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The Impact of Agricultural Growth on the Economic Growth of Saudi Arabia during 1995 -2021

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Abstract

The aim of this study is to investigate the impact of agricultural growth sector on the Saudi economy during the period (1995-2021). The study is represented in two main parts: the first used time series analysis to predict the Economic Growth (EG) in Saud Arabia, and the second used regression analysis to determine the relationship between EG and Agricultural Growth (AG) over the period (1995 – 2021). The study was able to determine the best model the Autoregressive Integrated Moving Average model of order (2) ARIMA (2,0,2), and estimate the EG for the next nine years. To examine the relationship between the variables the Study revealed that the relationship between EG and AG was positive; if the AG is increasing by one million riyals, the EG increases by 2.03 million riyals, and the AG participates by 21.2% total variation of the EG. The Study recommended that improving economic activities to support economic growth and expanding the agricultural sector to increase the abundance of agricultural products.

Keywords: Time series analysis, Agriculture, Economic Growth, Forecasting, ARIMA

1. FUNDAMENTALS

1.1Introduction

The Kingdom of Saudi Arabia seeks to improve Economic Growth (EG) by improving many other economic activities; the agricultural sector is one of the economic activities that support Saudi economic growth. It recorded a high contribution to the Gross Domestic Product (GDP) in general. In contrast, the contribution of agricultural output to non-oil GDP was so high compared to some sectors; the contribution of the agricultural sector to economic growth is noted in supporting food through agricultural products, as the Kingdom of Saudi Arabia is making significant efforts in the process of self-sufficiency in providing food locally, the Saudi Arabia has Plans to develop agricultural sector. The space will be used to advance agricultural product development, scale up new technologies for producing meat and dairy substitutes, and offer more locally produced, good quality alternatives to animal-derived products; as well as promoting healthier diets, it is also hoped the new deals will help to reduce the country's reliance on traditional livestock production and help towards achieving more robust food security, Saudi Arabia's push towards healthier and more sustainable eating is part of the government's Vision 2030 agenda, which looks to improve the local economy. These efforts indicate the development of the relationship between the Agricultural Growth (AG) and EG, which is one of the main points of this study.

1.2 Problem Statement

This paper tries to determine the relationship between EG and the AG and to determine a suitable model that leads to predicting the EG as well as the possibility of applying the approach of time series analysis and forecasting on the data analysis; the researchers looked at the relationship between the EG and the AG it is essential, as there is many people depend on the agricultural sector for the other economic activity. The researchers summarized the problem in the following questions:

Is there a relationship between the EG and the AG?

Does the EG rate increase with time? To what extent this can increase in the future?

Is the AG effect to EG?

1.3 Study importance

The importance of this study stems from EG of Saudi Arabia in last years it looked, and so the development in the Agricultural sector, that is very important for people of Saudi and the government of Saudi Arabia, by addition it is also important for economic students and specialists like.

1.4 objectives of paper

The study aims as follow:

1- To find the relationship between the EG and AG
2- To forecast the Economic Growth in Saudi Arabia
3- To find the mode of the relationship between the EG and the AG**.**

1.5 Study hypothesis

The study looked in to the hypotheses that follow:

1- There is a relationship between Economic Growth and Agricultural Growth
2- EG increase with time
3- AG is effect to EG.

1.6 Literature review

The researchers Alamri and et al [1] presented: Estimating the contribution of Saudi Agricultural Development Fund to GDP and economic growth. This is research was aimed to estimate the relative importance of the contribution of Agricultural Development Fund on agricultural output, gross domestic product and economic growth rate of Saudi Arabia during the period 1990–2019, using econometric analysis and binomial probability distribution. The important results of this study that the contribution to agricultural output ranged between a minimum of 1.8% and a maximum of 27.0%. The upper limit of the Agricultural Development Fund’s contribution on GDP was 2.81%. The upper limit of the Agricultural Development Fund’s contribution on economic growth rate was 0.115% during the study period. As for the contribution of the agricultural sector on the economic growth rate, it reached a maximum of 0.381% during the period 1990–2019.

