Original Research Article

Time Series Analysis of Dry Chilli Price Trends in Byadagi Market, Haveri District, Karnataka

ABSTRACT:

Spices are conventional aromatic vegetables mainly utilized for flavoring of food. Among these, chilli (*capsicum annuum*), is one of most important spice used around the world**.** The present studyexamined dry chillies price behaviour in the Byadagi market of Haveri District, Karnataka. Which was based on the secondary data from 2000-2022 collected in Agmarketnet.in. Here using a time series analysis is a complex mixture of four components namely, Trend (Tt), Seasonal (St), Cyclical (Ct), and irregular (It) variations.The result revealed that there was a significant increasing trend in prices of dry chillies from 2000-2022. The highest seasonal index was found in January (112.44) while the lowest seasonal index in the month of July (93.28)the analysis of seasonal indices in the price of dry chilli would help to understand the status of dry chilli marketing in the Byadagi market. The dry chilli prices exhibit no oscillatory movement and no definite periodicity during the study period.

Keywords*: Cyclical Variations,Moving Average method, Irregular Price Fluctuations,Price behavior, Seasonal Indices, and Trend analysis*

1. INTRODUCTION

India, often known as the "Spice Bowl of the World" or the "Land of Spices," is prominent in the global spice industry due to its extensive production, rich diversity, and historical importance in the spice trade. These titles reflect India's leading role as a cultivator and exporter of a vast array of spices. The country's unique geography, encompassing tropical, subtropical, and temperate climates, allows it to grow around 63 different varieties of spices. As the world's largest producer, consumer, and exporter of spices, India is widely recognized as the global spice capital. It's fertile soil and diverse climate conditions provide the perfect environment for cultivating various spices. For centuries, India's strategic location and thriving spice trade attracted foreign traders and explorers, leading to the discovery of new sea routes and drawing European colonizers to its shores. This rich history has cemented India's global significance in the spice trade and shaped its historical development.Price trend analysis helps determine the compound growth rate, trend, cyclic, and seasonal patterns of price time series data.

2. MATERIAL AND METHODS

The study was based on secondary data, month-wise price data was collected from 2000 to 2022. Time series analysis was done to study the variations in monthly prices of dry chilli for 22 years. A time series is a complex mixture of four components namely, Trend (Tt), Seasonal (St), Cyclical (Ct), and irregular (It) variations. These four types of movements are frequently found separately or in combination in a time series. The relationship among these components is assumed to be additive or multiplicative, but the multiplicative model is the most commonly used method in economic analysis. The material and method for this objective were adapted from books, *viz*., Applied Regression Analysis (1998) by Norman R Draper and Smith H and Fundamentals of Applied Statistics (1978) by Gupta S C and Kapoor V K.

A multiplicative model is appropriate if the magnitude of the seasonal fluctuation varies with the level of the series

$$Y_t = T_t \times C_t \times S_t \times I_t$$

Where,

Y_t = monthly data of dry chilli prices at a time 't'.

T_t = Trend component,

S_t = Seasonal variations,

C_t = Cyclical element,

I_t= Irregular fluctuations.

Estimation of Linear Trend (T_t)

For estimating the long-run trend of prices, the method of least squares estimate was employed. This method of ascertaining the trend in a series of annual prices involves estimating the co-efficient of intercept (β_0) and slope (β_i) in the functional form. The equation adopted for this purpose was specified as follows.

Linear model:

The simple linear regression model for n observations can be written as

$$Y = \beta_0 + \beta_1 X + \mathcal{E}.$$

Where,

Y = Dependent variable (monthly price),

X = Independent variable (Time),

β_0= Intercept,

β_1 = coefficient to be estimated,

$\mathcal{E}$ = error.

Estimation of Seasonal indices (Si)

To measure the seasonal variations in prices seasonal indices are calculated employing the monthly averaging method and expressed in percentage.

The seasonal indices were calculated by adopting the following steps:

In the first step, monthly prices for the study period were computed. In the second step, the overall average was computed for the whole length of the study period. Then the monthly average values were converted into seasonal indices by computing the ratio of monthly average values by the overall average value and expressed in percentage.

