Relationship between Technology and Economic Growth

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Abstract

The study analyzes the relationship between technology and economic growth in Jordan during 2009–2018 and the data are treated via Views E program. ARDL methodology are used. Results showed a co-integration relationship between the study variables (computer use in general; computer use at work; and computer use in education, training, and economic growth) and the results presented that the deviation from long-term equilibrium is corrected using an error correction model which long-term corrected as a percentage correction (−0.06) each year from the short-term to the long-term and showed the results of the structural stability test of the (ARDL) model. It is a structural stability test for long and short-term coefficients, which showed that the data used in this study are free from any structural changes has stable parameters over time The study also used CUSUM's Squerse test, where the test results showed that the study model used is economically good and can be relied upon to anticipate economic solutions in Jordan according to the situation in the coming years, and among the most important recommendations of the study are the following: the need to encourage the use of technology in work, education, and training, and the need for expansion in using these technological means as a gateway to the digital economy and the digital state.

Keywords: technology, computers at work, computers in education and training, economic growth, digital economy

1. Introduction

ICT has gained increasing importance in most countries of the world because of its significant impact on economic variables in general. On the demand side, it affects the economic behavior of the consumer. On the supply side, producer behavior is affected because technological development has led to the deepening of capital and the reorganization of economic and productive processes, especially in developing countries, as a major driver and actor in achieving economic and social development. Technology has also witnessed growth over the past years until it has a major role in economic development due to its direct connection to many economic sectors and as a very important productive component.

In this regard Magdi (Magdi ,S., 2011) indicates that information technology can affect economic growth through four main channels: producing goods and services, increasing the productivity of production in this sector, and contributing in financing trade, which leads to an increase in productivity in these sectors use information technology Capital as an input in the production of real and non-real goods such as services. In addition, the main technological indicators, such as computer use in general, computer use at work, and computer use in education and training, play an important role in data monetization, big data analytics, data visualization, advanced analytics, and in-memory databases, which are used in ways that contribute to distinguishing data from other technical concepts, such as quantitative measurement, measurement, recording, or digitization. These indicators contribute greatly to supporting economic decisions, directly promoting digital economic growth. These tools are also considered an important gateway to the digital economy. The digital state must provide people with basic technical skills that enable them to use these tools as sources of information as a gateway to the digital economy. There will be alternatives to traditional services or as a new form of technological development. Moreover, these technological indicators are part of the infrastructure for digital economic technologies, which is necessary to enable users to benefit from the achievements of technology and communications in economic activities.

Technology plays an important role in all countries of the world, especially in non-industrial countries such as Jordan, because these electronic tools can greatly affect development in general through their ability to develop the level of services, save time and effort, reduce costs, increase trade and digital investment ,thus raising economic growth rates.

In this regard, according to the statistics of ICT sector indicators, Jordan witnessed the highest growth rates in the indicators of the technology sector, as the percentage of computer use in training and education increased from 49.3% in 2017 to 60% in 2018. The percentage of computer use at work also increased between 2017 to 2018, which in turn led to an increase in the contribution economic growth in Jordan. This study includes four parts: the first part is the introduction, the second part is the Materials and Methods of the study, the third part is the Results, and the fourth part will discuss the Conclusion and Discussion. Accordingly, the study aims to track the developments in the rates of information technology indicators in Jordan during the study period, in addition to investigating the impact of technology indicators such as computer use, computer use at work, and computer use in education and training on economic growth in Jordan.

Based on the foregoing, the problem of the study revolves around answering the following main question: Do technological indicators in Jordan reflect positively on economic growth? Is there a common integration between ICT indicators (the percentage of computer use in general, the percentage of computer use at work, and the percentage of computer use in training and education) and economic growth in Jordan? Is there a relationship between ICT indicators (the percentage of computer use in general, the percentage of computer use at work, and the percentage of computer use in training and education) and economic growth? Is there a long-term equilibrium relationship between (economic growth, the percentage of computer use in general, and the percentage of computer use in work and the percentage of computer use in training and education). By reviewing the study literature and relying on previous studies, the study hypotheses can be formulated as follows:

(1) There is a statistically significant co-integration ($\alpha \leq 0.05$) between ICT indicators (the percentage of computer use in general, the percentage of computer use at work, and the percentage of computer use in training and education) and economic growth in Jordan.

(2) There is a significant relationship ($\alpha \leq 0.05$) between indicators of ICT (computer use in general, computer use at work, and computer use in training and education) and economic growth.

(3) There is a statistically significant long-term equilibrium relationship ($\alpha \leq 0.05$) between economic growth and the percentage of computer use in general, the percentage of computer use at work, and the percentage of computer use in training and education.

