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Research Article

Analyzing the effects of research and development activities on the development of the knowledge economy (Selected countries: case study)

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ABSTRACT

The basic elements of efficiency in the science, technology and innovation sector are traditionally embedded in the capabilities of institutions, to educate the scientific and technological workforce, technical knowledge and skills, approving research and development outcomes in order to develop new products and production processes. Research and development has become one of the qualitative production elements affecting the shift towards the dynamics of the knowledge economy environment, as a source of enhancing competitive advantage structures and thus economic growth. There was a relationship between spending on the research and development sector and economic growth in the long term. The research aims to analyze the implications of the economics of research and development and its impact on developing the knowledge economy environment. The research involves studying the impact of research and development activities on developing the knowledge economy environment, with spatial boundaries represented by selected Arab countries, including Iraq, and temporal boundaries represented by the period 2010-2021. The research problem is reflected in the decline in spending on research and development activities as a percentage of GDP, which leads to an exacerbation of the size of the technology gap.

Keywords: Research and development, economic growth, knowledge economy, technological progress, endogenous growth theory.

Introduction

There have been many attempts by humans to find a logical explanation for the phenomena they live with or control them and to devise solutions to the problems they face, and finding the path to knowledge is the mechanism that humans follow in dealing with these phenomena. Knowledge expresses certain information that a person obtains through (inspecting, studying and analyzing) various phenomena and problems.

Since scientific research represents the method or method through which the practice of its activities results in the discovery of knowledge, knowledge is a product of science.

As for the concept of scientific research, “the mechanism for properly organizing a basket of related ideas with the aim of revealing a specific truth that characterizes those ideas for the purpose of proving them and inferring their secrets” (1).

As for the concept of research and development, according to the definition of the Arab Knowledge Index for the year 2022, “a creative activity that takes place in a systematic manner in order to increase the stock of knowledge - including knowledge of humans, culture, and society - and to use this stock of knowledge in various applications.” It is also seen as one of the basic foundations in the production, dissemination and application of knowledge and provides the requirements for economic growth, development and transformation into a knowledge society (2).

Discovering new facts and adding them to the field of knowledge is one of the priorities of scientific research by following systematic and objective methods, and it carries within it implications that work to enhance education and training by providing a package of organized and integrated steps and mechanisms that help in

analyzing data and information and thus reach new results and help to conduct Amendments to ensure continuity of development of information.
As for the concept of development, “it is a codified application of knowledge for the purpose of producing or developing useful products or systems and means that include designing the basic templates for the products and making the required improvements,” as it is an activity whose basic components are knowledge and scientific experience with the aim of producing new products or systems and raising the efficiency of the performance of production functions and is linked to a direct relationship with investment. Research, where development is the result of research work and generates new innovations. Which contributes to raising competitiveness and enhancing added value.
Scientific research is a creative production that requires intellectual abilities and a degree of intelligence and is coupled with generality. Technological development may be an intellectual production that is manifested in new innovative processes, or a practical production that is embodied in the generation of products based on scientific research and requires high efficiency in terms of economic and social organization and the creation of a system of material and moral incentives.
In general, research and development is a creative, methodological method that aims to discover and increase knowledge and enhance knowledge accumulation in various scientific fields. Spending on it is equivalent to a double investment (3).
In addition to the above, research and development is one of the variables of the technological knowledge function. It is a qualitative variable that includes the dynamics of enhancing technological transformations with their various components (human, financial, material) and their theoretical and applied activities. And its dimensions (sectoral, institutional and environmental), research and development has become the focus of attention because its activities are linked to building technological capabilities and obtaining monopoly advantages (4). Research and development activities can be viewed in a broad sense through basic research (5): theoretical or experimental work intended primarily to acquire new knowledge of the underlying foundations of observed phenomena and facts without seeking any special or specific application. The focus of this research is to obtain and increase knowledge. The stock of knowledge and the promotion of new scientific discoveries by analyzing phenomena without taking into account the possibility of applying their results or employing them for a specific economic or commercial goal, and the time period required for their completion is difficult to analyze. It focuses on identifying results. Basic research is coupled with creative activities and the generation of new ideas and inventions. Government agencies, universities, and research centers carry out this type of research. (6) Applied research: - original research undertaken in order to obtain new knowledge, and it is directed towards a specific scientific goal or a specific process (7), and observations and experiments have a fundamental role in the activities of this research, in addition to harnessing scientific discoveries, as they depend on approved knowledge and transform it into Technical solutions that often work on applying the results of basic research (8) Experimental development: -a systematic work that relies on employing existing knowledge acquired from research (basic, applied, or both) to develop new applications, improve current or new processes, and generate creative products (9).

