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Price forecast for market information system (MIS) in maize crop in Ambala district of Haryana

Veer Sain and KK Kundu

Abstract
The present study was conducted in Ambala district, Sahzadpur and Naraingarh Blocks of Haryana which was selected purposively on the basis of maximum production under maize crop. Further, Sahazdpur, Mullana, Naraingarh and Ambala city markets were purposively selected for the market study. Finally, 4 regulated markets in Ambala district were purposively selected. Average prices in Haryana data for the period of 2005 to 2016 were analyzed the time series methods. Auto Correlation Function (ACF) and Partial Auto Correlation Function (PACF) were calculated for the data. Appropriate Box-Jenkins Auto Regressive Integrated Moving Average (ARIMA) model was fitted. Validity of the model was tested using standard statistical techniques. ARIMA (0, 1, 0) and ARIMA (1, 1, 1) model were used to forecast average prices in Ambala for one leading years. The results also shows average prices forecast for the year 2017 to be about 1433 per quintal with upper and lower limit 1438 and 1433 per quintal in Sahzadpur market, respectively. The results also shows average prices forecast for the year 2017 to be about 1439 per quintal with upper and lower limit 1447 and 1439 per quintal in Mullana market, respectively. The results also shows average prices forecast for the year 2017 to be about 1439 per quintal with upper and lower limit 1445 and 1439 per quintal in Naraingarh market, respectively. The results also shows average prices forecast for the year 2017 to be about 1435 per quintal with upper and lower limit 1435 and 1439 per quintal in Ambala city market, respectively.

Keywords: Forecasting average price, cotton, ARIMA, ACF, PACF, Ambala

Introduction

Marketing Information System as an interacting structure of people, equipments and procedures to gather sort, analyze, evaluate and distribute, timely and right information for use by proper marketing decision makers to improve their marketing design, implementation, and control. (Kotler and Keller 2012). The weekly wholesale maize price data for the period April, 2010 to March, 2014 from five markets in India, this study examined the extent of market integration. The overall results of the market integration analysis in India, indicated that, although, the five markets in India were co-integrated-meaning that they had a stable long run relationship. These markets were also integrated in the short run. The results from trace statistics show that there were four co-integrating vectors and four common trends, which suggested that maize markets were stationary in four directions and non-stationary in four directions. Granger-causality results indicated that Hoshiarpur market price had depicted a unidirectional causality on the prices of SBS Nagar. SBS Nagar market price had shown a uni-directional influence on the price of shown a bi-directional influence on the price of Ahmednagar. Vijayanagaram market price has Bengaluru. Bengaluru market price had shown uni-directional influence on the price of Ahmednagar. Ahmednagar market price had shown a bi-directional influence on the price of Bengaluru. The short-run results indicated that these maize markets were not well integrated while long-run integration was evident, suggesting that the markets did eventually move together in the long term Kaur *et al.* (2016). The specific objective of the study is as follows:

1. To estimate the price forecasts and long term relationship in prices among domestic markets.

Methodology

The annual data on average price for the period from 2005 to 2016 were used for forecasting the future values using ARIMA models. The ARIMA methodology is also called as Box Jenkins methodology. The Box-Jenkins procedure is concerned with fitting a mixed Auto Regressive Integrated Moving Average (ARIMA) model to a given set of data. The main objective in fitting this ARIMA model is to identify the stochastic process of the time series and predict the future values accurately. These methods have also been useful in many types of situation which involve the building of models for discrete time series and dynamic systems. But, this method was not good for lead times or for seasonal series with a large random component (Granger and Newbold, 1970) [2]. Originally ARIMA models have been studied extensively by George Box and Gwilym Jenkins during 1968 and their names have frequently been used synonymously with general ARIMA process applied to time series analysis, forecasting and control. However, the optimal forecast of future values of a time-series are determined by the stochastic model for that series. A stochastic process is either stationary or non-stationary. The first thing to note is that most time series are non-stationary and the ARIMA model refer only to a stationary time series. Since the ARIMA models refer only to a stationary time series, the first stage of Box-Jenkins model is reducing non-stationary series to a stationary series by taking first order differences. The main stages in setting up a Box-Jenkins forecasting model are as follows.

