Growth and Instability Analysis of Groundnut Price of Major Markets in Saurashtra Region of Gujarat State

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Authors' contributions

This work was carried out in collaboration between all authors. Author PRV designed the study, wrote the protocol and wrote the first draft of the manuscript. Author ASD managed the literature searches and arrange the research work in uniform. Authors MSS and DVP managed the statistical analysis of the study. All authors read and approved the final manuscript.

Original Research Article

ABSTRACT

The present study was carried out by using time series data of price from 1998 to 2018, to compare the price variation, to measure the price instability of major domestic groundnut markets of Saurashtra region of Gujarat state *i.e.* Rajkot, Junagadh, Amreli and Gondal. Data were collected from the registers maintained in the respective Agricultural Produce Market Committees (APMCs). The price variation had been compared by using descriptive statistics in which Range and standard deviation indicated wide variation in the price level of all the markets as well as markets have positively skewed ($\gamma_1 > 0$) and mesokurtic ($\beta_2 \sim 0$) distribution. The price instability based on trend model was measured. Fitting of trend model is done by regressing the variable under consideration on chronological time period. Estimates of fitted cubic trend model for all the markets were significant. Higher instability was observed for Gondal market.

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1. INTRODUCTION

Groundnut (*Arachis hypogaea* L.) is one of the important oilseed crops among the major oilseed crops. Groundnut accounts for 45 per cent of the area and 55 per cent of the production of total oilseeds in the India. It occupies an area of 7.5 million ha. in the country with an output of 6.21 million tonnes and with an average productivity of 1341 kg/ha during 2017-18, and the bulk of the crop is grown during the kharif season as a rainfed crop.

Gujarat ranks first in the area and production of groundnut among all the states of country accounting for 34 and 43 per cent respectively. It is annually grown on an area about 16.5 lakh ha. producing 30.5 lakh tonnes with an average productivity of 1879 kg/ha in 2017-18 [1]. Saurashtra region consisting of groundnut growing districts is leading in the Gujarat state. So, it is significant to study the performance of groundnut markets in these districts and price fluctuation occurring in these markets

The instability in the price of agricultural commodities are influenced by number of factors such as annual variation in production and low-price elasticity of agricultural production [2]. The information about behavior of the price in terms of price level, trend and fluctuations are the most important factors in determining competitiveness of the commodity in the domestic and international level to draw influence for future prices and to formulate the long-term strategy on trade. The past trend in area, production and market arrivals of commodities are also useful in understanding the present and to forecast the future. Prices of farm products fluctuate more than that of industrial goods due to heavy dependence on natural factor.

Time series modelling is a dynamic research area. The main aim of time series modelling is to carefully collect and rigorously study the past observations of a time series to develop an appropriate model which describes the inherent structure of the series. This model is then used to generate future values for the series, *i.e.,* to make forecasts.

Rakesh [3] studied growth and instability in agricultural production in Haryana by using Cuddy Della Valley Index (CDVI) and reported that rice and wheat were more stable (15) but the coarse cereals and pulses were found to be highly instable (> 30) in area and production in Haryana.

Sundaramoorthy et al. [4] studied instability in the price series of international (cost, insurance and freight (Argentina) as well as domestic (Hyderabad and Rajkot) groundnut markets. The instability in the price series over the trend were worked out using the Cuddy Della Valle Index (CDVI) and they found that instability was persisting in the both the markets.

Generally, the prices of commodity go down. But in a mixed economy, a certain amount of bearing is given to the market services and this regulation may not always hold worthy. This control mechanism of the market forces may aim at regulating market supplies or consumption or both, particularly in the case of commodity in the short return among the venders and consumers and effect of these returns at once reflected in the supply and price position. Thus, in a mixed economy it would be necessary to study the market arrivals as well as prices and to know the factors affecting to them. The study of the market concentration and role of middlemen will be of greater important to the policy makers to assess the market performance and to remove the bottleneck if any in the system of marketing of groundnut, to improve the income of the farmers.

2. MATERIALS AND METHODS

2.1 Data

The monthly time series data on prices of groundnut for 20 years (April-1998 to March-2018) were collected from the registers maintained in the Agricultural Produce Market Committees (APMCs).

