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Science and Technology Development Indicators in the Arab Region: A Comparative Study of Gulf and Mediterranean Arab Countries

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SCIENCE AND TECHNOLOGY DEVELOPMENT INDICATORS IN THE ARAB REGION: A COMPARATIVE STUDY OF GULF AND MEDITERRANEAN ARAB COUNTRIES

Samia Satti O. M. Nour*

Abstract

This paper employs both descriptive and comparative approaches to discuss science and technology (S&T) development in Arab countries in the Gulf and Mediterranean regions. Throughout the paper we use the Organisation for Economic Cooperation and Development's definition of S&T indicators (OECD, 1997). From this research we find that neither the Gulf nor the Mediterranean countries investigated possess sufficient human or financial resources to promote S&T performance. We show that the low level of resources devoted to S&T development together with inadequate economic structures mean that the Gulf and Mediterranean Arab countries lag behind the world's advanced and leading developing countries in terms of S&T input and output indicators. In both regions, most of the research, development and S&T activities occur within public and academic sectors, with only a very small contribution from the private sector. When comparing S&T indicators between the two Arab regions we find that despite the high standard of economic development in the Gulf countries, as measured by gross domestic product per capita and the human development index, it is the Mediterranean countries that perform better in most of the S&T input and output indicators. Furthermore, we show that there is very limited scientific cooperation within and between the Gulf and Mediterranean countries as well as between them and other Arab countries. In contrast, three Arab countries from the Mediterranean region – Morocco, Algeria and Tunisia – show active scientific cooperation with the international community, especially the OECD and France in particular. This implies that social proximity (sharing similar language, culture, etc.) can hardly help regional scientific cooperation within the Arab world; it is geographical proximity to Europe that motivates these countries' international scientific cooperation.

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TABLE OF CONTENTS

1. INTRODUCTION

In recent years, a new economic system has evolved that is characterized by both globalization and the rise of information and communication technologies. This has driven the need for development in science and technology (S&T), which has become more than simply an element of economic growth and industrial competitiveness, but is now also essential for improving social development, the quality of life and the global environment. For instance, the high level of economic and social development in today's industrialized countries is largely the result of past intensive investment in S&T; similarly, newly industrialized countries are catching up because of their active development of S&T.

"*Access to scientific and technological knowledge and the ability to exploit it are becoming increasingly strategic and decisive for the economic performance of countries and regions in the competitive globalized economy. The 50 leading S&T countries have enjoyed long-term economic growth much higher than the other 130 countries of the rest of the world. Between 1986 and 1994 the average growth rate of this heterogeneous group of countries was around three times greater than that of the rest of the world. The average economic wealth per capita of these 50 countries has grown by 1.1% per year. On the other hand, the per capita income of the group of 130 countries – which perform less well in education, science and technology – has fallen over the same period by 1.5% per year. These trends prefigure a new division of the global economy, based on access to knowledge and the ability to exploit it*". (OECD 1997, ix)

Hence, within this context, the aim of this paper is to assess S&T development indicators within the Arab region and, in particular, to compare the S&T development of those in the Mediterranean with those in the Gulf, and to compare them to countries in the rest of the world.[1] Given the recent progress of economic globalization coupled with the emergence of new nations active in S&T in different parts of the world, this paper extends the comparison to include these new countries as well as those in Europe, the United States and Japan, and then draws some policy implications and recommendations for ways to enhance S&T performance in the Arab region.

[1] The Mediterranean region includes eight Arab countries or territories: Algeria, Egypt, Lebanon, Libya, Morocco, Palestine, Syria and Tunisia, while the Gulf includes six Arab countries: Bahrain, Kuwait, Oman, Qatar, Saudi Arabia and the United Arab Emirates (UAE).

This study differs in several ways from the European Second Report on S&T Indicators (OECD 1997)[2], which provides an excellent and in-depth analysis of S&T performance in the Mediterranean countries. First, we distinguish between the Arab Mediterranean countries and the non-Arab Mediterranean countries. Secondly, we extend our analysis to compare Arab countries in the Mediterranean with those of the Gulf. Thirdly, we attempt to use more up-to-date data wherever possible. This is so we can help establish the information base necessary to stimulate S&T development and support new policies that aim to enhance S&T performance in the Arab region. This kind of study highlights recent efforts to create an active Arabian S&T base but also emphasizes the need to improve the quality of resources devoted to S&T development, which will ultimately contribute to and accelerate development in the region. Furthermore, it also helps governments to obtain the most positive impact possible from technological progress in terms of growth, employment and the well-being of all Arab citizens.

The paper is organized in the following way: section 2 discusses the literature available, focusing on the definition and significance of S&T indicators. Section 3 shows the general socio-economic characteristics of the two groups of Arab countries. Section 4 discusses S&T development indicators in the Arab countries, including a comparison of the indicators for Mediterranean and Gulf countries, and then compares the Arabian region with the rest of the world. Finally section 5 draws conclusions and proposes policies to enhance S&T performance in the Arab region, based on the experiences of other countries.

[2] In our view the only shortcoming of the excellent and comprehensive analysis offered by the European Second Report on S&T Indicators (OECD 1997) is the lack of information on Palestine and Libya, which constrained our attempts to fill this gap.

2. THE DEFINITION AND SIGNIFICANCE OF SCIENCE AND TECHNOLOGY INDICATORS

The S&T system is often defined as consisting of all the institutions and organizations essential to the education of scientific people, for example, research and development (R&D) institutions, professional societies and professional organizations linking individual scientists to each other and to their socio-economic environment. The theoretical and empirical literature identifies the important role that S&T plays in promoting economic growth and development in both developed and developing countries.[3]

More recent literature addresses the contribution to S&T performance of the 'national systems of innovation'; a widely used modern term that reflects the link between technical and institutional innovative development, including S&T (e.g. Lundvall 1992; Nelson 1993). Lundvall says this broad definition includes "all parts and aspects of the economic structure and the institutional set-up affecting learning as well as searching and exploring – the production system, the marketing system and the system of finance present themselves as subsystems in which learning takes place" (Lundvall 1992, 12–13). In addition, Freeman and Soete argue:

"The many national interactions (whether public or private) between various institutions dealing with science and technology as well as with higher education, innovation and technology diffusion in the much broader sense, have become known as 'national systems of innovation'. A clear understanding of such national systemic interactions provides an essential bridge when moving from the micro- to the macro-economics of innovation. It is also essential for comprehending fully the growth dynamics of science and technology and the particularly striking way in which such growth dynamics appear to differ across countries", (Freeman and Soete 1997, 291).

All the definitions of the systems of innovation share the view that S&T institutions play a vital role in determining or influencing innovation and development.

The literature on S&T development often distinguishes between input (resources) and output (performance) indicators. For instance, the European Second Report on S&T Indicators (OECD 1997) discusses numerous traditional input and output indicators for S&T development. The input indicators are generally divided into financial and human resources. First financial resource or input indicator includes "R&D expenditure – the most widely accepted indicator for

[3] For detailed theoretical and empirical literature and assessment studies, see e.g. Freeman and Soete (1997), Dasgupta and David (1994), Foray (1999), Mytelka (2001) and Cooper (1991, 1994). For earlier analyses of S&T in the Arab region, see e.g. Qasem (1998a, b), Zahlan (1999a, b), Fergany (1999), ESCWA (1999a, b), and ESCWA–UNESCO (1998a, b).

evaluating and comparing S&T efforts in different countries and regions. In the absence of an average measurement to determine R&D within the economic structure and the needs of each country, political decision-makers use indicators such as the intensity of R&D (measured as a percentage of GDP or per capita)… In addition to financial resources, human resources are central to research and technological innovation activities”. There are also general demographic and human capital indicators, “such as the number of science and technology graduates and the number of scientists and engineers employed in R&D… [There are] four major points relating to human capital: demographic trends, the development of public spending on education, the performance of education systems and researchers and engineers active in R&D”. Furthermore, “Human resources in science and technology (HRST) are one of the key resources for economic growth, competitiveness and more general social, economic and environmental improvement”, (OECD 1997, 5, 58, 59).

