Global Journal of Economics and Business
Vol. 6, No. 2, 2019, pp. 341- 355
e-ISSN 2519-9293 , p-ISSN 2519-9285

Refaad for Studies and Research
www.refaad.com

# Knowledge Economy and Competitiveness: The Relative Position of Saudi Arabia in 2016 [1]

**Benmbarek Mahmoud**
College Of Economics and Administrative Sciences - AL-Imam Muhammed Ibn Saud Islamic University (IMSIU)- Saudi Arabia
mmbenmbarek@imamu.edu.sa

***Abstract**:* With the global transformation of the world economy, knowledge and information technology become a key factor for the economic competitiveness.

Saudi Arabia realized that the overall national development must be built on knowledge. This requests the establishment of scientific and technical skills and equipment of scientific research, the development of institutional structures and systems, and the investment in human capital. Therefore, it has built a national policy for science and technology and has established strategic plans to join up with the knowledge-based economies.

In this perspective, we pursue through this research to study the impact of the engagement of Saudi Arabia in the knowledge economy (according to the plans and policies related to education and training, scientific research and infrastructure) on its economic competitiveness among a sample of some comparable countries.

As for empirical side, we tried through many indicators of knowledge and competitiveness, to rate Saudi Arabia in a sample of the countries the most dependent on export of fuel commodities. We used statistical methods of multivariate descriptive analyzes (principal component analysis (PCA) and agglomerative hierarchical clustering (AHC) to detect the relative position of the Saudi economy. We developed a typology of the samples on the basis of a set of twelve economic and institutional indicators that reflect the development of the knowledge economy and affect the level of competitiveness. The results proved that Saudi Arabia has to improve institutional development, knowledge infrastructure and innovation capacities to join most competitive economies.

***Keywords:** Knowledge economy, competitiveness, principal component analysis, agglomerative hierarchical clustering, Saudi Arabia.*
***JEL classification**: c38, o30, o57*

## Introduction:

The rapid assimilation of sciences in production systems and the use of knowledge as a productive factor reinforce the interest in what is today called the knowledge economy. As knowledge is essential to achieve efficient operations of production and distribution, it is a source of comparative advantage in the new world economy and there is a growing interest in the contribution of knowledge to competitiveness. In an empirical study, Philip Shapira and al. (2006), after building on a conceptual model of knowledge content, and Through a survey of over 1800 Malaysian firms in 18 manufacturing and services industries, found evidence of Positive associations between technological innovation (as a competitiveness indicator) and knowledge content.

One of the most important features of the development perceived by the Kingdom of Saudi Arabia during the last two decades is the interest in the so-called knowledge society. The signs of transition to a knowledge society are the increasing importance of knowledge and innovation in social and economic performance, and the increasing role of education and training in promoting the global competitive environment in the context of globalization.

[1] The author greatly appreciates the financial support provided by the Sheikh Mohammed Al - Fawzan Macroeconomic forecasting Chair (SMF Chair) at Al-Imam AL-Imam Muhammed Ibn Saud Islamic University (IMSIU), Riadh, Saudi Arabia

According to a theoretical vision, in contrast with traditional growth analyzes based on the external vision of sustainable growth, which limits their explanatory capacity, the new endogenous growth theories provide an explanation of economic growth as an internal growth resulting from the economic behavior. Due to the link between infrastructures, institutions, technical progress and basic scientific research, the role of the state through economic policies as a financier and promoter in this field is an indispensable role. Protagonists of endogenous growth theories consider that the intervention of the state (by providing public services, human resources development and consolidation the institutional framework) has a structural effect (the transition to knowledge economy) that determines the level of long-term development.

## 1. Economic Growth Theory And Knowledge

"Capital consists in a great part of knowledge and organization: and of this some part is private property and other part is not. Knowledge is our most powerful engine of production; it enables us to subdue Nature and force her to satisfy our wants. Organization aids knowledge; it has many forms, e.g. that of a single business, that of various businesses in the same trade, that of various trades relatively to one another, and that of the State providing security for all and help for many" ( Alfred Marshall (1890), Book Four, Chapter 1, Introductory).

In his book titled "the Age of Discontinuity", Drucker (1969) defined knowledge economy as "the use of knowledge to generate economic benefits". He explained the importance of knowledge and the Information and communication Technologies (ICT) industry in advanced economies and its important and increasing role in generating value added. Ever since, writings on the ***knowledge-based economy*** have been frequent, and revolve all around the economy's reliance on knowledge, creativity, innovation and modern technology as key pillars of economic growth.

In his seminal paper “A Contribution to the Theory of Economic Growth”, Robert Solow (1956) presented an analytical framework according to which economic growth is in the long run determined by exogenous technological progress. An essential limit of Solow’s growth theory is the assumption that technological progress is an exogenous factor and cannot be accounted in economic terms. The need to assess the importance of technological progress for sustainable growth, including related investments such as education and R&D, created the motivation for *new growth theories* that have tried to include other variables such as human capital and technological progress in their models as endogenous factors. These new theories defend government action and investment in public goods, in the area of education and infrastructure, which facilitate absorption, diffusion, and use of knowledge and innovation.

The first model of endogenous growth (Romer (1986)) has recognition for the emergence of knowledge as an endogenous economic growth factor: It assumes that knowledge is gained through investment in human capital and learning by doing. Furthermore technological knowledge is considered as an unrestricted commodity[2]. Lucas (1988) integrated human capital as a cumulative element, such as physical capital, and an element that accumulates over time thanks to people's decisions to invest in knowledge and training. He concluded that the degree of richness and poverty among different countries is mainly due to the difference in the length of time deployed for training and education. Romer (1990) concluded that the accumulation of technical knowledge is the engine of economic growth, and that the economy which allocates large proportions of capital to research achieves high growth over the long-run. Barro (1990) analyzed the impact of public infrastructure on private capital and concluded that public investment has a positive impact on private sector

[2] The positive externalities between companies are resulting from the accumulation of physical capital. These external factors arise because knowledge derived from investment and production cannot be fully allocated and acquired by the company that produces them. Investment is the source of learning by doing, which improves productivity not only for the company to invest but also for other companies to benefit from this additional investment in the economy.

productivity. He confirmed that physical capital can only play the desired role by integrating it with human capital[3].
Considering human capital and technological progress as an engine of growth is not a new topic[4]. The ideas of economies of scale[5] and learning by doing[6] came before the contribution of endogenous growth theories to this topic. However, the main growth factors presented by endogenous growth theories have a common feature: they generate positive externalities. The knowledge economy, which consists in creation of added value on the basis of knowledge use, is an economy of such externalities.