1.7 Methodology
The study was based on the theoretical approach that dealt with method of the time series analysis and forecast, and supported the practical side that depend on the data of EG and AG from Saudi Arabia, the paper used SPSS and Minitab programs

1.8 limitations of Study
The limitation of the study is the EG and AG data are for the Saudi Arabia only in the period 1995 to from 2021.

2. THEORETICAL FORMULATION

2. Time series
A time series is a series of observation taken sequentially over time. it is the order properly that is crucial to time series and the distinguishes time series from non-time series data. actions taken at some time have consequences and effects that experienced at some later time. Time itself through the mechanism of causality, imparts structure into a time series. In typical applications successive observations will be equally spaced: daily, weekly, monthly, for example. Andy Pole [2]

2.1 Stationary
Time series process is stationary if the mean and variance are constant over time, and if the autocorrelation between values of process at two time periods, say t *and* s, depends only on the distance between these time points and not on the time period itself.(we arbitrarily assume that $t > s$.). Let us summarize these three condition Vandael [3]

$$E(Z_t) = \mu \quad (2.1)$$

$$var(Z_t) = E(Z_t - \mu)^2 \quad (2.2)$$

$$\rho_{(Z_t, Z_s)} == E[(Z_t - \mu)(Z_s - \mu)]/\sigma^2 = \rho_{(t-s)} \ . \quad (2.3)$$

2.2 Autocorrelation function
The actual structure of the ARIMA(p,d,q) model is obtained by comparing the sample of the acf stationary series with the theoretical population acf,s. We must now include non-seasonal or seasonal parameters. Indeed, it's possible that after appropriate transformations have been made, the new series is simply a white noise series, and there is no need to include any parameter. This is precisely the case for a random walk series, only if autocorrelation is large at lag corresponding to the span, possibly multiplies thereof, should we include seasonal parameters Abow [4]

2.3 Autoregressive model
Autoregressive process if a current value of times can be expressed as a linear function of previous value of the series $Z_{t-1}, Z_{t-2}, \ldots Z_{t-p}$ and a random of shock formed AR(p) we can express this relationship model autoregressive rank p as follows. Tomah [5]

$$Z_t = \theta_0 + \theta_1 Z_{t-1}, \theta_2 Z_{t-2}, \ldots + a_t \quad (2.4)$$

2.4 Moving average model
Where is the error a_{t-1} at period $t - 1$ and θ the called the moving average parameter which describes the effect of past error on Z_t and which needs to be estimated. As with an autoregressive process, the random shocks in a moving average process as assumed to be normally and independently distributed with mean zero and constant variance σ^2

and moving average model expresses the current value of the series Z_t as follow: Abow [6]

$Z_t = \theta_0 + a_t - \theta_1 a_{t-1} - \theta_2 a_{t-2} - \ldots\ \theta_q a_{t-q}$ (2.5)

2.5 Mixed autoregressive Moving average

In equations (2.4- 2.5), we represented process with an autoregressive and moving average can often induce stationary so that of AR,MA or ARMA model can be written in the general form of degree(p,q) as follows:

$Z_t = \Phi_0 + \Phi_1 Z_{t-1} + \ldots + \Phi_p Z_{t-p} + a_t - \theta_1 a_{t-1} - \ldots\ \theta_q a_{t-q}$ (2.6)

Jobory [7]

2.6 Autoregressive Integrated moving average model

ARIMA models are considered the most widely used models, and all models can be derived from them. These models consist of three parts. The first part is an autoregressive model AR(p) used in forecasting. The second model represents the moving averages MA(q), and the third part describes the differences I(d) and is used. For the stability of the series, it is therefore expressed according to the following formula:

$Z_t = \Phi_0 + \Phi_1 Z_{t-1} + \ldots + \Phi_p Z_{t-p} + \ldots d\ Z_{t-p-d} + a_t - \theta_1 a_{t-1} + \ldots + \theta_q a_{t-q}$ (2.7)