2.2 Selection of Markets

Rajkot, Junagadh, Amreli and Gondal markets of Saurashtra region were selected on the basis of maximum arrival of groundnut.

3. STATISTICAL ANALYSIS

3.1 Regression Analysis

Regression analysis was carried out to ascertain the response of the prices on the arrivals. The

econometric models used for the purpose are as follows:

3.1.1 Growth models

Different regression equations such as Linear, Quadratic, Cubic, Logarithmic and Power were fitted for major groundnut markets of the Saurashtra region. The best fitted model was selected for estimating the growth pattern on the basis of the R^2 and adjusted R^2 ($\overline{R}^2$) values obtained. The model with highest values of R^2 and $\overline{R}^2$ was considered as the best model.

Linear function	$Y_t = a + bt$
Quadratic function	$Y_t = a + bt + ct^2$
Cubic function	$Y_t = a + bt + ct^2 + dt^3$
Logarithmic function	$Y_t = a + b \ln(t)$
Power function	$Y_t = at^b$ (or) $\ln(Y_t) = \ln(a) + b \ln(t)$

3.2 Cuddy Della Valle Index

Cuddy Della Valle Instability index [5] is a modification of coefficient of variation to accommodate trend present in the data, which is commonly present in economic time series data. This method is superior over the scale dependent measures such as standard deviation. The Cuddy Della Valle Index (CDVI) was calculated as follows:

$$CDVI = CV\sqrt{X}$$

Where, $X = 1 - \overline{R}^2$,

CV is coefficient of variation and $\overline{R}^2$ is adjusted coefficient of determination. The ranges of CDVI [3] are given as follows:

- Low instability = 0 to 15
- Medium instability = greater than 15 and less than 30
- High instability = 30 and above

4. RESULTS AND DISCUSSION

Polynomial models were fitted to price levels of four major domestic groundnut markets of Saurashtra region *viz.*, Rajkot, Junagadh, Amreli and Gondal to measure the instability.

4.1 Trend Model

To measure price instability, it is necessary to fit trend model to the price series. The instability index is calculated based on the fitted trend. The result of fitted trend model for three markets is given as under.

4.2 Fitting Trend Model for Rajkot Market

Trend is one of the components of time series data which means changes in the value of a variable in accordance with time. Fitting of trend model is done by regressing the variable under consideration on chronological time period.

The cubic model was found to be best fitted as it is having high $\overline{R}^2$ (0.85) with lower AIC (15.05) and SIC (15.11) values as compared to another models. Thus, the fitted model was adequate to describe trend in the data as per Table 1.

In addition to this, the actual and fitted data are depicted graphically in Fig.1. The residuals from the fitted model resembles white noise because they were almost within the two standard error limits. It is clear that the fitted cubic trend model was appropriate for Rajkot market in measuring instability and seasonal factor.

4.3 Fitting Trend Model for Junagadh Market

The results of trend model for Junagadh market are presented in Table 2. It revealed that cubic trend model was best fitted model on the basis of $\overline{R}^2$, AIC and SIC value which having high $\overline{R}^2$ (0.86) with lower AIC (14.91) and SIC (14.97) values as compared to another model. Thus, the fitted model was adequate to describe trend in the data.

The actual, fitted and residual of the fitted model are depicted in the Fig.2. It shows that the residuals obtained from the fitted cubic model are within the two standard error limits. So, this model was appropriate for Junagadh market to measure instability and seasonality.

4.4 Fitting Trend Model for Amreli Market

The results of trend model for Amreli market are presented in Table 3. The different types of trend equations were fitted depending upon its $\overline{R}^2$, AIC and SIC values to assess the trend in market prices. Among them, the cubic model was found to be better fit due to high $\overline{R}^2$ (0.85) with the lower AIC (15.03) and SIC (15.09) values. Thus, the fitted model was adequate to describe trend in the data.

In addition to this, the actual and fitted data are depicted graphically in Fig. 3. It is clear that the actual data reverting to its mean value (fitted value) was maximum and much of the residuals were within the standard error limits. So, this model was appropriate for Amreli market to measure instability and volatility.