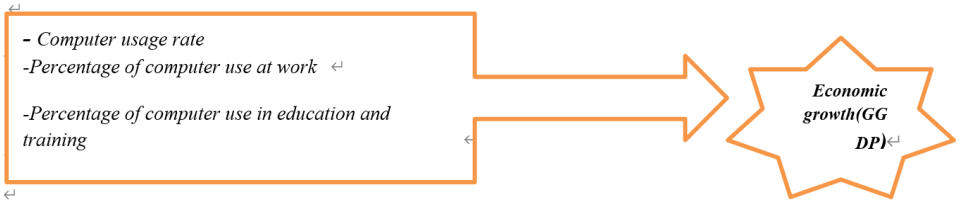

Figure 1. Study form Independent variables Dependent variable Prepared by the authors based on the study literature

2. Methodology

2.1 Data Collection

The data issued by the Department of Statistics will be used for the period of analysis 2009–2018, which is also the period available in the Department of Statistics. Given the small period of annual data, the researchers converted the data into quarterly data from 2009 to 2018 using the E-views program in order to increase the number of views, because the model used requires a number of views of not less than 30, and to avoid the problem of bias. Primary sources of books and journals will be utilized to achieve the best results and enhance the theoretical aspect of the study.

2.2 Analysis Method

Based on the Study literature and the theoretical aspect, the following model was adopted.

GGDP =f (RC, RL, RTE)

GGDP: Economic growth rate in Jordan

RC: Percentage of computer use in Jordan.

RL: Percentage of computer use at work in Jordan.

RTE: Percentage of computer use in training and education in Jordan.

The E-views program using the ARDL methodology will be utilized to achieve the study's objective, and other tests will be conducted to ensure no standard problems in the study model.

3. Previous Studies

Many international and Arab studies have discussed the impact of ICT on economic indicators in general and on economic growth in particular. These studies were diverse in terms of dealing with the elements of technological development.

Sought Dardour, S., Khawaldi (Dardour, S., Khawaldi ., 2022) to measure the impact of (ICT) on economic growth in Algeria between 1990 and 1990–2020 It used ICT indicators (the number of mobile subscribers and the number of fixed-line subscribers as independent variables and gross domestic product as a dependent variable). study of Al-abds (Al-abds ,B., 2021) Research on the relationship between the digital economy and economic growth in Algeria between 2000 and 2019 The study showed that there is a single relationship of co-integration in the long term between the impact of the digital economy and economic growth through the impact of each of the number of fixed-line subscribers and mobile subscribers on the gross domestic. study of ÇalÕúkan (ÇalÕúkan H K., 2015) The research discussed the role of technological changes and economic growth. The study showed that the use of technology and new technologies leads to reduced costs and increased productivity gains. In addition, the use of new technologies is the way to produce new, cheaper commodities and accumulate capital, in addition to enhancing the international competitiveness of countries and scientific research institutions. Study of Portillo .,et al (Portillo ,A ,F., et al .,2020). The research discussed the relationship between ICT development and economic growth in OECD European Union countries and clarified the impact of ICT development on economic growth.

In this context, Mohamed ,M., et al (Mohamed M., et al., 2022) sought to measure the impact of technological innovation on economic growth in developing countries during 1990, used an error correction model method. The results showed that the variables are stable after taking the first difference. Co-integration was tested, showing an increase in the indicators of technological innovation (such as spending on education, the number of patents for residents and non-residents, research and development expenditures, the number of researchers in research and development, high-tech exports, and scientific and technical research papers). Co-integration leads to increased economic growth. The relationship between technological innovation and GDP is two-way, and the analysis showed a short-term causal relationship that extends from technological innovation to GDP. The study also concluded that technological innovation directly impacts the sustainability of the country’s economic growth. Also, Raéf & Alaa (Raéf, B., & Alaa, A. Q., 2019) aimed to clarify the effects of (ICT) on the economic growth of a selected group of developing countries in the Middle East, North Africa, and Southern Africa from 2007 to 2016. The analysis showed a positive impact of (ICT) on economic growth.

Study of Alawneh (Alawneh A M., 2021) discussed and analyzed the effects of the growth of the (ICT) and education sectors on the growth of the industrial sector from 2005 to 2019the study a positive relationship between the growth of the (CIT) sector and the growth of the industrial and education sectors Abdullah (Abdullah A., 2020). Studied the role of digital transformation in supporting tax revenues in Egypt the study concluded that there is a risk of erosion of the tax base in light of the growing digital economy and the inadequacy of tax legislation in Egypt to digital transformations in financial transactions. Study of Bin Musa (Bin Musa H., 2012) showed that the digital economy contributes a large and positive role in expanding the outlets of services and increasing the volume of bank transactions and profits. study of Muhammad & bin Omar L (Muhammad K & bin Omar L., 2022) showed the reality of the digital economy and its impact on economic growth in Algeria from 1990 to 2020, using joint integration, population, and inflation rate. study of Kabeel (Kabee., 2021) Tested the relationship between the digital economy and economic growth in Egypt using the least squares method. The results showed a positive relationship between private investment spending and economic growth and between the digital economy and economic growth in Egypt.