## 2. What Is The Knowledge Economy?

For the Organization of Economic Cooperation and Development (OECD), such economy is defined as the economy based on the acquisition, generation and application of knowledge to drive growth and sustain development.The term "**knowledge-based economy**" results from a fuller recognition of the role of knowledge and technology in economic growth. "Knowledge, as embodied in human beings (as "human capital") and in technology, has always been central to economic development" (OECD [1996] p.9).

The World Bank introduced another similar definition, where the knowledge economy was defined as "the economy in which knowledge is generated, transferred and acquired more efficiently to stimulate economic development"[7] .
A knowledge-based economy relies primarily on the use of ideas rather than physical abilities and on the application of technology rather than the transformation of raw materials or the exploitation of cheap labor. Knowledge is being developed and applied in new ways. Product cycles are shorter and the need for innovation greater. Trade is expanding worldwide, increasing competitive demands on producers (World Bank 2003. P.17) .

It is clear from the above definitions that the knowledge economy is based on innovation and technology rather than factual resources. This has deeply changed the view of economics from the science of relative scarceness (rare exhaustible wealth) to the science of knowledge affluence (renewable wealth).

The measurement of knowledge in the economy is not an easy task. Many approaches have been built and many indicators are today adopted to provide a basic scale of countries' readiness for the knowledge economy. We present in the following some empirical indices of knowledge economy.

### 2.1. the Knowledge Index (KI) and the Knowledge Economy Index (KEI)

A well-known approach is the KAM (Knowledge Assessment Methodology) developed by the World Bank Institute in order to facilitate countries trying to make the transition to the knowledge economy. It was designed to provide a basic assessment of countries' readiness for the knowledge economy, and identifies sectors or specific areas where policymakers may need to focus more attention or future investments.

- Economic incentive and institutional regime: strong economic foundations can provide all legal and political frameworks increasing productivity and growth. These include policies making ICT

[3] The process of knowledge accumulation (as a manifestation of human capital accumulation) promotes technological progress through inventions, product innovation and new production processes. Technical progress also has dynamic externalities that make it crucial to long-term growth.
[4]Schultz (1967) and Nelson and Phelps (1966) views the human capital of the workforce as a crucial factor facilitating the adoption of new and more productive technologies
[5]The economic concept dates back to Adam Smith and the idea of obtaining larger production returns through the use of division of labour
[6]The concept of learning-by-doing has been used by Kenneth Arrow (1962) to explain effects of innovation and technical change
[7]Derek H. C. Chen; and Carl J. Dahlman (2005)

more accessible, reducing tariffs on technology products and increasing the competitiveness of small and medium enterprises.

- Education and human resources: skilled and creative labour or human capital (as well as creative skills in educational syllabuses and learning programs) integrates modern technologies into action.
- The innovation system: following the growing knowledge revolution to adapt it to national needs in the light of global environmental changes.
- Information and Communication Technology (ICT): It facilitates the dissemination and processing of information and knowledge, adapting it to local needs to support economic activity and motivating enterprises to produce high value added.

The indicators included in the four pillars of the KAM methodology make up two main indexes: the Knowledge Index (KI) and the Knowledge Economy Index (KEI)[8].

The (KI) is the average of the normalized performance scores of a country in three knowledge economy pillars – the effective innovation system, education and human resources, and information and communication technology (ICT). The calculation of the KI does not take into account the pillar of economic incentives and institutional regime. However**,** The Knowledge Economy Index (KEI) is an aggregate index that represents the overall level of development of a country or region towards the knowledge economy. It represents a country's overall readiness to enter in the knowledge economy and it judges whether the environment is conducive for knowledge to be used effectively for economic development. It is the simple average of the normalized performance scores of a country or region on all four pillars related to the knowledge economy - economic incentive and institutional regime, education and human resources, the innovation system and (ICT) (World Bank [2011]).

The four pillars of the KEI are supplemented with the indicators reflecting the general performance of the economy, which measure the degree of using knowledge to boost socio-economic development. The latest survey conducted by the World Bank in 2012 comprised as many as 148 specific variables (quantitative and qualitative). Due to the difficulties involved in the analysis of all available indicators, however, a basic scorecard was developed. It includes (12) basic indicators reflecting a country's preparedness for a knowledge economy[9].

### 2.2. the global innovation index (GII)

The (GII) is an annual ranking of countries by their capacity for, and success in, innovation. It is published by Cornell University, INSEAD, and the World Intellectual Property Organization (WIPO), in partnership with other organizations and institutions. Its goal was determining how to find metrics and approaches that better capture the richness of innovation in society and go beyond such traditional measures of innovation as the number of research articles and the level of research and development (R&D) expenditures (World Bank (2010)). The GII relies on two sub-indices—the Innovation Input Sub-Index and the Innovation Output Sub-Index— each built around several pillars[10].

The first sub-index of the GII, the Innovation Input Sub-Index, has five pillars: Institutions, Human capital and research, Infrastructure, Market sophistication, and Business sophistication. These pillars define aspects of the environment conducive to innovation within an economy. The second sub-index of the GII, the Innovation output Sub-Index, covers all those variables that are traditionally thought to be the fruits of inventions and/or innovations (patent applications filed by residents; scientific and technical published articles in peer-reviewed journals; property receipts as a percentage of total trade; high-tech net exports as a percentage of total exports; exports of ICT services as a percentage of total trade;…).

