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Assessing the Impact of the Knowledge Economy on Economic Growth in Selected Arab Countries: A Panel Data Analysis (2010–2020)

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ABSTRACT: This study demonstrates the impact of the knowledge-based economy in economic growth in Jordan, Qatar, Kuwait, Saudi Arabia, Oman, Bahrain, UAE, Egypt, Lebanon, Algeria, Tunisia, and Mauritania using annual Panel-Data analysis from 2010 to 2020. The knowledge economy is represented by total enrolment rate in secondary school, the total number of articles published in journals and the number of phones per 100 people. The study found a positive statistically significant effect of total capital formation, rate of participation in the labour force (15-64 years) and the total enrolment rate in secondary school on economic growth while also finding a negative statistically significant effect of trade and total number of published articles (a pillar of innovation in Knowledge-Based Economy) on economic growth. There is no statistically significant effect of the number of phones per 100 people (a pillar of information in a knowledge based economy) on economic growth. Only one of the three indicators of knowledge economy positively affects the economic growth. The other two indicators are either negatively affects economic growth or statistically insignificant.

KEYWORDS: Knowledge economy, Economic Growth, Arab Countries, Panel-Data analysis

1. INTRODUCTION

Neoclassical economists have identified land, capital and labour as main factors that determine economic growth. In this respect they argue that these factors explain the variations of economic growth in capitalist economies. The more these factors are utilised, the greater the economic growth (Piętak 2014). From the industrial revolution until the end of the twentieth century, economies have heavily depended on physical capital and skilled and unskilled labour to produce goods and services and promote economic growth. The USA, European Union and other developed economies have followed this path in their development journey (Baser, and Gokten, 2019, Smith and Chimucheka 2014).

Since the beginning of the twenty-first century, the role of physical capital and labour-intensive industries has declined (Anyanwu 2012, Asongu 2017, Gangi 2017). This is because the modern economy is comprised of more industries that require knowledge and human capital equipped with creative and innovative skills to manage and keep pace with scientific and technological progress (Vinnychu & Skrashchu 2014). In addition, the great spread of information and communication technologies during the first half of the twenty first century has led to a major change in the structure of national economies. Knowledge, and entrepreneurship has become the leading factors in production process after labour and capital, and it plays the primary role in creating wealth asset (Vinnychu & Skrashchu 2014).

During the past two decades, a series of empirical studies in America and Europe have been undertaken to examine the effect of the knowledge economy on economic growth. These studies used various models and measurements to analyse the main sources of knowledge creation and diffusion mechanisms. The results revealed that the stock of knowledge economy contributes positively to economic growth. However, there is a dearth of studies in developing countries, particularly the Arab world. The present study empirically analyses the knowledge economy's impact on economic growth in selected Arab countries.

2. LITERATURE REVIEW

Economic literature is replete with theories and models determining the forces driving economic growth. In the early years of the twentieth century, neoclassical economics depended on Harrod (1939) and Domar (1946) to explain variations in economic growth. Their models stress on capital, labour and land as the major factors that generate economic growth. These factors were considered the main forces driving economic growth in capitalist countries. The more these factors were exploited, the greater the economic growth (Piętak, 2014; Kaur and Singh, 2017). From the 1930s through to the 1950s, Schumpeter introduced entrepreneurship and innovations in his creative destruction theory as new factors explaining economic growth. According to this theory, economic growth is driven by new ventures created by entrepreneurs and governed by creative destruction (Aghion and Howitt, 1992; Acemoglu, 2009). Solow (1957) revised classical models of economic growth through the use of creative destruction theory. He added technological progress as another factor of production that affects economic growth. This technological progress was considered exogenous to the economy.

Romer (1986) and Lucas (1988) introduced the endogenous growth model based on creative destruction theory. According to this model, the economic growth rates is positively related to the size of innovations, the number of the skilled labour force, and the productivity of research (Aghion and Howitt 1992). The concept of knowledge economy developed further by integrating science, technology, and the economy. According to Švarc and Dabic (2017), the concept of a knowledge economy arose from the new economic growth theories of Solow (1957), Romer (1989), Abramovitz (1989), and Lall (1995). From a historical point of view, Švarc and Dabic (2017) posited that the knowledge economy evolved in Europe since the beginning of the twenty first century because of the essential shift in the structure of global economy from manufacturing to services sector.