However, Hussein (Hussein E., 2020) measured the impact of (ICT) in its three dimensions, namely, access, use, and skills, on inclusive growth. The study concluded that access has a positive and significant effect in a sample of countries, particularly developing and Arab countries, on inclusive growth. Moreover, the impact of skills on inclusive growth is negative and non-significant in the sample of non-industrialized countries. But Tanira & Barbakh (Tanira M., & Barbakh., 2020) found a direct positive relationship between Internet use and the rate of economic growth. In addition, Zhao (Zhao J., 2022) indicates that the digital economy has a significant impact on economic growth.

4. Distinguishing the Study

The study points necessity and importance of ICT for economic growth. A review on the meaning of ICT and measurable indicators their links to economic growth are done also The study contributes to the empirical analysis of the impact of technology (expressed in terms of computer usage) on economic growth by examining Jordan's case.

What distinguishes this study from previous studies, whether foreign or Arab, is that it aimed to track ICT developments in Jordan. Moreover, it aims to know the impact of some indicators of ICT, such as computer use, computer use at work, and computer use in education and training, on economic growth in Jordan during the study period. As far as the researchers know, previous studies have not dealt with these technological indicators.

5. Materials and Methods

5.1 ICT and Economic Growth

pointed out that In the 1960s, banks began to use computers for record-keeping and data storage. In the 1970s, companies began trading stocks electronically. In 1981, the first IBM personal computer was invented, ending the dominance of time-sharing peripheral computing. In the 1990s, e-commerce, and Internet business models flourished. For this reason, retail investors have been online stock trading through 50 years of developments in fintech, and innovators have created complex treasury management, risk management, data analytics tools, and trade stops for financial services firms and institutional banks. Financial services have been digitized for individuals through crowd-funding platforms and robot advisors for retirement and wealth planning, payment apps, and mobile wallets. Rubini (Rubini A., 2018)

ICT is defined as the use of technologies such as computers, printers, the Internet, wireless networks, scanners, cellular, numbering devices, and other modern means to process, preserve, distribute, and transmit data with great speed and accuracy, supporting decision-making, problem-solving, and data analysis to achieve some goals. As for economic growth, Franco Perot believes that the continuous increase during one period or long period in the gross domestic product, which is the continuous increase in gross income to the net real value, increases economic production over time (gross domestic product).

5.2 Importance of Using Computers in Economic Activities

A computer is an electronic device that processes data quickly and accurately. It stores and processes input data to produce the correct and required information. Computers implement many programs to achieve the correct result. Computers have made many contributions in various fields, including education, technology, science, and many others; they are now everywhere as these devices help perform mathematical operations, save a lot of effort and money, and store information. Sami (Sami., 2021)

The computer also provides many advantages in various businesses. It provides accuracy and speed in preparing documents, performing calculations, and implementing accounting procedures, such as recording, tabulating, analyzing, and saving operations. In turn, it saves time and effort, reduces the size of computational errors, and lessens costs because it operates the accounts carried out by the facility. Using the computer improves bookkeeping and accounting documents and facilitates information collection, storage, and retrieval through facility management. Similar operations can be completed at one time, recording many accounting operations and using fewer people fast. Accuracy in extracting information and final results can be achieved because the computer can control and verify results. Using a computer also increases confidence in the resulting information from operating on the computer and displaying reports, which decision-makers can use as a sound and reliable basis for making decisions. In the field of education and training, many computer analytical programs are used in management and business, such as Excel and Access. Quality control can be achieved through the Minitab program and the SPSS program. Structural equation modeling is introduced, and questionnaires are analyzed Al-Khatib (Al-Khatib A W., 2021) . The use of computers in digital transformation has developed greatly, especially in automation systems that are concerned with the manufacturing of automated robots. It also facilitates the completion of many other works.

It is also widely used today in many economic activities owing to the multiple and important services it provides to business owners or workers. It is also possible through the computer to do many different jobs, such as making online sales, transferring funds between accounts, carrying out bulk account operations, and other corporate work that requires speed and accuracy. The computer also allows the business firms to create economic forecasting plans according to some of the data provided.

In addition, computers protect companies' data and information from theft. The computer also facilitated the process of managing employee records in the company through specialized programs and the possibility of using the computer to prepare the company's budget and tax forms. Al-Asi (Al-Asi E., 2021)

The computer also allows for recording and processing many important documents.

