

# Knowledge Economy Modelling in Gulf Cooperation Council

## An Econometric Approach

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### Abstracts

This paper investigates how the governments of the Gulf Cooperation Council countries should make more efforts to transform into the Knowledge Economy. The study explained that some member countries gone far in the field of transition into the Knowledge Economy, but some are at their early stage. Also, the Gulf Cooperation Council countries urgently need to adopt effective policies for the advancement and transition to the Knowledge Economy, each country should allocate a percentage of Gross Domestic Products to encourage entrepreneurship activities, Innovation with research & development and removing the barriers on startup enterprises by establishing and operating as electronic governments, electronic business and electronic commerce to reduce the time of approving a startup business. The study revealed that the Gulf Cooperation Council economies are characterized by the character of the traditional economies, despite they occupy middle ranks according to the knowledge economy index, which is prepared by the World Bank. As these economies still expose a willful desire to move and shift from rentier economies to knowledge economies.

**Keywords:** Knowledge Economy. Innovation. Education. Information & Communication Technology. Economic Incentive Regime.

## 1.0 Introduction

If the Economy Science known as a scarcity science, so 'Knowledge Economy' is known as science of abundance for the reason that the inputs of knowledge and information increase when they are used, according to the law of increasing return to scale, this comes because the increase of inputs leads to the production of higher levels of knowledge.

Knowledge grows rapidly and in a cumulative way, this is why, the Economic Theorists describe Knowledge Economy as the science in which the knowledge is in the core of value-added, Coyle & Quah (2004). At the same time a highly-skilled human capital is considered the most valued assets in the Knowledge Economy, in addition to the advanced technological environment.

Based on the above, the economic advancement (continuity) considers that knowledge creation, dissemination and use, is a focal point in any strategy help promote Sustainable Development. Chen & Dahlman (2006) seen the fact that makes the transition to Knowledge Economy a strategic choice and imperative necessity for all countries. There are some requirements that must be met for the transition from a traditional economy to Knowledge Economy, which are as per Asgeirsdottir (2005):

- Stable macroeconomic policies that give rise to long-term planning.
- Effective employment and training policies that will lead to faster human resource learning and increase knowledge acquisition.
- Competitive policies by adopting a reduction in the technology producing cost, liberalizing telecommunications, opening up the commercial field, and giving way for the foreign investment that depends on modern technologies.

In addition to the availability of the four pillars: Innovation, Information and Communication Technology, Education and Human Capital, Economic Intensive, Institutional Regime and Governance.

On the other hand, Globalization affects the ease in which goods and services move between countries in the transition to the Knowledge Economy.

Gulf Cooperation Council states are trying to diversify their economy to Knowledge Economy. To this effect, Lester Throw argue: " Natural resources have dropped out of the contentious equation. The lack of natural resources may even be an advantage. because the industries we are competing for, the industries of the near future, are all based on brain power". Thus the role of Innovation, research & development and Information and Communication Technology are essential for Knowledge Economy within Gulf Cooperation Council states.

The drive by Gulf Cooperation Council states into the role of the four above pillars in the KE is due to the changes facing the world and the realities within Gulf Cooperation Council states.

The challenges facing Gulf Cooperation Council states are the fluctuating of oil and gas prices which are the source of public budgets revenue generation. The other challenges such as the need for human capital building, creation jobs for the Gulf Cooperation Council citizens and diversification of the economies are evidence to transform their economies into Knowledge Economy. Asan (2017).

### **1.1 Research Problem**

The problem of the research lies in the fact that the economies of Gulf Cooperation Council states are characterized as traditional rentier economies, although it has medium ranks compared to the Arab and Developing Economies, the fact that requires making fundamental changes in the economic structures through diversification of production sources, achieving a transition to Knowledge Economy.