[8](www.worldbank.org/kam)
[8] See for example Muhammad Bashir (2013)
[10] GII2017 (https://www.globalinnovationindex.org/gii-2017-report)

## 3. Knowledge And Competitiveness

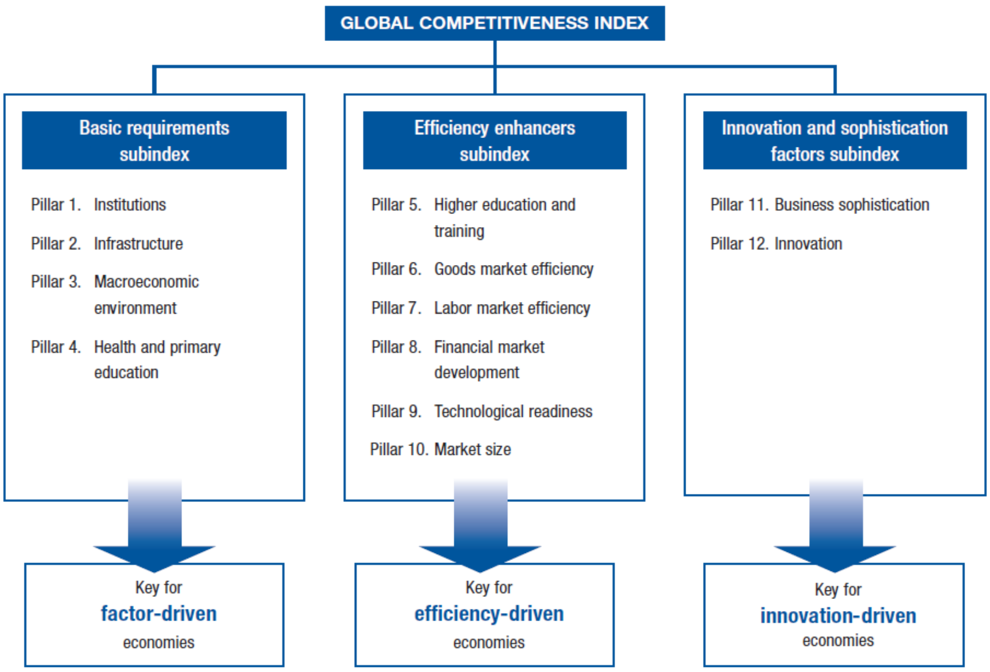
Capacity for innovation is the core of the knowledge economy, and technologies are a source of new competitive advantage. The creation and use of knowledge is important for long run economic growth and applications of scientific findings are essential for global competitiveness. "When a firm, industry, or country acquires a competitive edge, knowledge becomes the basis of a “rent” (income over and above normal profit) that replaces the rents derived earlier from resources and cheap labor." (WB 2007 p.5).

Leadbeater (1999) sustains that our societies should be organized around the creation of knowledge capital and social capital, rather than being conquered by the control of financial capital. He argues for a radical renovation of corporate and government institutions inherited from the industrial era which is inappropriate to the knowledge economy, including new approaches to measuring economic value and social entrepreneurship.

Knowledge influences competitiveness, economic growth, and development as long as it finds concrete applications—in other words, as long as it is at work[11].
Related to knowledge as the driver of competitiveness and productivity, The World Economic Forum (WEF) published annually since 2005 the Global Competitiveness Index (GCI).

### 3.1. the Global Competitiveness Index (GCI)

The last (GCI) issued in 2017 combines 114 indicators that capture concepts that matter for productivity. These indicators are grouped into 12 pillars: institutions, infrastructure, macroeconomic environment, health and primary education, higher education and training, goods market efficiency, labor market efficiency, financial market development, technological readiness, market size, business sophistication, and innovation. These pillars are in turn organized into three subindexes as shown in the following figure




**Figure(1): The Global Competitiveness Index framework**
**Source: World economic forum. The Global Competitiveness Report 2017–2018 (www.weforum.org/gcr)**

[11] (WB 2007. P.6)

It was mentioned in the "Global Competitiveness Report 2017–2018" that improving the determinants of competitiveness, as identified in the 12 pillars of the GCI, requires the coordinated action of the state, the business community, and civil society. All societal actors need to be engaged to make progress on all factors of competitiveness in parallel, which is necessary to achieve long-lasting results.

## 4. Transition To Knowledge Economy And Coompetitiveness In Saudi Arabia

Saudi Arabia's overall performance has enhanced over the years mainly due to several initiatives aimed at creating a knowledge-based economy. A broad national long-term plan for science and technology has been developed and The National System for Science, Technology and Innovation has been constructed. Subsequently, the Kingdom has prepared the National Long-run Plan for Science, Technology and Innovation,(which extends from 2008 to 2025) to be implemented over four five-year plans consistent with the Kingdom's five-year economic and social development plans.This long-run plan gains its importance by mobilizing national scientific and technical resources and capacities for inclusive development and achieving the Kingdom's vision of becoming a knowledge-based economy.

To displays the transition to a knowledge society in Saudi Arabia through the measurement of indicators of science, technology and innovation, a report was issued in 2014 jointly by the Ministry of Economy and Planning in Saudi Arabia, King Abdulaziz City for Science and Technology (KACST), the Communications and Information Technology Commission and Madar Research and Development Center. This report indicates that: With 237 patents The Kingdom was ranked first in the Arab world and ranked 29th in the world in terms of the number of patents granted by the US Patent and Trademark Office (USPTO) in 2013. In that year four Saudi universities realized an important success by entering the Shanghai List for the top 500 universities worldwide, achieving the top four Arab and Islamic positions.

