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The Role of
THE KNOWLEDGE ECONOMY
in the Economic Growth and Transformation
in Gulf Cooperation Council (GCC) Countries:
AN EMPIRICAL EVALUATION



WASD
WORLD ASSOCIATION FOR
SUSTAINABLE DEVELOPMENT



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Abstract

Purpose

Vision statements of current development strategies of GCC countries make clear that transformation into a knowledge-based economy is the developmental goal to be achieved in the next two decades. GCC countries are trying to transform from oil-dependent to knowledge-based diversified economies, utilising available financial capabilities. This paper assesses the role of the knowledge economy in GCC countries, and empirically tests the influence of the knowledge economy on economic performance and diversification.

Design/Methodology/Approach

The paper adopts econometric modelling based on panel data regression to achieve its objectives. The paper uses indicators related to economic performance, production and export structures to evaluate the effects of knowledge economy indicators during the period 2000-2015.

Findings

The paper finds that increasing investment in the knowledge economy improves economic performance, enhances diversification, and fosters structural transformation in GCC economies.

Originality/Value

Given the little literature that provides systematic empirical evaluation for the role of the knowledge economy in economic performance and transformation in GCC countries, the paper contributes to the literature by adopting statistical testing and panel data regression analysis to evaluate GCC countries' experience in this area of investigation. While most of the previous literature on the topic offers general descriptive evaluation of these effects, focusing on some aspects of the knowledge economy on GCC countries in the short term, the current paper pays more attention to long-term challenges facing these countries related to economic transformation and diversification.

Research limitations/Implications

The results of the paper lend strong support to the role of the knowledge economy in economic growth performance, in particular investment in increasing the quantity and quality of human capital. Moreover, investment in the knowledge economy will increase manufacturing and high technology exports and, in turn, increase diversification and foster structural transformation in GCC countries. The results of the paper are applicable to those countries with the same economic and export structures. The main limitation faced in the study was the lack of disaggregated data on economic activities in all countries in the GCC region.

Keywords

knowledge economy; the GCC; empirical;
economic growth; diversification; innovation.

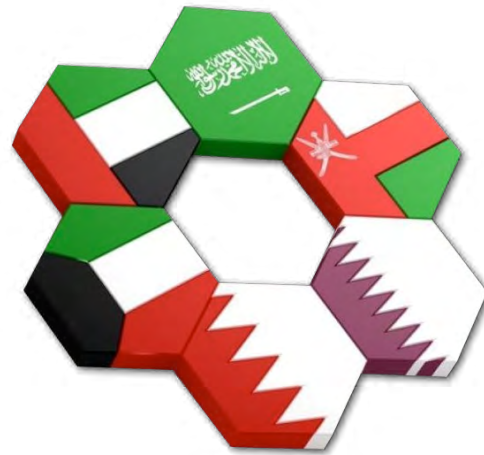
Introduction

In the era of globalisation, many countries needed to adjust their national strategies and plans to build knowledge-based economies. Focus was directed to the promotion of human capital, innovation, specialised training and competitiveness as basic requirements for sustainable economic growth driven by the knowledge economy. At present, knowledge-based activities represent more than 50% of the GDP of developed countries. Many government institutions have been built world-wide to serve this purpose.

GCC countries articulated their long-term visions for economic development on the basis of the knowledge economy. They invested heavily in human capital, sciences, technology, renewable energy and Information and Communications Technology (ICT). The GCC states, such as Kuwait, Qatar and the UAE, have set targets to increase their R&D expenditure. Some GCC countries have created an enabling environment to promote sciences, technology and innovation, and have achieved high rankings in international indices of comparative performance. GCC economies are trying to transform from oil dependent to knowledge-based diversified economies, taking advantage of their financial capabilities.

Despite good progress in building a knowledge-based economy compared to other countries in the region, GCC countries are still facing many challenges to transform their countries into knowledge-based economies. These include high fluctuation of oil prices, lack of diversification, high population growth, and high rate of youth unemployment. Moreover, economic activities in these countries are mainly driven by high government spending from oil revenues. GCC countries lack stable economic growth and the ability to create good quality jobs due to the existence of a weak private sector and failure of the large stagnant public sector to solve the problem of disguised unemployment.

GCC countries are investing in the knowledge economy to introduce changes in economic structures; this is to improve productivity and diversify exports from primary products to high technology exports. They have adopted economic



policies to promote a knowledge-based economy through increasing investment in education, improving innovation systems, building a high quality ICT infrastructure and systems, and adopting more open economies.

Given the little literature that provides a systematic empirical evaluation for the role of the knowledge economy in economic growth and transformation in the Middle East and North Africa (MENA) region in general and the GCC in particular, this paper contributes to the literature by adopting statistical testing and panel data regression analysis to evaluate the GCC countries' experience in this area of investigation. While most of the previous literature on the topic offers a general descriptive evaluation of these effects, focusing on some aspects of the knowledge economy in GCC countries in the short term, the current paper pays more attention to long-term challenges facing these countries related to economic transformation and diversification. Moreover, the paper assesses the current status of the knowledge economy in GCC countries and compares it to other regions; it then discusses the level of public expenditure on the knowledge economy.

The paper begins with an introduction, followed by a literature review in the second section. It describes the economic structure of GCC countries in the last four decades in the third section, and assesses the state of the knowledge economy in GCC countries using descriptive statistics in the fourth section. In the fifth section, it presents the empirical analysis, and the final section concludes the research.

Literature Review on the Knowledge Economy in GCC Countries

The Austrian writer Peter Drucker (1969) was possibly the first author to use the term 'knowledge economy' in his book *The Age of Discontinuity*: he also invented the term "knowledge worker" in the late 1950s. Human capital has been cited consistently in international reports as a fundamental aspect of development; a trained adaptable workforce that uses critical and analytical thinking skills in knowledge-based economic activities plays a decisive role (Lundvall, 1998).

Tadros (2015) investigated the opportunities and challenges facing the Arab Gulf States in establishing knowledge-based economies. He found that these countries face several challenges, including fluctuating oil and gas prices and lack of economic diversification. He noticed that these countries need to build up human capital and create jobs for GCC nationals to enable them to embark on knowledge-based economic development. However, his study relies on descriptive and analytical approaches, and does not use empirical research to support the findings.

In respect of the World Bank's four pillars of the knowledge economy (i.e., economic and institutional systems, education and skills, information and technology infrastructure, and innovation systems), Hvidt (2015) found that the Gulf States have not only fallen behind in international comparison but were also underperforming in the two pillars of education and innovation in relation to their ample GDPs. However, the mentioned paper has not tried to test the findings empirically.

Weber (2011) stated that education in the Arabian Gulf (GCC states) has been developing since the early 1990s to fulfil several specific roles: ending illiteracy, diversification of hydrocarbon-based economies, and preservation of cultural integrity. Aubert and Reiffers (2003) pointed out that Arabic-speaking nations have not met

their own goals for education; this hampered innovation both directly and indirectly through failure to produce knowledge workers who, in turn, generate new income-producing knowledge products, processes, and patents. Moreover, despite improvements in the gross enrolment ratios, the education system has been unable to overcome illiteracy and train enough engineers and scientists" (Aubert and Reiffers, 2003). Coury and Dave's (2010) analysis showed that severe implementation issues in the education, labour and trade sectors, as well as fundamental weaknesses in the GCC economic structure, had negatively affected economic diversification during the period 1985-2005.