1. Identification
2. Estimating the parameters
3. Diagnostic checking and
4. Forecasting

Step 1. Identification

Appropriate value of P,d and q are found first. The tools used for identification are the Autocorrelation Functions (ACF) and Partial Autocorrelation Functions (PACF).

The ARIMA process has the algebraic form :

$$Y_t = C+\phi_t Y_{t-1}+\phi_2 Y_{t-2}+\ldots\ldots\ldots+\phi_p Y_{t-p}- \theta_1 a_{t-1}- \theta_2 a_{t-2}\ldots\ldots\ldots\ \theta_q a_{t-q}+a_t$$

Where, C is a constant term related to the mean of the process. This is called a mixed auto regressive moving average model of order (p,q). It contains both AR and MA terms.

The general functional forms of ARIMA model used are

(i) Moving Average model of order q; MA (q)

$$Y_t = C-\sum_{i=1}^{q} \theta_i a_{t-i} + a_t$$

Where, a_t belongs to NID $(0, \sigma^2_a)$

(ii) Autoregressive model of order p; AR (p)

$$Y_t = C-\sum_{j=1}^{p} \ {}_{i} Y_{t-j} + a_t$$

(iii) Autoregressive Moving Average Model ARMA (p,q)

$$Y_t = C+\sum_{j=1}^{p} \ {}_{j} Y_{t-j} - \sum_{i-1}^{q} \theta_{i} a_{t-1} + a_t$$

(iv) Autoregressive Integrated Moving Average Model ARIMA (p,d,q)

$$\phi_p (B)\ \Delta^d\ Y_t = C+\theta_q(B)\ a_t$$

(v) Seasonal ARIMA model ARIMA $(p,d,q)(P,D,Q)^s$

$$\phi_p (B)\ \phi^*_p(B^s)\ \Delta^d \Delta^{sD}\ Y_t = \phi^*_Q(B^s)\theta_q(B)\ a_t$$

Where,

Y_t = Variable under forecasting

B = Lag operator

a = Error term (Y_t-Y_t, where Y_t is the estimated value of Y_t)

t = time subscript

$\phi_p(B)$ = Non-seasonal AR

$\phi^*_p(B^s)$ = seasonal AR operator

$(1-B)^d$ = Non-seasonal difference

$(1-B^s)^d$ = seasonal difference

$\theta_q(B)$ = Non-seasonal MA

$\phi^*_p(B^s)$ = seasonal MA operator

s = order of season (4 in quarterly data, 12 in monthly data etc.)

The above model contains p+q+P+Q parameters, which need to be estimated. The model is non-linear in parameters.

Step 2: Estimation

For estimating the parameters of the ARIMA model, the algorithm is as follows:

For p, d, q, P, D and Q each =0 to 2

Execute SPSS ARIMA with the set parameters.

Records the parameters and corresponding fitting error until all possible combinations are tried. Select the parameters that produce the least fitting error. This algorithm tries all combinations of parameters, which are limited to an integer lying between zero and two. The combination with the least fitting error will be searched. The range limitations of the parameters are set to restrict the searched to a reasonable scope. Parameters greater than two are rarely used in practices as per literature.

Step 3: Diagnostic checking

Having chosen a particular ARIMA model and having estimated its parameters the fitness of the model is verified. One simple test is to see if the residuals estimated from the model are white noise, if not we must start with other ARIMA model. The residuals were analyzed using Box- Ljung statics.

Step 4: Forecasting

One of the reasons for the popularity of the ARIMA modeling is its success in forecasting. In many cases, the forecasts obtained by this method are more reliable than those obtained from the traditional econometrics modeling, particularly for short–term forecasts. An Autoregressive Integrated Moving Average process model is a way of describing how a time series variable is related to its own past value. Mainly an ARIMA model is used to produce the best weighted average forecasts for single time series (Rahulamin and Razzaque 2000). The accuracy of forecasts for both Ex-ante and Ex-post were using the following test (Markidakis and Hibbon, 1979) [3] such as Mean absolute percentage error (MAPE).