To investigate the recent progress in transition to knowledge-based economy in Saudi Arabia, Samia Satti(2014) used the World Bank framework and definition of Knowledge Index (KI), Knowledge Economy Index (KEI) and its four pillars (economic incentive and institutional regime, education and human resources, innovation system and Information and Communication Technology (ICT) pillars). Her findings " support the hypothesis concerning some progress in transition towards knowledge-based economy in Saudi Arabia. The progress appears from improvement in terms of KI, KEI, ICT pillar, education pillar, economic incentive and institutional regime pillar, innovation efficiency index, knowledge creation index, knowledge impact index, knowledge diffusion index and technological infrastructure, despite deterioration in both innovation pillar and knowledge absorption index" Samia Satti(2014. P.1).

The Global Competitiveness Index (GCI) report (2017-2018) gives a clear idea about the performance released by the kingdom of Saudi Arabia in this area. It mentioned that the country, ranked 30$^{th}$ among 137 countries, has stable institutions (27th), good-quality infrastructure (29th), and the largest market in the Arab world (15th). However Saudi executives see restrictive labor regulations as their most problematic factor for doing business: the labor market is segmented among different population groups, and women remain largely excluded. Another concern is the lack of adequately educated workers: although tertiary enrollment is strong at 63 percent, more efforts are needed to advance the quality of education and align it with economic needs[12].

In comparison with the economies of the Middle East and North Africa (MENA), Saudi Arabia realized recently the best performance in term of global competitiveness.

[12] The Global Competitiveness Report 2017–2018 (p.252)

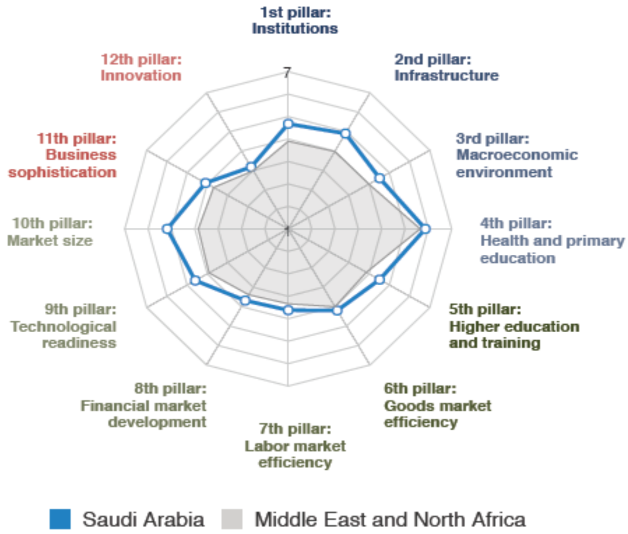



**Figure (2): Performance overview of Saudi Arabia**
**Source: The Global Competitiveness Index 2017-2018 (p.252)**

We argue that knowledge is a multidimensional factor. Therefore it continues to be hard, using the endogenous growth models, to measure the effect of knowledge on economic development and the contribution of knowledge to total factor productivity and competitiveness, which can be affected by other parameters such as the more effective utilization of knowledge incorporated in human capital, social capital and physical capital. In contrast, a more disaggregated set of analytical frameworks and indicators can cast new light on knowledge-based economic performance and its effect on global competitiveness.

## 5. Knowledge And Competitiveness: The Relative Position Of Saudi Arabia In 2016: A Multidimensional Data Analysis

Our drive is to detect the relative position of the Saudi economy in terms of knowledge and competitiveness (among a sample of 20 countries between the most dependent on export of fuel commodities[13]), and to perceive the possible existence of country clubs within this sample.

We attempt to develop a typology of countries on the basis of a set of economic and institutional indicators that reflect the development of the knowledge economy and affect the level of competitiveness. To do this, we use a statistical method of multivariate descriptive analyzes: principal component analysis (PCA) and agglomerative hierarchical clustering (AHC).

The remainder of this section is organized as follows: we present the approach used and the variables considered in the analysis, next we present the results and attempts to classify countries on the basis of the different outputs of the multidimensional statistical analysis methods that we adopt, and draw political conclusions in the light of theoretical ideas and in an endogenous manner according to the characteristics that we will have highlighted for the convergence clubs.

### 5.1. Method and database

The application of multivariate statistical methods has increased considerably. Herein, principal component analysis (PCA) and hierarchical cluster analysis (HCA) are the most widely used tools to explore similarities and hidden patterns among samples where relationship on data and grouping are until unclear (Daniel Granato and al. (2018)).

In order to determine the typologies of the sample of 20 countries among the most dependent on export of fuel commodities[14], in terms of competitiveness and knowledge economy,

[13] See appendix (I )

and to detect the relative position of the Saudi economy in this sample, we have combined the results of two statistical methods covered by multivariate descriptive analyzes: principal component analysis (PCA) and agglomerative hierarchical clustering (AHC).

The (PCA) is a descriptive statistical tool that allows studying simultaneously the relations between the variables and the similarities between the statistical units called individuals. This multidimensional method makes it possible to study and synthesize large masses of information by representing them in a simplified way, usually in a plane (space of dimension two) by deforming at least the initial configuration in the original multidimensional space. Thus, the factorial analysis charts make it possible to identify clusters, oppositions, and trends that cannot be discerned directly on a large data table (the number of variables multiplied by the number of countries).

The classification method (AHC) aims to group individuals into a small number of homogeneous classes in such a way that the individuals in the same class are as similar as possible (in terms of the values taken by the variables characterizing them) and that the classes are as separate as possible. This method is a complement to factorial methods. The classification methods take into account all the factorial axes that are relevant to correctly represent the structure of the variables and individuals in the original space. The problem of a large deformation of the initial structure due solely to taking into account the first two or three axes does not therefore arise with these methods. Moreover, the description of a large number of individuals in homogeneous classes (in the form of a convergence tree) is easier than their representation in a graphical plane.

The choice of these descriptive analytical methods stems from the desire to have a simplified representation of the statistical individuals (countries) without going through the constraint of econometric modeling which often raises the problems of specification and causality between explained and explanatory variables. We want to make a simpler picture of reality rather than simulate relationships. The results provided by the factor analysis methods must be interpreted within the theoretical framework in which they are conducted. The aim of this empirical work is therefore to study the data table (which claims to represent all the dimensions of the knowledge economy) from the point of view of links between variables and similarities between individuals, in order to provide a classification of the latter easy to interpret and rich in terms of prospecting development policies enhancing productivity and competitiveness.