Therefore, ARIMA models can be considered stable ARMA models with different ranks Kaiser [8]

2.6 Identification

In the identification stage, we choose a particular model from the general class of ARIMA models specified in previous sections. We select the order of consecutive to make the series stationary, as well as determine the order of the regular autoregressive and moving averages to represent the time series model adequately. In the identification phase, we use the autocorrelation and other properties introduced in the previous sections. After a tentative model has been identified, the parameters of the model are estimated. Then, by applying various diagnostic checks, we can determine whether or not the model adequately represents the data. Finally, the model that passes all the checks generates the forecast.

2.7 Estimation

The next step after identifying a particular ARIMA model from the general class of multiplicative models. There are basically two methods a variable for estimating these parameters

One such method is the least square method; the other is the maximum likelihood method, under the least square method we choose those values of the parameters which will make the sum of the squared residual as small as possible. The maximum likelihood method is summarized in that the feature matrix of the model to be estimated is chosen according to the principle of maximizing the likelihood function Pirce [9]

2.8 Diagnostic checking

Statistically adequate. A model that fails these diagnostic tests is rejected. This stage indicates how a model could be improved. This leads us back to the identification stage (B-J [10]

The principal diagnostic checks have been applied to test the validity of models as follows.

1- Residual analysis: if the estimated models are adequate, their residuals should be approximately white noise. Then, the autocorrelation function of the residuals within the 95% confidence limit

2- Q statistic: the overall adequacy can be tested by the Ljung-Box residual portmanteau test of model adequacy. Q statistic is therefore, expressed to the following formula. The principal diagnostic checks have been applied to test the validity of models as follows.

1- Residual analysis: if the estimated models are adequate, their residuals should be approximately white noise. Then the autocorrelation function of the residuals within 95% confidence limit

2- Q statistic: the overall adequacy can be tested by Ljung-Box residual portmanteau test of model adequacy, Q statistic it is therefore expressed to the following formula

$Q_{(s)} = n(n+2)\sum_{k=1}^{s}\frac{1}{n-k}{r^2}_k(a)$ (2.8)

Q_s Distributed to $\chi^2(s-m),\alpha)$

Forecasting is last step of time series analysis and it is basic goal of the study. After determining, a fitted model used to generate forecasts for future period L, and the prediction of the number L steps can be calculated according to the formula Douglas [11]

$\hat{Z}_{t+1} = E[Z_{t+1}|Z_{t-1}, Z_{t-2}, \ldots] \quad for\ L \geq 1$ (2.9)

If the model is AR (1), then the best prediction for the number of steps L is

$\hat{Z}_{t+1} = {\Phi_1}^{L} Z_{t-1+L} \quad for\ L \geq 1$ (2.10)

If the model is AR (2), then the best prediction for the number of steps L is

$\hat{Z}_{t+1} = {\Phi_1}^{L} Z_{t-1+L} + {\Phi_2}^{L} Z_{t-2+L} \quad for\ L \geq 1$ (2.11)

If the model is MA (q), then the best prediction for the number of steps L is

$\hat{Z}_{t+1} = a_{t+1} - {\theta_1}^{L} a_{t-1+L} - {\theta_2}^{L} a_{t-2+L} - \ldots {\theta_q}^{L} a_{t-q+L} \ for\ L \geq 1$ (2.12)

If the model is AR MA (p, q), then the best prediction for the number of steps L is

$\hat{Z}_{t+1} = {\Phi_1}^{L} Z_{t-1+L} + {\Phi_2}^{L} Z_{t-2+L} \quad for\ L \geq 1$ (2.13)

3. REGRESSION

Regression and time series are both two helpful studies for phenomena predicting the future.

