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A UNIVARIATE TIME SERIES MODELLING OF DATES EXPORTS IN PAKISTAN*

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ABSTRACT

Export plays a significant role in the economic growth of a country. Increase in export led to an increase in production and ultimate outcome is economic growth. The purpose of this study was to build a forecast model meant for the Exports of Dates in Pakistan for the next 15 years. The yearly data of dates export for the period 1962-2008 was used based on the assumptions that past trends (area planted and yield) and existence of normal weather pattern will hold. The Box-Jenkins methodology was taken as an appropriate set of Autoregressive integrated Moving Average (ARIMA) models that were constructed for future forecast of date exports of Pakistan. The final results of ARIMA showed that date exports of Pakistan provided better results in upward trend for future. Besides this, model selection criteria includes e.g. AIC, SIC, BIC, MAPE and RMSE were used.

Keywords: ARIMA Model; Box-Jenkins Methodology; Dates; Exports; Forecasting; Pakistan; Time Series Modeling.

INTRODUCTION

Date Palm is considered as an important cash crop of district Khairpur, which is a major area producing date in Pakistan. Along with the nutritive and energy value of its fruit the date palm has an economic importance as well. (Ishtiaq, Tariq, & Khalid, 1988). Due to rich nutrients and high carbohydrate content (70-80 %) Dates provide a good source of rapid energy (Al-Farsi et al., 2005). In addition to carbohydrates dates contain fats s, proteins, mineral, and vitamins etc. (Selim & Mahdi, 1970)

"The fruit of date palm is consumed as a best high-energy food. It is also used for the treatment of colds, fever, liver and abdominal troubles. Its nutritional composition strongly depends upon variety and ripening stage. A number of varieties are available in Pakistan but little is known about their composition and nutritional characteristics" (Khan et al., 2008).

Pakistan is blessed with rich soil i.e. plenty of sunshine and four variety of seasons which are ideal combination for cultivation of different varieties of agriculture crops. All these factors help in creating a very unique taste in farm produce. Although Pakistan produce more than 300 varieties of dates but due to lack of processing and packaging facilities these highly valuable varieties do not fetch their real worth in the export market.

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Pakistan's name was emerged being a date exporting country in the beginning of 80s in the last century. Today, Pakistan is the fourth largest exporters of this fruit in the world. Major buyers of our dates include Canada, the USA, Germany, the UK, Denmark, Australia, India, Bangladesh, Nepal, Sri Lanka, South Africa, Dubai, Japan, China, South Korea and North Korea etc. The current export stands at 89.10 thousand tones worth $32.0 million. The major countries importing both fresh and dried dates from Pakistan are India, USA, UK, Canada, Germany, Denmark, Malaysia and Indonesia.

The world largest importer of this fruit is India which has the market share of about 38 percent of total world import, while France and UK are second and third largest importers with shares of 4 percent and 2.5 percent respectively. The world date import is about 0.63 million tons per annum while it is estimated that annually about 6 million tones of dates are produced world over.

According to Food & Agriculture Organization, Egypt, Saudi Arabia, Iran, UAE, Algeria, Pakistan, Sudan, Oman, Libya, China and Tunisia are the major date producing countries of the world. Pakistan is one of the main growers of dates. It follows Egypt, Saudi Arabia, Iran and UAE in the list of top date producing countries with 10 percent share of global production. Baluchistan is the largest date producing province followed by Sind.

Objectives

The purpose of this study is to:

- Estimate the growth in Production and Export of Dates in Pakistan
- Forecast the production and export of Dates for next 15 years
- Suggest the policy guidelines to boost production and export of Dates and improve its marketing system

Therefore an extensive effort has been done to search the literature concerning the forecast of various commodities with the time series modeling.