Results and Discussion

In this study, we used the data average prices for the period 2005 to 2016. As we have earlier stated that development of ARIMA model for any variable involves four step: Identification, Estimation, Verification and Forecasting. Each of these four steps is now explained for maize average prices as follows.

Model Identification

For forecasting maize average price, ARIMA model estimated only after transforming the variable under forecasting into a stationary series. The stationary series is the one whose values over time only around a constant mean and constant variance. There are several ways to ascertain this. The most common method is to check stationary through examining the graph or time plot of the data is non-stationary. Non-stationary in mean is connected through appropriate differencing of the data. In this difference of order 1 was sufficient to achieve stationarity in mean. The newly constructed variable X_t can now be examined for stationary. The graph of X_t was stationaary in mean. The next steps is to identify the values of p, d and q. For this, the auto correlation and partial auto correlation coefficients of various orders of X_t are computed (Table 2). The model statistics showing goodness fit for Root Mean Square Error (RMSE), Mean Absolute Percentage Error (MAPE), Normalized Bayesian Information Criterion (Normalized BIC), Ljung-Box statistics are depicted in table 1. The Box-Ljung statistics of ARIMA model for cotton in Sahzadpur, Mullana, Naraingarh and Ambala city markets of Ambala district are presented in table 2 and shown significant statistics. The model statistics are given in table 1. The table shows that the seasonal ARIMA models in orders of (0,1,1)(1,1,3) were found satisfactory for prices of maize crop.

Model Estimation and Verification

Maize average prices model parameters were estimated using SPSS package. Results of estimation are reported in Table 1. The model verification is concerned with checking the residual of the model to see if they contain any systematic pattern which still can be removed to improve on the chosen ARIMA. This is done through examing the auto correlations and Partial auto correlations of the residuals of various orders. The ACF and PACF of residual (table 1) also indicate good fit of the model.

The time series plot of the residual showed a scattered trend, therefore models were fitted properly by residual analysis. The model parameters have been presented in table 1. The results showing that there was no transformation accounted for the model fitting. It is showing that none of series was found stationary and having volatile trend. In Sahazdpur, Mullana, Naraingarh markets the data set only first order differentiation was found to be fit and seasonal seasonal MA(q) of Lag 1 was fitted with the degree of differentiation. The tentative models were identified based on Autocorrelation functions (ACF) and Partial Autocorrelation functions (PACF) at fixed interval, showing significant for price of maize crop in Sahzadpur, Mullana, Naraingarh and Ambala city of Ambala district (table3 to 6).

Forecasting With Arima Model

ARIMA models are developed basically to forecast the corresponding variable. To judges the forecasting ability of the fitted ARIMA model important measure of the sample period forecasts accuracy was computed. Forecasting performance of the model was judged by computing Mean Absolute Percent Error (MAPE). The model with less MAPE was preferred for forecasting purposes. Forecasting was done through indentified models for the variable prices of maize crop in selected district markets. Using the obtained model, the ex-post forecasted values, considering the January 2005 to December 2016 were computed and have been presented in fig. 1 to 4. The table observed that the forecasted of price in Sahzadpur, Mullana, Naraingarh and Ambala city markets moved in same direction with observed values.

Price forecasts for maize

The price forecasts for the main market of Ambala district i.e. Sahzadpur market obtained for the year 2017 for arrival season in October to November were observed between Rs. 1433 to 1438 per quintal. While, in the forecasts for the remaining months i.e. from December to September were in the range Rs. 1381 to 1436 per quintal. Similarly, the price forecasts in reference market of Ambala district i.e. Mullana market was obtained in October to November Rs. 1439 to 1447 per quintal. While, in the forecasts for the remaining months i.e. from December to September were in the range Rs. 1456 to 1387 per quintal. Therefore, the farmers need not to store their produce in future and they have to dispose off the produce at the earlier.

The price forecasts in main market of Ambala district i.e. Naraingarh market obtained for the year 2017 for arrival season in October to November were observed between Rs. 1439 to 1445 per quintal. While, in the forecasts for the remaining months i.e. from December to September were in the range varied from Rs. 1456 to 1387 per quintal. Similarly, the price forecasts in reference market of Ambala district i.e. Ambala city market was obtained in October to November Rs. 1435 to 1439 per quintal. While, in the forecasts for the remaining months i.e. from December to September were in the range Rs. 1449 to 1378 per quintal. Therefore, the farmers need not to store their produce in future and they have to dispose off the produce at the earlier.