The current paper will evaluate the state of the knowledge economy in GCC countries and relate it to economic performance and transformation. It will do this using sets of different economic indicators and statistical methods, hoping to arrive at credible and reliable results in this area of investigation.





Economic Structure and Performance of GCC Economies

Continuous changes in economic structure are important for achieving technological changes and sustaining economic growth in the long term in developing countries. Structural transformation leads to the emergence of new dynamic sectors that act as engines of economic growth, leading to greater diversification of economic activities. Different sectors use different levels of technology that affect the level of the knowledge-based economy in the country. In this section, we will describe the changes in the production structure of GCC countries in the last three decades and compare them with other developing countries. The speed of transformation to the knowledge-based economy in GCC countries depends on the characteristics of the existing structures.

Economic structures of the GCC countries reflect a lack of diversification and concentration of economic activity in the industrial and services sectors, with low contributions from the manufacturing sector in the GDP value added of these countries: oil activities are the driving force of economic activity. Fluctuations in oil prices to have a profound impact on the GCC's economic performance. The decline in oil prices in 2014-2015 resulted in a loss of US\$300 billion of oil revenues in these countries, and current account surpluses fell from 16% of GDP in 2014 to 1.6% of GDP in 2015. Moreover, average GDP growth rate continued to decline, reaching 2.7% in 2016; a government surplus of an average of 4.6% of GDP turned to a deficit of 6.3% of GDP in 2015.

Changes in GDP Structure of GCC Countries (1975-2015)

The share of the industrial sector in Saudi Arabia fell from 71.8% in 1975 to 45.9% of the GDP value added in 2015. Similarly, the share of this sector decreased in Oman from 77.5% to 53.9% in the same period, in Kuwait from 61% in 2010 to 51% in 2015, and in Bahrain from 45% to 40.2% in the same period. In general, the contribution of this sector began to decline in the oil-exporting countries in recent years compared to its contribution in the 1970s and 1980s. Globally, the share of the industrial sector in the GDP value added declined from an average of 33.5% in 1995 to an average of 28.7% in 2010.

However, the share of the services sector value added in GDP of the world economy increased

from an average of 58.4% in 1995 to an average of 67.3% in 2010. GCC countries are not an exception. The share of this sector increased in Kuwait from 38.5% in 2010 to 48.3% in 2015, in Bahrain from 50.4% in 1985 to 59.4% in 2015, and in Saudi Arabia and Oman from 27.2% and 19.7% in 1975 to 51.8% and 47.4% in 2015 respectively.

By contrast, the share of the agricultural sector in GDP value added of the world economy fell from an average of 8% in 1995 to an average of 3.9% in 2010. The sector contributed a mere 2.3% in 2015 in Saudi Arabia, 1.6% in Oman, and to less than 1% in the remaining GCC countries in the same year; this was due to a lack of water and agricultural resources.



Value added in the manufacturing sector

Changes in the share of the manufacturing sector in the GDP value added over time are regarded as a sign of structural transformation in the economy of the developing country. The share of this sector in the MENA region decreased slightly from 15.7% in 1995 to 13.9% in 2010. However, the share of this sector as a percentage of GDP increased in Saudi Arabia from 9.6% to 12.3%, in Oman from 4.7% to 9.7% in the same period, and in Kuwait from 5.5% in 2010 to 6.2% in 2015. However, the share of this sector fell from 12.5% to 9.7% in Qatar in the same period.

Figure 1 shows the GDP value added in the various production sectors in Saudi Arabia as a model for the composition of economic structure in the GCC states during the period 1975-2015. The figure shows the concentration of economic activity in the industrial and service sectors, and the low contribution of the manufacturing sector in the country's GDP; this indicates the weakness of structural transformation and economic diversification in GCC countries.

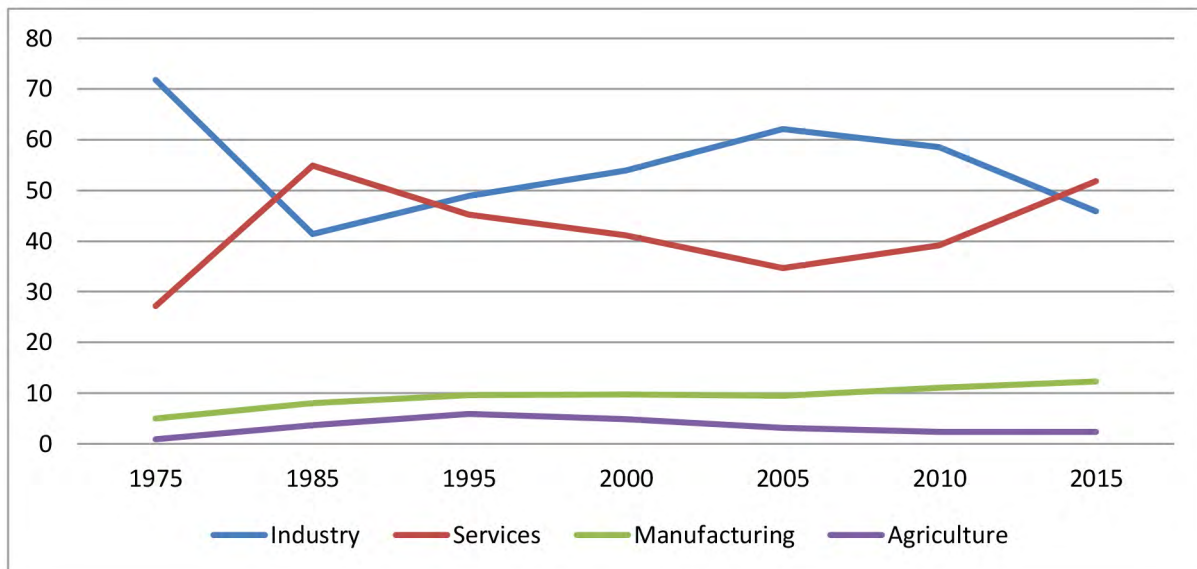


Figure 1: GDP value added in Saudi Arabia (1975-2015)

Source: The World Bank, 2017

It is clear from the earlier discussion that GCC countries continue to suffer from the concentration of economic activity in limited activities and sectors. The economic diversification that makes them resistant to internal and global exogenous shocks and makes their economic growth sustainable has not yet been achieved. In this respect, the shocks of the global economy have increased in recent years; these shocks include the decline in oil prices, the rise in world food prices, and the global financial crises. Moreover, internal challenges in GCC countries have also increased, including poor labour market efficiency, high levels of depletion of natural resources, weak competitiveness of industrial production, concentration of exports in a few commodities, lack of food and water security, and severe shortages in arable land.