New solutions and tools with considerably higher performance are needed in the era of big data and rapidly growing volumes of processed information. The NoSQL (Not-only SQL) concept is an answer to these problems, offering a high scalability of databases stored mainly in distributed systems. Computers are essential in the digital state through their use in modern robots and cloud computing. It also appears to be used in digital public finance. It is considered the basic structure for developing the digital economy, which includes using all digital transformation tools (cloud computing and robots). The use of technology is considered a duty for the state to carry out four functions to encourage the use of technology. Gąsiorkiewicz & Monkiewic (Gąsiorkiewicz L., Monkiewic J,. 2023) Thus, identifying four basic functions of the state in relation to the use of digital tools is necessary. Above all, it must act as a protector. This function includes all aspects related to the regulatory activities of the state as well as its efforts to protect the rule of law. Playing the role of a protector also includes certain activities in the social field, such as taking steps to eliminate social exclusion. Another function of the state is the function of the promoter in supporting research and development as well as innovation. The researchers also see that the support and development process includes computers, artificial intelligence, and modern technologies, including financial technologies. The third function relates to the producer role, which often includes activities aimed at providing access to broadly defined public services and infrastructure, including that required to maintain the provision of services developed by the digital economy. Finally, the fourth function is that of the forecaster, whose task is to create scenarios for the future regarding social and economic changes. In addition to being sources of information for private entities that make microeconomic decisions, these scenarios must, above all, be the basis for the actions implemented by the state as part of its development strategies and long-term policies. This infrastructure is necessary for transforming the digital economy and financial technology to achieve the desired growth of countries worldwide. Rubini (Rubini A., 2018)

Indicates Rubini (Rubini A, 2018) that using modern technologies, including financial technologies, requires devices and equipment connected in a cloud to communicate with each other and even facilitate intelligent payments. Moreover, conducting financial operations called peer-to-peer (p2p) requires interconnected computers to complete deals and other means of modern technology that rely on computers directly performing technical tasks via the Internet.

5.3 Descriptive Analysis

Table 1. Descriptive analysis of the study variables

Observations	**Std. Dev**	**Minimum**	**Maximum**	**Mean**	**variables**
37	2.71	2.92	10.6	6.24	GDP
37	9.9	24.3	55.92	44.82	RC
37	7.4	13.4	36.8	19.61	RCL
37	4.17	45.61	60.3	51.8	RTE

Source: Prepared by the authors based on E-views.

Table 1 shows that the average growth rate was 6.24%, the highest rate was 10.6%, and the lowest rate was 2.92%, with a standard deviation of 2.71%. The table also shows that the average computer use in Jordan generally amounted to 44.82%, which is considered a fairly acceptable percentage given that the highest percentage of computer use was recorded at 55.92%, while the lowest rate was recorded at 24.3%, with a standard deviation of 9.9% during the study period. The average was 19.61% for using the computer at work, which is a modest percentage. The highest rate was recorded at 36.8 during the study period, and the lowest rate was 13.4%, with a standard deviation of 7.4% during the study period. One of the highest averages was using the computer in training and education, reaching 51.8%, a good indicator. In Jordan, the highest rate was 60.3%, and the lowest rate was 45.61%, with a standard deviation of 4.17%. Accordingly, noting from the indicators, the percentages are higher, the highest rates during the study period were the use of computers in training and education by 51.8%, and the use of computers in general by 44.42%. The lowest percentage of computer use at work was 36.76% during the study period.

5.4 Development of Study Variables over Time

Figure 1 below shows the study variables fluctuate over time in general. Economic growth was high at the beginning of the study period, but it decreased with fluctuation over time until it reached its lowest level in 2015. Then, it returned to a slight increase until the end of the study. The percentage of computer use in general fluctuated across the study periods, as it was high until it reached its lowest at the end of the study period in 2018, due of the use of individuals to more flexible and more advanced technologies such as smartphones. The percentage of computer use at work was low at the beginning of the study. Then, it rose during the study period until it reached its highest at the end of the study period in 2018. Education is different as it fluctuated greatly during the study periods, indicating the different nature of computer use in training and education from year to year in Jordan, according to the capabilities and support in using computers for this education and training sector although its importance in supporting development and growth in Jordan was generally high.

