The Role of the Knowledge Economy in Achieving Sustainable Development in Kuwait in the Period (2000-2022)

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ABSTRACT

This study aimed to measure the impact of the knowledge economy on sustainable development in the Kuwaiti economy during the time period (2000-2022). It tested a basic hypothesis, which is: "The various aspects of the knowledge economy have a positive impact on sustainable development in Kuwait". The measurement was done using the ordinary least squares method OLS, then the causal relationship between the overall knowledge economy index and sustainable development was tested.

The results of the study indicate that there is a positive and significant impact for most aspects of the knowledge economy represented by innovation, information technology and scientific research on the total productivity of sustainable development factors and thus economic growth, and there is a negative and significant impact for the infrastructure of information and communications technology, the environmental investment index and the use of fossil fuels. The test also showed "Granger - Causality" the existence of a causal relationship that goes from the overall knowledge economy index (KEI) to the total productivity growth rate of the sustainable development index, and also to the economic growth rate.

According to the above, the research recommends the following:

- **Striving to keep pace with rapid technological changes to accommodate the ongoing developments in information and communications technology, and trying to apply the results of this research in the field.**
- **Advocating for development and innovation through national plans supported by regional and international agreements.**

Keywords: Scientific research; Communication technology; Economic research; Research &development; Social development.

INTRODUCTION

The world is witnessing great activity in the role of knowledge and information in the economy (Chen & Dahlman, 2004 and Kenaway & Abd-ElGhany, 2012). Knowledge is the engine of production and permanent economic growth in societies, and the principle of focusing on information and technology has become one of the basic factors in the contemporary economy (Brinkley, 2006 and Mahboub & Salman, 2008).

The knowledge economy represents a modern development trend in Kuwait (National Knowledge Economy Center, 2022) (In the Global Innovation Index for 2020, the State of Kuwait ranked 78th among 102 countries, it recorded poor performance in terms of business development (98 out of 102 countries) and knowledge and technology outcomes (73 out of 102 countries), and many initiatives have been taken regarding it, the most important of which is a comprehensive vision for a sustainable future. And the associated sectoral strategies, policies, initiatives and work programs, in turn, emphasized the trend towards a knowledge-based economy (Nour, 2013). This trend would change the pattern of development and economic growth and its foundations in Kuwait, from a pattern that relies solely on oil resources as the sole source of national income and efficiency in the use of resources, to a pattern that considers knowledge as the most important input for development in the next stage.

On the other hand, the Kuwaiti economy faces important challenges, which in turn confirm the importance of relying on knowledge as the most important engine of economic growth, which is the engine of development (Gulf Cooperation Countries, 2022). At the top of these challenges are the demographic transformations in Kuwait, which require opening new labor markets in order to accommodate the volume of new entrants to the labor market. Here comes the importance of the knowledge economy, which works on sustainable development in all sectors, especially the economic sector, without relying on traditional methods of growth, as it depends on activities related to innovations that rely on research and development, qualified human resources, and high-tech industries, so that investment in knowledge exceeds

many investments in many other material fields (Castillo et al., 2012).

Justification:

Given the dependence of the Kuwaiti economy on the petroleum sector and thus its exposure to the risks of oil price fluctuations at the global level and the many economic problems it entails, including the low rate of economic growth and the increasing severity of unemployment (International Labor Organization, 2015), which necessitates the necessity of creating a new economy based on knowledge through which sustainable development can be achieved in Kuwait by raising the rate of economic growth, raising its competitive capabilities, and shifting from dependence on depleted natural resources to renewable knowledge resources in achieving sustainable development.

Therefore, the problem of the study is to ask: To what extent the knowledge economy may affect sustainable development in Kuwait?

Assumptions:

The research assumes that the knowledge economy affects sustainable development in Kuwait.

OBJECTIVES OF THE STUDY

The study aims to test the validity of the previously mentioned hypothesis through the following:

- Identifying the basic aspects of the knowledge economy and its indicators.

- Analysis of the relative position of the knowledge economy in Kuwait.