In view of many scholars, the beginning of the twenty first century is marked by a paradigm shift in the process of knowledge creation and usages in the global economy. In this respect, they believe that scientific research has started to produce useful knowledge which has been transformed into commercially viable business ideas, and end up with producing goods and services with a large component of technology and innovations. This transformation has served as the main driver of economic growth in global economy during the recent years (Baum et al. 2009, Aparicio, et al 2021).

Technological advances promote and sustain economic growth by enhancing the effectiveness and efficiency of scarce resources (Romer 1986; Romer 1990; Lucas 1988; Acemoglu 2008). The particular properties of knowledge and its capacity to be transmitted from the user without losing its utility make it an exceptionally valuable factor in production, according to modern growth theories. Investments in new technologically advanced machinery as well as in education, invention, and other knowledge-enhancing endeavours all contribute to the growth of human capital.

Several studies have investigated the impact of the knowledge economy on national economic development. Dworak (2010) analysed the influence of a knowledge-based economy on the economic development of the European Union. His results reveal that the knowledge-based economy's impact on a country's economic development is evident in the case of new member countries. He explained this result by stating that countries that newly joined the European Union try to catch up with the civilised old European countries by investing resources in innovation. These investments have made their economic development dynamic. This result implies that the impact of the knowledge economy on economic development depends on the stage of development.

Barkhordari et al. (2019) adopted the Barro and Sala-i-Martin framework to investigate the impact of the knowledge economy on economic growth in a selected MENA economy for the period 2010 to 2015. Their empirical results reveal that institutions, human capital and research, infrastructure, and business sophistication are the pillars of the knowledge-based economy that significantly and positively influence economic growth in MENA countries. This result implies that governments in MENA countries should consider knowledge-related policies to accelerate the transition to a knowledge-based economy and promote economic growth.

Poorfaraj et al. (2011) examined the relationship between knowledge and economic growth using panel data from 16 developing countries. They employed a model based on a simple Cobb-Douglas production function, which included GDP, labour force, gross fixed capital formation, exports of goods and services, expenditure on research and development, expenditure on information and communication technology, and expenditure on public education as explanatory variables. They found that, except for education, all other parameters have the expected signs and are statistically significant. Regarding the impact of the knowledge economy on economic growth, their results indicated that the coefficient is positive and statistically significant at a 10% level. This implies that the results of this research support the important role of the knowledge economy in the economic growth of the selected group of developing countries. Based on these results, the authors recommended that the developing countries can improve the role of their knowledge economy on economic growth by enhancing educated and skilled workers, effective innovation systems, and modern and adequate information infrastructure. These goals can be accomplished by increasing investment in education and training, R&D and ICT.

Mohamed et al. (2022) used the cumulative regression model, the fixed-effects model, and the random-effects model to estimate the impact of the knowledge economy on economic growth in twenty developing countries. The results showed that more than 90% of the variations in economic growth in the sample countries is explained by changes in the knowledge economy index. Moreover, their results indicated that the fixed-effects model is the suitable model to be employed to estimate the parameters of the proposed model. The findings of this study emphasizes the important of the knowledge economy in economic growth and the suitability of the fixed-effects model for estimating economic growth model in developing countries.

Along the same line, Kaur and Singh (2016) studied the impact of the knowledge economy index on the economic growth of a group of 42 developing economies. They followed the regression analysis tradition pioneered by Barro and Sala-i-Martin (2004) and examined the GDP growth rate from 2000 to 2012 in the Knowledge Economy Index (KEI) values of 2000. For this purpose, they classified the selected economies into low-income, lower-middle and upper-middle income economies. Their result reflects a negative relationship between GDP per capita and KEI in low-income economies. They justify their result by stating that investment in the knowledge economy cannot ascertain economic growth unless the basic institutions comply with the knowledge economy.

