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Using random time series to predict barley production in Iraq

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Abstract

The use of random time series is one of the important statistical methods to forecast the studied chain and production of barley in Iraq. Barely has economic and livelihood importance. Also, it is used as livestock to feed animal because of the many problems facing farmers such as wars, water scarcity, migration and increasing salts Soil ... etc. This in itself is one of the prominent reasons that prevented the Iraqi farmer from directing attention to the production of barley. Because of its importance, barely is used in this research to predict its production in Iraq. Random time series models were used to obtain the best prediction model.

The results were reached using statistical methods to find out the reality of the development of production during 1965 to 2019. Also, the EVIEWS 10 program was used to reach the results. It was found that the extent of similarity of production between the governorates of Anbar and Salah al-Din according to the variables of sustainable development. The results show that the series does not It suffers from the heterogeneity of the variance nor from the seasonal variations of the studied series. In addition, the appropriate and best selected models for prediction are AR (1), MA (1), ARMA (1,1). Testing and estimating the parameters show that the best model is the AR model (1). It helped to obtain the predictive equation for the model and prediction for the years 2020 and 2021. Furthermore, it proved its accuracy and its close predictive value.

Keywords: Residual, Differences, Model, Inverse roots, Diagnose

1.1 The Introduction:

Barley is an important agricultural crop because of its economic and subsistence importance. It has multiple, as 10% of the Iraqi population uses barley bread instead of wheat because of its health aspects and its importance as food for different animal types. That is, it is one of the reasons for preserving livestock(1).

Barley production in Iraq is scarce because of the scarcity of water, migration of farmers from the countryside to the city, land salinity due to leaving it for long periods without cultivation and the lack of county support to farmers etc. Many agricultural crops decreased. In addition, farmers are not encouraged because of the lack of interest in cultivating barley. They only pay attention to wheat cultivation because it is the more important than barely. This lack of interest significantly decreased not filling the state's need for barley (2)

Iraq was one of the most important and best countries in exporting agricultural crops because of its fertile lands and the availability of water from the Tigris and Euphrates rivers. These factors caused the deterioration of the agricultural and economic situation, although Iraq is the cradle of civilizations that were the first to inhabit the land and were cultivated from crops of wheat and barley in the world. Because of the barely importance, the researcher decided to study it using the data of barley yield from 1965 to 2019.

1.2 Previous studies:

Several studies dealt with the use of the time series methodology to predict a number of phenomena in the economic and social, and a few in the agricultural field(11).

aimed to build a standard model for family demand for electricity in Algeria for the period 1969-2008, His study showed that the best model representing the demand for electricity is ARIMA (0,2,1).(10)

applied integrated self-regression models and moving average to crude oil production in Sudan for the period (2005-2012). The researcher found that the model ARIMA (1,1,0) suits the nature of his data achieving high predictive power according to the predictive power test.

The researcher Bahra study was intended for family consumption record analysis (a case study of Sonelgaz Unit of Bouira during the period 2008-1-12-2013). Mohammed confirmed that the first-rate self-regression model is the best representative model for the series (8)

1.3the study problem :

The research problem lies in answering the following questions:

Does the time series for barley production include the secular trend component?

Does the time series of barley production suffer from the problem of heterogeneity of variance?

Does the time series of barley production have a normal distribution?

The main problem is to find a suitable model for barley production in Iraq to get the reality of the decline in barley cultivation in Iraq

1.4 purpose of the Study :

The study aims to provide a sound and accurate statistical tool for forecasting the production of barley in Iraq.

1.5 the Importance of Studying:

The study is important because it aims at developing an appropriate model used to predict the production of barley in Iraq, using the methodology of random time series analysis.

1.6 study hypotheses :

To answer the research questions, the hypotheses were formulated as follows:

The first hypothesis:

The barley production time chain does not suffer from the problem of heterogeneity

The second hypothesis:

The time series for barley production does not include the secular trend component

The third hypothesis:

The time chain of barley production has a normal distribution

1.7 Research approach:

The descriptive and analytical method was used in the completion of this research. It reviews many studies on the Box - Jenkins methodology in analyzing time series because of its advanced capabilities in such analysis

This topic includes an introduction to random time series models

1-2 Random time series models (3 ,)

This methodology gives a powerful strategy and accurate predictions for time series. Box-Jenkins models or what is sometimes called ARIMA model are an organized method for building and analyzing models in order to find the optimal model among the models based on time series data. following (3):

2- 2 Box-Jenkins Model Application Considerations (3 , 4 , 5, 7)

Before applying the Box-Jenkins method for time series analysis, the following concepts must be studied, as they are closely related to this methodology:

First: Stability

All economic applications assume that the time series has the characteristic of stability or stationary, and that the first step in applying the Box-Jenkins method is to ensure that the time series is stable. Also, the stability in statistical terms is intended for the arithmetic mean and variance of the time series to be constant(4; 7).

The time series stability or instability can be decided in two ways. The first is by viewing the graph of the studied phenomenon. The second is by seeing the two functions of self-correlation and partial self-correlation, whose values do not approach zero after the second or third displacement, but rather their values remain large for a number of displacements,

Below is a brief presentation of how to use it to detect chain instabilities.

Second: Self-link function

The autocorrelation function plays a major role in testing the stability of the time series. It also has a big role in testing the stability of the time series through the following:

- **Confidence intervals**

The autocorrelation coefficient falls between (-1,1). The stability of the chain here requires that the estimated value of the autocorrelation coefficient to be equal to zero or not different from any time gap (4; 7). When the series is stable, the autocorrelation coefficients of the sample often have a normal distribution, the mean of which is equal to zero and the variance of (1 / n). The confidence limits for a large sample are:

$$\pm 1.96\sqrt{1/n}$$

It is lower than the level of significance (95%), therefore, we accept the null assumption that this parameter is equal to zero, and therefore the time series is considered stable.

- **Box, Pierce test**

A test can be performed to detect the significance of the autocorrelation coefficient as a group, using the Box, Pierce test statistic. This test can be administered in the following formula (4; 5): -

$$Q=n\sum_{k=1}^{m}\hat{P}_k^{\,2}$$

So that:

m is the number of time slots

Ljung-Box test

There are other alternative statistic that are used to perform the same Box, Pierce test, called the Ljung-Box statistic (4; 5):-

$$LB = n(n+2)\sum_{k=1}^{m}\frac{\hat{P}^2_k}{n-k}$$

It has a chi-square distribution with a degree of freedom equal to m and gives better results than Q in the case of small-sized samples, although it is suitable for large-sized samples.