- Measuring the impact of the knowledge economy on sustainable development in Kuwait.

Study Approach:

The research relies on the descriptive analytical method in explaining the relationship between the variables under study. The standard method was also used to estimate the effects of the various aspects of the knowledge economy on Total Factor Productivity (TFP) and then on sustainable development in Kuwait using a set of indicators each of which expresses an aspect of the knowledge economy. The measurement was carried out in two steps:

1- A model for estimating total productivity as Solow Residuals, which takes the form of the Cobb-Douglas production function.

2- The second step was to estimate the impact of aspects of the knowledge economy on the growth rate of total productivity. The causal relationship (Granger Causality) between the total knowledge economy index and the economic growth rate was also tested in order to give more confirmation of the relationship, but using the overall index. The model was estimated using the Ordinary Least Squares (OLS) method using time series data in the Kuwaiti economy for the period (2000-2022) due to the availability of the largest amount of data for the study variables, this is done through the Kwiatkowski - Phillips - Schmidt - Shin (KPSS) test, by using Eviews statistical program.

Conceptual Framework:

Knowledge economy:

The services based on knowledge-intensive activities that contribute to accelerate the pace of technology and scientific progress.

Characteristics of the knowledge economy:

- Extreme flexibility in adapting to developments and life changes.

- The ability to renew and fully communicate with other economies, innovates, creates and generates intellectual and knowledge products that did not previously exist (Brynjolfsson and Yang, 1996).

- It focuses on interest in scientific research, creativity and innovation, and it also calls for the dissemination of knowledge through education and training.

Contents of the knowledge economy and its elements:

The knowledge economy is an economy that responds primarily to the requirements and changes of the global market. Therefore, it consists of a set of integrated and interconnected basic elements, the most prominent of which are: providing a supportive community infrastructure, employing a research and development system, preparing and training knowledge workers who possess knowledge and have the ability to question, imagine, compare and innovate (Ghoneim and Mandour, 2008).

Knowledge economy indicators:

The knowledge economy includes an important set of indicators, including science and technology indicators, which include data related to research and development, patent statistics, scientific publications, the balance of technological payments, and indicators of information dissemination and communications. Indicators related to human resources: data on education, training, capital stock, and human capital consultations (Powell & Snellman, 2004 and Amin and Mattoo, 2008).

Determinants of the knowledge economy:

Keeping pace with this new economy is largely based on the knowledge revolution, as investment in research and development (R&D) is considered one of the catalysts for economic growth, and the budget allocated to it, whether at the country or institutional level, is what determines the level of prevailing

technologies in them (Coe & Helpman,1993; Ang & Madsen, 2011; Hulten, 2013 and Almfraji & Almsafir, 2014). With regard to the determinant of education and training, it is clear that indicators based on data related to education and teaching allow for the assessment of knowledge and skills acquired during the formal process of education, and these indicators also allow for the assessment of stock and investment in human capital, and the education and teaching index allows for stock and investment in human capital (Cohen and Soto, 2001). With regard to the determinant of information and communications technology: which refers to all the infrastructure that supports the information society and economy and provides effective access to information and communications, it is clear that studies indicate that all types of information systems in business management can facilitate information towards knowledge management, as the process of obtaining information has become Knowledge, attracting and encoding it, as well as participating in its distribution and even its creation and composition are among the basic issues of the organization (Hassan, 2003). The basic infrastructure and rules for information and communications technology must also be used and secured, for the purpose of improving the organization's position and enhancing its competitive capabilities. Finally, the economic and regulatory environment is defined, which means the role of governments in providing the economic framework and incentives for the business community and other conditions that work to raise the level of the knowledge economy (Lucas, 1988).

RESULTS AND DISCUSSION

RESULTS

Knowledge economy indicators in Kuwait in terms of Scientific research and education:

The Table (1) shows the knowledge economy indicators related to scientific research and education in Kuwait, showing an increase in interest in primary and secondary education in addition to interest in university education and scientific research in the country, which was reflected in an increase in the number of researchers and the number of articles published in scientific and technical journals.

