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The incidence and transfer of knowledge in the Arab countries

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The Incidence and Transfer of Knowledge in the Arab Countries

By Dr. Samia Satti Osman Mohamed Nour [1]

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Abstract

In this paper we use the systematic, descriptive and statistical approaches, fill the gap in the Arab literature and present a more comprehensive analysis of the important ways of enhancing the incidence and transfer of knowledge in the Arab countries. Different from the conventional view in the literature that use the conventional classification of countries according to income level, an interesting element in our analysis is that we use a more comprehensive classification not only by income level but also by geographic location and the structure of the economy to examine the important ways of enhancing the incidence and transfer of knowledge in the Arab countries. We find that somewhat surprising the classification of Arab countries by income level provides inconclusive evidences in terms of capacity to create knowledge. Our findings support the first hypothesis that the components of knowledge show positive correlation with economic growth and hence can be used to enhance economic growth and promote human capital in the Arab countries. Our results corroborate the second and third hypotheses that the incidence and transfer of knowledge can be enhanced by institutional support in the form of subsidies and incentives to knowledge components (education, R&D and ICT). The major policy implication from our findings is that in order to benefit from integration in global knowledge economy the Arab countries should create the most appropriate political, economic, educational, technological and scientific institutions. The Arab countries should stimulate local efforts and incentives for building and transferring knowledge and should pay more attention to enhance institutions setting, especially, effective system of intellectual property rights protection to motivate the creation and transfer of knowledge. A part from the role of Arab governments, it is essential for Arab societies to support the culture aimed at fostering and enhancing the incidence and transfer of knowledge.

Keywords: Tacit Knowledge, Codified Knowledge, Transfer of Knowledge, Arab countries

JEL classification: O10, O11, O30

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Executive Summary

In this project we discuss the impacts, importance and ways of enhancing the incidence and transfer of knowledge within the Arab societies. We use the systematic approach and the empirical (descriptive and statistical) approach based on an integration of several indicators used in the knowledge literature.

We begin with the discussion of the status of knowledge in the Arab countries compared to other world countries. We find that the Arab countries show poor performance and manifestly lagged behind the developed and leading developing countries in terms of knowledge, skills, technological capabilities, technology achievement index, spending and diffusion of ICT, competitiveness, integration in the world economy and average growth rate. The Arab states show poor absorptive capacity and capacity to create knowledge. Somewhat surprising that even greater than the knowledge gap is the gap in the capacity to create knowledge. Differences in some important measures of knowledge creation are far greater between advanced and Arab countries than differences in income, for instances figures on R&D spending and GDP per capita indicates that inequalities in the capacity to create knowledge exceed even those in income.

We present a comparative assessment and overview of knowledge across the Arab countries using several indicators of knowledge such as the levels of education, literacy, skills, ICT diffusion across Arab countries. In investigating the status of knowledge we use a certain criteria, mainly the classification of Arab countries according to income level. The selection of this criteria is based on/consistent with the conventional view concerning the positive relationship between knowledge and income and the view that knowledge is concentrated in high income countries. Our analysis of knowledge in the Arab region is more comprehensive since we compare the results using different classification of Arab countries defined by income level, geographic location and the structure of the economy. We show the great diversity amongst the Arab countries in terms of size of the country, demographic structure, socio-economic and development indicators, knowledge indicators: skills indicators, science and technology indicators and the use of ICT.

We find that despite the great heterogeneous performance across the Arab states, it was evident that none of the Arab states presents a sufficient, convincing and coherent performance. While, the Arab high income (Gulf oil economies) are leading Arab states in terms of GDP per capita, human development indicators, spending on ICT. They fail to present a convincing and coherent performance and to promote efficient educational system, technological capabilities and infrastructure needed for knowledge economy.

We fill the gap in the literature and present a more comprehensive analysis of the incidence, importance and ways of enhancing of the components of knowledge across Arab countries. Different from the analysis in the knowledge literature that use the classification of countries according to income level, a novel element in our analysis is that we use a more comprehensive classification not only by income level but also by geographic location and the structure of the economy to show incidence, importance and ways of enhancing of the components of knowledge across Arab countries. An interesting element in our analysis is that we incorporate several interesting indicators to define tacit and codified sources of knowledge. We find that somewhat surprising the classification of Arab countries by income level is inconclusive in terms of the capacity to create knowledge. For instance, the performance of Arab high income falls behind Arab medium income in terms of knowledge (codified knowledge, number of publications and patents) and the capacity to create knowledge (enrolment in tertiary education, FTER, total spending and spending on R&D as a percentage to GDP). These results probably can be interpreted along with the classification of Arab

countries according to the structure of the economy, for instance, the high income are Gulf oil based economies, while the majority of the medium income are Mediterranean and diversified economies. This result confirms the importance of diversification for the Arab economies.

Our findings support the first hypothesis that the components of knowledge show positive correlation and hence can be used to enhance economic growth (GDP) and promote human capital (schooling) across the Arab countries. Our findings corroborate the second and third hypotheses that the components of knowledge can be enhanced by skill upgrading (education) and also institutional support in the form of subsidies and incentives to knowledge components (education, R&D and ICT) across the Arab countries. We find that tacit (FTER) and codified sources of knowledge show positive correlation and can be used to enhance patent, publications and cooperation. We find positive complementary relationship between tacit knowledge defined by the FTER and part of codified knowledge defined by the share of ICT in GDP and codified knowledge defined by both the share of education and R&D in GDP and the share of education, R&D and ICT in GDP and codified knowledge defined by the total spending on R&D. These findings corroborate our fourth hypothesis that tacit and codified knowledge are complement to each other.

Our results prove the hypotheses that the incidence and transfer of knowledge within the Gulf society show positive correlation and hence can be used to enhance economic growth (GDP) technology indicators (R&D) skills level (schooling) and upskilling (education). Tacit and transfer of knowledge show complementary relationship, tacit and codified sources of knowledge in the Gulf are positively correlated with each other and with the transfer of knowledge. The incidence and transfer of knowledge in the Gulf show positive correlation and can be enhanced by increasing skills level and also by institutional support in the form of subsidies for enhancing education to upgrade skills. This implies that society with intensive tacit knowledge would have strong potential to enhance the transfer of knowledge and having positive knowledge spillover effect, which in turn enhance further effects on learning and tacit knowledge within the entire society. We show the significance of knowledge holders for enhancing the transfer of knowledge. We find that the transfer of knowledge can be enhanced by increasing tacit knowledge, codified knowledge, schooling year, public spending on education and R&D, number of FTER, publications and cooperation.

Therefore, from our findings in this project the major policy implications and recommendations is that for an efficient integration and benefit from the new economy, the Arab countries need to create the most appropriate educational, scientific, economic, political, technological and scientific institutions. Mainly to improve skill levels and performance of educational and training systems, S&T and ICT institutions, increase financial and human investment to build local technological capabilities, basic and high technology infrastructure, to learn from the international experiences of other advanced nations to promote the long- run harmonious development in the region and so integration in and benefit from the global knowledge economy/and new economic system. The Arab countries should stimulate local efforts and incentives for building and transferring knowledge and should pay more attention to enhance institutions setting, especially, effective system of intellectual property rights protection to motivate the creation, diffusion and transfer of new knowledge. A part from the role of Arab governments, it is essential and useful for Arab societies to support the culture aimed at fostering and enhancing the incidence and transfer of knowledge.

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Chapter 1
General Introduction

Introduction

This introductory chapter presents the definition of the research problem, aims, hypotheses to be tested, methodology and structure of the research. The rest of this chapter is organized as follows: Section 1 shows the motivation and aims of the research. Section 2 explains the importance and sources of knowledge in the new growth literature. Section 3 describes the variables and sources of data, the methodology: method of data collection and data analysis and hypotheses to be tested. Section 4 shows the structure of the research.

1. 1. Motivation and Aims of the Research

Since long time, knowledge has been at the heart of economic growth and the gradual rise and fall in levels of social well-being. More recent discussion in the new growth literature highlight the significance of both the incidence and the transfer of knowledge within firm, between firms, between firms and universities and within society at large.

Within this framework, it might be relevant to ask six related questions: (a) What are the major components of knowledge in the Arab society and to what extent they are interrelated? (b) What determine the incidence of knowledge components (tacit, codified) within firm, between firms, between firms and universities and within Arab society at large? (c) To what extent these variables/ determinants are interrelated? (d) What enhance/motivate the incidence/components of knowledge within firms, between firms, between firms and universities and within the Arab society at large? (e) What kinds of subsidies/incentives enhance the incidence/components of knowledge within firm, between firms, between firms and universities and within the Arab society at large and (f) To what extent the incidence/components of knowledge within firm (the micro level) coincide/consistent with that for Arab society (macro level)?

The respective answers to the above questions might be somewhat interrelated. First, knowledge is often defined as decomposed of codified and tacit sources in addition to their spillovers effect/ knowledge transfer. These components could be interrelated to enhance each other and to enhance knowledge process in general.

Second, the incidence/components of knowledge within firms is determined by many variables such as: (1) firm size; (2) skill level (education and training); (3) incentives; (4) capital investment; (5) organisation, co-operation and co-ordination; (6) information and (7) other variables such as socio-demographic structure, culture, language, etc. While, the major variables/ determinants of knowledge transfer between firms might be: (1) strong knowledge base within firms; (2) skill level (education and training); (3) competition between firms; (4) networks organisation, co-ordination and co-operation; (5) information; besides (6) other variables such as proximity, socio-demographic structure, culture, language, etc. Whereas, the major variables/ determinants of knowledge transfer between firms and universities might include: (1) strong knowledge base within firms; (2) skill level (education and training); (3) networks organization, co-ordination and co-operation; (4) interest and relevance; (5) information. In addition to other variables such as proximity, socio-demographic structure, culture, language, etc. Similarly, the incidence and transfer of knowledge within society at large might be influenced by: (1) skill level

(education and training); (2) subsidies and incentives to education, training, R&D; (3) Organization, co-ordination and co-operation; (4) Information and Communication technologies; (5) other variables such as socio-demographic structure, culture, language, etc.

Third, with respect to the third question, the incidence/components of knowledge within the firm could be independent from other firms and universities. However, the reverse is not necessarily true, because the transfer of knowledge between firms and between firms and universities might be closely related to strong/ efficient knowledge base within firms.

Fourth, concerning the fourth question, the incidence/components of knowledge could be enhanced/ motivated by the institutional support in the form of subsidies and incentives. Particularly the form of subsides that aim to motivate: (1) upskilling (to promote/support education and training), (2) R&D inside the firm, between firms and between firms and universities, (3) networks, co-ordination and co-operation between firms and between firms and universities and (4) information system.

Fifth, with respect to the fifth question, the major incentives to motivate the incidence/components of knowledge within the firm might come through both increasing skill level (education and training) and enhancing co-ordination and the external schooling effect. These factors besides others such as enhancing network and co-operation and enhancing information system could be major incentives to motivate the transfer of knowledge between firms, between firms and universities and within society at large.

Sixth, with respect to the sixth question, the micro (firm) – macro (society) levels could be consistent to complement each other.

Within this framework, the aim of this research is to add and contribute to the growing body of theoretical and empirical literature/studies in the new growth literature that focuses on the incidence and components of knowledge, mainly by investigating knowledge within the Arab society at large. In particular, the research aimed at investigating the significance of knowledge; the link between knowledge components; the determinants of the incidence and components of knowledge and ways of enhancing the incidence of knowledge within the Arab society at large.

Although, it might be interesting to give more focus to the above questions, in particular, the incidence and transfer of knowledge within the firm, the transfer of knowledge between firms and between firms and universities. However, due to practical problems related to availability of micro data, it will not be possible to address these micro questions in the current study. Therefore, we would be focusing only on the incidence, transfer, determinants and ways of enhancing knowledge within the Arab society at large. Our analyze of the importance and ways of enhancing of the transfer of knowledge is more limited covering only the Arab Gulf countries, due to lack of relevant data we could not extend the analysis to cover Arab countries, we hope to extend this results in future studies.

We fill the gap in the literature and present a more comprehensive analysis of the incidence, importance and ways of enhancing of the components of knowledge across Arab countries. Different from the analysis in the knowledge literature that use the classification of countries according to income level, a novel element in our analysis is that we use a more comprehensive classification not only by income level but also by geographic location and the structure of the economy to show the incidence, importance and ways of enhancing of the components of knowledge across Arab countries. An interesting element in our

analysis is that we incorporate several interesting indicators to define tacit and codified sources of knowledge.

1.2. The Definition, Importance and Sources of Knowledge in the Growth Literature

Knowledge creation, accumulation and acceleration is intensified the pace of scientific and technological progress and has been at the heart of economic growth literature. The ability to invent, innovate and create new knowledge and new ideas that are then either embodied in machines, products, processes and organizations, or disembodied/ codified in blueprints and operating instructions, has motivated the successful transfer of technology and enhanced economic development. The definition of knowledge in the literature is based on the distinction between codified and tacit knowledge (Dasgupta and David (1994)), and also between embodied flows of knowledge (knowledge incorporated in to machinery and equipment) and disembodied flows of knowledge (the use of knowledge transmitted through scientific and technical literature, consultancy, education systems, movement of personnel, etc). Often, investment in knowledge refers to public spending on education, total R&D and software and ICT.

The economic analysis of knowledge as a specific input to innovative activities has been approaching following two largely independent methodological approaches, on the one side, knowledge is seen as a public good generated via R&D activities that generate spillover and thus increasing returns (Romer, 1994; Grossman and Helpman, 1994). On the other side, modern innovation theory sees knowledge creation in a much more diffuse way. For instance, Langlois (2001) argues that knowledge, whether tacit or codified, is embodied in institutions and artefacts that make its transfer possible even in the absence of any codification. Moreover, Smith (2002) argues that R&D is but one component of knowledge and innovation expenditures, and by no means the largest. Because, R&D data tend to either overemphasize the discovery of new scientific or technical innovations, or to exclude a wide range of activities that involve the creation or use of new knowledge in innovation. Thus, knowledge rests not only on discovery and R&D but also on learning, external environment (network) of the firm, non- R&D expenditures such as training, market research, design, trail production and tooling up and IPR costs. In addition to capital expenditure, which is a key mode of 'embodied' knowledge spillover from the capital good sector to using industries.

Economists have long recognized the importance of knowledge for endogenous technological progress, innovation and economic growth. In the endogenous growth theories, the sole source of growth is knowledge accumulation. For instance, in the Lucas (1988) model knowledge accumulation is at the heart of the growth process, it could directly but partly determine growth performance. For Romer (1994); Grossman and Helpman (1994), knowledge is seen as a public good generated via R&D activities that generate spillover and thus increasing returns. Aghion and Howitt (1998) endogenous growth model predicts that long run growth should be positively correlated with R&D productivity and the rate of growth of human capital. Klette and Griliches (1998), propose a model of endogenous firm growth in which R&D and innovations are the engines of growth. Moreover, the evolutionary framework developed by Nelson and Winter (1982), makes the nature of knowledge and firms' investment in it a central factor in explaining the size, structure and dynamic of industries.

Moreover, nowadays differential in the productivity and growth of different countries is significantly related to improvement in the quality of human capital and factors of production, in particular,

the capacity to create new knowledge and ideas and incorporate them in equipment and people. Recent growth literature show increasing evidences of the growing relative importance of intangible capital in total productive wealth and the rising relative share of GDP attributable to intangible capital (Abramovitz and David, 1996; Abramovitz and David, 1998). Intangible capital largely falls into two main categories: on the one hand, investment geared to the production and dissemination of knowledge (i.e. training, education, R&D, information and co-ordination); on the other hand, investment geared to sustaining the physical state of human capital (health expenditures). In the US, the current value of the stock of intangible capital (devoted to knowledge creation and human capital) began to outweigh that of tangible capital (physical infrastructure and equipment, inventories, natural resources) at the end of the 1960s. Moreover, since 1960s annual investment rates in R&D, public education and software have grown steadily at an annual rate of 3% in the OECD countries. (David and Foray, 2001).

Recent empirical literature, for instance, a study by Loof and Heshmati (2002) shows that knowledge capital (defined as the ratio of innovation sales to total sales) is found to be a significant factor contributing to performance heterogeneity and the level of innovation among firms. Knowledge capital rises with innovation input, the firm's internal knowledge for innovation and cooperation on innovation with domestic universities. Several empirical studies confirm that survival and growth between firms is determined by / or at least influenced by differential rates of investment in knowledge (e.g. R&D) (Klepper and Simons, 1997) or intersectoral differences in the size and R&D intensity of firm (Levin et al., 1985). Moreover, Brusoni et al., (2002); David and Foray (1995) show that the increasing codification of knowledge stock would enhance firm's innovative performance.

Furthermore, Peter Drucker (1998) suggests that: "knowledge is now becoming the one factor of production, sidelining both capital and labour". A long the same line, the OECD (1999) has suggested that "... the role of knowledge (as compared with natural resources, physical capital and low skill labour) has taken on greater importance". Smith (2002) argues that in recent years, learning and knowledge have attracted increasing attention as a result of the claims that knowledge intensive industries are now at the core of growth, knowledge driven economy or even a knowledge society. The role of knowledge as an input to economic processes has fundamentally changed probably due to rapid technological changes/ advances in ICT, which is seen as factor enhancing knowledge. For instance, Van Zoon (2001), extends Lucas (1988) model by incorporating the effect of ICT – capital investment and assuming that ICT has positive influence on growth performance not only through improving the intensity of production and total factor productivity, but also through enhancing the efficiency of knowledge accumulation and learning process. David and Foray (1995) and Smith (2002) show that ICT revolution is increasing the common availability of codified knowledge.

The empirical literature shows that knowledge is positively related to human capital (mainly tacit skill or skill level). For instance, Winter (1987) suggests that tacit and codified knowledge need not be substitutes they can be seen as complements in the learning process. Brusoni et al., (2002) show strong positive relationship between the codification of the knowledge base of the industry and its investment in skilled people (high levels of investment in tacit skills) and R&D.

The literature uses several indicators to investigate the sources of knowledge. For instance, Jaffe (1989) and Griliches (1979) use patent as a proxy for innovation output to represent dependent variable and

private corporate expenditures and university research expenditures are used as explanatory variables to show the spillovers from university research to commercial innovation by firm. Both recent theories of National System of Innovation (Nelson, 1993; Lundvall, 1992) and interactive model of innovation stress the importance of flows of knowledge and information to the ability of firm to innovate (Kline and Rosenberg, 1986; Freeman, 1987). Within this framework, economic theory and empirical research have focused on two types of knowledge flows: between firms, through inter-firm research collaborations (Hagedoorn et al., 2001), user-producer networks (Lundvall, 1992), or linkages between competing firms (von Hippel, 1988); and between firms and public research organizations (PROs) such as universities, government laboratories, and publicly – funded technical institutes (Mansfield, 1991; Mansfield and Lee, 1996; Pavitt, 1991). The empirical evidence shows that both types of knowledge flows, including unintentional spillovers, make a substantial contribution to innovation and consequently to economic growth and public welfare. Estimates of the rate of return to publicly funded research, for example, range between 20% and 60% (Salter and Martin, 2001). These rates of return are dependent on firms acquiring knowledge and information produced by public research organizations PROs (Public Research Organizations: universities, public research institutes and government laboratories) and successfully applying this information to their innovative activities. Arundle et al., (2001) use the broad term of knowledge flows to mean knowledge that is transferred via market mechanisms and true knowledge spillovers, particularly, knowledge flows from PROs to firms. They show that innovative firms can use various external information sources to innovative activities such as public research e.g. universities other affiliated firms, supplier, customers, joint ventures and reverse engineering. Knowledge could be transferred through joint research projects, contracted- out research, temporary personnel exchanges, informal personal contacts, hiring trained scientists/ engineers, conferences/ meetings and publications. At the aggregate level, the incidence and transfer of knowledge is affected by several variables such as the overall quantity of scientific research (publications) and the public research base as measured by the ratio between the total amount of higher education R&D expenditure and the country GDP.

Brusoni et al., (2002) highlights the importance of knowledge sources within the enterprise for innovation among innovative firms in Europe, in particular, the internal divisions (including: R&D, design, sales and marketing and senior management). The important sources of knowledge for innovative firm in Europe are subdivided into three categories: (1) Within the industry: within the enterprise, suppliers, clients or customers, enterprises within the enterprise group and competitors. (2) External advisors including consultancy enterprises, research institutes, universities and innovation centers. (3) Publicly available sources including conference, journals, publications, fairs and exhibition, computer- based information network and patent disclosure.

1. 3. Definition, Source of Data, Methodology and Hypotheses

First, we support modern innovation theory and new growth literature in viewing knowledge in a more broad/diffuse way. Therefore, we define knowledge as decomposed of: (1) Tacit knowledge, which we define by the percentage share of high skilled people in total population, (2) Codified knowledge, which we define by embodied knowledge distributed in many aspects including total spending on education, R&D and ICT. Second, we use the linear and log linear OLS regression technique to test our hypotheses on the

effects and ways of enhancing the components of knowledge. And then we draw the major policy implications and conclusions based on the empirical findings.

At the aggregate level, Table 1.1 presents the secondary aggregate/ macro data that we collected from various sources and used in our discussion. First, we define tacit knowledge by tacit skills, which we define by both enrolment in tertiary education and the number of researchers or full time equivalent researchers (FTER). Codified knowledge is calculated as a total of the share of public spending on education, ICT and R&D spending as percentage of GDP. In addition we use several variables and many other indicators in relation to the components of knowledge, such as the number of full time equivalent researchers (FTE), number of publications, scientific cooperation as measured by joint publications, total spending on R&D, patents and average schooling years across Arab countries. Based on this framework, it is possible to assume that at the aggregate level the incidence or components of knowledge across Arab countries are most likely related to several variables. Such as skill level; the share of public expenditure on education (especially on higher education) as percentage of GDP; the share of public expenditure on R&D as percentage of GDP; networks organization, co-ordination and co-operation, for example between universities (O); and the information and communication system (ICT). Based on our earlier framework and the literature we test the hypotheses that across Arab countries:

1. The components of knowledge show positive correlation with economic growth and the promotion of human capital across Arab countries.
2. The components of knowledge can be enhanced by skill upgrading across Arab countries.
3. The component of knowledge can be enhanced by institutional support in the form of subsidies and incentives to knowledge components across Arab countries.
4. Tacit and codified knowledge are complement to each other.