Third: Partial autocorrelation function(6)

The PACF partial self-association function represents the relationship between values of a variable during two different time periods, assuming the stability of other periods, and symbolizes the partial self-association function of the symbol. The partial self-correlation factor between Yt,Yt-k indicates a correlation between them while excluding other Yt values that fall between the two periods (t,t-k) (6).The mathematical equation of the partial self-correlation factor can be formulated from the self-correlation equation and to calculate the partial self-bonding function of the sample repeatedly through the following:

$$r_{kk} = \frac{r_k - \sum_{j=1}^{k-1} r_{k-1,j} r_{k-j}}{1 - \sum_{j=1}^{k-1} r_{k-1,j} r_j}, \quad k = 2,3,...$$

-1 $V\left(r_{kk}\right) \cong \frac{1}{n}, \quad k > 0$ Here,

For large n values, r_{kk} has an almost normal distribution and thus we can perform the following test:

$$H_0 : \phi_{kk} = 0$$
$$H_1 : \phi_{kk} \neq 0$$

This is by using the following formula

$$\frac{|r_{kk}|}{n^{-\frac{1}{2}}} = \sqrt{n}\,|r_{kk}|$$

And that's at a mean value. $\alpha = 0.05$ rejecting H_0 if it is $\sqrt{n}\,|r_{kk}| > 1.96$ (5)

3- 2Models of Box-Jenkins Models (3)

The Box-Jenkins method relies on a set of (Stochastic models), including (5 ,6):

First: Self-regression model of the degree AR(p)

The self-regression model of p-degree can be written according to the following formula

$Y_t = \phi_0 + \phi_1 Y_{t-1} + \phi_2 Y_{t-2} + ... + \phi_p Y_{t-p} + e_t$

Here

P is the score of the autoregressive model

Yt is a variable representing the time series

Yt-p is a variable representing the slowed time series p of scores

$\phi_0, ..., \phi_p$ is the parameters of the model to be assessed.

e_t is the random error element, which is supposed to have a normal distribution with an average of zero and a constant variation equal to σ^2.

Second: Moving average model MA(q)

It is said that yt is a moving averages process of finite order q if it can be expressed as:

$y_t = \varepsilon_t - \theta_1 \varepsilon_{t-1} - \theta_2 \varepsilon_{t-2} - ..... - \theta_q \varepsilon_{t-q}; t = 0, \pm 1, ...$

whereas:

Where:

ε_t :Quiet disturbances

$\theta_1, ..., \theta_q$:Constants representing parameters or model transactions Constants representing parameters or model transactions

These models are referred to as MA (q) and are always static processes, because the order of form Q is limited. Ma (q) models are reflected if the roots of the distinctive equation $\theta(B) = 1 - \theta_1 B - \theta_2 B^2 - .... - \theta_q B^q = 0$

They are all outside the unit circle.

Third: ARMA (p,q)

The self-regression model - moving average of degree can be written as follows:

$$z_t = \delta + \phi_1 z_{t-1} + \phi_2 z_{t-2} + \cdots + \phi_p z_{t-p} + a_t - \theta_1 a_{t-1} - \theta_2 a_{t-2} - \cdots - \theta_q a_{t-q}$$

where

$a_t \sim WN\left(0, \sigma^2\right)$ White buzz sequences

$-\infty < \delta < \infty$: Fixed parameter representing the plane

$\phi_1, \phi_2, \ldots, \phi_p$: Autoregressive Parameters

$\theta_1, \theta_2, \ldots, \theta_q$ Moving Average Operators

2.4 Stages of application of Box-Jenkins methodology in time series analysis

Box-Jenkins methodology and the basic stages of its application can be summarized in the following points (12)

<u>First: the dentification (9 , 12)</u>

The first stage of the modern analysis of time series using the Box-Jenkins methodology is the identification of the appropriate initial model for the observed time series data. It is also conducted by identifying the model and the selection of the three model orders (p, d, q):

d is the order or degree of differences necessary to accommodate the time series

p is the number of previous observation boundaries that should be included in the appropriate prototype

q stands for the number of quiet disturbance variables that a suitable model should include.

The recognition stage is one of the most difficult and important stages of analysis, as it requires skill, experience, practical practice and a measure of personal judgment of the researcher (9 , 12)

Second: Appreciation

After completing the stage of identifying the initial model suitable for the available data, the parameters of this model must be estimated using one of the known methods in a statistical theory. The most important of which is the least squares method, which can be written according to the following formula as follows :

For ARMA (p,q) models that are written in shape

$$\phi_p(B)(z_t-\mu)=\theta_q(B)a_t, \quad a_t \sim N(0,\sigma^2)$$

Here $\phi_p(B)\ \theta_q(B)$

with no common roots and roots in the equation $\theta_q(B)=0$.

All of them are outside the circle of unity (coup clause). And the error model: a_t

$$a_t=\frac{\phi_p(B)}{\theta_q(B)}(z_t-\mu)$$

These capabilities are called conditional because here we condition the values $a_p=a_{p-1}=\cdots=a_{p+1-q}=0$ That is, equal to its expectation.

As for the variance estimate σ^2 it is :

$$\hat{\sigma}^2=\frac{S_c(\hat{\boldsymbol{\varphi}},\hat{\boldsymbol{\theta}},\mu)}{n-(p+q+1)}$$

Third: Diagnostic (2 , 9)

The model testing stage or examination is the most important and dangerous among other analysis stages. In this stage, the suitability of the initial model is assured and thus the possibility of using it in forecasting. This model is modified based on the results of the examinations and tests that take place at this stage, and in this case the model must be subjected to all the examinations and tests that we discuss here in detail. This means that the diagnostic stage is essentially a problem of improving or developing the initial model in order to be more suitable for the available data, and the diagnosis of the model in general depends on the conduct of many tests and tests, the most important of which are (2 , 9)

Static analysis

The model is static if the roots of the distinctive equation $\phi(B)=0$ All of them are outside the unit circle،

- ✓ **Reflection analysis**

The model that represents the time series is reflective if the roots of the equation $\theta(B)=0$ located outside the circle of unity،

- ✓ **Residual analysis**

If the prototype chosen in the first stage actually represents the characteristics of the random process that generated the series data, then the residuals resulting from the estimation process must fulfill the theoretical assumptions established regarding the limit of random error. Among the steps followed in the analysis of the remainders are:

• Draw leftovers

Examine the autocorrelation function of the remainder

Fourth: Prediction

Prediction is considered the last stage of the Box-Jenkins methodology. It is usually the final goal of time series analysis, and it is not possible to move to this stage until after the prototype passes all the diagnostic tests previously exposed. If the prototype does not pass these checks and tests efficiently, it is necessary to return to the first stage (the recognition stage) and read the two functions of self-correlation and partial self-correlation, and the following must be tested:

- ✓ **Mean test of variations**

This criterion relies on "Ex-Post Forecast" in testing the model's ability to predict. If the expected value is equal to the actual value of the predicted variable, or the difference between them is not substantial, then the model's ability to predict is high. However, if the difference between them is substantial, then there is a lack of the model's ability to predict

.