### **1.2 Research Importance**

The research is important because of the importance of the Knowledge Economy which is considered today as a strategic choice for the path of scientific and technical progress to produce knowledge and focus on how to acquire, transfer and consolidate it, and to generate new knowledge based on (Innovation, research & development) due to the Entrepreneurship role of the Knowledge Economy and raising the values of Gross Domestic Products at the governmental and private levels.

### **1.3 Research Methodology**

The research is based on the quantitative and analytical approach using the econometric approach based on building econometric models for the study sample represented by the six countries of the Gulf Cooperation Council in diagnosing the pillars of the Knowledge Economy for years (1995-2015).

### **1.4 Research Hypothesis**

states that each of the four pillars is considered an essential element for making increase in the Value of knowledge economy index, while the decline one of the sub-indexes which knowledge economy index includes is considered as a negative factor facing the other pillars for getting improvement in the knowledge economy index (KEI), so a degree of consistency and harmony should be achieved between these pillars.

## **2.0 Conceptual Framework And Literature Review**

The Knowledge Economy (KE) is the latest stage in the development of societies. P. Druker defined it as an economic system where knowledge -instead of capital, labour-becomes the key asset and a social order where Social Knowledge related inequalities pose the greatest challenge. Zak (2016).

The KE is a concept of economic development in which Innovation (INN) and access to information drive productivity growth. New trends, such as the Internet of things or digitalization, are examples of key elements of the transition towards the KE. Putting in place the key pillars that support KE development is therefore central to achieving long-term competitiveness in the world. European Bank (2019).

(Powell & Spellman) define KE as: Production and services based on intensive knowledge activities that contribute to accelerating scientific and technical progress. The main component of it is to depend on the input of mental capabilities and abilities for high extent, which can produce knowledge that maximizes the value of natural resources and material capabilities. Powell & Snellman (2004). (Leydesdorff) also defined the KE by designing the Triple Helix model is the interaction of the three components, which are the university and research centers, industry and government. The role of the university and research centers is to invent and produce new knowledge, and the techniques necessary to apply them, and to create bases and networks for data and information. While the role of industry is to apply knowledge for improving existing industries, creating new industries as a result of new technology rules and to provide feedback for universities and research centers. The role of government is establishing the necessary policies for intellectual property rights and to regulate the relationships of the institutions and labor market. Leydesdorff (2010).

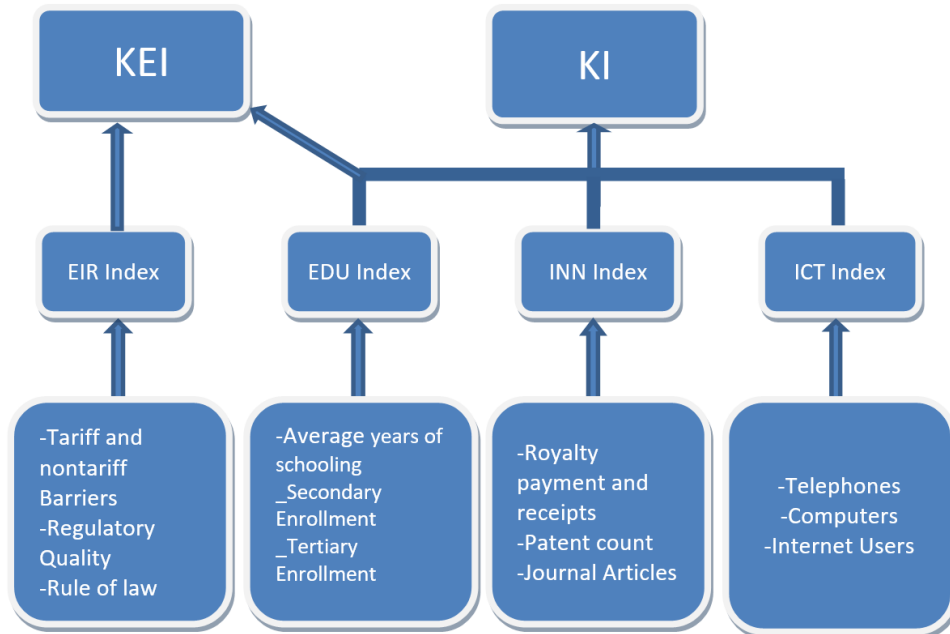
In 1996 the Organization for Economic Cooperation and Development (OECD) declared that "OECD economies are increasingly based on knowledge and information. Knowledge is now recognized as the driver of productivity and economic growth, leading to a new focus on the role of information technology and learning in economic performance. The term, knowledge -based economies, stems from this fuller recognition of the place of knowledge and technology in modern OECD economies".