Output indicators, on the other hand, “can be classified according to three parameters: economic, technological and scientific. As to economic outputs, many economists view increases in productivity as a major result of technological investment… The percentage of high-tech exports in total export figures emerges as a potentially useful means of measurement… Clearly not all results are measurable in economic terms. Scientists and engineers often cite the ‘learning experience’ as one major benefit of engaging in R&D activities. To assess the accumulated knowledge of a given country, its stock of technical knowledge must be quantified. Without doubt, patents and patents applications are the most commonly applied indicator in this respect and, irrespective of the shortcomings implicit in this approach, they continue to represent a very useful tool”. Finally there are direct research outputs or publications, “focusing on the impact of the publication output of a given country or zone and comparing it to the number of publications produced over a certain period of time” (OECD 1997, 79).

We use these definitions and the summary in Box 1 to evaluate S&T performance in section 4.

Box 1. Definition of S&T input and output indicators	
Types	S&T Indicators/Variables
S&T Input: Financial and Human Resources	1. Financial resources: percentage of R&D expenditure to GDP or expenditure per capita, R&D area of performance, and origin of funding change in public spending on education in relation to GDP 2. Human resources: HRST – the human capital engaged in science and R&D including the number of scientists and engineers employed in R&D total population size and proportion of young people, which represent the human resources potential of each country educational attainment of the labour force and graduation rates, which show the rate at which newly educated graduates are available at the country level to enter the labour force, particularly the scientific and technological qualifications and doctorate levels, including R&D staff numbers, particularly in S&T fields
S&T Output: Economic, Technological and Scientific Performance	1. Economic indicators: growth in productivity/economic outputs as a major result of technological investment percentage of high-technology exports in total exports 2. Technological indicators number of patents and patent applications 3. Scientific performance direct research output number of publications produced over a certain period of time

3. GENERAL SOCIO-ECONOMIC CHARACTERISTICS OF GULF AND MEDITERRANEAN COUNTRIES

S&T performance is often closely related not only to the resources directly devoted to its development but also to the whole economic structure that supports it. Therefore, before assessing S&T performance in the Gulf and Mediterranean Arab countries it is useful to explain the general socio-economic characteristics of the two groups of countries. Table 1 shows the demographic structure and the major socio-economic characteristics for this region.

Table 1. General socio-economic characteristics of the Arab countries[4]

Country	Population[a] (millions)	GDP per capita[b] (PPP[d] US $)	Human Development Index[b] (%)	Life Expectancy[b] (years)	Literacy Rate[b] (%)	Combined enrolment ratio[c] (%)
Arab Gulf countries						
High income						
United Arab Emirates	2.9	20,530	0.816	74.4	76.7	67
Qatar	0.6	19,844	0.826	71.8	81.7	81
Kuwait	2.4	18,700	0.820	76.3	82.4	54
Bahrain	0.7	16,060	0.839	73.7	87.9	81
Upper middle income						
Oman	2.7	12,040	0.755	72.2	73.0	58
Saudi Arabia	22.8	13,330	0.769	71.9	77.1	58
Average Gulf countries	5.4	16,751	0.804	73.4	79.8	67
Arab Mediterranean						
Upper middle income						
Lebanon	3.5	4,170	0.752	73.3	86.5	76
Libya	5.3	7,570	0.773	70.5	80.0	92
Lower middle income						
Tunisia	9.6	6,390	0.740	72.5	72.1	76
Algeria	30.7	6,090	0.704	69.2	67.8	71
Egypt	69.1	3,520	0.648	68.3	56.1	76
Syria	17.0	3,280	0.685	71.5	75.3	59
Morocco	29.6	3,600	0.606	68.1	49.8	51
Palestine	3.3	Na	0.731	72.1	89.2	77
Average Arab Mediterranean	21.0	4,946	0.705	70.7	72.1	72
Average Arab states	289.9	5,038	0.662	66.0	60.8	60

Source: UNDP (2003). Notes: [a] 2001, [b] 2000, [c] 1999, [d] PPP – purchasing power parity.

[4] The World Bank and United Nations Development Programme (UNDP) Human Development Report classify world countries differently according to income level. We use the World Bank classification of economies that puts all the Arab Mediterranean countries in the lower middle-income category with the exception of Lebanon and Libya, which are classified in the upper middle-income group.

Table 1 shows the considerable diversity between Gulf and Mediterranean Arab countries in terms of population, standard of economic development as measured by GDP per capita and human development index. Gulf countries generally have lower population numbers and higher standards of economic development. The World Bank classification of economies indicates that four of the Gulf countries are in the high-income group and the other two are among the upper middle-income economies. Moreover, the UNDP human development index (HDI) shows that the GDP per capita is higher for these countries than for both the Mediterranean countries and the world average, while life expectancy and literacy rates are classified as high in four of the Gulf countries; the other two are among the medium world countries.

In contrast, the Mediterranean Arab countries have both large geographical and population sizes coupled with low standards of economic development and growth indicators as measured by GDP per capita. The World Bank classification of economies puts all but two of the Arab Mediterranean countries among the lower medium-income group; Libya and Lebanon are classified in the upper medium-income economies. Moreover, the UNDP HDI shows that the average GDP per capita for each of the Mediterranean countries falls within the world medium-income bracket and is, on average, lower than for those of the Gulf countries. This also holds for the other HDI components: average life expectancy, literacy rate and combined enrolment ratios. Among the Arab Mediterranean countries, Lebanon, Libya and Tunisia show better performance in terms of GDP per capita and HDI compared to the others in the region, while the combined enrolment ratio is highest in Libya, followed by Palestine. For the Gulf countries, Bahrain, Kuwait, Qatar and the UAE show better performances in terms of the majority of indicators than either Saudi Arabia or Oman.

According to the UNDP indicators, poverty is widespread across most of the Mediterranean Arab countries especially in Egypt and Algeria, while none of the Gulf countries reportedly shares the same problem. Moreover, according to estimates from the International Monetary Fund’s World Economic Outlook (IMF 2002), average unemployment rates across the Mediterranean countries exceed those of the Gulf countries. However, trends in unemployment rates show either a slowing increase or an actual decline across the Mediterranean Arab countries compared to the rapid increase seen across the Gulf countries.

The next section of this paper examines whether this economic background affects S&T performance in the Gulf and Mediterranean countries.

4. S&T INDICATORS IN THE GULF AND MEDITERRANEAN COUNTRIES

Based on the definition of S&T indicators provided in section 2, this section presents the input indicators (financial and human resources) and output indicators (scientific and technological performance) required to measure S&T performance.

4.1. Human and Financial Input Indicators

In terms of both financial and human S&T input/resource indicators there are some differences between the Arab Gulf and Mediterranean countries as well as between them and other countries around the world. Table 2 shows that on the whole both financial and human S&T input indicators in these regions lag behind those of the advanced and leading developing countries.