- **Thiel unequal coefficient**

The higher the Thiel factor value than the correct one, the lower the model's predictability.

- **Gans coefficient**

This parameter measures the model's ability to predict during the sample period and during the post-sample period, and its value ranges (0. ∞).
The higher the value of this parameter, the more this indicates the weakness of the model's ability to predict. When it is equal to the correct one, this means that the model's ability to predict in the past is equal with it in the future.

- **Mean square error**

This scale is used to compare more than one model on predictive power and the best model is the one with the lowest mean of squares of error.

In this topic, the results of the barley production time series were presented, analyzed and discussed, depending on the EVIEWS 8.1 program, as follows:

3-1 Hypotheses testing phase:

Before starting the time series analysis, it is necessary to test the hypotheses that were dealt with in the general framework of the research, as follows:

The first hypothesis is a test of the uniformity of the variability of the time series of barley production in Iraq

In order to reveal the homogeneity of the series variation in relation to the production of barley in Iraq, the time series was drawn and is shown as follows:

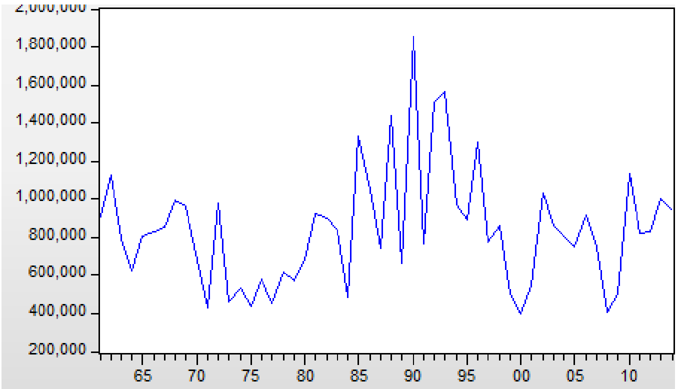


Figure 3-1. the barley production chain in Iraq.

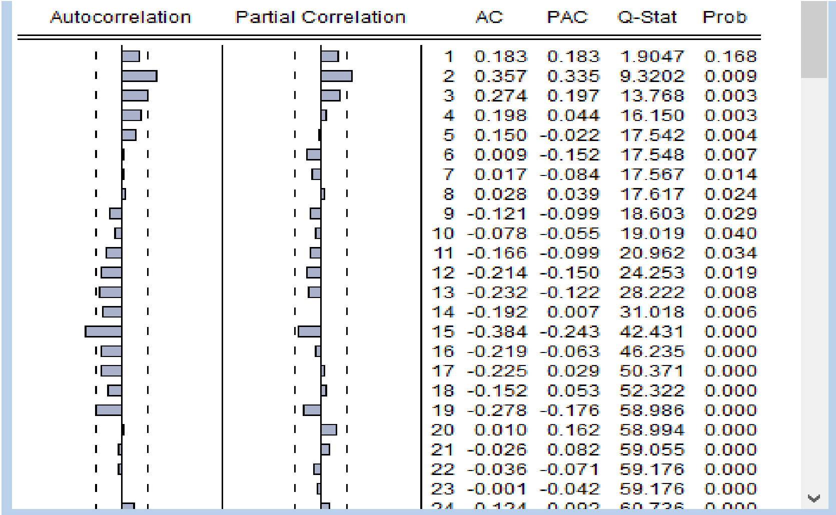
From the chart of the barley production chain in Iraq, there is no difference in the homogeneity of the series contrast. To be sure, the tests for the series contrast homogeneity available in EVIEWS 8.1 include Bartlett, Levene, Brown-Forsythe tests. These tests were used to test the hypothesis that the contrast is homogeneous in the series, as the test result was as follows:

Method	df	Value	Probability
Bartlett	3	12.26376	0.0065
Levene	(3, 50)	3.877411	0.0144
Brown-Forsythe	(3, 50)	2.312703	0.0873

Figure 3-2. Results of the homogeneity test of the variation of the time chain of barley production in Iraq.

The figure above shows that all tests confirm the acceptance of the hypothesis of nothingness that the seriesis homogeneous in variablity. Since the probability values of the tests equal 0.7258 for the TestBartlett, 0.2399 for Levene test and 0.3929 for the Prown-Forsythe test, these values are greater than the mean value (5%).

Hypothesis 2 is testing the secular trend for the time series of barley production in Iraq from the chart of a series of barley production in Iraq illustrated in figure (1-3). Thus, the series suffers from a decrease in the secular trend, an indication of the instability of the time series, and to make sure of this, the values of the self-link function and the partial self-association with the graph were created as shown as follows:



	AC	PAC	Q-Stat	Prob
1	0.183	0.183	1.9047	0.168
2	0.357	0.335	9.3202	0.009
3	0.274	0.197	13.768	0.003
4	0.198	0.044	16.150	0.003
5	0.150	-0.022	17.542	0.004
6	0.009	-0.152	17.548	0.007
7	0.017	-0.084	17.567	0.014
8	0.028	0.039	17.617	0.024
9	-0.121	-0.099	18.603	0.029
10	-0.078	-0.055	19.019	0.040
11	-0.166	-0.099	20.962	0.034
12	-0.214	-0.150	24.253	0.019
13	-0.232	-0.122	28.222	0.008
14	-0.192	0.007	31.018	0.006
15	-0.384	-0.243	42.431	0.000
16	-0.219	-0.063	46.235	0.000
17	-0.225	0.029	50.371	0.000
18	-0.152	0.053	52.322	0.000
19	-0.278	-0.176	58.986	0.000
20	0.010	0.162	58.994	0.000
21	-0.026	0.082	59.055	0.000
22	-0.036	-0.071	59.176	0.000
23	-0.001	-0.042	59.176	0.000

Figure 3-3. Values of the self-association function and partial self-association of the time series of barley production in Iraq.

2-3Application of Box-Jenkins methodology in time series analysis

First: Model recognition phase:

Box-Jenkins methodology can be applied to the first series of differences for barley production in Iraq through the graphic representation of both the self-association functions and the partial self-association shown in the form (3-3).

- ✓ For the self-regression model, we note that the most important gaps of the partial self-link function are at p=1.
- ✓ For the moving average model, we note that the gaps most important to the self-link function are at q=1.