The first step to estimate the seasonal index, a 12-month centered moving average was calculated as follows.

$$SI_i = \frac{Average_i}{Overall\ average}$$

Where,

SI_i = Seasonal Index for i^{th} month,

$Average_i$ = Average value for i^{th} month.

Estimation of Cyclical Indices (Ci)

Cyclical movements are fluctuations that differ from periodic movements. Cyclical movements have a longer duration than a year and are periodicity of several years as in business cycles. The most commonly used method for estimating the cyclical movement of a time series is the residual method by eliminating the seasonal variation and trend. This is accomplished by dividing (Yt) by corresponding (S) for time 't'. Symbolically,

$$T.C.I = \frac{T.C.S.I}{S}$$

Further, cyclical movements along with irregular fluctuations are calculated by detrending.

Symbolically,

$$C.I = \frac{T.C.I}{T}$$

These de-seasonalized data contain trend, cyclical and irregular components. This trend cycle components are plotted against time for examining cyclical behaviour. If there is any existence of cycle, the periodicity of cycle is noted. Again, moving average of length equal to periodicity of cycle is computed for eliminating cyclical behaviour.

These moving averages are arranged cycle-wise. These are adjusted for cyclical indices, as in the case of seasonal indices. The trend cycle values (TC) are divided by adjusted components CI.

The examination of both the graphs of trend cycle component as well as the trend component will give a clear idea of the presence of the cycle.

If there is a similarity in these two graphs, it is an indication of non-existence of the cycle. However, the non-similarity in the two graphs is an indication of the presence of the cycle. If ultimately a cycle is reflected, then the cyclical effect is removed from T-C components. If no cycle is detected, then the trend cycle values are treated as pure trend values.

3.RESULTS AND DISCUSSION

The study of trends enables us to indicate the general direction of prices in the market. The data on the nature of trend movement in the prices of chilli in the Byadagi market showed that the third-degree polynomial equation was the best fit with the lowest RMSE (1805.13) values.The trends are the changes over the years and are associated with changes in technology of production, input supply, infrastructure, etc. From Table 1,it could be seen thatthe degree of the polynomial increases, the model's flexibility is enhanced, resulting in a lower RMSE for the 3rd-degree model. The 3rd-degree model best fits with the lowest RMSE of 1805.13, suggesting it effectively captures the true relationship between time and price. However, the slightly higher RMSE (1807.89) in the 4th-degree model indicates that further increasing the polynomial degree could lead to overfitting, trend was visually represented in Figure 2(a) for the overall period and Figure 2(b), and (c) for the period I and II where the model becomes overly complex and starts capturing noise in the data rather than the actual trend. Shashikumar (2014) also observed an upward trend in the prices of dry chilli.

Table 1: Different degrees of polynomial for dry chilli prices of the Byadagi market

Degrees	Equations	RMSE
1^{st}	$y = 48.897\,x + 1340.5$	2452.15
2^{nd}	$y = 0.2808\,x^2 - 28.88\,x + 4944.2$	1861.65
3^{rd}	$y = 0.0012\,x^3 - 0.2062\,x^2 + 25.174\,x + 3685.2$	1805.13
4^{th}	$y = 0.000002\,x^4 + 0.0003\,x^3 - 0.0469\,x^2 + 15.328\,x + 3823.8$	1807.89

