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The Impact of the Transport and communications sector on Saudi Economic growth Using ARDL Model

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Abstract: This study examined the impact of the Transportation and Communications (TC) sector on Saudi Economic Growth (EG) in the period from 1975 to 2021 using the ARDL method. The study employed that the average of EG during the study period was 9.2 meanwhile the contribution of the TC on EG reached 22.4% and 5.5% in the short and long-run respectively. The study showed existence equilibrium relationship between the TC sector and EG in the long-run Therefore the speed from short-run to the long-run estimated at about 88%. The value of the error correction factor was (-0.8822), which means it takes about a year and a month (1/0.8822).The study recommended that more efforts should be taken into a count to raise the efficiency of the transportation and communications sector to play a greater role in increasing economic growth.

Keywords: Transport & Communication, Economic Growth, **I**mpact, ARDL.

1. Introduction

Transport has always been and remained one of the main driving forces in the economic development of any country, it plays a major role in the economic uplift of a country as it promotes internal and external trade. It considered to be the backbone of economic and it would be one of the most important sectors due to its direct connection with all aspects of life. Countries pay great attention to it because it raising the level of the vital infrastructure which leads to advancing the economic and social development. This sector is a basic pillar for investment, international cooperation, tourism, internal and external trade. However, any development in this sector will be followed by development in other sectors as well. The Kingdom of Saudi Arabia, with its wide area and strategic depth among the world's countries and the countries of the Gulf Cooperation Council and with all its economic, social and cultural dimensions, the transport and communications sector constitutes an important role that can never be ignored. The Kingdom of Saudi Arabia is considered one of the leading countries in terms of the economic activities related to the transport and communications sector. Therefore, the Kingdom has paid great attention to this sector in accordance with its plans for the year 2030 vision, regarding the budget of the year 2020, of which about 56 billion Saudi riyals were allocated to implementation of a numbers of activities regarding the transportation sector through which the Kingdom of Saudi Arabia achieved a tangible progress among many other countries. (Saudi Arabian Monetary Agency, 2020)[1]. The sector has a major role in supporting the economy of the Kingdom, as the sector's contribution to the gross domestic production (GDP) reached about 6.6% in 2016 and approximately 6% of the total economy. (General Authority for Statistics, 2021) [2]. According to the global competitiveness index, the kingdom jumped in its general index for the infrastructure of public transport services from the 40th place to the 34th place during the year 2019 and occupied the first stage beside United States and Spain in terms of the roads network. Regarding the aviation sector it jumped from 39 rank to 34 rank which considered to be a highest rank for the kingdom during the past few years. (International Economic Forum, 2019)[3].

2. Problem statement

The great economic renaissance in Saudi Arabia during the last two decades need to be a companied with strong means of success such as transport and communications sector to ease handling relative activities.

The problem of the study can be presented as:

- What is the contribution of the transport and communications sector on the gross domestic product?
- How transportation and communication sector help in development?

- How can transport and communication sector leads to high level of growth? And, to what extent this sector can contribute to the comprehensive development renaissance that the Kingdom of Saudi Arabia is witnessing? And
- To what extent can the transport and communications sector keep pace with the comprehensive plans (2030) adopted by local government?

3. Importance of the Study:

Transport and communication are clearly a factor of fundamental importance in all economic activities. However, the importance of the study stems from the importance of transport and communications sector and its overlapping relationships with all other sectors, on the other hand, statistical application on such real data is useful in scientific field for students acquiring knowledge and those interested in applied studies, in addition to that, the output results of the study will highly help decision-makers in the relevant sectors to get use of it for their future ambitious plans.

4. Literature review

Much of the literature of transport economics of the third world countries reveals widespread belief in the importance of transport and in the efficiency in transport improvement. Amore recent United Nations study claimed that transport and communication is the formative power of economic growth and the differentiating process (Voigt, 1976) [4]. Study handled by Hassan (2019) titled "frame structure of transport sector and it is effect on Sudanese economy" [5] revealed that the transport sector is the key success of the economic growth. A bidirectional causality between road transportation and economic growth, bidirectional causality between road transportation and capital formation, bidirectional causality between gross domestic capital formation and economic growth, unidirectional causality from rail transportation to economic growth and unidirectional causality from rail transportation to gross capital formation have been deducted in a study "Effect of transportation infrastructure on economic growth in India" (Rudra & Tapan, 2013)[6].The autoregressive distributed lag model (ARDL) is the major workhorse in dynamic single-equation regressions. One particularly attractive reparameterization is the error-correction model (EC) Hassler and Wolter [7]. Its popularity in applied time series econometrics has even increased, since it turned out for nonstationary variables that cointegration is equivalent to an error-correct ion mechanism, see Granger's representation theorem in Engle and Granger [8]. By differencing and forming a linear combination of the nonstationary data, all variables are transformed equivalently into an EC model with stationary series only. Working on feedback control mechanisms for stabilization policy, Phillips [9] introduced EC models to economics. Sargan [10] used them to estimate structural equations with autocorrelated residuals, and Hendry popularized their use in econometrics in a series of paper According to Hylleberg and Mizon[11] the error correction formulation provides an excellent framework within which it is possible to apply both the data information and the information available from economic theory\ A survey on specification, estimation and testing of EC models is given by Alogoskoufis and Smith [12] The present paper contributes to this literature in that it treats some aspects of testing cointegration and asymptotic normal inference of the cointegrating vector estimated from an EC format. The rest of the paper is organized as follows. The next section reviews different reparameterizations and interpretations of ARDL models. Then we use that the cointegrating vector computed from the ADL model is equivalent to the one estimated from EC in order to use results by Pesaran and Shin [13] on asymptotic normality. We review t-type and F-type test statistics in the final section.