RESEARCH METHODOLOGY

Modeling and forecasting of agriculture commodities has traditionally been carried out by using various econometric modeling techniques. The reason for using ARIMA model is that ARIMA is the most general class of forecasting models and a lot of work is done by various authors in different part of the world like Anwar & Javed (1997) used this model in the forecast of cotton yarn export from pakistan to gain its future estimates up to the year 2010. Ahmad, Ghafoor, & Hammad (2005) estimated the past growth trend in production and export of Kinnow using ARIMA model to forecast the production and export of Kinnow for next 20 years. Checking the past and future pattern in specific spesific sector or product is intresting area. Different studies used different methods to check the past and future pattern such as Mehmood et al. (2012) used Balassa index to explore the future patterns of chemical exports based on calculation of past patterns.

Yusuf et al. (2007) provides the prediction of future production of citrus and mango up to the year 2010 in Nigeria using various forecasting techniques. Sapsford et al. (1990) compares monthly coffee prices with the effectiveness of the seasonal ARIMA and econometric approaches in the forecasting finds that ARIMA approach appears more suitable and uses MSE (mean square error) criterion for selection of model. Chandranet, (2007) analyzed the Potato wholesale prices of Delhi market using univariate seasonal ARIMA model. Based on the Shwartz Bayes Criterion (SBC) and Akaike Information Criterion (AIC), they estimated best ARIMA model and find that Short term forecasts based on this model were close to the observed values.

Mad & Fatimah (1991) provides short term forecasts of Malaysian crude palm oil prices. They forecast by using multivariate-autoregressive-moving average (or MARMA) model that integrates the normal autoregressive-integrated-moving average (ARIMA) model for the residuals into an econometric equation. Nochai & Nochai (2006) worked on the model of palm oil price for forecasting in three types that is farm, wholesale and pure oil price for the period of five years, 2000 – 2004 in Thailand.

The data used in this study were collected from secondary sources like FAO Stat, Export Promotion Beureu of Pakistan for period of 1961-2008 covering a span of 48 years. Autoregressive Integrated Moving Average (ARIMA) model following Box-Jenkins technique is applied on the collected data. In this paper the aim is to build a suitable and the most appropriate model which can be used to forecast the Dates exports of Pakistan. In this chapter: Box-Jenkins Methodology, Unit Root test, Dickey Fuller Test, The Augmented Dickey Fuller Test, ARIMA model and diagnostic checks are described.

THEORETICAL BASIS OF TIME-SERIES ANALYSIS

The Box-Jenkins Methodology

The Box-Jenkins Methodology is regarded as the most efficient forecasting technique, used in analysis and forecasting and is used widely and extensively specially for univariate time series modeling. The four step strategy of identification, estimation and diagnostic checking, forecasting is applied. Box-Jenkins methodology is distinct to other techniques, in a way that it uses a variable's past performance to select the best forecasting model from a general class of models. It assumes that one of these three categories of models can represent any time series pattern.

- Autoregressive models (AR): Basis of forecasts is linear function of variables past values.
- Moving Average model (MA): Basis of forecasts is linear combination of past errors.
- Autoregressive-Moving Average models (ARMA): combination of both categories.

Investigation of Unit Root

Unit root test is used to test the proposition that in an autoregressive statistical model of a time series, the autoregressive parameter is one. This unit root test has become widely used in time series analysis to check the stationary of a variable using an autoregressive model (Afzal, 2012 and Mehmood, 2012). Let us consider the unit root (stochastic) process:

$$Y_t=PY_{(t-i)} + e_t \qquad -1\leq\rho\leq+1$$

Where ε_t represents the white noise error term .As if $\rho=1$, that is in the case of unit root, the above equation becomes:

$$Y_t=Y_{(t-1)} + \varepsilon_t$$

That represents the random walk model without drift which is a part of non-stationary stochastic process. Thus, if the estimated value of P equals TO one, then Yt is non stationary. This is the general idea behind the unit root test of stationarity.