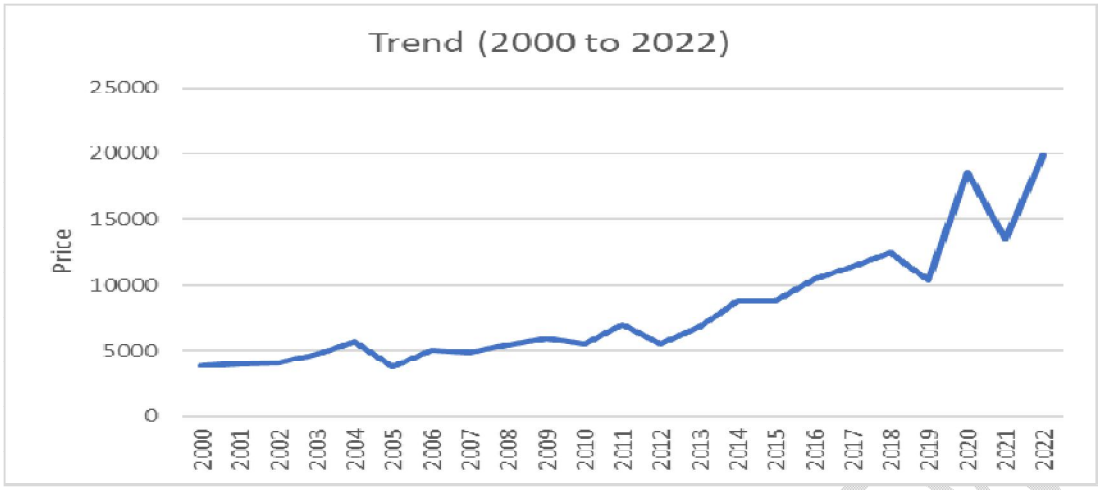

Figure 1(a): Trends in prices of dry chilli in the Byadagi market (2000-2022)

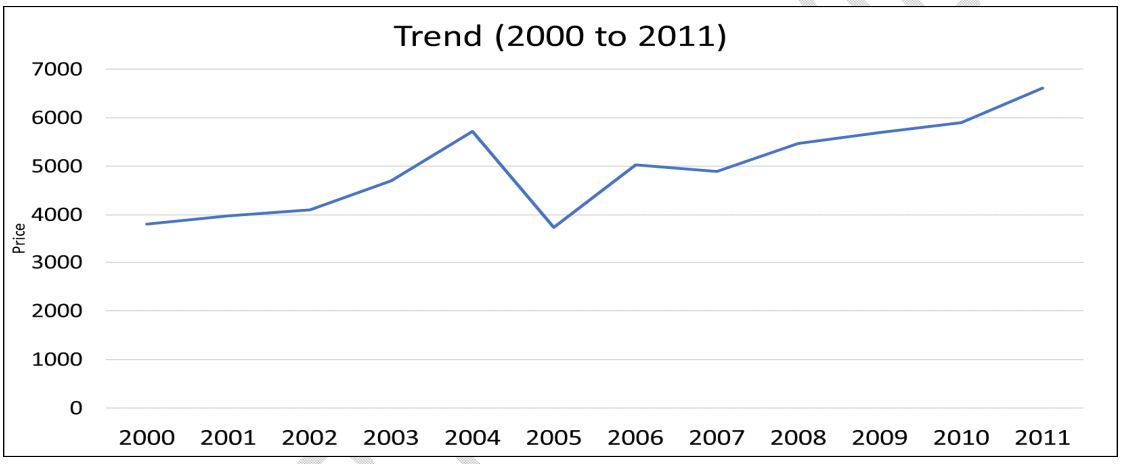

Figure 1(b): Trends in prices of dry chilli in the Byadagi market (2000-2011)