5. Study methodology

Analytical approaches to estimate the impact of transportation and communication sector in Saudi economic growth started out using time series analysis in particular the autoregressive distributed lag model (ARDL) due to the length of the time period of the study's data, that extends to cover the period from 1970 to 2021 in order to find out the relationship between the dependent and independent variables and test the predictive ability of the estimated model. Transportation and communication facilities in a specific country are located to provide services to a wide range of sectors including local and abroad communities within a specific geographical area and their use is directly related to moving goods and people between two points. Furthermore, because transportation services are provided within a network, what happens in one place affects what happens in another. However, the appropriate methodology has to take in to consideration not only the spatial relations as the goods and people are moved between two points, but also how these movements fit into a network in a way that can enables to forecast for the future growth rate of the economic, as well as the gross domestic production (GDP), and to construct a statistical model to reflect these relations.

5.1 Description of the model of study:

The standard model for measuring the impact of the transportation and communications sector on Saudi economic growth includes a number of economic variables expressed by a mathematical function which determined through the literature represented in economic theory and applied studies.

5.2 Study variables:

Dependent variable: Economic Growth (EG).
Independent variables: Transport and Communications (TC).

6. Theoretical formulation

6.1 Economic growth and measuring economic growth rates

Economic growth is considered a quantitative economic indicator that can be measured, it differs from the concept of economic development. It is defined as an annual increase expressed as a percentage of real GDP, measured per capita reflects the true standard for the level of economic progress and well-being, Marouf [14]. Economic growth means an increase in the gross domestic product and national income, thus achieving an increase in the average per capita share of real income Ajamya [15]. Economic growth expresses the difference between the amount of gross domestic product for two years follows. If Δy symbolizes economic growth, then it is

$$y\Delta = y_t - y_{t-1}$$

From it, the economic growth rate is the gross domestic product rate for the year $y_{t-1}$where we get an indicator of the percentage of the economic growth rate for the yeary_t. If we denote the economic growth rate with the symbol$g$, then:

$$g_i = \frac{y_t - y_{t-1}}{y_{t-1}} \ldots\ldots\ldots\ldots\ldots\ldots \quad (1)$$

Table 1. Saudi Economic Growth rate during the period 1970-2021

Year	EG	Year	EG	Year	EG	Year	EG	Year	EG	Year	EG
1970	11.7	1980	45.6	1990	23.4	2000	17.2	2010	23.1	2020	-12.5
1971	33.2	1981	13.9	1991	12.4	2001	-2.8	2011	27.1	2021	18.5
1972	24.3	1982	-15.7	1992	3.7	2002	3	2012	9.6		
1973	38.3	1983	-15	1993	-3	2003	13.8	2013	1.5		
1974	191	1984	-5.5	1994	1.7	2004	19.9	2014	1.3		
1975	2.1	1985	-10.7	1995	6	2005	26.8	2015	-13.5		
1976	37.3	1986	-14.4	1996	10.7	2006	14.7	2016	-1.4		
1977	15.7	1987	-0.3	1997	4.6	2007	10.4	2017	6.8		
1978	4.3	1988	3	1998	-11.4	2008	25	2018	18.6		
1979	37.8	1989	8	1999	10.2	2009	-17.4	2019	-1.6		

Source: General Authority for Statistic of-KSA

6.2 Mathematical model:

The study was conducted depending on an autoregressive distributed lag model (ARDL) which was presented by Pesaran and Shin (2001)[16]

The idea behind ARDL method is to merge the autoregressive and distributed lag model to forecast the effect of the regressor on the dependent variable, this is not only for the present time but also for a multiple previous time period (t-r).

The (ARDL) model has a shape of equation

$y_t=\lambda_1 y_{t-1}+\lambda_2 y_{t-2}+\cdots+\lambda_p y_{t-p}+u_t$…….....(2)

The dynamic behavior of the model can also be described in terms of the lag values of the dependent variable (i.e.y_{t-i}), hence:

$$y_t =\alpha+\alpha_1 y_{t-1}+\beta_0 x_t+\beta_1 x_{t-1}+u_t \ldots\ldots\ldots\ldots\ldots\ldots \quad (3)$$

Where (y, x) represent stationary variables with zero degree, or degree one or a combination of zero and one.

Depending on the method of bound test approach.