Gross fixed capital formation (as percentage of GDP) in GCC countries

The share of gross fixed capital formation in GDP is linked to the variation in international oil prices in the Arab petroleum exporting countries. These countries have shown similar patterns in the rise and fall of the ratios of gross fixed capital formation as a percentage of GDP. These ratios increased in GCC countries in the 1980s, reaching 21% in Saudi Arabia in 1985. They then declined to 10.7% in Kuwait in 2000, and rose again in 2010 in all GCC countries to reach 30% in Saudi Arabia in the same year. This was due to the rise in international oil prices. Globally, these ratios have stabilised between 25% in 1985 and 23.8% in 2010.

Industrial competitiveness in the GCC

To assess the GCC countries' ability to produce and export manufactured goods, we use the competitive industrial performance (CIP) Index issued by the United Nations Industrial Development Organization (UNIDO). The CIP index measures a country's ability to produce and export manufactured goods competitively. The index contains four sub-indicators related to the country's productive and technological structure; these include per capita value added in manufacturing, per capita exports, industrial density and export quality. The indicator measures the productive capacities of the state based on production output (not inputs), and it is therefore useful for evaluating industrial performance as well as evaluating the performance of the country's exports. The higher the value of this index, the higher the competitiveness of the country's industrial production.

GCC countries recorded very low values for the CIP index in 2015 compared to the EU and Asian countries, as shown in Figure 2. The index value was 0.10 in Saudi Arabia, followed by 0.07 in both Qatar and the United Arab Emirates, 0.06 in Kuwait and Bahrain, and it dropped to 0.04 in Oman, the lowest in the GCC countries. At the same time, the index values in Germany, France and Ireland were 0.54, 0.28 and 0.27 respectively. Moreover, it registered 0.40 in China and 0.39 in South Korea. The values of the CIP index indicate very low levels of industrial competitiveness and weak production capacity in GCC countries compared to other countries in the EU and Asia. The previous values of the CIP index show that the industrial capacities of these Arab countries represent less than one-third of the capacities of the comparators mentioned above.

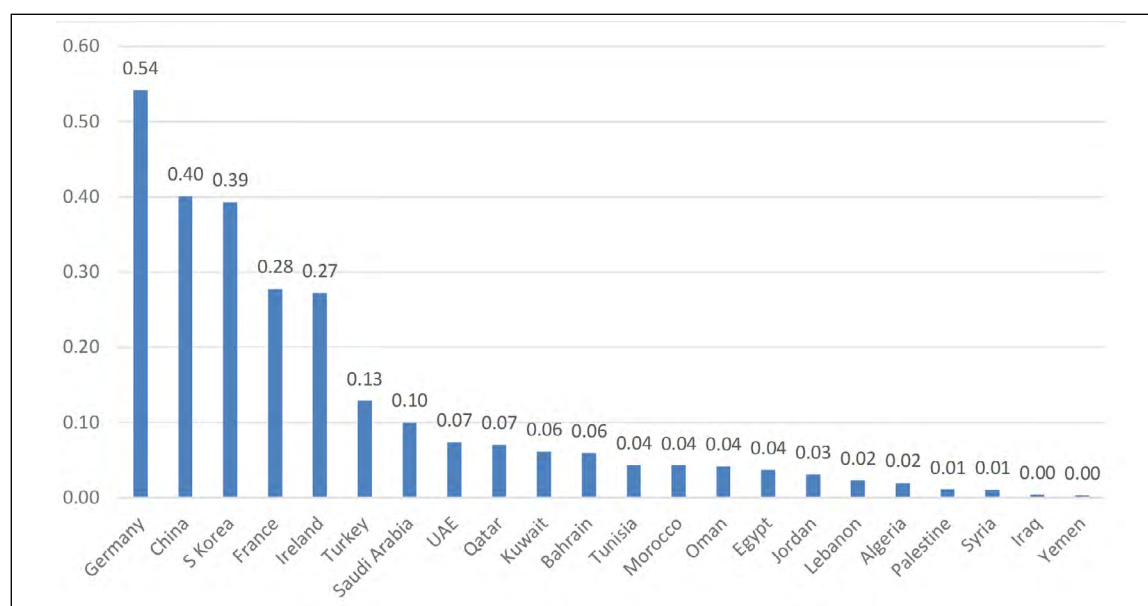


Figure 2: CIP Index in GCC countries (2015)

Source: UNIDO database, 2017

Export concentration in GCC countries

We use the export concentration index to measure the level of export concentration in GCC countries. The index shows the degree of product concentration in a country's exports (also known as the Herfindahl-Hirschman Index). The closer the value of this index is to zero, the more homogeneous and diversified are the exports of the country. However, if the value of the index is close to one, it indicates a high level of concentration of exports in a limited number of products. The index can also be expressed as percentages.

Figure 3 shows the GCC export concentration index compared to other countries for 2010 and 2014. The figure shows that the index values were high in GCC countries, where they reached 0.74% in Saudi Arabia, 0.66% in Kuwait, and 0.59% in Oman, indicating the concentration of exports in a few products in these countries in 2010. The index registered values of 0.52%, 0.41% and 0.37% in Qatar, the UAE and Bahrain in the same year, respectively. The last two values indicate that UAE and Bahrain exports are more diversified than their GCC counterparts. In general, these data show that GCC countries are still suffering from export concentration and lack of diversification in the export sector.