The Table (2) shows the economic activity in Kuwait, where economic growth achieved high rates, including merchandise and service exports, manufactured exports, and exports of information and communications technology goods, with the exception of 2008, which was affected by global economic events (the financial crisis). These indicators were also affected in 2020 by the COVID-19 crisis, reaching their lowest levels (compared to previous years' numbers).

Table 1. Knowledge economy indicators in terms of Scientific research and education in Kuwait during (2000-2022)

Indicators	Average
Expenditure on scientific research to GDP (%).	0.14
Expenditure on Education (US$ billion).	8.33
Expenditure on Education to GDP (%).	7.07
Per capita expenditure on Education (US$ 000).	1.44
Ratio of enrollment in primary school	95.0
Ratio of enrollment in secondary school	86.4
Ratio of enrollment in Undergraduate Education.	39.6
Researchers in R&D (per million people)	157.5
Articles & Scientific and technical journals.	700.5

Source: Collected and calculated from World Bank database, www.worldbank.org.
Appendixes Table (1).

Table 2. Knowledge economy indicators in terms of economics environment in Kuwait during (2000- 2022)

Indicators	Average
Economic growth ratio	3.8
Commodities Exports (US$ billion).	55.4
Commodities Exports and services (US$ billion).	67.7
Services Exports (US$ billion).	7.6
Industrial commodities exports (US$ billion).	3.4
Value of industrial commodities Exports to total commodities exports (%).	5.04
Value of information technology's commodities exports (US$ billion).	0.12
Value of information technology's commodities exports to total commodities exports (%).	0.28
Value of information technology and communications services' exports (US$ billion).	3.27
Value of information technology and communications services' exports to total services exports (%).	39.1
Value of information technology exports (US$ billion).	0.05
Value of information technology exports to total industrial commodities exports (%).	1.25

Source: Collected and calculated from World Bank database, www.worldbank.org.

The following Table (3) shows knowledge economy indicators related to communications and information technology in Kuwait, and what is evident from the increase in landline telephone lines, mobile phone users and Internet service subscribers in relation to the total population, which indicates progress in the level of Internet services and communications and information technology in Kuwait.

Table 3. Knowledge economy indicators in terms of communications and information technology in Kuwait during (2000- 2022)

Indicators	Average
Subscriptions to mobile services (million).	3.7
Fixed telephone lines (million).	0.5
Fixed telephone lines (per 100 individuals).	20.9
Subscriptions to mobile services (per 100 individuals).	135.0
Internet subscribers (per 100 individuals).	52.4
Secure internet servers	359.04
Internet users (% of resident).	52.3

Source: Collected and calculated from World Bank database, www.worldbank.org.

Appendixes Table (2).

Analysis of the dimensions of sustainable development in Kuwait:

Determination the role of the knowledge economy in sustainable development in Kuwait requires analyzing its economic, social and environmental dimensions, of sustainable development in Kuwait to achieve the goals of the third millennium, which were approved by the United Nations and signed by Kuwait among the countries of the world, according to which governments must take measures and arrangements to diversify energy sources, taking into account preserving the environment and increasing its supply to different regions.

The economic dimension:

The macroeconomic indicators in Kuwait, as shown in Table (4) indicate that it achieved promising and tangible positive results during the study period, such as the rate of growth and savings, and rates of inflation and unemployment within the minimum limits. With the exception of some years in which the world went through crises that affected these rates, such as the global financial crisis of 2008 and the COVID 2019.

The environmental dimension:

It consists of preserving natural resources and ecosystems and making optimal use of them on a sustainable basis, and using new and renewable energy sources.

The environmental indicators shown in Table (5) indicate an increase in carbon dioxide (CO_2) emissions as a result of the use of fossil fuels as the primary source of energy not renewable energy, which confirms the deterioration of the environmental situation and the increase in the rate of pollution.