Dickey fuller test. A Dickey-Fuller test is used to check whether a certain kind of time series data has an autoregressive unit root. This test is widely used in many researches to test the Stationary of any process (Javed, 2012; Mehmood, 2012; and Rehman, 2012). Let us consider the following three different forms of random walk process:

$\Delta Y_t = \delta Y_{t-1} + \varepsilon_t$ $\qquad Y_t$ Represents random-Walk

$\Delta Y_t = \beta_0 + \delta Y_{t-1} + \varepsilon_t$ $\qquad Y_t$ Represents random-Walk with drift

$\Delta Y_t = \beta_0 + \beta_1 t + \delta Y_{t-1} + \varepsilon_t$ $\qquad Y_t$ Represents random-Walk with drift with trend

Where 't' represents the time or trend variable. In each case, the null hypothesis is that there is a unit root, $\delta = 0$, $\delta=\rho-1$ it means that there is a unit root and there is non-statinarity in time series. The alternate hypothesis is that <0, that is time series stationary. Whereas the possibility of alternate hypothesis i.e. δ>0 is ruled out because in this case ρ is greater than one which is not possible.

The augmented dickey fuller test. It is an augmented version of the Dickey–Fuller test for a unit root for a larger and more complicated set of time series models. It is the extension of Dickey–Fuller (DF) test which removes all the structural effects of autocorrelation in the time series. The augmented Dickey–Fuller (ADF) statistic, used in the test shows a negative number. The more negative it is, the stronger the rejection of the hypothesis that there is a unit roots at some level of confidence. The testing procedure for the ADF test is the same as for the Dickey–Fuller test but it is applied to the model.

$$\Delta y_t = \alpha + \beta t + \gamma y_{t-1} + \delta_1 \ \Delta y_{t-1} + \cdots + \delta_{p-1} \ \Delta y_{t-p} + \varepsilon_t$$

Where α is a constant, β the coefficient on a time trend and p the lag order of the autoregressive process. Imposing the constraints α = 0 and β = 0 corresponds to modeling a random walk and using the constraint β = 0 corresponds to modeling a random walk with a drift. Consequently, there are three main versions of the test, analogous to the ones discussed on the Wikipedia page for the Dickey-Fuller test. See that page for a discussion on dealing with uncertainty about including the intercept and deterministic time trend terms in the test equation.

By including lags of the order p the ADF formulation allows for higher-order autoregressive processes. This means that the lag length p has to be determined when applying the test. One possible approach is to test down from high orders and examine the t-values on coefficients. An alternative approach is to examine information criteria such as the Akaike information criterion, Bayesian information criterion or the Hannan-Quinn information criterion.

ARIMA Model (Auto-Regressive Integrated Moving Average)

This model is a generalized form of ARMA model by Box and Jenkins. The model is generally referred to as an ARIMA (p,d,q) model where p, d, and q the autoregressive order of, integrated, and moving average parts of the model respectively. ARIMA models form an important part of the Box-Jenkins approach to time-series modelling. When one of the terms is zero, it can be eliminated. For example, an I(1) model is ARIMA(0,1,0), and a MA(1) model is ARIMA(0,0,1).

An autoregressive (AR) model is a type of random process which is often used to model and predict various types of natural phenomena. The notation AR (p) indicates an autoregressive model of order p. The AR (p) model is defined as:

$$Y_t = \alpha_1 Y_{t-1} + \alpha_2 Y_{t-2} \dots \dots + \alpha_p Y_{t-p} + \varepsilon_t$$

In time series analysis, the moving average (MA) model is a common approach for modeling univariate time series models. The notation MA (q) refers to the moving average model of order q:

$$Y_t = \varepsilon_t + \beta_1 \varepsilon_{t-1} + \beta_2 \varepsilon_{t-2} \dots \dots + \beta_q \varepsilon_{t-q}$$

Then the ARMA (p,q) model is given as:

$$Y_t = \alpha_1 Y_{t-1} + \alpha_2 Y_{t-2} \dots \dots + \alpha_p Y_{t-p} + \varepsilon_t + \beta_1 \varepsilon_{t-1} + \beta_2 \varepsilon_{t-2} \dots \dots + \beta_q \varepsilon_{t-q}$$

This model is a generalized form of ARMA model by Box and Jenkins. The model is generally referred to as an ARIMA (p,d,q) model where p, d, and q are non-negative integers that refer to the order of the autoregressive, integrated, and moving average parts of the model respectively. ARIMA models form an important part of the Box-Jenkins approach to time-series modeling.