Lower and upper limits for the F test (F-statistic) are determined by the null hypothesis (H_0), which means that there is no possibility of a cointegration relationship in the long run between the variables of the model. When the calculated F value is less than the critical values, the null hypothesis is rejected and the alternative hypothesis is accepted, which means the existence of cointegration,

According to the above, from an applied standpoint, the error correction model and boundary testing are done after determining the degree of stationarity for the studied variables. We apply the following equation:

$$+\beta_1 y_{t-1} + \beta_2 p_{t-1} + \beta_3 m_{t-1} + \varepsilon t \ldots\ldots\ldots\ldots (4)$$

Δ=The first difference of the variable values,a_0 = constant r =number of optimal lag time, $a_{1i} a_{2i} a_{3i}$ =Short-run coefficients of the dynamic relationship

$\beta_1, \beta_2, \beta_3$ = Long-run coefficients through which the possibility of cointegration is known, ε_t =Random error term,$t = time$

According to the above equation, if the possibility of cointegration between the variables under study becomes possible according to the bounds test, the short-term relationship will be estimated using the error correction model as follows:

$$\Delta y_t = a_0 + \sum_{i=0}^{r} a_{1i}\, \Delta y_{t-1} + \sum_{i=0}^{r} a_{2i}\, \Delta p_{t-i} + \sum_{i=0}^{r} a_{3i}\, \Delta m_{t-i} + yECT_{t-1} + \varepsilon t \ldots\ldots (5)$$

Where (ECT) represents the error correction term that is added to the model, while y represents the percentage of deviation that is corrected in the period (t-1$t-1$ to period$t$). This means the speed of error correction of the dependent variable in the short run towards its equilibrium value in the long run. The ARDL methodology has many advantages, the most important of which are

1. The possibility of combining variables with more than one level of stability, such as I(0) and I(1), and it is not required that they all be stable at the same level in conjunction, if the time series of the variables are not integrated of the second order (I(2)) or of the higher order.
2. Through the ARDL, we can determine the integrated relationship of the dependent variable with the independent variables in the short run and long run, in addition to determining the size of the effect of each of the independent variables on the dependent variable.
3. The estimators resulting from this model are characterized by non-bias and efficiency, in addition to helping to eliminate problems related to deleting variables and autocorrelation problems Alshorbajy[17]
4. In addition, the study relied on the ARDL as it is one of the most appropriate models with the size of the observations used, which numbered (52) observations during period from1970 to 2021 obtained from the General Authority for Statistics in the Kingdom of Saudi Arabia. The study also relied on the use of the logarithmic formula in order to obtain the elasticities of the independent variables, in addition to reducing the dispersion of the data. Therefore, the natural logarithm of the independent variable was taken, and thus the final formula of the model to be estimated as follows:

$$EG = \beta_0 + \beta_1 Log(TC) + \cdots . + u_i \quad \ldots\ldots\ldots\ldots (6) \ , \beta_0, \beta_1 > 0$$

7. Results and discussion

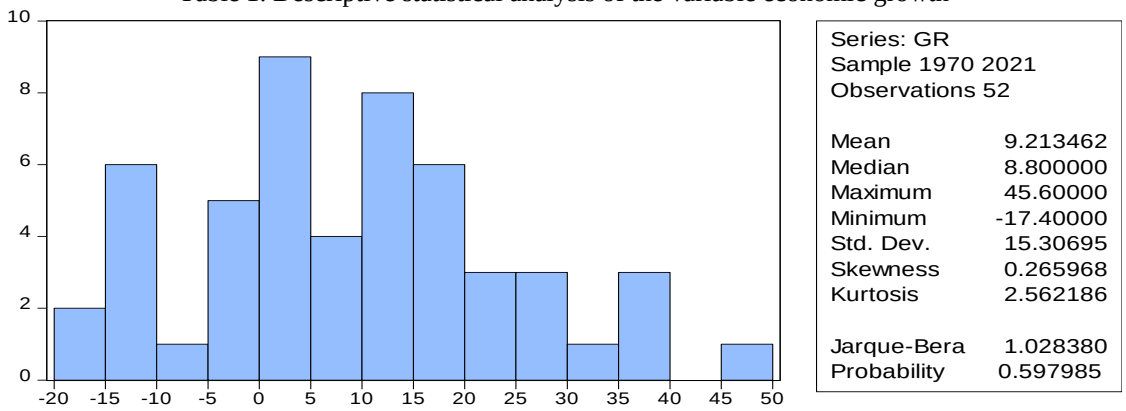
The practical application of the ARDL includes three steps: determining the integration order of the variables using unit root tests, testing the existence of an integral relationship using the Bounds Testing Approach, and finally estimating the ARDL to obtain the short- and long-run coefficients. The following is a discussion for the results of the analysis of the study model:

7.1 Descriptive statistical analysis of the study variables

Descriptive statistical analysis is used to give a quick glance of the data under the study.