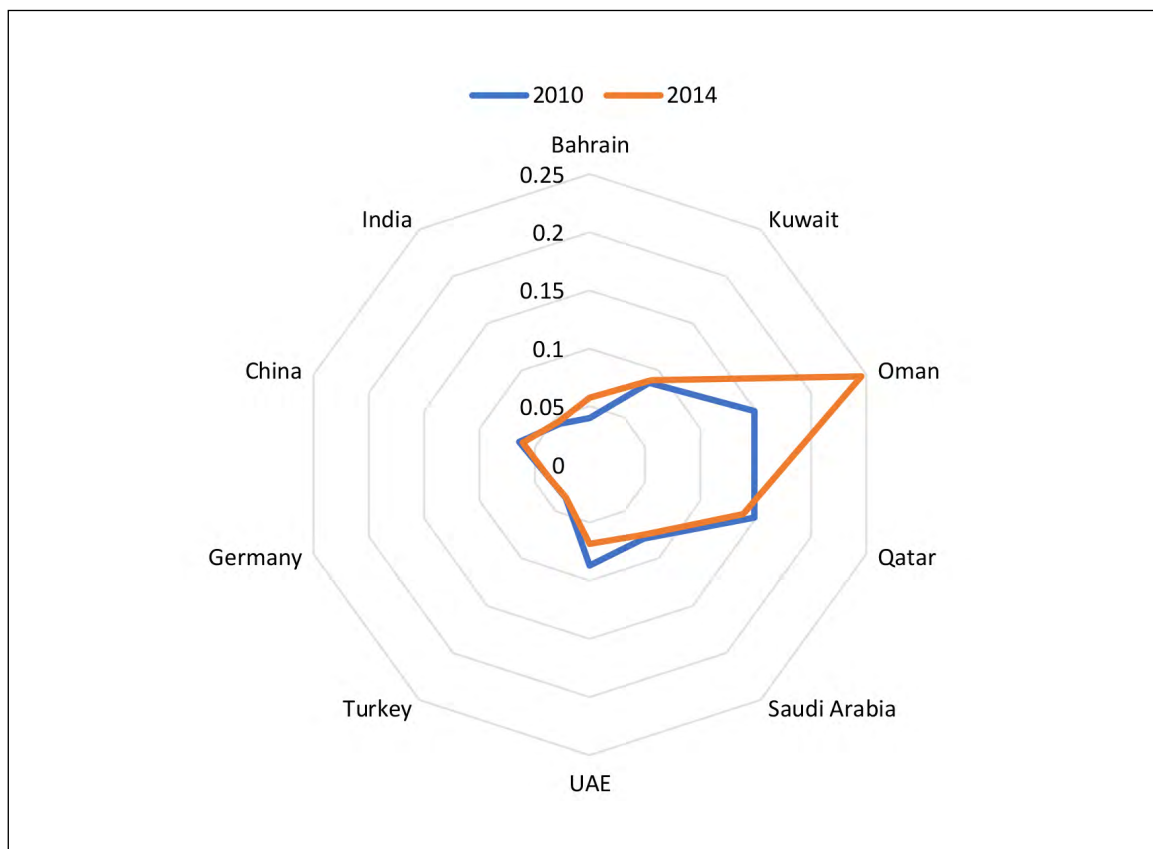


Figure 3: Herfindahl-Hirschman Export Concentration Index for the GCC Compared to Other Countries

Source: The World Bank database, 2017

Moreover, Figure 3 compares the level of export concentration in GCC countries with some other countries such as India, China, Germany and Turkey. The values of the index are approaching zero in India, China, Germany and Turkey, which means that the exports of these countries are highly homogenous and diversified, while the values of the index are close to one in the Gulf countries, and hence reflect a high level of export concentration in these countries and a lack of diversification. The highest levels of export concentrations are witnessed in Oman and Qatar, where the values of the index are very close to

one, indicating the dependence of exports on a very small number of products.

Similarly, Table 1 shows the export market penetration index for the period 2000-2014 for GCC countries compared to other countries. The index measures the extent to which a reporter's exports reach proven importers of those products worldwide. High values for the index indicate good performance in this respect and low value indicates low performance. The table shows that the performance of GCC countries is very weak compared to China, Germany and India.

Table 1: Export Market Penetration Index (2000-2014)

	2000	2005	2010	2014
Bahrain	1.9	2.2	2.3	2.5
Kuwait	1.9		2.3	2.5
Oman	1.8	2.2	2.4	2.6
Qatar	1.6	2.0	2.6	2.9
Saudi Arabia	4.1	5.0	5.2	5.1
UAE	8.7	13.2	14.3	14.0
Turkey	11.9	17.1	20.6	22.6
Germany	43.0	45.1	44.8	43.1
China	30.1	45.2	53.1	51.5
India	16.0	23.0	27.0	27.6

Source: The World Bank, 2017



Economic performance in GCC countries (1985-2015)

The average growth rate in most Arab countries was less than 5% in the last three decades. Even for those countries that grew by an average rate of more than 5% in that period, the growth was not stable and was very volatile, indicated by the high values of the standard deviation of the economic growth rates in Arab countries. Table 2 shows the average growth rates, and Figure 4 shows the standard deviation of growth rates of GCC countries compared to global average rates during the period 1985-2015. From this figure, economic growth in Arab countries has been characterised by a high degree of volatility compared to global levels. The standard deviation of this indicator registered an average value of 6.8% compared with an average of 1.26% in the world economy during that period. Figure 4 shows that all GCC countries recorded higher average values than the world averages in this indicator, reflecting the high level of volatility in economic growth rates in these countries compared to global levels.

Similarly, export volatility in the GCC is very high because of its concentration in a few products and lack of penetration of export markets. The average ratio of exports to GDP was 88.5% in the UAE, 79.6% in Bahrain and 50% in Saudi Arabia during the period 1990-2010. However, the values of the standard deviations of exports as a percentage of GDP are high, indicating high levels of volatility. In general, the average value of the standard deviation of exports' percentage of GDP in Arab countries is approximately 2.5 times greater than that of the world average, indicating a high volatility in Arab exports compared to other regions of the world. This is due to weak economic diversification and reliance on exports of raw materials.

The earlier discussion confirms the high level of concentration of economic activity and lack of diversification that makes economic performance highly volatile and prevents GCC countries from achieving sustainable economic growth. The knowledge economy provides the means that can allow these countries to build a diversified economy, and produce and export highly sophisticated products. In the next section we review the state of the knowledge economy in GCC countries.

Table 2: Average Growth Rates in Some Arab counties (1985-2015)

	1985-1989	1990-1994	1995-1999	2000-2004	2005-2009	2010-2015
Algeria	1.4	-0.3	3.5	4.8	3.0	3.4
Bahrain	2.8	7.0	4.0	4.9	6.1	3.8
Egypt	4.4	3.6	5.1	3.7	6.0	2.9
Jordan	-0.4	6.2	3.6	5.6	7.4	2.6
Kuwait	5.7	21.2	2.0	7.3	3.8	2.9
Lebanon		16.8	2.5	3.6	6.6	2.7
Morocco	5.9	3.7	2.7	4.6	4.9	3.9
Oman	6.1	4.9	3.3	1.5	5.3	4.3
Qatar				8.5	16.3	8.3
Saudi Arabia	0.8	4.6	1.7	4.5	5.8	5.0
Tunisia	2.5	5.0	5.2	4.2	4.5	2.1
UAE	-1.1	6.1	4.8	6.6	3.2	4.2
Yemen		6.3	5.1	4.3	3.9	-4.3
World	3.8	2.2	3.2	3.2	2.5	3.0

Source: Calculated from World Bank data (2017)