Table 1.1- The Proposed Data and Sources of Data on the Determinant of Knowledge in the Arab societies

Variables	Source
Spending on R&D	Data from ESCWA/ UNESCO (1998), UNDP (2003, 2004)
FTER	Data from ESCWA/ UNESCO (1998), UNDP (2003, 2004)
Schooling years	Data from Barro and Lee (2001), Economic Trends in MENA Region (2002) and UNESCO: www.unesco.org
Publication	Data from ESCWA/ UNESCO (1998)
Public spending on Education	Data from ESCWA/ UNESCO and UNDP (2002) "UNDP Human Development Report"
Cooperation	Data from ESCWA/ UNESCO (1998)
Spending on ICT/ GDP	Data from WISTA (2002) and ESCWA (2003).
GDP	Data from UNDP (2004) "Human Development Report"
TACIT KNOWELDGE: TACIT SKILL/ High skilled	UNDP (2001, 2002, 2003, 2004) UNDP "Arab Human Development Report- (2002, 2003)" UNESCO, ILO, etc.
Codified Knowledge: (EDU) +(R&D)+(ICT	Data collected from (1)+(5)+(7)

1. 4. Structure of the Research

This research is composed of six chapters that organized in the following way: Chapter 1 is an introductory chapter presents the definition of the research problem, aims, hypotheses to be tested, methodology and structure of the research. Chapter 2 provides the conceptual and theoretical frameworks that show the definition and the importance and sources of knowledge in the new growth literature that may be relevant to enhance knowledge within the Arab societies. Chapter 3 discusses the status of knowledge in the Arab countries compared to other world countries. Chapter 4 presents a comparative assessment and overview of knowledge across Arab countries, in particular, discusses and compares the various elements or indicators of knowledge including levels of education, literacy, skills, ICT diffusion across the Arab countries. Chapter 5 describes the data and variables and reports on the estimation results and empirical findings and

discusses the hypotheses on the impacts/ importance, determinants and ways of enhancing of the component of knowledge across Arab countries defined by income level and other classification: geographic location and structure of the economy, Finally, Chapter 6 provides the conclusions, policy implications and recommendations. Scheme 1 below summarizes the questions, hypotheses of the research.

Scheme 1- Questions, Expected Answers and Hypotheses

Questions	Expected Answers	Hypotheses
1. How important is knowledge for the Arab society?	- 1. The incidence and transfer of knowledge have major importance for the enhancement of economic development within the Arab society at large	**H_1.** The positive influence of knowledge supports the influence of human capital/ skill in economic growth in the Arab region.
2. How important is the relationship between knowledge components?	- 2. The components of knowledge (the incidence of tacit and codified sources of knowledge and the transfer of knowledge) are significantly correlated.	**H_2.** The incidence and transfer of knowledge are expected to enhance each other significantly.
3. What enhance the incidence and transfer of knowledge within society at large?	- 3. The incidence of knowledge within society at large can be enhanced by: skill level (education and training), public spending on education, R&D and ICT, network organisation and co-operation, information and other variables such as socio-demographic structure, culture, language, etc. - The transfer of knowledge within society at large can be enhanced by enhancing skill level.	**H_3.** The incidence and transfer of knowledge can be enhanced by skill upgrading within society at large.
4. What kinds of subsidies/ incentives enhance the incidence and transfer of knowledge within society at large?	- 4. The major subsidies/ incentives to motivate the incidence of knowledge within society at large are: increase skills level (increase public spending on education and training), motivate the incidence of external schooling effect, increase public spending in research and development, enhance network, co-ordination and co-operation and enhance information system (ICT).	**H_4.** Subsidies/ incentives could lead to/ motivate the incidence of knowledge within the Arab society at large.

Chapter 2

Survey of Theoretical and Empirical Literature on the Definition, Nature, Significance and Measurement of Knowledge

Introduction

The aim of this Chapter is to survey the major theoretical and empirical literature on the definition, nature, significance and measurement of knowledge. Section 1 shows the definition, nature, and characteristics of knowledge. Section 2 discusses the significance, impacts, sources and measurements of knowledge. Section 3 examines the importance of knowledge in the new growth literature. Section 4 discusses knowledge gaps, information problem and policies to narrow knowledge gap. Section 5 indicates the institutional dimensions on both the provision and transfer of knowledge. Section 6 shows the literature on the transfer of knowledge. Finally Section 7 provides the summary and conclusions.

2. 1. Definition, nature and characteristics of knowledge in the literature:

Knowledge creation, accumulation and acceleration is intensified the pace of scientific and technological progress and has been at the heart of economic growth literature. The ability to invent, innovate and create new knowledge and new ideas that are then either embodied in machines, products, processes and organizations, or disembodied/ codified in blueprints and operating instructions, has motivated the successful transfer of technology and enhanced economic development. The definition of knowledge in the literature is based on the distinction between codified and tacit knowledge (Dasgupta and David, 1994), and between embodied flows of knowledge (knowledge incorporated in to machinery and equipment) and disembodied flows of knowledge (the use of knowledge transmitted through scientific and technical literature, consultancy, education systems, movement of personnel, etc). Often, investment in knowledge refers to public spending on education, training, R&D and ICT. Moreover, in analyzing knowledge as specific input to innovative activities, economists on the one hand, view knowledge as a public good generated via R&D activities that generate spillover and thus increasing returns (Romer, 1994; Grossman and Helpman, 1994). On the other hand, modern innovation theory views knowledge creation in a much more diffuse way. For instance, Langlois (2001) argues that: “knowledge, whether tacit or codified, is embodied in institutions and artefacts that make its transfer possible even in the absence of any codification”. Moreover, Smith (2002) argues that: “R&D is but one component of knowledge and innovation expenditures, and by no means the largest. Because, R&D data tend to either overemphasize the discovery of new scientific or technical innovations, or to exclude a wide range of activities that involve the creation or use of new knowledge in innovation. Thus, knowledge rests not only on discovery and R&D but also on learning, external environment (network) of the firm, non- R&D expenditures such as training, market research, design, trail production and tooling up and IPR costs. In addition to capital expenditure, which is a key mode of ‘embodied’ knowledge spillover from the capital good sector to using industries”.

The World Bank Development Report (1998) indicates that the quest for knowledge begins with the recognition that knowledge cannot easily be bought off the shelf, like cabbages or computer. The marketability of knowledge is limited by two features that distinguishes it from more traditional

commodities. The first is that one person's use of this or that bit of knowledge does not preclude the use of that same bit by others- it is, as economists say, nonrivalrous. Second, when a piece of knowledge is already in the public domain, it is difficult for the creator of that knowledge to prevent others from using it – knowledge is nonexcludable. Others argue that knowledge is not a pure public good, there is a range of situations varying from the completely appropriable to the completely public (cf. Romer, 1993). Figure 2.1 defines both public and private forms of knowledge.

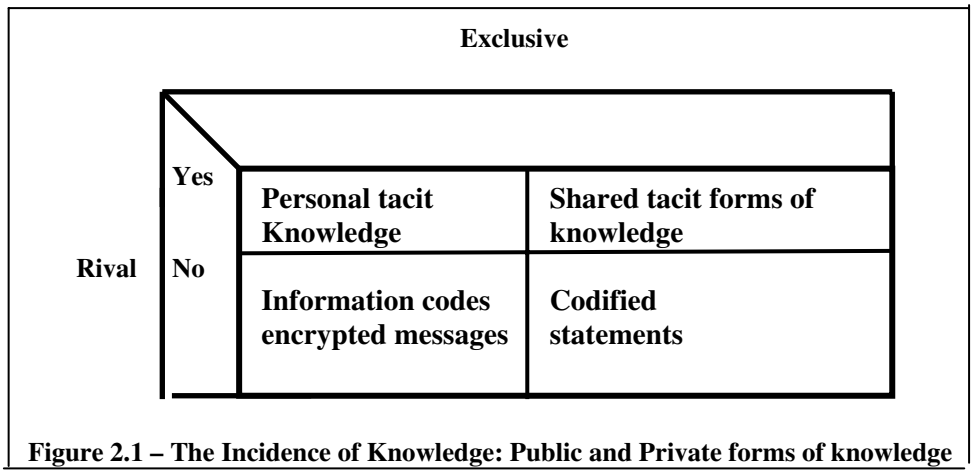


Figure 2.1 – The Incidence of Knowledge: Public and Private forms of knowledge

Source: Llerena (2003)

The contributions from Lundvall, David and Foray (amongst many others) are very helpful to draw distinction between codified knowledge, which is measurable as indicators of knowledge (and which is the foundation of most economic analysis) and the easily overlooked, but complementary area of tacit knowledge.

David and Foray (2001) explore the black box of knowledge and made significant distinction between knowledge and information. In their view, a basic distinction should be made between knowledge and information, knowledge – in whatever field- empowers its possessors with the capacity for intellectual or physical action. So what we mean by knowledge is fundamentally a matter of cognitive capability. Information, on the other hand, takes the shape of structured and formatted data that remain passive and inert until used by those with the knowledge needed to interpret and process them. The full meaning of this distinction become clear when one looks into the conditions governing the reproduction of knowledge and information. While the cost of replicating information amounts to no more than the price of making copies (i.e. next to nothing thanks to modern technologies), reproduction of knowledge is a far more expensive process because some, indeed many cognitive capabilities are not easy to articulate explicitly or to transfer to others. There are elements that therefore remain "tacit". David and Foray (2001) discuss codification of tacit knowledge, they argue that, on the other hand, knowledge may, be codified: so articulated and clarified, that it can be expressed in a particular language and recorded on a particular medium. Codification thus plays a central role in the knowledge economy because it serves to further memorization, communication and learning, and forms a sound basis for the creation of new knowledge objects. In more complex cases, however, the codified knowledge, while certainly useful, will only provide partial

assistance. Knowledge reproduction will then occur through training, practice and simulation techniques (aircraft pilots, surgeons).

David and Foray (2001) discuss knowledge-based communities as agents of economic change. They argue that knowledge-based activities emerge when people, supported by information and communication technologies, interact in concreted efforts to co-produce (i.e. create and exchange) new knowledge, new information and communication technologies are intensively used to codify and transmit the new knowledge. Therefore, a knowledge intensive community is one wherein a large proportion of members are involved in the production, reproduction of knowledge. David and Foray (2001) argue that access to the knowledge economy is highly limited and that there are great disparities between countries and social groups.

Pavitt (2002) study reflects mixed achievements in developing and using Nelson and Winter's original insights into the nature, sources and impacts of knowledge. The importance of tacit and organizational knowledge has greatly increased understanding and improved action in three areas: the public support of basic research; the nature of technological backwardness in a country or region; and the sources of corporate competitiveness. More recent work by Nelson (1993), Lundvall (1992) and others has developed the concept of national system of innovation, namely, the institutions, incentives and competencies that influence the generation, diffusion and application of knowledge in a country. This concept implicitly recognizes the importance of tacit and person-embodied knowledge, the diffusion of which is strongly influenced by distance and language. In particular, if knowledge is primary tacit and person embodied, knowledge then flows mainly through person contacts and mobility, so the degree of international "leakage" is limited by both language and by the limited degree of international mobility. Effective absorption (i.e. replication) of research results from elsewhere requires a minimum threshold of investment in research skills, equipment and professional networks. And the case for public support shifts from producing information to the training of skilled problem-solvers. It also recognizes the importance of specialization in the production of knowledge, since the core of national system of innovation is composed of specialized institutions combining and interacting in the production, diffusion and application of knowledge. As a consequence of increasing specialization- even large firms are now finding it difficult to internalize all the technological competencies that they need. As a consequence, the appropriate unit of analysis may no longer be the business firm, but the knowledge-related networks in which it is embedded (Brusoni et al., 2001). Pavitt (2002) notes that the evolutionary concepts developed by Nelson and Winter have proved most valuable to our understanding of the nature and policy implications of what has come to be called the knowledge economy. Pavitt (2002) says that successful clusters of knowledge do not simply emerge from locating close together (proximity), and they have many important knowledge linkages outside them. He argues that we still need more systematic knowledge about how far and how quickly different types of knowledge can travel, as in the case of basic research productive knowledge, which cannot be fully codified, but involves tacit elements- both technological and organizational that can be learned only through emulation and practices. Pavitt (2002) indicates that firms and countries apparently have different capabilities to do this, and "learning" is not a simple- and often unintended –by product of "doing", but a consequence of deliberate investments in activities designed to improve performance.

Nelson (2000) has made distinction between knowledge as technological understanding (strong and reliable) and knowledge as organizational practices (weak and unreliable).

According to the taxonomy defined by Lundvall and Johnson (1994) knowledge can be distinguished and sub divided into four types:

- Know what - which involves the transfer of codified information as facts.
- Know why - which involves understanding basic principles, rules and ideas.
- Know how - which involve direct experience and skills.
- Know who - which requires direct contact between individuals, the ability to communicate, form relations of trust and so on and referring to the knowledge supporting indirect access to knowledge.

Cowan and Foray (1997) argue that using this taxonomy, we can identify different logics and trends of codification (see Foray and Lundvall, 1996). Ducatel (1998) argue that 'know-what' and to some extent 'know-why' knowledge can be more readily formalized, written down or reproduced as codified information. By contrast 'know-how' and 'know-who' types of knowledge are more socially embedded. They are acquired in social context such as work place, or in clubs or associations, conferences or in real-live market places. This is because a large proportion of these forms of knowledge is 'tacit'- which means it is either not yet articulated or else it cannot be written down. It has to be acquired either by experience or direct interpersonal contacts.

Ducatel (1998) argue that there are several important implications of this division between types of knowledge and their possibility of transfer. First, when we measure the 'knowledge economy' we are nearly always limited to measuring the parts of the knowledge system, which can be codified. For instance, we refer to patents, investments in formal R&D, qualifications achieved by personnel, papers published and cited, etc. Economic research is almost entirely constructed on this foundation of codifiable knowledge. This implies that we are not capturing a large part of the knowledge, which is in the economy. Second, the unmeasured (immeasurable) part of the economy is possibly the most significant part of the economy-although this is probably worthy of debate in itself. The point is that the tacit forms of knowledge are in a sense the 'live areas' of knowledge, which are not yet well defined and so are harder to transfer in a routine manner. However, tacit knowledge resides in the minds of individuals and the practices and shared understanding of social groups. This makes tacit knowledge much harder to control in a completely controllable and predictable way. It implies that the social side of management really is just as important as getting structures, routines and technological systems in place. Third, Foray and Lundvall suggest that a large part of technological innovation actually represents efforts to codify tacit knowledge so that they can be transferred more effectively. But whilst this undoubtedly true as intention, the codification can never be complete. As Nanoka (1991) suggests each step toward codification leads to the production of new tacit knowledge, even though its form may change radically and the people who possess the knowledge may also be quite different. In fact, therefore, there is an interaction between all four forms of knowledge. The know-what and know-why depend heavily on the know-how to replicate experimental results; and getting experimental results accepted depends heavily on being recognized and legitimate actor in the know-who networks of scientists.

Ducatel (1998) looks not just at the forms of knowledge, but also on who has the knowledge and how they use their knowledge, i.e. the sociology of knowledge in the firm, rather than just expecting knowledge to reside in a few 'knowledge workers' such as senior executives and scientific personnel. So, according to Ducatel (1998) the fundamental point that in the knowledge economy is organizational learning, which is a social process and depends upon application of appropriate management practices. As Nonaka notes: a learning organization is where inventing new knowledge is not specialized activity…it is a way of behaving in which everyone is a knowledge worker (Nonaka, 1991, p.97). Ducatel (1998) note that the recognition of the key role of tacit knowledge implies the need for careful management of the social relations of learning at the individual level and in the shared knowledge, which is helped by social groups. At each stage there are a number of critical implications for policy and managerial strategies- not least of which is the need to recognize and capitalize upon the interactions between codified forms of knowledge and those that are not fully articulated. Ducatel (1998) provides a schematic introduction to the recent debate on the importance of learning and skill acquisition in the knowledge economy and points out the issue of learning is a cross –roads of interest not only of sociologists and economists but of policy makers and management. But because of this wide variety of interest there is considerable variation in the scale of analysis and concepts behind terms such as competence, skills, knowledge and so on.

Cowan and Foray (1997) find that the process by which knowledge or information evolves and spreads through the economy involves changing its nature between tacit and codified forms. They argue that it will always be true that tacit knowledge is needed to use codified knowledge, thus an addition to the codified knowledge base, implies an addition to the tacit knowledge base by which agents can use the new codified knowledge and thus give it economic value. In their views, typically, a piece of knowledge initially appears as purely tacit, then it goes through a process whereby it becomes more codified and transformed into some systematic form that can be communicated at low costs. The process of codification includes three aspects: model building, language creation and the writing of messages, i.e. coding and decoding. Recent technical changes in several technologies have lowered the costs of codification and facilitated the diffusion of codified knowledge, which has increased its value. Moreover, concerning the relations between codified and tacit knowledge, Cowan and Foray (1997) argue that there is now a consensus that codified and tacit knowledge are complements rather than substitutes. The process of codification does not provide all of the knowledge needed to undertake an action; there will always be some tacit knowledge involved in performing any action. This is the reason that codification cannot be considered as a simple transfer of knowledge from the tacit to the codified domain. It is, rather, the construction of new ensembles of codified and tacit knowledge. In other words, codification is never complete, and some forms of tacit knowledge will always continue to play an important role. This is not to argue that there are absolute limits to codification, rather, that there will always be some tacit knowledge needed to use any codified knowledge, particularly, because technical and technological advances are such that the complexity of the knowledge that we can codify continues to expand.

Smith (2002) says that in recent years learning and knowledge have attracted increasing attention as a result of the claim that knowledge-intensive industries are now at the core of growth, and that we are entering a new type of knowledge-driven economy or even a completely new form of "knowledge society". Smith (2002) discusses the concept of a 'distributed knowledge base' for industries across many agents and

organizations, and argues that the term 'knowledge economy' is only meaningful if we see it in terms of widely-spread knowledge intensity across economic activities, including so- called 'low technology' sectors. Smith (2002) indicates that knowledge creation is a sectorally distributed, economy wide process, not dependent on R&D, this argument opposed the idea that the knowledge economy should be identified with high-technology industries. Smith (2002) argues that the 'knowledge economy' in a general indicates that all economic activity rests on some forms of knowledge, not only in our society but also in all forms of human society. Smith (2002) argues that a distributed knowledge base is a systemically coherent set of knowledge, maintained across an economically and/ or socially integrated set of agents and institutions.

2. 2. Significance, impacts, sources and measures of knowledge in the growth literature

Economists have long recognized the importance of knowledge for endogenous technological progress, innovation and economic growth. In the endogenous growth theories, the sole source of growth is knowledge accumulation. For instance in the Lucas (1988) model, knowledge accumulation is at the heart of the growth process, it could directly but partly determine growth performance. For Romer (1994); Grossman and Helpman (1994), knowledge is seen as a public good generated via R&D activities that generate spillover and thus increasing returns. Aghion and Howitt (1998) endogenous growth model predicts that long run growth should be positively correlated with R&D productivity and the rate of growth of human capital. Klette and Griliches (1998), propose a model of endogenous firm growth in which R&D and innovations are the engines of growth. Moreover, the evolutionary framework developed by Nelson and Winter (1982), makes the nature of knowledge and firms' investment in it a central factor in explaining the size, structure and dynamic of industries.

Furthermore, differential in the productivity and growth of different countries is significantly related to improvement in the quality of human capital and factors of production, in particular, the capacity to create new knowledge and ideas and incorporate them in equipment and people. "Recent growth literature show increasing evidences of the growing relative importance of intangible capital in total productive wealth and the rising relative share of GDP attributable to intangible capital (Abramovitz and David 1996; 1998). Intangible capital largely falls into two main categories: on the one hand, investment geared to the production and dissemination of knowledge (i.e. training, education, R&D, information and co-ordination); on the other hand, investment geared to sustaining the physical state of human capital (health expenditures). In the US, the current value of the stock of intangible capital (devoted to knowledge creation and human capital) began to outweigh that of tangible capital (physical infrastructure and equipment, inventories, natural resources) at the end of the 1960s. Moreover, since 1960s annual investment rates in R&D, public education and software have grown steadily at an annual rate of 3% in the OECD countries". (David and Foray, 2001).

Recent empirical literature (cf. Loof and Heshmati, 2002) shows that knowledge capital[2] is found to be a significant factor contributing to performance heterogeneity and firm's innovative level. Knowledge capital rises with innovation input, the firm's internal knowledge for innovation and cooperation on innovation with domestic universities. Some empirical studies indicate that survival and growth between firms is determined by/ or at least influenced by differential rates of investment in knowledge (i.e. R&D)

[2] Defined as the ratio of innovation sales to total sales.

(cf. Klepper and Simon, 1997) or intersectoral differences in the size and R&D intensity of firm (cf. Levin et al., 1985). Moreover, David and Foray (1995) show that the increasing codification of knowledge stock would enhance firm's innovative performance.

Drucker (1998) argues that "Knowledge has become the key economic resource and the dominant—and perhaps the only—source of competitive advantage". Moreover, the European Second Report on S&T Indicators (1997) explains that "the economic and social development of today's industrialized countries is largely the fruits of the efforts of the past intensive investment in knowledge and S&T. Hence, access to scientific and technological knowledge, 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" (European Second Report on S&T Indicators, 1997).

Furthermore, Drucker (1998) suggests that: "knowledge is now becoming the one factor of production, sidelining both capital and labour". In addition, the OECD (1999) has suggested that "... the role of knowledge (as compared with natural resources, physical capital and low skill labour) has taken on greater importance". Smith (2002) argues that in recent years, learning and knowledge have attracted increasing attention as a result of the claims that knowledge intensive industries are now at the core of growth, knowledge driven economy or even a knowledge society. The role of knowledge as an input to economic processes has fundamentally changed probably due to rapid technological changes/ advances in ICT, which is seen as factor enhancing knowledge and increasing the common availability of codified knowledge (David and Foray, 1995; Smith, 2002). For instance, Zon Van (2001), extends Lucas (1988) model by incorporating the effect of ICT– capital Investment and assuming that ICT has positive influence on growth performance via both improving the intensity of production and total factor productivity and enhancing the efficiency of knowledge accumulation and learning process.

The empirical literature shows that knowledge is positively related to human capital (mainly tacit skill or skill level). For instance, Winter (1987), Cowan and Foray (1997) suggest that tacit and codified knowledge need not be substitutes they can be seen as complements in the learning process. Brusoni et al., (2002) show strong positive relationship between the codification of the knowledge base of the industry and its investment in skilled people (high levels of investment in tacit skills) and R&D.

The literature uses several indicators to investigate the sources of knowledge. For instance, Jaffe (1989) and Griliches (1979) use patent as a proxy for innovation output to represent dependent variable and private corporate expenditures and university research expenditures are used as explanatory variables to show the spillovers from university research to commercial innovation by firm. Both recent theories of National System of Innovation (Nelson, 1993; Lundvall, 1992) and interactive model of innovation stress the importance of flows of knowledge and information to the ability of firm to innovate (Kline and

Rosenberg, 1996; Freeman, 1987). Within this framework, economic theory and empirical research have focused on two types of knowledge flows: between firms, through inter-firm research collaborations (Hagedoorn et al., 2001), user-producer networks (Lundvall, 1992), or linkages between competing firms (von Hippel, 1988); and between firms and public research organizations (PROs) such as universities, government laboratories, and publicly – funded technical institutes (Mansfield, 1991; Mansfield and Lee, 1996; Pavitt, 1991). The empirical evidence shows that both types of knowledge flows, including unintentional spillovers, make a substantial contribution to innovation and consequently to economic growth and public welfare. Estimates of the rate of return to publicly funded research, for example, range between 20% and 60% (Salter and Martin, 2001). These rates of return are dependent on firms acquiring knowledge and information produced by public research organizations PROs (universities, public research institutes and government laboratories) and successfully applying this information to their innovative activities. Arundle et al., (2001) use the broad term of knowledge flows to mean knowledge that is transferred via market mechanisms and true knowledge spillovers, particularly, knowledge flows from PROs to firms. They show that innovative firms can use various external information sources to innovative activities such as public research e.g. universities, other affiliated firms, supplier, customers, joint ventures and reverse engineering. Knowledge could be transferred through joint research projects, contracted- out research, temporary personnel exchanges, informal personal contacts, hiring trained scientists/ engineers, conferences/ meetings and publications. At the aggregate level, the incidence and transfer of knowledge is affected by several variables such as the overall quantity of scientific research (publications) and the public research base as measured by the ratio between the total amount of higher education R&D expenditure and the country GDP.