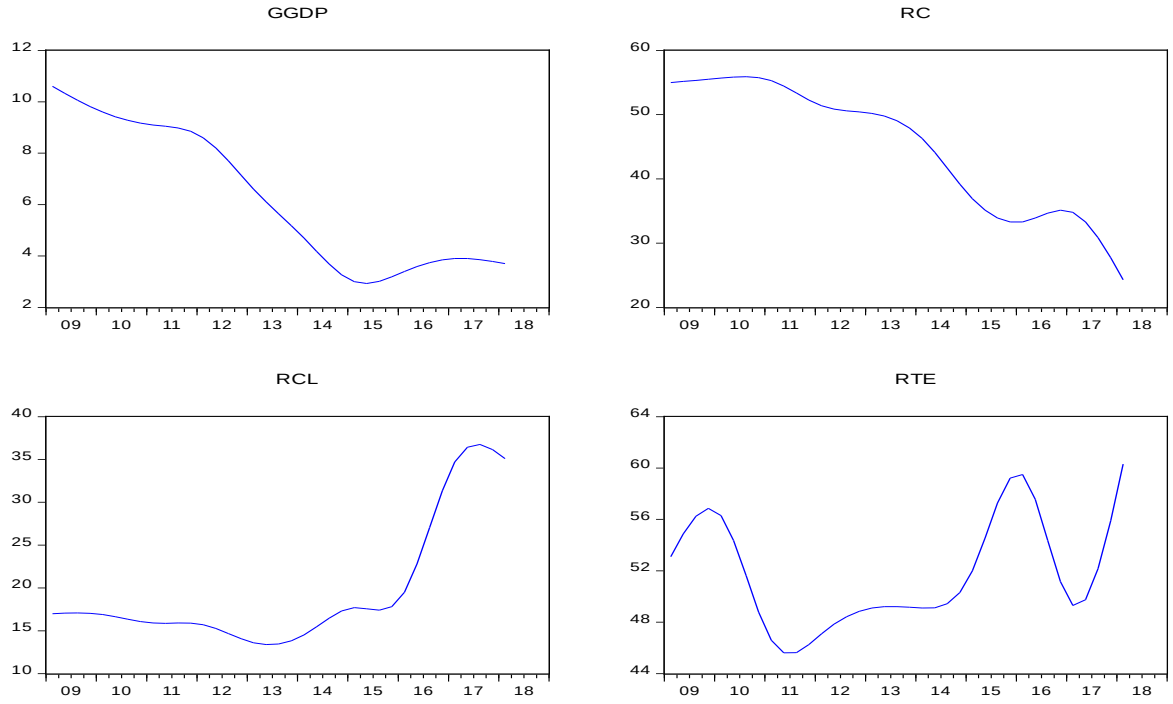

Figure 1. Development of study variables over time

Source: Prepared by the authors based on E-views.

5.5 Theoretical Relationship between Technology Indicators and Growth

(Rubini,A,2018) states that using modern technologies, including financial technologies, requires devices and equipment connected to a cloud to communicate with one another and even perform payments intelligently. Moreover, conducting financial operations called peer-to-peer (p2p) requires interconnected computers to complete deals and other means of modern technology that rely on computers directly to perform technical tasks via the Internet. Financial technology promises good returns on investments and growth opportunities. Rubini (Rubini A., 2018)

many studies have confirmed and supported this positive relationship between the technology and growth sector as study by (Alawneh , A, M., 2021) Also study by (H`ussein, E,. 2020) as well (Portillo A,F et al., 2020) and (Raef ,B., & Alaa,A.Q.,2021) Some financial technology companies can achieve very low purchase costs, not exceeding 1% of the costs (Raéf, B., & Alaa, A. Q., 2019) Therefore, many studies confirm that the use of technology and modern technologies in the economy leads to lower costs and increased productivity gains and the production of new, cheaper commodities and capital accumulation (ÇalÕúkan H K., 2015).

6. Results

6.1 Testing the Stability of the Study Variables

In the ADF - Fisher Unit root test, as shown in Table 2, the study variables are unstable at the level according to the ADF - Fisher Chi-square test and the ADF - Choi Z-stat test, but they are stable at the first difference, as shown in Table 2. Therefore, one of the conditions for conducting the ARDL methodology is that the data is unstable at the level. Based on the results in Table 2, the ARDL methodology can be conducted.

Table 2. Summary of the stability test of the variables

Level			**1st difference**		
Method	statistic	Prob	Method	statistic	Prob
ADF - Fisher Chi-square	8.77780	0.3614	ADF - Fisher Chi-square	49.3022	0.0000
ADF - Choi Z-stat	1.00330	0.8421	ADF - Choi Z-stat	-5.34847	0.0000

Source: Prepared by the authors based on E-views

6.2 Integration is Shared between the Variables

To ensure the existence of co-integration between the variables in the model, the bounds test methodology for co-integration was used, as shown in table 3. The table shows that the calculated value is equal to 62.11, greater than its highest tabular value, at the significance level of 5%. Thus, the null hypothesis, which states no co-integration and the emphasis on the existence of a co-integration relationship between the variables of the model, is rejected. Moreover, the first hypothesis is accepted, which states that there is a statistically significant co-integration at the level of statistical significance ($\alpha \leq 0.05$ between ICT indicators (the percentage of computer use in general, the percentage of computer use at work, and the percentage of computer use in training and education) and economic growth in Jordan.

Table 3. Bounds F-test for co-integration

Significant	**LB(I0)**	**UB(I1)**	**F-statistic**
10%	2.72	3.77	62.11
5 %	3.23	4.35	
2.5%	3.69	4.89	
1%	4.29	5.61	

Source: Prepared by the authors based on E-views program outputs.

6.3 Co-integration Test using Autoregressive Distributed Lags Model (ARDL)

Given the co-integration between the model's variables, the long-term relationship between the variable is ensured. The results of estimating the long-term relationship were as shown in the following table:

Table 4. Estimation Results for ARDL (2, 2, 5, 5)

Variables	**Coefficient**	**Str. Error**	**t-statistic**	**Probability**
LOG(RC(-2))	1.008558	0.250135	4.032057	0.0012
LOG(RCL(-5))	0.461935	0.105485	4.379136	0.0006
LOG(RTE(-5))	0.539696	0.286544	1.883467	0.0806
C	-1.983217	0.305678	-6.487923	0.0000

Source: Prepared by the authors based E-views program outputs.