In 2005 the OECD highlighted that the "knowledge -based economy" described on advanced economies toward greater dependence on knowledge, information and skill and the increasing need for ready access to all of these by business and government. The World Bank (2013).

### **3.0 Knowledge Assessment Methodology (KAM)**

The measurement of knowledge in the economy is a difficult task. The study presents the holistic approach includes one of the available comprehensive methods, KAM developed by the World Bank (WB). The primary assumption of this methodology is that the building of a national KE relies on country's Economic Intensive, Institutional Regime and Governance (EIR), the Education (EDU) and quality of its human capital, an efficient INN system and finally a modern Information and Communication Technology (ICT) infrastructure. Zak (2016).

One of the most frequently used aggregate (holistic) methods measuring a KE is the KAM, developed by the World Bank Institute. Fig. 1 presents its general framework.



**Fig.1.** Knowledge Indexes. Source: <http://www.worldbank.org>

The KAM is comprised of two main indexes, namely the Knowledge Index (KI) and the KEI. Both the indexes are based on four KE pillars which are. Chen & Dahlman (2006):

1. The ICT, which ensures effective communication and data transfer. These aspects facilitate the dissemination and processing of information and data.
2. EDU and Human Resources where the workforce can adapt to constantly improving technological solutions by acquiring of resources and developing adequate skills.
3. The EIR are responsible for improved economic policies and the ways in which institutions operate. The generation dissemination and application of knowledge in these entities are to contribute to more efficient operations by adequate allocations of resources and the stimulation of creativity.
4. The INN system comprising economic entities, Universities, Research Centers, consulting agencies and other organizations, which are able to adapt the needs of increasingly demanding consumer.

The four pillars are supplemented with the need of indicators reflecting the general performance of the economy, which measure the degree to which knowledge is used to boost socio-economic growth. Moreover all the time new variables affecting the KAM indexes are being introduced.

KAM Basic Scorecard is often used, which consists of fourteen index as a measure of the performance of countries in the field of KE according to the four pillars mentioned above, as it appears in the table 1. below:

**Table 1.** The KAM Basic Scorecard

Performance Indicators	Average annual GDP growth (%) Human Development Index.
EIR	Tariff and non-tariff barriers Regulatory Quality Rule of Law.
EDU and Human Resources	Adult Literacy rate (% age 15 and above) Secondary enrollment Tertiary enrollment
INN system	Researchers in research & development (R&D), per million population Patent applications granted by the U.S Patents and Trademarks office (USPTO) per million population Journal Articles per million population.
Information Infrastructure	Telephones per 1,000 persons, (telephone main lines + mobile phones) Computers per 1,000 persons. Internet users per 1,000 persons

Source: The KAM website.

#### 4.0 Estimation of KE functions for the Gulf Cooperation Council (GCC) states

Based on the WB database. <http://info.worldbank.org> for the study sample represented by the six countries for GCC states, The KE function is estimated for each country separately, and KEI represents the dependent variable and the independent variables (ICT, EDU, INN, EIR) and the ordinary Least Squares method(OLS) was used to estimate parameters function In the Minitab program for estimating regression models for KEI for the sample countries. The linear model was chosen in the regression estimation, as it reflects the nature of the true relationship between dependent and independent variables. Goodness of fit was also chosen by the Stepwise included in the program.