a. Economic growth

Table 1. Descriptive statistical analysis of the variable economic growth

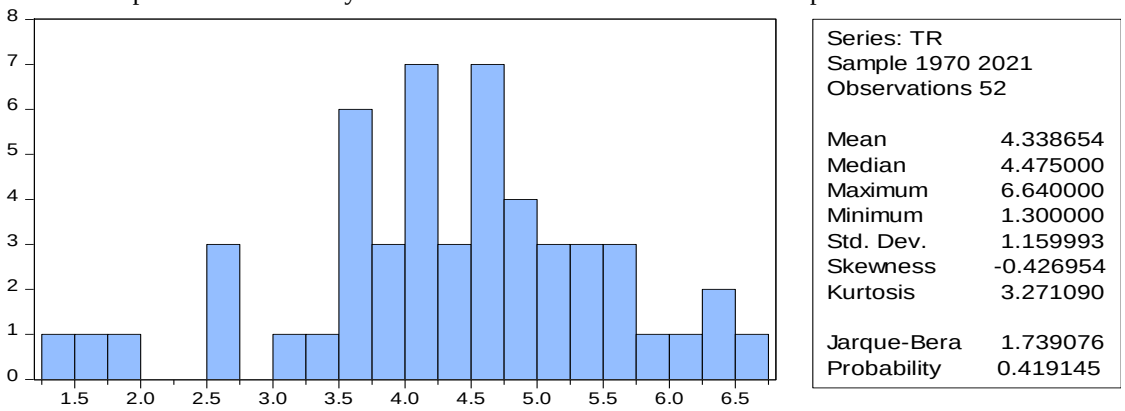


Source: Prepared by the researchers from the estimation results using the E. Views12

The economic growth mean is 9.2 with standard deviation 15.3 and it has maximum value at 45.6 in the year 1980 and minimum value at – 17.4 in the year 2009. The value of the coefficient of skewness 0.256 indicate the normality appearance of the economic growth, this result is also supported by the test of Jarque-Bera with level of significance 0.597 which is greater that the significance value 0.05

b. Contribution of the transportation and communications sector

Table 2 Descriptive statistical analysis of the variable contribution of the transport and communications sector



Source: Prepared by the researchers from the estimation results using the E. Views12

The average contribution of transportation and communications sector was 4.33, with a standard deviation of 1.15, it has maximum value at 6.64 in the year 2016 and minimum value at 1.30 in 1974. The value of the coefficient of skewness – 0.42 indicate the normality appearance of the sector's data, this result is also supported by the test of Jarque-Bera with level of significance 0.419 which is greater that the significance value 0.05

7.2 Testing the stationary of time series data (unit root tests)

To check for the properties and stationarity of the variables under the study Augmented Dicky Fuller test (ADF) has been used, the result shown in table (3) indicate obvious stationarity of the EG variable at 0.05 significance level, which means that it is integrated in degree (zero) I(0), while the TC variable showed non stationary level at the same level of significance, therefore the test is repeated once again and givesaresult revealed stationary level in the first lag difference, so this could be considered as a good indicator of using co-integration test in time series analyses(see appendix 3).

Table 3 Unit root test results for the study variables during the period (1970-2021)

Variables	Level		First difference	
	P. Value	Test Value (ADF)	P. Value	Test Value ADF
EG	0.309	-1.946	0.0000	-6.924
CT	0.0003	4.700	-	-

Source: Prepared by the researchers from the estimation results using the E. Views12

7.3 Choose the optimal lag period for the differences

The optimal lag period for the study variables was determined using an Unrestricted Autoregressive Model Vector through five different criteria to determine the lag period (Al-Shorbagy, 2009, 157), these are:

Final prediction Criteria (FPC), Akaike Information Criteria (AIC), Schwarz Criterion (SC), Hanan Quinn information criterion (Q-H) and Maximum likelihood Ratio criterion (LR).

According to these criterions lag period with minimum value is chosen, however, from table (4) second lag period is an optimum one at 0.05 level of significance which will be used for estimating the model under the study.

Table 4 Criteria for choosing the optimal lag period for the study variables

Lag	LR	EPF	CIA	CS	H-O
0	8.986939	9.036043	8.957313	26.61757	NA
1	6.926173	7.073483	6.837294	3.195959	100.7702
2	6.622530*	6.868046*	6.474398*	2.226119*	22.39057*
3	6.824748	7.16847	6.617362	2.575575	1.089925
4	6.830052	7.271981	6.563414	2.452808	8.518129

Source: Prepared by the researchers from the estimation results using the E. Views12

7.4 Bounds Testing Approach

Co-integration method is used to determine the equilibrium relationship between variables in the long run. In this method F-test is run to test for the significance that all the variables with the same lagged period is equal to zero, so that:

$H_0: \beta_0 = \beta_1 = \beta_2 = \beta_4 = 0$ (There is no cointegration between the variables)

$H_1: \beta_0 = \beta_1 = \beta_2 = \beta_4 \neq 0$ (There is cointegration between the variables)

F-statistic	K	Value
30.25	1	
I(1) Bound	I(0) Bound	Significance
3.51	3.02	10%
4.16	3.62	5%
4.79	4.18	2.50%
5.58	4.94	1%

Source: Prepared by the researchers from the estimation results using the E. Views12

The F-test has nonstandard distribution with two different critical values (lower limit value and upper limit value), the null hypotheses is rejected when the F-test value is greater than the upper limit value and it would be accepted when it was less than the lower limit value, if it lies between the upper and lower limit value the decision among the null hypotheses will be ambiguous (abdelgadir, 18, 2013) [18]

From the results shown in table (5) the null hypotheses is rejected since the F-value 30.25 is greater than the upper limit value 4.16 and conclude that there is cointegration between the variables, hence there is an equilibrium relationship in the long run between independent variable TC and dependent variable EG.