The above results table 4 of the long-term transactions within the framework of the methodology clearly show that each of the percentage of computer use in general, the percentage of computer use at work, and the percentage of computer use in training and education in Jordan has a significant impact in the long term on economic growth in Jordan. Based on this result, the second hypothesis is accepted, which states that there is a statistically significant

positive relationship at the level of statistical significance ($\alpha \leq 0.05$) between ICT indicators (the percentage of computer use in general, the percentage of computer use at work, and the percentage of computer use in training and education) and economic growth.

These results are consistent with previous studies that have found a positive relationship between technology and economic growth, such as the study of (Tanira M., Barbakh., 2020) Study of (Zhao Ji., 2022) and the study of (Muhammad K., bin Omar L., 2021)

The researchers conducted some standard tests to ascertain the extent of stability and validity of the model through tests. Figure 2 shows that the bias proportion was (0.000), the variance proportion by (0.00%), and the value of covariance proportion equal (99%), which indicate that the error in the model is random, showing that the predictive ability of the model is acceptable.

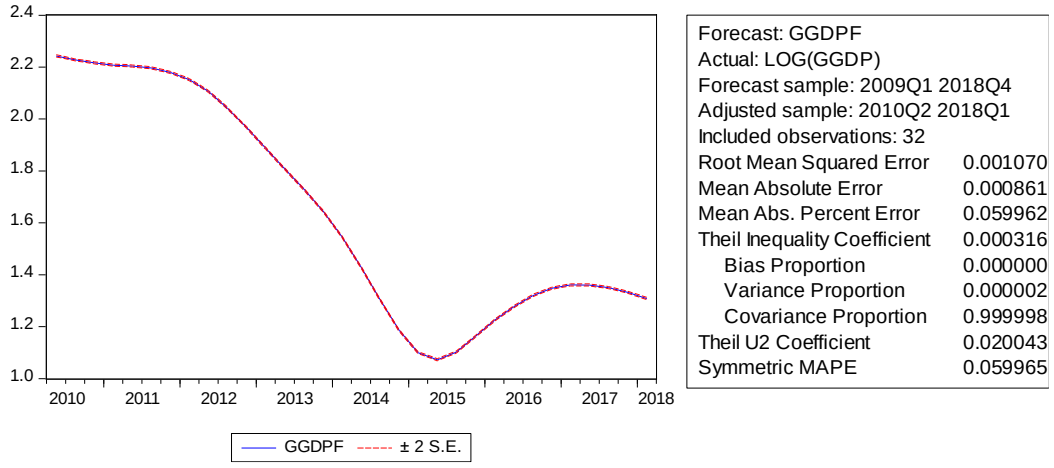

Figure 2. Stability and validity of the model

Source: Prepared by the authors using E-views programs, based on Tables 3 and 4.

Figure 3 The Optimal Slowdown Periods shows the top 20 models. It reveals the best model selected by the ARDL model analysis as (2, 2, 5,5), which is shown in Table 4. This analysis was conducted to demonstrate further the validity and reliability of the selected model.

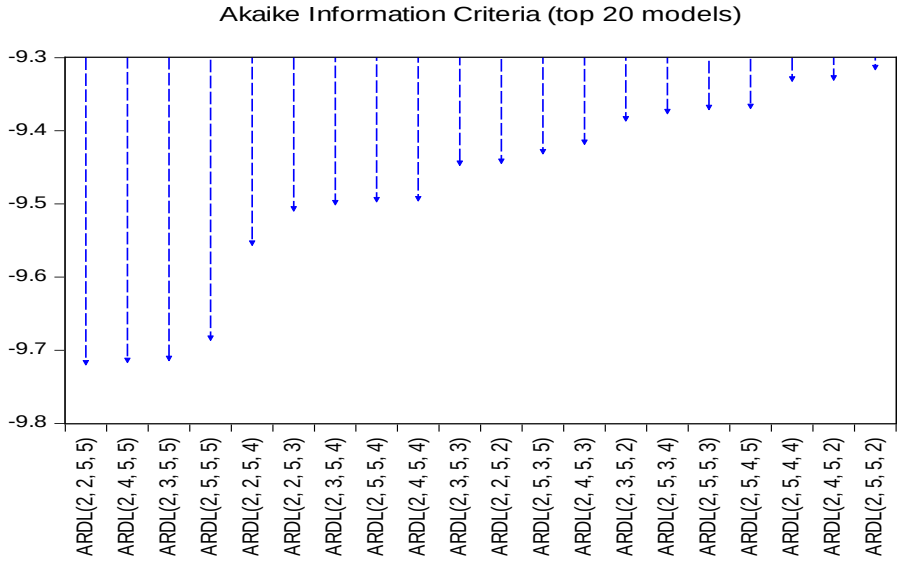

Figure 3. Optimal slowdown period

Source: Prepared by the authors based on E-views based on Table 4.

After the co-integration test results showed the existence of long-term complementary relationships, the error correction model is the appropriate model for estimating the study models which must fulfill its three conditions (its value is less than one and its sign is negative and significant). We then judge the existence of a long-term equilibrium relationship. The table below shows the results of the test.