Brusoni et al., (2002) highlights the importance of knowledge sources within the enterprise for innovation among innovative firms in Europe, in particular, the internal divisions (including: R&D, design, sales and marketing and senior management). The important sources of knowledge for innovative firms in Europe are subdivided into three categories: (1) Within the industry: within the enterprise, suppliers, clients or customers, enterprises within the enterprise group and competitors. (2) External advisors including consultancy enterprises, research institutes, universities and innovation centers. (3) Publicly available sources including conferences, journals, publications, fairs and exhibition, computer- based information network and patent disclosure. Brusoni et al. (2002) study explores ongoing debate about the role that codified forms of knowledge play in fostering firms' and countries' innovative performance and provides an empirical exploration of the use of codified sources of information for innovation at the sectoral level. They explore the relationship between the use of codified sources by individual firms and increases in the 'distributional power' of an innovation system and develop a proxy measure for the importance of codified knowledge relying on 'information networks' and 'patents 'disclosure'.

Ducatel (1998) argues that knowledge and learning are now almost universally regarded as sources, or at least a fundamental condition, of competitive advantage, as can be seen from an increasing interest in learning and the transfer of knowledge in academic writing, especially in the economics of technology and management (Drucker, 1993; Lundvall, 1996). Considerable progress has been made in this area, especially through the contribution of Lundvall (Lundvall, 1996; Lundvall and Johnson, 1994; Foray and Lundvall, 1996, etc). Ducatel (1998) says that the rise of the knowledge economy lies in the

observation that the 'knowledge' or 'skills' or 'information' based activities are playing an increasingly significant role in economic growth, both through the form of the knowledge and its mode of transfer. Cowan, Soete and Tchervonnaya (2001) argue that keeping afloat in highly competitive market requires that the companies in any sector of the economy should be able to access and use new knowledge that is relevant for their activity. The sources of knowledge are usually accessed by means of knowledge transfer. Improved accessibility of knowledge is especially important nowadays, when mankind has entered the new century characterized by increasingly "knowledge -driven" (European Commission 2000) and "learning" (Lundvall 1996) economy – there are estimates that more than half of GDP in the major OECD countries is based on the production and distribution of knowledge (World Bank 1999).

David and Foray (2001) argue that knowledge has been at the heart of economic growth and the gradual rise in levels of social well being since time immemorial. The ability to invent and innovate, that is to create new knowledge and new ideas that are then embodied in products, processes and organizations, has always served to fuel development. And there have always been organizations and institutions capable of creating and disseminating knowledge. "Knowledge-based economy", however, is a recently coined terms, as such, its use is meant to signify a change from the economies of earlier periods. A new kind of organization is spearheading the phenomenon: knowledge-based communities, i.e. networks of individuals striving, first and foremost, to produce and circulate new knowledge and working for different, even rival, organizations. One sign that a knowledge-based economy is developing can be seen when such individual penetrate conventional organizations to which their continuing attachment to an "external" knowledge-based community represents a valuable asset. As members of these communities develop their collective expertise, they become agents of change for the economy as a whole. Moreover, David and Foray (2001) discuss the rise of intangible capital at macroeconomic level and argue that economic historians point out that nowadays disparities in the productivity and growth of different countries have far less to do with their abundance (or lack) of national resources than with the capacity to improve the quality of human capital and factors of production, to create new knowledge and ideas and incorporate them in equipment and people. A related characteristic of economic growth, that became increasingly evident from the early twentieth century onwards, is the growing relative importance of intangible capital in total productive wealth, and the rising share of GDP attributable to intangible capital (Abramovitz and David, 1996).

The World Bank Development Report (1999) examines the roles of knowledge in advancing economic and social well- being, it realizes that economies are built not merely through the accumulation of physical capital and human skills, but on a foundation of information, learning, and adaptation. The report indicates that the information revolution makes understanding knowledge and development more urgent than ever before due to shrinking distance, costs, eroding borders and time, and offering potential opportunities to extend learning and distance education to millions who would otherwise be denied a good education. But the tremendous risks of globalization of trade, finance, and information flows is intensifying competition, raising the danger that the poorest countries and communities will fall behind more rapidly than ever before.

The World Bank Development Report (1999) states that knowledge is like light, weightless and intangible, it can easily travel the world, enlightening the lives of people everywhere. Yet billions of people still live in darkness of poverty. Poor countries- and poor people- differ from rich ones not only because

they have less capital but because they have less knowledge and having fewer institutions to certify quality, enforce standards and performance, and gather and disseminate information needed for business transactions. Knowledge is critical for development, because everything we do depends on knowledge. Simply to live we must transform the resources we have into the things we need, and that takes knowledge. To Raise living standards for household or country, improve health, education and environment, we must do more than simply transform more resources, for resources are scarce. We must use those resources in ways that generate ever- higher returns to our efforts and investments. That, too, takes knowledge, and in ever- greater proportion to our resources. Knowledge also illuminates every economic transaction, revealing preference, giving clarity to exchange, in forming a market. For countries in the vanguard of the world economy, the balance between knowledge and resources has shifted so far toward the former that knowledge has become perhaps the most important factor determining the standard of living – more than land, than tools, than labor. Today's most technologically advanced economies are truly knowledge- based. And as they generate new wealth from their innovations, they are creating millions of knowledge related jobs.

2.3. Knowledge in the new growth theory and economic growth literature[3]:

The World Bank Development Report (1999) indicates that efforts to evaluate the aggregate impact of knowledge on growth have often proceeded indirectly, by postulating that knowledge explains the part of growth that cannot be explained by the accumulation of tangible and identifiable factors, such as labor and capital. The growth not accounted for by these calculation – is attributed to growth in their productivity. This residual sometimes called the Solow residual, after the economists Robert M. Solow, who spread headed the approach in the 1950s, and what it purports to measure is conventionally called total factor productivity (TFP) growth. Some also call the Solow residual a measure of our ignorance, because it represents what we can not account for. However, it is not possible to attribute all of TFP growth to knowledge, for there may be other factors lurking in the Solow residual. Many other things do not contribute to growth- institutions are an example – but are not reflected in the contributions of the more measurable factors. While, in the early TFP analyses, physical capital was modeled as the only country-specific factor that could be accumulated to better people's lives. Technical progress and other intangible factors were said to be universal, equally available to all people in all countries, and thus could not explain growth differences between countries. Their contributions to growth were lumped with the TFP growth numbers. Although this assumption was convenient, it quickly become obvious that physical capital was not the only factor whose accumulation drove economic growth. A study that analyzed variation in growth rates across a large number of countries showed that the accumulation of physical capital explained less than 30 percent of those variations. The rest- 70 percent or more – was attributed directly or indirectly to the intangible factors that make up the TFP growth. Later attempts introduced human capital to better explain the causes of economic growth. A higher level of education in the population means more people can learn to use better technology. Education was surely a key ingredient in the success of four of the fastest- growing East Asian economies: Hong Kong (China), the Republic of Korea, Singapore and Taiwan (China). Adding education reduced the part of growth that could not be explained, thus shrinking the

[3] This section is adapted from the World Bank Development Report (1999).

haystack in which TFP growth (and knowledge) remained hidden. Some analysts even concluded, perhaps too quickly, that physical and human capital properly accounted for, explained all or virtually all of the East Asian economies rapid growth, leaving knowledge as a separate factor out of the picture. One reason these analyst came up with low values for TPF growth is that they incorporated improvements in labor and equipment into their measurement of factor accumulation. So even their evidence of low TFP growth in East Asia does not refute the importance of closing the knowledge gaps. Indeed, it shows that the fast-growing East Asian economies had a successful strategy to close knowledge gaps: by investing in the knowledge embodied in physical capital, and by investing in people and institutions to enhance the capability to absorb and use knowledge. Thus, the East Asian economies recognized the importance of knowledge and this consciously made the decision to invest in it to close the knowledge gaps.

The report says that however, our limited ability to fully account for knowledge in growth, certainly not diminish its importance for development. Many would agree with the British economist Alfred Marshall that "While nature… shows a tendency to diminishing return, man … shows a tendency to increasing return… Knowledge is our most powerful engine of production; it enables us to subdue nature and …and satisfy our wants." If anything, recognition of the importance of knowledge has gained momentum, and there is a renewed impetus to integrate knowledge into countries' development strategy.

Some economists have incorporated in their growth model this purposeful investment in education, innovation, and adaptation of knowledge by people and firms as the main source of productivity growth. However, this approach faces the challenge of usefully quantifying knowledge. But some studies have found that some knowledge- related factors affect countries' growth rates. In addition to human capital, they include investment in R&D, openness to trade, and the presence of infrastructure to disseminate information. Still other factors, not immediately associated with knowledge probably add to growth as well. For instance, recent studies conclude that quality of institutions and economic policies explain a significant part of economic growth. These institutions and policies foster the creation of knowledge. Without protection of the ownership of physical capital and knowledge capital, little investment or research would take place, because investors would not expect to earn appropriate returns from their efforts. And good institutions and policies facilitate the transfer of knowledge and enhance the likelihood that it will be used effectively. Moreover, relationship between knowledge and institutions goes two ways: supportive institutions facilitate the production and dissemination of knowledge, and knowledge, especially about the consequences of alternative institutional arrangements, can lead to more supportive institutions. These interaction make it all the more important for countries to develop institutions that complement market in creating a climate for producing and supporting the inflow of knowledge and information.

2. 4. Knowledge gaps, information problem and policies to narrow knowledge gaps[4]:

As indicated by the World Bank Development Report (1999), knowledge is often costly to create, and that is why much of it is created in industrial countries. But developing countries can acquire knowledge overseas as well as create their own at home. For instance, forty years ago, Ghana and the Republic of Korea had virtually the same income per capita. By the early 1990s Korea's income per capita was six

[4] This section is adapted from the World Bank Development Report (1999).

times higher than Ghana's. Some reckon that half of the differences is due to Korea's greater success in acquiring and using knowledge. Hence, the World Bank Development Report (1999) proposes that we look at the problems of development in a new way- form the perspective of knowledge, focusing on two sorts of knowledge and two types of problems that are critical for developing countries. First, knowledge about technology, which the report call technical knowledge or simply know-how (e.g. nutrition, software engineering, etc.), typically developing countries have less of this know-how than industrial countries, and the poor have less than the non poor, the report calls these unequal distributions across and within countries knowledge gaps. Second, knowledge about the attributes, such as the quality of a product, the diligence of a worker, or creditworthiness of a firm- all crucial to effective markets, the report calls the difficulties posed by incomplete knowledge of attributes information problems. Mechanisms to alleviate information problems, such as product standards, training certificates, and credit reports, are fewer and weaker in developing countries.

The report indicates that approaching development from a knowledge perspective- that is, adopting policies to increase both types of knowledge, know how and knowledge about attributes – can improve people's lives in myriad ways beside higher incomes. Better knowledge about nutrition can mean better health, even for those with little to spend on food. Public disclosure of information about industrial pollution can lead to a cleaner and more healthful environment. And micro credit programmes can make it possible for poor people to invest in a better future for themselves and their children. In short, knowledge gives people greater control over their destinies. The twin issues of knowledge gaps and information problems cannot be untangled in real life: to unleash the power of knowledge, governments must recognize and respond to both types of problems often simultaneously.

The report suggests three lessons of particular importance to the welfare of the people in the developing countries: First, developing countries must institute policies that will enable them to narrow the knowledge gaps that separate them from rich countries. Examples of such policies include making efficient public investments in lifelong education opportunities, maintaining openness to the world, and dismantling barriers to competition in the telecommunication sector. Second, developing- country governments, bilateral donors, multilateral institutions, non-governmental organizations, and the private sectors must work together to strengthen the institutions needed to address information problems. Third, no matter how effective we are in these endeavors, problems with knowledge will persist. We cannot eliminate knowledge gaps and information failures, but by recognizing that knowledge is at the core of all our development efforts, we will sometimes discover unexpected solutions to seemingly intractable problems.

Closing knowledge gaps will not be easy. Developing countries are pursing a moving target, as the high-income industrial countries constantly push the knowledge frontier outward. Indeed, even greater than the knowledge gap is the gap in the capacity to create knowledge. Differences in some important measures of knowledge creation are far greater between rich and poor countries than differences in income, for instances figures on R&D spending and GDP per capita indicates that inequalities in the capacity to create knowledge exceed even those in income. But developing and poorer countries, rather than re-create existing knowledge, have the option of acquiring and adapting much knowledge already available in the richer countries, which might be more cheaper, particularly with the declining ICT costs. The report examines three critical steps that developing countries must take to narrow the knowledge gaps. First, acquiring

knowledge involves tapping and adapting knowledge available elsewhere in the world- for example, through an open trading regime, foreign investment, and licensing agreements- as well as creating knowledge locally through R&D and building on indigenous knowledge. Second, absorbing knowledge involves, for example ensuring universal basic education, with special emphasis on extending education to girls and other traditionally disadvantaged groups; creating opportunities of lifelong learning; and supporting tertiary education, especially in science and engineering. Third, communication of knowledge involves taking advantage of new information and communication technology- through increased competition, private sector provision, and appropriate regulation- and ensuring that the poor have access. But even if knowledge gaps could be closed entirely, with everyone in developing countries enjoying access to the same know-how as well – educated people in the industrial countries, developing countries would still be at a disadvantage in another respect: knowledge about attributes. The report shows that know- how is only one part of what determines society's well - being. Information problems lead to market failures and impede efficiency and growth.

The reports indicates that international institutions can help the poor to bridge knowledge gaps and resolve information problems, by creating new knowledge, transferring and adapting knowledge to the needs of developing countries, and managing knowledge so that it kept accessible and constantly refreshed. The government of the developing countries can narrow knowledge gaps, address information problems, and design policies that take into account the reality that information and markets are always imperfect. Development institutions have three roles in reducing knowledge gaps: to provide international public goods, to act as intermediaries in the transfer of knowledge, and to manage the rapidly growing body of knowledge about development.

2. 5. Knowledge and institutional settings of IPRs and patents:

The World Bank Development Report (1999) indicates that the two properties of knowledge, the main characteristics of public goods: nonrivalrous and nonexcludable, often makes it possible for people to use knowledge without paying for it. This reduces the gain to innovators from creating knowledge- and in no small measure. The inability to appropriate all the returns to knowledge is the disincentive to its private supply. If anyone can use innovation, the returns are diluted, and innovators have no incentive to invest in the costly research and development (R&D) to generate in the first place. There will thus be too little investment in the creation of knowledge.

Precisely because knowledge is underprovided, governments often set up institutions to restore the incentives to create it. These take the form of patents, copyright, and other forms of intellectual property rights (IPRs), all of which are designed to provide innovators an opportunity to recoup the costs of creating knowledge and to earn a fair return. As knowledge becomes a critical asset of firms and individuals in the new, knowledge- based economy, the need to protect their rights with respect to those assets increases. At the same time, efforts to encourage the creation of knowledge must be balanced against the need to disseminate knowledge, especially to developing countries, and especially where the social returns exceeds the private returns. There are many examples in health and environmental matters, to mention just two areas, where patents are not a solution because the social returns to an innovation (to all those benefiting from it) far exceeds the private returns (to just those investing in it). Think about innovation that might lead

to a cure for such life threatening diseases as AIDS and malaria, or reduce the threat of global warming. When the social returns exceeds the private, inventors, driven by the latter, invest too little from a social perspective in knowledge creation. And because of the large gaps between private returns and social returns, many governments have assumed responsibility – or provided financial incentives to the private sector – for creating some types of knowledge. Given the special characteristics of knowledge, publication is sometimes required to provide the right incentives for its creation and dissemination by the private sector, as well as to directly create and disseminate knowledge when the market fails to provide enough. The payoffs to such public action have often huge, especially for public health.

Cowan, Soete and Tchervonnaya (2001) indicates the institutional setting, specially the three main aspects of the GATS regulations, which are important for ensuring effective knowledge transfer through the FDI channel: market access commitments, transparency, and recognition of qualifications. Moreover, effective system of intellectual property rights protection motivates creation and diffusion of new knowledge. So, a government can stimulate innovativeness of local firms and knowledge transfer from foreign knowledge holders by ensuring such protection on its territory.

Verspagen and Schoenmakers (2000) use patent citations for measuring knowledge spillover, indicating that Grossman and Helpman (1991), indicates that technology spillovers increases the research process within an individual firm. In their view the notion behind this is that technological knowledge is non-rival good, i.e. can be shared without reducing its value. The paradoxical situation is that this characteristic of knowledge, while beneficial at the aggregate level, leads to a lack of incentives to produce knowledge at the micro level. The reasons is that firms that have the prospect that the knowledge they develop will be imitated by other firms at lower costs will decide not to invest in research, so one of the institutions that has been developed to remedy this incentive problem is the patent system. That solves the incentive paradox by granting a temporary monopoly to part of the knowledge that has been developed by the patent applicant, while leaving other aspects of this knowledge for public use. For example, a patent prohibits (exact) copying of the knowledge described in it, but it does not prohibit the possibility of building further on this knowledge to develop a new piece of knowledge (which can then on its turn be patented). It is this process of cumulative inventions that Grossman and Helpman use to model the research sector in their model of endogenous economic growth, and without which, in their view, growth ceases in the long run.

2. 6. The Transfer of knowledge in the literature:

Cowan, Soete and Tchervonnaya (2001) examine the process of knowledge transfer in the services sector in the economic reality, increasingly affected by the use of information and communication technologies, to explore whether the knowledge transfer channels, traditionally used in the manufacturing, can also be made use of in services. They find that in services the following transfer channels are highly important: foreign direct investment, training and producer-consumer two-way knowledge transfer; whereas for manufacturing links with academy and patents are very significant. They indicate that the characteristics of knowledge holders and recipients are very important for the process of knowledge transfer. For Cowan, Soete and Tchervonnaya (2001) “knowledge transfer” phenomena is taken to mean “the process by which knowledge travels from a knowledge holder (a person or organization possessing the knowledge)” to a knowledge

recipient (a person or organization receiving the knowledge) through one or a greater number of transfer channels". Transfer of knowledge, just like the transfer of any good, can be seen as having two main aspects- a mere "physical movement" and an "economic circulation" (involving the transfer of ownership) (Gallouj 2000, p.63). A "transfer channel", in its turn, is/ will be seen as "a connection or a set of connections between the knowledge holders and a knowledge recipient, enabling the knowledge 'transportation' between them". A knowledge holder and a knowledge recipient can be separated geographically (two companies in different countries); or they may be involved into different types of activity (academic research and business); or they may be at different levels of hierarchy in one and the same company (a manger and a trainee). By enabling knowledge transfer between such diverse actors transfer channels help to lessen these- geographical, occupational, authority- based and, possibly, some other- types of expertise asymmetries holders (which become potential sources of knowledge for other potential recipients), and improves accessibility of knowledge when and where it is needed. The study of Cowan, Soete and Tchervonnaya (2001), employs the systematic approach[5] to the analysis of knowledge transfer channels by seeing them as an element of a larger system (knowledge transfer landscape) knowledge recipients and institutional settings. A full landscape knowledge transfer is shown in Figure 2.2 Indeed, it is usually in the power of the knowledge holder to regulate the amount and quality of what she shares. These refer to as the "transmission qualities" of the source of knowledge and they "denotes the cognitive aptitudes, the technical conditions and the attitudes of a source, which may be more or less favourable to the transfer or, conversely, retention of knowledge" (Gallouj, 2000, p.64). These qualities are known to increase when knowledge is codified and to decline when knowledge is perceived by the source as "strategic", or when the application of the knowledge is likely to "call into question" the source itself (Gallouj, 2000, p.64). Thus knowledge holder is important as the "point of departure" of the knowledge being transmitted since they can influence knowledge flows. On the other hand, as for knowledge recipients, the ability of knowledge recipient to employ new knowledge successfully has received different names in literature: "receptive qualities", "receptivity", "translation capabilities", and "absorptive capacities" (reviewed in Gallouj, 2000). Thus, in the literature discussing the problems of catch-up by less industrialized countries with respect to more advanced nations, it is stressed the increased outward orientation is not enough to have rapid technological catch-up-- what is needed for implementation of the foreign technologies is more skills built by domestic workers and mangers -- "the absorptive capacity of the economy" (Keller, 1996, p.200).

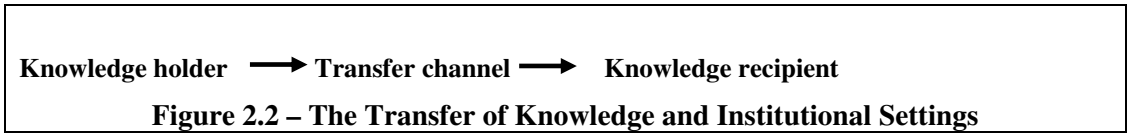


Figure 2.2 – The Transfer of Knowledge and Institutional Settings

Source: Cowan, Soete and Tchervonnaya (2001): p.9

Cowan, Soete and Tchervonnaya (2001) indicate that there are three features of knowledge transfer that take on increased importance in the context of the new economy. First, it is taking place under considerable uncertainty resulting from constantly and some times radically changing scientific and technological

[5] This approach holds that "everything, whether concrete or abstract, is a system or a component of one or more systems…." (Bunge, 2000: p.403).

realities. Second, the level of knowledge required to manage successfully many of the modern industries is so high that even competitors choose to collaborate; there are many alliances of companies formed with the primary purpose of combining their complementary competencies. Third, the sectoral composition of output and thus the sectoral importance of innovation and knowledge creation are changing rapidly as the new economy expands.

Cowan, Soete and Tchervonnaya (2001) indicates that the value of "human capital mobility" as a knowledge transfer channel is based on the fact that human beings are "carriers" of tacit knowledge, which is often unique and inseparable from its holders. Literature exists which shows that this tacitness sometimes manifests itself in the difficulties which firms face when they try to find replacement for their former employees, who possess specific expertise. Hence, human capital mobility is an important transfer channel for diffusion of tacit knowledge (interpersonal skills and know–how) which is valuable in itself and also for the diffusion of codified knowledge in innovative activity (European Commission, 2000). Moreover, in order to be transferable, knowledge needs to be clearly expressed in some type of code, ICT and assist in knowledge codification.

Cowan, Soete and Tchervonnaya (2001) identified eleven most typical knowledge transfer channels used in both manufacturing and services sectors. They argue that firstly, given the fact that knowledge transfer in both sectors is taking place in the era of the new economy characterized by wide and fast spread of new technologies (especially ICT) which lead to increasing convergence between goods and services, the channels of knowledge transfer in manufacturing and services are very similar. In fact, it is possible to state that the main differences lies not in the nature of the channels, but in the degree of their appropriateness and intensity of use. Similarities present in knowledge transfer processes are to some extent also based on the sectors' embeddedness in the same large economic and knowledge generating systems as well as some "universal" features of knowledge itself (it can be theoretical and empirical, modern and traditional, tacit and codified, general and specific in both sectors).