7.5 Estimation of the study model

The autoregressive distributed lag model (ARDL) in the long and short run is estimated in accordance to the previous findings which is indicated the stationarity and the existence of an equilibrium relationship in the long run between the variables.

7.6 Evaluating the model estimation results

a. Evaluate the model according to the economic criterion

The following tables (6 and 7)give a fundamental result to estimate the model in both short and long run term:

Table 6 Estimation results of the long-run study model during the period 1970-2021

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
LOG(TC)	5.455407	1.618519	3.370616	0.0016
C	7.98761	2.305078	3.46523	0.0012

Source: Prepared by the researchers from the estimation results using the E. Views12

$$Log(GR) = \mathbf{7.98761} + \mathbf{5.4554}\log(TC)$$

R-squared= 0.36, Adjusted R-squared=0.34, F-statistic=6.450
Prob (F- statistic=0.0003.

Table7 Estimation results of the short-run model and the error correction parameter

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
DLOG(TC)	22.3956	10.35165	2.16348	0.036
CointEq (-1) *	-0.88223	0.193219	-4.56595	0.0002

Source: Prepared by the researchers from the estimation results using the E. Views12

$$\mathbf{D}(\mathrm{GR}) = 22.395$$

R-squared= 0.74, Adjusted R-squared=0.73, F-statistic=41.80
Prob(F-statistic) = (0.000).

The value of the coefficient of the independent variable (TC) indicate a positive significant relationship towards the EG in both long and short run term, with it is value 5.445 in the long run which mean that if the contribution of the TC sector to the gross domestic product increased by 1% , this will lead to an increase in the EG by 5.5% in the long run, while its value in the short run reached 22.395, which mean that if the contribution of the TC sector to the gross domestic product by 1% will leads to an increase of the EG rate by 22.4% in the short run.

From the table (7) it is clear the error correction coefficient is statistically significant at level 0.05 with a negative value consolidated the existence of a long run equilibrium relationship between the variables. Therefore, its speed from the short run to the long run is estimated at about 88%. The value of the error correction factor was (-0.8822), which means that it takes about a year and a month (1/0.8822).

Based on the number of lag periods specified according to the criteria for choosing the lag period for all variables. All calculations for estimating the model were also performed using the E-views12 program, and the following tables show the results of the estimates of the model measuring the impact of the contribution of the TC sector on EG in the Saudi economy during the period 1970-2021 in the long and short terms.

b. Evaluate the model according to the statistical criterion

In one hand, the value of the T-test in table(6) and (7) indicates that the transportation and communication sector has significant impact on the economic growth in both long and short run term since the T- test value in the long run was (3.37) accompanied with p-value (0.0016) while the T-test value in the short run was (2.163) with p-value (0.036), and all of them were less than 0.05 which indicate an existence significant relationship between the TC and EG in the long and short run term in the Saudi economy. On the other hand, the overall model is statistically significant at level 0.05 since the F-test value is (6.45) in the long run with p-value (0) and (41.8) in the short run with p-value (0) which all of them were less than 0.05 as well.

The adjusted coefficient of determination, whose value was 0.36 in the long term and 0.74 in the short term, indicates that the independent variable (contribution of the TC sector) explains about 36% of changes that occur in the dependent variable (EG) are due to the independent variable; that is in the long run term and 74% of the changes that occur in the dependent variable are due to the independent variable in the short run term, while the remaining percentage of changes (64% and 26%) are due to other un known variables (usually random variables) . These results indicate the goodness of fit of the ARDL model in explaining the impact of the TC sector on EG.

7.7 Checking the Model's Validity:

A good fitted model should meet some basic criteria; that is:

- Independency of the random error

- The variance of the error must be homogeneous.
- The random error must be identically and normally distributed
- The model should pass the test of the parameter's stability
- Model ability to forecast.

The following are the findings regarding the model validity:

1. Findings of the Residual autocorrelation test:

The below table (8) showed the finding to test for the independency of the residuals for the autocorrelation in term of the null hypotheses $H_0: e_1, e_2, e_3, \dots\dots, e_n$(are not independent) against $H_1: e_1, e_2, e_3, \dots\dots, e_n$(are independent) using the Lagrange Multiplicative Test. The findings tell us that there is no obvious evidence to accept the null hypotheses since the p-value is equal to (0.1168). Therefore, there is no residual autocorrelation problem.