Cointegration between selected markets for maize agricultural commodities in Ambala district of Haryana (at zero order integration)

Cointegration is a statistical property obtained by given time series data set that is defined by the concepts of stationarity and the order of integration of the series. The stationary series is one with a mean value which will not change during the sampling period. For an illustration, the mean of a subset of a given series does not vary significantly from the mean of any other subset of the same series. Further, the series will constantly return to its mean value as fluctuations occur. In other words, a non-stationary series will shows a time-varying mean. The order of integration of a series is given by the number of times the series must be differenced in order to produce a stationary series.

Cointegration analysis was carried out to study the long run relationship of average price of maize for Ambala districts in all four markets. The Dickey-Fuller test was used to study the order cointegration of prices among different markets.

The table 7 revealed that dickey-fuller test ‘tau’ was found highly significant for all the Ambala district markets of the maize. That is clearly shown that there is a long relationship and this shows that the price will remain constant over the change of time.

Table 1: Model parameters of different markets in Ambala district of Haryana

Sahazdpur market				Ljung Box(18)		
Model	**RMSE**	**MAPE**	**N-BIC**	**Statisitcs**	**Df**	**Sig.**
Model(0,1,0)(1,1,1)	35.099	2.392	7.228	35.644	16	.003
Mullana market				**Ljung Box(18)**		
Model	**RMSE**	**MAPE**	**N-BIC**	**Statisitcs**	**df**	**Sig.**
Model(0,1,0)(1,1,1)	34.738	2.408	7.207	37.038	16	0.002
Naraingarh market				**Ljung Box(18)**		
Model	**RMSE**	**MAPE**	**N-BIC**	**Statisitcs**	**df**	**Sig.**
Model(0,1,0)(1,1,1)	34.816	2.359	7.212	38.099	16	0.001
Ambala city				**Ljung Box(18)**		
Model	**RMSE**	**MAPE**	**N-BIC**	**Statisitcs**	**df**	**Sig.**
Model(0,1,0)(1,1,1)	35.475	2.490	7.249	34.943	16	0.004

Table 2: Model parameters of different markets of Ambala district of Haryana

Sahazdpur market					
Model	**Parameters**	**Estimated Parameters**	**Asymptotic S.E.**	**Asymptotic t-value**	**p**
Model(0,1,0)(1,1,1)	SAR1	-0.074	0.118	-0.629	0.530
	SMA1	0.922	0.236	3.905	0.000
Mullana market					
Model	**Parameters**	**Estimated Parameters**	**Asymptotic S.E.**	**Asymptotic t-value**	**p**
Model(0,1,0)(1,1,1)	SAR1	-0.047	0.120	-0.390	0.697
	SMA1	0.963	0.506	1.903	0.059
Naraingarh market					
Model	**Parameters**	**Estimated Parameters**	**Asymptotic S.E.**	**Asymptotic t-value**	**p**
Model(0,1,0)(1,1,1)	SAR1	-0.074	0.118	-0.630	0.530
	SMA1	0.920	0.234	3.929	0.000
Ambala city					
Model	**Parameters**	**Estimated Parameters**	**Asymptotic S.E.**	**Asymptotic t-value**	**p**
Model(0,1,0)(1,1,1)	SAR1	-0.047	0.119	-0.396	0.693
	SMA1	0.979	0.884	1.108	0.270

Table 3: Autocorrelation and partial autocorrelation functions of average monthly price in Sahzdapur market of Ambala district