Raspe and Van Oort (2006) examined the impact of the knowledge economy on economic growth in the European context. They used three main components of the knowledge economy: knowledge workers, innovation, and R&D, along with several other variables. Their results revealed that innovation and knowledge workers were more related to economic growth than R&D. In their policy implications, they suggested that policymakers emphasise innovation output and knowledge workers' density rather than R&D to capture urban growth potentials in the knowledge economy.

In addition to the direct impact of the knowledge economy on economic growth, some authors investigated its influence on factors related to economic growth. For example, Zeb (2022) examined the impact of the knowledge economy on Asian businesses using data from 45 countries from 2000 to 2019. They used education, innovation, and ICT as indicators for the knowledge economy. Their findings reveal that two main knowledge economy indicators (education and ICT) help decrease the time and cost to start a business, thus positively promoting the business environment and boosting business growth. In addition, the results reveal that innovation helps increase the number of businesses and business density. Based on these results, the authors recommended that Asian countries improve their knowledge infrastructure and promote human capital skills by adopting suitable educational policies and strategies to obtain increased benefits from starting and doing business.

In a different context, Liargovas and Repousis (2015) investigated the validity of the Business Knowledge Society model in Greece from 2007 to 2013. They examined the effect of physical capital, labour, human capital, knowledge capital and venture capital in each region's production. Their results demonstrated that in comparison with knowledge capital, business capital has a more profound impact on economic growth. They recommended that policymakers and regulators consider entrepreneurship as a tool for spreading knowledge.

In another study, Bogoviz et al. (2017) investigated the role of human capital in the economic system under the conditions of a knowledge economy in Russia. They used correlation analysis to find the dependence of the knowledge economy on technological, human, and material resources and investments from 2010–2016. They concluded that a knowledge economy provides more opportunities in the source of creation, implementation, and dissemination of innovation goods. This led people to become active innovation entrepreneurs.

3. DATA AND METHODOLOGY

The study used the annual data from the World Bank dataset. The description of the variables is reported below:

GGDP	Current Growth domestic product in USD World Bank
GCF	Current Gross capital formation (% of GDP) in USD. World Bank
TLPR	Total Labour Force Participation Rate (age 15-64) World Bank
TRADE	Trade (% of GDP) World Bank
GSER	Gross secondary enrolment rate to represent a pillar of education and skill in a Knowledge-Based Economy World Bank
TELEFIX	Telephones for 100 people to represent a pillar of information in a Knowledge-Based Economy World Bank
JOURNAL	Total Journal articles to represent a pillar of innovation in Knowledge-Based Economy World Bank

Notes: GCF, TLPR, and TRADE portray production economy (p-economy); GSER,
TELEFIX and JOURNAL represent pillars in the knowledge-based economy.

4. METHOD OF ANALYSIS

Panel Unit Root Tests

Before co-integration analysis, all the data must be integrated in the same order. For that purpose, we employed the first-generation tests for panel unit root by Im, Pesaran and Shin (2003) and, Maddala and Wu (1999). For the second-generation panel unit root test, we employed the Pesaran (2007) method. These two tests are more powerful and less restrictive than the panel unit root developed by Levin, Lin and Chu (2002). The Im et al. (2003) tests allowed for heterogeneity in the autoregressive coefficient. Indirectly these tests can resolve serial correlation problems.

Standard Model

The study model was formulated to show the role of the knowledge economy in economic growth in the sampled countries (Bahrain, Jordan, Kuwait, Oman, Qatar, Kingdom of Saudi Arabia, UAE, Egypt, Lebanon, Algeria, Tunisia and Mauritania) using annual data from 2010 to 2020. The model can be formulated as follows:

$$GGDP_{it} = \beta_0 + \beta_1 GCF_{it} + \beta_2 TLPR_{it} + \beta_3 TRADE_{it} + \beta_4 GSER_{it} + \beta_5 TELEFIX_{it} + \beta_6 JOURNAL_{it} + U_t$$

Descriptive Statistics

Table (1) shows the descriptive analysis results of the study variables.