3.1Simple regression

The relationship between EG and AG, when the EG was dependent variable and the AG was independent variable, we wish to examine the way in which a response Y depends on variable $X_1, X_2, \ldots X_k$,we determine a regression equation from the data as follows

$Y_i = \beta_0 + \beta_1 X_i + \varepsilon_i$ (3.1)

β_0, β_1 are called the parameters of the model, ε_i the error term

3.2 Estimating $\boldsymbol{\alpha}$ & $\boldsymbol{\beta}$

We will used least square method for estimating β_0 & β_1 from equation (3.1) let

$$S = \sum_{i=1}^{n} {\varepsilon^2}_i = \sum_{i=1}^{2} (Y_i - \beta_0 - \beta_1 X_i)^2 \qquad (3.2)$$

By differentiating Eq. (3.2) first with respect to β_0 and then with respect to $\beta_1$and setting the result equal to zero, where was substitute (b_0, b_1) for β_0, β_1 the result equations are called the normal equations as follows

$$nb_0 + b_1 \sum_{i=1}^{n} X_i = \sum_{i=}^{n} Y_i$$

$$b_0 \sum_{i=1}^{n} X_i + b_1 \sum_{i=1}^{n} X^2{}_i = \sum_{i=}^{n} X_i Y_i \qquad (3.3)$$

By solution of Eq (3.3) find

$$b_1 = \frac{\sum_{i=}^{n} X_i Y_i - [(\sum X_i)(\sum Y_i)]/n}{\sum X^2{}_i - (\sum X_i)^2/n} \qquad (3.4)$$

And also, the intercept as follows, Draper &Smith [12]

$$b_0 = \bar{Y} - b_1 \bar{X} \qquad (3.5)$$

3.3 Testing hypotheses

The hypothesis typically tested is the null hypothesis mean that the AG does not affect to EG against the two -sided alternative mean that the AG affect to EG denoted as follows:

$$\left.\begin{matrix} H_0: \beta_1 = 0 \\ H_0: \beta_1 = 0 \end{matrix}\right\} \qquad (3.6)$$

3.4 Model significance testing

We tested is the null hypothesis mean that the model is not significance using F-test it is called the variance ratio forms as follows

$$F = \frac{\sum(\hat{Y}_i - \bar{Y})^2}{\left(\sum(Y - \hat{Y}_i)\right)^2} = \frac{\text{variance explained by regression}}{\text{unexplained variance}} \qquad (3.7)$$

3.5 Determination Coefficient R^2

Coefficient of determination it the proportion of total variation in Y explained by fitting the regression and it is the square of the correlation coefficient r it is expressed as follows, Wonnacott [13]

$$R^2 = r^2 = \frac{\sum(\hat{Y}_i - \bar{Y})^2}{\sum(Y_i - \bar{Y})^2} = \frac{Explained\ vartion\ of\ Y}{Total\ vartion\ of\ Y} \qquad (3.7)$$

4. APPLICATION

In this section, the study data is analyzed, which is the Saudi economic growth rate, which is the dependent variable, and the agricultural growth rate, which is the independent variable, in the period from 1995 to 2021, which was taken from the General Authority for Statistics in the table below.

Table1.Economic Growth and Agricultural Growth

Year	EG	AG	AG	AG	AG
1995	6	1.5	2009	-17.4	1.7
1996	10.7	1.8	2010	23.1	13.9
1997	4.6	3.8	2011	27.1	4.5
1998	-11.4	1.5	2012	9.6	5
1999	10.2	1.6	2013	1.5	5.3
2000	17.2	1.5	2014	1.3	4.6

2001	-2.8	2.1	2015	-13.5	1.7
2002	3	1.1	2016	-1.4	1.1
2003	13.8	1	2017	6.8	0.5
2004	19.9	3.8	2018	18.6	0.3
2005	26.8	4.7	2019	-1.6	1.1
2006	14.7	5	2020	-12.5	1.3
2007	10.4	3.8	2021	18.5	7.8
2008	25	4.6			

Source: General Authority for Statistic -KSA

4.1 Data Examination

A time series plot of EG and AG data from 1995 to 2021. By looking at the Figure, we can immediately detect it is not an upward trend in the series, and the seasonal pattern could be more apparent with peaks and valleys at specific periods because we are dealing with year data unadjusted for seasonal variations. Suggesting that it is optional to stabilize the variance leads us directly to identify the model.