Table 4. Variables associated with economic growth in Kuwait during (2000- 2022)

Indicators		Average
Gross Domestic Product GDP ((US$ billion).		108.5
Economic growth ratio		2.9
Domestic Save	(US$ billion).	51.0
	GDP (%).	43.6
Unemployment rate.		1.82
Inflation rate.		3.14
Per capita GDP (US$ 1000).		34.9
Final Expenditures	(US$ billion).	58.5
	GDP (%).	49.9
Tourism revenue	(US$ billion).	0.59
	GDP (%).	0.63

Source: Collected and calculated from World Bank database, www.worldbank.org.

Table 5. Environmental indicators in Kuwait during (2000- 2022)

Indicators	Average
CO_2 emissions (1000 Tons).	81.8
Energy consumption from fossil fuels (%).	96.9
Renewable energy and combustible waste (% of total energy).	0.0

Source: Collected and calculated from World Bank database, www.worldbank.org.

Table 6. Human development indicators in Kuwait during (2000- 2022)

Indicators		Average
Human development indicators	value	0.82
	global ranking	49.9
	level	very high
Per capita expenditure on Education (US$).		2606.3
Per capita expenditure on health (US$).		776.2
Expenditure on Education to GDP (%).		7.17
Expenditure on health to GDP (%).		2.4

Source: Collected and calculated from World Bank database, www.worldbank.org.

The social dimension:

It represents the human dimension, as current generations must make growth choices according to their desires and the desires of future generations. Through the human development indicators accompanying the economic development process in Kuwait, the most important of which is spending on education and health, as shown in Table (6). It is evident that the human development index has risen according to the global level, which is reflected in the amount allocated from GDP to spending on education and health, whether at the individual or at the state level.

Measuring the role of the knowledge economy in achieving sustainable development in Kuwait:

In order to predict the relationship between the knowledge economy and sustainable development in Kuwait, this requires building and estimating two models. The first includes estimating the overall growth rate of the elements of sustainable development, and then the second includes measuring the impact of the various aspects of the knowledge economy through indicators expressed on total productivity. The relationship will be estimated using the ordinary least squares (OLS) method for the time period (2000-2022) at the level of the Kuwaiti economy, to verify the stationary of the time series of the study variables.as follows:

Table 7. Unite root test results for the knowledge economy and sustainable development in Kuwait

Null Hypothesis: 12 has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 1 (Fixed)

t-Statistic		
-0.227050	Elliott-Rothenberg-Stock DF-GLS test statistic	
-3.770000	1% level	Test critical values:
-3.190000	5% level	
-2.890000	10% level	

DF-GLS Test Equation on GLS Detrended Residuals
Dependent Variable: D(GLSRESID)
Method: Least Squares
Date: 03/17/22   Time: 04:36
Sample (adjusted): 2002 2022
Included observations: 21 after adjustments

Prob.	t-Statistic	Std. Error	Coefficient	Variable
0.8231	-0.227050	9.06E-17	-2.06E-17	GLSRESID(-1)
0.0000	1.98E+15	5.05E-16	1.000000	D(GLSRESID(-1))
-5.92E-16	Mean dependent var		-2.583705	R-squared
6.58E-31	S.D. dependent var		-2.794512	Adjusted R-squared
2.79E-59	Sum squared resid		1.28E-30	S.E. of regression
			3.331013	Durbin-Watson stat

Source: Collected and calculated from the Table (1) using the Eviews program.

According to the test results, the time series for the variables under study were characterized by stationary

in the case of intercept and in the case of intercept& trend, as shown in the previous Table (7).