Arundel and Geuna (2001) study whether proximity matter for knowledge transfer from public institute and universities to firms. Their study examines the effects of proximity on the sourcing of knowledge by firms from suppliers, customers, joint ventures, competitors (via reverse engineering) and publicly- funded research organization (PROs), since they are essential components to National Innovations Systems. Their results show that proximity effects are greatest for PROs, and that proximity effects decline with an increase in the firm's R&D expenditures, the importance attached to basic research results in publications, and activity in North American market, but increase with the quality and availability of outputs from domestic PROs. Although the study evaluates the value of firms of several knowledge sources, the primary focus of their study is on knowledge flows from PROs. First, they examine the general importance of PROs as a source of knowledge for firm's innovative activities and compare the importance of PROs to other knowledge sources. Second, they determine whether the effect of proximity on the transfer of technical knowledge from PROs differs in importance compared to other external sources of knowledge. Third, they explore the methods that firms use to obtain information from PROs. These include methods of acquiring tacit and codified knowledge.

The study by Jaffe (1989) and Acts et al. (1992) provide evidences that confirm the importance of public research (university research expenditures) to both patenting activities and the industrial innovations.

Several studies on patent citations provide a more direct method of tracing knowledge flows from PROs to firms. A patent citation of a scientific paper is assumed to represent the flow of knowledge from scientific research to the firms that patented the invention (Narin and Olivastro, 1992). Jaffe et al (1993) report that patent granted to US universities received more citation than patents granted to corporations. Narin et al. (1997) find that 73% of the papers cited to US industry patent were produced by PROs, Malo and Geuno (2000) found that 81% of patent citations to the literature are to universities and other research institutions. At the more micro level, Verspagen (1999) studied the citation recorded for patents taken out by Philiphs Electronic. Half of the literature citations are to papers from PROs. Adams (2001) explore the effects of four methods for obtaining knowledge from academic and private research, the four methods for academic research are outsourcing research, faculty consulting, licensing university, patents, and hiring engineering graduates; the four methods for private research are outsourcing research, joint research, publications and patents. Adams concludes that firm-university interactions tend to be more localized than interactions with other private firms.

These developments suggest that knowledge production and use are becoming increasingly globalised, resulting in a decline in the importance of proximity to access tacit knowledge. Senker (1995) proposes that most rapidly developing technologies that are characterized by complexity will always be dependent on tacit knowledge and, consequently, on inter-personal mechanisms for knowledge flows.

Cowan, David and Foray (2000) theoretical evaluation of 'tacit' versus codified knowledge suggest that very little knowledge is intrinsically tacit in the sense that it is impossible to codify. Instead, much of what believed to be 'tacit' could be codified if economically worthwhile, while other knowledge appears to be tacit only to the uninitiated. Arundel and Guein (2001) added that the view of Cowan, David and Foray (2000), although raising doubt about the role of tacit knowledge per se, does not counter a need for direct personal contact in order to effectively transfer knowledge. This is because the real issue for the firms might simply be whether or not the knowledge is codified and publicly available. When knowledge is neither codified nor publicly accessible to firm's researchers, it becomes crucial to understand who knows what- i.e. where the knowledge is. In this context proximity matters because direct, personal contacts allow a company faster and more successful access to knowledge gatekeepers to discover where and how to access the new knowledge.

Moreover, various methods have been proposed to implement for measuring knowledge spillover such as patent citations (Jaffe et al., 1993; Verpagen and Schoenmakers, 2000). Verspagen and Schoenmakers (2000) use patent citations for measuring knowledge spillover, they argue that externalities are related to public aspects of knowledge does not mean that all parties are equally well able to use the spillovers. The two most extensively discussed factors that impacts on the efficiency with which knowledge spillovers are received include the absorptive capability of the receiver, and geographical distance. The first of these, absorptive capacity, relates to the notions that the receiving party must have specific competencies to make use of the received knowledge. Cohen and Levinthal (1989) show how these competencies are often (broadly) the same as the competencies that are required to actively develop knowledge. In other words, receiving and using spillovers on the one hand, and actively creating knowledge on the other hand, are two processes that can hardly be separated in practical terms.

The geographical dimension of absorbing knowledge spillovers results from the distinction between tacit and codified knowledge. Tacit knowledge is embodied in people, and cannot be transferred by other ways than personal interaction. Codified knowledge on the other hand can be put down in written instructions, and can thus be studied independently of personal contacts. In this interpretation, the new information and communication technologies are mainly related to codified knowledge. Thus, their increased efficiency in transferring information or codifiable knowledge over large distances would not necessarily have a large impact on the transfer of tacit knowledge.

If knowledge is mainly tacit, geographical distance is important in transmitting it. In other words, tacit knowledge travels easily over small distances, but far less over longer distance (Caniels, 1999). Also, the transmission of tacit knowledge is easier in a highly dense network of researchers working on similar topics (Saxenian, 1994). This leads to the hypothesis that, controlling for factors such as technological relatedness, the intensity of spillovers increases with geographical proximity (Jaffe et al., 1993; Verpagen and Schoenmakers, 2000). Verpagen and Schoenmakers (2000) results support the proximity effects on technological spillovers, they find that personal contact is important in transferring spillovers. This phenomenon has important implications for countries or regions that attempt to implement a technological catching-up strategy based on imitation knowledge developed elsewhere, such a strategy may in fact be stimulated by trying to attract research activities of (foreign) multinational firms.

2. 7. Summary and Conclusions

In this chapter we show the literature addressing and highlighting the knowledge economy. In Section 1 we present the definition, nature, and characteristics of knowledge based on the distinction between codified and tacit knowledge and between embodied flows and disembodied flows of knowledge and based on the nature and characteristics of knowledge as non-rival and non-excludable commodity. In Sections 2 and 3 we discuss the literature on the importance and impacts of knowledge creation, accumulation and acceleration on enhancing scientific and technological progress, productivity and economic growth and human development, particularly within the framework and recent debate in the new growth literature. In Section 4 we illustrate the concepts of knowledge gaps, information problem and policies to narrow the knowledge gap based on the World Bank report on knowledge for development. In Section 5 we indicate the institutional settings concerning both the provision and transfer of knowledge based on the nature and characteristics of knowledge as non-rival and non-excludable commodity. In Section 6 we discuss the literature on the transfer of knowledge, indicating the importance of the transfer of knowledge and the channels and ways of enhancing the transfer of knowledge.

Chapter 3

Arab States and the New Knowledge Economy

3. 1. Introduction

In the recent years the world economy is witnessing a fundamental structural change driven by both globalization and the revolution in information and communication technology (ICT) leading to a new economic system. The new economic system is characterizing by increasing significance of knowledge, the rapid diffuison of ICT, productivity growth and intensified competition and globalization trend. Hence, the role of knowledge, skills, technological capability, competitiveness and ICT have intensified and attracted a great deal of interest at the international level. More recent literatures raised a debate on the interaction between these elements and the various influences or opportunities they might create for the new economy for both developed and developing countries.

Economists have long recognized the importance of knowledge for endogenous technological progress, innovation and economic growth. In the endogenous growth theories, the sole source of growth is knowledge accumulation, for instance, for the OECD (1999) and in the Lucas (1988) model, knowledge accumulation is at the heart of growth process, it could directly but partly determine growth performance. For Romer (1994); Grossman and Helpman (1994), Aghion and Howitt (1998); Klette and Griliches (1998), knowledge is seen as a public good generated via R&D activities that generate spillover and thus increasing returns. Moreover, the evolutionary framework developed by Nelson and Winter (1982), makes the nature of knowledge and firms investment in it a central factor in explaining the size, structure and dynamic of industries. "Recent growth literature show increasing evidences of the growing relative importance of intangible capital in total productive wealth and the rising relative share of GDP attributable to intangible capital (Abramovitz and David, 1996; Abramovitz and David, 1998). Intangible capital largely falls into two main categories: on the one hand, investment geared to the production and dissemination of knowledge (i.e. training, education, R&D, information and co-ordination); on the other, investment geared to sustaining the physical state of human capital (health expenditures). In the US, the current value of the stock of intangible capital (devoted to knowledge creation and human capital) began to outweigh that of tangible capital (physical infrastructure and equipment, inventories, natural resources) at the end of the 1960s. Moreover, since 1960s annual investment rates in R&D, public education and software have grown steadily at an annual rate of 3% in the OECD countries". (David and Foray, 2001).

Hence, Drucker (1998) argues that *"Knowledge has become the key economic resource and the dominant—and perhaps the only—source of competitive advantage"*. Moreover, the European Second Report on S&T Indicators (1997) argues that *"the economic and social development of today's industrialized countries is largely the fruits of the efforts of the past intensive investment in knowledge and S&T. Hence, access to scientific and technological knowledge, 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"(European Second Report on S&T Indicators, 1997). Hence now, knowledge creation, accumulation and acceleration is intensified the pace of scientific and technological progress and has been at the heart of economic growth literature. Moreover, the advance of knowledge revolution and the increasing appreciation of its strategic importance in the new economy is enhancing with the continuous rapid progress of ICT diffusion, science and technology and globalization process.

Furthermore, over the past two decades the fast diffusion of information and communication technologies (ICT) play an increasing role in enhancing economic growth of the developed countries. More recent literature focused on the various influences of IT on economic growth, productivity, employment, work organization, competitiveness and human capital development. A debate was raised to link the recent rapid progress in ICT particularly to the fast progress in globalization of world economy, because the role of ICT is vital in facilitating, motivating and activating communications and fast delivery of different products (good and services) between different world countries. On the one hand, more recent theoretical and empirical studies in the literature discussed the positive impacts of ICT and mainly IT on productivity (cf. Hitt and Brynjolfsson, 1996; Brynjolfsson and Yang, 1996), growth and development (cf. Jorgenson and Stiroh, 1995; Pohjola, 2000; 2001), work place organization (cf. Bresnahan, Brynjolfsson and Hitt, 1999), human capital development and skill upgrading (cf. Acemoglu, 1998; Hwang, 2000). On the other hand, some recent studies in the literature show the potential negative impacts of ICT on some dimensions of economic development. Several studies that focused on this side is mainly related to the debate that ICT is similar to various kinds of technical changes in imposing the so called creative- destruction effects and labour saving/ skilled biased effects (cf. Aghion and Howitt, 1998; Freeman and Soete, 1985; 1994; 1997).

Moreover, the intensive globalization process has accelerated the diffusion of ICT and raised the debate whether it widens the gap between the developed and the developing nations in terms of technological capabilities, skills and income, or it creates an immediate chance for enhancing growth in the developing countries. Hence, some studies raised the controversy that ICT and globalization could impose some negative impacts for the developing countries, particularly, because the developed countries will have some more advantages to raise their competitiveness in the global world at the expense of the developing countries. Mainly because ICT and globalization provides some more comparative advantageous for the developed countries by facilitating the attack and open of some new markets in the developing countries. So, not only will it make it hard for the developing countries to compete with the developed countries in the international market, but also will threatened/deprive the developing countries in/from their original local markets. Additionally, it might delay the catching up of the developing countries to the developed countries. Hence, it could raised the already exited differentials and widen the already existed gap between the developed and the developing countries. Moreover, both globalization and ICT also might create some negative impacts in the status of the poor via raising the already existing inequalities in income distribution and increasing poverty of the poor.

Within this framework, the new economy, which is characterizing by the rapid development in ICT, knowledge economy and rapid globalization trend and their various influences in different economic

systems have been an exciting and interesting recent research issues that received increasing interest amongst economists in both developed and developing countries. However, the literatures often tend to address the case of the developed countries and neglect the developing countries, hence, the lack of studies particularly addressing the case of the Arab countries is the major motivation behind this study. Therefore, it might be interesting in this chapter to fill the gap in the literature by addressing the status of the Arab countries compared to the other world countries and showing the major reasons and implications of the insignificant participation in/ benefit from the new economic system. Moreover, it might be relevant to contribute to the recent efforts aimed at enhancing effective/ active Arabian participation in the global/new economic system, which will ultimately turn to accelerate the achievement of development in the Arab region and hence obtain the most positive impact from technological progress and globalization. In this chapter we would like to argue that the Arab countries are not benefiting yet from the new economic system because they manifestly lagging behind the world countries due to serious shortcomings in knowledge, skills, technological capabilities, spending and diffusion of ICT, FDI inflows, competitiveness and average growth rates.

Since several studies in the literature address one or more of these issues, e.g. S&T indicators (c.f. Zahlan, 1999; Fergany, 1999), ICT (cf. Nour, 2002), competitiveness (cf. Haddad, 2001; Lall, 2002; Belkacem, 2002), skills and education (cf. Lall, 2002; Barro and Lee, 2001), technological infrastructure/capability (cf. Rasiah, 2002). Hence, the value of this study is to integrate these issues and present more comprehensive analysis. In order to elaborate our argument we will integrate the most widely used indicators of knowledge, ICT and competitiveness, utilizing the most update data and information from different sources. We define knowledge by literacy rate, skills indicators and S&T input and output indicators (R&D and patent) and define ICT by total spending and the percentage share of population accessing the Internet, telephone and mobile. Moreover, we define competitiveness and integration into global world using some indexes such as ability to attract the inflows of FDI, ability to create basic and high technology infrastructure, technological structure of manufacture exports, mainly high technology export, value added in manufacturing and value added per employee.

The rest of this chapter is organized in the following way: Section two, presents the general socio-economic characteristics of the Arab countries. Section three discusses the various elements of the new economy, mainly the major indicators of knowledge, skills, ICT diffusion and globalization and competitiveness in the Arab countries compared to the other world counties. Section four, provides the conclusions and policy implications.

3. 2. General Socio-Economic Characteristics of the Arab countries (1990-2000)

Table 3.1 presents the general socio- economic characteristics of the Arab states, including the demographic structure/ composition, economic growth and human development indicators. We find that for the entire Arab countries, the total population is accounting for 246 thousand million, while, the average GDP per capita is amounting for US$ 4,793. We observe that there is great diversity amongst Arab countries in terms of demographic structure and both economic and development indicators, including GDP per capita, HDI, life expectancy, combined enrolment ratios and poverty rate. For instance, despite the tiny population the Arab Gulf countries and oil economies are leading the Arab region in terms of both

economic and development indicators, including GDP per capita, HDI, life expectancy and combined enrolment ratio, the gap between them and the other Arab countries remain wide. Moreover, the World Bank classification of economies put only four of the Arab states, which are Gulf states (oil economies) amongst the high income economies, while majority of the Arab states are classified amongst either medium or low income economies.[6] Consequently, the great heterogeneity in human development indicators across the Arab states can be interpreted in relation to variation of economic growth indicators/ income level, particularly GDP/ per capita. That also holds for the disparities in the diffusion of ICT measured by the percentage of population accessing the Internet, Telephone and Mobile.[7]

Table 3.1-General Socio-Economic Characteristics: Demographic composition, Economic Growth and Human Development Index in Arab countries (1990-2000) (Defined by income level and geographical location and structure of the economy)

Country	Total Population (Million) (2000)	GDP/per capita (PPP US $) (2000)	HDI (%) (2000	Life Expectancy (years) (2000	Literacy Rate (%) (2000	Combined enrolment ratio (%) (1999)	Population below income poverty line % (1983-2000)	
							$ 1 day (1993 PPP US $)	$ 2 day (1993 PPP US $)
Arab Gulf countries: Oil Economies (OE)								
High income								
Qatar	0.6	18,789	0.803	69.6	81.2	75	Na	Na
United Arab Emirates	2.5	17,935	0.812	75.0	76.3	68	Na	Na
Kuwait	1.9	15,799	0.813	76.2	82.0	59	Na	Na
Bahrain	0.6	15,084	0.831	73.3	87.6	80	Na	Na
Upper Middle Income								
Oman	2.6	13,356	0.751	71.0	71.7	58	Na	Na
Saudi Arabia	20.3	11,367	0.759	71.6	76.3	61	Na	Na
Average (Total) Gulf	(28.5)	15,373	0.795	72.8	79.2	66.8	Na	Na
Arab Mediterranean: (Mixed Oil Economies (MOE) and Diversified Economies (DE))								
Upper Middle income								
Lebanon	3.5	4,308	0.755	73.1	86.0	78	Na	Na
Lower Middle Income								
Tunisia	9.5	6,363	0.722	70.2	71.0	74	<2	10.0
Algeria	30.3	5,308	0.697	69.6	66.7	72	<2	15.1
Egypt	67.9	3,635	0.642	67.3	55.3	76	3.1	52.7
Syria	16.2	3,556	0.691	71.2	74.4	63	Na	Na
Morocco	29.9	3,546	0.602	67.6	48.9	52	<2	7.5
Average (Total) Arab Mediterranean	(157.3)	4,453	0.685	69.83	67.05	69.17	<2-3.1	7.5 –52.7
Other Arab countries								
Upper Middle Income								
Libyan Arab Jamahiriya	5.3	7,570	0.773	70.5	80.0	92	Na	Na
Lower Middle Income								
Jordan	4.9	3,966	0.717	70.3	89.7	55	<2	7.4
Djibouti	0.6	2,377	0.445	43.1	64.6	22	Na	Na
Iraq	22.946	Na	Na	58.7	55.9	49	Na	Na
Low Income: Primary Export Economies (PEE)								
Sudan	31.1	1,797	0.499	56.0	57.8	34	Na	Na
Somalia	8,778	Na	Na	46.9	Na	7	Na	Na
Yemen	18.3	893	0.479	60.6	46.3	51	15.7	45.2
Mauritania	2.7	1,677	0.438	51.5	40.2	40	26.3	67.8
Average (Total) Arab states	(246)	4,793	0.653	66.8	62.0	62	26.3 - < 2	67.8- 7.4

Source: UNDP (2002)

Table 3.2 shows that although the level of economic growth and unemployment rates varied enormously across the Arab countries, however, now the Arab states are facing the challenges of declining trend of economic growth rates and increasing unemployment rates [8]. Moreover, the presence of high poverty rate adds to the challenging situation in the Arab countries[9].

[6]For instance thirteen of the Arab countries are classified as medium income countries and four as low- income countries.

[7] See, for example, Nour (2002a).

[8] See Elbadawi (2002) and Makadisi et al. (2003) for an excellent recent analysis of slowing economic growth in the Arab world.

[9] For instance, the UNDP (2002) information in Table 1 shows that the percentage of population below income poverty line during the period (1983-2000) is estimated between <2% and 67.8% of total population. Moreover, the results of

Table 3.2 - Real GDP Growth and Unemployment in the Gulf countries (1990-2002) (Defined by geographical location)

Country	Real GDP Growth (average annual change in percent)					Unemployment (in percent of total labor force)			
	1995-2000 Average	1999	2000	2001	2002 Projected	1990	1995	2000	2001
Arab Gulf (GCC)									
Bahrain	4.3	4.3	5.3	4.8	4.1	Na.	10.0	12.0	12.0
Kuwait	3.8	-2.9	2.9	-0.6	-0.5	0.5	1.5	2.1	2.3
Oman	3.6	-0.2	5.1	7.3	3.3	Na.	Na.	Na.	Na.
Qatar	9.4	5.3	11.6	7.2	3.0	Na.	Na.	Na.	Na.
KSA	1.9	-0.8	4.9	1.2	0.7	Na.	Na.	Na.	Na.
UAE	5.7	3.9	5.0	5.1	0.3	Na.	Na.	Na.	Na.
Average Gulf countries	3.3	0.3	5.1	2.5	0.9	0.5	5.8	7.1	7.2
Arab Mediterranean									
Algeria	2.9	2.3	2.8	3.4	2.9	19.8	28.0	27.3	28.5
Egypt	5.3	6.0	5.1	3.3	2.0	8.6	9.6	7.9	7.6
Lebanon	2.3	1.0	-0.5	2.0	1.5	Na.	Na	Na	Na
Morocco	1.9	-0.1	1.0	6.5	4.4	15.4	16.0	13.7	12.8
Syria	3.0	-2.0	0.6	2.7	3.1	Na.	Na	Na	Na
Tunisia	5.1	6.1	4.7	5.0	3.8	16.2	16.2	15.5	15.0
Average Mediterranean	3.42	2.22	2.28	3.82	2.95	15	17.45	16.1	15.975
Other Arab countries									
Libyan Arab Jamahiriya	1.6	0.7	4.4	0.6	1.7	Na.	Na	Na	Na
Djibouti	-0.9	2.2	0.7	1.9	2.6	Na.	Na	Na	Na
Jordan	3.6	3.1	4	4.2	5.1	16.8	14.7	14.7	14.7
Iraq	Na.	Na	Na	Na	Na	Na.	Na	Na	Na
Sudan	6.3	6.9	6.9	5.3	5.0	16.6	14.6	12.0	11.6
Somalia	Na.	Na	Na	Na	Na	Na.	Na	Na	Na
Yemen	6.5	2.7	4.4	3.4	4.1	Na.	Na	Na	Na
Mauritania	4.3	4.1	5.0	4.6	5.1	Na.	26.0	Na	Na
Average Arab states	3.92	2.37	4.106	3.77	2.9	13.41	13.83	13.15	13.063
MENA	3.6	2.9	4.4	3.6	3.4	12.7	13.8	12.7	12.6
Developing countries	5.3	3.9	5.7	4.0	4.2	NA.	NA.	NA.	NA.

Source: The IMF World Economic Outlook (WEO) September 2002; staff estimates. I/ Simple Averages: nationals only for Bahrain

Despite, the great heterogeneity in economic and development indicators/performance across the Arab countries, it is evident that none of the Arab country presents a sufficient, coherent and convincing performance in the new economy. While, the Arab Gulf states and oil economies are leading the Arab states in terms of GDP per capita, human development indicators, spending and diffusion of ICT. They fail to present a coherent and convincing performance in the new economy due to recent declining trend in growth rates coupled with increasing unemployment[10], insignificant economic impacts of ICT[11] and failure to attract FDI, to promote efficient educational system, local technological capabilities, skills and heavy dependence on foreign technologies.[12]

3. 3. 1. Knowledge: Literacy, Skills/ Education, Science and Technology (S&T) Indicators[13]:

3. 3. 1.1. Literacy and Skills/ Education:

We observe that the literacy rates have been insufficient for the spread of knowledge within the Arab society, for instance, Figure 3.1 illustrates that despite the relative decline in illiteracy rates, however, the illiterate population is accounting for 40% of total Arab population. The illiteracy rates for all Arab countries together remain higher than the World total, LCD's, Asia, Latin America and the Caribbean and seem comparable to those of Africa and Sub-Saharan Africa.

Ali (2001) and Ali and Elbadawi (2000) indicate the high incidence of poverty in the Arab states, estimating about 22% of the Arab population were living below a real poverty line measured in term of purchasing power parity price (PPP) of $ 56 per person per month.

[10] For instance, the results of Wadi (2001) and Abdelkarim and Ibrahim (2001) indicate the declining growth rates and declining labour productivity in Kuwait and the UAE respectively.

[11] See Nour (2002b) and Pohjola (2002) and Kenny (2002) for evidences of insignificant impacts of ICT in developing countries.

[12] See, for example, Muysken and Nour (2006).

[13] See, for example, Qasem (1998), Zahlan (1999) and Fergany (1999).

