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ROLE OF KNOWLEDGE ECONOMY IN ECONOMIC GROWTH: "AN EMPIRICAL STUDY" ON SELECTED ARAB COUNTRIES

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Abstract

Despite the mounting importance of the knowledge economy in diversifying Arab economies, the knowledge transition in these countries is still in its early stages, with a long road ahead. The study's main aim is to examine the role of the knowledge economy in economic growth and to recognize the most influential knowledge pillar for a sample of 11 Arab countries during the period 2000–2020, namely: Algeria, Bahrain, Egypt, Jordan, Kuwait, Lebanon, Morocco, Oman, Qatar, Saudi Arabia, and Tunisia. The panel generalized least squares model, with its two methods (fixed-effects model and random-effects model), was performed using an extended version of Chen and Dehlman's (2004) empirical framework. The fixed regression findings confirmed the positive and significant role of knowledge in stimulating economic growth. The estimated results of the random regression revealed that knowledge pillars like innovation, information and communication technology, economic and institutional regimes, and the socio-economic sustainability index have a positive and significant impact on Arab economic growth, whereas education has a significant negative relationship with GDP. This can be attributed to poor quality, unequal access, and infrastructure, as well as the COVID-19 pandemic, which has had a negative impact on education. The results also showed that, in comparison to the other four pillars, the socio-economic sustainability index, which was added to the benchmark Knowledge Economy Index, was the most notable pillar that participated in the examined relationship. As a result of these findings, this study contributes to broadening the scope of Arab countries through investing in key knowledge pillars that promote economic growth and where policies should place a greater emphasis on developing education. Furthermore, because of their critical and significant role in exploring the knowledge-growth relationship, sustainability dimensions must be explicitly included in the knowledge framework.

Keywords

Knowledge Economy, Economic Growth, Knowledge assessment Methodology (KAM), Sustainable Knowledge Economy Index (SKEI).

1. INTRODUCTION

The growing phenomenon of the knowledge economy as a long-term key driver of growth and the main reason for disparities in economic growth among nations has encouraged all countries to build effective knowledge economies to harness the benefits of this new economy. In Arab countries, the role of knowledge in development remains insufficient to promote rapid transformation and enhance productivity diversification. The knowledge gap between the Arab world and the developed world is getting wider, as is the gap in per capita income since the early 1990s, reflecting their inability to establish effective development strategies and policies to close the existing knowledge gap (Al-Roubaie, 2013). Switzerland ranked first globally for the fifth time in the most recent 2021 data for the global knowledge index, which tracks countries' knowledge status in vital fields such as education, innovation, and information. It was followed by Sweden, the United States, Finland, and the Netherlands. The United Arab Emirates (UAE) was ranked 11th globally and first in the Arab region at GKI 2021. Qatar is ranked 38th, followed by Saudi Arabia (48), Kuwait (48), Oman (52), Egypt (53), Bahrain (55), Tunisia (83), and Lebanon (92) (UNDP and MBRF, 2021).

A quick glance at the state of the Arab countries reveals that they are facing a huge number of continuous socio-economic challenges and are witnessing a high level of wealth disparity and income inequality, high unemployment rates, severe poverty dimensions, low productivity, a poor labor force participation rate, a weak job market, and rapid population growth. The region becomes home to an estimated 444.81 million inhabitants in 2021, growing from 216.9 million in 1990 (ASDR, 2020). Arab countries have the highest youth unemployment rate in the world, with the region's youthful unemployment rate expected to rise to 24.8% by 2022 (ILO, 2022). Furthermore, it is estimated that around 101.4 million people in the region are currently impoverished, with 52 million suffering from food insecurity. The Arab region has $5.8 trillion in household wealth, according to ESCWA data, with the top 10% of the population recording $4.4 trillion and an average wealth of $182,939, primarily from Gulf Cooperation Council (GCC) countries (ESCWA, 2020a).

The economic and financial perspectives of Arab countries vary enormously, including both internal and external factors influencing country performance over time. In 2018, the Arab region's GDP per capita was $6,610, compared to a global average of $11,317 (UNCTAD, 2020). Furthermore, the consequences of COVID-19's spread and eventual lockdown were severe, with Arab countries losing nearly 3.7% of their GDP, or approximately US$42 billion (ESCWA, 2020b). Besides that, oil and natural gas, as well as the effects of long-term conflicts, have all played a significant role in causing such disparities and imbalances across the region, along with shaping the economic structure. The Arab region has the highest percentage of oil rents to GDP in the world, with an average of 21.4% in 2018 compared to the global average of 1.4%, peaking at 45% in Kuwait (World Bank, 2020).

Several Arab countries are characterized by their wealth in natural resources and oil reserves, especially the oil-exporting countries, which are considered rentier states since oil revenues account for more than 90% of revenues and 95% of exports. However, only about 3% of the working population is effectively involved in the creation and distribution of oil wealth, which currently accounts for 60 to 80% of GDP (Beblawi, 2015). The rentier model has contributed to economies that rely heavily on imports as well as income and revenue from oil and gas (Hvidt, 2016). This demonstrates that having vast oil resources did not propel the countries to a certain level of development and welfare, and that relying on oil revenues caused their development processes to lag and be weaker than those of other advanced countries. In these countries, the rentier model has resulted in risky and uncertain growth patterns, owing primarily to their reliance on oil and gas prices, as seen in Saudi Arabia, which ran a current account deficit of 8.7% of GDP in 2015 and 4.3% of GDP in 2016, equivalent to 27.5 billion USD, as a result of oil price drops in 2014 (Faudot, 2019).

As aforementioned, the Arab countries' macroeconomic projections differ, with some concentrating on agriculture exports, tourism, and services, such as Egypt and Lebanon, and others, such as the GCC countries, relying on energy resources and oil. This over-reliance on a single resource as the primary source of revenue has hampered economic diversification and subjected Arab countries to global market prices and shocks. This extreme reliance is defined as

a symptom of Dutch disease, with resource dependency being its primary indicator (Bajwa et al., 2019). Thus, the high resource reliance, the collapse of oil prices, the rise in wealth inequality in the Arab region, rigorous poverty, the regression in economic growth, high unemployment, unstable social conditions, and remarkable differences in living conditions have pushed Arab governments to develop and diversify the structure of their economies in order to accelerate the shift towards knowledge-based economies.