First: The implications of transforming into a knowledge base

Knowledge works on the process of structuring information with the aim of developing smart products. The basis for qualitative transformation in the economic environment is knowledge, which is the strategic resource, in order to keep pace with knowledge-intensive structures and the shift from capital resources to information. The fundamental role that technological change plays within the framework of the production function has been interpreted by the economic literature along two axes: The first axis, which represents the basis of analysis, as technology is embodied in the physical infrastructure of production processes (equipment, machines, and production structures) and that it imposes a new pattern of activity. . The second axis includes the qualitative moral aspect that contributes to technological change, which is embodied in investment in human capital (human and institutional development). Amsden emphasized the importance of human capital accumulation compared to physical capital accumulation. The accumulation of knowledge that occurs in educational institutions, research and development centers, and the practice of productive and commercial activities is the main engine of growth, the reason for varying standards of living and development, and the primary contributor to bringing about changes in the first axis through innovations.
In addition, each stage of capital goods and its certain level of technology needs to adapt the material and moral framework and organizational structures appropriate to this level.
At levels of global competitiveness and complex technology, organizational models and capacity building are more difficult and require efforts, time, and technology transfer mechanisms (10).
Technology can be defined as a way of accomplishing a particular task using technical processes, methods and knowledge. This definition captures the broader perspective used by social scientists, but it also highlights the challenges associated with measuring it. Technology is not just machines or “devices” but often includes a process or method.
Current technological differences between countries mostly arise from differences in how intensively new technologies are used.
Technological catch-up happens through companies. Companies are the main source of adoption of more advanced technologies to be applied in the production of goods and the provision of services. These

developments are key to enhancing gains in productivity, the engine of economic growth and prosperity. While technology can raise well-being through various channels, it is primarily through the adoption process by companies that most workers are affected by.
Workers can reach higher productivity, jobs and countries can achieve higher prosperity by adopting more sophisticated technologies. With very few exceptions in countries rich in natural resources, there is no successful example of a developing country qualifying to become an advanced economy without improving the technological level, whether in agriculture, manufacturing or services.
Rapid jumping (evolution) is rare. Technology development by companies is mostly a continuous learning process.
Despite some opportunities for technological development, technological progress should be viewed as a continuous and cumulative process: one that requires firms to acquire the capabilities necessary to adopt more sophisticated technologies. It takes a great deal of knowledge to learn about the leading technologies in a particular field, to determine which ones are most relevant to production processes, and to know how to integrate them into the business under different market conditions. Knowledge is also needed to enhance the accumulation of thought about the types of products, services and processes that can be produced sustainably, once a plan is in place to develop the technology, to implement it and to train the workforce in it. As a result, innovation should be the main goal, and policies in developing countries should be supportive of building this management and technological capability (11).

Second: Models of internal growth theory

Romer's (1986) cognitive accumulation model

Romer's work focused on changing the assumption of exogenous technological development in the Solow model with other factors (Solow residuals), which are among the main sources of economic growth that emerge from within the model, and based on previous ideas (innovation) by Schumpeter and (learning by doing) by Arrow. Romer presented a model in which he emphasized that the accumulation of knowledge is an internal variable and knowledge is a semi-public good and is considered a reward for capital. Capital consists of the stock of physical capital and the stock of knowledge generated from it. Long-term economic growth is linked to the ability to acquire and accumulate knowledge. Therefore, economic measures aimed at enhancing the economy's ability to acquire knowledge will leave favorable effects on the desired growth rates (12), as Romer sought to clarify the growing role of technological knowledge in stimulating economic growth through what is called (knowledge accumulation).
The growth of the domestic product (Y) is linked to the technological level (A) and capital (k) directly and not by including technological knowledge in the labor and capital components. The functional formulation of the model is as follows:
$(Y)=F(A.K)$

By performing the differentiation of the previous function:
$Y=A*K$ (1)
$\Delta Y/Y=\Delta A/A+\Delta K/K$ (2)

(Δ) represents the growth rate in transactions. Since saving (S) expresses the increase in capital (ΔK)
To GDP we get:
$S=AK/Y$
$\Delta K=S*Y$ (3)

By replacing Y in equation (3) with its equal in equation (4)
$\Delta AK=S*A*K$ (4)

By replacing (ΔK) in equation (2) with what it equals in equation (4)
$\Delta Y/Y=\Delta A/A+S*A*k/K$
$\Delta Y/Y=\Delta A/A+S*A$ (5)

According to equation (5), the GDP growth rate ($\Delta Y/Y$) depends on the technological growth rate on the one hand, and on the technological level and the level of saving on the other hand. In this regard, Romer emphasized that human capital should be distributed between research, development, innovation and production activities, based on the following hypothesis: "Increasing the proportion of human capital allocated to research, development and innovation will lead to achieving a higher economic growth rate in the long term." Romer argues that the output is determined through the model itself, depending on the level of technological development, which is linked to the level of human capital allocated to research and development activities (14).