Table 8LaGrange's multiple tests for the residual independence hypothesis of a model:Breusch-Godfrey Serial Correlation LM Test:

F-statistic	2.0170	Prob. F(2,42)	0.1457
Obs*R-squared	4.2940	Prob. Chi-Square(2)	0.1168

Source: prepared by the researchers from the data of the study based on the outputs of the E. Views12 program

2. Results of the Stability of Variance Hypothesis Test:

To test for the homogeneity of the variance error, Breusch-Pagan-Godfrey Test has been used. The findings in table (9) indicate that the null hypotheses $H_0: \sigma_1 = \sigma_2 = \sigma_3 = \cdots = \sigma_n$(Variance error are homogeneous) will not be rejected since p-value is equal to (0.772) which is greater than 0.05

Table 9 Breusch-Pagan-Godfrey test for the instability of variance hypothesis

F-statistic	0.080	Prob. F(1,46)	0.778
Obs*R-squared	0.083	Prob. Chi-Square (1)	0.772

Source: prepared by the researchers from the data of the study based on the outputs of the E. Views12 program

3. Results of Normal Distribution Test for the Error Limit:

To check for the error normality (Jarque-Bera) test is used. From the table (10) the test value is (1.443) with p-value (0.486) which is greater than 0.05 therefore the null hypotheses $H_0: e_1, e_2, e_3, \dots\dots, e_n$ (residual error are normally distributed) is accepted at a level of significance 0.05.

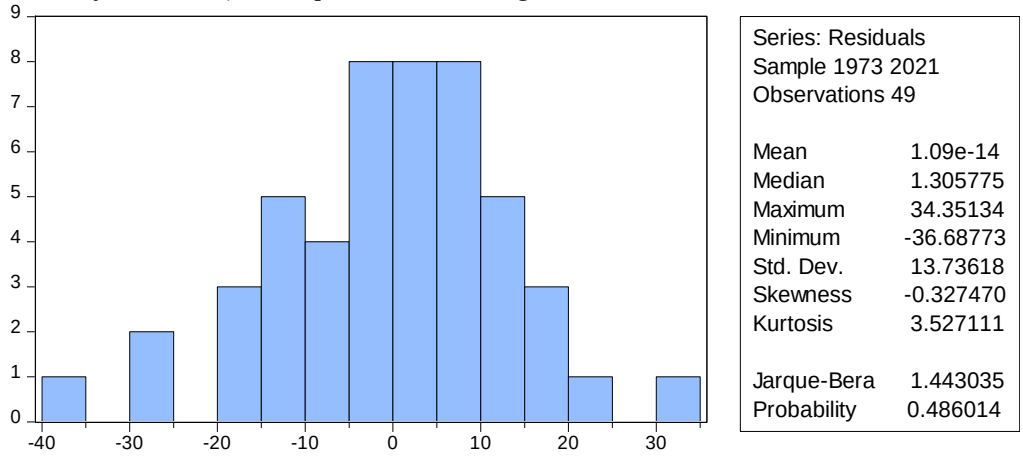


Figure 1 Test for normal distribution error limit

Source: prepared by the researchers from the data of the study based on the outputs of the E. Views12 program

7.9 The Structural Stability Test for the Model Parameters:

To find out the consistency of the coefficients of the model variables in the long and short term, the cumulative sum of the residuals (CUSUM) test was used. According to this test, the structural stability of the coefficients estimated by the error-corrected formula of the (UESM) model is achieved when the CUSUM graph

line is confined within the critical graph lines at a significant level (5%). Whereas, these coefficients are not stable in case the statistical graph line exits outside the critical graph lines. In the estimated model, it is noted that the test of the cumulative sum of the remainder (CUSUM) falls within the critical limits at a significant level (5%), which indicates that the parameters stability is exist then one can conclude that the unrestricted estimated coefficients of the model is structurally stable during the period of the study.