$$\Delta^d Y_t = \alpha_1 Y_{t-1} + \alpha_2 Y_{t-2} \dots\dots + \alpha_p Y_{t-p} + \varepsilon_t + \beta_1 \varepsilon_{t-1} + \beta_2 \varepsilon_{t-2} \dots\dots + \beta_q \varepsilon_{t-q}$$

Diagnostic Checks

Subsequent are few diagnostic checks which each estimated model has to fulfill:

- The residuals are normally distributed
- The projected model is stable
- The residuals of the projected model are not serially correlated

The Q- statistic. In any huge group of autocorrelations, some surpass two-standard deviation because of pure possibility even while the true values in the data generating process are “0”. The Q-statistic is exercise to test whether a set of autocorrelations is significantly diverse from zero. Box and Pierce (1970) make use of sample autocorrelation to form the statistics.

$$Q = T \sum_{k=1}^{s} r_k^2$$

In the null hypothesis that every values of r_k= 0, Q is asymptotically χ^2 distributed by s degree of freedom. A difficulty by way of the Box-Pierce Q-statistic is that it work is inadequate even in moderate huge samples. Ljung and Box (1978) reports better small sample performance in support of the modified Q-statistics designed as:

$$Q = T\,(T+2) \sum_{k=1}^{s} \frac{r_k^2}{T-K}$$

In the null hypothesis, in addition has a χ^2distribution by s degree of freedom.

Histogram-normality test and jarque-bera statistic. The Jarque-Bera test is used to check the normality of the residuals. This test is based on the fact that skewness and kurtosis of normal distribution equal zero. Therefore, the absolute value of these parameters could be a measure of deviation of the distribution from normal. Using the sample Jarque-Bera statistic is calculated:

$$Jarque - Bera = \frac{N-p}{6}\left[S^2 + \frac{(k-3)^2}{4}\right]$$

Where Sand K represents the kurtosis and skewness respectively while p denotes estimated number of coefficients employed to create the series. The distribution of Jarque-Bera is chi-square by 2 degree of freedom in the null hypothesis with the purpose of distribution of error is normal. The non-normality of the error term can be specifying by the significance of this check statistic.

Model Selection Criteria

Schwaarz Information Criteria (SIC) and Akaike Information Criteria (AIC). SIC is applied to enforce harsher penalty than AIC for adding huge number of regressors in the model. The measure is symbolically written as:

$$SIC = n^{k/n} \frac{RSS}{n}$$

Or

$$\text{In}(SIC) = \frac{k}{n} \text{In}\, n + \text{In}\,(\frac{RSS}{n})$$

AIC is exercised to enforce penalty for adding increasingly huge number of regressors in the model. This measure is symbolically written as:

$$AIC = e^{2k/n} \frac{RSS}{n}$$

Or

$$\text{In}(AIC) = \frac{2k}{n} + \text{In}\left(\frac{RSS}{n}\right)$$

Where "n" is number of observations and "k"n is number of regressors including intercept and "RSS" Residuals sum of squares. Both the criteria can be utilizing in sample as well out-of-sample forecasting lower values of SIC and AIC is chosen.

Goodness of Fit. The major concern is to approximate a model that can elucidate the data well and such a model is measured as a superior projected model. Within regression theory, two measures; 〖R〗^2 and sum of squares of residuals, are the vital measures to verify the goodness of fit of any model. Although there is one weakness linked by these measures is that they depend on the number of the parameters incorporated in the model. The raise in the number of parameters reason the loss of degree of freedom. Because of this weakness, two other criterion, known as SBC (Schwartz Bayesian Criteria) and AIC (Akaike Information Criteria) are preferred for the purpose of model selection.

RESULTS AND DISCUSSIONS

Root mean squared error (RMSE), mean absolute percentage error (MAPE), mean absolute error (MAE) were used as the selection criteria to determine the best forecasting model. This study revealed that time series data were influenced by a positive linear trend factor. Moreover, the autocorrelation function (ACF) and augmented dickey fuller (ADF) have shown that time series data was not stationary after the first order of differentiating process was carried out. Various diagnostic checks were carried out which shows that ARIMA (2, 1, 0) is an appropriate model for time series data of dates export from the year 1961-2008. The forecast exhibited that up to the year 2025 there will be a significant improvement in the exports of dates.