**Database**

For a sample of 20 countries among the most dependent on export of fuel commodities, we use a two-input data table with 20 rows (individuals) and 12 columns (variables). Each individual is described by the values he takes for 12 variables (Var1, ... Var12) chosen to reflect a set of socio-economic criteria that define the general environment of each economy in question[15]. These variables are the main pillars of the Global Competitiveness Index indicated in the global competitiveness report published by the World Economic Forum ( 2017-2018):

Institutions (V1); Infrastructure (V2); Macroeconomic environment (V3); Health and primary education (V4); High education and training (V5);Goods market efficiency (V6); Labor market efficiency(V7);Financial market development (V8);Technological readiness (V9); Market size (V10); Business sophistication: (V11) ;Innovation (V12)

The variables cited above will be noted respectively Var1, Var2, ..., Var12 and the countries will be numbered from 1 to 20.

[14] The data base is presented in appendix I, and the most reliant on oil countries are presented in World bank database (2016). (www.weforum.org/agenda/2016/05/which-economies-are-most-reliant-on-oil/).

[15]there are no standard methods of describing the extent to which an economy is knowledge-intensive or, in particular, of measuring levels or changes in the 'knowledge content' of the various sectors that comprise an economic system. Philip Shapira and all (2006) define knowledge content as "the sum of human capabilities, leadership assets and experience, technology and information capital, collaborative relationships, intellectual property, information stocks, and capabilities for shared learning and utilization that can be used to create wealth and foster economic competitiveness". In this study we adopt the main pillars of the Global Competitiveness Index indicated in the global competitiveness report published by the World Economic Forum ( 2017-2018).

### 5.2. Results of the principal component analysis and classification

To perform a classification of the economies in this sample and detect the relative position of Saudi Arabia, the choice of the statistical tool is based on the Principal Component Analysis (PCA). Following a PCA, the Software, in particular XLSTAT2017 that we have used, provides the following information:

• The correlation matrix of variables

• The eigenvalues associated with each factor axis (edited by the software also as a percentage of the total inertia, thus allowing the cumulative percentages to judge the importance of the reduced space considered for the representation of the sample).

• The eigenvectors: the coefficients of the variables in the linear equations of determination of the principal components. These coefficients are interpreted as the correlations between the variables and the factorial axes and thus allow interpreting the positions of the individuals on the factorial axes by reference to the initial variables of the data table.

• The coordinates of the individuals on the main axes; by observing the distribution of individuals according to the factorial axes or using classification methods, the latter allow the individuals of the sample to be classified into homogeneous subgroups and to be able to interpret the nomenclature observed by reference to the roles of the initial variables in the determination of the principal components.

• Plane graphs to visualize the distribution of individuals according to the chosen factorial axes and to judge their similarities and proximities.

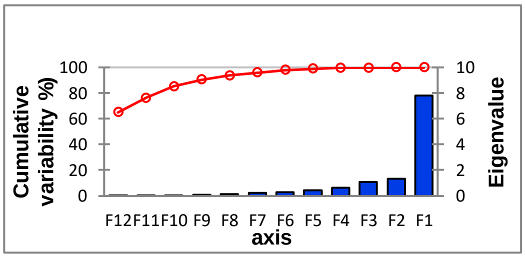
- **Principal Component Analysis:**

In a PCA with reduced centered data, each initial variable, by definition, has inertia equal to one; the total inertia is therefore equal to the number of initial variables. The ratio between each eigenvalue and the sum of the values represents the share of the initial information contained by each factorial axis (or main component). The number of axes chosen to interpret the relative positions of the countries studied depends on the share of information contained in each axis. So we can say that we have to look at the axes until we get an accumulation of information deemed "sufficient". As a general rule, the examination is limited to three or four axes. However, the degressive form of eigenvalues must be taken into account. Generally in PCA, we are interested in the axes for which the share of the information is greater than 1 / number of variables.

**Table(1): Eigenvalues**

| | F1 | F2 | F3 |
|---|---|---|---|
| Eigenvalue | 7.808 | 1.331 | 1.092 |
| Variability (%) | 65.068 | 11.092 | 9.103 |
| Cumulative % | 65.068 | 76.159 | 85.263 |

The analysis of the eigenvalues indicates that the information conveyed by the eleven variables considered in the analysis can be summarized to 85% by the first three axes. More specifically, it can be seen that the first main component explains 65% of the total variance present in the initial data and that the first two components account for almost 76%. The following scree plot resumes this result