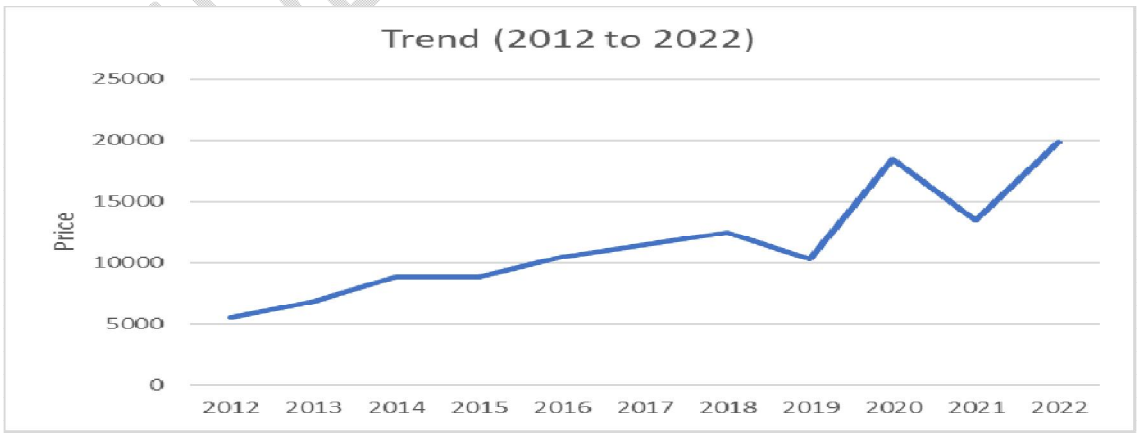

Figure 1(c): Trends in prices of dry chilli in the Byadagi market (2012-2022)

3.1 Cyclic Indices for dry chilli prices of the Byadagi market

Cyclical variations are long-term oscillatory movements lasting over a year. The residual method, which removes seasonal variation and trends, is commonly used to estimate these cycles. Cycles are classified into Kitchin (less than 3.3 years), Juglar (less than 10 years), and Kondratiev (less than 60 years), as defined by Schumpeter (1939). A 23-year analysis of deseasonalized and detrended data was conducted to estimate the amplitude and hidden periodicity in dry chilli price cycles at APMC, Byadagi. The computed coefficients are visually represented in Figure 2(a) for the overall period and in Figures 2(b) and (c) for periods I and II, with a summary in Table 2. The analysis shows no discernible trend in chilli prices at APMC, Byadagi from 2000 to 2022. However, the data from 2001 to 2011 indicates a consistent decline in cyclic indices, followed by stabilization from 2011 to 2013. From 2014 to 2021, there is a clear upward trend, but no clear cycles were detected for the entire 2000-2022 period.

Table 2: Cyclic indices of dry chilli prices in the Byadagi market, Haveri district

Year	Cyclic Indices
2000	
2001	179.97
2002	149.85
2003	138.63
2004	117.88
2005	104.68
2006	85.77
2007	87.28
2008	83.63
2009	79.99
2010	80.06
2011	72.66
2012	72.71
2013	73.74
2014	80.74
2015	87.40
2016	90.19
2017	95.90
2018	91.47
2019	104.46
2020	102.47
2021	120.54
2022	

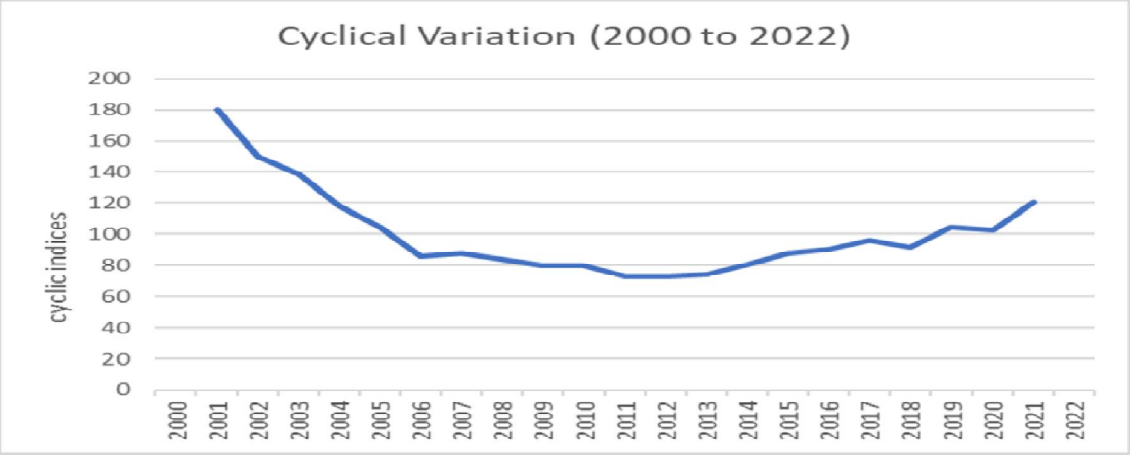

Figure 2(a): Cyclic variation in prices of dry chilli in the Byadagi market (2000-2022)