Summary Statistics

Figure 1 indicated that Pakistan average Dates exports were 28.129 thousand tons during the last 48 years from 1960 to 2009. And the most balanced point of the Dates export during this period was 17654.50 tons. In this duration the minimum export was 0.000 tons in 1971 and the maximum export was 104090.0 tons in 2007. This summary showed an increasing trend in the GDP of Pakistan. The statistics also pointed out the high variation of 32027.89 tons from the average of dates export. The skewness was greater than zero reveal the right skewed distribution, which was 0.789071 while kurtosis is 2.307470 showed, the leptokurtic distribution.

Insert Figure 1 about here

Insert Figure 2 about here

Tests for Stationary

The basic prerequisite of time series analysis was that the utilized data have to be stationary. The mathematical measures these measures incorporated the Philips Perrin (PP) and of Unit-Root Tests of Dickey Fuller (DF) a type. Within this study both the objectives and subjective measures were used for checking the stationarity of the observed figures.

ADF test of Dates Export at first difference. The Augmented Dickey-Fuller unit root test on Dates exports at level below data indicates that the hypothesis: Dates exports has a unit root, was acknowledged that means of the series was non stationary at level. Whereas results from Table 1evidently indicated that the series was stationary at first difference.

TABLE 1
ADF Test of Dates Export at First Difference

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-9.650560	0.0000
Test critical values:	1% level	-3.584743	
	5% level	-2.928142	
	10% level	-2.602225	

It was observed that the series of Dates export was not stationary at level however it became stationary at the first difference. The same results were shown by correlograms from Figure 3, at first difference.

Insert Figure 3 about here

TABLE 2
Comparison of Different ARIMA Models

Fit Statistics	0,0,0	0,1,1	1,0,1	2,1,0
Stat. R Square	5.280E-17	.271	.882	.398
R square	5.280E-17	.934	.882	.946
RMSE	32027.893	8321.625	11236.236	7649.199
MAPE	131311.168	20128.764	3636.097	21430.570
MaxAPE	2812864.583	450394.886	59076.522	451964.250
MAE	27352.045	6418.418	6288.167	5971.844
MaxAE	75960.354	22453.043	43821.150	23067.491
BIC	20.829	18.217	18.896	18.130
Q State	246.432	24.146	12.585	12.139

The initial step in Box-Jenkins methodology is recognition: to be come across the appropriate principles of p (Auto-regressive term), d (no of difference taken) and q (moving average term), which depend on the presentation of correlograms of auto-correlations and partial auto correlations. The significance of p is obtained from correlogram of partial auto correlations and the significance of q is attaining from the correlogram of auto-correlation.

In the above Table 2, four different models are given to estimate the best fit model, for this it is considered that the value of R-squared must be maximum and remaining values of Stationary R-squared, RMSE, MAPE, MaxAPE, MAE, MaxAE and Normalized BIC must be minimum. While analyzing the above table, the parameters of ARIMA (2, 1, 0) have been noticed and the outcomes of the projected ARIMA model are given in below table.

TABLE 3

Best Selected Model among Different ARIMA Models

ARIMA (2,1,0)	Estimate	SE	t	Sig.
Constant	2097.433	529.500	3.961	.000
AR1	-.633	.130	-4.853	.000
AR2	-.508	.133	-3.823	.000
Difference	1			

Results from Table 3 indicate that ARIMA (2, 1, 0) is an appropriate model obtained from Table 2 among different model. Figure 4 indicates the econometrics form of best fit ARIMA model.