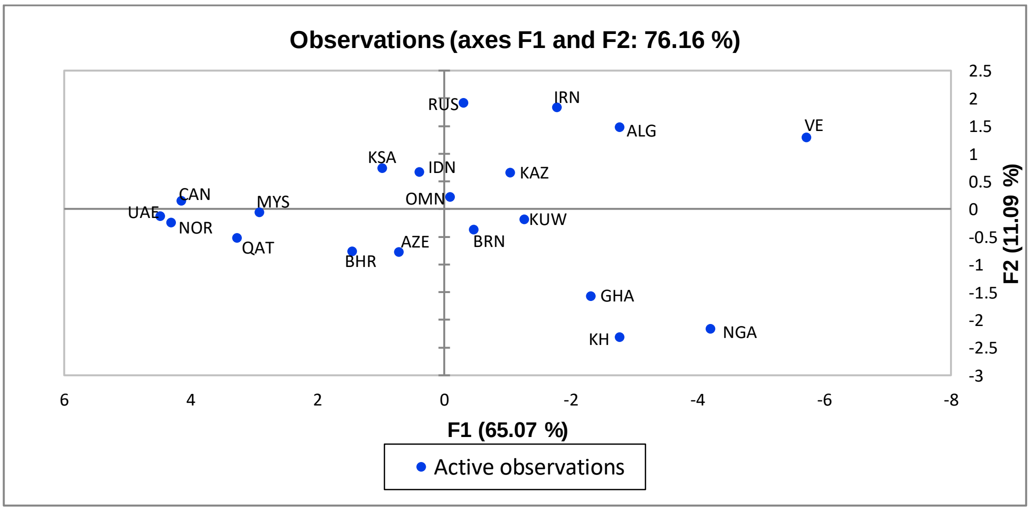

**Figure(3): Scree plot**

To be able to comment on the graphs relating to individuals, it is necessary to interpret the factorial axes or principal components with respect to the initial variables. The composition of the factorial axes is only the result of a linear combination of the original variables. Thus, one of the most important elements allowing interpreting the relative positions of the individuals according to the factorial axes is the information on the relative contribution of the 12 variables of the study in the proliferation of the factorial axes. This information is the subject of the correlation table between the variables and the factors. This matrix of correlation of variables with the factorial axes gives a clear idea of the composition of the latter and allows interpreting the relative positions of individuals (countries) in the light of their proximities to the factorial axes chosen to represent them.

**Table(2): Correlations between variables and factors: Factors loading**

| | V1 | v2 | v3 | V4 | V5 | V6 | V7 | V8 | V9 | V10 | V11 | V12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| F1 | 0.931 | 0.916 | 0.756 | 0.734 | 0.599 | 0.924 | 0.725 | 0.835 | 0.882 | 0.094 | 0.94 | 0.941 |
| F2 | -0.06 | 0.256 | 0.107 | 0.354 | 0.631 | -0.266 | -0.468 | -0.313 | 0.069 | 0.556 | -0.157 | -0.019 |

The representation of individuals takes place in Euclidean planes or images whose axes are the most interesting main components. We are primarily interested in the plan generated by axes I and II. It is actually the plan that synthesizes the maximum information; it is called the main plane or (plane1_2). According to the share of information explained by this plane (76.15%) it is not very instructive to examine others.




**Figure(4): First Plan of (PCA)**

The following table gives an idea about the significant contribution of the variables in determining the principal components

**Table(3): Squared cosines of the variables**

| | V1 | v2 | v3 | V4 | V5 | V6 | V7 | V8 | V9 | V10 | V11 | V12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| F1 | **0.867** | **0.839** | **0.572** | **0.539** | 0.359 | **0.853** | **0.525** | **0.698** | **0.778** | 0.009 | **0.883** | **0.885** |
| F2 | 0.004 | 0.065 | 0.011 | 0.125 | **0.398** | 0.071 | 0.219 | 0.098 | 0.005 | 0.309 | 0.025 | 0 |

**Values in bold correspond for each variable to the factor for which the squared cosine is the largest**

From the last table, and according to the contribution of the variables of the study to the proliferation of principal components, the first factorial axis can be titled axis of knowledge economy and competitiveness. The second axis represents mainly the market size.

The distribution of individuals on the principal plane shows at first sight a polarization of the sample studied at least in two convergence clubs. It is also clear that countries in the left side of the first axis (which can be named the knowledge and competitiveness axis) form together a club of convergence. The other countries lagged along this axis form the second group.

The factorial plan clearly shows the proximity and distance relationships between individuals. Indeed, if the representative points of two individuals are close to one another in a plane, this means that these two individuals have almost the same characteristics in relation to the variables most correlated with the main components defining the plan in question. On the other hand, two points that are distant from each other along an axis have antagonistic characters according to the variables defining the axis. The nearest countries to Saudi Arabia in this plane are Bahrain, Azerbaijan and Indonesia.

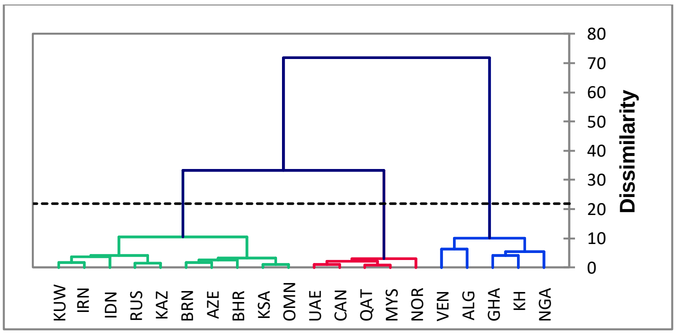
As already mentioned above, the classification methods are a complement to the factorial method. They are a means of grouping individuals into a restricted number of homogeneous classes so that the individuals of the same class are as similar as possible and the classes are as separate as possible.

### 5.3. Classification analysis (Agglomerative hierarchical clustering (AHC))

The classification methods take into account all the factorial axes that are relevant to well represent the structure of the variables and individuals in the original space. The problem of deformation of the information due to the consideration of only the first two or three factorial axes during the PCA does not therefore arise with the classification method.

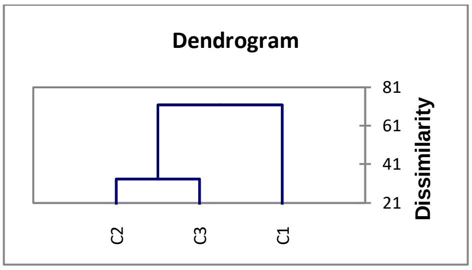
The agglomerative hierarchical clustering (AHC) method we adopt produces a series of partitions containing increasingly larger classes; it consists in grouping the two most similar individuals, then the next two, and so on until there is only one class. A hierarchical tree represents this sequence of partitions. The study of the form of the tree makes it possible to acquire knowledge of the probable number of classes in the set of individuals. The height of the jumps between two cutouts is particularly important. This prior knowledge therefore makes it possible to guide the choice of the optimum number of classes, which may be apriori inspired by the main plan of the (PCA).

The graph below is the dendrogram. It clearly shows how the algorithm proceeds to group the individuals and then form the subgroups.