First model: Estimating the overall growth rate of sustainable development components:

The form of the model takes the logarithmic form of the production function (Cobb - Douglas) to obtain the estimated residuals that are known as the total productivity of the factors of production, according to the following formula (Sánchez-Martín et al., 2015):

$$Ln\ Y_1 = b_0 + b_1\ Ln\ X_1 + b_2\ Ln\ X_2 + b_3\ Ln\ X_3 + b_4\ Ln\ X_4 + b_4\ Ln\ X_4 + U_t$$

$$Ln\ Y_2 = b_0 + b_1\ Ln\ X_1 + b_2\ Ln\ X_2 + b_3\ Ln\ X_3 + b_4\ Ln\ X_4 + b_4\ Ln\ X_4 + U_t$$

Where (Y_1) Economic growth rate.
      (Y_2) Human Development Index.
X_1 Expenditure on Education to GDP (%)
X_2 Expenditure on research and development (R&D) to GDP (%).
X_3 Expenditure on foreign direct investment (FDI) to GDP (%).
X_4 Advanced technology exports to GDP (%).
X_5 Patents for residents and non- residents.

U_t: Random error

The following table shows the results of estimating the previous equation after using Autoregressive AR (1) to address the problem of serial correlation between the residuals.

It is clear from the previous Table (8) that the effect of all knowledge economy indicators related to scientific research and education on the social dimension of sustainable development in Kuwait is positive and significant at the 1% level, as increasing

capital by 1% leads to growth in output by 0.39%. An increase in the knowledge economy index by 1% also results in an increase in the sustainable development index by approximately 1%. This indicates that scientific research explains the largest proportion of the social dimension that occurs in sustainable development in Kuwait during the study period.

Estimation results of the **second model** (the impact of knowledge on sustainable development).

The results of the previous Table (9) showed the following:

- There is a positive and statistically significant effect of the economic knowledge economy on the overall growth rate of sustainable development, as increasing the knowledge economy by 1% leads to an increase in the total productivity of sustainable development indicators in Kuwait by 0.66%, which is consistent with economic theory and with many studies to confirm the role the positive that education represents. This highlights the importance of the knowledge economy in supporting long-term economic growth, even though education in Kuwait is characterized by high spending rates relative to the gross domestic product.

- There is a positive and statistically significant effect for the parameter of patents as an indicator of innovations, meaning that increasing the number of patents by 1% leads to an increase in the sustainable development index by 0.068%. This is the trend supported by many recent studies in this regard.

Table 8. Simple Regression Equations Results

Method: Least Squares
Date: 03/17/22   Time: 13:11
Sample: 2000 2022
Included observations: 22

Prob.	t-Statistic	Std. Error	Coefficient	Variable
0.0010	3.874729	0.050691	0.396415	Log(k)
0.0000	5.565786	0.049839	0.798198	Log(l)
				N=34
0.000000	S.D. dependent var		1.000000	Mean dependent var
-1.546878	Akaike info criterion		0.106717	S.E. of regression
-1.447399	Schwarz criterion		0.216382	Sum squared resid
-1.525288	Hannan-Quinn criter.		18.24222	Log likelihood
			0.848937	Durbin-Watson stat

Source: Collected and calculated from the Table (6) using the Eviews program.

Table 9. Simple Regression Equations for the impact of knowledge economy on sustainable development

Dependent Variable: C
Method: Least Squares
Date: 03/17/22 Time: 13:11
Sample: 2000 2022
Included observations: 22

Prob.	t-Statistic	Std. Error	Coefficient	Variable
0.0010	1.874729	0.050691	0.666415	(X1)
0.0000	2.565786	0.049839	0.068198	(X2)
0.0359	-2.9499015	0.025864	-0.040178	(X3)
0.0235	-2.3688654	0.058797	-0.018139	(X3)
0.0189	1.7895655	0.025898	-0.041072	(U)

Prop(f-statistic)				0.027956
0.000000	S.D. dependent var		1.000000	Mean dependent var
-1.546878	Akaike info criterion		0.106717	S.E. of regression
-1.447399	Schwarz criterion		0.216382	Sum squared resid
-1.525288	Hannan-Quinn criter.		18.24222	Log likelihood
			1.918937	Durbin-Watson stat

Source: Collected and calculated from the Tables (2,3) using the Eviews program.