Egypt has implemented a series of macroeconomic and structural reforms to stabilize the economy, stimulate growth, and achieve its Sustainable Development Strategy (SDS), Egypt Vision 2030, in order to compete in the twenty-first century. By 2030, one of the strategy's main goals is for the economy to be a "balanced, knowledge-based, competitive, diversified, market economy". The Egyptian government has made a challenging decision to implement price reform, fiscal adjustments, and exchange rate adjustments by developing an economy based on R&D and innovation. A knowledge-, research-, and innovation-based development case is expected to boost GDP growth to 8–9% per year by 2029–2030. This necessitates the growth of knowledge-based assets, which leads to greater investment and productivity growth (ESCWA, 2019). Saudi Arabia is switching to a more diverse knowledge-based economy. As a result of its diversification strategy, the Kingdom's oil-based economy has changed. The Saudi Vision 2030 plan, adopted in 2016, promoted significant radical reforms to improve the business environment, totaling eight reforms. Out of 190 economies, it ranks among the ten most improved in the World Bank's Doing Business 2020 report. Saudi Arabia must achieve three major goals by 2030 in order to transition to a knowledge-based economy: developing a prosperous community as a solid foundation for economic development, making opportunities available to all, and constructing an inspiring nation (Al-Fehaid and Shaili, 2021).

Despite the fact that several Arab countries, including Egypt 2030, the UAE 2030, Qatar 2030, Saudi Arabia 2030, and Algeria 2030, have established strategic plans and objectives to create knowledge economies and societies, the steps taken remain insufficient to catch up with the rest of the world. Arab countries rank low in a variety of measures relating to the application of knowledge, technology, and innovation. According to World Bank data, the Arab region appears to contribute only 2% of global researchers and spends 0.7% of GDP on R&D, which is less than half the global average of 2.1%. Between 2013 and 2018, the Arab region's government expenditure on education was 3.6 percent, which was lower than the global average of 4.7 percent. Arab residents filed 3,807 patent applications in 2018, far fewer than the global average of 2,294,881. The regional average of 744 full-time equivalent researchers per million people is less than 60% of the global average of 1,2679. ICT investment is increasing in the GCC countries, with Qatar and the UAE ranking among the top ten global technology adopters. Other Arab countries are also seeing visible improvements, but the ICT sector's contribution to GDP remains low. It ranged between 0.6 and 6% from 2016 to 2018, with little export of technology-related products due to its concentration in telecommunications (ASDR, 2020).

It is well established that in order to achieve typical economic conditions such as sustainable growth, reducing unemployment, and lowering poverty, Arab countries must use their resources efficiently so that they can gain an adequate growth position and achieve prosperity. In fact, despite reaching a certain level of development, the traditional economy, or "natural-resource economy", faced numerous challenges in dealing with the determinants of long-term growth rates, and it is still incapable of confronting and resolving its economic and social problems. This means that they have to switch urgently from resource economies to knowledge economies in order to improve their economic performance and standard of living and thus catch up with the developed countries.

The knowledge economy is a controversial, debated, and intriguing research topic that has attracted the interest of many economists and researchers. The existing literature on this topic, however, remains limited and less researchable for Arab countries, as most applied research in this field focuses on developed countries or regions. Furthermore, many researchers concentrate only on the four pillars of knowledge and how they contribute to economic growth. Rather, studies rarely establish a link between the knowledge economy framework as a whole and economic growth research. Given this void in the literature, the current study seeks to fill it by empirically investigating the role of the knowledge economy on economic growth in a selected sample of Arab countries from 2000 to 2020. By accomplishing this goal, this study first

contributes to the ongoing debate about the relationship between the knowledge economy and economic growth. Second, it provides a broad understanding of knowledge performance in Arab countries and how they can strengthen their knowledge investments to enhance higher growth rates.

The remainder of this paper is organized into five sections. The first section serves as an introductory paragraph. The second section summarizes theoretical and empirical reviews, while the third section discusses methodology, data, and model specification. The fourth section presents the study findings, and the fifth section concludes.

2. LITERATURE REVIEW

Throughout history, the investigation of the growth determinants has been one of the main debates amongst scholars and economists. One of the most important factors related to the economic process in neoclassical growth theory is investment in labor and capital, where an increase in the quantity of labor or capital invested leads to an increase in economic output. In the absence of technological change, the economy's growth rate will be slow, and it will eventually reach an equilibrium level of output with no further potential growth, according to Solow's (1956) neoclassical economic growth theory. Technological progress is critical to long-term economic growth. It is, however, exogenous to the model.

This traditional approach suffered from many difficulties in dealing with the determinants of long-term growth rates, in which the shortcoming and the unexplained residual growth in the neoclassical model encouraged economists such as Romer (1986, 1990), Lucas (1988), and many others to develop new endogenous growth models to add more ideas and contributions to the Solow residual. The new model considered technology as an endogenous growth factor where literature analyzed the significant role of knowledge in the production process and recognized it as the third most important input, in addition to labor and capital, in which strengthening the investments in the knowledge economy pillars will promote sustained growth rates and hence development levels.

The concept of "knowledge economy" served as the empirical foundation for economic performance, and the discussion centered on the positive relationship between a country's level of knowledge and its growth, where results have confirmed the huge significance of the knowledge economy and that growth would suffer without knowledge support, as knowledge becomes a key determinant for long-term growth. According to the United Nations forecasts, the contribution of knowledge economies to the global GDP is at least 7 % and their share are growing at least 10 % per year (Mohamed et al., 2022).

Given the scarcity of quantitative investigation into the effects of knowledge economies on economic growth in emerging economies, the current study focuses on Arab countries, where it contributes to the existing debate on the relationship between knowledge and growth by investigating the role of knowledge in growth in these countries. It also provides a broad understanding of knowledge performance in Arab countries and how they can boost higher growth rates by increasing knowledge investments. This section reviews some previous empirical studies in the literature that address the knowledge- growth relationship as follows:

Mohamed et al. (2022) examined a number of knowledge-based economy variables for a sample of 20 developing countries during the period 1996-2020. Using panel data, the estimated results revealed that reliance on the knowledge economy is responsible for 93 % of the changes in economic growth in the developing countries under study. Hasan and Bousrih (2020) examined the effects of some knowledge-based economic indicators on economic growth in Saudi Arabia from 1992 to 2018 using a vector auto regression estimation of a dynamic model. According to empirical findings, the most important pillars that have a conclusive impact on economic growth are education and human resources. These findings support policymakers' decision to diversify the Saudi economy away from its reliance on oil resources. Barkhordari et al. (2019) conducted empirical research on the linkage between knowledge-based economies and economic growth in Middle Eastern and North African countries from 2010 to 2015. The findings show that institutions, human capital, research, infrastructure, and business sophistication all have a significant and positive impact on the MENA region's economic growth. Utku-smihan (2017) investigated the impact of knowledge indicators on economic

growth and catch-up performance in 17 Middle Eastern and North African (MENA) and 18 Latin American countries during the period 1980 to 2014. The empirical results suggest that knowledge indicators have an important role in improving economic growth performance and that, in the long run, convergence occurs in both regions.

Murat et al. (2017) examined the relationship between indicators of knowledge economy performance and various macroeconomic variable sets for 34 OECD member countries, discovering a strong, statistically significant, and positive relationship. Using the "knowledge economy" approach, Cooray and Paradiso (2012) investigated which knowledge variables have significant level and growth impacts in the Nordic region. According to the study's findings, trade openness, human capital, and the investment-to-GDP ratio all play important roles in determining their short- and long-run growth rates. Education, according to the findings, played an important role in determining long-term growth rates in Sweden, Norway, and Denmark. In contrast to openness and education, which were thought to be driven by R&D, there have been no growth impacts in any of the Nordic countries.