Insert Figure 5 about here

TABLE 4

Forecast Values Based on Best Select Model for the period of 2010-2025

Years	Forecast(000 tons)	LCL(95%)	UCL(95%)
2010	97071	81668	112475
2011	104638	88231	121046
2012	102339	85452	119227
2013	104441	84814	124067
2014	108770	87919	129621
2015	109452	87792	131112
2016	111311	88182	134441
2017	114279	90029	138529
2018	115947	90797	141097
2019	117874	91635	144112
2020	120297	93068	147527
2021	122275	94161	150388
2022	124283	95243	153322
2023	126498	96568	156427
2024	128566	97802	159331
2025	130622	99023	162221

CONCLUSION & RECOMMENDATIONS

This paper provided the prediction of future production of dates in Pakistan for a period of 15 years. The prediction is based on the assumptions that past trends and existence of normal weather pattern will hold. The time series analysis is used for forecasting future trends of production and exports. Forecasting is done for the period of 2008-2025; Figure 4 graphs reveal that the forecast behavior is showing an upward trend while the Table 4 shows that the Dates export of Pakistan is showing an increased growth percentage could attain 130.6 thousand tons in 2025 with the lower limit of 99.02 thousand tons and the upper limit of 162.22 thousand tons. The finding of the study indicates that Dates exports in ARIMA model (2, 1, 0) has been provided better results and upward trend for future.

There is a huge gap to improve quality of product to enhance foreign exchange earnings by removing pre and post harvest production constraints and improved marketing. It is therefore important that measure should be taken to find new date products that could increase the value of their exports.

Future Research

To improve the forecasting ability of econometric models it is suggested that co-integration might be utilized in further work.