Table 10. Granger Causality Tests Results

Pairwise Granger Causality Tests
Date: 03/17/22 Time: 14:28
Sample: 2000 2022
Lags: 2

Prob.	F-Statistic	Obs	Null Hypothesis:
0.01258	7.92312	21	KEI does not Granger Cause D2
0.23546	4.91942		SD does not Granger Cause D1
0.12365	3.86545	21	KEI does not Granger Cause D2
0.78952	0.548662		EG does not Granger Cause Y

Source: Collected and calculated from the Tables (1,5,6) using the Eviews program.

- There is a negative and significant effect of knowledge technology as a second indicator of innovation and technology transfer on productivity, as increasing FDI by 1% results in a decrease in productivity by 0.30%. This means that the final result of its negative effects on the Kuwaiti economy is greater compared to the positive effects, and this is due to the poor quality of these products. This may be due to the fact that achieving a positive impact from FDI depends on the degree of benefit from it in transferring modern technology, forming links with companies working in the field of sustainable development, and providing job opportunities and training.

- There is a negative and significant impact of ICT infrastructure on productivity, contrary to what is expected from this aspect of the knowledge economy, as increasing the number of cellular and fixed phone lines per 100 individuals by 1% results in a decrease in growth by 0.018%. This is due to the

fact that the use of ICT in Kuwait is still largely directed towards entertainment and time consumption rather than supporting sustainable development and completing economic transactions

- There is a positive and significant effect of the degree of saving on economic growth, as increasing saving by 1% results in an increase in the sustainable development index by 0.031% during the study period in Kuwait, which demonstrates the positive impact of further integration with the global market.

- The value of the coefficient of determination shows that the independent variables that express the knowledge economy explain more than half of the changes in the economic, environmental, and social dimensions of sustainable development in Kuwait.

The causal relationship between the overall Knowledge Economy Index (KEI) and sustainable development (SD) (Mehrara and Rezaei, 2015):

A causality test (Granger - Causality) was conducted for the time period (2000-2022), and the

results showed the existence of a causal relationship trending from the (KEI) to (SD) at 5% significance level. There is also a causal relationship trending from the (KEI) to (SD) (Expressed by the annual growth rate in GDP) but with a lower degree of confidence, because the impact of the knowledge economy is transmitted to SD through the economic, social and environmental dimensions. This is what the following Table (10) shows.

CONCLUSION

This study aimed to measure the impact of the knowledge economy on sustainable development in the Kuwaiti economy during the time period (2000-2022). It tested a basic hypothesis, which is: "The various aspects of the knowledge economy have a positive impact on sustainable development in Kuwait." To achieve this goal, the various concepts of the knowledge economy, its aspects and basic indicators were introduced, then the relationship between knowledge economy and economic growth and the transfer of impact to the dimensions of sustainable development, with an analysis of its relative status in Kuwait at the level of the overall performance of the Knowledge Economy Index (KEI) and then at the level of the sub-variables that express the various aspects, for measuring its role. The measurement was done using the ordinary least squares method OLS, then the causal relationship between the overall knowledge economy index and sustainable development was tested.

The results of the study indicate that there is a positive and significant impact for most aspects of the knowledge economy represented by innovation, information technology and scientific research on the total productivity of sustainable development factors and thus economic growth, and there is a negative and significant impact for the infrastructure of information and communications technology, the environmental investment index and the use of fossil fuels. The test also showed "Granger - Causality" the existence of a causal relationship that goes from the overall knowledge economy index (KEI) to the total productivity growth rate of the sustainable development index, and also to the economic growth rate.

According to the above, the research recommends the following:

- Striving to keep pace with rapid technological changes to accommodate the ongoing developments in information and communications technology, and trying to apply the results of this research in the field.
- Employing knowledge in building the state's economy requires integration between the efforts of the state, the private sector, and society in order to diversify the economy and increase its growth to achieve social development.
- Advocating for development and innovation through national plans supported by regional and international agreements.