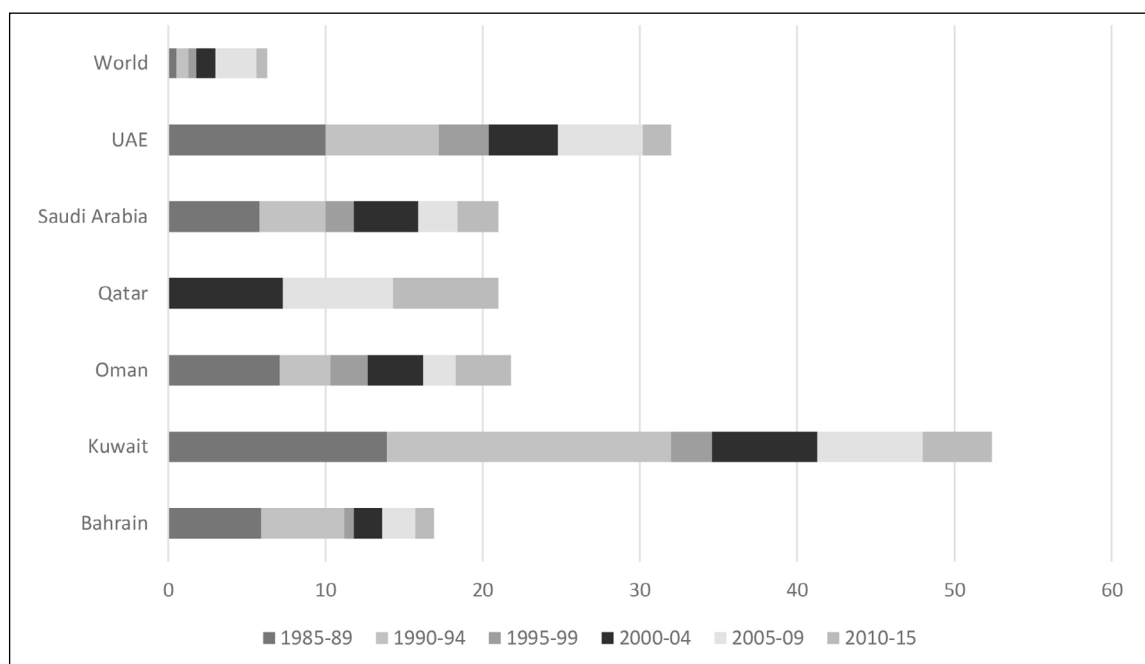


Figure 4: Growth Volatility in the GCC (1985-2015)

Source: World Bank, 2017

The State of the Knowledge Economy in GCC Countries

According to the knowledge economy index issued by the World Bank in 2012 (the latest report), the performance of GCC countries in this index is higher than the world average but lower than countries with the same level of income. This indicates that the knowledge gap between GCC countries and countries with the same level of income is still wide, in particular, the performance in education and innovation pillars are the lowest among the four pillars of the knowledge economy index. Table 3 shows the GCC countries' performance in the knowledge economy index and its four pillars, i.e., economic and institutional systems, education and skills, information and technology infrastructure, and innovation systems.

The number of years of schooling in GCC countries ranges from 6.3 in Kuwait to 9.5 in Bahrain and

UAE, while it reaches 12 years in high-income countries. Similarly, tertiary education enrolment rates in GCC countries ranges from 10.4% in Qatar to 51% in Bahrain, compared to 69.68% in high income countries.

Moreover, there is weakness in the knowledge economy output in GCC countries, such as the number of scientific research articles and patents. The number of articles published in scientific research journals in GCC countries ranges between 24.31 articles per one million people in Saudi Arabia to 90.86 articles in Kuwait, compared with 560 articles in high income countries. The number of patents ranges from 0 per one million people in Bahrain to 3.5 in Kuwait, compared to 163.1 patents in high income countries.

Table 3: Performance of GCC Countries in the Knowledge Economy Index (2000, 2012)

	Knowledge economy index		Knowledge index		Incentive systems index		Innovation index		Education index		ITC index	
	2000	2012	2000	2012	2000	2012	2000	2012	2000	2012	2000	2012
UAE	6.05	6.94	5.56	7.09	7.51	6.5	4.32	6.6	4.44	5.8	7.92	8.88
Bahrain	6.85	6.9	6.66	6.98	7.45	6.69	6.37	4.61	6.34	6.78	7.26	9.54
Oman	5.28	6.14	4.67	6.05	7.51	6.96	4.25	5.88	4.22	5.23	5.12	6.49
Saudi Arabia	4.6	5.96	4.53	5.87	4.4	5.68	4.24	4.14	4.28	5.65	5.49	8.37
Qatar	6.01	5.84	5.81	5.5	6.64	6.87	5.51	6.42	4.85	3.41	7.05	6.65
Kuwait	6.16	5.33	5.88	5.15	7	5.86	5.38	5.22	5.17	3.7	7.09	6.53
High income countries	8.84	8.6	8.97	8.67	8.45	8.39	9.2	9.16	8.81	8.46	8.88	8.37
World	5.95	5.12	5.15	5.07	5.61	5.45	7.75	7.72	3.89	3.72	6.53	3.58

Source: World Bank, 2018

The rankings of GCC countries in the World Bank's knowledge economy index range between 42 in the UAE (as the best performer) and 64 in Kuwait (as the worst performer) in 2012. The period 2000-2012 witnessed improvement in the ranking of the UAE from 48 to 42, Oman from 65 to 47, and KSA from 76 to 50. By contrast, the period witnessed deterioration in the ranking of Bahrain from 41 to 43, Kuwait from 46 to 64, and Qatar from 46 to 54. The previous indicators show that the performance

of GCC countries in the knowledge economy is mixed between improvement in some countries and deterioration in others. Moreover, the global competitiveness index for the year 2016/2017 shows that all GCC countries except the UAE have retreated in the global competitiveness indicators. This retreat was due to the decline in international oil prices and geopolitical instability in the Arab region.

R&D expenditure in GCC countries

The R&D expenditure percentage of Gross National Income (GNI) is a major input indicator of the knowledge economy and a key driver to innovation. This percentage reflects the efforts of the state in developing knowledge and sciences in the economy. R&D expenditure in all the GCC countries was less than 1% of GNI during the period 2005-2014 compared to an average of

2% in high income countries. The average R&D expenditure in GCC countries was a mere 0.32% of GNI. Lack of expenditure in R&D is one of the main challenges for building knowledge-based economies in GCC countries. Economic policies directed to build the knowledge-based economies in these countries need to address these issues.



Shares of manufactured exports in commodity exports

This is a key indicator reflecting the level of export diversification. The ability to export manufactured products reflects the level of production capabilities and economic structure in the country. The shares of manufactured exports in commodity exports were small in most Arab countries during the period 1985-2015 compared to the global average of 69% of total world exports. However, there are some exceptions in the Arab countries, such as Tunisia, Morocco, Lebanon and Jordan. Manufactured exports as a percentage of total exports in GCC countries ranges between 19-20% in Bahrain, Kuwait and Saudi Arabia, and between 8-11% in Oman, UAE and Qatar.



Exports of computer and other communications services

This is an important output indicator showing the existence and penetration of a knowledge-based economy in the country. The higher the level of ICT services' exports, the deeper and greater the level of knowledge-based economy. The share of this type of export is small in GCC countries, reaching 10.4% in Oman and 5% in Qatar compared to the world average of 37.6% during the period 1985-2010.

The earlier discussion indicates weakness in the knowledge-based economy in GCC countries at the production and exportation levels. This weakness can be attributed to weakness in knowledge economy inputs, in particular a low level of spending on R&D, weakness in the innovation system, weakness in education and training systems, poor economic incentives, weak inter-linkages between knowledge, enterprises, and human resources, and at the local and state levels.

Empirical Analysis

In this section we will use panel data from GCC countries to evaluate the role of the knowledge economy in these countries for the period 2000–2015. We begin our evaluation by estimating a standard economic growth regression to gauge the strength of the relationship between the knowledge economy variables and the economic growth performance in these countries. This is followed by using a panel model estimation to find the effect of the knowledge economy on some proxies of economic structure and diversification in GCC countries. We regress performance proxies on some explanatory variables related to economic structure, macroeconomic policy stance, qualitative variables, and exogenous non-policy variables.

We begin our empirical analysis by describing the regression variables and the datasets used. However, evaluation of the role of the knowledge economy in GCC countries is normally complicated by finding appropriate proxies and lack of sufficient data for relevant variables in these countries.