4.1.1. Financial Input Indicators

In particular, table 2 shows that the financial resources devoted to S&T, as measured by the percentage share of GDP spent on R&D, are poor in the Arab countries compared to both advanced and leading developing countries like Singapore and Korea. For instance, in the period 1996–2000, the Arab Mediterranean and Gulf countries devoted an average of only 0.3% of their GDP to R&D whereas Sweden, one of the leading advanced industrial countries, spent 3.8% of GDP on R&D. However, spending on education, as measured by percentage of both GDP and total government expenditure, was found to be similar for the Arab countries and the advanced countries.

Comparing S&T indicators between the two Arab regions shows that the Mediterranean countries on average perform better than the Gulf countries in terms of expenditure on both education and R&D as percentage of GDP.

Table 2. S&T resource indicators of the Gulf, Mediterranean and world countries

Country	Public expenditure on education as % of GDP [a]		Public expenditure on education as % of government expenditure [a]		R&D expenditure as % of GDP [a]	Number of scientists and engineers in R&D (per million population) [a]	Number of patents [a, b]	High technology exports as % of manufactured exports [a]	
	1990	1998–2000	1990	1998–2000	1996–2000	1996–2000	1990–1999	1990	2001
Gulf countries									
Bahrain	4.2	3.0	14.6	11.4	Na	Na	2	0	0
Kuwait	4.8	Na	3.4	Na	0.2	212	27	4	1
Oman	3.1	3.9	11.1	Na	Na	8	3	11	3
Qatar	3.5	3.6	Na	Na	Na	591	0	0	0
Saudi Arabia	6.5	9.5	17.8	Na	Na	Na	103	0	Na
UAE	1.9	1.9	14.6	Na	Na	Na	15	0	Na
Average Gulf	4.0	4.4	12.3	11.4	0.2	270	25	2.5	1
Mediterranean countries									
Algeria	5.3	Na	21.1	Na	Na	Na	Na	0	4
Egypt	3.7	Na	Na	Na	0.2	493	38	0	1
Lebanon	Na	3.1	Na	11.1	Na	Na	Na	Na	3
Morocco	5.3	5.5	26.1	26.1	Na	Na	Na	0	11
Syria	4.1	4.1	17.3	11.1	0.2	29	3	0	1
Tunisia	6.0	6.8	13.5	17.4	0.5	336	Na	2	3
Average Mediterranean	4.9	4.9	19.5	16.4	0.3	286	20.5	0.4	3.8
Norway	7.1	6.8	14.6	16.2	1.7	4,112	97	8	12
Sweden	7.4	7.8	13.8	13.4	3.8	4,511	285	13	18
UK	4.9	4.5	Na	11.4	1.8	2,666	76	23	31
Korea, Rep. of	3.5	3.8	22.4	17.4	2.7	2,319	931	18	29
Singapore	Na	3.7	Na	23.6	1.1	4,140	12	39	60
China	2.3	2.1	12.8	Na	0.1	545	793	0	20

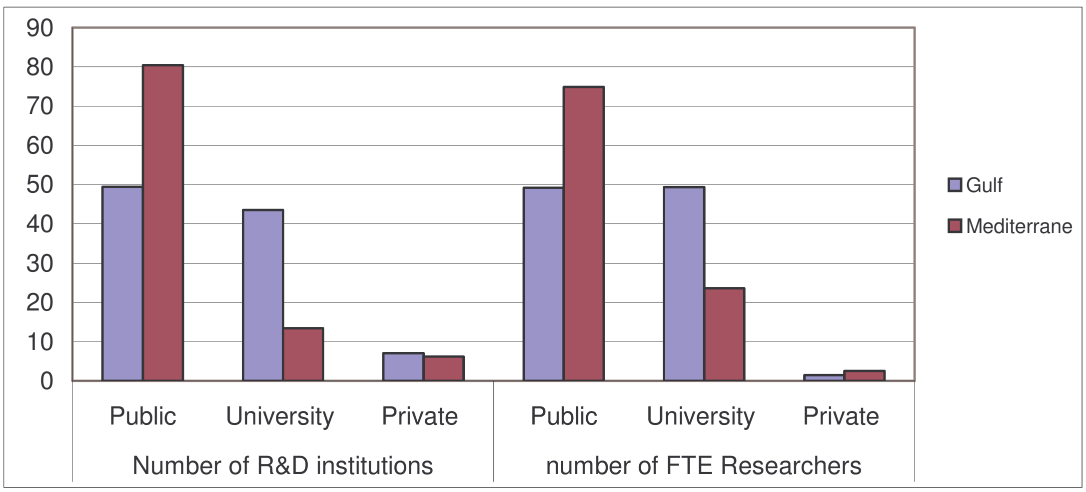
Sources: [a] UNDP (2003), [b] United States Patent and Trademark Office (USPTO) website: http://www.uspto.gov. Patent data for Korea, Norway, Singapore, Sweden and the UK obtained from UNDP (2003) and refers to patents granted in 1999 to residents per million people. For China and all Arab countries, patent data was obtained from USPTO during 1991–1999 and refers to the number of registered US patents where the inventor of the patent is resident in the selected countries. [5]

Investigation of the distribution of R&D in Gulf and Mediterranean Arab countries indicates that the public sector is responsible for the majority of R&D activities, accounting for 49.4% and 80.4% of all R&D institutions respectively (figure 1). Next to public sector, universities

[5] One limitation of the comparison in our analysis is that we use data and information from two different sources; the scarcity of data and information covering all countries limited our attempt to use a unified source. For instance there was no data covering Libya or Palestine.

contribute 43.5% and 13.4% of R&D institutions in Gulf and Mediterranean countries respectively; the private sector makes only a minor contribution, accounting for 7.0% and 6.2% of R&D institutions respectively. The Mediterranean countries appear to be more dependent on the public sector than the Gulf countries, reflecting a lack of incentives for private sector institutions to invest in R&D in the Mediterranean compared to the Gulf. This compares poorly to most of the industrialized countries, where more than half of R&D expenditure is financed by industry (OECD 1997).

Figure 1. Percentage distribution of R&D in the Gulf and Mediterranean Arab countries



Source: Adapted from ESCWA–UNESCO (1998b). Notes: Refers to 1995. FTE – full-time equivalent.

4.1.2. Human Resources Input Indicators

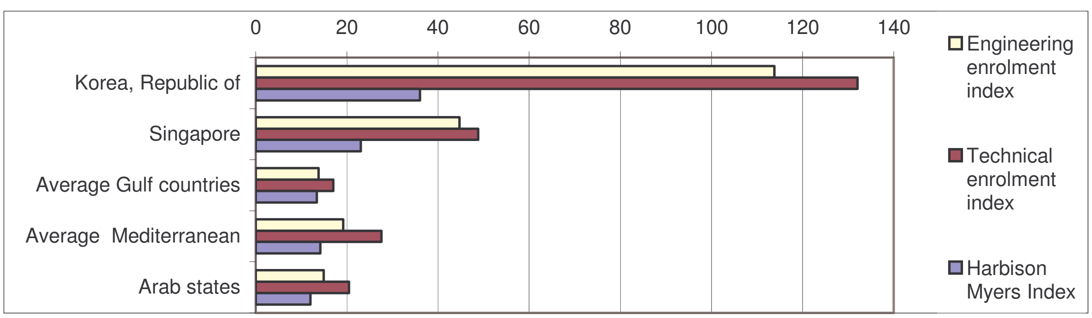
Table 2 shows that there is a low number of scientists and engineers in R&D in the Gulf and Mediterranean countries compared to both advanced and leading developing countries. Moreover, the OECD (1997) Second European Report on S&T Indicators shows that there is proportionally 10 times fewer R&D personnel in the Mediterranean countries than in the European Union.