These data show that both models weight following:

1- Integrated Self-Regression Model First Class
2- Model Integrated Moving Averages First Class
3- Self-Regression Model and Integrated Moving Averages (1.1)

Second: Evaluation 1: Evaluation 1 self-regression model of the stable series must be assessed

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.038132	0.072662	0.524785	0.6018
AR(1)	-0.546609	0.113320	-4.823581	0.0000

R-squared	0.293526	Mean dependent var	0.026808
Adjusted R-squared	0.280911	S.D. dependent var	1.009052
S.E. of regression	0.855667	Akaike info criterion	2.560004
Sum squared resid	41.00132	Schwarz criterion	2.631053
Log likelihood	-72.24011	Hannan-Quinn criter.	2.587679
F-statistic	23.26693	Durbin-Watson stat	2.083661
Prob(F-statistic)	0.000011		

Inverted AR Roots	-.55

Figure 3-4. Estimate of the first-class self-regression model of the stable chain for barley production in Iraq.

According to figure (3.4), the results of the first-class self-regression model estimate and the significance of the first-order autoregressive model can be written as follows:

$$y_t = \delta + \phi y_{t-1} + \varepsilon_t$$

So: $\delta = (1-\phi)\mu = (1+0.546609)\times 0.038132 = 0.058975$

On this basis, the estimated model is:

$$y_t = 0.058975 - 0.546609\, y_{t-1} + \varepsilon_t$$

- First-class integrated moving average model estimate:

The first-class integrated moving average model was estimated based on EVIEWS 8.1 outputs where the results were as follows:

Equation: UNTITLED Workfile: UNTITLED::Untitled\

View | Proc | Object | Print | Name | Freeze | Estimate | Forecast | Stats | Resids

Dependent Variable: S3
Method: Least Squares
Date: 02/18/16 Time: 13:12
Sample (adjusted): 2010M02 2014M12
Included observations: 59 after adjustments
Convergence achieved after 14 iterations
MA Backcast: 2010M01

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.038014	0.057590	0.660089	0.5119
MA(1)	-0.500674	0.114706	-4.364854	0.0001

R-squared	0.264461	Mean dependent var	0.038172
Adjusted R-squared	0.251557	S.D. dependent var	1.004116
S.E. of regression	0.868688	Akaike info criterion	2.589644
Sum squared resid	43.01323	Schwarz criterion	2.660069
Log likelihood	-74.39449	Hannan-Quinn criter.	2.617135
F-statistic	20.49417	Durbin-Watson stat	2.198120
Prob(F-statistic)	0.000031		

Inverted MA Roots	.50

Figure 3-5. The results of the estimate of the first-class moving average model of the stable series for barley production in Iraq.

The results of the figure (3.5) show that the estimated first-order moving averages n as follows:

$$y_t = \delta + \theta(B)\varepsilon_t \Rightarrow y_t = \delta + (1-\theta B)\varepsilon_t \Rightarrow y_t = 0.038014 + (1+0.500674B)\varepsilon$$

- Estimate of the first-class integrated moving slope model:

The first-class integrated moving-average self-regression model was estimated based on EVIEWS 8.1 outputs based on the results as follows:

Equation: UNTITLED Workfile: UNTITLED::Untitled\

View | Proc | Object | Print | Name | Freeze | Estimate | Forecast | Stats | Resids

Dependent Variable: S3
Method: Least Squares
Date: 02/18/16 Time: 13:17
Sample (adjusted): 2010M03 2014M12
Included observations: 58 after adjustments
Convergence achieved after 7 iterations
MA Backcast: 2010M02

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.036389	0.065041	0.559471	0.5781
AR(1)	-0.410270	0.221924	-1.848697	0.0699
MA(1)	-0.191010	0.237523	-0.804174	0.4248

R-squared	0.300219	Mean dependent var	0.026808
Adjusted R-squared	0.274772	S.D. dependent var	1.009052
S.E. of regression	0.859312	Akaike info criterion	2.584968
Sum squared resid	40.61290	Schwarz criterion	2.691543
Log likelihood	-71.96407	Hannan-Quinn criter.	2.626481
F-statistic	11.79801	Durbin-Watson stat	1.987387
Prob(F-statistic)	0.000055		

Inverted AR Roots	-.41
Inverted MA Roots	.19

Figure 3-6. The results of the estimate of the first-class moving self-regression model of the stable series for barley production in Iraq

The above figure shows the estimated model in the form of a self-regression factor and the moving average as follows:

$$(1+0.410270B)\,y_t = 0.036389 + (1+0.191010B)\,\varepsilon_t$$

Third: Diagnostic examination

The identification of the best model of the time series for barley production in Iraq depends on the sample estimated in the second step on an important set of theoretical assumptions for the random process that generated data and the general form of the sample and random changes. For the purpose of identifying the best model among the candidate models tested, statistic analysis for the model of first-degree self-regression was conducted to ensure that the estimated self-regression model achieves the condition of being static. Also, the unit circle has been extracted for the inverse roots as follows:

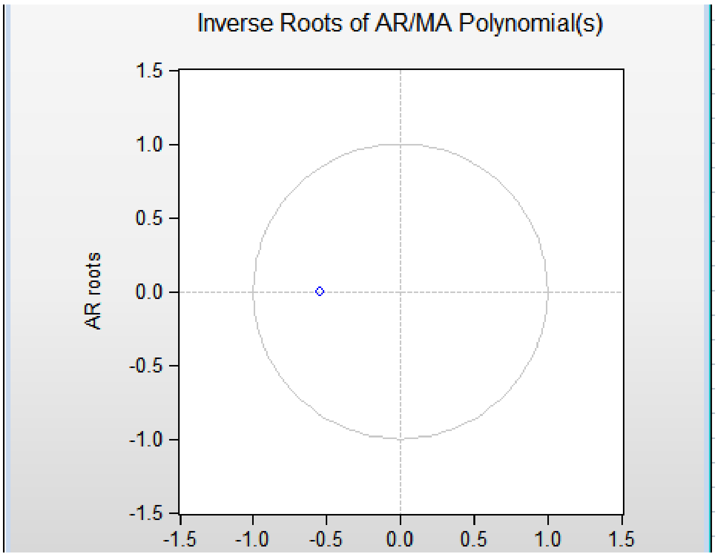


Figure 3.7 The unit circle for the inverse roots of the first-degree self-regression model.

The mirrored roots are located within the unit circle. It is an indication that the sample is static. The propagation chart of the residuals for the first-rate self-regression model displays the the residuals drawing, which seems devoid of all the regular patterns and movements that can be used to improve the model, the data swing randomly around the zero line.