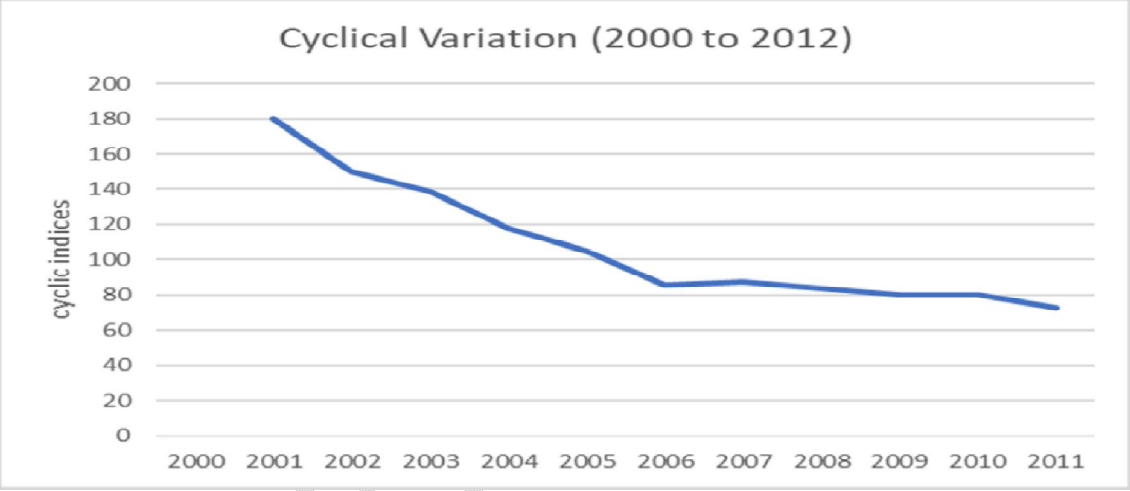

Figure 2(b): Cyclic variation in prices of dry chilli in the Byadagi market (2000-2011)

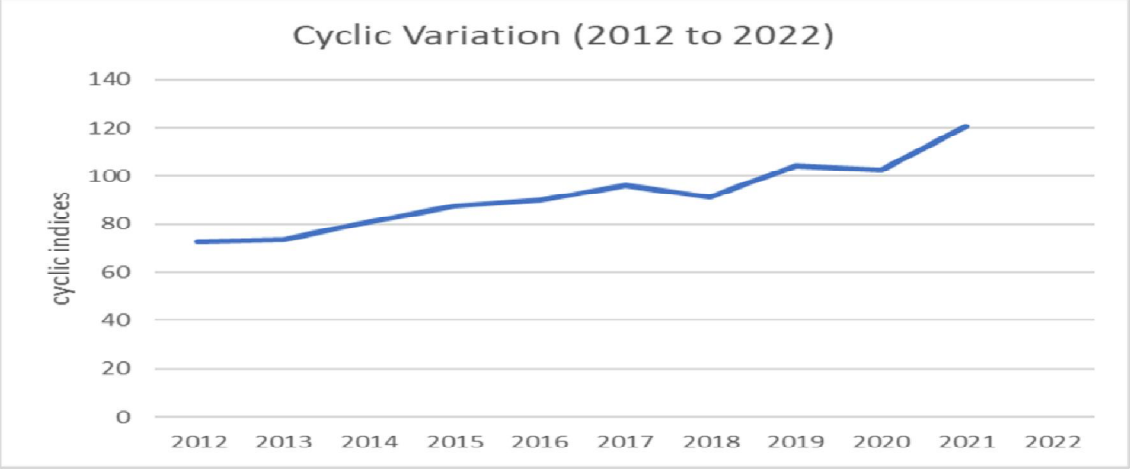

Figure 2(c): Cyclic variation in prices of dry chilli in the Byadagi market (2012-2022)

3.2 Seasonal Indices for dry chilli prices of the Byadagi market

The seasonal price index for dry chilli, presented in Table 3, shows that January is the peak month with the highest index of 112.44, followed by February (109.52), December (107.03), March (102.22), and November (100.13). The lowest prices are observed in July, with an index of 93.28. Figure 3 illustrates the monthly price variations, highlighting that farmers receive better prices from November to March. Similar findings were reported by Ashoka *et al.* (2022).