When comparing the two Arab regions, it is the Mediterranean countries that show a marginally better performance than the Gulf countries in terms of the number of scientists and engineers in R&D.

In terms of the human resources devoted to R&D, defined by the number of full-time equivalent (FTE)[6] researchers, and their distribution within R&D organizations (figure 1), we find that the majority of FTE researchers are employed by public and university sectors. The percentage share of FTE researchers in the public sector is estimated to be 49.2% and 74.9% in the Gulf and Mediterranean Arab countries respectively. Next to the public sector, it is the university sector that has the largest percentage share of FTE researchers: at 49.3% and 23.6% respectively; the private sector accounts for only 1.4% and 2.6% of total FTE researchers in the regions. As with the distribution of R&D institutions, it is the Mediterranean countries that appear to be more dependent on the public sector for FTE researchers than the Gulf countries. Again, it is the lack of incentives for private sector institutions to hire FTE researchers that leads to this disparity.

In addition, there are fewer human resources in S&T in both the Gulf and Mediterranean Arab countries compared to more developed countries, shown in figures 2 and 3. The Arab countries score poorly compared to Korea and Singapore for the Harbison Myers Index[7], technical enrolment index, engineering enrolment index, gross enrolment ratio at tertiary education and the share of tertiary students in science, mathematics and engineering.[8] The only exception (not shown in figure 3) is the share of tertiary students in science, mathematics and engineering in Algeria, which is higher compared to both advanced and developing countries (UNDP 2004).

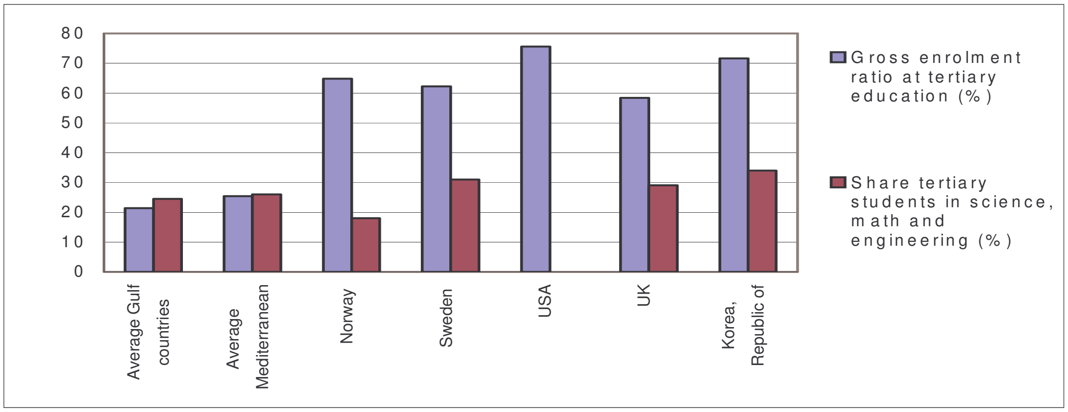
Figure 2. Skill indicators in Korea, Singapore and the Arab countries



Source: Adapted from Lall (1999).

[6] The concept of full–time equivalent researcher is adopted by UNESCO statistics on R&D personnel.
[7] According to Lall (1999): "Harbison Myers Index is the sum of secondary enrolment and tertiary enrolment times five, both as a percentage of age group. Technical enrolment index is tertiary total enrolment (times 1000) plus tertiary enrolment in technical subjects (times 5000), both as a percentage of population. Engineering skills index is the same as the previous index, with tertiary enrolments in engineering instead of enrolment in technical subjects" (Lall, 1999: p.52).
[8] See also Muysken and Nour (2005) and UNDP–AHDR (2003).

Figure 3. Percentage enrolment at tertiary education



Source: Adapted from UNDP (2002).

When comparing average skill indicators for the Arab Gulf countries with those of the Mediterranean, figures 2 and 3 indicate that, on average, the Mediterranean countries perform better. Additional information from Lall (1999) and UNDP (2004) indicate that all these skill indices are especially high in Lebanon and Kuwait, while the gross enrolment ratio at tertiary education is highest in Egypt and Lebanon followed by Qatar and Bahrain. The share of tertiary students in science, mathematics and engineering is highest in Algeria, followed by Syria, Oman, Morocco, the UAE and Tunisia. With the aforementioned exception of Algeria, enrolment in science, mathematics and engineering is lower than enrolment for all other subjects in both Mediterranean and Gulf countries. In addition, school-leaving age is highest in Tunisia, Qatar, Bahrain and Lebanon.

4.2. Science and Technology Output and Impact

As we explained briefly in section 2, the literature distinguishes between S&T outputs, which can be measured in terms of publications and patents, and S&T impact, which can be measured in terms of economic growth. This section discusses S&T output as measured by number of patent filings and scientific publications (in the international refereed literature) but discusses S&T impact as measured only by the share of high-technology manufacturing exports. Owing to limitations concerning data availability it is not possible to address the impact of technological development on economic/productivity growth in much detail.

We integrate the findings in section 3, concerning the general economic characteristics of the Arab economies, with those of section 4.1, regarding S&T input indicators. Using a systematic approach we assess S&T performance in terms of inputs and the economic system as a whole. Our analysis aims to explain the connection between the S&T system, S&T profile and the economic or productive structure of these countries. For example, table 2 shows that for both patent numbers and the percentage of high-technology exports Arab Gulf and Mediterranean countries are substantially behind the advanced and leading developing countries.