Table (1): Descriptive Statistics

Variable	Mean	Median	Maximum	Minimum	Std. Dev.
GGDP	2.31	2.54	19.59	-21.46	4.21
GCF	28.10	26.54	50.78	5.62	9.74
TLPR	61.05	52.88	88.51	41.53	15.19
TRADE	95.60	91.61	191.87	30.25	36.24
GSER	86.88	93.96	116.65	22.90	21.48
TELEFIX	12.44	12.68	27.05	1.27	6.13
JOURNAL	7.17	7.28	9.81	1.65	1.72

The results showed that the arithmetic mean of economic development amounted to (2.31%), while the median amounted to (2.54%). The highest value of economic development was (19.59%), whereas the lowest value was (-21.46%). The standard deviation amounted to (4.21%).

Furthermore, the arithmetic mean of total capital construction was (28.1%) with a standard deviation of (9.74%). The highest value of total capital construction amounted to (50.78%), while the lowest value was (5.62%). The arithmetic mean of the labour force participation rate was (61.05%), with the highest value amounting to (88.51%) and the lowest value amounting to (41.53%).

The results showed that the arithmetic mean of trade as a percentage of the gross domestic product amounted to (95.6%), while the median was (91.61%). The highest value of trade as a percentage of the gross domestic product was (191.87%), whereas the lowest value was (30.25%) and the standard deviation was (36.24%).

The arithmetic mean of the total secondary-stage joining rate amounted to (86.88%), with a standard deviation of (21.48%). The highest value of the total secondary-stage joining rate was (116.65%), while the lowest value was (22.9%).

On the other hand, the arithmetic mean of the number of phones per 100 persons amounted to (12.44%). The highest value was (27.05%), and the lowest value was (1.27%). The arithmetic mean of total journal articles amounted to (7.17%), with the highest value amounting to (9.81%) and the lowest value amounting to (1.65%).

Normal Distribution Test

In order to examine the data normality of distribution, skewness and kurtosis were used to ensure that the data of the study followed normal distribution. Table (2) shows the results.

Table (2): Normal Distribution Tes

Kurtosis	Skewness	Variable
1.020675	-1.18536	**GGDP**
2.735036	0.473273	**GCF**
1.714033	0.439978	**TLPR**

3.231324	0.723879	**TRADE**
4.072075	-1.28471	**GSER**
2.491761	0.086806	**TELEFIX**
4.349509	-1.17069	**JOURNAL**

The results showed that all the skewness values were within the normal rate (-3,3). All the kurtosis values were less than (10). This is evidence that all the study variables' values are subject to normal distribution. Consequently, all the study variables are free of problems related to the normal distribution of data.

Unit Root Test

The Levin, Lin and Chu (LLC) test was used to ensure the stationary of the time series of the study variables before starting the process of estimation, in order to check the null hypothesis, which states that the time series is non-stationary in addition to the existence of the unit root at the significance level of (5%) (Gugarati and Porter, 2009). Table (3) illustrates the results.

Table (3): Unit Root Test (LLC)

Variable	At level	At first difference	Stationary
GGDP	2.73002 (0.9968)	-9.21145 (0.0000)	**I(1)**
GCF	-1.33258 (0.1913)	-6.2234 (0.0000)	**I(1)**
TLPR	2.83913 (0.9524)	-4.73306 (0.0000)	**I(1)**
TRADE	2.60573 (0.1146)	-6.00440 (0.0000)	**I(1)**
GSER	-1.27174 (0.1017)	-26.4599 (0.0000)	**I(1)**
TELEFIX	-2.97757 (0.9235)	-9.36254 (0.0000)	**I(1)**
JOURNAL	1.28496 (0.2108)	-3.14365 (0.0000)	**I(1)**

Table (3) indicated that the study variables were non-stationary at the level, while they were stationary at the first difference at the significance level of 5%. Accordingly, the null hypothesis was rejected, stating the non-stationary of the time series at the significance level of 5%, while the alternative hypothesis was accepted, stating that the time series is stationary at the significance level of 5%.

Comparison of Study Models

The Hausman test was used to compare the fixed-effect model and the random-effect model (Baltaji, 2005). The Chow test was used to compare the fixed-effect model and the pooled-data model, while (BP-LM) test was used to compare the pooled-data model and the random-effect model. Table (4) shows the results of those tests.