4.5 Fitting Trend Model for Gondal Market

The results of trend model for Gondal market are presented in Table 4. It revealed that cubic trend coefficient was highly significant and the adjusted R-squared (0.83) value was also high. The AIC (15.20) and SIC (15.26) values were also

comparatively low. Thus, the fitted model was adequate to describe trend in the data.

The actual and fitted data are also depicted graphically in Fig. 4. It is clear from the graph that the actual data reverting to its mean value (fitted value) was maximum and much of the residuals were within the standard error limits. So, this model was appropriate for Gondal market to measure instability and volatility.

4.6 Cuddy Della Valle Index (CDVI)

In time series analysis, instability in the data is measured by Cuddy Della Valle Instability index because this index accommodates trend present

Table 1. Estimates of fitted cubic trend model for Rajkot market

Model	Adjusted R square	Constant ($\hat{\alpha}$)	$\hat{\beta}_1$	$\hat{\beta}_2$	$\hat{\beta}_3$	AIC	SIC
Linear	0.80	849.13**	14.70**	-	-	15.33	15.36
Logarithmic	0.54	-1,307.55**	873.75**	-	-	16.16	16.19
Quadratic	0.80	996.42**	11.05**	0.02	-	15.31	15.35
Cubic	0.85	1,670.14**	-22.15**	0.36*	-0.01	15.05	15.11
Power	0.63	464.13**	0.36*	-	-	15.89	15.93

*, ** indicates significant at 5% and 1% levels, respectively

Table 2. Estimates of fitted cubic trend model for Junagadh market

Model	Adjusted R square	Constant ($\hat{\alpha}$)	$\hat{\beta}_1$	$\hat{\beta}_2$	$\hat{\beta}_3$	AIC	SIC
Linear	0.81	785.69**	14.35**	-	-	15.18	15.22
Logarithmic	0.55	-1,327.61**	854.62**	-	-	16.07	16.10
Quadratic	0.82	919.33**	11.04**	0.01	-	15.19	15.23
Cubic	0.86	1,561.17**	-20.60**	0.34*	-0.01	14.91	14.97
Power	0.64	424.87**	0.37*	-	-	15.72	15.75

*, ** indicates significant at 5% and 1% levels, respectively

Table 3. Estimates of fitted cubic trend model for Amreli market

Model	Adjust R square	Constant ($\hat{\alpha}$)	$\hat{\beta}_1$	$\hat{\beta}_2$	$\hat{\beta}_3$	AIC	SIC
Linear	0.79	953.86**	14.25**	-	-	15.33	15.36
Logarithmic	0.54	-1,169.20**	854.23**	-	-	16.10	16.13
Quadratic	0.79	1,052.64**	11.80**	0.01	-	15.31	15.35
Cubic	0.85	1,752.35**	-22.68**	0.37*	-0.01	15.03	15.09
Power	0.63	512.98**	0.35*	-	-	15.89	15.93

*, ** indicates significant at 5% and 1% levels, respectively

Table 4. Estimates of fitted cubic trend model for Gondal market

Model	Adjusted R Square	Constant ($\hat{\alpha}$)	$\hat{\beta}_1$	$\hat{\beta}_2$	$\hat{\beta}_3$	AIC	SIC
Linear	0.77	900.78**	14.59**	-	-	15.47	15.50
Logarithmic	0.52	-1,230.77**	865.10**	-	-	16.22	16.25
Quadratic	0.78	1,050.37**	10.88**	0.02	-	15.46	15.51
Cubic	0.83	1,771.29**	-24.65**	0.38*	-0.01	15.20	15.26
Power	0.61	501.01**	0.35*	-	-	15.97	16.01

*, ** indicates significant at 5% and 1% levels, respectively

in the data which is not done by the commonly used instability measure *i.e.* Coefficient of Variation (CV%). The latter measures instability around mean but the former measures instability around the trend. Since, time series data contain trend, it should be detrended in order to measure instability in a statistically sound manner. So CDVI was utilized to measure instability in all the four markets and the results are presented in Table 5. It revealed that instability for all the four markets was quite moderate (above 15).