Lucas Model (1988)

In endogenous growth theory, technological progress is considered a strategic factor in long-term economic growth along with a set of high-quality qualitative economic determinants represented in the following:

* The quality of human capital that depends on investment in human development (health and education).
* Creating the necessary conditions and requirements to protect thought (intellectual property rights)
*The role of the government in creating a suitable investment climate and attracting new technologies (15)
Lucas pointed out the importance of human capital in light of the insufficiency of physical capital alone to achieve continuous economic growth. According to the model, investment in education and training leads to achieving many gains at both the individual and aggregate levels. On the individual side, it leads to an increase in worker productivity, while on the aggregate level, it works to enhance the rate of economic growth in the long term.

Lucas explained the reason for the increase in the disparity in the growth rate between developed and less developed countries, as he asserts that the marginal productivity of capital increases by increasing the ratio of human capital to in-kind capital, thus achieving the savings that result from working in the presence of more efficient people. Economic growth in developed countries is characterized by being efficient and high-quality compared to less developed countries. This is due to the tendency of in-kind capital to move to countries of the first type, thus increasing the disparity between them. In contrast to the idea of convergence that Solow called for in his model, Lucas asserts that growth and the accumulation of in-kind capital are considered among the most important and prominent factors in the business environment of developed countries in comparison with less developed countries (16).

In this model, the accumulation of human capital is an economic process that requires certain resources, which is the cause of opportunity cost, as it suggests that people can choose one of two ways to spend their time. Participation in the stream of production or accumulation of human capital, in fact. Allocating time between these alternatives has a significant impact on the rate of economic growth, as a decrease in the time a person spends on production leads to a decrease in the production of the current product, but at the same time with accelerated investment in human resources, it increases the growth of the product's output and improves its quality. Therefore, the distinctive feature of this model is the inclusion of the education and human capital factor in the production function (17), and this is done through the mechanism of the individual acquiring skills to improve productivity by devoting time to such acquisition. The cumulative effect of this mechanism leads to an increase in the average level of skills in the economy as a whole through an indirect impact on the productivity of all individuals (18).

Regarding the model's production function, it can be formulated as follows (19):
$Y=K^{B} (HL)^{1-B}$.............(1)

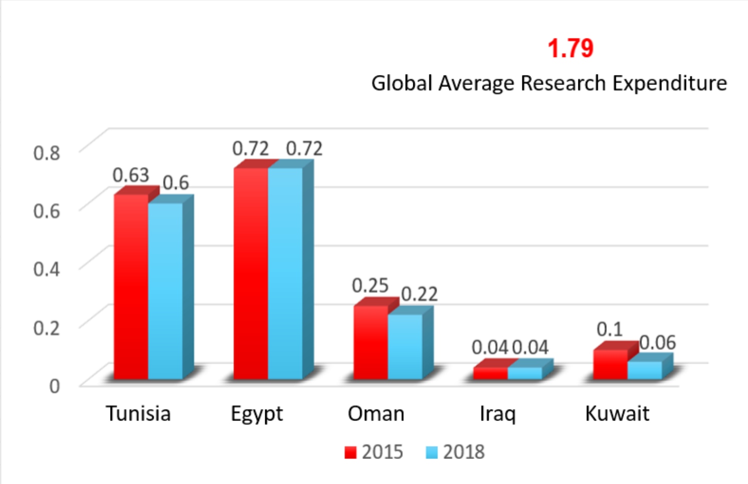
Equation (1) confirms that this model is similar to the Solow model only by replacing (H), which expresses the accumulation of human capital, instead of (A), which expresses technological progress according to Solow, and the accumulation of human capital represents the inventory of technological knowledge and skills that accumulate over time, according to the equation. next:
$h=B(1-u_t)h$..................(2)
u_t =Time period
$(1-u_t)$ = The period of establishing and developing human capital, which is the time period required to acquire technological knowledge.
B=Percentage of output allocated to human capital

From Dependency (2), we note that the focus on obtaining knowledge has a significant impact on increasing economic growth. The greater this factor, the greater its contribution to enhancing the efficiency of human capital and thus driving economic growth in the long term.