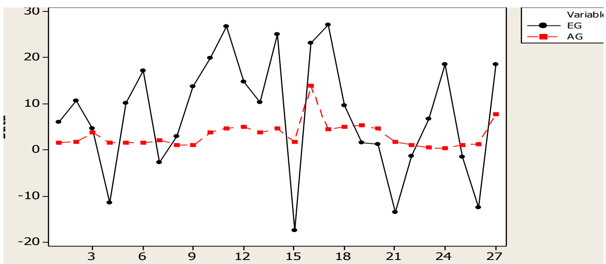

Figure 1.Time series Plot of Economic Groth and Agricultural Groth

4.2 Identification

By looking at the tables 2 and 3 and the plots 2and3 we observe that the autocorrelation of this series gradually decay to Zero and also partial autocorrelation APCF, and we see all values lower lags the autocorrelation and partial autocorrelation lie inside the approximate 95% sample confidence limits .Furthermore ,since the autocorrelation seen to die out quickly the value of the first autocorrelation is 0.045,we can safely conclude that this series is stationary ,and that differences was not required. Table 2 - 3and Figure 2-3 shows from which we conclude that the appropriate model is ARIMA (2,0,2). To determine its rank more precisely, it was compared with the ARIMA (0,0,2) model, which showed the significance of its parameters. The comparison statistics used that $[RMSE = 12.891,\ MAE = 9.683]$ of the ARIMA (2,0,2) model were less than $[RMSE = 13.08,\ MAE = 9.864]$ of the ARIMA (0,0,2) model, this indicates ARIMA (2,0,2).is the best model.

Table 2. Autocorrelation Function of EG:

Lag	ACF	T	LBQ
1	0.0454	0.24	0.06
2	-0.1589	-0.82	0.85
3	0.0951	0.48	1.15
4	-0.0194	-0.10	1.16
5	0.0197	0.10	1.17
6	0.0974	0.49	1.53

Table 3. Partial Autocorrelation Function of EG

Lag	ACF	T	LBQ
1	0.045400	0.24	0.24
2	-0.161274	-0.84	-0.84
3	0.113939-	0.59	0.59
4	0.060248	-0.31	-0.31
5	0.062280	0.32	0.32
6	0.070137	0.36	0.36
7	0.011230	0.06	0.06

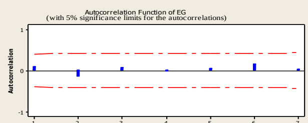

Figure 2.Autocrrelation Function of EG

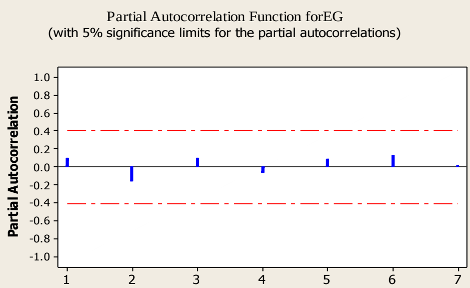

Figure 3. Partial Autocorrelation Function of EG

Table 4. Autocorrelation Function of AG

Lag	**ACF**	T	LBQ
1	0.187430	0.97	0.24
2	0.251161	1.26	-0.84
3	0.115907	0.55	0.59
4	0.075322	0.35	-0.31
5	-108953	-0.51	0.32
6	-0.148707-0.218831	-0.69	0.36
7		-1.00	0.06

Table 5. Partial Autocorrelation Function of AG

Lag	P ACF	T
1	0.187430	0.97
2	0.223896	1.16
3	0.040815	0.21
4	-0.003138	-0.02
5	-0.168688	-0.88
6	-0.149979	-0.78
7	-0.143981	-0.75