One of the key variables in a knowledge economy is technology. However, technology is intangible and difficult to measure directly. Indirect approaches to measure technology include using variables such as patent outputs, R&D expenditure, and productivity changes. The dataset for these variables is incomplete and insufficient for GCC countries; we are not, therefore, able to use them. Total Factor Productivity (TFP) as a measure of technology is computed in the production function as the remainder after subtracting the contribution of capital and labour inputs from output values. Unlike previous measures, TFP is a derived measure of technology. This introduces measurement error and perhaps biases, because the appropriate

data on inputs and outputs are rarely available. Moreover, the TFP is constructed as a residual, and may potentially capture spurious influences that complicate econometric analysis (Keller, 2009).

Bearing in mind these difficulties, we used three dependent variables as proxies to assess the role of the knowledge economy in GCC countries. These were economic growth, manufacturing exports, and high technology exports' performances in the CC countries for the period 2000–2014. The annual GDP growth is used as an indicator of general macroeconomic performance in the countries.

Manufacturing exports are used to reflect export diversification and production capabilities. They are defined as a percentage of merchandise exports; these comprise chemical, basic manufactures, machinery and transport equipment, and miscellaneous. The variable roughly reflects technological levels or capabilities in developing countries. The data for this variable are collected from the World Bank indicators for the period 2000–2014.

Moreover, we use the values of high-technology exports (in current US\$) as a proxy of quality of production technology levels and sophistication in GCC countries. High technology exports are defined as exports of products with a high level of R&D intensity, such as aerospace, computers, pharmaceutical scientific instruments, and electrical machinery. The data for the variable were collected from the World Bank Website. The indicators of the manufacturing percentage of commodity exports and high-tech exports reflect the level of economic diversification and export sophistication in the country.



Economic growth regression

To test the significance of the knowledge economy on economic growth performance, we estimate a standard growth regression equation for GCC countries for the period 2000-2014, incorporating some knowledge economy indicators. We exclude Qatar from the GCC countries' economic growth regression due to insufficient data.

The dependent variable is the annual GDP growth rate. The independent variables are indicators of availability of capital (share of gross capital formation denoted by CSH_I), and availability of human capital (denoted by HC); this is a key variable that reflects the significance of the knowledge economy to economic growth in the model. It captures the average years of schooling and return to education. The two variables are obtained from the Penn World Tables Version 9. We expect the coefficient sign for these variables to be positive, implying that an increase in human capital and capital stock leads to an increase in economic growth.

To control for the internal and external environment, and to account for different shocks affecting the production function in GCC countries, we introduce some policy and non-policy variables. In this respect, government consumption

as a share of GDP (CSH_G) is introduced to reflect the fiscal policy stance. An increase in this variable will increase the growth rate if it does not create a budget deficit and crowd-out private investment.

Moreover, inflation rate is introduced to reflect internal macroeconomic stability. Inflation rate is expected to have positive effect on the economic growth rate in developing countries if it is low and less than two digits. Price increases promote production by providing incentives for producers and therefore increase economic growth.

To account for external macroeconomic management and assess the role of exchange rate policy in economic growth, we introduce exchange rate misalignment as a policy indicator variable. Misalignment is defined as the deviation of the real exchange rate (RER) from its equilibrium values. Following Rodrick's (2008) approach in computing exchange rate misalignment, we adopted a measure of the domestic price level adjusted for the Balassa-Samuelson effect. Rodrick (2008) uses data on exchange rates ($exch$) and purchasing power parity conversion factors (PPP) to calculate a "real" exchange rate (RER) according to the following Equation 1:

$$\ln rer_{it} = \ln\left(\frac{exch_{it}}{PPP_{it}}\right) \quad (1)$$

where i denotes countries and t denotes years. $Exch$ and PPP are expressed as national currency units per US dollar. Values of RER greater than one indicate that the value of the currency is lower (more depreciated) than indicated by purchasing power parity.



Rodrick then regresses *RER* on GDP per capita (*RGDPCH*):

$$\ln rer_{it} = \alpha + \beta \ln RGDPCH_{it} + f_t + u_{it} \quad (2)$$

where f_t is a fixed effect for time period and u_{it} is the error term. We run this regression for GCC countries and yield an estimate of β (β^*) of -0.43 (with t statistic of about 14.7), suggesting a strong estimated Balassa-Samuelson effect. This indicates that when incomes rise by 10%, the real exchange rate falls by around 4.3%. Finally, to arrive at exchange rate misalignment we take the difference between the actual real exchange rate and the Balassa-Samuelson-adjusted rate:

$$\ln misalignment_{it} = \ln rer_{it} - \ln rer_{it}^{\wedge}$$

where $(\ln rer_{it}^{\wedge})$ is the predicted value from Equation 2:

Finally, we control for initial conditions economic growth regression equation in different GCC countries by introducing variables such as the logarithm of the real GDP of these countries, measured on a PPP basis, and population growth rate. The data for the model are collected from the World Bank indicators, the Penn World Tables Version 9, and the IMF databases.

Economic growth regression equation

We estimate a general growth equation of the following form:

$$gr_{i,t} = \alpha y_{i,t-1} + x'_{i,t} \beta + \omega_t + \varphi_t + v_{it} \quad (3)$$

where gr denotes the GDP growth rate in period t for country i , $y_{i,t-1}$ is the logarithm of initial income, $x'_{i,t}$ is a vector of potential determinants of growth performance, ω_t captures sample-wide time effects, φ_t are the unobserved time-invariant country-specific effects, and v_{it} is the residual error component (see Hesse, 2009).

Moreover, population growth rate (pop_gr) is added to reflect initial conditions in GCC countries. The variable denotes the demographic factors in GCC countries that are characterised by high levels of population growth and high dependency ratios compared to the world average rates in these aspects. Demographic factors affect economic growth rates by changing consumption and saving patterns in the country.

To account for governance issues in GCC countries, we incorporated one of the variables reflecting government effectiveness (Gov_eff). This variable captures the perception of the quality of public services, the quality of civil services, and the degree of independence from political pressure. The data for this variable are obtained from the World Bank (WBG).

The regression model also incorporates variables related to exogenous non-policy factors affecting GCC countries, such as variation in economic activity in the world economy proxied by the world average economic growth rate (Wld_gr), and the terms of trades (TOT) shocks. All these variables are expected to affect economic growth rates in GCC countries.



Empirical results

In estimating the model, we employ the Generalised Least Squares Estimator (EGLS) to estimate Equation 3 for five GCC countries (Bahrain, Kuwait, Oman, Saudi Arabia, and UAE) for the period 2000-2014 using fixed effect.

Table 4 shows the results of the GCC panel regression. From Table 4 (model No. 1), the economic growth in GCC countries is affected positively and significantly by the level of human capital, investment level, inflation rate, world economic growth rate, and TOT shocks during the period 2000-2014. Similarly, the GDP growth rate is affected negatively by government consumption, exchange rate misalignment, and weak government effectiveness.

These results indicate that economic growth rates are influenced negatively by government fiscal policy and the lack of flexibility in exchange rate regimes. Moreover, governance issues such as government effectiveness might impede economic growth in GCC countries.