In addition to the above studies that examined the knowledge-growth relationship based on the aggregate knowledge economy framework, a large number of empirical studies have been conducted to investigate the relationship between each pillar of the knowledge economy separately (education, innovation, information and communication technologies, and economic incentives and institutional regime) and economic growth, leading to varying outcomes and conclusions due to differences in the research environment, country characteristics, study time span, research methodology, and data and estimation techniques used. Nowak and Dahal (2016) conducted a long-term study of the relationship between education and economic growth and discovered a link between secondary, tertiary, and higher education and Nepal's real GDP per capita. Furthermore, while elementary education is beneficial to economic growth, it is statistically insignificant. On the other hand, Abugamea (2017) calculated the contribution of education to per capita real GDP growth in Palestine from 1990 to 2014. According to the findings, annual per capita real GDP increased by about 3.6 %. Education, via the private-to-public enrollment ratio, contributed only about 11 % of the 47 % contributed to economic growth by total employed labor and capital components. While secondary school enrollment is expected to be detrimental to economic growth, Wang and Liu (2016) examined the impact of education and human capital on economic growth using recent education data from 55 countries and regions from 1960 to 2009.

According to Abdellaoui and Mekhzoumi's (2020) research, innovation has a positive effect on GDP per capita growth as well as unemployment in Algeria, Tunisia, Morocco, Egypt, the United Arab Emirates, Kuwait, and Saudi Arabia from 2007 to 2016. Nour (2019) discovered that R&D spending has a positive and statistically significant relationship with GDP in the MENA region from 1996 to 2016, but the relationship is weak. In another study, Elbagoury (2018) investigated the impact of scientific research on economic growth in six Arab countries between 2000 and 2014, namely Algeria, Egypt, Kuwait, Morocco, Saudi Arabia, and Tunisia, and discovered that R&D had a positive but non-significant impact on Arab growth. Conversely, Pala (2019) used a random coefficient model to investigate the impact of technology on economic growth in 25 developing countries. According to the findings, spending on research and development has a significant negative impact on economic growth in China, Egypt, Iran, Moldova, Panama, Serbia, and Uzbekistan. The number of researchers in research and development had a significant negative impact on growth in Iran, Mexico, Tunisia, and Uzbekistan. Only in Ukraine, Turkey, Russia, and China, however, does the number of researchers in R&D have a significant and positive impact on economic growth.

Dahmani et al. (2022) investigated the effects of information and communication technology and increased trade openness on Tunisian economic growth in 14 economic sectors from 1995 to 2018. According to empirical findings, the use of ICTs is associated with increased economic growth and value addition in Tunisia over the long term. Furthermore, trade openness and gross fixed capital formation boost economic growth. From 2007 to 2016, Bahrini and Qaffas (2019) investigated the impact of ICT on economic growth in the MENA and SSA regions. According to the findings, the remaining information and communication technologies, such as mobile phones, internet usage, and broadband adoption, are the primary drivers of economic growth in both regions. Ejemeyovwi and Osabuohien (2018) conducted an empirical

study of the role of mobile technology adoption in inclusive growth in 15 West African countries from 2004 to 2014. In accordance with the results of the system generalized moments method, mobile phone subscriptions have a statistically insignificant effect on growth. The findings in West Africa demonstrate the negative and significant role of mobile technology adoption in inclusive growth.

Samarasinghe (2018) examined the impact of governance on economic growth using data from 145 countries from 2002 to 2014. As proxies for governance status, corruption control, political stability, the absence of violence and terrorism, and voice and accountability, they are chosen. The model also includes four control variables: foreign direct investments, gross capital formation, government consumption, and trade openness. According to the study's findings, corruption control is a critical determinant of growth, with one unit of corruption control increasing economic growth by 6.9 percent. Kraipornsak (2018) compared the Worldwide Governance Indicator across 16 Asian countries from 1996 to 2016. The estimated outcomes showed that, in addition to capital per head and total factor productivity growth, good governance can be a significant contributor to income per head growth. A 1% increase in the composite governance index over the previous year can contribute to a 0.54% annual increase in per capita income of US $31.34. While controlling for traditional sources of growth, Fayissa and Nsiah (2013) examined the role of governance in explaining suboptimal economic growth performance in African economies. According to the findings, poor governance, or a lack thereof, contributes to income disparities between rich and poor African countries.

3. RESEARCH METHODOLOGY

The main objective of this study is to investigate the role of the knowledge economy on economic growth in 11 Arab countries out of the 22 from 2000 to 2020, namely: Algeria, Bahrain, Egypt, Jordan, Kuwait, Lebanon, Morocco, Oman, Qatar, Saudi Arabia, and Tunisia. These countries were chosen due to data availability constraints and after excluding countries affected by war and insecurity, as well as countries that lacked data variables for the entire sample period. An unbalanced panel dataset is applied where real GDP per capita and purchasing power parity (PPP) are the dependent variables that are defined as proxies for economic growth. The traditional factors of production, capital and labor, the Sustainable Knowledge Economy Index (SKEI), and the indicators of the four pillars of the World Bank framework, as well as the fifth additional pillar related to sustainability, are taken as independent variables, along with three control variables adopted from growth models to control their predicted significant impact on economic growth. These variables are the general government's final consumption expenditure (measured as a percentage of GDP), foreign direct investment (net inflows), and population growth (annual percentage).

The Knowledge for Development Program (K4D) was established by the World Bank Group's World Bank Institute to assist countries in increasing their capacity to gain access to and use knowledge in order to increase competitiveness and improve growth and welfare. The Knowledge Assessment Methodology (KAM) was developed by the program in 1999 as a knowledge economy framework for its member countries to specify their level of knowledge-based economic development. This methodology emphasizes the importance of developing knowledge-connection strategies that improve economic growth, welfare, and competitiveness (Chen and Dahlman, 2005).

The knowledge economy, according to the KAM, can be quantified using the numerical index known as the "Knowledge Economy Index (KEI)". The Knowledge Economy Index (KEI) is a composite index that assesses the overall level of development of a country or region in the knowledge economy. It is a simple average of the basic scorecard's 12 knowledge indicators, which summarizes performance across the four KE pillars: education and human capital, the innovation system, ICT infrastructure, and economic incentives and institutional regime (Palicková, 2014). Since the index data was discontinued in 2012, there is no recent KEI data available. One of the primary goals of this study is to develop a continuous and updated index for calculating the Knowledge Economy.