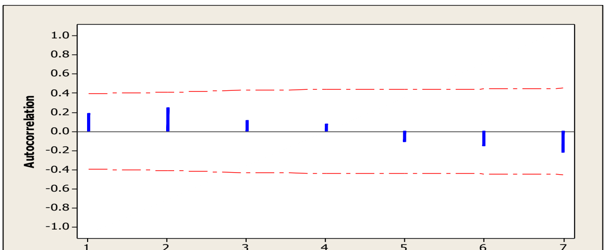

Figure 4. Autocorrelation Function of AG

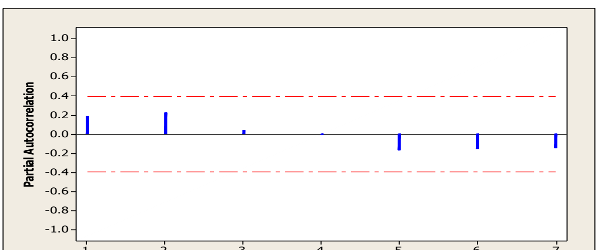

Figure 5.Partial Autocorrelation Function of Ag

4.3.Estimation

After verifying the suitability of the model, testing the significance of its parameters, and testing the homogeneity of variance, the second step in building the time series model is estimating the model and applying the ordinary least squares method to the series data, the statistics and parameters of the model were estimated using Minitab according to following table(6) and table (7)

Table 6. Estimates of Parameters

Type	Coef	f	T	P
AR 1	-1.3293	0.2519	-5.28	0
AR 2	-0.947	0.2126	-4.45	0
MA 1	-1.4609	0.3575	-4.09	0
MA 2	-0.8935	0.3515	-2.54	0.019
Constant	24.226	8.122	2.98	0.007
Mean	7.394	2.479		
N	27			
Res SS	3472.85			
Res MS	157.86			
DF	22			

3.4 Model diagnostic Checking

To test the white noise of the residual's series, the autocorrelation and partial correlation coefficients for the residuals were extracted as shown in Figure 6, that all autocorrelation coefficients fall within confidence limits.

To ensure the suitability of the model, test statistics were applied [(Q.Stat)(Ljung&Box)].It is noted that the calculated value ($Q_{12} = 9.9$) is less than the tabulated value ($\chi^2(0.05,10) = 18.3$) , and this means accepting the null hypothesis this is good indication that the residuals are white Noise. Therefore, the model adequately specified data. These conclusions show that the ARIMA (2,0, 2) is the most adequate model for the Economic Growth series. To ensure the significance of the model parameters, we provided that the residuals were normally distributed (see Figure 7), which led to the model being accepted and used for prediction.

Table 7. Modified Box-Pierce (Ljung-Box) Chi-Square statistic

Lag	Chi-square	DF	P-value
12	9.9	7	0.192
24	16	19	0.655
36	*	*	
48	*	*	

Confidence Interval Test

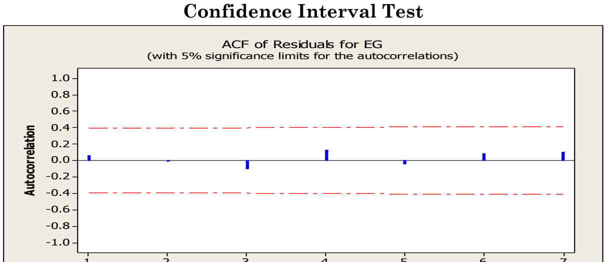

Figure6. Autocorrelation Function of Residuals

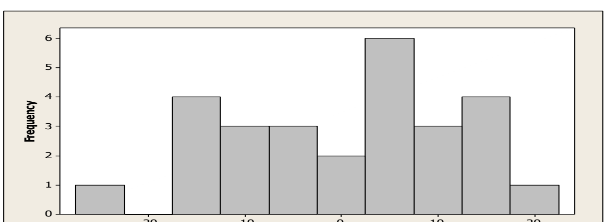

Figure 7. Residual Histogram for EG

3.5 Forecasting

In this section, the model in Paragraph 3.4 is used to predict E G in the Kingdom of Saudi Arabia for the period (1995-2021), the results of which are presented in Table 8. The time series for these predictions was also represented in Figure 8, which showed the same behavior as the original series