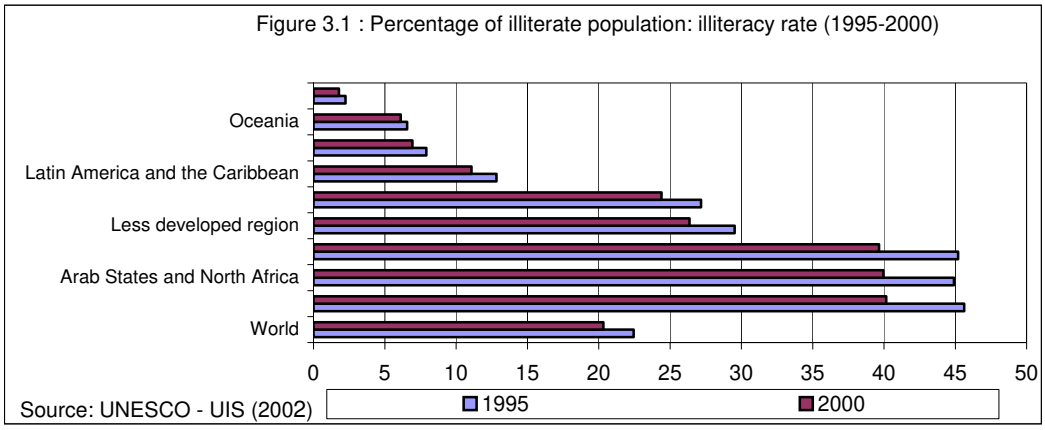


Table 3.3 – Skills indicators in the Arab countries (1992–2000) (Defined by geographical location)

Country	Skill indices (1995)			Gross enrolment ratio (%) at tertiary education	Share tertiary students in science, math and engineering	School life expectancy	
	Harbison Myers Index [a]	Technical enrolment index [a]	Engineering enrolment index [a]	1998 [b]	1994-1997 [b]	1992 [c]	2000 [c]
Arab Gulf (GCC)							
Bahrain	Na	Na	Na	25.2	NA.	13.5	13.0
Kuwait	19.10	36.49	30.57	21.08	23	7.0	8.7
Oman	8.95	5.35	4.44	NA	30	NA.	8.7
Qatar	Na	Na	Na	27.66	NA.	11.8	13.1
Saudi Arabia	13.45	18.96	14.42	20.71	18	8.5	NA.
UAE	12.20	7.51	5.70	12.10	27	10.6	10.7
Average Gulf countries	13.425	17.0775	13.7825	21.35	24.5	10.3	10.8
Arab Mediterranean							
Algeria	11.65	31.14	21.55	15	50%	10.4	12[5]
Egypt	16.45	16.10	13.87	39	15%	10.3 [2]	Na
Lebanon	21.60	46.89	34.60	36	17%	Na	13 [5]
Morocco	9.55	23.73	11.46	9	29%	Na	8[6]
Syria	13.35	23.47	17.67	6	31%	10	9[5]
Tunisia	12.55	24.49	16.15	17	27%	10.6 [1]	14
Average Mediterranean	14.19	27.64	19.22	20.33	28.17%	10.325	11.2
Other Arab countries							
Libyan Arab Jamahiriya	Na	Na	Na	56	Na.	Na	Na
Djibouti	Na	Na	Na	1[7]	Na.	3.4[1]	4
Jordan	18.55	39.27	27.64	29[6]	27	9.1	9 [3]
Iraq	Na	Na	Na	13	Na	Na	9 [6]
Sudan	2.80	3.50	2.92	7	Na	Na	Na
Somalia	Na	Na	Na	Na	Na	Na	Na
Yemen	4.45	4.60	4.17	11	6	Na	8[5]
Mauritania	3.55	5.28	3.74	6	Na	Na	7
Arab states	12.01	20.48	14.92	19.636	12.091	9.625	9.875
Other advanced countries							
Norway	38.85	73.52	60.25	64.83	18%		17
Sweden	34.45	64.50	49.94	62.3	31%		16
Canada	62.05	103.02	86.01	58.93	Na.		15
USA	50.25	88.10	68.98	75.66	Na.		15
UK	37.55	68.69	49.83	58.39	29%		16
Australia	50.55	112.70	84.29	63 [6]	32%		17
Japan	30.05	63.54	63.54	44	23%		14
Korea, Republic of	36.10	132.06	113.83	71.69 [6]	34%		15
Iran	14.30	37.58	30.03	10 [6]	36%		11.5 [4]

Sources: Sources: (a) Lall (2002) (b) UNDP (2002), Human Development Report (2002). (c) UNESCO (1996) and UNESCO: www.unesco.org Notes: (1) data refer to the year 1991 (2) 1993 (3) 1995 (4) 1996 (5) 1998 (6) 1999 (7) 2000 (**) data refer to 1996

Table 3.3 presents major skills indicators defined by the percentage share of gross enrolment ratio in tertiary education, the share of tertiary students in science, math and engineering and school life expectancy, beside, Harbison Myers Index, Technical enrolment index and Engineering enrolment index.[14]

[14] Harbison Myers Index is sum of secondary enrolment and tertiary enrolment times 5, both as % of age group. Technical enrolment index is tertiary total enrolment (times 1000) plus tertiary enrolment in technical subjects (times

We find that the average percentages share of gross enrolment ratio in tertiary education and the share of tertiary students in science, math and engineering for all Arab countries together are accounting only for 19.636 and 12.091. Implying that the Arab countries are lacking sufficient skills and lagging far behind the comparable percentages of the advanced countries, which ranges between 44-75.66 and 18-32 respectively and even behind the comparable percentages of the developing countries like Korea, which accounts for 71.69 and 34 respectively. That also hold for school life expectancy, for which the average for all Arab countries together is accounting only for 9.875, appears lagging behind the comparable percentages of the advanced countries 14-17 and even those of the developing countries like Korea. Moreover, for all Arab countries other average skill indices measured by Harbison Myers Index, Technical enrolment index and Engineering enrolment index are accounting for 12.01, 20.48 and 14.92 respectively. Indicating the poor skills level, particularly in comparison to those of the advanced countries, which ranges between 30.05-62.05, 63.54-112.70 and 49.83-86.01 respectively. The Arab countries are also lagging far behind the other developing countries such as Korea (36.10, 13206, 113.83) and Iran (14.30, 37.58 and 30.03).

3. 3.1.2. S&T Input Indicator: R & D:

Table 3.4 shows that knowledge/S&T input indicator measured by spending on R&D as percentage of GDP for all Arab countries together is accounting only for 0.4 of GDP. Indicating that the Arab countries are lagging far behind the comparable range of the advanced countries 1.7-3.8, and even behind those of the developing countries such as Singapore (1.1) and South Korea (2.7).

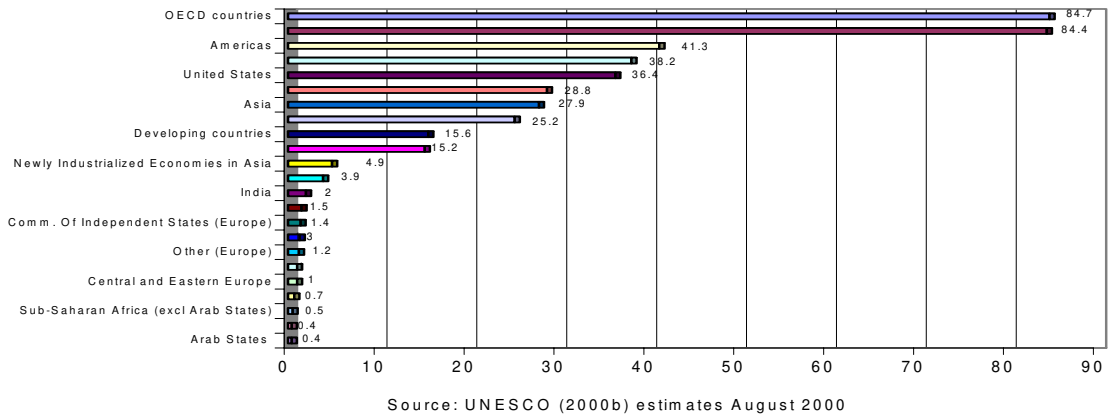
Table 3.4 – Technology indicators in the Arab countries (1992–2000)

Country	% of population accessing				Spending on R&D (million US$)	Patents	High technology exports as % of manufactures exports	
	the Internet		telephone	Mobile				
Arab countries	1996 [a, e]	2000 [b, e]	2000 [a, e]	2000 [a, e]	1996 [c, e]	1990-1999 [d, e]	1990 [e, e]	2000 [e, e]
Bahrain	5.81	16.67	23.55	9.07	3.7	2	Na	Na
Kuwait	4.90	8.25	20.18	10.28	67.1	27	3	1
Oman	1.91	3.36	7.67	2.28	10.8	3	2	4
Qatar	5.58	10.27	18.46	5.65	5.5	0	Na	Na
Saudi Arabia	1.76	2.59	13.62	4.39	196.1	103	Na	Na
UAE	16.62	24.44	38.02	41.54	10.9	15	Na	Na
Algeria	0.06	0.60	7.25	0.11	35.6	Na.	Na.	4
Egypt	0.43	0.82	5.71	0.55	227.5	Na.	Na.	Na.
Lebanon	6.27	6.56	19.30	15.99	7.4	Na.	0	1
Morocco	Na.	Na.	Na	Na	74.8	Na	Na.	12
Syria	0.12	0.18	7.85	Na	24.2	3	0	1
Tunisia	1.13	2.82	6.74	0.52	28.9	Na.	2	3
Libyan Arab Jamahiriya	0.14	0.40	7.25	Na	16.9	Na	Na	Na
Djibouti	Na.	Na.	Na	Na	Na.	Na	Na	Na
Jordan	1.70	4.57	7.82	0.22	20.6	13	1	8
Iraq	Na.	0.06	2.89	Na	27.6	Na	Na	Na
Sudan	0.03	0.08	1.11	0.06	10	Na	Na	Na
Somalia	Na	Na	Na	Na	Na.	Na	Na	Na
Yemen	0.07	0.08	1.16	0.18	10.3	2	1	Na
Mauritania	Na	Na	Na	Na	Na.	Na	Na	Na
Arab states	3.102	5.11	11.79	6.99	45.76	168	9	36
Arab states		5.11 [e]	11.79 [e]	6.99 [e]	0.4 [e]	168 [e]	9 [e]	36 [e]
Advanced countries								
Norway		52.40 [e]	60.73 [e]	46.20 [e]	1.7 [e]	103 [e]	12 [e]	17 [e]
Sweden		50.70 [e]	67.80 [e]	43.21 [e]	3.8 [e]	271 [e]	13 [e]	22 [e]
Canada		42.03 [e]	58.56 [e]	13.32 [e]	1.7 [e]	31 [e]	14 [e]	19 [e]
USA		53.23 [e]	69.77 [e]	24.89 [e]	2.5 [e]	289 [e]	33 [e]	34 [e]
UK		32.64 [e]	58.47 [e]	21.79 [e]	1.8 [e]	82 [e]	24 [e]	32 [e]
Australia		40.14 [e]	49.49 [e]	33.06 [e]	1.7 [e]	75 [e]	12 [e]	15 [e]
Japan		21.35 [e]	47.63 [e]	50.39 [e]	2.8 [e]	994 [e]	24 [e]	28 [e]
Korea, South		31.49 [e]	50.10 [e]	56.36 [e]	2.7 [e]	779 [e]	18 [e]	35 [e]
Singapore		40.46 [e]	44.83 [e]	54.25 [e]	1.1 [e]	8 [e]	40 [e]	63 [e]
China		1.73 [e]	10.60 [e]	5.11 [e]	0.1 [e]	793 [e]	19 [e]	105 [e]

Sources: (a) CIA World Fact Book (2001): www.globalstat.com. (b) www.ajeeb.com for ICT data. (c) UNESCO (1998) (d) US Patent and Trademark office web site: www.uspto.gov (e) UNDP (2002), Human Development Report (2002).

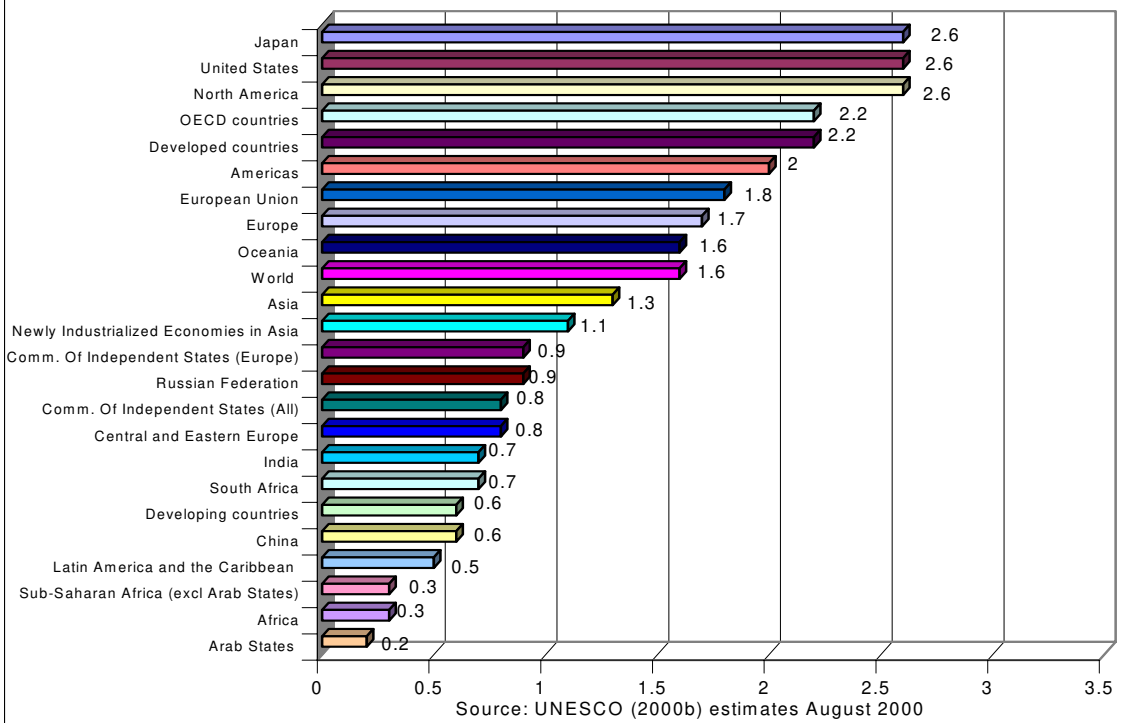
5000), both as % of population, Engineering skills index is the same as previous index, with tertiary enrolments in engineering instead of enrolment in technical subjects.

Figure 3.2: The Share of World Expenditure (GERD) by Principal regions/ countries 1996/97
(%)



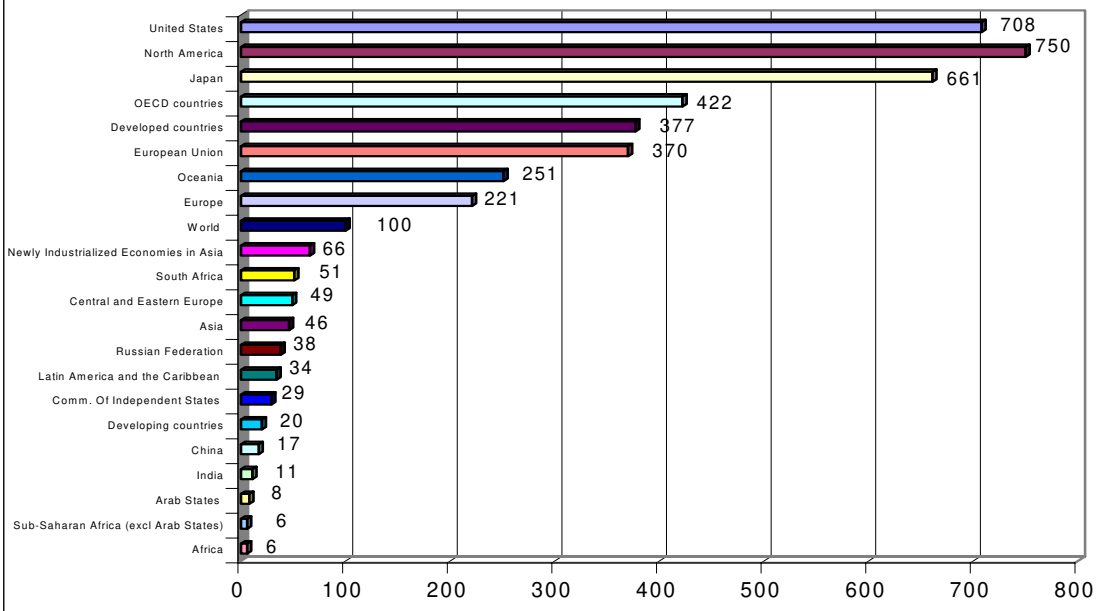
Source: UNESCO (2000b) estimates August 2000

Figure 3.3: The GERD as a % of GDP by principal regions/ countries 1996/97



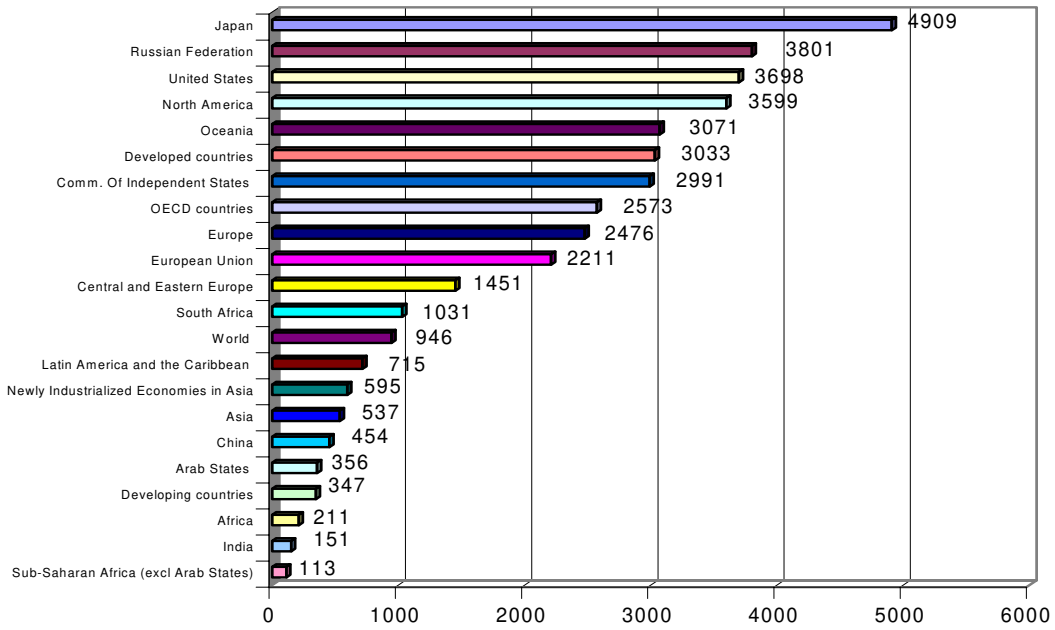
Source: UNESCO (2000b) estimates August 2000

Figure 3.4: R&D expenditure (GERD) per capita of total population 1996/97 (PPP US$)



Source: UNESCO (2000b) estimates August 2000

Figure 3.5: Researchers per million inhabitants 1996/97, by principal region/ countries



Source: UNESCO (2000b) estimates August 2000

In addition, Figure 3.2 shows the regional distribution of the world Gross Domestic Expenditure on R&D GERD during the period (1996/1997). Provides further evidence that the share of all Arab countries together is insignificant when seen from a global perspective, because it is accounting for less than 0.5% of the world GERD, hence, lagging far behind not only advanced countries but also all principal world regions, even Africa and Sub-Saharan Africa. Figures 3.3 indicates that the Arab countries together spend only 0.2 of GDP on GERD, hence they have the lowest share of GERD as percentage of GDP compared to other regions in the world, they lag far behind the advanced countries, the developing countries and even behind Africa and Sub-Saharan Africa. Moreover, Figures 3.4 and 3.5 indicates the insufficient R&D per capita and the number of researchers in the Arab countries compared to advanced countries and other developing countries like China.

3. 3.1.3. S&T Output Indicator: Patent:

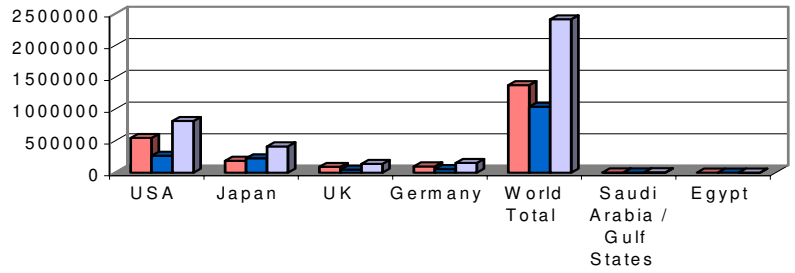
In addition, Table 3.4 on knowledge/S&T output indicator measured by the number of patents awarded to firms and individuals shows that the total number for some of the Arab countries fall far below world average and does not exceed similar figures from other developing countries. For instance, the poor performance appears from an electronically published data on patents originating from a number of the Arab countries in comparison with figures for other countries that registered in the United States during the period 1990- 1999. The low patenting activities indicate the low innovative activities in the Arab countries compared to advanced countries and developing country, particularly China and Korea.

3. 3. 2. The diffusion and Spending on ICT in the Arab countries:

When we measure the diffusion of ICT by the percentage of population accessing the Internet, telephone and mobile, we find that the average percentages of Arab population with access to Internet, telephone and mobile are accounting only for 5.11%, 11.79% and 6.99%. Hence, implying an inadequate diffusion of ICT, which appears lagging far behind the comparable percentages or ranges for the advanced countries 53.23%-21.35%, 69.77-47.63%, and 50.39-13.32 and behind those of another developing countries such as Singapore and South Korea.

Moreover, when we define the status of ICT spending in the Arab states represented by both Egypt and the Arab Gulf countries we find them below those of the world countries. For instance, Table 3.5 and Figures 3.6–3.9 show that ICT spending and IT variables in both Egypt and the Gulf countries are lagging far behind the world total and especially the developed countries such as the United States, Japan, United Kingdom and Germany. For instance, while, the total ICT spending in Egypt and Saudi Arabia/ the Gulf states are ranged between 6,194 and 2,383, the comparable amount for the advanced countries is ranged between 812,635 and 137,726. Moreover, priority of ICT spending in the economy of Egypt and Saudi Arabia/ the Gulf states when measured by the percentage share of ICT spending in GDP is accounting only for 2.5% and 3.6% respectively, while the comparable percentages of the advanced countries is ranged between 9.7% and 7.6%. Furthermore, the amount of ICT/Capita in Egypt and Saudi Arabia/ the Gulf states is accounting for 36.8 and 309.4, whereas the comparable amount for the advanced countries is ranged between 3,256.2 and 1,880.4. In addition, the Arab states represented by Egypt and Saudi Arabia/the Gulf states are lagging behind the world and the advanced countries in terms of total personal computers installed in education, home, business and government.