Table (4): Comparison of Study Models

Model	Sig.	Chi^2	Test
Fixed-Effect Model	0.0000	8.010525	**Chow Test**
Random-Effect Model	0.0000	40.56283	**Lagrange Multiplier**
Fixed-Effect Model	0.0000	61.107327	**Hausman Test**

The Chow and Hausman tests showed that the fixed-effect model is the most appropriate one since the probability of Chi^2 is less than 5% for both tests. Furthermore, the (BP-LM) test results showed that the random-effect model is more appropriate since the probability of Chi^2 is less than 5%. Accordingly, the study model estimation was carried out using the fixed-effect model.

Co-integration Test

It is necessary to conduct the co-integration test to examine the existence of a long-term integration relationship between the study variables. Pedroni Engel-Granger co-integration test was used based on testing the null hypothesis stating that there is no co-integration between the study variables at the significance level of 5%. Table (5) shows the results of this test.

Table (5): Pedroni Engel – Granger Test

Within dimension	Statistic	Prob.	Weighted statistics	Prob.
Panel v-Statistic	-3.280796	0.9995	-3.684973	0.9999
Panel rho-Statistic	3.378096	0.9996	3.618999	0.9999
Panel PP-Statistic	-15.15552	0.0000	-15.82605	0.0000
Panel ADF-Statistic	-2.498216	0.0062	-4.677399	0.0000
Between dimension	**Statistic**	**Prob.**		
Group rho-Statistic	-4.841076	0.0000		
Group PP-Statistic	-19.64600	0.0000		
Group ADF-Statistic	-3.242496	0.0006		

The Pedroni Engel-Granger co-integration test indicates that most of the statistics (7 out of 11) are significant. Consequently, the null hypothesis is rejected, and the alternative hypothesis is accepted, which states that there is a co-integration between economic growth and knowledge economy in the study sample countries at the significance level of 5%.

Variance Inflation Factor (VIF) Test

The variance inflation factor test is used to reveal the presence of a multicollinearity problem between the independent variables by implementing a linear regression equation between each independent variable. We compare the VIF value for each variable with the VIF value for the model as a whole, where the VIF value for the model should be higher than the VIF value for each variable.

The VIF value of the model is calculated using the following equation:

$$VIF = \frac{1}{1 - R^2}$$

Table (6) shows the results of this test.

Table (6): Variance Inflation Factor (VIF) Test

Variables	Centred VIF
GGDP	1.268584
GCF	1.272397
TLPR	2.134034
TRADE	1.209805
GSER	1.246999
TELEFIX	1.558437

The results showed that the centred VIF values for the independent variables were less than 10% and that the VIF value for the model as a whole was (7.47), which is higher than the VIF value for each independent variable. Consequently, the study model is free of the problem of Multicollinearity between the independent variables.

5. EQUATION ESTIMATION RESULTS

Panel-Data analysis was used by utilising the ordinary least squares (OLS) method and adopting the fixed-effect model because all the study variables were stationary at the same degree. Table (7) shows the results.

Table (7): Estimate equation by Fixed-Effect Model

Dependent Variable	Independent Variable	Coefficient	Std. Error	t-Statistic	Prob.
GGDP	GCF	0.091996	0.027390	3.358802	0.0069
	TLPR	0.609354	0.246940	2.467623	0.0151
	TRADE	-0.011334	0.004836	-2.343626	0.0318
	GSER	0.023900	0.006680	3.577888	0.0005
	TELEFIX	0.025889	0.178495	0.145043	0.8849
	JOURNAL	-6.938641	1.038424	-6.681895	0.0000
	Intercept	85.63086	17.95429	4.769381	0.0000
R^2		84.6159%			
Adjusted R^2		83.5847%			
F-statistics		5.804323			
Prob. (F-statistics)		0.000000			

The results revealed that the value of the coefficient of determination (R^2) amounted to (0.8462), meaning that the independent variables together explain (84.62%) of the variation in economic development in the study sample countries.

The results showed a proportional, statistically significant effect of total capital construction on economic development in the sampled countries, where an increase in total capital construction by (1%) results in an increase in economic development by (0.092%).

The null hypothesis is rejected, stating that "there is no statistically significant effect at the significance level of ($\alpha \leq 0.05$) of total capital construction on economic development in the study sample countries".