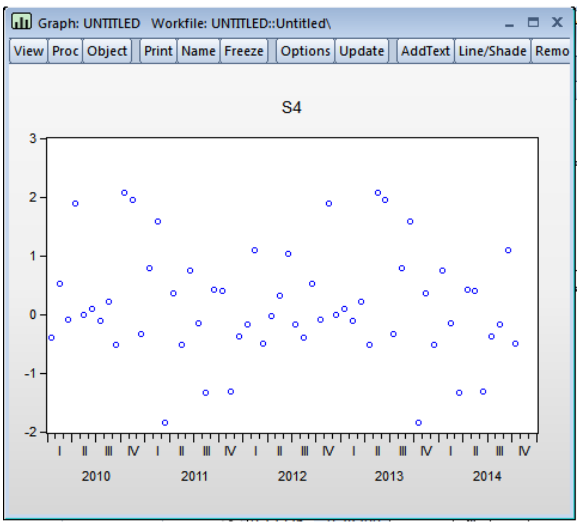
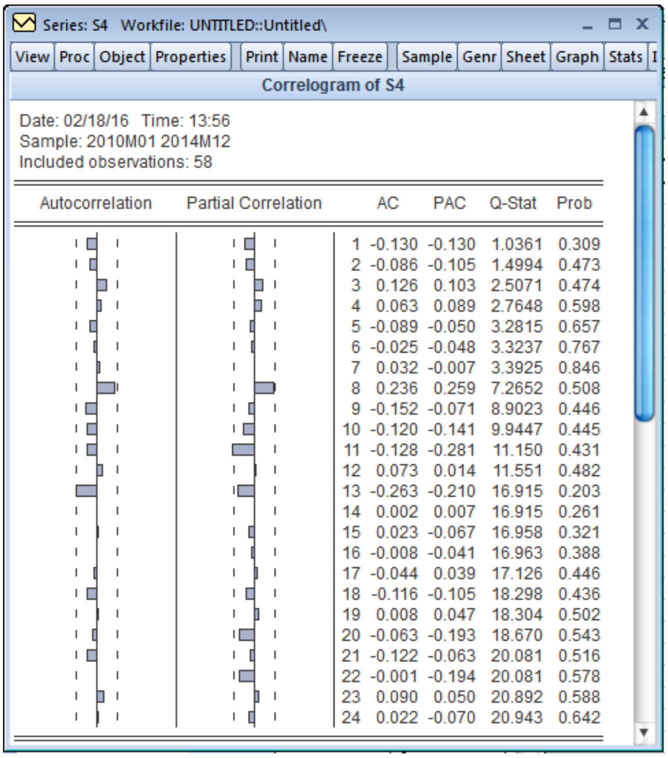


Figure 3-8. Spread point chart for first-class self-regression model

Checking the protective self-association function for the first-class self-regression.

Figure (3.9) shows the residuals self-association function for the estimated first-degree self-regression model, as the values of the self-association function fall within the limits of confidence and a large sample of gaps. This indicates that the form of the self-association function is free of humps and errors representing purely random changes.

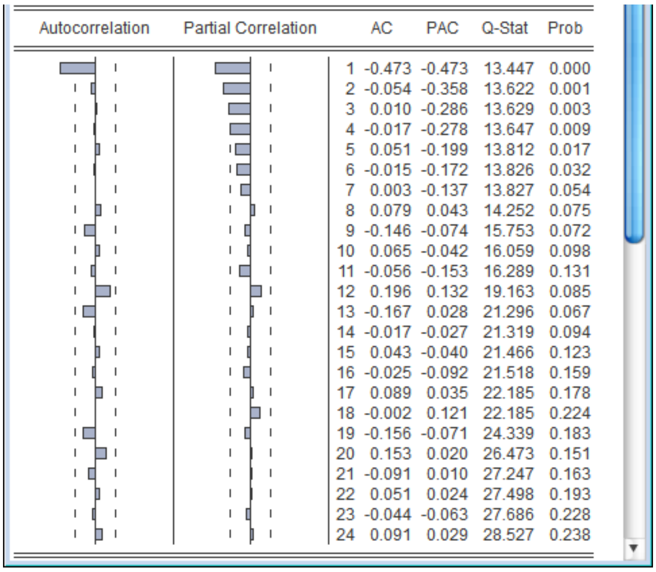

Series: S4 Workfile: UNTITLED::Untitled\
View | Proc | Object | Properties | Print | Name | Freeze | Sample | Genr | Sheet | Graph | Stats
Correlogram of S4

Date: 02/18/16 Time: 13:56
Sample: 2010M01 2014M12
Included observations: 58

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	-0.130	-0.130	1.0361	0.309
		2	-0.086	-0.105	1.4994	0.473
		3	0.126	0.103	2.5071	0.474
		4	0.063	0.089	2.7648	0.598
		5	-0.089	-0.050	3.2815	0.657
		6	-0.025	-0.048	3.3237	0.767
		7	0.032	-0.007	3.3925	0.846
		8	0.236	0.259	7.2652	0.508
		9	-0.152	-0.071	8.9023	0.446
		10	-0.120	-0.141	9.9447	0.445
		11	-0.128	-0.281	11.150	0.431
		12	0.073	0.014	11.551	0.482
		13	-0.263	-0.210	16.915	0.203
		14	0.002	0.007	16.915	0.261
		15	0.023	-0.067	16.958	0.321
		16	-0.008	-0.041	16.963	0.388
		17	-0.044	0.039	17.126	0.446
		18	-0.116	-0.105	18.298	0.436
		19	0.008	0.047	18.304	0.502
		20	-0.063	-0.193	18.670	0.543
		21	-0.122	-0.063	20.081	0.516
		22	-0.001	-0.194	20.081	0.578
		23	0.090	0.050	20.892	0.588
		24	0.022	-0.070	20.943	0.642

Figure 3-9. Drawing the self-correlation function for the first-rate self-regression model residuals

Figure (3.9) shows that Box-pierce statistics values are not mean. This entails that the residuals are random and this confirms the appropriateness of the estimated model. Examining the model of the first differences of the residuals for the first-class self-regression model to increase the assurance that the resduals follow random changes. The first difference model of the residuals must follow a first-class moving average model. Accordingly, the self-link function was extracted for the first differences of the residuals as follows:



	AC	PAC	Q-Stat	Prob
1	-0.473	-0.473	13.447	0.000
2	-0.054	-0.358	13.622	0.001
3	0.010	-0.286	13.629	0.003
4	-0.017	-0.278	13.647	0.009
5	0.051	-0.199	13.812	0.017
6	-0.015	-0.172	13.826	0.032
7	0.003	-0.137	13.827	0.054
8	0.079	0.043	14.252	0.075
9	-0.146	-0.074	15.753	0.072
10	0.065	-0.042	16.059	0.098
11	-0.056	-0.153	16.289	0.131
12	0.196	0.132	19.163	0.085
13	-0.167	0.028	21.296	0.067
14	-0.017	-0.027	21.319	0.094
15	0.043	-0.040	21.466	0.123
16	-0.025	-0.092	21.518	0.159
17	0.089	0.035	22.185	0.178
18	-0.002	0.121	22.185	0.224
19	-0.156	-0.071	24.339	0.183
20	0.153	0.020	26.473	0.151
21	-0.091	0.010	27.247	0.163
22	0.051	0.024	27.498	0.193
23	-0.044	-0.063	27.686	0.228
24	0.091	0.029	28.527	0.238