Figure 3.6 : Total ICT Spending (2001) (in US Dollar)



Source: WITSA (2002)

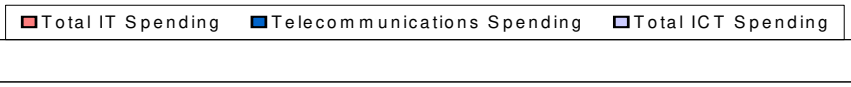
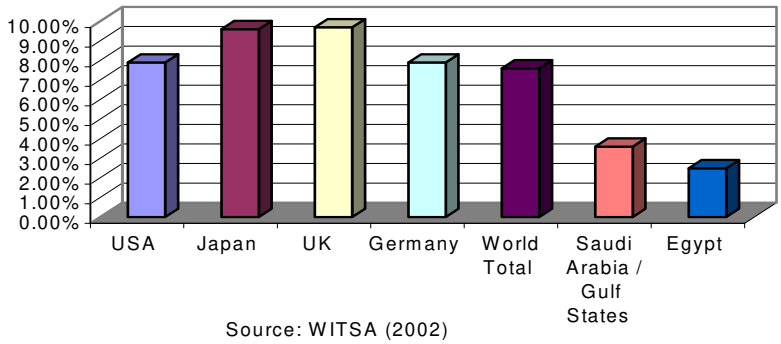
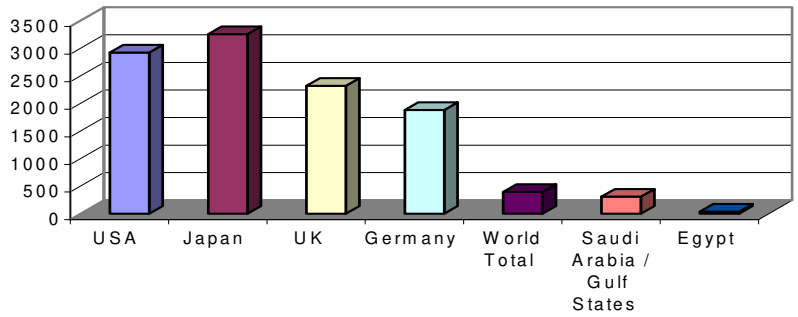


Figure 3.7 : The Percentage Share of ICT in GDP (2001)



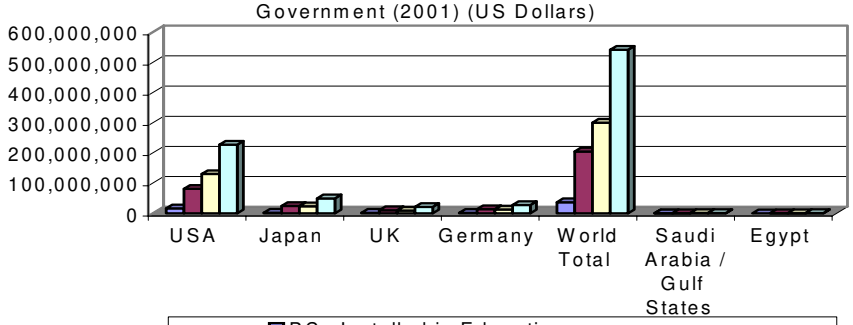
Source: WITSA (2002)

Figure 3.8 : The Percentage of ICT Per Capita (2001)



Source: WITSA (2002)

Figure 3.9 : Total Personal Computer Installed in Home, Education, Business and Government (2001) (US Dollars)



Source: WITSA (2002)

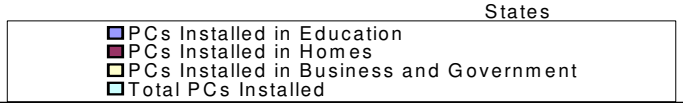


Table 3.5 - ICT Spending and IT Variables in Egypt, Saudi Arabia/ Gulf States, USA, Japan, UK, Germany and World Total (2001)

Country	USA	Japan	UK	Germany	World Total	Saudi Arabia/ the Gulf States	Egypt
(1) ICT Spending (US$M)							
IT Hardware Spending	$136,051	$49,686	$21,287	$24,488	$376,119	$1,043	$417
IT Software Spending	$96,556	$13,729	$13,798	$14,697	$196,237	$302	$124
IT Services Spending	$199,203	$52,320	$27,354	$27,018	$425,660	$922	$245
IT Internal Spending	$107,428	$67,786	$26,723	$29,075	$345,500	$557	$223
IT Other Office Equipment Spending	$7,442	$4,491	$2,194	$2,982	$33,705	$94	$38
Total IT Spending	$546,681	$188,012	$91,356	$98,260	$1,377,221	$2,918	$1,046
Telecommunications Spending	$265,954	$225,761	$46,370	$56,385	$1,037,877	$3,276	$1,337
Total ICT Spending	$812,635	$413,772	$137,726	$154,645	$2,415,098	$6,194	$2,383
(2) Economic Ratios							
ICT/GDP	7.9%	9.6%	9.7%	7.9%	7.6%	3.6%	2.5%
ICT/Capita	$2,923.8	$3,256.2	$2,318.6	$1,880.4	$395.3	$309.4	$36.8
Software/Hardware Spending	71.0%	27.6%	64.8%	60.0%	52.2%	28.9%	29.8%
(3) IT Variables							
PCs Installed in Education	16,322,694	2,172,000	1,824,106	1,054,871	36,778,755	66,391	48,816
PCs Installed in Homes	80,943,489	24,276,412	10,201,092	13,550,184	204,483,990	220,386	147,827
PCs Installed in Business and Government	129,868,818	22,791,000	8,906,587	12,762,242	299,914,464	618,054	454,441
Total PCs Installed	227,135,001	49,239,412	20,931,785	27,367,298	541,177,209	904,831	651,084
Telephone lines/HH	1.98	1.50	1.50	1.30%	N.A.	1.12	.34

Source: WITSA (2002): ICT Spending Data: Digital Planet 2002. * N.A: data not available.

3. 3. 3. Globalization, Competitiveness[15] and Technology Achievement Index (TAI[16]):

On the other side, when we define the degree of competitiveness and integration in the global world, using some indexes such as the ability to attract foreign direct investment inflows, ability to create basic and high technology infrastructure, value added in manufacturing and value added per employee. And the technological structure of manufactured exports as percentage of total manufactured exports, especially, the share of high- technology exports as percentage of manufacture exports, we find that the Arab states have poor performance and lagged far behind world countries in terms of all these indicators.

In this regard, the low ability to attract Net Foreign Direct Investment Inflows (NFDI) to the Arab region as compared to other regions in the world provides evidence for the low degree of competitiveness and integration in the global economy. For instance, Figure 3.10 shows that during the last decade the share of Arab states is accounting only for 1% of the regional distribution of the world NFDI as percentage of GDP (NFDI/GDP). In contrast to the increasing trends in NFDI/GDP amongst all principal regions in the world, the trend for all Arab countries together shows an opposite declining trend. Hence, the share of all Arab countries together is insignificant when seen from a global perspective and lagging far behind not only the OECD, but also all principal regions in the world and even LDC's, developing countries, Africa and Sub-Saharan Africa. Furthermore, the UNCTAD International Investment Report (2002) says that in the year 2001, the total amount of FDI attracted by all Arab countries together is less than the total amount attracted by Singapore alone, implying the low degree of attractiveness/competitiveness in the Arab countries. Moreover, the report indicates that within the Arab region only Bahrain is classified among the

[15] The results in this section are consistent with the findings of Haddad (2001), Lall (2002) and Belkacem (2002). For instance, Belkacem (2002), indicates that "despite the huge efforts made by many Arab countries in stabilizing and adjusting their economies as part of their economic reforms programs, their performance is unfortunately below their potential and are not taking full advantage of the opportunities that the global economy has offered to them. This is reflected in the weak record of Arab growth as compared to growth in LDC's. Low GDP growth rates coupled with high population growth rates meant stagnant per capita GDP growth rates. At the same time Arab Countries have attracted very little of net private capital which surged to LDC's in recent years. Arab exports growth which averaged only 1.5 % per annum during 1990-95 is far below LDC's performance where growth reached 10 % during the same period. Added to this slow growth of exports, most of it is made of traditional exports. These facts reflect that Arab Countries are far from being prepared to face globalization challenges. Given their resource endowments Arab countries are under-achievers and are falling behind in an increasingly competitive world" (c.f. Belkacem (2002)).

[16] For definition and details about TAI see UNDP (2001).

high performance country in terms of attracting FDI. While, the group of UAE, Syria, Oman, Lebanon, Qatar, Kuwait, Egypt and Saudi Arabia and the group of Libya, Morocco and Yemen are classified as low and very low attracting countries respectively.

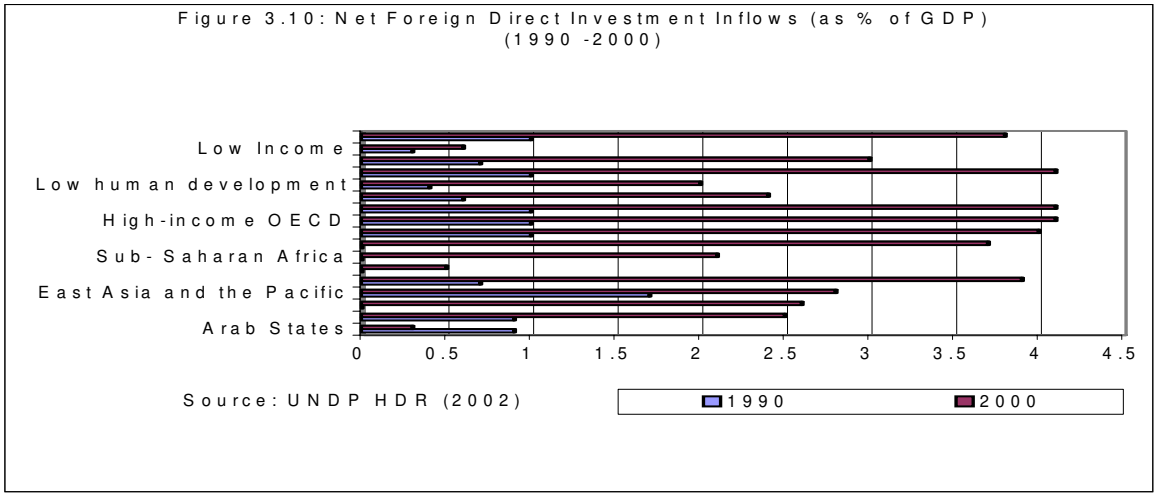


Table 3.6 - Indicators of Arab Competitiveness: Technological structure of Manufactured Exports 1996/1997 (percentage of each country's total manufactured exports)

Countries	Primary products [a]		Resources based manufactures [a]		Low technology manufactures [a]		Medium technology manufactures [a]		High technology manufactures [a]	
Arab countries	1985	1997	1985	1997	1985	1997	1985	1997	1985	1997
Algeria	60.1	81.2	39.3	17.7	0.1	0.2	0.5	0.7	0.0	0.0
Bahrain	54.4	56.1	10.9	12.5	11.8	13.1	22.0	16.7	0.6	1.5
Egypt	74.7	31.4	15.4	34.4	8.8	26.8	0.4	5.5	0.3	1.6
Jordan	43.7	39.0	10.3	19.8	13.7	8.2	16.6	26.5	14.4	5.6
Kuwait	Na.	Na.	Na.	Na.	Na.	Na.	Na.	Na.	Na.	Na.
Lebanon	Na.	Na.	Na.	Na.	Na.	Na.	Na.	Na.	Na.	Na.
Libya	88.8	78.6	10.1	18.1	0.0	1.6	1.2	1.7	0.0	0.0
Morocco	44.5	35.1	30.6	30.0	15.9	22.4	8.5	12.2	0.4	0.3
Mauritania	Na.	Na.	Na.	Na.	Na.	Na.	Na.	Na.	Na.	Na.
Oman	93.8	76.9	0.7	5.7	0.4	2.6	3.3	11.8	1.2	1.6
Qatar	72.2	67.4	11.0	10.5	5.2	7.9	11.4	13.9	0.1	0.3
KSA	82.7	74.5	13.6	18.0	0.6	1.6	2.9	5.7	0.1	0.2
Sudan	Na.	Na.	Na.	Na.	Na.	Na.	Na.	Na.	Na.	Na.
Syria	61.6	80.2	26.4	10.0	7.8	8.3	4.0	1.1	0.2	0.2
Tunisia	48.2	11.3	14.1	19.0	22.2	51.3	14.0	15.1	1.1	3.3
UAE	22.3	35.6	15.0	14.9	16.1	33.4	33.0	15.7	5.6	0.3
Yemen	9.6	92.5	90.3	5.6	0.0	0.6	0.1	0.9	0.0	0.1
Average Arab	58.2	58.45	22.13	16.63	7.89	13.69	9.07	9.81	1.85	1.15

1996	Resources based manufactures	Low technology manufactures	Medium technology manufactures	High technology manufactures
Average Arab [a]	16.63	13.69	9.81	1.15
Middle East, North Africa [b]	19.5	59.6	15.3	5.6
Sub- Saharan Africa [b]	25.0	36.8	32.3	6.0
Latin America, Caribbean [b]	22.8	23.1	31.3	22.8
Developing Asia [b]	11.4	32.3	15.8	40.4
World [b]	13.7	21.3	37.2	27.7
Singapore [b]	12.7	7.9	14.0	65.4
Malaysia [b]	17.8	13.1	8.7	60.4
Korea [b]	9.4	28.4	26.6	35.7
Mexico [b]	7.1	20.9	35.2	36.9
Brazil [b]	25.6	31.8	34.0	8.6

Source: (a) Haddad (2001) and (b) Lall (2002) computations based on UNCOMTRADE data 2000 and 1996 respectively.

Furthermore, when we define the technological capability building by the shares of basic and high technology infrastructure, we observe that while, the shares of basic technology infrastructure is relatively better than those of high technology infrastructure in the Arab countries.[17] However, Table 3.7 and Figure

[17] Rasiah (2002) defines basic technology infrastructure (BII) as weighted proxies representing basic education (enrolment in primary schools), health (physicians per thousand people) and communications (main telephone lines per

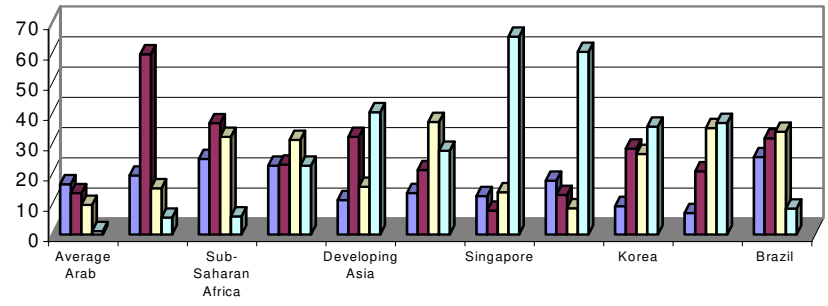
3.12 shows that the shares of both basic and high technology infrastructure in all Arab countries are inadequate for building the local technological capability and still lagging far behind the advanced countries and even behind the developing countries like Singapore, Korea, Hong Kong and Turkey. The above conclusions that the Arab countries are lacking adequate infrastructure for technological capability building and are lagging behind the advanced countries and even behind the developing countries also holds for competitiveness in manufacturing in comparison with the developed and developing countries. For instance, Tables 3.8-3.10 and Figures 3.13-3.14 illustrate that Arab countries are lagging behind the advanced countries and the developing countries such as China and Korea in terms of manufacturing per capita growth rate, the share of manufacturing activities in GDP, value added in manufacturing and value added per employee. Moreover, Table 3.7 indicates that the Arab performance in terms of TAI is lagging far behind advanced and leading developing countries.

Table 3.7- Indicators of Arab Competitiveness: Basic and High Technology Infrastructure

Country/ Year	1992	1994	TAI and classification
Arab countries	BASIC	HIGH	
Egypt	NA	0.27	0.236 - Dynamic Adopter
Iraq	NA.	NA	Na
Kuwait	1.45	0.16	Na
Libya	1.06	NA	Na
Oman	0.86	NA	Na
Tunisia	0.82	0.17	0.255 - Dynamic Adopter
KSA	1.08	NA	Na
Syria	1.02	0.07	0.240 - Dynamic Adopter
Yemen	0.18	NA	Na
UAE	1.41	NA	Na
Average Arab	0.985	0.1675	Dynamic Adopter
Other countries			
Turkey	1.49	0.31	Na
Singapore	1.64	1.39	0.585 – Leader
Korea, Republic	1.76	2.14	Na
Hong Kong	1.99	NA	0.455 - Potential leader
Malaysia	1.05	0.13	0.396 – Potential leader
Finland	2.64	2.40	0.744 – Leader
Sweden	2.95	3.26	0.703 – Leader
Japan	2.26	3.18	0.698 – Leader
USA	2.67	2.67	0.733 – Leader

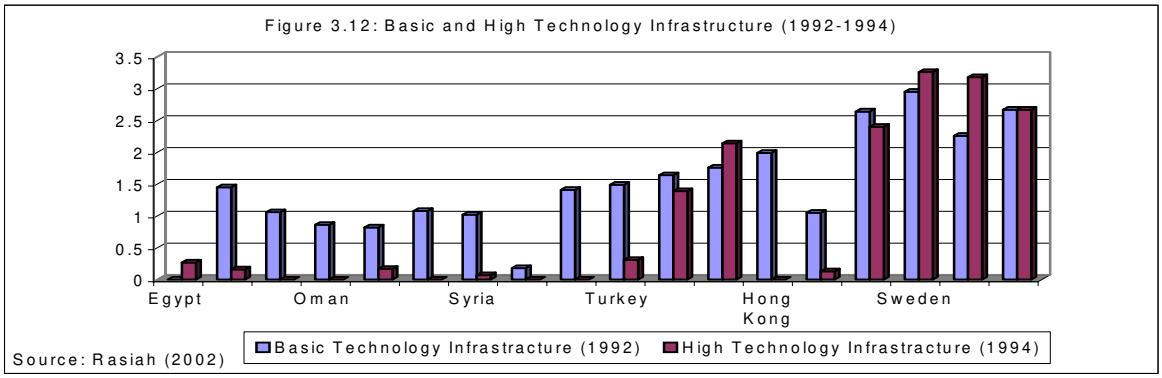
Source: Rasiah (2002)

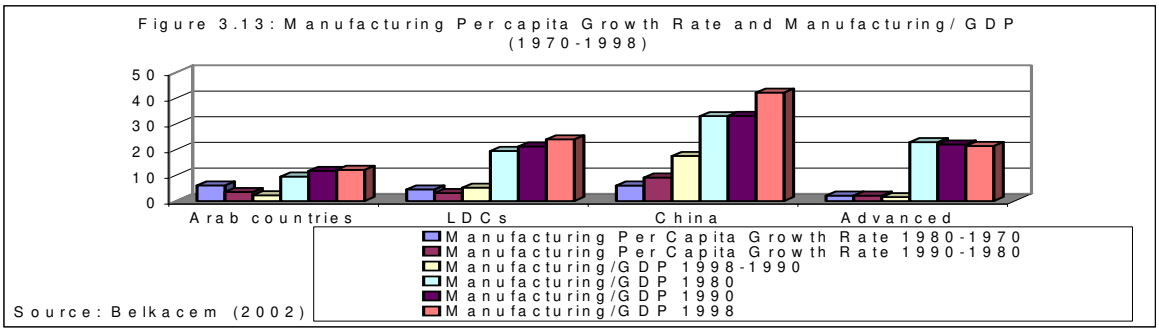
Figure 3.11: Technological Structure of Manufactured Exports (1996-1997)
(% of total manufactured exports)



Source: Haddad (2001) and Lall (2002)

thousand people). And defines high technology infrastructure (HII) as weighted proxies represents R&D investment in Gross National Investment and R&D scientists and engineers per million people. Rasiah (2002) argues that BII is an essential but not sufficient condition for economies to achieve technological capabilities, the incidence of economies generating innovation is higher when they also have the high technology support institutions, the lower BII the lower the capacity and resources for high technology development.





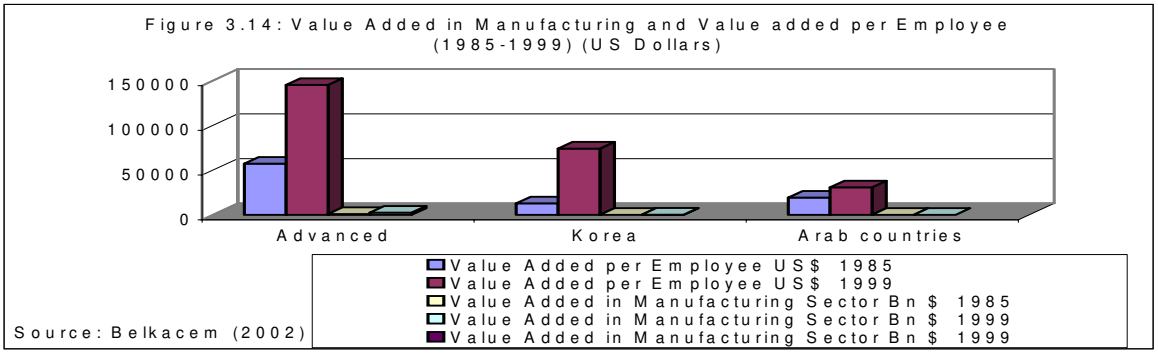


Table 3.8- Indicators of Arab Competitiveness: Some Productivity Indices in the Arab Countries.

Countries	Per Capita Manufacturing Output			Manufacturing Per Capita Growth Rate			Manufacturing/GDP		
	1980	1990	1998	1980-1970	1990-1980	1998-1990	1980	1990	1998
Arab countries									
Algeria	275.00	247.00	106.00	4.20	0.40	-11.10	10.80	9.90	4.60
Bahrain	951.00	1367.00	2011.00	1.60	4.60	5.20	8.20	16.70	21.00
Egypt	136.00	198.00	260.00	1.90	3.80	3.30	21.10	23.20	25.90
Jordan	149.00	140.00	160.00	14.40	-2.30	2.30	13.10	16.10	16.80
Kuwait	1163.00	998.00	3153.00	2.80	-2.00	23.80	6.30	11.60	20.00
Lebanon	312.00	170.00	167.00	-8.10	-7.10	-1.20	15.20	13.10	7.90
Libya	284.00	448.00	638.00	10.90	40.90	5.70	2.80	7.30	12.00
Mauritania	44.00	46.00	34.00	1.50	1.20	-4.40	7.30	9.20	6.20
Morocco	161.00	199.00	214.00	3.50	1.90	0.90	17.60	18.40	18.50
Oman	36.00	192.00	283.00	24.40	15.60	5.00	0.30	2.90	3.70
Qatar	2015.00	1955.00	2265.00	-0.50	0.70	2.40	7.70	12.90	14.00
KSA	415.00	496.00	540.00	1.50	2.10	-0.30	3.90	7.60	8.60
Sudan	113.00	87.00	94.00	-1.00	-1.40	-0.30	9.90	8.60	7.80
Syria	135.00	101.00	144.00	2.30	-0.20	4.20	6.10	5.30	5.8
Tunisia	242.00	255.00	315.00	12.10	1.30	3.60	18.00	16.90	17.70
UAE	1168.00	1311.00	1428.00	25.40	-3.30	1.90	3.60	7.50	8.40
Yemen	Na	60.00	64.00	Na	Na	-3.90	Na	Na	7.80
Arab	474.94	486.47	698.59	6.06	3.51	2.18	9.49	11.70	12.16
LDCs	161.00	203.00	291.00	4.50	3.10	5.20	19.50	21.20	24.00
China	55.00	113.00	301.00	6.00	9.10	17.50	33.00	33.10	42.20
Advanced	3712.00	4430.00	4880.00	2.10	2.10	1.50	22.90	22.00	21.40

Source: Belkacem (2002)

Table 3.9 - Indicators of Arab Competitiveness: Long Term Growth Trends in Arab Countries.