**Figure(5): Dendrogram**

The algorithm gradually regrouped all the observations. The dashed line in the figure above represents the automatic truncation if one does not a priori lay down the number of classes desired, and makes it possible to visualize that three homogeneous groups have been identified for this sample




Automatically, the XLSTAT software has identified three group of countries in light of the data table: the first group contains 10 countries, the second group and the third group contains 5 countries each. We note that the homogeneity is not strong within the first group. The relative heterogeneity of this group, as shown by the dendrogram, makes it possible to adopt a less aggregated truncation and to choose the grouping of countries in a larger number of groups.


**Figure(6): The countries groups**

This clustering of each country to the group to which it is assigned may be reused for further analysis or interpretation of the structural characteristics of each group.

The effort exerted by the Kingdom of Saudi Arabia in the way of the knowledge society has led to results in terms of competitiveness compared to oil-related countries. The Kingdom's belonging to the second group of the studied sample based on the pillars of the overall index of competitiveness is an evidence of the ovaries of efforts in the fields of knowledge economy. Saudi Arabia is in a relatively good position in the sample of countries most dependent on export of fuel commodities. However, it stills at a distance from other countries in the first group, such as Norway and Malaysia, which had invested more in the knowledge economy and thus achieved a good competitiveness. From the table that represents correlations between variables and factors, we see that Saudi Arabia has to invest more in institution, knowledge infrastructure, and innovation to improve knowledge economy achievement and competitiveness.

## 6. Conclusion:

The principal component analysis (PCA)and the agglomerative hierarchical clustering (AHC) are two descriptive analysis methods used in this paper to view the relative position of Saudi economy in term of knowledge and competitiveness. The description of the comparative situation of the Saudi Economy, in view of the twelve variables in the study, confirms that Saudi Arabia is in a relatively medium position in the sample of countries most dependent on export of fuel commodities. In comparison with the economies of the Middle East and North Africa (MENA), Saudi Arabia realized the best performance in term of global competitiveness. However, within a sample of most competitive countries it doesn't relief good performance in term of knowledge economy and competitiveness.

The results confirm that Saudi Arabia has to use its considerable wealth to improve institutional development, knowledge infrastructure and innovation capacities to join the most competitive developed economies.

The transition to a knowledge economy is not defined by any particular set of emerging technologies themselves, but rather by the transition to new systems that built on new institutions, on knowledge and on the infrastructure of the digital revolution. Therefore, the sustainability of a such economy requires the promotion of investment in some areas[16] where return in the short term can be low, so the state needs to support the economic policy that reach a knowledge-based economy.

The improvement of technological infrastructure, economic incentive and institutional regime, innovation efficiency, knowledge creation, knowledge absorption, knowledge impact, and knowledge diffusion, are therefore the main goals of the long run development plan in Saudi Arabia.

## References:

[1] Aghion, P & Howitt, P., A Model of Growth Through Creative Destruction, Econometrica, 60(2) (1992), 323-351, https://doi.org/10.2307/2951599

[2] Alfred Marshall, Principles of Economics, (http://oll.libertyfund.org/titles/marshall-principles-of-economics-8th-ed), (1890)

[3] Arrow Kenneth .J. (1962), The Economic Implications of Learning by Doing, The Review of Economic Studies, 29(3)(1962), 155-173, https://doi.org/10.2307/2295952

[4] Barro. R.G., Government Spending in a Simple Model of Endogenous Growth. Journal of Political Economy, 98(1990), 103-125.

[5] Charles, W. Leadbeater, Living On Thin Air: The New Economy, Penguin Books Ltd, (1999)

[6] Charlie Leadbeater, Living on Thin Air – The New Economy. Published by Penguin Group, 27 Wrights Lane, London, (1999)

[7] Derek. H. C. Chen & Carl, J. Dahlman., The Knowledge Economy, the KAM Methodology and World Bank Operations, The World Bank ,Washington DC 20433, (2005) P.4

[8] Daniel Granato, Jânio S. Santos, Graziela B. Escher, Bruno L. Ferreira, & Rubén M. Maggi, functional properties in foods: A critical perspective, Trends in Food Science & Technology 72(2018), 83-90

[9] Drucker. Peter. F., The Age of Discontinuity. Guidelines to Our Changing Society. Butterworth-Heinemann, (1969)

[10] Grossman. Gene. M & Elhanan, Helpman, Endogenous Innovation in the Theory of Growth, Journal of Economic Perspectives, 8(1)(1994), 23-44, https://doi.org/10.1257/jep.8.1.23

[11] King AbdulAziz City for Science and Technology (KACST), (2014).

[12] Muhammad Bashir, Knowledge Economy Index (KEI) 2012 Rankings for Islamic Countries and Assessment of KEI Indicators for Pakistan, International Journal of Academic Research in Economics and Management Sciences, 2(6)(2013), https://doi.org/10.6007/ijarems/v2-i6/439

[13] OECD.(1996), The Knowledge-Based Economy, pp.9.

[16] Investment in human resources, technology of information and communication, and research and development are fundamental pillars of the knowledge-based economy.

[14] Organization for Economic Co-operation and Development, the knowledge-based economy". Paris (1996). (https://www.oecd.org/sti/sci-tech/1913021.pdf)

[15] Philip Shapira, Jan Youtie, K. Yogeesvar & Zakiah Jaafar, Knowledge economy measurement: Methods, results and insights from the Malaysian Knowledge Content Study. Research Policy 35(10) (2006), 1522–1537, https://doi.org/10.1016/j.respol.2006.09.015

[16] Porter. M.E., The Competitive Advantages of Nations. London, Macmillan Press, (1990)

[17] Richard. R .Nelson & Edmund. S. Phelps., Investment in Humans, Technological Diffusion, and Economic Growth. The American Economic Review, 56(1_2)(1966) 69-75.

[18] Robert. M. Solow, A Contribution to the Theory of Economic Growth, The Quarterly Journal of Economics, 70(1)(1956), 65-94.