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APPENDIX

FIGURE 1
Summary Statistics

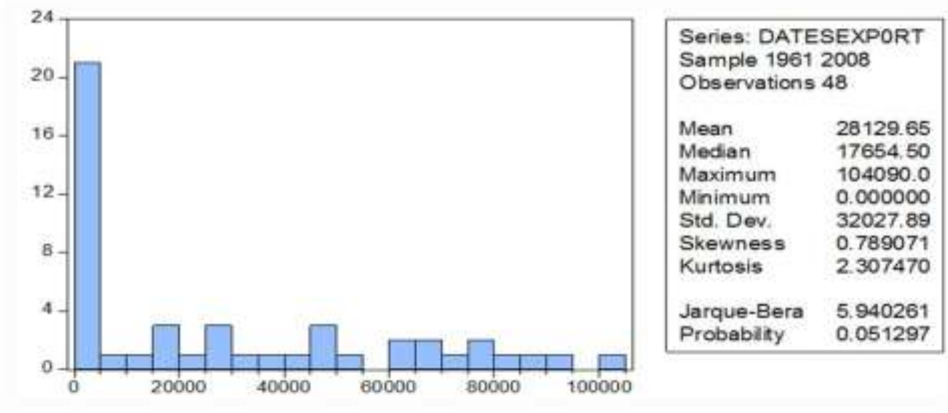

FIGURE 2
Line Graph of Dates Export at First Difference

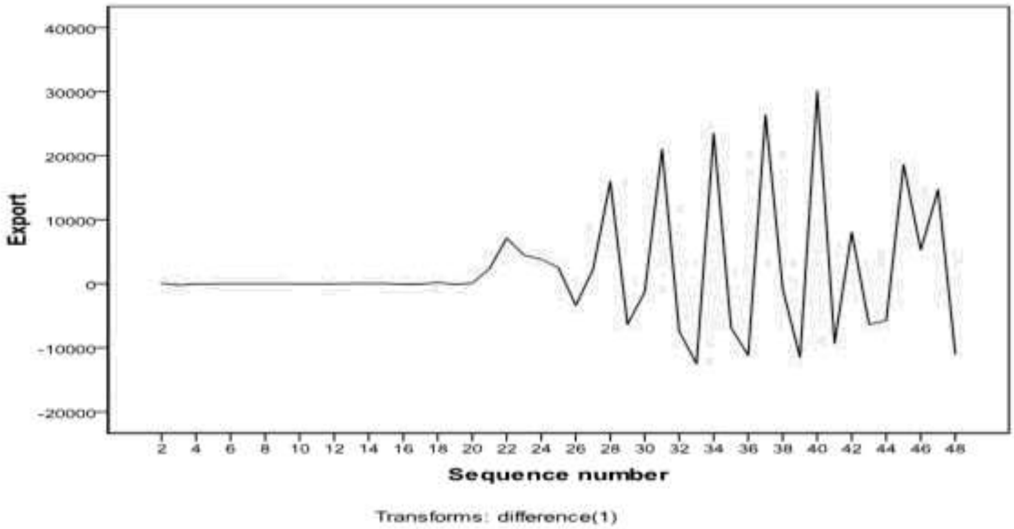

FIGURE 3
Correlogram of Dates Export at First Difference

<table>
<tr><th>Autocorrelation</th><th>Partial Correlation</th><th></th><th>AC</th><th>PAC</th><th>Q-Stat</th><th>Prob</th></tr>
<tr><td>***| . |</td><td>***| . |</td><td>1</td><td>-0.418</td><td>-0.418</td><td>8.7468</td><td>0.003</td></tr>
<tr><td>**| . |</td><td>****| . |</td><td>2</td><td>-0.243</td><td>-0.506</td><td>11.760</td><td>0.003</td></tr>
<tr><td>. |**** |</td><td>. |** |</td><td>3</td><td>0.501</td><td>0.223</td><td>24.889</td><td>0.000</td></tr>
<tr><td>**| . |</td><td>.*| . |</td><td>4</td><td>-0.305</td><td>-0.072</td><td>29.870</td><td>0.000</td></tr>
<tr><td>.*| . |</td><td>. | . |</td><td>5</td><td>-0.080</td><td>-0.037</td><td>30.224</td><td>0.000</td></tr>
<tr><td>. |** |</td><td>. | . |</td><td>6</td><td>0.312</td><td>0.054</td><td>35.695</td><td>0.000</td></tr>
<tr><td>.*| . |</td><td>. |** |</td><td>7</td><td>-0.066</td><td>0.283</td><td>35.948</td><td>0.000</td></tr>
<tr><td>.*| . |</td><td>. | . |</td><td>8</td><td>-0.158</td><td>0.040</td><td>37.432</td><td>0.000</td></tr>
<tr><td>. |** |</td><td>. |*. |</td><td>9</td><td>0.227</td><td>0.123</td><td>40.541</td><td>0.000</td></tr>
<tr><td>. | . |</td><td>. |*. |</td><td>10</td><td>-0.028</td><td>0.078</td><td>40.590</td><td>0.000</td></tr>
<tr><td>.*| . |</td><td>. |*. |</td><td>11</td><td>-0.102</td><td>0.161</td><td>41.256</td><td>0.000</td></tr>
<tr><td>. |*. |</td><td>.*| . |</td><td>12</td><td>0.080</td><td>-0.080</td><td>41.675</td><td>0.000</td></tr>
<tr><td>. | . |</td><td>.*| . |</td><td>13</td><td>-0.016</td><td>-0.095</td><td>41.693</td><td>0.000</td></tr>
<tr><td>. | . |</td><td>.*| . |</td><td>14</td><td>-0.047</td><td>-0.112</td><td>41.847</td><td>0.000</td></tr>
<tr><td>. | . |</td><td>. | . |</td><td>15</td><td>0.039</td><td>-0.054</td><td>41.958</td><td>0.000</td></tr>
<tr><td>. | . |</td><td>.*| . |</td><td>16</td><td>0.022</td><td>-0.108</td><td>41.994</td><td>0.000</td></tr>
<tr><td>. | . |</td><td>. | . |</td><td>17</td><td>-0.024</td><td>-0.034</td><td>42.036</td><td>0.001</td></tr>
<tr><td>. | . |</td><td>. | . |</td><td>18</td><td>0.022</td><td>0.026</td><td>42.075</td><td>0.001</td></tr>
<tr><td>. | . |</td><td>. |*. |</td><td>19</td><td>0.030</td><td>0.132</td><td>42.151</td><td>0.002</td></tr>
<tr><td>. | . |</td><td>. | . |</td><td>20</td><td>-0.062</td><td>0.017</td><td>42.483</td><td>0.002</td></tr>
</table>

FIGURE 4
Pattern of Forecast Values