Autocorrelations						Partial Autocorrelations		
Lag	**Autocorrelation**	**Std. error**[a]	**Box-Ljung statistic**			**Lag**	**Partial autocorrelation**	**Std. error**
			Value	**Df**	**Sig.**[b]			
1	0.971	0.082	138.592	1	0.000	1	0.971	0.083
2	0.938	0.082	268.839	2	0.000	2	-0.083	0.083
3	0.905	0.082	391.008	3	0.000	3	-0.009	0.083
4	0.877	0.082	506.385	4	0.000	4	0.054	0.083
5	0.852	0.081	616.157	5	0.000	5	0.046	0.083
6	0.827	0.081	720.326	6	0.000	6	-0.029	0.083
7	0.802	0.081	819.096	7	0.000	7	-0.001	0.083
8	0.783	0.080	913.819	8	0.000	8	0.085	0.083
9	0.763	0.080	1004.545	9	0.000	9	-0.022	0.083
10	0.743	0.080	1091.135	10	0.000	10	-0.026	0.083
11	0.723	0.080	1173.684	11	0.000	11	0.006	0.083
12	0.702	0.079	1252.189	12	0.000	12	-0.007	0.083
13	0.685	0.079	1327.522	13	0.000	13	0.047	0.083
14	0.667	0.079	1399.574	14	0.000	14	-0.031	0.083
15	0.651	0.078	1468.675	15	0.000	15	0.025	0.083
16	0.636	0.078	1535.032	16	0.000	16	0.008	0.083
[a]. The underlying process assumed is independence (white noise).								
[b]. Based on the asymptotic chi-square approximation.								

Table 4: Autocorrelation and partial autocorrelation functions of average monthly price in Mullana market of Ambala district

Autocorrelations						Partial Autocorrelations		
Lag	**Autocorrelation**	**Std. error**[a]	**Box-Ljung statistic**			**Lag**	**Partial autocorrelation**	**Std. error**
			Value	**Df**	**Sig.**[b]			
1	0.970	0.082	138.429	1	0.000	1	0.970	0.083
2	0.938	0.082	268.594	2	0.000	2	-0.067	0.083
3	0.905	0.082	390.824	3	0.000	3	-0.006	0.083
4	0.877	.00082	506.217	4	0.000	4	0.041	0.083
5	0.852	0.081	615.911	5	0.000	5	0.045	0.083

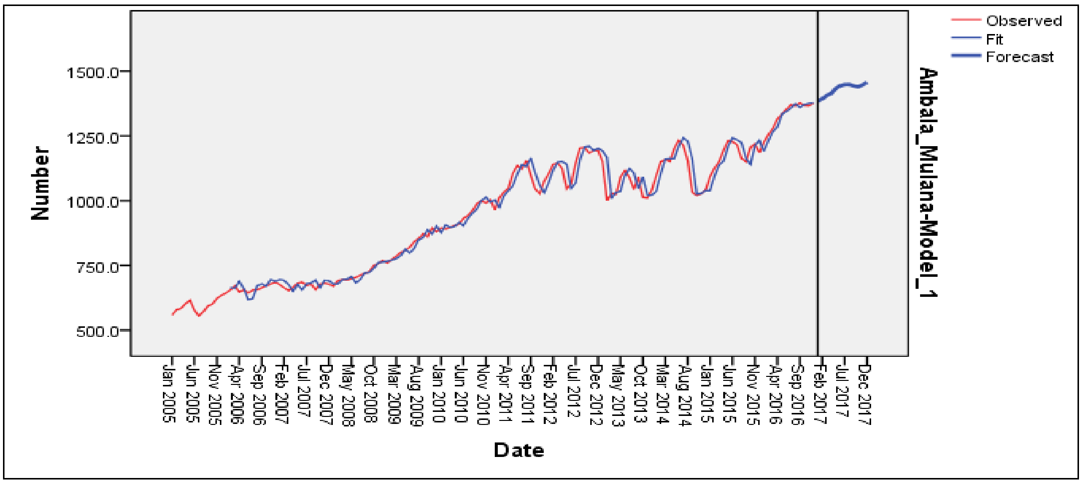
6	0.827	.00081	719.987	6	0.000	6	-0.021	0.083
7	0.801	0.081	818.567	7	0.000	7	-0.009	0.083
8	0.782	0.080	913.118	8	0.000	8	0.089	0.083
9	0.763	0.080	1003.753	9	0.000	9	-0.014	0.083
10	0.743	0.080	1090.260	10	0.000	10	-0.031	0.083
11	0.722	0.080	1172.765	11	0.000	11	0.006	0.083
12	0.702	0.079	1251.358	12	0.000	12	0.001	0.083
13	0.686	0.079	1326.875	13	0.000	13	0.045	0.083
14	0.668	0.079	1399.076	14	0.000	14	-0.040	0.083
15	0.652	0.078	1468.254	15	0.000	15	0.024	0.083
16	0.636	0.078	1534.721	16	0.000	16	0.017	0.083
[a]. The underlying process assumed is independence (white noise).								
[b]. Based on the asymptotic chi-square approximation.								