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الملخص العربي

دور اقتصاد المعرفة فى تحقيق التنمية المستدامة في دولة الكويت فى الفترة من (۲۰۰۰ – ۲۰۲۲)

جراح مطلق دغيم الخالدى ، ولاء على محمد أحمد

استهدفت الدراسة قياس أثر الاقتصاد المعرفي على التنمية المستدامة في الاقتصاد الكويتي خلال الفترة الزمنية (۲۰۰۰-۲۰۲۲). حيث تم اختبار الفرض الأساسى وهو "أن الجوانب المختلفة للاقتصاد المعرفي لها أثر إيجابي على التنمية المستدامة في الكويت". ولتحقيق هذا الهدف تم تحديد المفاهيم المختلفة لاقتصاد المعرفة وجوانبه ومؤشراته الأساسية، ثم دراسة العلاقة بين اقتصاد المعرفة والنمو الاقتصادي وانتقال الأثر إلى أبعاد التنمية المستدامة، مع تحليل وضعه النسبي في الكويت على مستوى الأداء العام لمؤشر اقتصاد المعرفة (KEI) ومن ثم على مستوى المتغيرات الفرعية التي تعبر عن الجوانب المختلفة لقياس دوره. وتم إجراء القياس باستخدام طريقة المربعات الصغرى العادية OLS، ثم تم اختبار العلاقة السببية بين المؤشر العام لاقتصاد المعرفة والتنمية المستدامة.

وتشير نتائج الدراسة إلى أن هناك تأثير إيجابي وكبير لأغلب جوانب الاقتصاد المعرفي المتمثّل في الابتكار وتكنولوجيا المعلومات والبحث العلمي على الإنتاجية الإجمالية لعوامل التنمية المستدامة وبالتالي النمو الاقتصادي، كما أن هناك تأثير سلبي وكبير التأثير على البنية التحتية لتكنولوجيا المعلومات والاتصالات ومؤشر الاستثمار البيئي واستخدام الوقود الأحفوري. كما أظهر اختبار "جرانجر – السببية" وجود علاقة سببية تمتد من مؤشر اقتصاد المعرفة الشامل (KEI) إلى معدل نمو الإنتاجية الإجمالية لمؤشر التنمية المستدامة، وأيضا إلى معدل النمو الاقتصادي.

الكلمات المفتاحية: البحث العلمى؛ تكنولوجيا الاتصالات؛ النمو الاقتصادى؛ البحث والتطوير؛ التنمية الاجتماعية.

APPENDIXES

Table 1. Knowledge economy indicators average in terms of Scientific research and education in Kuwait during (2000- 2022)

Indicators	(2000-2005)	(2006-2011)	(2012-2017)	(2018-2022)
Expenditure on Education (US$ billion).	3.15	9.47	10.10	12.54
Per capita expenditure on Education (US$ 000).	1.07	1.32	1.70	1.90
Ratio of enrollment in primary school	92.84	98.35	96.80	96.28
Ratio of enrollment in secondary school	85.13	87.27	86.38	89.66
Ratio of enrollment in Undergraduate Education.	21.43	37.73	52.27	54.36
Researchers in R&D (per million people)	169.78	149.73	133.02	197.62
Articles & Scientific and technical journals.	509.6	740.25	718.27	982.46

Source: Collected and calculated from World Bank database, www.worldbank.org

Table 2. Knowledge economy indicators average in terms of communications and information technology in Kuwait during (2000- 2022)

Indicators	(2000-2005)	(2006-2011)	(2012-2017)	(2018-2022)
Subscriptions to mobile services (million).	1.19	2.61	4.90	8.23
Fixed telephone lines (million).	0.49	0.52	0.46	0.56
Fixed telephone lines (per 100 individuals).	23.25	19.02	15.37	32.91
Subscriptions to mobile services (per 100 individuals).	56.22	90.48	209.15	233.92
Internet subscribers (per 100 individuals).	16.13	47.26	78.59	83.04
Secure internet servers	32.50	254.33	534.17	877.80
Internet users (% of resident).	16.13	47.26	78.59	82.94

Source: Collected and calculated from World Bank database, www.worldbank.org