Figure (3-10) The values of the self-association function and partial self-association for the first differences of the residuals

Figure (3.10) depicts that the self-correlation function suddenly breaks after the first time gap, and the partial self-correlation function is close to zero reluctantly indicated. Thus, the first series of differences of the residulas follows a first-class moving average model. To confirm that moving average parameter is mean (i.e. no different from the correct one) the following regression was performed :

Equation: UNTITLED Workfile: UNTITLED::Untitled\

View | Proc | Object | Print | Name | Freeze | Estimate | Forecast | Stats | Resids

Dependent Variable: S5
Method: Least Squares
Date: 02/18/16 Time: 14:55
Sample (adjusted): 2010M02 2014M10
Included observations: 57 after adjustments
Convergence achieved after 27 iterations
MA Backcast: 2010M01

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.006560	0.007812	0.839784	0.4047
MA(1)	-0.971902	0.020545	-47.30674	0.0000

R-squared	0.518225	Mean dependent var	-0.016603
Adjusted R-squared	0.509465	S.D. dependent var	1.235033
S.E. of regression	0.864995	Akaike info criterion	2.582271
Sum squared resid	41.15189	Schwarz criterion	2.653957
Log likelihood	-71.59472	Hannan-Quinn criter.	2.610131
F-statistic	59.16106	Durbin-Watson stat	2.126379
Prob(F-statistic)	0.000000		

Inverted MA Roots .97

Figure (3-11) The estimate of the first-class moving average model for the first differences of the residual

In the above figure, the average moving parameter is mean because the probability value of the test of (0.000) is below the mean level (5%). This confirms the randomness of the residuals. Its Reflection examination for the first-class moving average model was conducted to ensure that the first-class moving average model has the character of reflection. The unit circle was found and as described in the figure (12-3) where it is noted that the inverse root of the estimated model is located on the boundaries of the unit circle

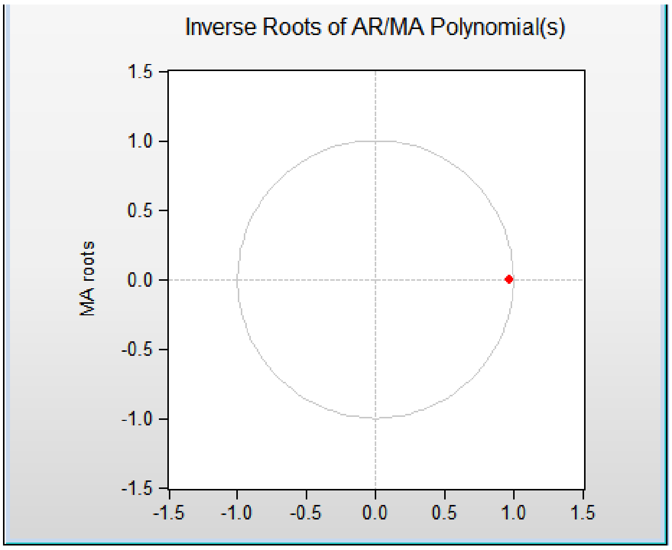


Figure (3-12) The unit circle for the inverse root of the first-class moving average model.

- The propagation chart for the first-class moving average model is displayed in figure (3.13), which seems free of all the regular patterns and movements that can be used to improve the model. The data fluctuate randomly around the zero line.

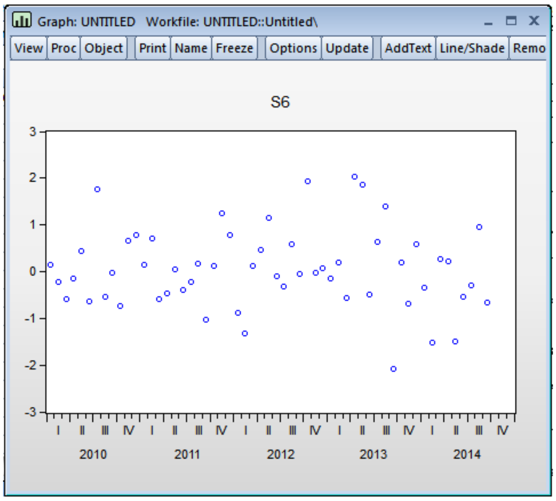
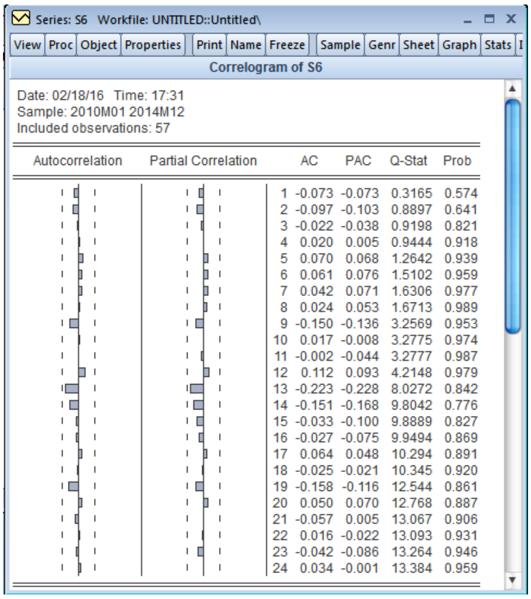


Figure (3-13) The diffusion point chart for the first-rate moving average model.

The figure examines the self-association function of the residuals for the first-rate moving average model for the estimated first-rate moving average model. In this model, the values of the self-association function fall within the limits of confidence and a large sample of gaps, and this indicates that the form of the self-association function is free of humps. It also enatils that errors represent purely random changes.