Table 5. Results of estimating the short-term relationship of the model

Variables	Coefficient	Str.Error	t-statistic	Probability
DLOG(RC(-1))	-1.008558	0.068788	-14.66173	0.0000
DLOG(RCL(-4))	-0.461935	0.066489	-6.947528	0.0000
DLOG(RTE(-4))	-0.539696	0.201061	-2.684238	0.0178
CointEq(-1)*	-0.063525	0.003657	-17.36989	0.0000

Source: Prepared by the authors based on E-views program outputs.

The Table 5 above shows that The error correction results show that the coefficient of slowing down the error correction limit reveals the speed of the return of the economic growth variable toward its equilibrium value in the long term. The imbalance rate in each period was estimated at -0.06), which is considered an acceptable correction coefficient. Based on the results, the hypothesis is accepted that computer use in general and computer use at work have positive relationship at the level of statistically significant of $\alpha \leq 0.05$,and computer use in training and education $\alpha \leq 0.05$.

6.4 Testing the Structural Stability of the ARDL Model

The study was also based on conducting the results of the structural stability test of the ARDL model according to Pesaran (1997) the step that follows the estimation of the model formula is to test the structural stability of the long- and short-term coefficients, which means that the data used in this study are free of any structural changes. It has stable parameters over time, and the model is good from an economic point of view, which was achieved by using the Cumulative Sum of Recursive Residual (CUSUM) test as in Figure 4.

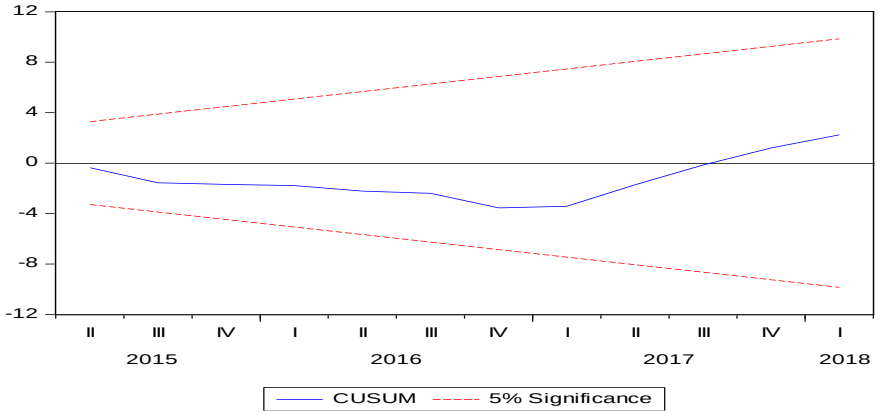

Figure 4. Cumulative Sum of Recursive Residual (CUSUM)

Source: Prepared by the authors based on E-VIEW based on Table 4.

To ensure the stability of the parameters of the ARDAL model, the researchers used the Squerse test of CUSUM. The results in Figure 5 showed that the model is good economically and can be relied upon to predict economic solutions according to the situation in the coming years.

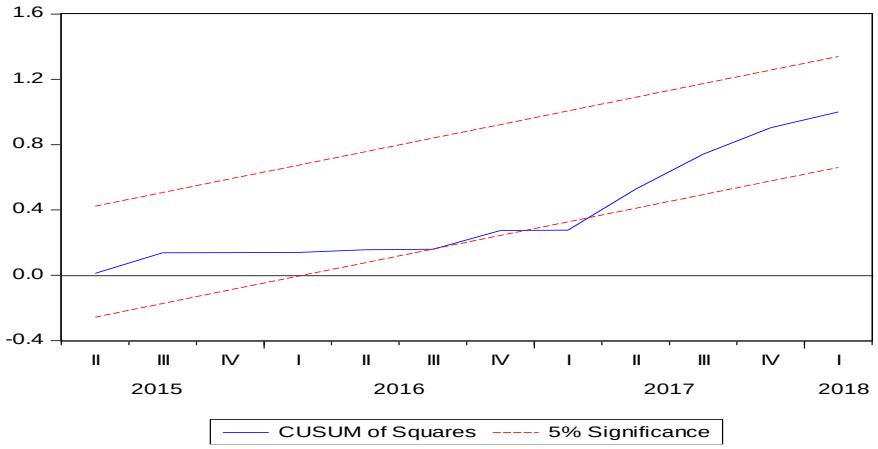

Figure 5. Squares test of CUSUM

Source: Prepared by the authors based on E-views based on Table 4.

6.5 Residuals Samples

To ensure that the data is used normally, a residual sample test is performed in Figure 6, where the Jarque-Bera value is 18%. Its corresponding probability value of 91% confirms that the data is normally distributed.