According to the four pillars of knowledge, none of the KEI indicators are related to sustainability. Although the KEI considers sustainability to be a valuable goal and potential outcome, the concept is not properly defined within the World Bank framework, and the index does not take into account factors related to sustainability in its three main dimensions: economic, social, and environmental aspects. There is a growing consensus in the literature that science, technology, and knowledge play an important role in sustainable development (Dayan, 2005). It is said that the sustainability of growth is becoming increasingly dependent on innovation capabilities, particularly the ability to properly harvest knowledge. This raises significant theoretical and conceptual issues concerning the connections between sustainable development and knowledge (Djeflat, 2016).

Therefore, in addition to the main KE pillars established by the World Bank framework, a fifth pillar related to the sustainability concept is incorporated in calculating the new knowledge index, namely the Sustainable Knowledge Economy Index (SKEI), as sustainability requires further knowledge assets and abilities. The newly constructed SKEI by the researcher takes the initial KEI as a benchmark; both are calculated using the Knowledge Assessment Methodology (KAM) applied by the WB, and it includes five sub-indicators: the education index, the innovation index, the information, communication, and technology index, the economic and institutional regime index, and the socio-economic sustainability index.

The KAM methodology begins by normalizing each of the five sub-indices, then calculating the SKEI using the arithmetic mean and comparing countries based on the SKEI value before proceeding to regression. Through the normalization process, KAM's normalization procedure brings all indicators to the same measurement criterion: (Nw/Nc) * 10 = N(u).

Countries are assigned ranks based on the absolute values (raw data) that are extracted from the World Bank datasets and international literature that describe each of the 148 variables to form a "u" ranking. where N (u) represents an index's normalized score, (Nw) identifies the number of countries with a lower ranking after computing for each country, and (Nc) is the total number of countries in the sample. The formula above assigns absolute and normalized values ranging from 0 to 10 to the data variables. Top performers in knowledge receive a score of 10, while laggards receive a score of 0. The top 10% of performers receive normalized scores ranging from 9 to 10, the next 10% receive normalized scores ranging from 8 to 9, and so on. The 0–10 scale describes each country's performance on each variable in relation to the other countries in the sample (Chen and Dahlman, 2005).

The data variables are derived from World Bank databases, specifically the World Development Indicators (WDI), World Data Archives (WDA), and World Governance Indicators (WGI), as well as the Penn World Table, version 10.0.

From a theoretical framework perspective, to investigate the relationship between the knowledge economy and economic growth, the estimated model is based on the neoclassical Solow-Swan model (1956) and employs the Cobb-Douglas production function:

$$Y = A\ F\ (K^{\alpha}, L^{\beta}) \qquad (1)$$

Equation (1) represents a Cobb-Douglas functional form production function with technological progress as the third input. Y denotes aggregate output, L total labor force, K capital stock, α is the output-to-capital elasticity, β is the output-to-labor elasticity, and factor A denotes Total Factor Productivity (TFP). TFP includes all exogenous input factors, excluding labor and capital, that influence aggregate output (Y).

The econometric model that has been employed to empirically examine the knowledge growth relationship in the selected sample is derived from the empirical framework suggested by Chen and Dahlman (2004). Thus, in order to analyze how knowledge determines growth, the monotonic transformation of Chen and Dahlman's aggregate Cobb-Douglas production function is extended as follows:

$$Y_{it} = A\ (g, e, r, i, s) + \alpha\ K_{it} + \beta L_{it} + \varepsilon_{it} \qquad (2)$$

Where "g" is the institutional and economic regime of the country, "e" is education and training, "r" is the country's domestic innovation level, and "I" is the country's information and communication infrastructure, "s" is the socio-economic sustainability, and the other variables are the same as defined above.

Based on the above, the total factor productivity in the extended Cobb-Douglass production function is a function of education, innovation, ICT, the economic and institutional regime, and the socio-economic sustainability pillar. Therefore, TFP is replaced by the Sustainable Knowledge Economy Index (SKEI):

$$A\ (TFP) = A(g,e,r,i,s)$$

$$A\ (TFP) = SKEI_{it}$$

Replacing the factor A (g,e,r,i,s) with the SKEI in the Cobb-Douglas production function and adding the control variables, the fundamental econometric model "1" used to investigate the role of the knowledge economy on economic growth is as follows:

$$GDP_{it} = \gamma 0 + \gamma 1(SKEI_{it}) + \gamma 2(GGOV_{it}) + \gamma 3(FDI_{it}) + \gamma 4(POP_{it}) + \alpha\ (K_{it}) + \beta\ (L_{it}) + \varepsilon_{fit} \qquad (3)$$

Where GDP represents the real gross domestic product. The three control variables are GGOV, FDI, and POP, which represent the general government's final consumption expenditure, foreign direct investment, net inflows, and population growth, respectively.

By replacing the SKEI with its knowledge sub-indicators, the Model "2" panel equation is applied to determine which index of the knowledge pillars has the most significant role in growth:

$$GDP_{it} = \gamma 0 + \gamma 1(ED_{it}) + \gamma 2(INN_{it}) + \gamma 3(ICT_{it}) + \gamma 4(EIR_{it}) + \gamma 5(SUS_{it}) + \gamma 6(GGOV_{it}) + \gamma 7(FDI_{it} + \gamma 8(POP_{it}) + \alpha\ (K_{it}) + \beta\ (L_{it}) + \varepsilon_{fit} \qquad (4)$$

Where ED is the index of the education pillar, INN is the innovation index, ICT represents the information, communication and technology index, EIR is the economic and institutional regime index, and SUS reflects the socio-economic sustainability index.

4. EMPIRICAL RESULTS AND DISCUSSIONS

In this section, the role of the knowledge economy on economic growth is empirically examined, as well as which knowledge pillar has the most powerful impact on growth for 11 Arab countries in two separate models, followed by a discussion of the results. Since the diagnostic tests reveal no problems in the data such as serial correlation and heteroscedasticity, the static panel data estimation method used is the Generalized Least Squares (GLS): Fixed Effects Model (FEM) and the Random Effects Model (REM), up to the Hausman specification test to select the most convenient model between FEM and REM. The estimation technique used is fixed effects regression for Model "1" and random effects regression for Model "2", with FEM and REM chosen based on the results of Hausman's test. The appendix section contains all of the Model "1" and Model "2" tables.

Before proceeding with the estimation techniques, a brief descriptive statistical summary of all variables is presented. Table "1" displays a close mean and median for the majority of variables. The dependent variable GDP had a huge value of 34142.7 and a range of 33164.6 to 141635, but this will not affect the regression because the GDP will be transformed with a LnSKEI, the main independent variable in Model "1", which showed a mean of 0.46, indicating that the sample countries' average development level is low.

Table "2" reveals the means, standard deviations, and number of observations for each knowledge variable (education, innovation, ICT, economic and institutional regime, and socioeconomic sustainability) used to calculate the SKEI index. Except for EIR, which recorded a minimum negative value, the five indicators are between zero and one (EIR). This means that the selected countries have varying levels of development. However, the mean for all variables is nearly 0.5, implying that half of the countries have similar levels of welfare development.