Series: S6 Workfile: UNTITLED::Untitled\

Correlogram of S6

Date: 02/18/16 Time: 17:31
Sample: 2010M01 2014M12
Included observations: 57

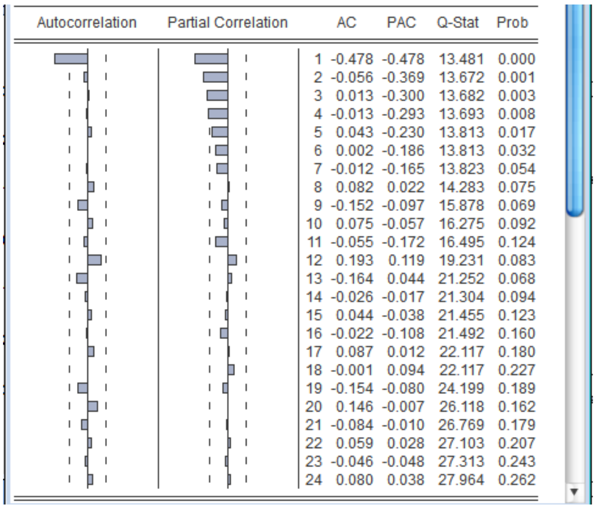
Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	-0.073	-0.073	0.3165	0.574
		2	-0.097	-0.103	0.8897	0.641
		3	-0.022	-0.038	0.9198	0.821
		4	0.020	0.005	0.9444	0.918
		5	0.070	0.068	1.2642	0.939
		6	0.061	0.076	1.5102	0.959
		7	0.042	0.071	1.6306	0.977
		8	0.024	0.053	1.6713	0.989
		9	-0.150	-0.136	3.2569	0.953
		10	0.017	-0.008	3.2775	0.974
		11	-0.002	-0.044	3.2777	0.987
		12	0.112	0.093	4.2148	0.979
		13	-0.223	-0.228	8.0272	0.842
		14	-0.151	-0.168	9.8042	0.776
		15	-0.033	-0.100	9.8889	0.827
		16	-0.027	-0.075	9.9494	0.869
		17	0.064	0.048	10.294	0.891
		18	-0.025	-0.021	10.345	0.920
		19	-0.158	-0.116	12.544	0.861
		20	0.050	0.070	12.768	0.887
		21	-0.057	0.005	13.067	0.906
		22	0.016	-0.022	13.093	0.931
		23	-0.042	-0.086	13.264	0.946
		24	0.034	-0.001	13.384	0.959

Figure (3-14) The self-correlation function for the first-rate self-regression model Residuals

Figure (14-3) is that Box-pierce statistics values, which are, not mean. Thus, the residuals are random and this confirms the appropriateness of the estimated model.

- Examining the first difference model for the first-rate moving average

To increase the assurance that the residuals follow random changes, the first difference model of the residuals must follow a first-rate moving average model. Accordingly, the self-link function has been extracted for the first differences of the residuals as follows:



Lag	AC	PAC	Q-Stat	Prob
1	-0.478	-0.478	13.481	0.000
2	-0.056	-0.369	13.672	0.001
3	0.013	-0.300	13.682	0.003
4	-0.013	-0.293	13.693	0.008
5	0.043	-0.230	13.813	0.017
6	0.002	-0.186	13.813	0.032
7	-0.012	-0.165	13.823	0.054
8	0.082	0.022	14.283	0.075
9	-0.152	-0.097	15.878	0.069
10	0.075	-0.057	16.275	0.092
11	-0.055	-0.172	16.495	0.124
12	0.193	0.119	19.231	0.083
13	-0.164	0.044	21.252	0.068
14	-0.026	-0.017	21.304	0.094
15	0.044	-0.038	21.455	0.123
16	-0.022	-0.108	21.492	0.160
17	0.087	0.012	22.117	0.180
18	-0.001	0.094	22.117	0.227
19	-0.154	-0.080	24.199	0.189
20	0.146	-0.007	26.118	0.162
21	-0.084	-0.010	26.769	0.179
22	0.059	0.028	27.103	0.207
23	-0.046	-0.048	27.313	0.243
24	0.080	0.038	27.964	0.262

Figure (3-15) The values of the self-association function and partial self-association relative to the first differences of the residuals

It is seen in figure (3.15) that the self-correlation function suddenly breaks after the first time gap. Also, the partial self-correlation function is approaching zero reluctantly to indicate the first series of differences of the residuals following a first-class moving average model. To confirm the moving average parameter is mean (i.e. no different from the correct one) the following regression was performed:

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.030075	0.023386	-1.286003	0.2039
MA(1)	-1.190510	0.110104	-10.81260	0.0000

R-squared	0.624603	Mean dependent var	-0.014539
Adjusted R-squared	0.617652	S.D. dependent var	1.261260
S.E. of regression	0.779891	Akaike info criterion	2.375737
Sum squared resid	32.84445	Schwarz criterion	2.448071
Log likelihood	-64.52063	Hannan-Quinn criter.	2.403781
F-statistic	89.84785	Durbin-Watson stat	2.204074
Prob(F-statistic)	0.000000		

Inverted MA Roots 1.19
Estimated MA process is noninvertible

Figure (3.16)estimate of the first-class moving average model for the first differences of the residuals

According to the figure above. the estimated model shows that the average moving parameter is mean because the probability value of the test of (0.000) is below the mean level (5%). This confirms the randomness of the residuals, but the estimated moving average model is not reflective, as shown by the results of the figure (3.16).

- Examining the stillness and reflection of the self-regression model - the first-class moving average

To ensure that the self-regression model - the moving average of the first degree is static and reflective, the circle of unity was created and as described in the figure (3.17). It is noted that the inverse roots of the estimated model are located within the boundaries of the unit circle, this means the model reflective and static.

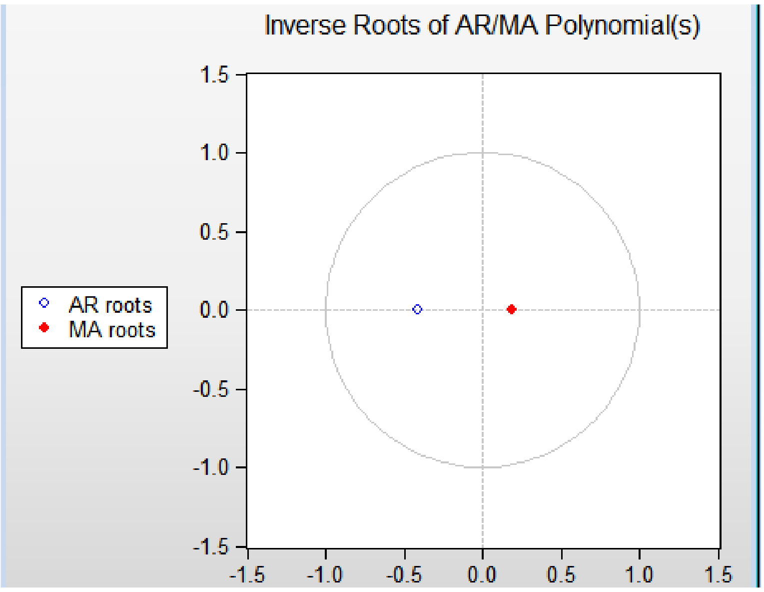
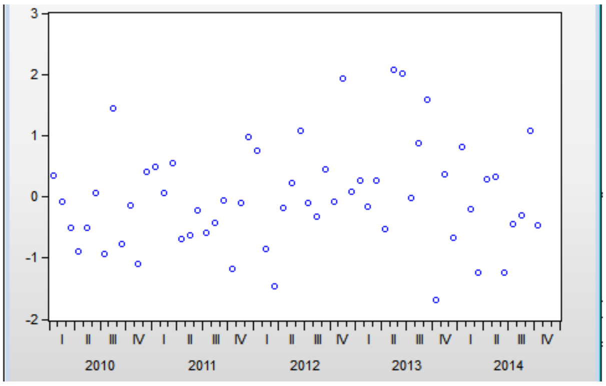


Figure (3-17) The unit circle for the inverse roots of the self-regression model - the first-class moving average

- The propagation chart below displays the residual drawing, which seems free of all patterns and regular movements that can be used to improve the model, the data fluctuate randomly around the zero line.