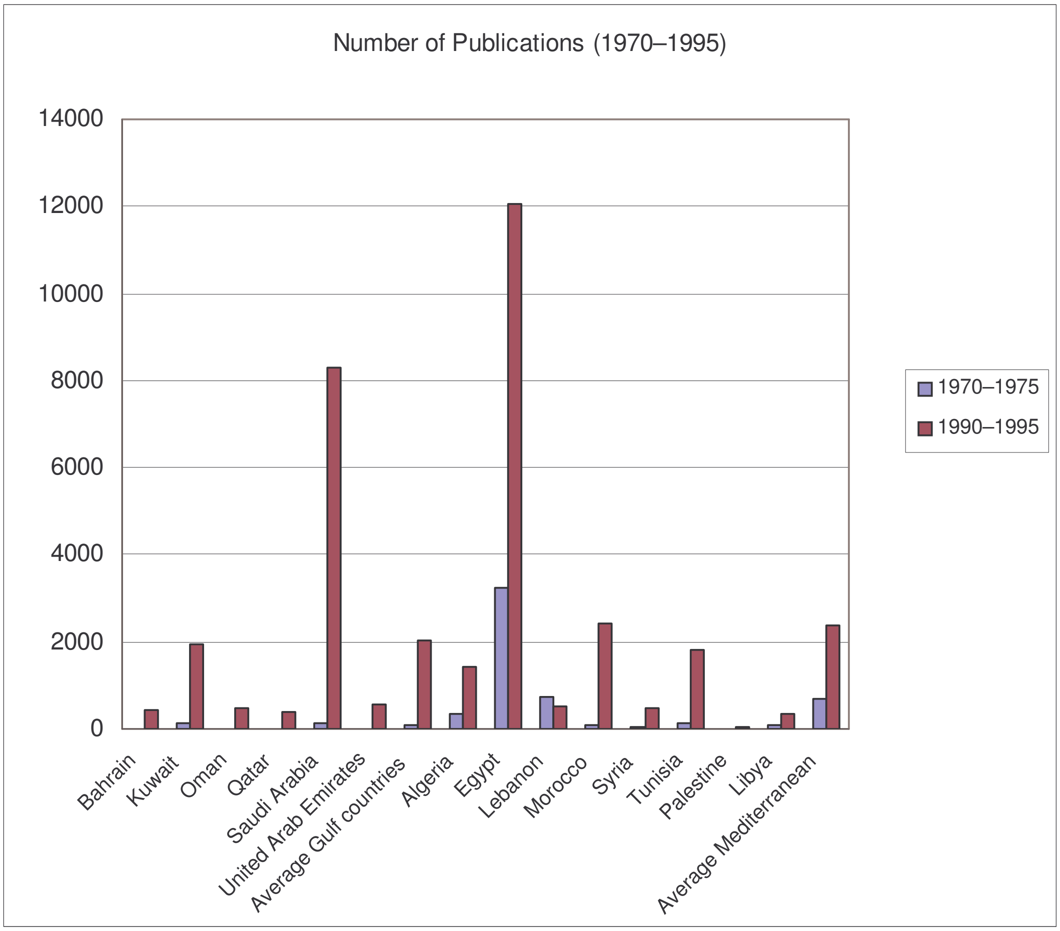
In our view, which is backed up by general S&T literature, the weakness of the S&T base in the Arab regions should be interpreted not only in terms of a lack of appropriate inputs but also in relation to a poor economic system as a whole. Measuring the strength of the economic and welfare systems using income per capita implies that the Gulf countries do very well. However, they also exhibit low S&T activity, which seems at odds with the idea that strong S&T is necessary for economic growth and development. Of course, the Gulf is hugely dependent on oil, giving the impression that there are other ways to become rich than investing in S&T. The big question is whether the Gulf countries will stay rich once their oil reserves expire; despite their big wealth from oil they still lack well-defined, targeted plans and policies and proper incentives to promote S&T performance. For while the Gulf countries perform better than the Mediterranean countries in economic terms they lag behind in measurements of S&T performance. Therefore, the big wealth from oil, far from contributing to the improvement of S&T performance in the Gulf may actually hinder it as it masks the need to develop incentives and effective policies to enhance S&T development. The Mediterranean countries' story is simpler: poor economic structure in combination with inadequate resources devoted to S&T development leads to poor S&T performance compared to advanced and developing world countries.

4.2.1. Scientific Publications[9]

Figure 4 shows that the number of scientific publications for both Gulf and Mediterranean countries grew between the periods 1970–1975 and 1990–1995. On average, Mediterranean countries performed better than Gulf countries for number of scientific publications, which could be a consequence of their superiority to the Gulf countries in terms of most of the S&T indicators: total expenditure on both education and R&D; number of R&D employees; and number of R&D scientists and engineers. Egypt and Saudi Arabia show the largest overall numb

[9] The OECD (1997) report indicates that prizes awarded to individual scientists is an extreme indicator of S&T performance and is one way of measuring R&D output. Of all scientific prizes the Nobel prizes for science, which have been awarded to scientists in the fields of chemistry, physics and medicine/physiology since 1901, are probably the most prestigious. The Arab Gulf and Mediterranean countries have only received one Nobel Prize between them: in 1999 an Egyptian scientist received the Nobel Prize for chemistry.

Figure 4. Number of S&T publications in the Gulf and Mediterranean countries



Source: Adapted from Zahlan (1999b).

Table 3 indicates that, of the Arab Mediterranean countries, Egypt has the best percentage share of total world scientific publications. However, the average share of all Arab Mediterranean countries remains very low compared to those of the United States, European top 15 and non-Arab Mediterranean countries. Moreover, the percentage share of both total papers published and number of citations in publications in the region is much lower for any of the Arab Mediterranean countries than the non-Arab Mediterranean countries (Turkey and Israel specifically). Again, Egypt leads the Arab Mediterranean countries in this indicator, followed by the group of Algeria, Morocco and Tunisia and then the group of Albania, Cyprus, Lebanon, Malta and Syria. Furthermore, in the period 1985–1995, it is Morocco, Algeria and Tunisia that display the most coordination, cooperation and networking with the European top 15 countries in terms of internationally co-authored papers.

Table 3. Technology output indicators by share of the world's scientific publication output, published papers, citations and internationally co-authored papers

Countries	Share in world's publication output in all scientific fields combined (%)		Share of published paper and citation in the Mediterranean countries (%)				Mediterranean countries' share of internationally co-authored papers with EUR 15 (%)			
	1985-1989	1990-1995	1985-1989		1990-1995		1985	1989	1990	1995
			Papers	Citation	Papers	Citation				
Egypt	0.27	0.29	16.5	16.5	5.7	15.6	8.0	7.5	9.7	11.2
Algeria/ Morocco/ Tunisia	0.08	0.13	4.6	4.6	2.4	6.7	40.4	56.4	54.7	58.7
Lebanon/ Syria/ Malta/ Albania/ Cyprus	0.03	0.04	1.9	1.9	0.7	2.0	23.7	30.7	21.1	48.5
Average Arab Mediterranean [1]	0.13	0.15	7.7	7.7	2.9	8.1	24.0	31.5	28.5	39.5
Average Non-Arab Mediterranean [2]	0.65	0.72	38.6	38.6	45.6	37.9	9.3	12.4	9.4	12.3
EUR 15	30.42	33.92	Na	Na	Na	Na	Na	Na	Na	Na
USA	36.33	35.82	Na	Na	Na	Na	Na	Na	Na	Na

Source: Adapted from RASCI Data: Science Citation Index, OECD (1997). Pp. 455, 460.

Notes: [1]Refers to average for each group: Egypt; Algeria/Morocco/Tunisia; and Albania/Cyprus/Lebanon/Malta/Syria. [2]Refers to average for Turkey and Israel.

Despite, the increasing importance of international cooperation, there is very limited cooperation among scientists in both Arab Gulf and Mediterranean countries as indicated by the number of joint publications and co-authorships (table 4). In particular, it is scientists from the Gulf countries who lag behind, accounting for less than 2% of worldwide cooperation. Zahlan (1999a) finds that in 1990, co-authorship within the Gulf countries was only 1.4% of all co–authored papers; this increased to 3% in 1995. Such limited regional cooperation is also true for the Mediterranean countries, for instance in 1995 scientists in the Maghreb countries of Algeria, Morocco and Tunisia published 1,206 publications. Of these, 769 were co-authored with scientists from other countries yet only 11 included scientists from two Maghreb countries. Furthermore, only one out of the 11 did not involve an OECD partner.

Table 4. Scientific cooperation: total number of publications and joint publications in the Gulf and Maghreb countries

Country	Total number of published papers		Number of joint papers		Co-authored with GCC[1] partners		Co-authored with Arab partners		Main Arab partners	
									Egypt	
Gulf countries	1990	1995	1990	1995	1990	1995	1990	1995	1990	1995
Bahrain	59	106	17	29	3	2	2	1	-	1
Kuwait	487	290	132	117	0	14	12	12	10	11
Oman	48	84	25	37	0	0	1	0	1	-
Qatar	48	59	19	36	2		6	24	6	23
Saudi Arabia	1,031	1,240	242	294	6	9	59	71	48	57
UAE	49	137	33	55	2	10	13	19	10	14
Total Gulf	1,722	2, 716	468	568	13	35	93	127	75	106
	Total number of published papers		Number of joint papers		Co-authored with OECD partners		Co-authored with Arab partners		Main partners	
									France	
Maghreb countries	1990	1995	1990	1995	1990	1995	1990	1995	1990	1995
Algeria	172	328	137	227	120	187	4	3	90	151
Morocco	240	536	153	395	132	314	0	2	90	241
Tunisia	268	342	77	147	69	122	0	3	55	87
Total Maghreb	680	1206	367	769	321	623	4	8	235	479
Libya [2]	58	58	31	35	11	16	3	7	11	9
Total Mediterranean	738	1264	398	804	332	639	7	15	246	488

Source: Adapted from Zahlan (1999a).