The human capital indicator (HC) is highly significant with the correct sign. This result lends strong support to the role of the knowledge economy in growth performance, in particular investment in increasing quantity and quality of education promotes economic growth performance.

The model is estimated for the period 2000-2014 using the EGLS with fixed effects. White Period standard errors and covariance and correcting for the number of degree of freedom were also chosen. The Hausman tests reject the redundancy of the fixed effects by a probability of 0.024.

Table (4): Regression results: Fixed effects estimation of the relationship between knowledge economy variables and economic growth, manufacturing exports and high tech exports in GCC countries for 2000-2014 Economy Index (2000, 2012)

Model	1	2	3	4
Dependent variable	Growth rate (GR)	Augmented growth rate (GR)	Manufactures export regression (LMAN_EXP)	High tech export (LHTECH_EXP)
C	-39.466*	-89.25794*	-23.19387*	-11.18509*
HC	11.594*	20.94715*	0.610065**	2.221774**
CSH_I	6.574***	14.46556*		
CSH_G	-5.197**			
MISALIGN	-10.379*	-9.253059*	-1.873822*	
INF	0.389*	0.505810*	-0.002308	0.029148
GOV_EFF	-9.556*	-8.979012*	0.243394	1.157495**
WLD_GR	0.844*			
POP_GR	-0.464*			
TOT	0.046*			
LOPEN		8.215475*	0.803965**	4.555962**
LBROAD		0.737035*		
EDU_EXP		-0.481860		
MOB_POP		-2.243870**		
LKC			1.344931*	
REG_Q			-0.435254*	-0.293628
RUL_L			0.928215*	
INV				0.007451
VOL_RER				-1.295147**
R-Squared	0.412166	0.446842	0.876103	0.847993
Adjusted R-squared	0.286890	0.288797	0.847511	0.823005
S.E. of regression	4.076921	4.174484	0.288660	1.387399
F- stat (prob (F-stat))	3.290066 (0.000803)	2.827311 (0.006306)	30.64196 (0.000000)	33.93671 (0.000000)
The Hausman test (prob)	3.029522 (0.0241)		33.964300 (0.0000)	25.498130 (0.0000)

*: Indicates significant at 1% level. **: Indicates significant at 5% level.

***: Indicates significant at 10% level.

Note: Dependent variables in models (1-4) are Economic Growth Rate (GR), manufacturing exports (LMAN_EXP) and high tech exports ((LHTECH_EXP))

Source: Authors' calculation

The growth regression model is re-estimated in Table 4 (model No. 2) by adding some additional proxies for the knowledge economy level in GCC countries; these include the availability of information technology proxied by the number of fixed broadband subscribers in the country per 100 people, government expenditure on education, percentage of the total expenditure and the mobile cellular subscribers divided by the population size.

the regression results in Table 4 (model No. 2) show that the economic growth rate is positively and significantly related to investment, inflation rate, and degree of openness. It is negatively and significantly related to exchange rate misalignment and government effectiveness.

Moreover, the knowledge economy variables, such as availability of human capital and availability of Internet, are highly significant and influence the economic growth rates positively. However, the expenditure on education is not significant; this may be due to association with human capital. Moreover, the number of mobile phones is significant to growth but with the wrong sign.

The earlier discussion shows that both human capital and physical capital are highly significant to growth performance in GCC countries. The results indicate a positive association between these variables and economic growth performance,

which means that improvement in human capital indicators leads to an increase in economic growth rates.

Moreover, macroeconomic policy variables are also found to be significant for growth performance, in particular, exchange rate misalignment affects the growth rate negatively. This will call for good management for the exchange rate system.

Government consumption negatively affects growth in the GCC; this may be justified by the very large governmental sector that tends to employ the majority of GCC nationals, and the small size of the private sector in these countries. Reducing the size of the public sector and increasing the role of the private sector will improve performance in these countries. Inflation affects growth performance positively, which is not surprising in the GCC countries that tend to have a very low level of inflation compared to the rest of the developing areas. The model shows that initial conditions represented by population growth (pop_gr) are significant to growth performance.

The above results lend a great deal of support for the significance of the knowledge economy for GCC economic growth. This relationship is valid in a variety of model specifications and knowledge economy proxies.



Regression on manufacturing exports

Manufacturing exports as a percentage of merchandise exports are used to reflect the level of technological capabilities in GCC countries. The higher the levels of these exports, the greater the technological capabilities the country has. Moreover, levels of manufacturing exports in developing countries are good proxies of levels of diversification and economic transformation.

To assess the effect of the knowledge economy on manufacturing exports, we regress the logarithm of this variable on explanatory variables related to production inputs, knowledge economy and macroeconomic policy management indicators, such as exchange rate, domestic price level and governance.

Table 4 (model No. 3) shows the regression results. The table indicates that the manufacturing exports in GCC countries are affected positively and significantly by the availability of human capital, degree of openness, capital stock and governance (rule of law). Moreover, the dependent variable is affected negatively by exchange rate

misalignment and poor regulation quality. However, internal price level (represented by inflation rates) and government effectiveness indicators have insignificant effects on manufacturing exports in GCC countries.

The model is estimated using the EGLS with fixed effects: the Hausman tests reject the redundancy of the fixed effects with the probability of 0.000.

These results prove that the knowledge economy is highly important in promoting manufacturing exports and therefore achieving diversification for economic structure and revenues. GCC countries are striving to achieve diversification and economic transformation due to their reliance on the oil sector as a sole source for revenue. Moreover, the concentration of exports on a few products is the main source of economic instability. Consequently, investment in the knowledge economy will increase manufacturing exports and, in turn, increase diversification and foster structural transformation in GCC countries.



Regression on high technology exports

We also regressed high technology exports on some explanatory variables for the period 2000-2014 for GCC countries. We used panel EGLS on our regression. The explanatory variables included are the level of human capital in the country (HC), gross capital formation as a percentage of GDP (INV), and the degree of openness (OPEN) to reflect the level of trade liberalisation in the country. The last variable is measured as the sum exports and imports as a percentage of GDP. These three variables reflect government efforts in improving export capabilities related to the knowledge economy.