In four markets, the instability of Gondal market (18.04) was quite higher than others which indicated that the persistence of volatility may be higher in Gondal market than other three markets.
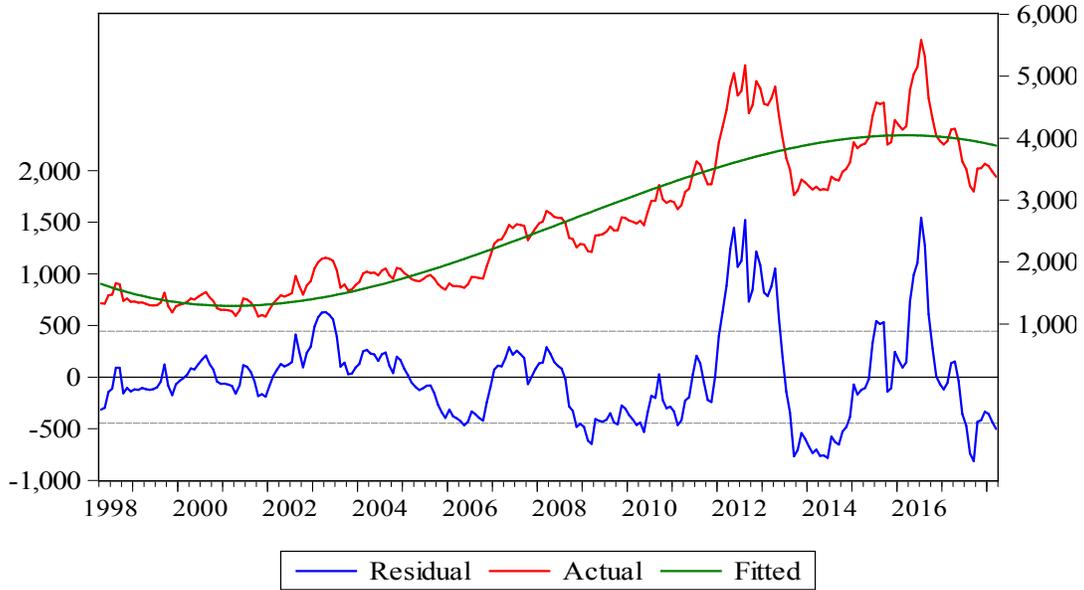
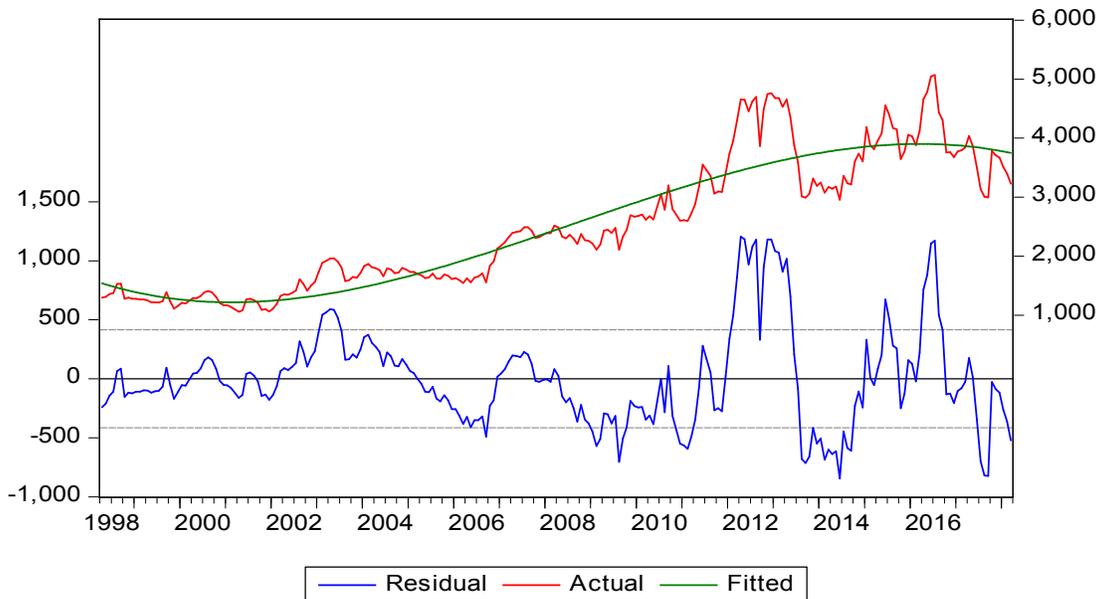**Fig. 1. Fitted cubic trend model for Rajkot market**