Table 3: Seasonal indices of dry chilli prices in the Byadagi market, Haveri district

Sl. No	Month	Seasonal
1	January	112.44
2	February	109.52
3	March	102.22
4	April	98.60
5	May	97.51
6	June	94.08
7	July	93.28
8	August	94.22
9	September	95.52
10	October	95.46
11	November	100.13
12	December	107.03

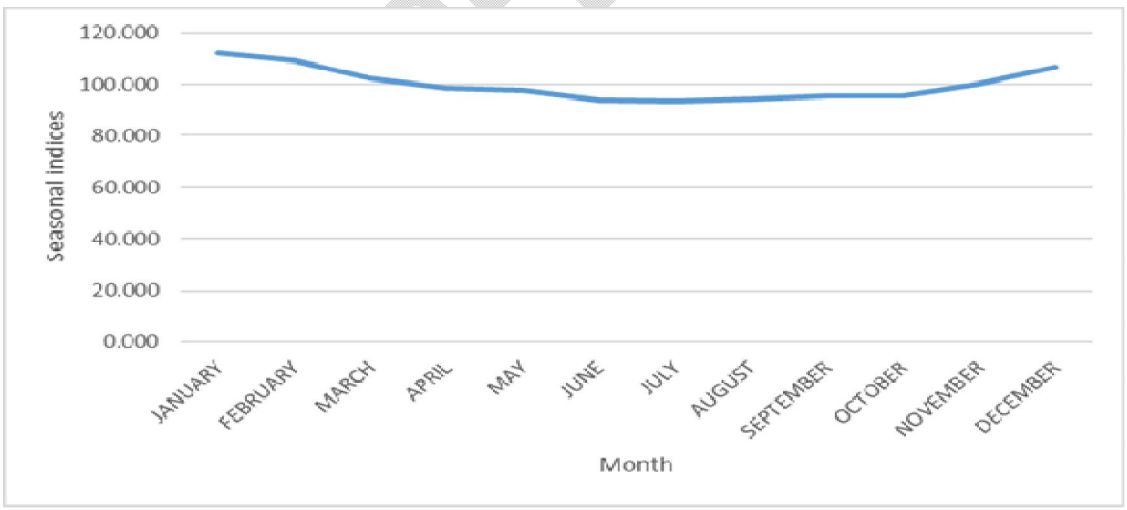

Figure 3: Seasonal Variations in prices of dry chilli in the Byadagi market

3.3 Irregular variations in chilli prices:

Irregular price movements represent that part of the behaviour of prices, which is not systematic. No generalizations can be made about such price fluctuations because of irregularity in their occurrence. The random effect is the residual effect left after the trend, seasonal and cyclical effects have been removed from the original observations. The indices of irregular variations have been worked out to capture the random effect. The results revealed that chilli prices are subjected to high irregular variations during the period of study. Satheesh et al. (2012) also reported high irregular variations of cardamom prices during the period from 1995 to 2012.

4. CONCLUSION

As the polynomial degree increases, model flexibility improves, reducing RMSE. The 3rd-degree model achieved the best fit with the lowest RMSE of 1805.13, accurately capturing the relationship between time and price. The 4th-degree model, with a slightly higher RMSE of 1807.89, suggested that further increasing the polynomial degree may lead to overfitting, capturing noise rather than the true trend.

The analysis of 23 years of deseasonalized and detrended data at APMC, Byadagi, focused on identifying cycles in dry chilli prices, such as Kitchin, Juglar, and Kondratiet cycles. The results reveal no discernible trend in dry chilli prices from 2000 to 2022, indicating that the prices fluctuated without a clear pattern or direction during this period.

The dry chilli crop, mainly grown in Karnataka under rain-fed conditions, is sensitive to moisture stress. Chilli seedlings are transplanted in May and June, with harvesting from November to January, requiring warm, dry weather for ideal growth and post-harvest techniques. Thus, the highest prices for farmers occur from November to March, with the lowest in June to July, reflecting climatic influences.

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