The study sample covers six countries within the GCC and for the period (1995-2015) with the exception of Oman Sultanate, as the period (2000\_2015) was approved because of the inconsistency of the growth rates between the two independent variables) EDU, INN) With the growth of KEI during the years (1995-1999), the fact that affected the results of the estimate.

The start and the end of the period were chosen due to the fact that the data prepared by WB according to KAM started in 1995 and it is available until the last update in 2015.

The estimated functions of the sample countries are as follows:

##### 4.1 Bahrain

$$KEI = 1.713 + 0.375 EDU + 0.214 INN + 0.171 ICT$$

T- test 7.01    8.59    11.06    12.31

F-test =388.82

R – sq = 98.6%

R - Sq (adj) = 98.34%

D - w statistic=1.46

INN      EDU

Corr. (pearson) =

EDU -0.443

ICT -0.148    0.785

The value of R-sq(R<sup>2</sup>) for this model shows that 98.6% from changes in KEI in Bahrain attributed to ICT, INN, EDU, and the remaining percentage of 1.4% is due to the influence of other variables which were not included in the model, these were called random variables.

#### 4.2 Qatar

KEI = 0.003 + 0.685 INN + 0.354 EDU

T- test 0.01      7.97      5.92

F - test =43.99

R - sq=79.3%

R - sq (adj) =77.3%

D - W statistic =1.37

Corr. (pearson) of INN and EDU = -0.459

The value of R<sup>2</sup> for this model shows that 79.3% from changes in KEI in Qatar attributed to INN, EDU and the remaining percentage of 20.7% is due to the influence of other variables that were not included in the model which were called random variables.

#### 4.3 Saudi Arabia

KEI = -0.029 + 0.456 EIR + 0.240 INN + 0.284 ICT

T- test    - 0.4      4.56      2.49      6.55

F- test = 258.03

R – sq = 97.9%

R –sq (adj) = 97.5%

D - w statistic =1.73

EIR      INN

Corr. (pearson)

INN -0.624

ICT 0.737    -0.33



The value of R<sup>2</sup> for this model it shows that 97.9% from changes in KEI in Saudi Arabia attributed to INN, EIR, ICT, and the remaining percentage 2.1% was due to the influence of other variables that were not included in the model which are called random variables.

#### 4.4 Kuwait

$$KEI = 1.231 + 0.146 EIR + 0.301 INN + 0.460 EDU$$

$$T\text{-test} = 5.16 \quad 4.68 \quad 7.21 \quad 15.78$$

$$F\text{-test} = 320.34$$

$$R\text{-sq} = 98.3\%$$

$$R\text{-Sq (adj)} = 98\%$$

$$D\text{-w statistic} = 1.87$$

	EIR	INN
Corr. (Pearson) =		
	INN -0.122	
	EDU 0.769	-0.302

The value of R<sup>2</sup> for this model shows that 98.3% from the changes in KEI in Kuwait were attributed to EDU, INN, EIR and the remaining percentage of 1.7% is due to the influence of other variables that were not included in the model called random variables.

#### 4.5 Oman

$$KEI = 2.40 + 0.26 ICT + 0.230 INN + 0.133 EDU$$

$$T\text{-test} = 29.48 \quad 16.64 \quad 2.50 \quad 9.13$$

$$F\text{-test} = 1226.48$$

$$R\text{-sq} = 99.7\%$$

$$R\text{-sq (adj)} = 99.6\%$$

$$D\text{-W statistic} = 2.21$$

	INN	EDU
Corr. (pearson) =		
	EDU 0.741	
	ICT 0.605	0.943

The value of R<sup>2</sup> for this model shows that 99.7% from changes in KEI in Oman Sultanate were attributed to EDU, INN, ICT and the remaining percentage of 0.3% is due to the influence of other variables which were not included in the model and are called random variables.