To achieve the study's objective, several diagnostic tests are used, the first of which is the correlation coefficients, which are used to see if there is a strong relationship between the model variables. Tables "3" and "4" show that there is no strong relationship between the variables chosen, implying that the explanatory variables in the two models are not correlated.

The problem of heteroscedasticity is then detected by applying the Breusch-Pagan test. It is important to mention that this problem is corrected by Stata software with the robust standard error ticked while running the regression. A test for heteroscedasticity is available with a null hypothesis of homoscedasticity. The presence of heteroscedasticity is specified within the two models' equations.

After transforming all variables into their natural logarithm form (Ln), the test results presented a p-value of 0.3462 for model "1" and 0.3651 for model "2" as presented in Table "5" and Table "6". Both results are greater than the significance level, which means that the null hypothesis failed to be rejected. Therefore, the data used doesn't suffer from a heteroscedasticity problem.

After that, the Hausman specification test is applied as per Tables "7" and "8" to assess whether the next suitable model after performing the OLS is a random effect (REM) or a fixed effect (FEM). The null hypothesis states that the individual effects (ai) are independent of the other explanatory variables included in the model, where H_0: ai is equal to 0 and H_1:ai is not equal to 0.

For Model "1", the Hausman test registered a p-value that is equal to zero, which counts against the null hypothesis that the random effects model is consistent. Therefore, the suitable model to be employed is the FEM, as it is better than REM. However, for model "2", the Hausman test recorded a p-value that is equal to 1, which means a failure to reject the null hypothesis. This means that REM is preferable than FEM as it leads to more efficient estimators.

As aforementioned, there are two distinct knowledge panel models. The first model investigates the knowledge economy's role in economic growth, while the second model determines which knowledge index has the greatest impact on growth. Therefore, the results will be divided into two sections: one with the SKEI as a proxy of knowledge and one with the sub-indicators as a measure of knowledge.

- **Model "1": Sustainable Knowledge Economy Index (SKEI)**

  The OLS regression analysis shows that the relationship between the main independent variable (SKEI) and the dependent variable (GDP) is not significant, which means more advanced econometric techniques must be applied to investigate this relationship deeply. Consequently, the Generalized Least Squares (GLS) with its two methods, Fixed Effects and Random Effects, is applied as a more efficient and accurate technique, in which the applied Hausman test was in favor of the fixed effects estimation.

  Table "9" reveals the estimation outcomes of model "1" using the FEM equation. The estimated results show that the relationship between SKEI and GDP changed from an insignificant relationship under the OLS estimator into a significant relationship under the fixed effects estimator. The impact of SKEI on GDP is positive, with a coefficient of 0.491 at a 1 % significance level. These results are along with Murat et al. (2017), Utku-smihan (2017), and Mohamed et al. (2022). For labor (L), it is inversely and significantly related to GDP and this can be explained by the serious This can be explained by the serious challenges that characterize the Arab labor market, such as the decline in oil prices, the outbreak of COVID-19, the poor labor force participation recorded in 2020 at 47.96 %, significantly lower than the global average of 60.5% due to the low enrollment of women at 20.78 %, a discrepancy between labor supply and labor demand resulting in high unemployment levels in many countries, particularly among youth, as well as declining shares of public sector employment (ILO, 2019) whereas capital (K) shows a non-significant relationship with GDP under FEM. This outcome can be attributed to a lack of sufficient capital investment as well as a scarcity of physical capital. It can also be referred to as the deficiency of modern machines, equipment, infrastructure, and technology, which frequently encourages labor to produce more, resulting in higher outputs and raising rates of growth.

  In terms of control variables, the findings show that population growth (POP) loses significance as GDP increases. Further, the relationship between general government final consumption expenditure (GGOV) and economic growth reveals an inverse and significant one. Foreign direct investment (FDI) has a significant negative effect, and the result is in

line with Lean and Tan (2011), Bayar (2014), and Khobai et al. (2018). This negative impact can be attributed to the global economic slowdown, which is exacerbated by the COVID-19 effect, which contributes to a reduction in global FDI flows. According to ESCWA 2020, the high proportion of FDI in oil and gas activities in the Arab region will result in a 45% decrease in annual FDI inflows in 2020 compared to 2019. Furthermore, the lack of human capital that can harness the benefits of technology transfers in host countries can be a reason for this outcome.

The overall regression of the F-statistic is highly significant where the prob (F-statistic) value is less than 0.05, showing a value of 0.0004, which means that the joint coefficients are statistically significant. R-squared within recorded a good value of 66 %, which means that 66% of the GDP variation is explained by the selected independent variables in the model.

- **Model "2": Knowledge Pillars**

To determine which knowledge pillar has the most significant role in growth, the SKEI is replaced by its five sub-indicators. Since the OLS model failed to control for unobserved heterogeneity, a Random Effects Model (REM) was performed as a suitable model based on the Hausman test results. Table "10" represents the estimated random regression outcomes of model "2", where the result shows that the "Education Index" (ED) has a negative and significant relationship with GDP. Access to education in the Arab region has been exposed to a real threat, and youth have suffered as a result of poor educational quality particularly in countries that have witnessed political instability, prolonged conflicts, and humanitarian crises. Moreover, the presence of COVID-19 led to school closures, which affected the education process in the region, where online learning has become popular but Internet access has been restricted and not available in all Arab countries. The obtained results conflict with Palicková (2014), who considered this sub-indicator as one of the main knowledge index pillars, and they can also be explained by the different education levels in the selected sample, as per the findings of Abugamea (2017) and Wang and Liu (2016). Both the Innovation Index (INN) and the "ICT Index" (ICT) significantly increase GDP, confirming the findings of Dahmani et al. (2022); Abdellaoui and Mekhzoumi (2020); and Nour (2019). Economic and institutional regime index (EIR) also affects GDP significantly, and this is consistent with the outcomes of Kraipornsak (2018) and Wang et al. (2022). As a result, the findings confirmed the significance of the three sub-indicators for economic growth.

The results of the Socio-economic Sustainability Index (SUS) that is added to the KEI benchmark index record a positive and significant impact on GDP with a coefficient value of 1.903. This coefficient is the highest compared to the remaining four sub-indicators, and it's strongly significant since it's at the 1% significance level. Thus, it is the pillar with the highest impact on GDP, and this confirms the importance it has gained by being added to the knowledge index.

Labor (L) and growth show an inverse and significant relationship with GDP, similar to Model "1" results, while capital (K) and growth show a positive and significant relationship. Population growth (POP) and GDP have a positive impact. General government final consumption expenditure (GGOV) has lost significance, and foreign direct investment (FDI) has a negative impact on economic growth, same as Model "1". The overall regression F-statistic is highly significant because it recorded a zero value that is less than 0.05, which means that the joint coefficients are statistically significant. R-squared calculated a perfect value of 93%.