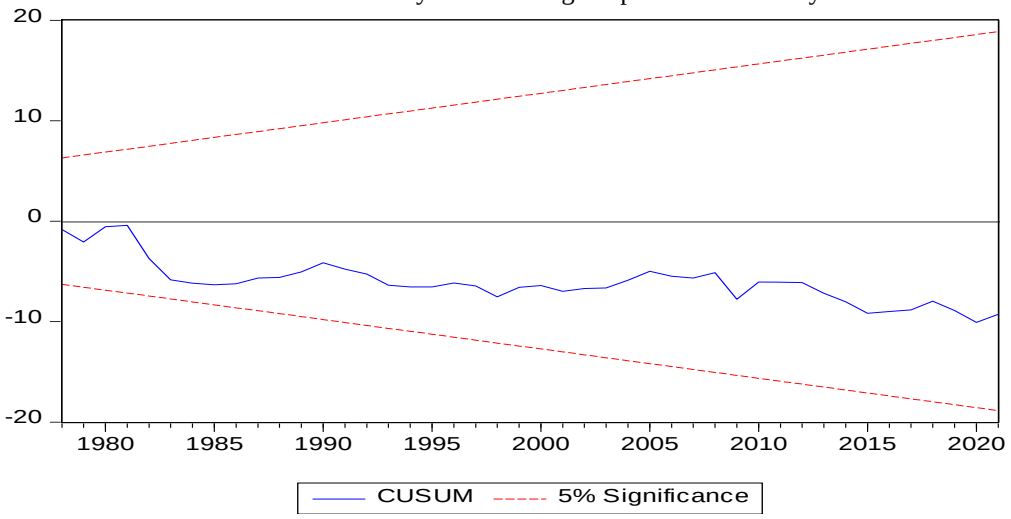


Figure2 The model's stability test

Source: prepared by the researchers from the data of the study based on the outputs of the E. Views12 program

7.10Analysis of the Impulse Response Function of the Economic Growth Rate:

From the previous findings, it is noted that there is a co-integration between the variables, so that the Vector Error Correction Model will be used to estimate the impulse response function which reflects the response of the dependent variable to a shock of one unit of the standard deviation of another variable. According to the impulse response function which is extended for (52) years, the response of the EG rate in case of a shock happened by standard deviation equal to one in the EG rate, the effect of the shock will have positive impact in the first year, then turns into a negative impact in the second and the third year, then returns to a positive impact in the fourth and fifth year, after that the impact of the shock takes a downward trend in the period (7-10), while the response of the EG in case of a shock at standard deviation equal to one regarding the contribution of the TC sector there will be no impact in the first year except for the period extended from 2 to 10 year which demonstrates a positive impact.

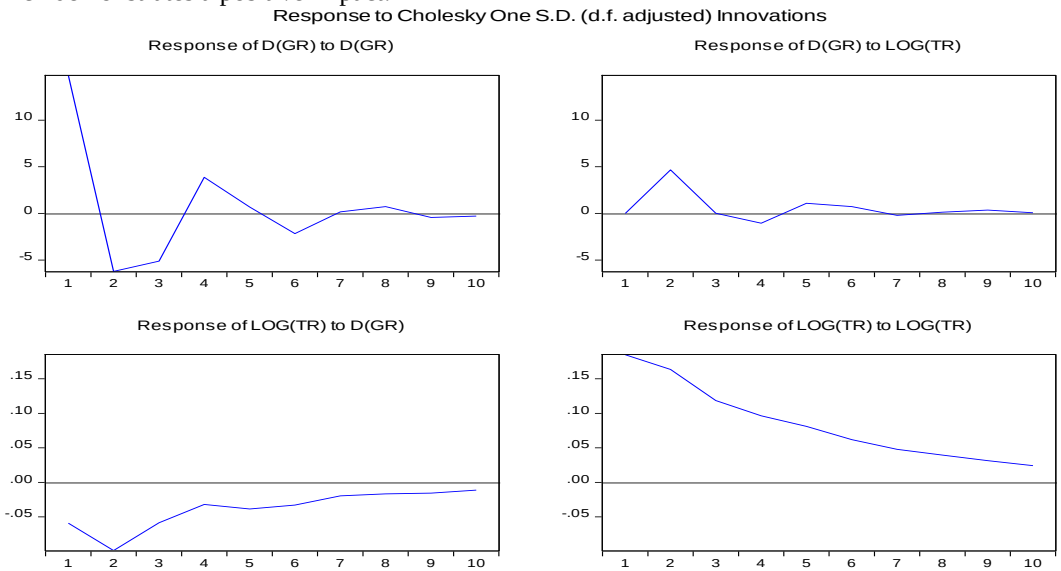


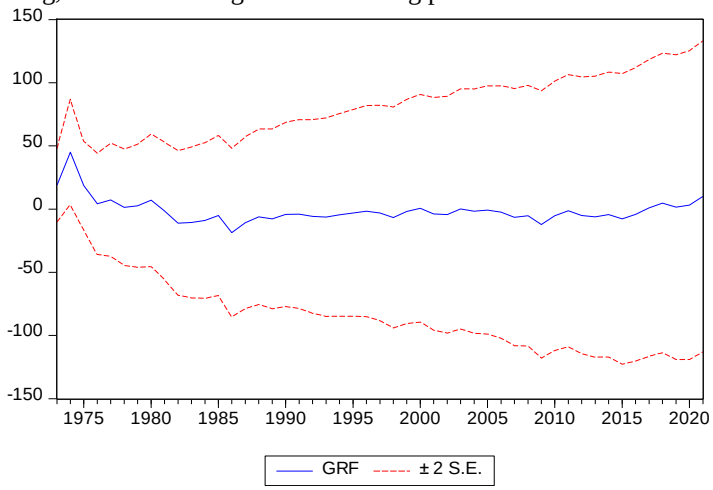
Figure 2. The Impulse Response Function for Economic Growth Rate variations

Source: prepared by the researchers from the data of the study based on the outputs of the E.Views12 program

7.11 Testingthe Model Ability to Prediction:

Theil equality coefficient criterion has been used to test the prediction ability of the estimated model as shown in the below graph (3):

The result reflects an acceptable forecasting ability of the estimated model since the Theil coefficient is equal to (0.61) which is close to the zero. These results are also consolidated by the finding appears in graph (2) which is explain the behavior of the actual and predicted values of the Saudi economic growth rate. Therefore, the postulated results extracted by the estimated model would be very informative in terms of prediction, future planning, decision making and formulating political evaluation.



