price series. Co-integration was used instead of regular regression methods because of its capacity in dealing with non-stationary variables. The most popular co-integration test method, developed by Johansen (1988), and Johansen and Juselius (1990), was applied. The results are presented in Table.3. Presence of three co- integration equations at 5 per cent level of significance confirmed the existence of strong long-run equilibrium relation in the markets of Erode, Duggirala and Nizamabad. Thus, a strong integration of different turmeric markets in India

Fig. 1. Turmeric price in Erode market during 1986-2012



was confirmed through the results of the study which implies that farmers throughout India are getting almost the same price for turmeric in a particular point of time may be with minimum variations in the same for quality parameters. Hence, it could be concluded that any area adjustment programmes or subsidy or market intervention in any one market would influence the prices in other markets.

Table 4. Pairewise Granger Casuality Test Results

Null hypothesis	Obs	F-Statistic	Prob.	Direction of causality
NIZAM does not Granger cause ERODE	112	2.34649	0.1006	Unidirectional
ERODE does not Granger cause NIZAM		11.9765	2.E-05***	
DUGI does not Granger cause ERODE	112	12.2344	2.E-05***	Unidirectional
ERODE does not Granger cause DUGI		1.00357	0.3700	
DUGI does not Granger cause NIZAM	112	3.75043	0.0267**	Bidirectional
NIZAM does not Granger cause DUGI		13.0991	8.E-06***	

(*** 1% level of significance, * *5% level of significance)

The test for causality is based on F statistics that is calculated by using unconstrained and constrained forms, $F = \{SSE_r + SSE_f)/ m\} / \{SSE_f / (T-2m-1)\}$, Where SSE_r and SSE_f are residual sum of squares of the reduced and full models respectively; T= total number of observations, and m= number of lags.

Having confirmed the operation of price cycles and market integration how to save the farmers from the resultant price risks? One way is to forecast the anticipated prices of turmeric for the steason well in advance of sowing. Based on the price forecasts, farmers could take their planting decisions on turmeric like whether to plant or not? and if so, what is the acreage etc., Farmers can take a decision on whether to sell immediately or store for few months or one or two years.

Another way out is the area adjustment programme. Once the price forecast is given, the Agriculture and Agricultural Marketing Departments could draw an area adjustment programme, disseminate the same among farmers and could reduce the forthcoming area under turmeric, which could arrest the decline in prices considerably.

Government should frame market intervention policies during slump phases to safeguard the farmers. Support price could be provided to the farmers in order to reduce the price risk. Additional storage facilities could be provided to the farmers to store at assembly market centres at cheaper cost. There is a need to make farmers aware of the existence of State and Central Ware housing corporations to store their produce at a cheaper cost. Also they can watch price movements of turmeric both on spot and future market.

Conclusion

Turmeric price in Tamil Nadu showed a positive trend over years, and hence, the hypothesis of declining trend in price is rejected in case of turmeric. Turmeric price exhibited a cyclical behavior with a length of 5 years approximately (peak-peak) as evidenced in the present study. Turmeric prices showed consistent shape in cycle, and hence, there is scope for predicting duration of booms and slumps, which would attract commodity analyst to give market advisory at appropriate time. The time spent in slump is higher than the time spent in boom. The length of the price cycle does not depend upon the percentage change of price within a cycle. During slump phases, support price could be provided to the farmers, who could not be able to stock their produce. Additional storage facilities could be provided to the farmers, to store at assembly market centres, at a cheaper cost.

Dissemination of the market intelligence advisory could be increased to reach and benefit more number of turmeric farmers. Thus, a strong integration of different turmeric markets in India was confirmed through the results of the study, implying that farmers throughout India are getting almost the same price for turmeric in a particular point of time, with reference to similar quality turmeric. Hence, any area adjustment programmes or subsidy or market intervention in any one market will influence the prices in other markets also.

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