5. CONCLUSIONS

There is no doubt that the growing importance of the knowledge economy contributes significantly to economic growth, since knowledge capital is regarded as a key determinant of economic performance and social welfare. Several Arab countries have incorporated knowledge economies into their growth and development strategies, whereas others have achieved

significant progress; however, the transition path to a knowledge economy in Arab countries is still complicated and diverse, relying on economic, social, and political circumstances. The successful transition to a knowledge economy necessitates protracted strategies that include identifying major points of strength and weakness and investing in all knowledge pillars to accelerate development. It is also substantial to convert implicit and tacit knowledge into codified knowledge, which can be done through knowledge sharing, education, and learning by doing (Al-Roubaie, 2013).

The United Arab Emirates is the Arab country that took one of the most significant and progressive steps forward in developing a competitive knowledge-based economy, depending on a comprehensive knowledge and innovation strategy. Saudi Arabia has launched a strategy to transition to a knowledge economy by 2025, including a range of educational reforms such as the development of new universities to enhance science and technology. Jordan has started a major effort to reform the education system at the primary, secondary, and post-graduate levels in order to generate graduates with the qualifications required for the knowledge economy. It has taken steps to become a regional ICT development center. Morocco has created a variety of national plans in several domains, including industry, agriculture, industry, ICT, and tourism, all of which are deeply influenced by a determination to follow a knowledge-based development path (World Bank, 2013).

Nonetheless, despite various reforms implemented in many of these countries, the evolution of the knowledge economy lags behind that of the developed countries, where the steps taken are not enough to keep up with the rest of the world. Today, the urgent diversification of Arab economies is very important, as it is considered a basic requisite to accelerate the transition to a knowledge-based economy.

This study aims to investigate the relationship between the knowledge economy and economic growth in 11 Arab countries using the Sustainable Knowledge Economy Index (SKEI) and knowledge pillars as knowledge measurements and GDP per capita as an economic growth proxy. Since most applied research on this topic focuses on developed countries, this study aims to contribute to the discussion about the knowledge economy and its role in achieving economic progress in developing countries, including the Arab region, where a considerable amount of both theoretical and empirical research is still required to fill this gap in the existing literature.

The empirical results show that there is a significant relationship between the knowledge economy and economic growth, as the SKEI has a positive impact on the GDP. The results also show that economic growth is positively affected by innovation, information and communication technology (ICT), economic and institutional systems, and social and economic sustainability. Education, on the other hand, has a significant negative relationship with GDP, and this can be attributed to the COVID-19 pandemic that has had a negative impact on education. In 2019, more than 16.2 million primary and secondary school-aged children, adolescents, and young people were not attending school (UNESCO, 2020). The statistical results confirm that the social and economic sustainability pillars added to the KEI benchmark have the greatest impact on GDP, underscoring the relative importance of sustainability in the process of knowledge accumulation, as knowledge has the potential to make significant and critical contributions to sustainability in a variety of regions.

Despite a sharp increase in school enrollment in the Arab region between 2000 and 2019 (ASDR, 2020), overall educational development lags behind the global average, and the relationship between education and economic growth has remained weak. These findings are critical for policymakers to develop appropriate policies and strategies that focus on implementing reforms and improving educational quality in order for countries to reach their full potential. Further, this necessitates an increase in the education system's investments, which will have a positive and significant effect on increasing economic output and accelerating economic performance. Also, this is vital for individual and social development because skilled labor is required for knowledge and technology creation and dissemination.

In addition, the preceding findings provide important confirmation of the importance of sustainability. To attain sustainable development and growth, the knowledge framework must explicitly include a pillar related to sustainability with its three dimensions: economic, social, and environmental, since sustainability is regarded as an essential goal and the probable result of

the knowledge economy. A development agenda that prioritizes productive capital while ignoring intellectual and human capital is unsustainable and will not result in long-term economic growth.

The purpose of the study is to investigate the knowledge-growth relationship in the whole sample without classifying the Arab countries into two groups, such as oil-exporting and non-oil-exporting. However, it is suggested to apply a dummy variable in future studies to accommodate the impact of structural differences between the classified groups. Based on the results of previous studies in the literature, the dynamic panel technique can be recommended as an alternative estimation approach for distinguishing the short-run and long-run effects of the knowledge economy on economic growth.

Governments and policymakers in the Arab countries must develop knowledge plans and strategies that enable them to capture the benefits provided by the global knowledge revolution and learn from the successful lessons of top knowledge performers. They have to invest more in their human capital than their natural and physical capital in order to reduce poverty, promote economic development, and provide social welfare for their citizens. Future studies can recognize a longer time period and a broader number of countries to be included in the sample. Furthermore, the study can be repeated by comparing the state of the knowledge economy in Arab countries with the top knowledge countries to see how large the existing disparities are and how Arab countries can benefit from their experiments.

REFERENCES

- Abdellaoui, O. & Mekhzoumi, L. (2020). "The impact of innovation on economic development in Arab countries: The Case of Selected Arab Countries from 2007 to 2016".
- Abdul A. E., & Deb, K. D. (2016). "Information and communication technology and economic growth in India". Telecommunications Policy, 40(5), 412-431.
- Abugamea, G. H. (2017). "The impact of education on economic growth in Palestine: 1990-2014".
- Ahmad Bajwa, I., Ather Elahi, M., Rafi, W., & Ahmad Bajwa, F. (2019). "Oil overdependence and dutch disease, KSA evidence". Management Studies and Economic Systems, 4(3), 213-223.
- Al-Fehaid, Y. N., & Shaili, V. (2021). "Knowledge Economy and its Implications in the Kingdom of Saudi Arabia". Available at SSRN 3846918.
- Al-Roubaie, A. (2013). "Building knowledge capacity for sustainable development in the Arab world".
- ASDR (2020). "Arab Sustainable Development Report, 2020". United Nations publication issued by United Nations Economic and Social Commission for Western Asia ESCWA. Retrieved from: https://www.unescwa.org/publications/arab-sustainable-development-report-2020.
- Bahrini, R., & Qaffas, A. A. (2019). "Impact of information and communication technology on economic growth: Evidence from developing countries". Economies, 7(1), 21.
- Barkhordari, S., Fattahi, M., & Azimi, N. A. (2019). "The impact of knowledge-based economy on growth performance: Evidence from MENA countries". Journal of the Knowledge Economy, 10(3), 1168-1182.
- Bayar, Y. (2014). "Effects of Foreign Direct Investment Inflows and Domestic Investment on Economic Growth: Evidence from Turkey". International Journal of Economics and Finance 6: 69–78.
- Beblawi, H. (2015). "The rentier state in the Arab world. In The Arab State" (pp. 85-98). Routledge.
- Chen, D. H., & Dahlman, C. J. (2004). "Knowledge and Development: Global Trends and a Literature Survey". World Bank Policy Research Working Paper, 3366.
- Chen, D. H., & Dahlman, C. J. (2005). "The knowledge economy, the KAM methodology and World Bank operations". World Bank Institute Working Paper, (37256).
- Cooray, A. V., & Paradiso, A. (2012). "The level and growth effects in empirical growth models for the Nordic countries: A knowledge economy approach". Papers.ssrn.com.
- Dahmani, M., Mabrouki, M., & Ben Youssef, A. (2022). "ICT, trade openness and economic growth in Tunisia: what is going wrong?". Economic Change and Restructuring, 1-20