Third: Analysis of the efficiency of performance of research and development activities for selected Arab countries

High research spending in some countries is a common justification for low spending on research and development, although some oil-based economies have a high enough GDP to finance research activity, but this spending is still low. However, this argument contradicts the reality of the challenges facing the Arab region (water and food security, economic diversification, social cohesion and the transformations brought about by the Fourth Industrial Revolution), which require greater support for research and development than it currently has, and some Arab countries have implicitly acknowledged this. It worked to enhance the intensity of research, as shown in Figure (1).

Figure (1) Total spending on research and development as a percentage of GDP for the period (2015-2018).



Source: Figure prepared by the researcher based on information extracted from: UNESCO Science Report: the race against UNESCO "UNESCO Science Report: the race against time for smarter development; statistical annex." . 2021p434.

The intensity of funding for research and development in Egypt reached a level of (0.72%) in 2018, and research spending has been rising since 2019, reaching (0.51%). In order to collect and analyze data, the Egyptian Society for Science, Technology and Innovation was established, and this association has published statistics on research. and development since its establishment in 2014, but it does not regularly survey the financing of the business sector (20).

In Tunisia, the percentage of spending on research and development reached (0.63) in 2015, then decreased to (0.6) in 2018. Tunisia and Egypt rank first among the selected Arab countries in terms of the intensity of funding for research and development.

While Oman ranked second in terms of the intensity of funding for research and development, the spending ratio reached about (0.22) in 2015. It rose to (0.25) in 2018.

Kuwait ranked third with a modest spending ratio of (0.10) in 2015, and (0.06) in 2018.

Iraq recorded the lowest percentage of spending on research and development among the sample countries, as the spending percentage reached about (0.04) in 2015.

There is a shortage of world-class researchers, which compounds the challenges resulting from the Fourth Industrial Revolution, which blurs the boundaries between the virtual world and the reality of services such as (biotechnology, nanotechnology and information technology) where cognitive sciences converge to produce new fields such as (bioinformatics and nanorobotics). These areas are rooted in the basic science laboratories of universities, which means that any country that wants to understand these new and cutting-edge technologies must have internal capacity in basic and applied research in order to develop its own technologies. This poses a dilemma for the Arab world, as the researchers cited from all over the world amounted to only about (90) researchers out of (6,100) researchers in the year (21) (2018). Table No. (1) shows the total number of male and female researchers per million population for the period (2015-2018).

Table (1) Percentage of female researchers out of the total number of male and female researchers per million people for the period (2015-2018).

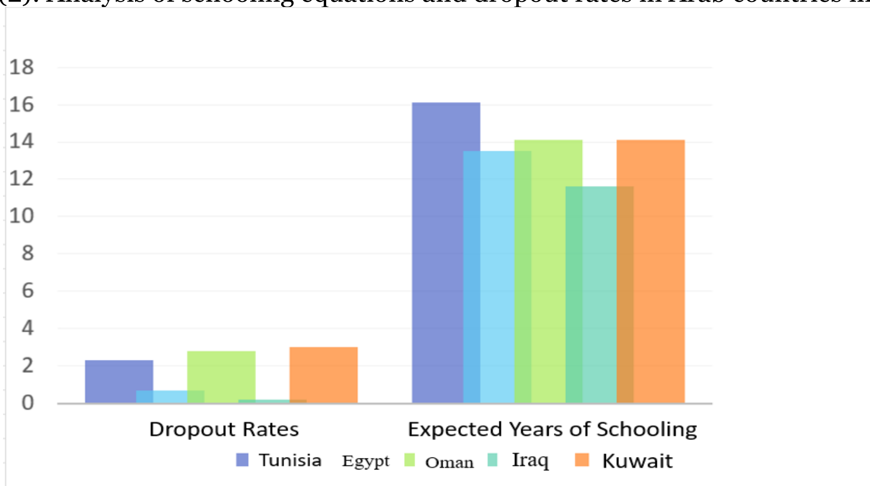
Researchers Per Million Population	Male Researchers *(%)	Total Researchers	Researchers Per Million Population	Female Researchers *(%)	Total Researchers	Country
2018			2015			
281	29.87	1358	213	27.14	907	Oman
514	50.42	2126	396	48.29	1518	Kuwait
111	42.02	4271	66	40.78	2341	Iraq
687	43.80	67589	673	42.56	62208	Egypt
1772	59.15	20489	1799	58.89	20113	Tunisia

Source: Table prepared by the researcher based on information extracted from: UNESCO Science Report: the race against UNESCO"UNESCO Science Report: the race against time for smarter development; statistical annex." programmed and meeting document. 2021 P.S.62.