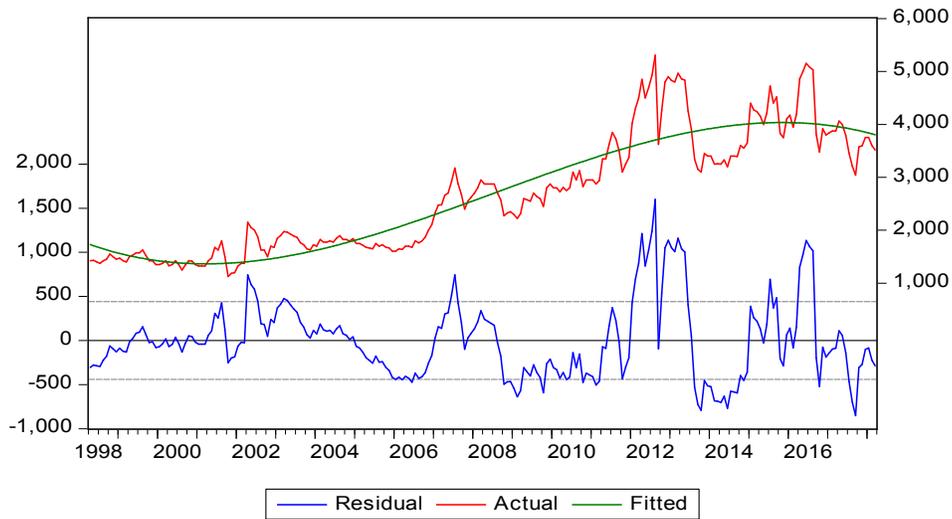**Fig. 2. Fitted cubic trend model for Junagadh market**
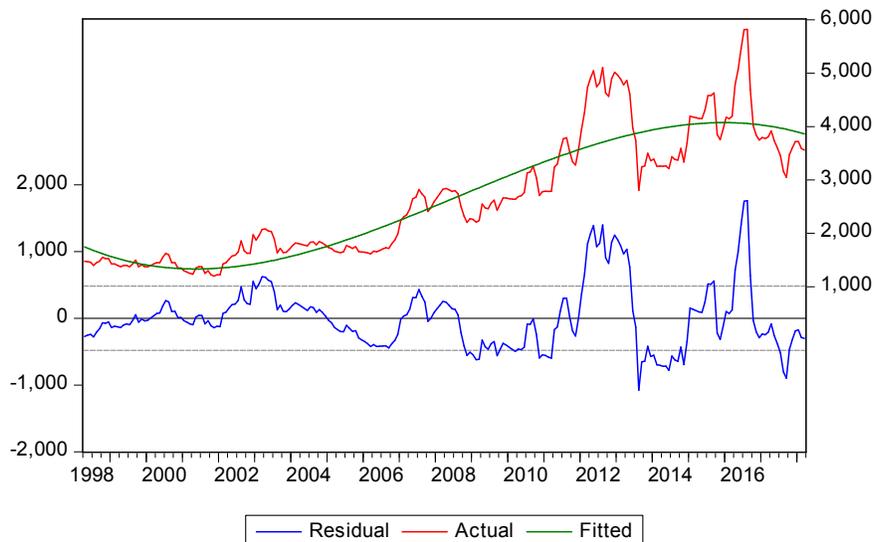
Fig. 3. Fitted cubic trend model for Amreli market

Fig. 4. Fitted cubic trend model for Gondal market

Table 5. Instability of the major domestic markets

Market	Adjusted-R square	CV%	CDVI	Range
Rajkot	0.85	43.48	16.96	Medium
Junagadh	0.86	43.86	16.45	Medium
Amreli	0.85	41.60	16.48	Medium
Gondal	0.83	43.27	18.04	Medium

5. CONCLUSION

In all the markets medium instability was observed and there was also a trend of positive and negative seasonality. In all the four markets the instability was not low. As compared to the Rajkot, Amreli and Junagadh markets, the instability in the Gondal market was quite high. The seasonal component was estimated by fitting the cubic trend model in all the selected

four markets. The seasonally adjusted data were utilized for volatility analysis.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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