The results also showed a proportional, statistically significant effect of labour force participation rate (aged 15-64 years) on economic development in the study sample countries, where an increase in the labour force participation rate (aged 15-64 years) by (1%) leads to an increase in the economic development of the study sample countries by (0.609%). The null hypothesis stating that "there is no statistically significant effect at the significance level of ($\alpha \leq 0.05$) of labour force participation rate on economic development in the study sample countries" is rejected.

Furthermore, the results revealed an inverse, statistically significant effect at the significance level of ($\alpha \leq 0.05$) of trade as a percentage of the gross domestic product on the economic development of the study sample countries, where an increase in trade as a percentage of the gross domestic product by (1%) results in a decrease in the economic development of the study sample countries by (0.011%). The null hypothesis stating that "there is no statistically significant effect at the significance level of ($\alpha \leq 0.05$) of trade as a percentage of the gross domestic product on economic development of the study sample countries" is rejected.

The results revealed the existence of a proportional, statistically significant effect of total secondary-stage joining rate on economic development in the study sample countries, where an increase of total secondary-stage joining rate by (1%) leads to an increase in economic development in the study sample countries by (0.024%). The null hypothesis stating that "there is no statistically significant effect at the significance level of ($\alpha \leq 0.05$) of total secondary-stage joining rate on economic development in the study sample countries" is rejected.

On the other hand, the results revealed no statistically significant effect of the number of phones per 100 persons on economic development in the study sample countries. Therefore, the null hypothesis is accepted, stating that "there is no statistically significant effect at the significance level of ($\alpha \leq 0.05$) of the number of phones per 100 persons on economic development in the study sample countries.

Also, the results revealed an inverse, statistically significant effect of total journal articles on economic development in the study sample countries, where an increase in total journal articles by (1%) leads to a decrease in economic development in the study sample countries by (6.939%). The null hypothesis stating that "there is no statistically significant effect at the significance level of ($\alpha \leq 0.05$) of total journal articles on economic development in the study sample countries" is rejected.

The value of μ_i was calculated for each country separately depending on the cross-section fixed-effect results, where the value of μ_i for each country was added to the fixed term. Table (8) shows the results.

Table (8): Cross-Section Fixed-Effect

Country	Individual Effect		Intercept		Individual Effect for Each Country
Bahrain	-3.5952				82.03566
Jordan	-8.12391				77.50695
Kuwait	3.350198				88.98106
Oman	0.812041				86.4429
Qatar	15.555	+	**85.63086**	=	101.1859
Saudi Arabia	9.159994				94.79085
UAE	18.11093				103.7418
Egypt	9.94503				95.57589
Lebanon	-9.17157				76.45929
Algeria	-4.33335				81.29751
Tunisia	2.055854				87.68671
Mauritania	-37.1415				48.48935

The results showed that the fixed term for UAE was the highest among the study sample countries, amounting to (103.7418), meaning that the characteristics related to economic development in UAE are the highest among the study sample countries over the study period, followed by Qatar with a fixed term of (101.1859). Furthermore, the fixed term for Mauritania was the lowest among the sampled countries, with a value of (48.48935), meaning that the characteristics related to economic development in Mauritania are the lowest compared to those of the other study sampled countries over the study period, while the second-least value of the fixed term was for Lebanon with (76.45929).

CONCLUSION

The study's objective was to examine the role of the knowledge economy on the economic growth of a selected group of Arab countries. Panel-Data analysis for 12 countries covering the period (2010-2020) was undertaken. The study found a positive statistically significant effect of the total enrolment rate in secondary school (represent education pillar in the knowledge-based economy) on the economic growth of the sampled countries. Moreover, the study revealed a negative statistically significant effect of trade and total number of the published articles (a pillar of innovation in Knowledge-based economy) on economic growth. Also, there is no statistically significant effect of the number of phones per 100 people (a pillar of information on knowledge-based economy) on economic growth. This result implies that education is the most important pillar of knowledge economy that positively contributed in economic growth in the selected Arab countries. Based on this result, the Arab countries should launch policy package that encourage education in order to promote economic growth in these countries.

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