- Dayan, L. (2005). "Economie de la connaissance et durabilité: Ecoefficience, Attractivité, Durabilité". International Seminar, MAGHTECH, University of Biskra, Algeria.
- Djeflat, A. (2016). "Linking Knowledge Economy and Environmental Performances: Evidence for Arab countries". Oran 2 University Journal, 1(01), 27-48.
- Economic and Social Commission for Western Asia (ESCWA). (2019). "Egypt from stabilization to a knowledge-based economy A computable general equilibrium modelling approach". Ministry of. Retrieved from: https://archive.unescwa.org/publications/egypt-stabilization-knowledge-based-economy
- Economic Outlook Database. (IMF, 2020). [ONLINE] Available at: https://www.imf.org/external/pubs/ft/weo/2020/01/weodata/index.aspx [Accessed 30 November 2020].
- Ejemeyovwi, J. O., & Osabuohien, E. S. (2018). "Investigating the relevance of mobile technology adoption on inclusive growth in West Africa". Contemporary Social Science.
- Elbagory, A. (2018). "The Impact of Research and Development on Economic Growth in Arab Countries". Revue des étudeshumainesetsociales-A/Sciences économiqueset droit. N, 51-63.
- Faudot, A. (2019). "Saudi Arabia and the rentier regime trap: A critical assessment of the plan Vision 2030". Resources Policy, 62, 94-101.
- Fayissa, B., & Nsiah, C. (2013). "The impact of governance on economic growth in Africa". The Journal of Developing Areas, 91-108.
- Hasan, F., & Bousrih, J. (2020). "The Impact of Knowledge Economy on Economic Growth for the Kingdom of Saudi Arabia over the Period 1992-2018". Multi-Knowledge Electronic Comprehensive Journal for Education and Science Publications (MECSJ) ISSUE (29). ISSN: 2616-9185.
- Hvidt, M. (2016). "Challenges to implementing Knowledge-based economies in the Gulf region". Videnscenter om det moderne Mellemøsten.
- International Labor Office (ILO). (2022). "Global employment trends for youth 2022: Investing in transforming futures for young people".
- Khobai, H., Hamman, N., Mkhombo, T., Mhaka, S., Mavikela, N., & Phiri, A. (2018). "The FDI-growth nexus in South Africa: A Re-examination using quantile regression approach". Studia Universitatis Babes-Bolyai Oeconomica, 63(3), 33–55. https://doi.org/10.2478/ subboec-2018-0013.
- Kraipornsak, P. (2018). "Good governance and economic growth: An investigation of Thailand and selected Asian countries". Eurasian Journal of Economics and Finance, 6(1), 93-106.
- Lean, Hooi Hooi, & Bee Wah Tan. (2011). "Linkages between foreign direct investment, domestic investment and economic growth in Malaysia". Journal of Economic Cooperation and Development 32: 75–96.
- Lucas Jr. R. E. (1988). "On the mechanics of economic development". Journal of monetary economics, 22(1), 3-42.
- Mohamed et al., (2022). "Do Knowledge Economy Indicators Affect Economic Growth? Evidence from Developing Countries". Sustainability 2022, 14, 4774. https:// doi.org/10.3390/su14084774.
- Mohammed bin Rashid Al Maktoum Foundation (MBRF) and the United Nations Development Programme/Regional Bureau for Arab States (UNDP/RBAS). (2021) "Global Knowledge Index 2021". Retrieved from:https://www.undp.org/publications/global-knowledge-index-2021.
- Murat, D., Betül, İ. N. A. M., & Güzel, S. (2017). "Relationship between Knowledge Economy Performance Indicators and Selected Macroeconomic Variables: An Application for OECD Countries". Yönetim Bilimleri Dergisi, 15(30), 9-26.
- Nour, S. M. (2019). "Knowledge economy and economic development in the Arab region". Maastricht Economic and Social Research Institute on Innovation and Technology (UNU-MERIT).
- Nowak, A. Z., & Dahal, G. (2016). "The contribution of education to economic growth: Evidence from Nepal". International Journal of Economic Sciences, 5(2), 22-41.
- OECD (1996). "The knowledge-based economy". Retrieved from https://www.oecd.org/sti/sci-tech/1913021.pdf.
- Pala, A. (2019). "Innovation and economic growth in developing countries: Empirical implication of Swamy's random coefficient model (RCM)". Procedia Computer Science, 158, 1122-1130.

- Paličková, I. (2014). "Influence of the knowledge economy on the economic growth and economic level of the countries". World, 2, 26.
- Romer, P. M. (1986). "Increasing returns and long-run growth". Journal of political economy, 94(5), 1002-1037.
- Romer, P.M. (1990). "Human Capital and Growth: Theory and Evidence". Carnegie-Rochester Conference Series on Public Policy, 32, 251-86.
- Samarasinghe, T. (2018). "Impact of governance on economic growth".MPRA_paper_89834.pdf Available: Online at https://mpra.ub.uni-muenchen.de/89834/ MPRA Paper No. 89834, posted 07 Nov 2018 02:25 UTC.
- Solow, R. M. (1956). "A contribution to the theory of economic growth". The quarterly journal of economics,70(1),65-94.
- The International Labor Organization (ILO). July 2019. ILOSTAT. [ONLINE] Available at: https://www.ilo.org/ilostat [Accessed 28 November 2020].
- The World Bank. (2020). "World Development Indicators". [ONLINE] Available at: https://data.worldbank.org/indicator/NY.GDP.PETR.RT.ZS [Accessed 30 November 2020].
- United Nations Conference on Trade and Development (UNCTAD). (2020). [ONLINE] Available at: https://unctadstat.unctad.org/wds/TableViewer/tableView.aspx [Accessed 30 November 2020].
- United Nations Economic and Social Commission for Western Asia (ESCWA). (2020a). "Wealth Inequality and Closing the Poverty Gap in Arab Countries. The Case for a Solidarity Wealth Tax". Distr. LIMITED E/ESCWA/CL2.GPID/2020/TP.9 2 June 2020. Retrieved from: https://archive.unescwa.org/sites/www.unescwa.org/files/publications/files/wealth-inequality-closing-poverty-gap-arab-countries-english_0.pdf.
- United Nations Economic and Social Commission for Western Asia (ESCWA). (2020). "The Impact of COVID-19 on Arab Economies: Trade and Foreign Direct Investment. "Available at: https://www.unescwa.org/sites/www.unescwa.org/files/20-00153-en_impact-covid-19-trade-investment.pdf . ONLINE. [Accessed 30 November 2020].
- United Nations Organization for Education, Science and Culture (UNESCO). (2020). UIS Institute for Statistics. [ONLINE] Available at: http://data.uis.unesco.org/# [Accessed 06 November 2020].
- Utku-İsmihan, F. M. (2017). "Knowledge, technological Catch-Up and economic growth: a dynamic panel data analysis for MENA and Latin America". Working Papers 1146, Economic Research Forum, available at: http://erf. Org. eg/wp-content/uploads/2017/03/Macr_ERF23AC_FatmaIsmihan. Pdf (Acc. Oct. 2003).
- Wang, Y., & Liu, S. (2016). "Education, human capital and economic growth: Empirical research on 55 countries and regions (1960-2009)". Theoretical Economics Letters, 6(02), 347.
- World Bank. (2013). "Transforming Arab Economies: Traveling the Knowledge and Innovation Road".