Table 5: Autocorrelation and partial autocorrelation functions of average monthly price in Naraingarh market of Ambala district

Autocorrelations						**Partial Autocorrelations**		
Lag	**Autocorrelation**	**Std. error[a]**	**Box-Ljung statistic**			**Lag**	**Partial autocorrelation**	**Std. error**
			Value	**df**	**Sig.[b]**			
1	0.971	0.082	138.561	1	0.000	1	0.971	0.083
2	0.938	0.082	268.816	2	0.000	2	-0.078	0.083
3	0.905	0.082	391.067	3	0.000	3	-0.007	0.083
4	0.877	0.082	506.573	4	0.000	4	0.052	0.083
5	0.852	0.081	616.404	5	0.000	5	0.039	0.083
6	0.827	0.081	720.596	6	0.000	6	-0.025	0.083
7	0.802	0.081	819.300	7	0.000	7	-0.005	0.083
8	0.783	0.080	913.965	8	0.000	8	0.090	0.083
9	0.763	0.080	1004.685	9	0.000	9	-0.018	0.083
10	0.743	0.080	1091.312	10	0.000	10	-0.027	0.083
11	0.723	0.080	1173.915	11	0.000	11	0.004	0.083
12	0.702	0.079	1252.507	12	0.000	12	-0.006	0.083
13	0.686	0.079	1327.942	13	0.000	13	0.047	0.083
14	0.668	0.079	1400.060	14	0.000	14	-0.035	0.083
15	0.651	0.078	1469.195	15	0.000	15	0.026	0.083
16	0.636	0.078	1535.587	16	0.000	16	0.011	0.083
[a]. The underlying process assumed is independence (white noise).								
[b]. Based on the asymptotic chi-square approximation.								

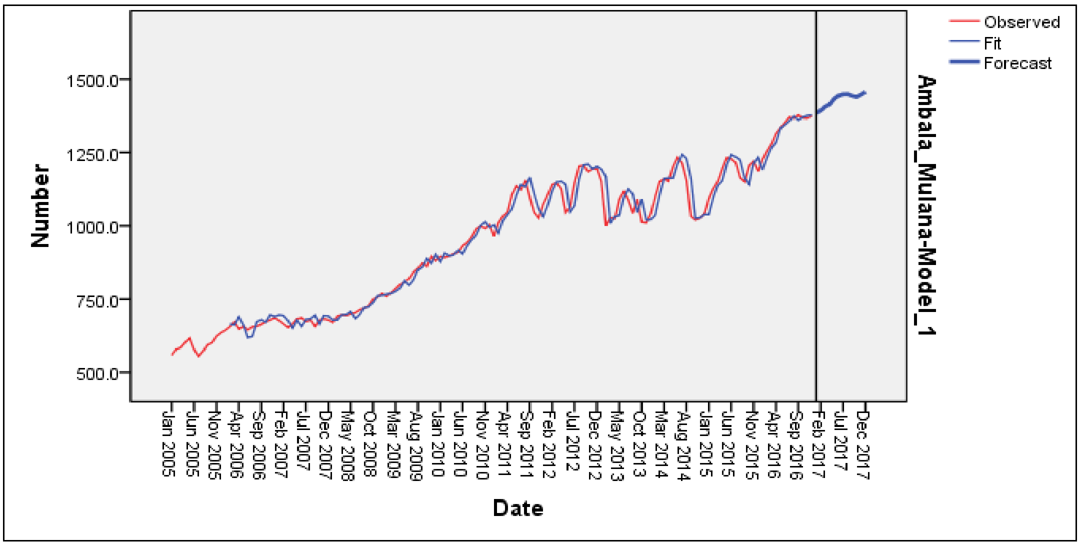
Table 6: Autocorrelation and partial autocorrelation functions of average monthly price in Ambala city market of Ambala district