Table 8. Forecasts from period 2022-2023

Period	Forecast	Period	Forecast
2022	8.7115	2027	15.4102
2023	-0.8252	2028	-0.9788
2024	17.0732	2029	10.9341
2025	2.3122	2030	10.6183
2026	4.9846		

4.6. Regression Analysis: EG versus AG

In this section we Study the relationship between EG&AG, firstly the Stationary series of AG (see Tables 4-5 & figure 4-5-6), then we found that (DW- Statistic=1.8) lead to accept the null hypothesis indicate that there is no autocorrelation(look table 9) , On the other hand, as Granger and Newbold suggested, Gujarati D.N [14], if the value of $R^2$is greater than DW-Statistic, this means that the regression is false, but the opposite is proven, then R^2 is smaller than DW-Statistic ($R^2 = 0.212 < DW = 1.8$), (see table 9-10) and therefore the regression is real, and this proves that the two series EG and AG are stationary, note a low value of r indicates poor goodness of fit .The P value of F-test ($P = 0.016$) is less than ($\propto = 0.05$) reject the null hypothesis this indicate the model is significance(see table 8) .

Table 8. Analysis of Variance

Sources	SS	DF	MS	F	P
Regression	873	1	873	6.74	0.016
Residual	3238.1	25	129.5	0	
Lack of Fit	2388.4	16	149.3	1.58	0.246
Pure Error	849.7	9	94.4	0.019	
Total	4111.2	26	2.98	0.007	

Table 9.Unusual Observations

Obs	AG	EG	Fit	SE Fit	Residual	St Resid
16	13.9	23.1	29.42	8.64	-6.32	-0.85X
Durbin-Watson statistic = 1.75999						

4.1 Estimating

We determine a regression equation EG on AG using least square to estimate the parameters β_0, β_1 are given as the following table .10

Table 10. Coefficients

Predictor	Coef	SECoef	T	P	VIF
Constant	1.199	3.33	0.36	0.722	
AG	2.0305	0.7821	129.5	0.016	1
S = 11.3809 R-Sq =21.2% R-Sq(adj) = 18.1% PRESS = 3779.45 R-Sq (pred) = 8.07%					

Thus, the fitted regression equation obtained as: $EG = 1.199 + 2.0305AG$

The value of $\hat{\beta}_1 = +2.0305$, this means the relationship between the EG and the AG is positive ,(if the AG increase with one unit the EG increase with 2.035) .For testing of $\beta_1$we note that the P-value of t-test is less than 5% ($P = 0.016 < \alpha = 0.05$ is reject the null hypothesis indicate is significance that means the AG is effect to EG

5. CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

The Kingdom of Saudi Arabia seeks to improve EG by improving many other economic activities; the agricultural sector is one of the economic activities that support Saudi economic growth. The paper aimed to represent two parts: the first used time series analysis to predict the EG in Saud Arabia, and the second used regression analysis to determine the relationship between EG and AG from 1995 to 2021. The finding shows the autoregressive integrated moving average model of order (2) ARIMA (2,0,2) is the best model for data of EG and forecasted the EG to the next year and expected the EG amount to 17.0732. In addition, there is a positive relationship between EG and AG, and the AG explains 21.2% of the total variation in the average EG.

5.2 Recommendation

In view of these results, the researchers recommend the following

1- The possibility of studying the series of Saudi economic and agricultural growth

2- The researchers recommend improving economic activities that support economic growth

3- The possibility of expanding the agricultural sector to achieve an increase and abundance of agricultural products

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