[19] Romer. Paul M , Increasing Returns and Long-Run Growth, The Journal of Political Economy, 94(5) (1986), 1002-1037, https://doi.org/10.1086/261420

[20] Romer, Paul. M (1990). Endogenous technological change. Journal of Political Economy, 98(5), Part 2, S71-S102.

[21] Samia. Satti, Prospects for transition to a knowledge-based economy in the Arab region, World Journal of Science, Technology and Sustainable Development, 11(4)(2014), 256-270, https://doi.org/10.1108/wjstsd-07-2014-0017

[22] Samia. Satti, Transition to knowledge-based economy in Saudi Arabia, UNU-MERIT Working Paper, (2014).

[23] Schultz. T, The Economic Value Education. New York: Columbia University Press, (1967)

[24] World bank. WBI Development Studies; Building Knowledge Economies, Advanced Strategies for Development,(2007)

[25] World Bank, Innovation Policy: A Guide for Developing Countries. Washington, DC. Jean-Eric Aubert (editor), (2010)

[26] World Bank, Lifelong Learning in the Global Knowledge Economy: Challenges for Developing Countries,(2003), https://doi.org/10.1596/978-0-8213-5475-9

[27] World Economic Forum . Global Competitiveness Report (2017–2018).

# Appendix

**Table(1): Database (sample of oil-dependent countries)**

| | Country | GCI | V1 | V2 | V3 | V4 | V5 | V6 | V7 | V8 | V9 | V10 | V11 | V12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Algeria (ALG) | 4.07 | 4.4 | 3.6 | 3.6 | 4.6 | 5.8 | 4 | 3.6 | 3.3 | 3.4 | 4.8 | 3.3 | 2.9 |
| 2 | Azerbaijan (AZE | 4.69 | 4.6 | 4.5 | 4.8 | 5.7 | 4.5 | 4.8 | 5 | 3.8 | 4.6 | 4 | 4.4 | 4 |
| 3 | Bahrain (BHR) | 4.54 | 5 | 5.1 | 4 | 6.2 | 5 | 5 | 4.6 | 4.3 | 5.6 | 3.3 | 4.5 | 3.6 |
| 4 | Brunei (BRN) | 4.52 | 4.4 | 4.3 | 5.1 | 6.3 | 4.5 | 4.3 | 4.4 | 3.7 | 4.5 | 2.9 | 3.7 | 3.2 |
| 5 | Cambodia (COL) | 3.93 | 3.4 | 3.1 | 4.6 | 5.3 | 2.9 | 4.2 | 4.4 | 4.1 | 3.4 | 3.4 | 3.6 | 2.9 |
| 6 | Canada (CAN) | 5.35 | 5.4 | 5.7 | 5.1 | 6.6 | 5.8 | 5.2 | 5.4 | 5.4 | 5.9 | 5.4 | 5 | 4.7 |
| 7 | Ghana (GHA) | 3.72 | 4 | 3.3 | 2.6 | 4.5 | 3.7 | 4.3 | 4.3 | 3.8 | 3.6 | 3.8 | 4.1 | 3.4 |
| 8 | Indonesia (IDN) | 4.68 | 4.3 | 4.5 | 5.7 | 5.4 | 4.5 | 4.6 | 3.9 | 4.5 | 3.9 | 5.7 | 4.6 | 4 |
| 9 | Iran (IRN) | 4.27 | 3.7 | 4.4 | 5.2 | 6 | 4.7 | 4 | 3.3 | 3 | 3.6 | 5.2 | 3.7 | 3.3 |
| 10 | Kazakhstan(KAZ) | 4.35 | 4 | 4.2 | 4.2 | 5.9 | 4.6 | 4.3 | 4.6 | 3.3 | 4.6 | 4.5 | 3.6 | 3.2 |
| 11 | Kuwait (KUW) | 4.43 | 4 | 4.3 | 5.6 | 5.6 | 3.9 | 4.2 | 3.6 | 4.1 | 4.3 | 4.4 | 4 | 3 |
| 12 | Malaysia (MYS) | 5.17 | 5 | 5.5 | 5.4 | 6.3 | 4.9 | 5.1 | 4.7 | 5 | 4.9 | 5.1 | 5.1 | 4.7 |
| 13 | Nigeria (NGA) | 3.3 | 3.2 | 2 | 3.5 | 3 | 3.1 | 4.1 | 4.6 | 3.7 | 3 | 5 | 3.7 | 2.8 |
| 14 | Norway (NOR) | 5.4 | 5.8 | 5 | 6.6 | 6.6 | 5.9 | 5 | 5.1 | 5.2 | 6.1 | 4.4 | 5.4 | 5 |
| 15 | Oman (OMN) | 4.31 | 5 | 4.9 | 4.7 | 5.9 | 4.4 | 4.5 | 3.5 | 4.2 | 4.5 | 4.1 | 4 | 3.3 |
| 16 | Qatar (QAT) | 5.11 | 5.6 | 5.8 | 5.9 | 6.2 | 5 | 5.2 | 4.9 | 4.7 | 5.4 | 4.4 | 5 | 4.7 |
| 17 | Russia (RUS) | 4.64 | 3.7 | 4.9 | 5 | 6 | 5.1 | 4.2 | 4.3 | 3.4 | 4.5 | 5.9 | 4 | 3.5 |
| 18 | Saudi Arabia(SAU) | 4.83 | 5 | 5.2 | 4.9 | 6 | 4.9 | 4.6 | 4.1 | 4.2 | 4.9 | 5.4 | 4.5 | 3.7 |
| 19 | United Arab Emirates (UAE) | 5.3 | 5.9 | 6.3 | 5.6 | 6.3 | 5 | 5.6 | 5.2 | 4.8 | 5.8 | 4.9 | 5.3 | 4.6 |
| 20 | Venezuela (VE) | 3.23 | 2.2 | 2.6 | 2.4 | 5.3 | 4.6 | 2.8 | 2.7 | 3.1 | 3 | 4.4 | 3 | 2.6 |

**Source : prepared by the author from the global competitiveness report (2017-2018). The world economic forum**