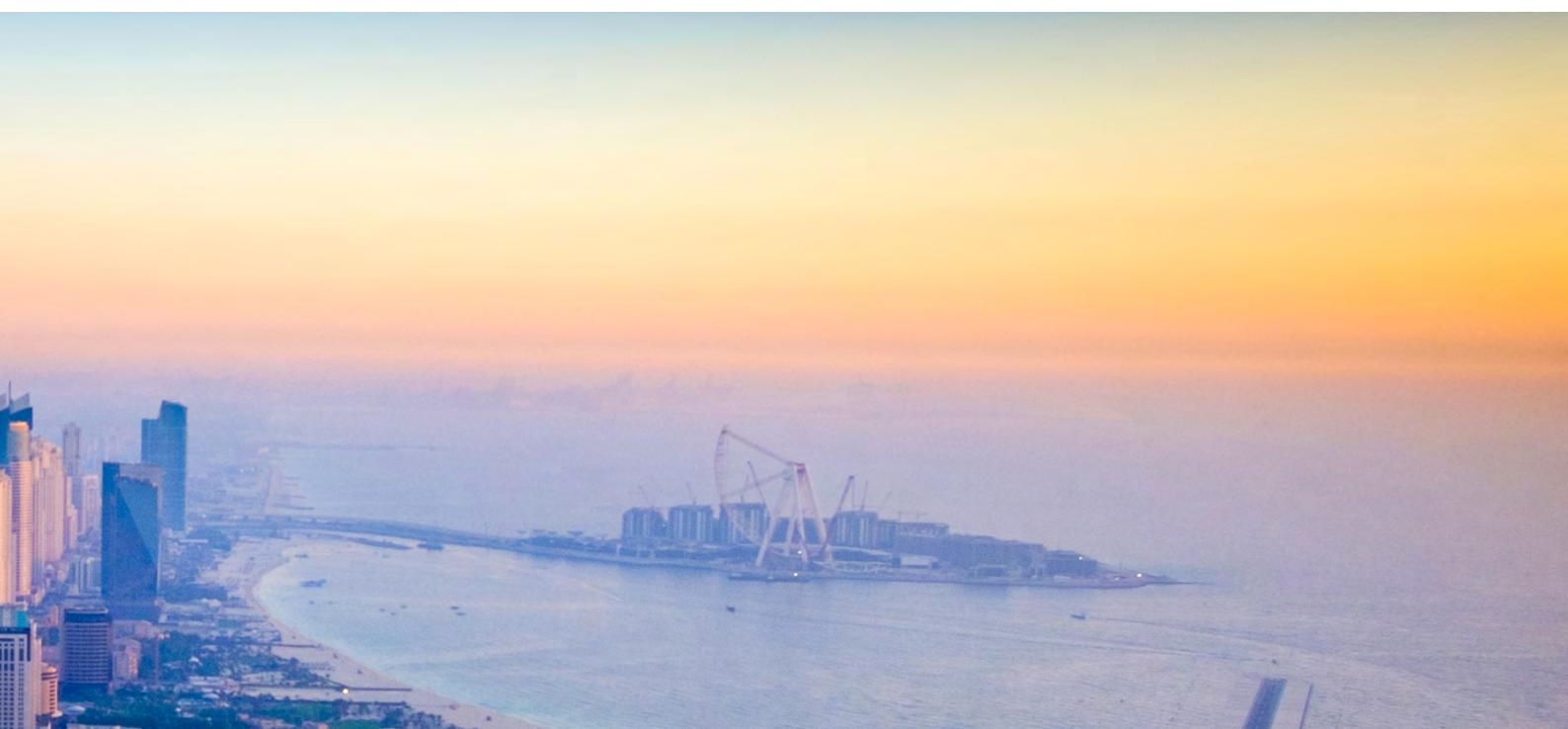
The annual rate of inflation (INF) is introduced to reflect the changes in local prices of exported products. In addition, we introduce the real exchange rate volatility (VOL_RER) to reflect the government policy stance from the exchange rate, and how different internal and external shocks affect this variable. Volatility is calculated as two year rolling standard deviations of percentage changes of local currency against the US dollar.

We also incorporate some qualitative variables to reflect the governance status in GCC countries, such as the government effectiveness indicator

(GOV_EFF) that captures public perceptions of the quality of public and civil services. Also, we introduce an indicator of regulatory quality (REG_Q) that captures perceptions of the ability of the government to formulate and implement sound policies and regulations that promote the private sector. We assume that these two qualitative factors are important for export performance.

The results of this regression are shown in Table 4 (model No. 4). The table shows that high technology exports in GCC countries are influenced positively and significantly by human capital, degree of trade liberalisation, and government effectiveness. However, the dependent variable is influenced negatively and significantly by real exchange rate volatility. The other variables are not significant. Testing for the redundancy of the fixed effect rejects the redundancy at 0000 probability, as shown in Table 4.

These results indicate that building a knowledge-based economy in the GCC requires promoting human capital, enhancing trade liberalisation, improving government effectiveness, and reviewing exchange rate policies.



Conclusions

This paper evaluates the role of the knowledge economy in GCC countries. The economic literature stresses the significance of the knowledge economy on economic growth and structural transformation in developing countries. Many authors stress that developing countries that fail to become part of the information revolution risk becoming more marginalised than those left aside in the earlier industrial revolution (Aubert and Reiffers, 2003).

GCC countries have made generous investments in financing education, computer telecommunication infrastructure, science, technology, and innovation. However, they face some challenges to build a knowledge-based economy, including volatility in public finance due to oil dependency and lack of economic diversification, insufficient human capital, and high population growth. After surveying the literature on the role of the knowledge economy in GCC countries, the paper finds a dearth of empirical studies in this area of investigation. This paper fills a gap in the literature.

The economic structure of GCC countries reflects a lack of diversification and a concentration of economic activity in the industrial and services sectors, with a low contribution from the manufacturing sector in the GDP of these countries. Changes in the share of the manufacturing sector in the GDP value added over time are regarded as a sign of structural transformation in the economy in developing countries. Shifting economic activity from the industrial to the manufacturing sector reduces the effect of fluctuations in oil prices that normally have a profound impact on economic activities in these countries.

This paper investigates the state and role of the knowledge economy in GCC countries. It demonstrates a wide gap between GCC countries and countries with the same level of income in this respect, despite registering higher than the world average ranking. Performance in education and innovation are the lowest among the four pillars of the knowledge economy index.

The paper uses panel data from GCC countries to evaluate the role of the knowledge economy in these countries for the period 2000-2014. It begins the evaluation by estimating a standard economic growth regression to gauge the strength of the relationship

between the knowledge economy variables and the economic growth performance in these countries.

In addition, we use the values of high-technology exports as a proxy of levels of export diversification and production sophistication. Other proxies used include the levels of exports of manufacturing as a percentage of merchandise exports.

The results of the GCC panel regression show that the economic growth in GCC countries is affected positively and significantly by the level of human capital, investment level, inflation rate, world economic growth rate and terms of trade during the period 2000-2014. Similarly, the GDP growth rate is affected negatively by government consumption, exchange rate misalignment, and weak government effectiveness. This result lends strong support to the role of the knowledge economy in growth performance, in particular, investment in increasing the quantity and quality of human capital promotes economic growth performance.

Similarly, the regression on manufacturing exports in GCC countries shows that the variable is affected positively and significantly by the availability of human capital, degree of openness, capital stock and governance (rule of law), and negatively by exchange rate misalignment and poor regulation quality. However, internal price level and government effectiveness indicators have insignificant effects on manufacturing exports in GCC countries. These results prove that the knowledge economy is highly important in promoting manufacturing exports and hence achieving diversification for economic structure and revenues. Consequently, investment in the knowledge economy will increase manufacturing exports and, in turn, increase diversification and foster structural transformation in GCC countries.

Moreover, regression on high technology exports in GCC countries has shown that the variable is influenced positively and significantly by human capital, the degree of trade liberalisation, and government effectiveness, and negatively and significantly by real exchange rate volatility. These results confirm the earlier findings on the significance of the knowledge economy on economic growth and diversification.

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Biography

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