Forecast: GRF	
Actual: GR	
Forecast sample: 1970 2021	
Adjusted sample: 1973 2021	
Included observations: 49	
Root Mean Squared Error	16.56043
Mean Absolute Error	13.47944
Mean Abs. Percent Error	214.0787
Theil Inequality Coefficient	0.616495
Bias Proportion	0.345886
Variance Proportion	0.110824
Covariance Proportion	0.543290
Theil U2 Coefficient	1.422401
Symmetric MAPE	147.4510

Figure 3. Results of testing the model's predictive ability during the period (1970-2021)
Source: prepared by the researchers from the data of the study based on the outputs of the E.Views12 program

Recommendations

Based on the findings of the study, it presents the following recommendations

- Developing the infrastructure related to the transportation and communications sector to raise the level of global competitiveness of this sector
- Raising the efficiency of the transportation and communications sector to play a greater role in increasing economic growth
- Work to reduce these negative impacts on the sector to the extent that contributes effectively to increasing economic growth rates

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Appendix:

(1) Testing the stationary of the EG variable

Null Hypothesis: GR has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, max lag=10)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-4.700750	0.0003
Test critical values:	1% level	-3.565430	
	5% level	-2.919952	
	10% level	-2.597905	

*MacKinnon (1996) one-sided p-values.

(2) Testing the stationary of the contribution variable of the TC sector

Null Hypothesis: D(TC) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, max lag=10)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-6.924522	0.0000
Test critical values:	1% level	-3.568308	
	5% level	-2.921175	
	10% level	-2.598551	

*MacKinnon (1996) one-sided p-values.

(3) Co-integration Test result

Null Hypothesis: No levels relationship F-Bounds Test

I(1)	I(0)	Signif.	Value	Test Statistic
3.51	3.02	10%	30.25669	F-statistic
4.16	3.62	5%	1	K
4.79	4.18	2.5%		
5.58	4.94	1%		

(4) Estimation results of the long-run study model

Levels Equation
Case 2: Restricted Constant and No Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.

LOG(TC)	5.455407	1.618519	3.370616	0.0016
C	7.987613	2.305078	3.465225	0.0012

(5) Estimation results of the short-term study model (error correction model

EGM Regression
Case 2: Restricted Constant and No Trend

Prob.	t-Statistic	Std. Error	Coefficient	Variable
0.0009	3.550947	0.120875	0.429221	D(GR(-1), 2)
0.0360	2.163478	10.35165	22.39557	DLOG(TC)
0.0002	-4.565951	0.193219	-0.8 82231	CointEq(-1)*

0.814286	Mean dependent var	0.737111	R-squared
26.79044	S.D. dependent var	0.725681	Adjusted R-squared
8.179773	Akaike info criterion	14.03162	S.E. of regression
8.295599	Schwarz criterion	9056.767	Sum squared resid
8.223717	Hannan-Quinn criter.	-197.4044	Log likelihood
		1.942082	Durbin-Watson stat

* p-value incompatible with t-Bounds distribution.

(6) Study data

year	GR	TC	Year	GR	TC	year	GR	TC
1970	11.7	4.5	1992	3.7	4.46	2014	1.3	5.1
1971	33.2	3.8	1993	-3	4.78	2015	-13.5	6.33
1972	24.3	3.7	1994	1.7	4.85	2016	-1.4	6.64
1973	38.3	3.5	1995	6	4.64	2017	6.8	6.4
1974	19.1	1.3	1996	10.7	4.22	2018	18.6	5.42
1975	2.1	1.6	1997	4.6	4.2	2019	-1.6	5.82
1976	37.3	1.99	1998	-11.4	4.87	2020	-12.5	6.16
1977	15.7	2.7	1999	10.2	4.6	2021	18.5	5.48
1978	4.3	3.5	2000	17.2	4.1			
1979	37.8	3.2	2001	-2.8	4.23			
1980	45.6	2.5	2002	3	4.49			
1981	13.9	2.55	2003	13.8	4.11			
1982	-15.7	3.34	2004	19.9	4.02			
1983	-15	4.14	2005	26.8	3.54			
1984	-5.5	4.51	2006	14.7	3.53			
1985	-10.7	3.69	2007	10.4	3.92			
1986	-14.4	5.64	2008	25	3.99			
1987	-0.3	5.48	2009	-17.4	5.52			
1988	3	5.5	2010	23.1	5.11			
1989	8	5.16	2011	27.1	4.58			
1990	23.4	4.52	2012	9.6	4.5			
1991	12.4	4.38	2013	1.5	4.8			

Source: General Authority for Statistic of-KSA