#### 4.6 United Arab Emirates (UAE)

$$KEI = 4.186 + 0.715 ICT + 0.042 INN - 0.419 EIR - 0.223 EDU$$



T-test 4.30      8.34      1.87      -3.73      -2.26

F- test = 266.37

R- sq = 98.5%

R-Sq (adj) =98.2%

D-W statistic =1.10

EIR      INN      EDU

Corr. (pearson) =

INN -0.742

EDU -0.90      0.581

ICT -0.81      0.717      0.899

The value of  $R^2$  for this model shows that 98.5% from changes in KEI in UAE were attributed to EDU, INN, ICT, EIR and the remaining percentage of 1.5% is due to the influence of other variables that were not included in the model and are called random variables.

After adopting the period (2000-2015) for the UAE and doing the re-estimating the results were as follows:

KEI= -0.429 - 0.338 EDU +1.47 ICT

T- test = - 7.69      - 5.37      14.88

F- test= 374.53

R - Sq= 98.3%

R - sq (adj) = 98%

D - W statistic = 0.87

Corr. (pearson) of EDU and ICT = 0.930

The value of  $R^2$  for this model shows that 98.3% from changes in KEI attributed to EDU, ICT and the remaining percentage of 1.7% is due to the influence of other variables that were not included in the model which are called random variables.

### 5.0 Analysis of the results of the estimated functions of the GCC states.

All the estimated functions passed the statistical tests (adjusted  $R^2$ ,  $R^2$ , F-Test, T-Test) at a significant level (0.05), econometric tests, D-W statistic (Serial Correlation), and Klein test (Multicollinearity).

The value of D-W statistic for KEI reached to the function of (1,10) in Oman, the fact that means that test is inconclusive, so it is not possible to say whether there is serial correlation between the remaining random residuals or not.

The value of D-W statistic reached in UAE (2.21), it is slightly higher than (2) but it is within the limits that do not violate the basic assumptions of the OLS method, so that this method remains appropriate to estimate its coefficients.

- 5.1 KEI depends on INN in six countries within the GCC states, at the top of which comes Qatar with a score of (0.685), this means that the change in the INN index is only one unit, with the fixed of other factors, the fact that leads to a change in the KEI in an amount of (0.685) then after that comes Kuwait in the same context (0.301), Saudi Arabia (0.240), Oman (0.230), Bahrain (0.214) and UAE (0.042) on the same context.
- 5.2 KEI in four countries within GCC states depends on EDU, on the top of which comes Kuwait in estimated amount of (0.460) the fact that means that the change in the EDU index is only one unit with the fixed of other factors which resulted in to a corresponding change in the KEI amount (0.460) and then after that comes Bahrain in the same context (0.375), Qatar (0.354), Oman (0.133), Bahrain (0.214) on the same context.
- 5.3 In four countries within GCC states KEI depends on ICT on the top of which comes UAE in an amount of (0.715) This means that the change in the ICT index is one unit with the fixed of other factors, the fact that leads to a corresponding change in the KEI by a percentage (0.715), then by Saudi Arabia (0.284), then comes respectively Oman in the same context in an amount of (0.260), and Bahrain in the same context in an amount (0.171).
- 5.4 While in two countries within GCC states, KEI depends on EIR on the top of which comes Saudi Arabia in percentage of (0.456) and this means that the change in the EIR index is one unit with the fixed of other factors that leads to a corresponding change in the KEI in a percentage of (0.456) then comes Kuwait (0.146) in the same context.
- 5.5 The INN index is not considered realistically within the states of the GCC, as it appears less than its actual value, because it depends on patents, and trademarks registered under the USPTO registered in the national and international offices outside U.S.A are not included the INN index prepared by WB.
- 5.6 The increase of the ICT indicator value within the GCC states is caused by the high value of the capital invested in preparing the infrastructure and the importation of devices such as main lines telephones and mobile, computers and the Internet, as well as the absence of the information content industry due to the weak efforts of R&D in the digital industries sector, the reason that makes these countries exposed to penetration and information theft. The high value of the ICT indicator in general, does not necessarily mean contributing in knowledge generation, as the communications sector depends on the consumption of knowledge products without any consolidation of the production of these devices and tools on nationwide.
- 5.7 The appearance of the EDU parameter negative sign in the KEI function estimate model for UAE is attributed to the fact that the EDU indicator prepared by WB is concerned with the quantitative aspect such as the number of those who enrolled in schools , secondary education and tertiary education , but it does not address the qualitative level of education requirements of qualified teachers and buildings or scientific laboratories and the extent of compatibility of the curriculums and the extent of compatibility of the graduates with requirements of KEI.
- 5.8 In addition to what was mentioned above, there are challenges facing the EDU system in the GCC states in general and the UAE in particular, the most important of which is