Figure(3-18) The diffusion point chart for the self-regression model trumpets - the first-rate moving average

- Examining the self-bond function of the residuals in relation to the self-regression model - the first-rate moving average

Figure (3.19) is the self-associated function of the residuals relative to the estimated mode. The values of the self-association function fall within the limits of confidence and a large sample of gaps. This means that there is an indication that the form of the self-link function does not include humps which entails that errors represent purely random changes.

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.002	0.002	0.0003	0.987
		2	-0.003	-0.003	0.0007	1.000
		3	-0.039	-0.039	0.0957	0.992
		4	0.052	0.052	0.2675	0.992
		5	0.093	0.093	0.8342	0.975
		6	0.090	0.090	1.3822	0.967
		7	0.076	0.083	1.7743	0.971
		8	0.052	0.061	1.9648	0.982
		9	-0.124	-0.127	3.0487	0.962
		10	0.035	0.021	3.1373	0.978
		11	0.012	-0.011	3.1475	0.989
		12	0.124	0.091	4.3153	0.977
		13	-0.183	-0.200	6.9097	0.907
		14	-0.122	-0.127	8.0831	0.885
		15	-0.037	-0.031	8.1918	0.916
		16	-0.009	-0.022	8.1978	0.943
		17	0.048	0.054	8.3963	0.957
		18	-0.031	-0.025	8.4820	0.971
		19	-0.160	-0.126	10.760	0.932
		20	0.026	0.080	10.822	0.951
		21	-0.089	-0.016	11.565	0.951
		22	0.004	-0.036	11.566	0.966
		23	-0.049	-0.056	11.801	0.973
		24	0.003	0.004	11.802	0.982

Figure(3-19) The self-correlation function for the self-regression model trumpets - the first-class moving average.

- Examing the first difference model of the trumpet relative to the self-regression model - the first-class moving average

To increase the assurance that the residual meet random changes, the first difference model of the residulas must follow a first-class moving average model. On this model, the self-correlation function was extracted:

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	-0.489	-0.489	14.346	0.000
		2	0.010	-0.301	14.351	0.001
		3	-0.063	-0.294	14.597	0.002
		4	0.018	-0.263	14.618	0.006
		5	0.029	-0.203	14.671	0.012
		6	0.010	-0.151	14.678	0.023
		7	-0.015	-0.136	14.693	0.040
		8	0.092	0.055	15.277	0.054
		9	-0.165	-0.091	17.183	0.046
		10	0.087	-0.048	17.725	0.060
		11	-0.069	-0.135	18.071	0.080
		12	0.199	0.132	21.023	0.050
		13	-0.165	0.041	23.094	0.041
		14	-0.018	-0.051	23.120	0.058
		15	0.029	-0.044	23.187	0.080
		16	-0.003	-0.082	23.188	0.109
		17	0.068	0.028	23.574	0.131
		18	0.011	0.104	23.584	0.169
		19	-0.154	-0.088	25.685	0.139
		20	0.147	0.004	27.655	0.118
		21	-0.097	0.006	28.535	0.126
		22	0.067	0.015	28.972	0.146
		23	-0.046	-0.047	29.183	0.174
		24	0.074	0.015	29.738	0.194

Figure (3-20) The function of self-association of the first differences for the residuals of the self-regression model - the moving average of the first degree

Figure (3.20) shows that the self-correlation function suddenly breaks after the first time gap, and the partial self-correlation function appraoches zero fluctuatingly meaning that the first series of differences of the residuals follows a first-class moving average model. To make the moving average mean, the next regression has been conducted :

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.007279	0.007858	0.926356	0.3583
MA(1)	-0.971363	0.021685	-44.79414	0.0000

R-squared	0.496518	Mean dependent var	-0.014253
Adjusted R-squared	0.487364	S.D. dependent var	1.200461
S.E. of regression	0.859514	Akaike info criterion	2.569557
Sum squared resid	40.63200	Schwarz criterion	2.641243
Log likelihood	-71.23238	Hannan-Quinn criter.	2.597417
F-statistic	54.23920	Durbin-Watson stat	2.039304
Prob(F-statistic)	0.000000		
Inverted MA Roots	.97		

Figure(3-21) The estimate of the first-rate moving self-regression model for the first differences of the residual

The figure above of the estimated model entail that the average moving parameter is mean because the probability value of the test (0.000) is below the morale value (5%). This confirms the randomness of the residuals.

Fourth: forecasting

The previous results of the diagnostic examination show that the best representative model of the time series is the model of first-degree self-regression. In particular, this is because it has the lowest indicator for the information of Akek and Schwarz. Accordingly, we will use this model for forecasting purposes, for example the forecasting equation for the first month of 2015 can be formulated as follows:

$$y_t^* = 0.058975 - 0.546609 y_{t-1}^* + \varepsilon_t$$
$$\Rightarrow y_t - y_{t-1} = 0.058975 - 0.546609 * (y_{t-1} - y_{t-2}) + \varepsilon_t$$
$$\Rightarrow y_{2015-1} - y_{2014-12} = 0.058975 - 0.546609 * (y_{2014-12} - y_{2014-11}) + \varepsilon_t$$
$$\Rightarrow y_{2015-1} = 0.058975 + (1 - 0.546609) * y_{2014-12} + 0.546609 * y_{2014-11} + \varepsilon_t$$

So, we can formulate the rest of the forecast equations for the coming months of 2002-2021.

4-1 conclusions

Based on the conclusions, the following points were reached:

1- The time series for the production of barley in Iraq does not suffer from the problem of heterogeneous inequality.
2- The time chain for the production of barley in Iraq does not suffer from seasonal variation.
3- The time series of barley production in Iraq includes anomalous values and it does not follow a normal distribution.
4- By examining both the self-association and partial self-association functions for the stable and converted series, the integrated self-regression model of the AR(1), the integrated moving average of the first-order MA (1), the self-decline and the integrated moving average of the first order ARMIM (1.1.1) were nominated in the analysis of the time series of barley production in Iraq. Ar (1) is the best representative model for the time series, depending on the diagnostic tests.

4.2 Recommendations

The study recommends the following:

1. Taking care of agricultural land reclamation
2. Giving importance to irrigation
3. Proving enough fertilizers

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