Notes: [1] GCC – Gulf Cooperation Council including Bahrain, Kuwait, Oman, Qatar, Saudi Arabia and the United Arab Emirates. [2] The main partners for Libya are India (1990) and UK (1995).

As shown in table 4 there is an absence of scientific cooperation and co-authorship among scientists from the Gulf and Mediterranean countries as well as between them and other Arab countries. Where Gulf countries do cooperate with Arab scientists, it tends to be limited to only a small number of countries. According to Zahlan (1999a) this is because universities in Gulf countries employ professors mainly from other Arab countries. Similarly, in the Mediterranean Arab region, cooperation between Maghreb countries and other Arab scientists accounts only for 3.0% and 3.5% of all co-authored published papers in 1990 and 1995 respectively (Zahlan, 1999a).

Arab countries in the Gulf have only limited cooperation with foreign institutes. For instance, while the number of the published papers in the Gulf countries increased from 1,722 in 1990 to 2,716 in 1995, fewer than a quarter were co-authored with foreign institutes. This contrasts with the Mediterranean Arab countries, particularly the Maghreb countries that have significant cooperation with the OECD: papers co-authored with OECD countries accounted for 90.0% and 81.3% of total joint publications in 1990 and 1995 respectively. Of all the OECD countries France has the highest share of joint papers with Algeria, Morocco and Tunisia, comprising 67.0% and 61.7% of total joint papers in 1990 and 1995 respectively. These data are backed up by Zahlan (1999a) who finds that scientific workers in the Maghreb are deeply integrated with the international scientific community.

So, despite the social proximity between the populations in terms of religion, language, culture and traditions, there is only limited scientific cooperation within and between the Gulf and Mediterranean Arab countries, or between them and other Arab countries. In contrast, there is active international scientific cooperation between some of the Mediterranean countries and other world countries, but this is very limited for all the Gulf countries. One reason for this is that scientific workers in the Maghreb, on an individual level, have become deeply integrated into the international scientific community but not, however, with their own national or regional economies or societies (Zahlan 1999a). More recent literature indicates the role of geographical location and proximity in relation to S&T indicators and the transfer of knowledge (Arundel and Geuna 2001). France is geographically close and also has colonial ties to Algeria, Morocco and Tunisia. Hence, we argue that it is geographic proximity rather than social proximity that drives the Maghreb countries' scientific cooperation with the international community and Europe.

4.2.2. Patent Applications

Table 2 shows the low number of patent applications made by countries in both of the Arab regions compared to advanced and leading developing countries like Singapore, Korea and China. In light of our earlier findings, this can be attributed to the Arab countries' low percentage share of GDP spent on R&D and the small number of scientists and engineers in R&D. The low number of patent applications implies a low level of innovative activities across both Arab Mediterranean and Gulf countries compared to both advanced and developing countries.

Table 5 shows the number of patent applications made between 1985 and 1995 in the Arab countries, Europe and the United States by residents and non-residents of the Arab Mediterranean countries. During that period residents made fewer patent applications than non-residents in all Arab Mediterranean countries. Among the Arab Mediterranean countries, the highest number of patent applications were filed in Egypt, followed by Morocco, Algeria, Tunisia and finally Syria. Moreover, table 5 shows that all Arab Mediterranean countries together have filed far fewer patents in both the European and United States patent offices than non-Arab Mediterranean countries.

Table 5. Patent applications made by Mediterranean countries at home, in Europe and the United States

	Residents	Non-residents	Europe	America	Residents	Non-residents	Europe	America	Residents	Non-residents
Year	1985 [a]	1985 [a]	1985 - 1989 [b]	1987-1989 [b]	1990 [a]	1990 [a]	1990-1994 [b]	1990-1994 [b]	1992/1993/1994/1995 [a]	
Algeria	19	235	2	Na	0	139	3	Na	0	119
Egypt	168	671	4	7	278	511	12	16	328	503
Lebanon	Na	Na	1	Na	Na	Na	3	Na	Na	Na
Morocco	35	255	4	4	61	268	12	12	89	292
Syria	4	54	1	Na	3	12	3	Na	4	45
Tunisia	14	202	3	Na	26	134	5	Na	31	84
Total Arab Mediterranean	240	1417	15	11	368	1064	38	28	452	1043
Total non-Arab Mediterranean	851	3077	828	812	-	-	1579	1,997	1352	3827

Source: Adapted from [a] OECD (1997): LIRHE Data, WIPO-Geneva. [b] OECD (1997) OST Data INPI/EPO (EPAT) and USPTO. Non-Arab Mediterranean refers to Albania, Cyprus, Israel, Malta and Turkey.

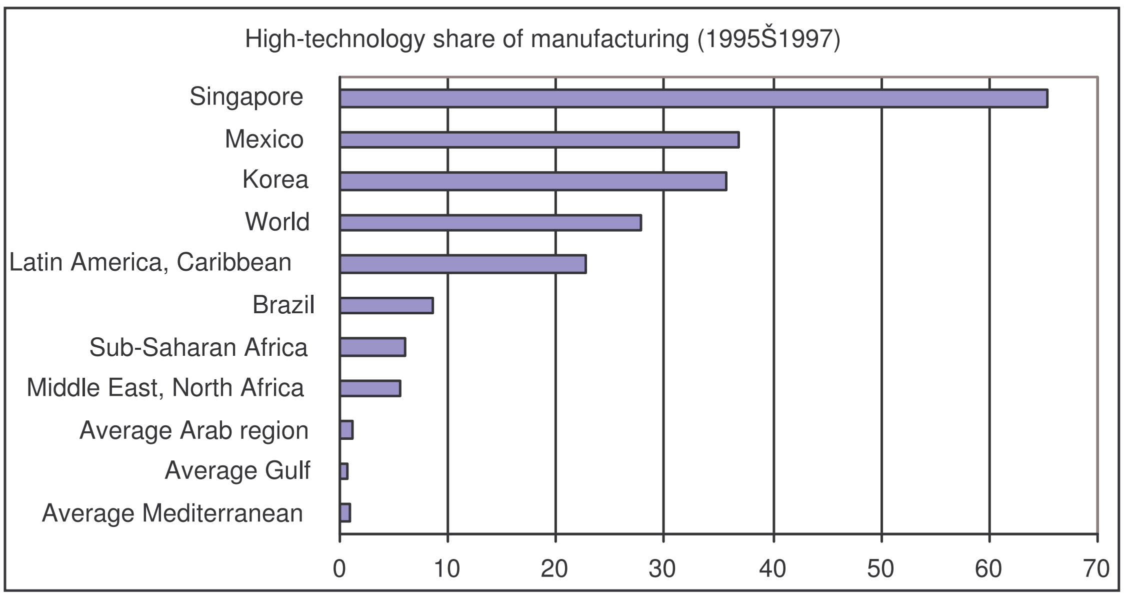
The low number of patents filed by residents of the Arabic countries can be related to low S&T activity in the country. The low number of patents recorded by non-residents, however, needs a different interpretation. It is partially because there is a lack of adequate patent legislation, but more importantly it is also due to lack of an economic structure within which to take advantage of patents. Foreign companies will only register a patent in a country if they fear that a local competitor might exploit their technology without paying for it. Therefore the low number of patents filed by non-residents in the Arab region implies that the region lacks industries that are internationally competitive, which can also be interpreted in terms of there being a poor economic structure.