Autocorrelations						**Partial Autocorrelations**		
Lag	**Autocorrelation**	**Std. error[a]**	**Box-Ljung statistic**			**Lag**	**Partial autocorrelation**	**Std. error**
			Value	**df**	**Sig.[b]**			
1	0.970	0.082	138.395	1	0.000	1	0.970	0.083
2	0.937	0.082	268.498	2	0.000	2	-0.067	0.083
3	0.905	0.082	390.565	3	0.000	3	-0.011	0.083
4	0.876	0.082	505.844	4	0.000	4	0.050	0.083
5	0.851	0.081	615.506	5	0.000	5	0.046	0.083
6	0.827	0.081	719.592	6	0.000	6	-0.024	0.083
7	0.802	0.081	818.214	7	0.000	7	-0.009	0.083
8	0.782	0.080	912.816	8	0.000	8	0.089	0.083
9	0.763	0.080	1003.450	9	0.000	9	-0.018	0.083
10	0.743	0.080	1089.966	10	0.000	10	-0.028	0.083
11	0.722	0.080	1172.474	11	0.000	11	0.006	0.083
12	0.702	0.079	1250.973	12	0.000	12	-0.006	0.083
13	0.685	0.079	1326.347	13	0.000	13	0.048	0.083
14	0.668	0.079	1398.424	14	0.000	14	-0.035	0.083
15	0.651	0.078	1467.481	15	0.000	15	0.021	0.083
16	.636	0.078	1533.831	16	0.000	16	0.017	0.083
[a]. The underlying process assumed is independence (white noise).								
[b]. Based on the asymptotic chi-square approximation.								



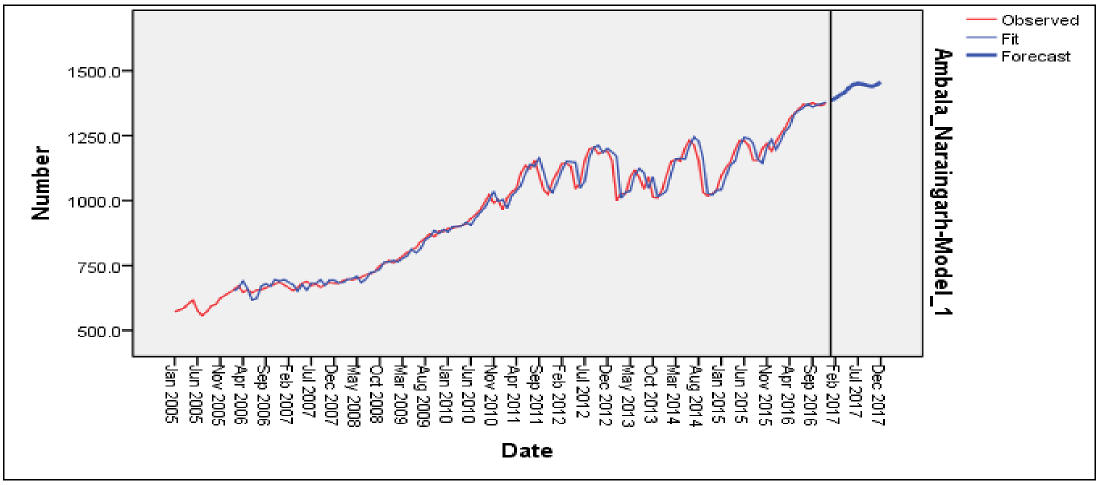
Month	Jan.-2017	Feb.-2017	Mar.-2017	Apr.-2017	May-2017	Jun.- 2017	Jul.-2017	Aug.-2017	Sep.-2017	Oct.-2017	Nov.-2017	Dec.-2017
Prices Rs./q	1381	1387	1400	1409	1428	1440	1444	1441	1436	**1433**	**438**	1449

Fig 1: Forecasting of maize for average monthly price of Sahazdpur market of Ambala district (Main market).