It is noted from Table No. (1) that Tunisia leads the sample of selected Arab countries in terms of the number of researchers, as the total number of researchers reached (20,113) and the percentage of female researchers

(58.98), while the number of researchers per million people was about (1799) in 2015, then the total number of researchers increased to reach To (20,489) and the percentage of female researchers (59.15) in 2018. Tunisia relied on the efforts of senior scholars and their effective influence in universities and research institutes, as well as granting permanent residency to foreign scientists and doctors in order to train more researchers in the future. This explains why Tunisia topped the sample of selected Arab countries. .
While Egypt ranked second among the sample of selected Arab countries, if the total number of researchers reached (62,208) and the percentage of female researchers reached (42.56) and researchers per million people (673) in 2015, then the total number of researchers increased to reach (67589) and the percentage of female researchers was (43.80).) and researchers per million people (687). Egypt intended to train more researchers compared to the past, which reflects the density of researchers (22).
Kuwait ranked third in terms of density of researchers, as the total number of researchers reached (1,518), the percentage of female researchers was about (48.29), and the number of researchers per million people was about (396) in 2015. Then the total number of researchers increased to reach (21,216) and the percentage of female researchers was (42.02). The ratio of researchers per million people is about 514 in 2018.
Oman ranked fourth in terms of density of researchers, as the total number of researchers reached (907), the percentage of female researchers (27.14), and the percentage of researchers per million people about (213) in 2015. Then the total number of researchers increased to reach (1358), the percentage of female researchers (29.87), and the percentage Researchers per million population (281) in 2018.
Iraq came in fifth place, recording the lowest percentage among the sample of selected Arab countries, where the total number of researchers reached (2341), the percentage of female researchers (40.29), and the percentage of researchers per million people about (66) in the year (2015), then the total number of researchers increased to reach (4271). The percentage of female researchers is (42.02) and the percentage of researchers per million people is about (111) in (2018).
In this regard, Arab magazines obtain an average quality of (8.308) according to the Hirsh index, on par with magazines from Eastern Europe (8.740). Half of the Arab journals specialize in the field of health care and medicine, noting that there is a research focus on the areas of sustainability, especially the topics of photovoltaics and smart grid technology. This was according to a study conducted by UNESCO that included (56) research topics related to the goals of sustainable development. The European Union is still a partner with many Arab countries, as Tunisia, Algeria, Egypt, and the Maghreb signed a partnership agreement with the European Union for research and innovation in the Mediterranean region during the year (2017-2018). This agreement works to discover new methods of research and innovation (23).
The Arab average for years of schooling is estimated at about (12.1) years (2019), and this is considered less than the average for countries with high human development, which reached about (13.7). It is also lower than the average for all countries of the world, which amounted to about (12.7) in the same year. Regarding dropout rates from education in Arab countries, the data indicate that this rate reached about (11.5), which is higher than the global average of about (8.9) (24). Figure No. (2) shows the schooling equations and dropout rates in the selected Arab countries.

Figure (2): Analysis of schooling equations and dropout rates in Arab countries in (2019).



Source: Figure prepared by the researcher based on data extracted from: the Arab Monetary Fund. "Unified Arab Economic Report 2021." Arab Monetary Fund 12-31-2021. p. 52.
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The level of women's education in Arab countries is still below the global level at all levels of education, and this situation has had a negative impact on women's participation in the fields of science, technology and innovation. At the global level, it is noted that there is a wide gap between the sexes with regard to levels of education and participation in scientific research (25).

Conclusions

The techno-economic reality in the selected Arab countries is consistent with the research hypothesis, which confirmed that there is a relationship between spending on the research and development sector and economic growth in the long term, meaning that the ability of the economic environments to keep pace with technological progress is coupled with the development of the level of maturity in supporting the research and development sector in order to improve Competitive advantages in the international market and achieving greater opportunities for economic growth. Given the insufficient resources allocated to such activities in Arab countries and the lack of clearly defined national policies, which undermines the effectiveness of creative performance and leads to a widening of the gap between Arab countries individually and collectively compared to developed countries.

The increasing contribution of intangible assets to the added value, the basis of which is intellectual capital. The selected Arab countries suffer from structural imbalances, especially in light of the great challenges resulting from the rise in global interest rates, which have a direct impact on the economies of the region. Participation in the knowledge future occurs through embracing technological progress, supporting development based on scientific knowledge, and monitoring modern skills critical to the transformative capabilities that... Promotes resilience and creates sustainable growth.

Margins

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