In terms of the number of patent applications filed in the United States Patent and Trademark Office, table 2 indicates that the Gulf performs better than the Mediterranean. This is probably because the Gulf countries have better regulation for patents and better cooperation with the United States than the Mediterranean countries.

4.2.3. Share of High Technology Manufacturing Exports

According to table 2, both the Gulf and the Mediterranean countries have a low share of high-technology manufacturing exports compared to advanced and leading developing countries. In addition, the share of hi-tech manufactured goods in the Arab countries in 1995–1997 is well below that of the world average or the corresponding figures for Brazil, Korea, Latin America and the Caribbean, Mexico, Singapore and even sub-Saharan Africa (figure 5). This can be explained in relation to our earlier findings concerning the Arab countries' inadequate economic structure, poor spending on R&D, low number of scientists and engineers in R&D and low patent filings.

Figure 5. Proportion of high-technology manufactured goods



Source: Adapted from Haddad (2002) and Lall (1999). Computations based on UN COMTRADE data 2000 and 1996 respectively.

When comparing the average share of exports of high-technology goods manufactured, our findings in table 2 indicate that the Mediterranean countries perform much better than the Gulf countries. However, information from the OECD (1997) indicates that the Mediterranean countries are still some way behind Malta and Israel. For instance, in 1997, hi-tech exports from the Arab Mediterranean countries to Europe and the rest of the world ranged between 0.7%–17% and 0.8%–22% of all exports respectively; lower than the comparable percentages in both Malta and Israel, which were around 66% and 32–35% respectively.

4.2.4. Productivity Growth

Once again it is the Mediterranean Arab countries that out-perform their Gulf counterparts in terms of S&T impact as measured by economic growth. Table 6 shows that annual growth rate for average GDP per capita during the periods 1975–2001 and 1990–2001 and the average real GDP growth rate during the period 1995–2000 are higher in the Mediterranean countries than in the Gulf. Moreover, during 1999–2001, the Mediterranean countries show continuous growth whereas the Gulf countries experienced rapid economic growth followed by rapid slow down.

Table 6. Real GDP growth and GDP per capita annual growth rates in the Gulf and Mediterranean countries

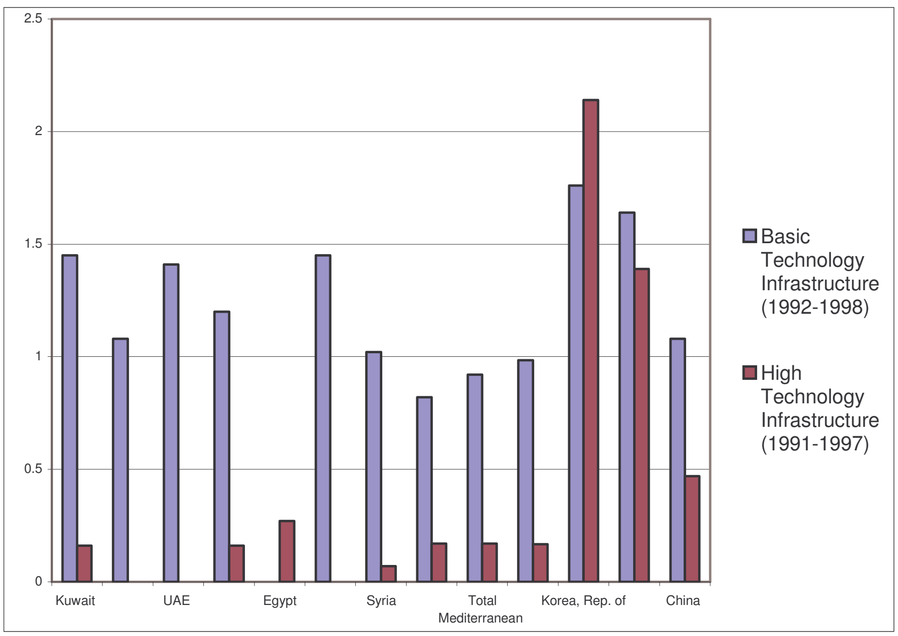
Country	GDP per capita annual growth rate (%) [a]		Real annual GDP growth (%) [b]			
	1975-2001	1990-2001	1995-2000 Average	1999	2000	2001
Arab Gulf (GCC[1])						
Bahrain	1.1	1.9	4.3	4.3	5.3	4.8
Kuwait	-0.7	-1.0	3.8	-2.9	2.9	-0.6
Oman	2.3	0.6	3.6	-0.2	5.1	7.3
Qatar	NA	NA	9.4	5.3	11.6	7.2
Saudi Arabia	-2.1	-1.1	1.9	-0.8	4.9	1.2
UAE	-3.7	-1.6	5.7	3.9	5.0	5.1
Total GCC	-0.6	-0.2	4.8	1.6	5.8	4.2
Arab Mediterranean						
Algeria	-0.2	0.1	2.9	2.3	2.8	3.4
Egypt	2.8	2.5	5.3	6.0	5.1	3.3
Lebanon	4.0	3.6	2.3	1.0	-0.5	2.0
Morocco	1.3	0.7	1.9	-0.1	1.0	6.5
Syria	0.9	1.9	3.0	-2.0	0.6	2.7
Tunisia	2.0	3.1	5.1	6.1	4.7	5.0
Total Mediterranean	1.8	2.0	3.4	2.2	2.3	3.8
Arab State	0.3	0.7	3.9	2.4	4.1	3.8
Developing countries	2.3	2.9	5.3	3.9	5.7	4.0

Source: [a] UNDP (2003) and [b] IMF (2002). [1] GCC – Gulf Cooperation Council.

4.2.5. Technology Infrastructures and Technology Achievement Index

Figure 6 indicates that countries both the Arab regions are lagging behind the rest of the world, including advanced and developing countries, in terms of both basic and high technology infrastructure (BTI and HTI).[10] On average the BTI for Gulf countries is better than for Mediterranean countries, while the opposite is true for the HTI. Overall, poor BTI is to blame for the low HTI in both Gulf and Mediterranean countries (Rasiah 2001). Moreover, according to the UNDP (2001) HDI classification of world countries according to technology achievement index, both the Gulf and Mediterranean countries lag far behind the world's advanced and leading developing countries. In fact, the majority of Mediterranean countries are classified as being dynamic adopters of new technologies, while the status of the Gulf countries with respect to the same classification is unclear, as none of the Gulf countries are classified as either leader, potential leader, dynamic or marginalized adopter.

Figure 6. Basic and high technology infrastructure rating in the Gulf and Mediterranean Arab countries compared to world countries



Source: Adapted from Rasiah (2002).

[10] Rasiah (2002) defines basic technology infrastructure (BTI) as weighted proxies representing basic education (enrolment in primary schools), health (physicians per thousand people) and communications (main telephone lines per thousand people), and defines high technology infrastructure (HTI) as weighted proxies representing R&D investment and R&D scientists and engineers per million people. Rasiah also argues that BTI is an essential but not sufficient condition for economies to achieve advanced technological capacity; the incidence of economies generating innovation is higher when they also have the high-technology support institutions. The lower the BTI, the lower the capacity and resources for high technology development.