Countries	Growth Rate (65-99)		Sectoral Growth Rates			Demand Growth		
Arab countries	GDP (65-99)	Per Capita (65-99)	Agriculture	Industry	Services	Exports	Consumption	Investment
Algeria	3.90	1.00	4.70	2.90	4.00	2.70	3.30	4.60
Egypt	5.60	3.30	2.80	6.50	7.80	5.40	5.80	5.10
Jordan	4.70	0.40	6.50	5.30	4.00	7.10	4.50	4.70
Kuwait	0.00	-3.90	9.70	-4.10	6.20	-3.00	8.50	7.80
Libya	0.50	-3.60	10.30	-1.20	11.40	-1.20	NA	12.70
Mauritania	2.40	-0.20	1.50	2.60	3.20	2.10	NA	3.70
Morocco	4.20	1.90	2.30	3.90	5.20	5.30	4.20	4.40
Oman	9.50	5.00	Na	Na	Na	Na	Na	Na
KSA	4.60	-0.10	7.40	3.20	6.90	Na	Na	Na
Sudan	3.10	0.50	3.10	3.70	3.50	-2.10	NA	3.90
Syria	5.70	2.30	4.30	8.40	6.20	6.20	0.70	4.50
Tunisia	5.00	2.70	3.90	5.90	5.00	6.70	4.30	5.60
UAE	3.30	-3.90	11.40	1.10	6.40	Na	Na	Na
Arab	4.04	0.42	5.66	3.18	5.82	2.92	4.47	5.70
MENA	3.00	0.10	4.20	1.30	4.00	Na	Na	Na
EA & Pacific	7.40	5.60	3.60	9.60	7.80	10.10	9.70	6.70

Source: Belkacem (2002)

Table 3.10 - Indicators of Arab Competitiveness: Performance of the Manufacturing Sector In Arab Countries (1985-1999)

Countries	Value Added per Employee US$		Average Wages in $		Value Added in Manufacturing Sector (Billions US $)		Wages to Value Added	
Arab states	1985	1999	1985	1999	1985	1999	1985	1999
Algeria	15525.00	NA	8175.00	NA	6.51	Na	Na	Na
Bahrain	Na	Na	Na	9653.00	Na	Na	Na	Na
Egypt	6029.00	7426.00	3331.00	2577.00	5.47	8.36	55.00	35.00
Jordan	13840.00	12152.00	4319.00	3145.00	0.50	1.07	Na	Na
Kuwait	28015.00	68207.00	12035.00	10511.00	1.27	4.03	Na	Na
Lebanon	Na	Na	Na	Na	Na	Na	Na	Na
Libya	Na	Na	Na	Na	Na	Na	Na	Na
Morocco	4964.00	9470.00	2325.00	3507.00	1.17	5.47	Na	Na
Oman	23807.00	22458.00	4533.00	5318.00	0.60	0.69	Na	Na
Qatar	34332.00	32364.00	9076.00	7671.00	0.50	0.80	Na	Na
KSA	40543.00	NA	10427.00	NA	4.89	NA	Na	Na
Syria	12539.00	62745.00	5669.00	9255.00	1.29	6.55	Na	Na
UAE	13333.00	NA	8163.00	NA	NA	NA	Na	Na
Arab	19292.70	30688.86	6805.30	6454.63	22.20	26.97	55.00	35.00
Advanced	57188.00	145344.00	22681.00	45368.00	966.44	2537.06	Na	Na
Korea	12829.00	74202.00	3476.00	14053.00	30.73	176.52	Na	Na

Source: Belkacem (2002)

3. 4. Conclusions:

In this chapter we show that the new economy, which is characterizing by the rapid diffusion of ICT, advanced knowledge system and the recent trend of globalization and their various influences in different economic systems and global prosperity seems to have passed the Arab countries. We find that the Arab countries are manifestly lagged behind the developed and leading developing countries in terms of the capacity to create knowledge, skills, technological capabilities, spending and diffusion of ICT, competitiveness, integration in the world economy and average growth rate. Consequently, the poor performance leads to insignificant share of Arab states in the new/global economic system, poor technology achievement index, poor absorptive capacity and capacity to create knowledge.

We observe that despite, the great heterogeneous performance across the Arab states, it was evident that none of the Arab states presents a sufficient, convincing and coherent performance. While, the Arab Gulf countries and oil economies are leading the Arab states in terms of GDP per capita, human development indicators, spending and diffusion of ICT. They fail to present a convincing and coherent performance in the new economy, probably due to failure to promote efficient educational system, local technological capabilities, skills, heavy dependence on foreign technologies the recent declining trend in growth rates coupled with increasing unemployment, insignificant economic impacts of ICT and low ability to attract foreign investment.

Therefore, for an efficient integration and benefit from the new economy, the Arab countries need to create the most appropriate economic, political, social and scientific institutions. Mainly to improve the performance of domestic and regional knowledge and S&T institutions, attract both financial and human investment to build local technological capabilities, particularly, basic and high technology infrastructure, ICT, skills level and competitiveness. In addition to learning from the experiences of the other nations to create a wider range of technological capabilities to promote the long- run harmonious development in the region and hence significant participation/ integration in and benefit from the new economic system.

A part from the role of Arab governments, it is also essential and useful for Arab societies to support the culture aimed at fostering and enhancing the incidence and transfer of knowledge.

Chapter 4

Comparative assessment and overview of Knowledge across the Arab countries

4.1. Introduction

In the earlier chapter we provide an aggregate and broad overview of the status of knowledge in the Arab region compared with other regions in the world. We find that the new knowledge economy, which is characterizing by the rapid diffusion of ICT, advanced knowledge system and the recent trend of globalization and their various influences in different economic systems and global prosperity seems to have passed the Arab countries. Our results show that the Arab countries are not benefiting yet from the advantages of the new economic system because they manifestly lagged behind the developed and leading developing countries in terms of knowledge, skills, technological capabilities, spending on ICT, competitiveness, integration in the world economy and average growth rate. Consequently, the poor performance leads to insignificant share of Arab states in the new/global economic system, poor technology achievement index, poor absorptive capacity and capacity to create knowledge.

Against this background, considering our earlier discussion of the status of the Arab region compared with other world regions, the interpretations and implications of the insignificant participation to benefit from the new knowledge economy, in this chapter it is convenient to complete our analysis of knowledge across Arab countries. In particular, this chapter aims to provide a comparative assessment and more in-depth overview of the status of knowledge across Arab countries. It may be interesting in this chapter to fill the gap in the literature by investigating the status of knowledge according to certain criteria, mainly the classification of the Arab countries according to income level.[18] The selection of this criteria is based on and consistent with the conventional view concerning the positive relationship between knowledge and income and the view that knowledge is concentrated in high income countries as indicated in numerous studies (cf. European Second Report on S&T Indicators, 1997). Moreover, our analysis can be relevant to contribute to the recent efforts aimed at enhancing knowledge by understanding the determinants and the relationship between knowledge and income level in the Arab countries. In this

[18] The Arab region is composed of twenty-two countries, including Algeria, Bahrain, Comoros, Djibouti, Egypt, Iraq, Jordan, Kuwait, Lebanon, Libyan Arab Jamahiriya, Mauritania, Morocco, Oman Occupied Palestine Territories, Qatar, Saudi Arabia, Somalia, Sudan, Syrian Arab Republic, Tunisia, United Arab Emirates (UAE) and Yemen. According to the World Bank classification, the Arab high-income group includes only four countries: UAE, Qatar, Kuwait and Bahrain. Arab medium-income group includes thirteen countries: Saudi Arabia, Oman, Egypt, Algeria, Tunisia, Morocco, Syria, Lebanon, Jordan, Iraq, Libyan Arab Jamahiriya, Occupied Palestine Territories and Djibouti. Arab low-income group includes five countries: Sudan, Somalia, Yemen, Comoros and Mauritania. Several studies in the literature use different classifications of Arab countries for instance according to the structure of the economy (cf. Ali, 2004; ERF, 1998) and/or the geographical location in Asia and Africa (cf. UNESCO, 2004) in the Gulf or Mediterranean (cf. Nour, 2003; 2005). In addition we use the classification of Arab countries according to geographical location: the Mediterranean and Gulf. The Arab Mediterranean includes eight Arab countries: Algeria, Egypt, Lebanon, Libya, Morocco, Palestine, Syria, and Tunisia and the Arab Gulf includes six Arab countries: Bahrain, Kuwait, Oman, Qatar, Saudi Arabia and the United Arab Emirates. Ali (2004) indicates the diversity of the Arab countries: The Arab countries have very diverse characteristics in such key areas as the structures of economies, level of development, geographic location, and type of governance and institutions. To highlight the economic diversity of the region, ERF (1998) grouped the countries of the region into four broad categories: mixed oil economies (MOE: Algeria, Iraq and Libya); Oil Economies (OE), which include the countries of the Gulf Cooperation Council of Bahrain, Kuwait, Oman, Qatar, Saudi Arabia and UAE; diversified economies (DE: Egypt, Jordan, Lebanon, Morocco, Syria and Tunisia); and, primary export economies (PEE: Comoros, Djibouti, Mauritania, Somalia, Sudan and Yemen) (cf. Ali, 2004: pp.11).

chapter we would like to argue that the Arab countries are displaying a remarkable heterogeneity and non-homogenous performance with respect to knowledge components, in particular, education, literacy rate, skill level, R&D, FTER, spending and diffusion of ICT. Thus our argument implies that across the Arab countries, not only the remarkable diversity observed in terms of country size/area of land, demographic composition/ size of population, per capita income, economic growth, income level, structure of the economy and labor markets and average growth rates, but also a notable heterogeneity with respect to knowledge components: mainly the levels of education, literacy rate, skill, technological capabilities, spending and diffusion of ICT across the Arab countries. Thus our aim is to show this heterogeneity and its relationship with the level of income, in particular, high, medium and low levels of income across Arab countries.

Our classification of Arab countries according to the World Bank classification of economies according to the levels of income is interesting and will add new aspects, since several studies in the literature use different classifications of Arab countries for instance according to the geographical location (cf. Nour, 2003, 2005). Our analysis is more comprehensive because we extend and compare the findings using the classification of Arab countries according to geographic location and the structure of the economy. Hence, the value of this chapter is to integrate knowledge components with income level, geographic location and the structure of the economy and present a new and more comprehensive analysis. To elaborate our argument we integrate the most widely used indicators of knowledge components utilizing the most update data and information from different sources. Similar to our earlier chapter, we define knowledge by education, literacy rate, skills indicators and S&T input and output indicators (R&D, patent and publication) and define ICT by the percentage share of population accessing the Internet, telephone and mobile. Moreover, we use other indicators such as the ability to create basic and high technology infrastructure, technological structure of manufacture exports, mainly high technology exports.

The rest of this chapter is organized in the following way: Section two, presents and compares the socio-economic and development characteristics of Arab countries. Section three discusses and compares the various elements or indicators of knowledge including levels of education, literacy, skills and ICT diffusion across the Arab countries. Section four, provides the conclusions and policy implications.

4. 2. General Socio-Economic Characteristics of the Arab countries (1990-2000)

Table 4.1 presents the general socio-economic and development characteristics of the Arab countries, including the country area (area size), demographic structure/composition (population size), economic growth (GDP per capita) and human development indicators, life expectancy, literacy rate, combined enrolment ratio and poverty rates. Our classification of Arab countries into three groups is based on the World Bank classification of countries according to income level. On that basis the high-income group includes only four countries of UAE, Qatar, Kuwait and Bahrain. Next the medium-income group includes thirteen countries of Saudi Arabia, Oman, Egypt, Algeria, Tunisia, Morocco, Syria, Lebanon, Jordan, Iraq, Libyan Arab Jamahiriya, Occupied Palestine Territories and Djibouti. Finally, the low-income group includes five countries of Sudan, Somalia, Yemen, Comoros and Mauritania. This classification implies that majority of Arab countries are amongst the medium and low income countries and characterizing by medium or low income level. With respect to area of land we find that for the entire Arab countries, the

total area of the region is 13488.65 thousand KM^2, the high; medium and low income groups account for 112.647; 8673 and 4703 respectively. The total Arab population is accounting for 296.6 thousand million, the high; medium and low income population account for 6.6; 228.21 and 65.18 respectively. With respect to economic growth- as measured by GDP per capita, we find that the average GDP per capita for all Arab; high; medium and low income countries is amounting for US$ 5,069; 18,918.5; 6,13.27 and 1636.67 respectively. Regarding HDI, the average for all Arab; high; medium and low income countries account for 0.651; 0.830; 0.700 and 0.500 respectively. Concerning life expectancy, the average for all Arab; high; medium and low income countries account for 66.3; 74.25; 68.79 and 55.22 respectively. With respect to literacy rate, the average for all Arab; high; medium and low income countries account for 63.3; 83.23; 73.73 and 51.58 respectively. With regards to combined enrolment ratio, the average for all Arab; high; medium and low income countries account for 60; 76.8; 69 and 44.50 respectively.

From the above figures, we observe the great diversity amongst Arab countries in terms of size of the country, demographic structure and both socio-economic and development indicators, including GDP per capita, HDI, life expectancy, combined enrolment ratios and poverty rate. The medium income group is coming first in terms of the size of land and population, but reached second following the high income group in terms of level of GDP per capita, HDI, life expectancy, combined enrolment ratio and literacy rate. The high income group is leading and coming first in terms of high level of GDP per capita, HDI, life expectancy, combined enrolment ratio and literacy rate, but in contrast it is coming last with the smallest tiny size of population and area. The low income group, is coming first in terms of poverty rate, coming second in terms of sizes of population and area, but coming last in terms of the level of GDP per capita, HDI, life expectancy, combined enrolment ratio and literacy rate. From these findings, the major characteristics differs across the three groups, the high income countries are characterizing by smallest tiny size of area and population and high levels of income and socio-economic development indicators. The medium income countries are characterizing by big size of area and population and medium levels of income and socio-economic development indicators. The low income countries are characterizing by medium size of area and population, high poverty rate and low levels of income and socio-economic development indicators. All high income countries are clustered in the Gulf and located in Asia, while, the location of both medium and low income countries are distributed between Asia and Africa, majority of low income are located in Africa. Furthermore, while the incidence of poverty is widely recognized across all low and most of the medium income countries especially in Sudan, Yemen, Somalia and Mauritania and both Egypt and Algeria, none of the high income countries reported to experience the same phenomenon. While there is no reported figure for the high income countries, the poverty is widely observed in the medium and low income countries and accounts for 17.46 and 20.8-54.15 respectively.

When comparing between Arab countries according to the structure of the economy we find that the Arab countries show great diversity: in terms of total number of population the rank of Arab economies are as follows: the primary exports; the mixed oil economies, the diversified economies and the oil economies, in terms of the total area of land the rank of Arab economies are as follows: the primary exports; the mixed oil economies, the oil economies and the diversified economies. In terms of the average high GDP per capita and high HDI and low poverty rate the rank of Arab economies are as follows: the oil economies; the mixed oil economies, the diversified economies and the primary exports. In terms of the life

expectancy and literacy rate the rank of Arab economies are as follows: the oil economies; the diversified economies, the mixed oil economies and the primary exports. In terms of the combined enrolment ratio the rank of Arab economies are as follows: the mixed oil economies; the diversified economies, the oil economies and the primary exports economies.

Table 4.1- General Socio-Economic Characteristics in the Arab countries (1990-2002) (Defined by income level)

Country	Area (thousands KM^2)[a]	Total Population (Million) (2002)[b]	GDP/per capita (PPP US $) (2002)[b]	HDI (%) (2002)[b]	Life Expectancy (years) (2002)[b]	Literacy Rate (%) (2000)[b]	Combined enrolment ratio (%) (2001/2002)[b]	Population below income poverty line (%)[b]	
								$ 1 a day (1990-2002)[b]	$ 2 a day (1990-2002)[b]
Year	2001[a]	2002[b]	2002[b]	2002[b]	2002[b]	2000[b]	(2001/2002)[b]	(1990-2002)[b]	(1990-2002)[b]
High income									
United Arab Emirates	83	2.9	22,420	0.824	74.6	77.3	68	Na	Na
Qatar	11	0.6	19,844	0.833	72.0	84.2	84.2	Na	Na
Kuwait	18	2.4	16,240	0.838	76.5	82.9	76	Na	Na
Bahrain	0.647	0.7	17,170	0.843	73.9	88.5	79	Na	Na
Average (total) high income	(112.647)	(6.6)	18918.5	0.830	74.25	83.23	76.8	Na	Na
Middle income									
Oman	212	2.8	13,340	0.770	72.3	74.4	63	Na	Na
Saudi Arabia	1,961	23.5	12,650	0.768	72.1	77.9	57	Na	Na
Libyan Arab Jamahiriya	1,759	5.4	7,570	0.794	72.6	81.7	97	Na	Na
Tunisia	164	9.7	6,760	0.745	72.2	73.2	75	<2	6.6
Algeria	2,382	31.3	5,760	0.704	69.5	68.9	70	<2	15.1
Lebanon	11	3.6	4,360	0.758	73.5	86.5	78	Na	Na
Jordan	92	5.3	4,220	0.750	70.9	90.9	77	<2	7.4
Egypt	1,001	70.5	3,810	0.653	68.6	55.6	76	3.1	43.9
Morocco	447	30.1	3,810	0.620	68.5	50.7	57	<2	14.3
Syria	185	17.4	3,620	0.710	71.7	82.9	59	Na	Na
Occupied Palestine Territories	Na	3.4	Na	0.726	72.3	90.2	79	Na.	Na.
Djibouti	22	0.7	1,610	0.445	49.4	51.9	52	Na	Na
Iraq	437	24.51	Na	Na	60.7	Na	57	Na	Na
Average (total) middle income	(8673)	(228.21)	6137.27	0.700	68.79	73.73	69	<2	17.46
Low income									
Sudan	2,506	32.9	1,820	0.505	55.5	59.9	36	Na	Na
Somalia	638	9.48	Na	Na	47.9	Na	Na	Na	Na
Yemen	528	19.3	870	0.482	59.8	49.0	53	15.7	45.2
Mauritania	1,031	2.8	2,220	0.465	52.3	41.2	44	25.9	63.1
Comoros	Na	0.7	1,690	0.530	60.6	56.2	45	Na	Na
Average (total) low income	(4,703)	(65.18)	1,650	0.500	55.22	51.58	44.5	20.8	54.15
Average (total) Arab states	(13488.65)	(296.6)	5,069	0.651	66.3	63.3	60	25.9 - < 2	63.1- 7.4
Average (total) low income	(4703)	(65.18)	1,650	0.500	55.22	51.58	44.5	20.8	54.15
Average (total) middle income	(8673)	(228.21)	6137.27	0.700	68.79	73.73	69	<2	17.46
Average (total) high income	(112.647)	(6.6)	18918.5	0.830	74.25	83.23	76.8	Na	Na
Average (total) Gulf	2285.647	(32.9)	16,944	0.813	73.566	80.87	71.2	Na	Na
Average (total) Mediterranean	(4190)	(162.6)	4,686.67	0.6983	70.9	69.633	69.17	<2-3.1	7.5 –52.7
Average (total) Oil Economies (OE)	(2285.65)	(32.9)	16944	0.8127	73.567	80.867	71.2	Na	Na
Average (total) Mixed Oil Economies (MOE)	(4578)	(61.21)	6665	0.749	67.6	75.3	74.667	<2	15.1
Average (total) Diversified Economies (DE)	(1900)	(140)	4430	0.7088	71.1	75.714	71.571	<2-3.1	6.6-43.9
Average (total) Primary Exports Economies	(4725)	(65.88)	1642	0.4854	54.25	51.64	46	15.7- 25.9	45.2- 63.1

Sources: (a) CIA World Factbook (2001), (b) UNDP (2004)

Moreover, according to the estimates of the World Bank-WEO (2002), average unemployment rates across medium and low income exceed those of high income countries, on average the trends of unemployment rates show either slow increase or decline across low and medium income compared to rapid increase across high income countries. In addition, the average real GDP growth rate in the period 1995-2000 is

higher for the high income group followed by the low and medium income respectively, the average real GDP growth rate in the period 1999-2000 shows increasing trend in high, medium and low income countries respectively. In contrast the average real GDP growth rate in 2000-2001 is higher for the low income followed by the high and medium income, the average trend shows declining trend in the high and low income, but the medium income shows an opposite increasing trend.

When comparing between Arab countries according to the structure of the economy in terms of real GDP growth the trend increased only in the primary exports economies but they were low and decreased in the oil economies; the mixed oil economies and the diversified economies respectively. In terms of low unemployment the rank of Arab economies are as follows: the primary exports economies; diversified economies; the oil economies and the mixed oil economies, the trends decreased in the primary exports and the diversified economies but increased in the oil economies and the mixed oil economies.

Table 4.2 - Real GDP Growth and Unemployment in the Arab countries (1990-2002) (Defined by income level)

Country	Real GDP Growth (average annual change in percent)					Unemployment (in percent of total labor force)			
	1995-2000 Average	1999	2000	2001	2002 Projected	1990	1995	2000	2001
High income									
Bahrain	4.3	4.3	5.3	4.8	4.1	Na.	10.0	12.0	12.0
Kuwait	3.8	-2.9	2.9	-0.6	-0.5	0.5	1.5	2.1	2.3
Qatar	9.4	5.3	11.6	7.2	3.0	Na.	Na.	Na.	Na.
UAE	5.7	3.9	5.0	5.1	0.3	Na.	Na.	Na.	Na.
Average high income	5.8	2.65	6.2	4.13	1.73	0.5	5.75	7.05	7.15
Medium income									
Oman	3.6	-0.2	5.1	7.3	3.3	Na.	Na.	Na.	Na.
KSA	1.9	-0.8	4.9	1.2	0.7	Na.	Na.	Na.	Na.
Algeria	2.9	2.3	2.8	3.4	2.9	19.8	28.0	27.3	28.5
Egypt	5.3	6.0	5.1	3.3	2.0	8.6	9.6	7.9	7.6
Lebanon	2.3	1.0	-0.5	2.0	1.5	Na.	Na	Na	Na
Morocco	1.9	-0.1	1.0	6.5	4.4	15.4	16.0	13.7	12.8
Syria	3.0	-2.0	0.6	2.7	3.1	Na.	Na	Na	Na
Tunisia	5.1	6.1	4.7	5.0	3.8	16.2	16.2	15.5	15.0
Libyan Arab Jamahiriya	1.6	0.7	4.4	0.6	1.7	Na.	Na	Na	Na
Djibouti	-0.9	2.2	0.7	1.9	2.6	Na.	Na	Na	Na
Jordan	3.6	3.1	4	4.2	5.1	16.8	14.7	14.7	14.7
Average medium income	2.75	1.66	2.98	3.46	2.83	15.36	16.9	15.82	15.72
Low income									
Sudan	6.3	6.9	6.9	5.3	5.0	16.6	14.6	12.0	11.6
Somalia	Na.	Na	Na	Na	Na	Na.	Na	Na	Na
Yemen	6.5	2.7	4.4	3.4	4.1	Na.	Na	Na	Na
Mauritania	4.3	4.1	5.0	4.6	5.1	Na.	26.0	Na	Na
Average low income	5.7	4.57	5.43	4.43	4.73	16.6	20.3	12	11.6
Total Mediterranean	3.42	2.22	2.28	3.82	2.95	15	17.45	16.1	15.975
Total GCC	3.3	0.3	5.1	2.5	0.9	0.5	5.8	7.1	7.2
Average high income	5.8	2.65	6.2	4.13	1.73	0.5	5.75	7.05	7.15
Average medium income	2.75	1.66	2.98	3.46	2.83	15.36	16.9	15.82	15.72
Average low income	5.7	4.57	5.43	4.43	4.73	16.6	20.3	12	11.6
Average Oil Economies (OE)	4.783	1.6	5.8	4.167	1.817	0.5	5.75	7.05	7.15
Average Mixed Oil Economies (MOE)	2.25	1.5	3.6	2	2.3	19.8	28	27.3	28.5
Average Diversified Economies (DE)	3.533	2.35	2.483	3.95	3.317	14.25	14.13	12.95	12.525
Average Primary Exports Economies	4.05	3.975	4.25	3.8	4.2	16.6	20.3	12	11.6
Average Arab states	3.92	2.37	4.106	3.77	2.9	13.41	13.83	13.15	13.063
MENA	3.6	2.9	4.4	3.6	3.4	12.7	13.8	12.7	12.6
Developing countries	5.3	3.9	5.7	4.0	4.2	NA.	NA.	NA.	NA.