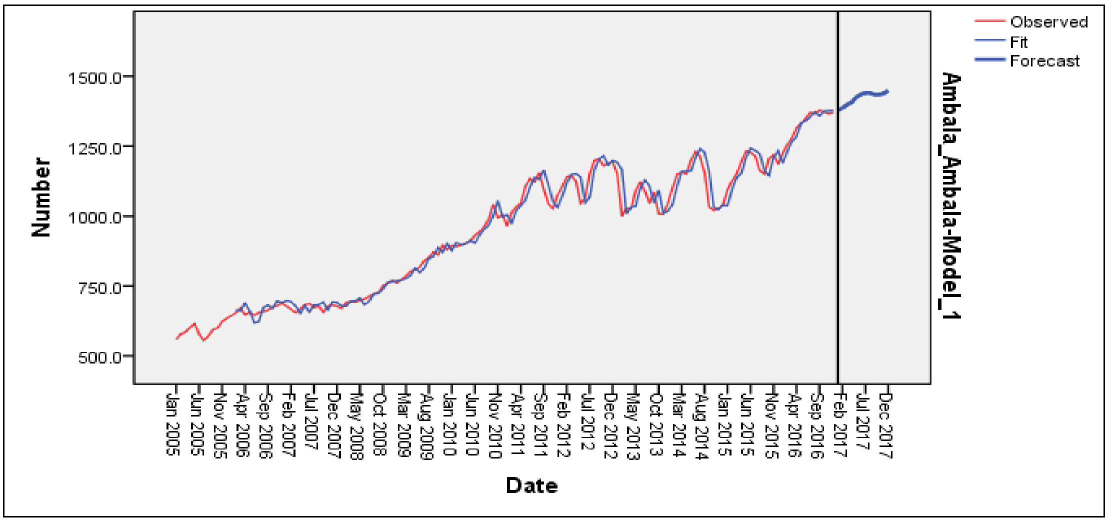
Month	Jan.-2017	Feb.-2017	Mar.-2017	Apr.-2017	May-2017	Jun.- 2017	Jul.-2017	Aug.-2017	Sep.-2017	Oct.-2017	Nov.-2017	Dec.-2017
Prices Rs./q	1384	1393	1406	1413	1433	1443	1448	1448	1443	**1439**	**1447**	1456

Fig 2: Forecasting of maize for average monthly price of Mullana market of Ambala district (Reference market).



Month	Jan.-2017	Feb.-2017	Mar.-2017	Apr.-2017	May-2017	Jun.- 2017	Jul.-2017	Aug.-2017	Sep.-2017	Oct.-2017	Nov.-2017	Dec.-2017
Prices Rs./q	1387	1393	1406	1415	1435	1447	1451	1448	1443	**1439**	**1445**	1456

Fig 3: Forecasting of maize for average monthly price of Naraingarh market of Ambala district (Main market).



Month	Jan.-2017	Feb.-2017	Mar.-2017	Apr.-2017	May-2017	Jun.- 2017	Jul.-2017	Aug.-2017	Sep.-2017	Oct.-2017	Nov.-2017	Dec.-2017
Prices Rs./q	1378	1386	1399	1406	1425	1436	1441	1440	1435	1435	1439	1449

Fig 4: Forecasting of maize for average monthly price of Ambala city market of Ambala district (Reference market).

Table 7: Cointegration between selected markets for maize selected agricultural commodities in Haryana

Name of district	Name of Market	Name of Crops	Dickey-Fuller test	Dickey- Fuller value	Order of integration
Ambala	Sahzadpur	Maize	-2.350	-0.836	0
	Mullana		-2.340	-0.836	0
	Naraingarh		-2.350	-0.836	0
	Ambala city		-2.335	-0.836	0

Conclusion

In our study the developed model for average prices for maize in Ambala district was found to be ARIMA (0,1,0) (1,1,1) respectively. From the forecast variable by using the developed model, it can be seen that forecasted average price increases the next years. The validity of the forecasted value can be checked when data for the lead periods become available. The model can be used by researchers for forecasting average prices in Ambala. However, it should be updated from time to time with incorporation of current data.

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