5. CONCLUSIONS

This paper shows the status of S&T indicators in the Arab Gulf and Mediterranean countries. It is clear that a great disparity exists between these regions in terms of S&T input and output indicators. Furthermore, countries in both Arab regions lag behind the world's developed and leading developing countries in terms of the same input and output indicators. The combination of poor S&T inputs/resources together with an inadequate economic system as a whole results in the Gulf and Mediterranean countries producing poor S&T outputs/performances. Moreover, we find that most R&D and S&T activities in both Gulf and Mediterranean countries occur within the public and university sectors, while the private sector and industry make only a minor contribution .

When comparing S&T input and output indicators of the Gulf countries with those of the Mediterranean, our findings indicate that in terms of most S&T input indicators (both financial and human resources) the best performances come from Mediterranean countries. That also holds for the average share of high-technology exports, GDP per capita growth, number of scientific publications and level of international cooperation, while the performance of the Gulf countries is only better with respect to number of patent filings.

Moreover, we observe that the Mediterranean countries appear to be benefiting from their geographical location and proximity to Europe, as shown by the higher levels of cooperation with the OECD and in particular France. This implies that social proximity (sharing similar religion, culture, language, values and traditions) and intra-regional linkages and networks do not matter for scientific cooperation. Instead, for some of the Mediterranean Arab countries (notably Algeria, Morocco and Tunisia), geographical proximity and external regional linkages and networks with Europe are the motivations for scientific cooperation.

Hence, our analysis indicates that in order to improve S&T performance, the Arab Gulf and Mediterranean countries need to invest heavily in both financial and human resources as well as to learn from the lessons of the advanced and developing S&T nations. Such investment can be more effective if they are made according to targeted, well-defined plans that connect with policies covering industry, science and technology and accompanied by an overhaul in the economic system.

None of the Gulf or Mediterranean Arab countries alone possess all the human and financial resources necessary to promote S&T. However, these countries could have a wider range of capabilities to promote S&T if they pooled and integrated their resources. Restructuring the economic systems, encouraging the private sector and implementing effective S&T cooperation and integration between all the Arab countries will most likely enhance S&T development and hence long-term harmonious development in the region.

REFERENCES

Arundel, A. and A. Geuna. 2001. Does proximity matter for knowledge transfer from public institutes and universities to firms? SPRU Electronic Working Paper Series No.73. Brighton, UK: University of Sussex.

Cooper. C. 1991. Are innovation studies on industrialized economies relevant to technology policy in developing countries? UNU-INTECH Working Paper Series No.3. Maastricht, the Netherlands: UNU-INTECH.

——— 1994. Science and technology in Africa under conditions of economic crisis and structural adjustment. UNU-INTECH Working Paper Series No.4. Maastricht, the Netherlands: UNU-INTECH.

Dasgupta, P. and P. David. 1994. Toward a new economics of science. MERIT Research Memoranda Series No.2/94-003. Maastricht, the Netherlands: Maastricht University.

ESCWA (Economic and Social Commission for Western Asia). 1999a. *Science and technology policies in the twenty-first century*. New York, NY: United Nations. Pp. 75, 209.

——— 1999b. ESCWA proceedings of the expert group meeting on science and technology policies and strategies in the twenty-first century. Beirut, 10–12 March 1999. (E/ESCWA/TECH/1999/8/Rev. 1: December 1999). New York, NY: United Nations.

ESCWA–UNESCO (Economic and Social Commission for Western Asia–United Nations Educational, Scientific and Cultural Organization). 1998a. Research and development systems in the Arab states: Development of science and technology indicators. (E/ESCWA/TECH/1998/Rev. 1). Cairo, Egypt: UNESCO.

——— 1998b. Research and development system in the Arab states: Development of science and technology indicators. (E/ ESCWA/ TECH/ 1998/3). Cairo, Egypt: UNESCO.

Fergany, N. 1999. Science and research for development in the Arab region. Chapter 2 in: *Research for development in the Middle East and North Africa*, E. Rached and D. Craissati, eds. Ottowa, Canada: IDRC.

Foray, D. 1999. Science, technology and market. In: *World Social Science Report*. Paris: UNESCO/Elsevier.

Freeman, C. and L. Soete. 1997. *The economics of industrial innovation, 3rd ed*. London, UK: Cassell.

Haddad, M. 2002. Export competitiveness: Where does the Middle East and North Africa region stand? In: *Economic Trends in MENA Region*. Cairo, Egypt: Economic Research Forum.

IMF. 2002. World economic outlook: The Middle East and North Africa regional outlook. Washington, DC: International Monetary Fund.

Lall, S. 1999. Competing with labour: Skills and competitiveness in developing countries. Development Discussion Paper No.31. Development Policies Department, Geneva, Switzerland: International Labour Organization.

Lundvall, B-Å. ed. 1992. *National systems of innovation: Towards a theory of innovation and interactive learning*. London, UK: Pinter Publishers.

Muysken, J. and S. Nour. 2005. Deficiencies in education and poor prospects for economic growth in the Gulf countries: The case of the UAE. Paper presented at the ETIC European Doctoral Training Programme, Maastricht, October 2003. *Journal of Development Studies*, 2005, Taylor and Francis Ltd.: UK *forthcoming*.

Mytelka, L. 2001. Do the least developed countries need science and technology for sustainable development? http://www.intech.unu.edu/publications/index.php

Nelson, R. ed. 1993. *National innovation systems: A comparative study*. New York, NY: Oxford University Press.

OECD (Organisation for Economic Co-operation and Development). 1997. *The Second European Report on S&T Indicators 1997*. Luxembourg, European Commission.

Qasem, S. 1998a. Research and development in the Arab states: Development of science and technology indicators. In: Review of science and technology in ESCWA member countries, ESCWA (1999), Issue No.1. New York, NY: United Nations.

——— 1998b. Research and development systems in the Arab states: Development of science and technology indicators. Chapter 4 in: *Economic Trends in MENA Region 2002*. Cairo, Egypt: Economic Research Forum and the American University in Cairo.

Rasiah, R. 2002. TRIPs and capability building in developing economies. Discussion Paper No.1. Tokyo, Japan: UNU–INTECH.

UNDP (United Nations Development Programme). 2001. Summary human development report 2001: Making new technologies work for human Development. New York, NY: UNDP; Oxford, UK: Oxford University Press.

——— 2002. *Human development report 2002: Deepening democracy in a fragmental world.* New York, NY: UNDP; Oxford, UK: Oxford University Press.

——— 2003. *Arab human development report 2003*: *Building a knowledge society.* Amman, Jordan: UNDP–RBAS; New York, NY: National Press.

——— 2003. *Human development report 2003. Millennium development goals: A compact among nations to end human poverty*. New York, NY: UNDP; Oxford, UK: Oxford University Press.

——— 2004. *Human development report 2004: Cultural liberty in today's diverse world*. New York, NY: UNDP.

Zahlan, A. 1999a. Science policy for the twenty-first century: Mobilization and development. In: Proceedings of the expert group meeting on science and technology policies and strategies for the twenty-first century, Beirut, 10–12 March 1999, (E/ESCWA/TECH/1999/8/Rev.1: December 1999). New York, NY: United Nations. Pp. 14–16.

——— 1999b. The Arabs and the challenges of science and technology: Progress without change. Beirut, Lebanon: The Center for the Study of Arab Unity.

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