the low perception of EDU and the adoption of traditional teaching methods based on memorization and indoctrination and a lack of orientation towards science specializations, mathematics and engineering. In addition to the weakness of EDU outputs and its inconsistency with the requirements of Tertiary EDU, the fact that force students to spend a rehabilitation (foundation) year before entering university, in addition to the weakness of EDU outputs and not compatible with the labor market.

- 5.9 The emergence of the negative signal in the EIR in the KEI function estimation model for UAE is due to the limited population base of the UAE citizens to accomplish the requirements of sustainable development, the fact that depending on foreign human resources, and this resulted in two problems: disequilibrium in the structure of the demographics and disequilibrium in labor market. Another economic challenge is the continued dependence on oil as a major income (supplier) to the country and the consequence of fluctuations in crude oil prices which causes a fluctuation in the state's oil revenues , and consequently effects the development plans, in addition to the fact that the oil extraction and export industry have low added value knowledge, the same as other economic sectors such as trade, transport and communications (based on the consumption of knowledge products), all of which suffer from a decrease in the added value which leaves a negative impact reflected in the emergence of the negative signal for the EIR.

## 6.0 Conclusion

The governments of the GCC states should make more efforts to transform into the KE. The study explained that some member countries of the GCC gone far in the field of transition into the KE, but some are at their early stage. Also, the GCC countries urgently need to adopt effective policies for the advancement and transition to the KE, each country should allocate a percentage of GDP to encourage entrepreneurship activities, INN with R&D and removing the barriers on startup enterprises by establishing and operating as e - governments, e-business and e-commerce to reduce the time of approving a startup business.

The study concludes with the following recommendations:

- 6.1 Encouraging students to enroll in the Secondary EDU with the scientific and technical branch to prepare the qualifying base to enter the Tertiary EDU with engineering specializations pure science and technical science and to ensure equal opportunities access to all levels of EDU and vocational training after graduation.
- 6.2 Directing economic resources in the GCC states towards the knowledge sectors, corresponds to the volume of resources destined for investment in the building and construction sectors, the development of recreational and tourism facilities, and the construction of sports stadiums and building sports fields.
- 6.3 Establishing specialized centers R&D linked to the ministries of oil, industry and mining, telecommunications, science and technology, agriculture, water resources and others, enhancing the spirit of cooperation between them and the research centers and universities, and exchanging experiences in the field of R&D, and enhancing knowledge industries.

- 6.4 Liberalize the EDU sector especially secondary and tertiary so that foreign institutions can create campuses within the GCC states, there should be important emphasis on institutional foundation of the KE.
- 6.5 Setting an integrated strategic plan to raise the knowledge reality for each of the GCC states that includes accurate diagnosis of strengths and weaknesses, and the development of policies aimed at directing investments and achieving goals and simulations of experiences of knowledge and developing countries (emerging) in the field of knowledge in a way that ensures the optimal investment of available knowledge resources.
- 6.6 Focusing on human resource development, and create apprenticeships programs via enhance learning by doing (work).

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