APPENDIX

Table "1": Summary Statistics for Model "1", using the observations 1:01 - 11:21
(missing values were skipped)

Variable	Mean	Median	Minimum	Maximum	Std. Dev.	Missing obs.
GDP	34142.7	14095.6	3579.35	141635.	33164.6	10
SKEI	0.457065	0.479832	0.0510711	0.755920	0.147675	10
L	6.45139e+06	2.42371e+06	305458.	2.99727e+07	7.52694e+06	10
K	1.00058e+06	495899.	58856.8	7.09338e+06	1.23930e+06	11
POP	3.22712	2.25977	-0.0546155	17.5109	2.74871	10
GGOV	17.4637	17.2605	7.66022	30.0035	4.12100	10
FDI	3.41440	2.17448	-2.76002	23.5374	3.75154	10

Table "2": Summary Statistics for Model "2"

Variable	Mean	Median	Minimum	Maximum	Std. Dev.
ED	.504	0.554525	0	1	.291
INN	.365	0.324432	0	.997	.239
ICT	.491	0.495445	0	.987	.217
EIR	.439	0.489394	-.285	.959	.24
SUS	.491	0.478290	.212	.854	.118

Table "3": Correlation coefficients for Model "1"

Correlation coefficients, using the observations 1:01 - 11:21
(missing values were skipped)
5% critical value (two-tailed) = 0.1291 for n = 231

GDP	SKEI	L	K	POP	GGOV	FDI	
1.0000	0.1687	-0.3912	0.0091	0.6591	0.0241	-0.2253	GDP
	1.0000	0.1263	0.4234	0.0478	0.1418	-0.0748	SKEI
		1.0000	0.4476	-0.3431	-0.2768	-0.1755	L
			1.0000	-0.1923	0.2938	-0.2523	K
				1.0000	-0.1891	0.1206	POP
					1.0000	-0.1895	GGOV
						1.0000	FDI

Table "4": Correlation coefficients for Model "2"

Correlation coefficients											
Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(
(1) GDP	1.000										
(2) ED	-0.089	1.000									
(3) INN	0.034	0.654	1.000								
(4) ICT	0.137	0.650	0.572	1.000							
(5) EIR	0.252	-0.149	-0.248	-0.059	1.000						
(6) SUS	0.296	0.504	0.441	0.485	0.058	1.000					
(7) L	-0.386	0.180	0.086	0.076	0.002	0.084	1.000				
(8) K	0.000	0.353	0.276	0.355	0.002	0.639	0.452	1.000			
(9) POP	0.682	-0.078	-0.148	0.018	0.261	0.146	-0.340	-0.187	1.000		
(10) GGOV	0.030	0.074	0.253	0.176	0.000	0.192	-0.293	0.289	-0.196	1.000	
(11) FDI	-0.198	-0.070	-0.209	-0.182	0.250	-0.080	-0.191	-0.244	0.128	-0.153	1.

Table "5": Heteroscedasticity Test Model "1"

BREUSCH-PAGAN / COOK-WEISBERG TEST FOR HETEROSKEDASTICITY
Variable: Fitted values of wGDP
H0: Constant variance
CHI2(1) = 21.94
PROB > CHI2 = 0.0004
BREUSCH-PAGAN / COOK-WEISBERG TEST FOR HETEROSKEDASTICITY
Variable: Fitted values of lnwGDP
H0: Constant variance
CHI2(1) = 00.89
PROB > CHI2 = 0.3462

Table "6": Heteroscedasticity Test Model "2"

BREUSCH-PAGAN / COOK-WEISBERG TEST FOR HETEROSKEDASTICITY		
Assumption: Normal error terms		
Variable: Fitted values of lnwGDP		
H0: Constant variance		
chi2(1)	=	0.82
Prob > chi2 = 0.3651		

Table "7": Hausman Test for Model "1"

Hausman (1978) specification	
	Coef.
Chi-square test value	126.463
P-value	0

Table "8": Hausman Test for Model "2"

Hausman (1978) specification	
	Coef.
Chi-square test value	1369.86
P-value	1

Table "9": Fixed Effects Regression Results for Model "1"

lnwGDP	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
lnwSKEI	.491	.074	6.65	0	.346	.636	***
lnwL	-.399	.115	-3.48	.001	-.624	-.174	***
lnwK	.063	.083	0.76	.446	-.099	.226	
lnwPOP	.017	.021	0.81	.417	-.025	.059	
lnwGGOV	-.478	.153	-3.12	.002	-.778	-.178	***
lnwFDI	-.031	.011	-2.70	.007	-.053	-.008	***
Constant	16.89	1.299	13.00	0	14.345	19.436	***

Mean dependent var	9.919	SD dependent var	0.955
Overall r-squared	0.474	Number of obs	206
Chi-square	79.525	Prob > chi2	0.000
R-squared within	0.662	R-squared between	0.463

This table reports empirical results from estimating model reports results obtained from fixed-effects (within-groups estimator) method. Standard error of FE estimators is reported in brackets and based on robust standard errors corrected for potential heteroscedasticity and time-series autocorrelation within each country.

**** p<.01, ** p<.05, * p<.1*

Table "10": Random Regression Results for Model "2"

lnwGDP	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
wED	-1.523	.295	-5.17	0	-2.101	-.945	***
wINN	.905	.29	3.12	.002	.337	1.473	***
wICT	.93	.223	4.17	0	.493	1.366	***
wEIR	.315	.164	1.92	.055	-.007	.637	*
wSUS	1.952	.653	2.99	.003	.672	3.233	***
lnwL	-.722	.141	-5.10	0	-.999	-.445	***
lnwK	.599	.207	2.89	.004	.194	1.005	***
lnwPOP	.328	.13	2.52	.012	.073	.584	**
lnwGGOV	-.415	.35	-1.19	.235	-1.1	.27	
lnwFDI	-.199	.031	-6.46	0	-.259	-.139	***
Constant	12.743	1.037	12.29	0	10.712	14.775	***

Mean dependent var	9.930	SD dependent var	0.954
Overall r-squared	0.848	Number of obs	213
Chi-square	26940.190	Prob > chi2	0.000
R-squared within	0.211	R-squared between	0.933

**** p<.01, ** p<.05, * p<.1*