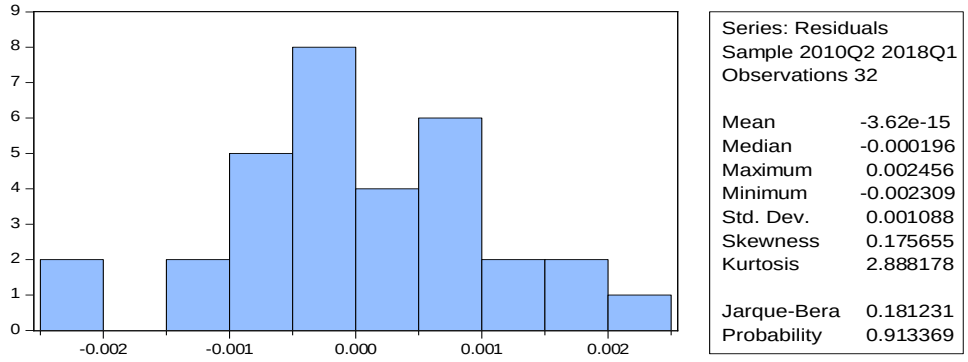

Figure 6. residual sample test

Source: Prepared by the authors based on E-views.

6.6 Diagnostic Tests

The following diagnostic tests were performed to ensure the quality of the model used in the analysis and that it is free from standard problems: Serial correlation LM test, ARCH, and Ramsey RESET Test.

The results were as shown in the table below.

Table 6. Results of the Diagnostic Tests for the Model

Test type	**Value**	**Probability**
Serial correlation LM test	0.069307	0.7965
ARCH	0.464938	0.4953
Ramsey RESET Test	0.711858	0.4891

Source: Prepared by the authors based on E-views based on Table 5.

The table 6 above shows that no autocorrelation problem arises between the independent variables and the dependent variable, as the probability value of the LM test amounted to (0.3544), which is greater than (0.05). Therefore, we accept the null hypothesis that the model does not suffer from serial autocorrelation of errors. The table also shows the results of the heterogeneity test. The variance of errors indicates that the problem does not exist; that is, the errors of the model are fixed or homogeneous because the probability value of the chi-square was (0.5292), which is greater than (0.05). Therefore, we accept the null hypothesis, which states that the errors of the model are homogeneous. The

table also shows that, from the result of the Ramsey reset test in Table 6, the t-statistic of 0.77 and its corresponding p-value of 0.58 indicate that the model is correctly defined. Therefore, the null hypothesis that the model follows the linear specification at the 5% level is not rejected, given that the p-value is > 5%.

7. Conclusion and Discussion

Many countries, including Jordan, are interested in technology as a major element of production, especially at present when technology has developed greatly. Thus, this study focused on analyzing the relationship between the main indicators of technology (computer use in general, computer use at work, and computer use in education) on economic growth.

The study analyzes the relationship between technology and economic growth in Jordan during 2009Q1–2018Q1, where all the data was done through the data issued by the Department of Statistics in Jordan, and given the lack of quarterly data, it was converted into quarterly data using the Views E program.

The results of the analysis showed the existence of a co-integration relationship between the variables of the study. Moreover, they showed the existence of a positive effect with a long-term statistical significance between the independent variables (computer use in general, the use of the computer at work, and the use of the computer in education) and economic growth. Furthermore, the results presented that the deviation from long term equilibrium is corrected using an error correction model. The coefficient of slowing down the error correction limit reveals the speed of the return of the economic growth variable toward its equilibrium value in the long run at a rate of −0.06. The reason is the inverse relationship in the short-term to spending on infrastructure and equipment in the long term to obtain positive results on economic growth.

The results confirm that economic growth is greatly affected by technology. Based on these results, technological indicators are considered an important component of the production elements that lead to an increase in the economic growth rate in Jordan. Thus, decision-makers must pay attention to the technology sector as an important component of the production elements.

By analyzing a long-term complementary relationship according to the ARDL model, where the analysis indicated that the use of computers at work has the strongest impact on economic growth, and this is a good indicator for the national economy in the possibility of strengthening computers at work in government institutions, departments, and private civil society institutions, as well as Training employees and encouraging them to use computers and robots at work in order to increase production and productivity and reduce costs in general at work, which in turn is reflected in increasing economic growth in Jordan.

Based on the results, the study recommends the following The results show that the government should pay great attention to the information technology sector and create the appropriate environment for using information technology by increasing use, provision, and training. It must work to exploit the existing human resources to receive appropriate training on the use of modern technologies to promote development and economic growth, as well as cooperation with leading countries in the field of information technology, benefiting from their experience in this field as a gateway to the digital state. Moreover, decision-makers and economic and financial policies in the country must encourage technology and the use of modern technologies by supporting research and development in this field and supporting small and medium-sized companies in the field of digital innovation as a gateway to the gradual transition toward electronic services replacing traditional services in the country and society as a whole. The Ministry of Digital Economy in the country must also take into account global technological development, such as the use of smartphones, smart assets, and robots in work and training, in addition to the aspiration by government departments to use cloud computing and big data analysis that directly helps to forecast economic growth. In institutions and departments, thus achieving the desired economic growth rate.

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