Source: The IMF World Economic Outlook (WEO) (September 2002): staff estimates. I/ Simple Averages: nationals only for Bahrain.

One should observe that for instance, despite the tiny population the Arab Gulf countries are leading the Arab region in terms of both economic and development indicators, including GDP per capita, HDI, life expectancy and combined enrolment ratio, the gap between them and the other Arab countries remain wide. Moreover, the World Bank classification of economies put only four of the Arab states, which are Gulf states amongst the high income economies, while majority of the Arab states are classified amongst medium and few amongst low income economies. Consequently, the great heterogeneity in human

development indicators across the Arab states can be interpreted in relation to variation of economic growth indicators/ income level, particularly GDP/ per capita. As we will investigate below that also holds for the disparities in the diffusion of ICT as measured by the percentage of population accessing the Internet, telephone and mobile. Table 4.2 shows that the level of economic growth and unemployment rates varied enormously across the Arab countries, however, now the Arab states are facing the challenges of declining trend of economic growth rates and increasing unemployment rates. Moreover, the presence of high poverty rate adds to the challenging situation in the medium and low income groups in the Arab countries. As we mentioned in the last chapter and will discuss at length in this chapter, despite, the great heterogeneity in economic and development indicators/performance across the Arab countries, it is evident that none of the Arab country presents a sufficient, coherent and convincing performance in the knowledge economy. While, the Arab high income Gulf states are leading the Arab states in terms of GDP per capita, human development indicators, spending and diffusion of ICT. They fail to present a coherent and convincing performance in the knowledge economy, due to recent declining trend in growth rates coupled with increasing unemployment, insignificant economic impacts of ICT and failure to attract FDI, to promote efficient educational system, local technological capabilities, skills and heavy dependence on foreign technologies.

4. 3. Knowledge: Literacy, Education, Skills, Science and Technology (S&T) Indicators

4. 3. 1. Literacy, Education and Skills

In the earlier chapter we noticed that the literacy rates have been insufficient for the spread of knowledge within the Arab society, for instance, we observed that despite the relative decline in illiteracy rates, the illiterate population is approaching around 40% of total Arab population. The illiteracy rates for all Arab countries together remain higher than the World total, LDC's, Asia, Latin America and the Caribbean and seem comparable to those of Africa and Sub-Saharan Africa. From Table 4.1, we realize the great differences in the literacy rates across the Arab countries, especially between the high and low income groups. While, for all Arab countries the average literacy rate account for 63.3, the high, medium and low income groups account for 83.23, 73.73 and 50.03 respectively. This is implies that literacy rate related to or increasing in income level. When comparing across Arab countries we find that the high literacy rates are reported in Jordan and Palestine, followed by Bahrain, Lebanon, Qatar, Kuwait, Syria, Libya, the UAE and Saudi Arabia. Therefore at the individual level, the highest literacy rates are reported in two medium income countries (DE) rather than high income countries (OE), which are coming next.

Moreover, Table 4.3 presents major skills indicators defined by the percentage share of gross enrolment ratio in tertiary education, the share of tertiary students in science, math and engineering and school life expectancy, beside, Harbison Myers Index, Technical enrolment index and Engineering enrolment index. From the last chapter we find that the average percentages share of gross enrolment ratio in tertiary education and the share of tertiary students in science, math and engineering for all Arab countries together are accounting only for 19.636 and 12.091 respectively. We observe the variation across the Arab high, medium and low income groups, while, the average for high and medium are close to each other, but the gap between them and low income is high. It is surprising that the average percentages share of gross enrolment ratio in tertiary education and the share of tertiary students in science, math and engineering for medium income group account for 25 and 25.4 respectively exceeding the high income

group, which account for 18.75 and 25 respectively. That also holds for average school life expectancy in 2000, the average for medium income group (11.57) exceeds the high income groups (11.38), while in 1992 the average for the high income group was higher than the medium income group, since they account for 10.73 and 9.82 respectively. Moreover, for all Arab countries other average skill indices measured by Harbison Myers index, Technical enrolment index and Engineering enrolment index are accounting for 12.01, 20.48 and 14.92 respectively. The average for both high and medium income groups is near to each other, but there exists large differences between them and low income group. With respect to both Harbison Myers Index and Engineering enrolment index, the average for the high income group are accounting for 15.65 and 18.14 respectively, little higher than the average for the medium income group, which account for 14.01 and 17.98 respectively. However, it is surprising that the opposite is true for the Technical enrolment index, the average for medium income group is higher than high income group and they accounts for 25.49 and 22 respectively.

When comparing skill indicators between the individual high, medium and low income countries, we observe that the school life expectancy in 2000 is higher in Libya and Tunisia, followed by Qatar, Jordan, Bahrain, Lebanon, Palestine and Algeria. The gross enrolment in tertiary education is higher in Libya and Lebanon, followed by Egypt, Jordan, Palestine, Tunisia, Qatar, Bahrain and Kuwait. The Harbison Myers Index is higher in Lebanon and Kuwait, followed by Jordan and Egypt. The Engineering enrolment index is higher in Lebanon and Kuwait, followed by Jordan and Algeria. The Technical enrolment index is higher in Lebanon and Jordan, followed by Kuwait and Algeria. Therefore at the individual level, the highest school life expectancy, gross enrolment in tertiary education and Technical enrolment index are reported in two medium income countries rather than high income countries. While, the highest Harbison Myers Index and Engineering enrolment index are reported in one medium income followed by high income countries.

When comparing between Arab countries according to the structure of the economy in terms of high Harbison Myers Index the rank of the Arab economies as follows; the diversified economies; the oil economies, the mixed oil economies and the primary exports economies. In terms of the highest school life expectancy, gross enrolment in tertiary education, Engineering and Technical enrolment index the rank of Arab economies are as follows: the mixed oil economies; diversified economies; the oil economies and the primary exports, in terms of the share of tertiary students in science, math and engineering the rank of the Arab economies as follows: the mixed oil economies; the oil economies; the diversified economies and the primary exports economies.

With respect to Arab educational system, the literature indicates the problem of poor quality of education across the Arab countries (cf. UNDP – AHDR, 2003). Another serious problematic feature concerning the tertiary education in the Arab countries is the (biases against) low share of tertiary students in science, math and engineering, with the exception of Algeria – cf. Table 4.3 below. Moreover, Figures 4.1-4.2 shows that according to the UNESCO World Education Report (2000) in the year (1996), on average enrolment and graduation ratios in medical sciences, natural sciences, engineering and agriculture accounted for 33.69% and 27.64% compared to 70% and 64.92 for art, humanities, law and social sciences in all Arab countries respectively. Nour (2005) finds that the biases are more serious for the Arab Gulf compared to Arab Mediterranean countries. Furthermore, another problematic feature of higher education

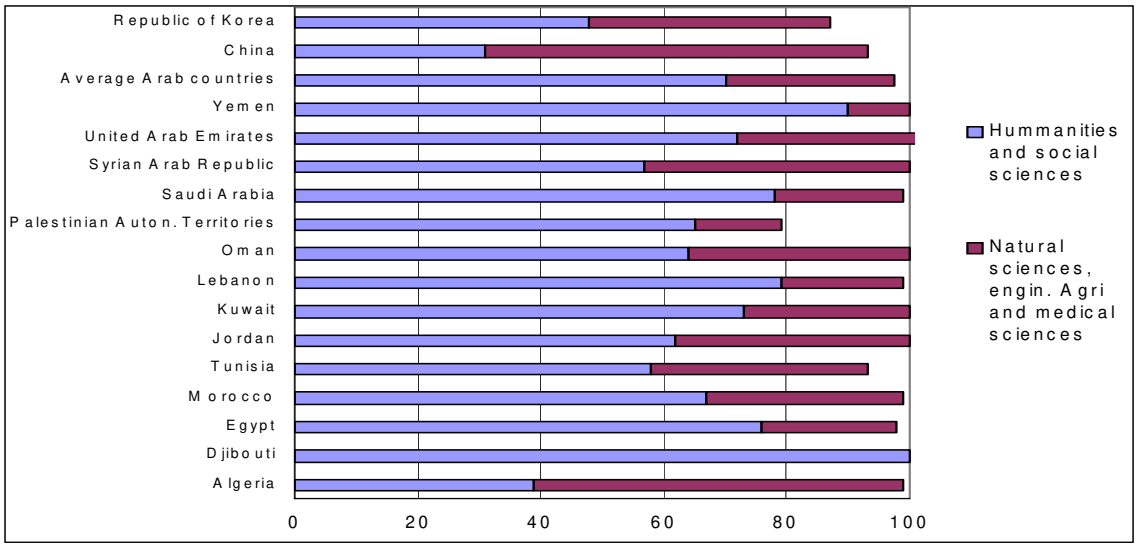
in the Gulf and Mediterranean countries appears from the relative distribution of tertiary education students by attainment levels. Figure 4.3 shows that for the majority (83.8%) of tertiary students in all Arab countries the attainment was less than the university degree, while only few (14.92%-1.29%) obtained the first university degree or higher, falling far behind China (48%) and Korea (41%).

Table 4.3 – Human capital and Skills indicators in the Arab countries (1992–2002/2003) (Defined by income level)

Country	Skill indices (1995)			Gross enrolment ratio (%) at tertiary education	Share tertiary students in science, math and engineering	School life expectancy	
	Harbison Myers Index [a]	Technical enrolment index [a]	Engineering enrolment index [a]	1998 [b] – 2002/2003 [d] (7)	1994-1997[b]	1992[c]	2000 [c]
Arab high income							
Bahrain	Na	Na	Na	21	NA.	13.5	13.0
Kuwait	19.10	36.49	30.57	21	23	7.0	8.7
UAE	12.20	7.51	5.70	10	27	10.6	10.7
Qatar	Na	Na	Na	23	NA.	11.8	13.1
Average high income	15.65	22	18.14	18.75	25	10.73	11.38
Medium income							
Oman	8.95	5.35	4.44	7	30	NA.	8.7
Saudi Arabia	13.45	18.96	14.42	22	18	8.5	NA.
Algeria	11.65	31.14	21.55	15	50	10.4	12(5)
Egypt	16.45	16.10	13.87	38	15	10.3(3)	Na
Lebanon	21.60	46.89	34.60	45	17	Na	13 (5)
Morocco	9.55	23.73	11.46	10	29	Na	8 (6)
Syria	13.35	23.47	17.67	6	31	10	9 (5)
Tunisia	12.55	24.49	16.15	23	27	10.6(4)	14
Occupied Palestine Territories	Na	Na	Na	31 (8)	10		12(6) - 13 (8)
Libyan Arab Jamahiriya	Na	Na	Na	58 (8)	Na.	Na	16 (8)
Jordan	18.55	39.27	27.64	31 (8)	27	9.1	13 (8)
Iraq	Na	Na	Na	14 (8)	Na	Na	9(6)
Djibouti	Na	Na	Na	Na	Na.	Na	Na
Average medium income	14.01	25.49	17.98	25	25.4	9.82	11.57
Low income							
Sudan	2.80	3.50	2.92	7 (5)	Na	Na	5 (5)
Yemen	4.45	4.60	4.17	11 (6)	6	Na	8(5)
Mauritania	3.55	5.28	3.74	5 (6) (8)	Na	Na	7
Comoros	Na	Na	Na	Na	Na	Na	Na
Average low income	3.6	4.46	3.61	6.75	6	Na	6.67
Average high income	15.65	22	18.14	18.75	25	10.73	11.38
Average medium income	14.01	25.49	17.98	25	25.4	9.82	11.57
Average low income	3.6	4.46	3.61	6.75	6	Na	6.67
Average Mediterranean	14.19	27.64	19.22	22.83	28.17	10.33	11.2
Average Gulf countries	13.43	17.08	13.78	17.33	24.5	10.28	10.84
Average Oil Economies (OE)	13.425	17.0775	13.7825	17.333	24.5	10.28	10.84
Average Mixed Oil Economies (MOE)	11.65	31.14	21.55	29	50	10.4	12.333
Average Diversified Economies (DE)	15.342	28.992	20.232	26.286	22.2857143	10	11.667
Average Primary Exports Economies	3.6	4.46	3.61	7.667	6	Na	6.667
Arab states	12.01	20.48	14.92	19.636	12.091	9.625	9.875
Advanced countries							2000
Korea, Republic of	36.10	132.06	113.83	85 (1)	34%		15
Singapore	23.05	48.81	44.76	24.2 (2)	Na		Na
Malaysia	11.10	15.98	12.65	27	Na		12
China	9.75	9.85	8.75	13	53		10
India	8.10	11.85	7.18	11	25		9

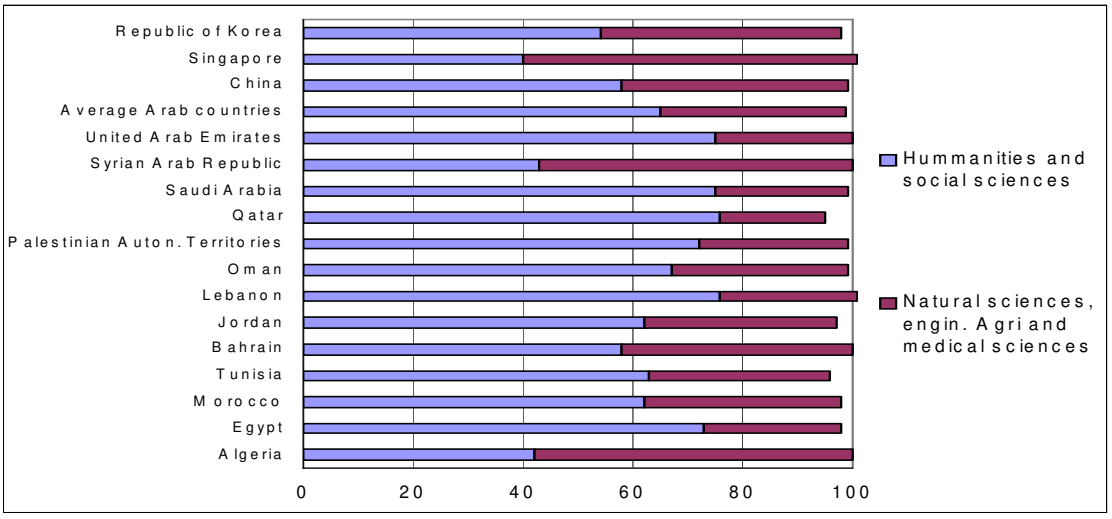
Sources: (a) Lall (1999) (b) UNDP (2002), (c) UNESCO (1999) and (d) UNESCO (2004): www.unesco.org, most recent data on gross enrollment in tertiary education.
Note: (1) data refer to 2002/2003 (2) data refer to 1995/1997 (3) data refer to 1993, (4) data refer to 1991, (5) data refer to 1998, (6) data refer to 1999, (7) refer to most recent data on gross enrollment in tertiary education, (8) data refer to 2001.

Figure 4.1: Percentage share of students across Arab countries (1996)



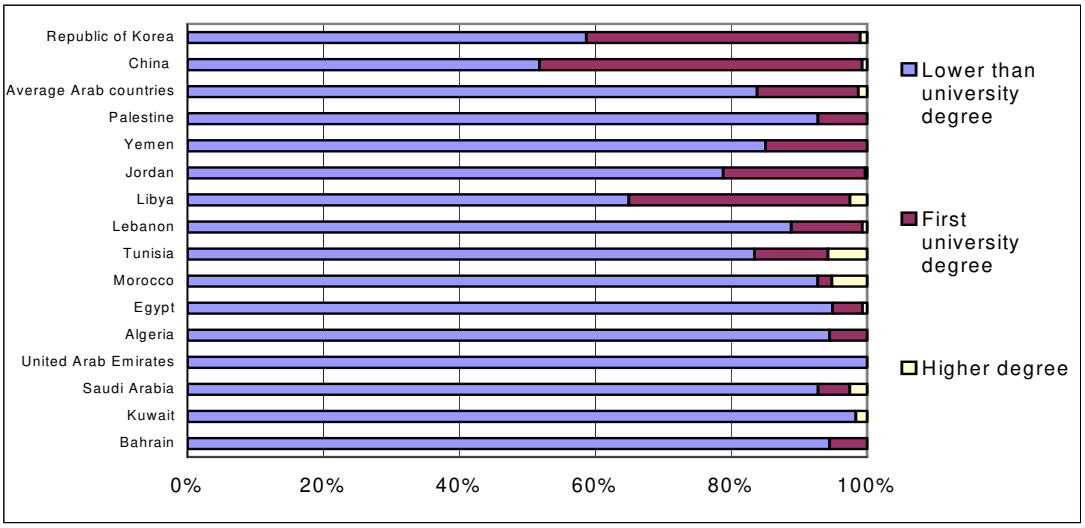
Source: The UNESCO (2000a) World Education Report (2000a), figures for 1996

Figure 4.2: Percentage share of students (and graduates) across Arab countries (1996)



Source: The UNESCO (2000a) World Education Report (2000a), figures for 1996

Figure 4.3: Relative distribution of tertiary education students by level of higher education 1999-2000



Source: The UNDP – AHDR (2003)

4. 3. 2. S&T Input Indicator: R&D

From the last chapter and Table 4.4 we find that knowledge defined by S&T input indicator measured by spending on R&D as percentage of GDP for all Arab countries is accounting only for 0.4-0.7 of GDP, indicating that the Arab region is lagging far behind other world regions. We showed evidences that the share of all Arab countries together is insignificant when seen from a global perspective, because it is accounting for less than 0.5% of the world GERD, hence, lagging far behind not only advanced countries but also all principal world regions, even Africa and Sub-Saharan Africa. In addition to an insufficient R&D per capita and number of researchers in the Arab countries compared to both advanced and developing countries like China.

We observe enormous variation/gap between high, medium and low income groups in terms of S&T input-output indicators, public spending on education as percentage of GDP and government expenditure, public spending on R&D as percentage of GDP, total number of researchers, S&E, patents and high technology exports. In 2001 the average public spending on education as a percentage of GDP for high; medium and low income account for 2.38; 4.97 and 6.8 respectively, while as a percentage of government expenditure the average for high; medium and low income account for 11.4; 15.05 and 32.8 respectively. In 1996-2002 the average public spending on R&D as percentage of GDP for high and medium income account for 0.09 and 1.24 respectively, while the total number of researchers, S&E in research in the high and medium income account for 803 and 3171 respectively. During the period 1991-1999 the total number of patents granted for high and medium income account for 44 and 147 respectively, while, the share of high technology exports in total exports in 1997-2002 for high; medium and low income account for 3.5; 29.2 and 7 respectively. Therefore, it is surprising that with respect to all S&T input-output indicators the medium income countries show higher performance than the high income countries. It is surprising that the highest priority for public spending on education as percentage of GDP and total government expenditures is reported for a low income country exceeding the average levels for both high and medium income countries.

When comparing spending on education and S&T indicators between individual high, medium and low income countries, we observe that the public spending on education as a percentage of GDP in 1999-2001 is high in Yemen, Saudi Arabia and Tunisia, followed by Morocco, Jordan, Oman, Syria, Qatar and Mauritania. While, the public spending on education as a percentage of government expenditure in 1999-2001 is high in Yemen and Jordan, followed by Tunisia, Bahrain, Oman and Syria. Whereas the public spending on R&D as percentage of GDP in 1996-2002 is high in Jordan and Tunisia, followed by Kuwait, Egypt, Syria, Saudi Arabia, Qatar and Bahrain. When comparing between high, medium and low income groups, we observe that the total number of researchers, S&E in research in 1990-2001 are high in Jordan and Qatar, followed by Egypt, Tunisia, Libya, Kuwait, Syria and Oman. When comparing between high, medium and low income groups, we observe that the total number of patents in 1991-1999 are high in Saudi Arabia, Kuwait and Qatar, followed by Egypt, the UAE, Syria, Oman and Bahrain. When comparing between high, medium and low income groups, we observe that the high technology exports in 1997-2002 are high in Morocco and Sudan, followed by Algeria, Tunisia, Egypt, Lebanon, Jordan Oman and the UAE. Therefore, at the individual level, the highest spending on R&D as percentage of GDP, the total number of researchers, S&E in research and total number of patents are reported in one or two medium income

countries rather than high income countries. The highest public spending on education as percentage of GDP and total government expenditures and the high technology exports are reported in one medium and one low income countries respectively rather than high income countries.

When comparing between Arab countries according to the structure of the economy in terms of high S&T indicators we observe that the public spending on education as a percentage of GDP and as a percentage of government expenditure in 1999-2001 is high in the primary exports economies followed by diversified economies and the oil economies respectively, the lowest public spending on education as a percentage of GDP is reported in the mixed oil economies. The public spending on R&D as percentage of GDP in 1996-2002 is high in the diversified economies followed by the oil economies, the total number of researchers, S&E in research in 1990-2001 are high in the diversified economies followed by the oil economies and the mixed oil economies; and the primary exports, in terms of the total number of patents the rank of the Arab economies as follows: the oil economies, the diversified economies and the primary exports economies. The high technology exports in 1997-2002 are reported in the diversified economies, the primary exports economies; the oil economies and the mixed oil economies.

Table 4.4 – Science and Technology indicators in the Arab and World countries (1990–2002) (Defined by income level)

Country	Public expenditure on education as % of GDP [a]		Public expenditure on education as % of government expenditure [a]		R&D Expenditures as % of GDP	Researchers (Scientists and Engineers) in R&D (per million population) [(6)]	Patents [a, b(6)] (1991-1999)[b]-1999[a]	High technology exports as % of manufactures exports[c(6)]	
Year	1990	1999-2001	1990	1999-2001	1996-2000 [a]	(1990-2001) [a]	1991-1999 [b]	1985[c]-1990[b]	1997[c]-2002[b]
High income									
Bahrain	4.2	3.0	14.6	11.4	0.06	NA	2 [b]	0.6 [c (1)]	1.5 [c (5)]
Kuwait	4.8	Na	3.4	Na	0.20	212	27 [b]	3	..
UAE	1.9	1.9	14.6	Na	0.02	NA	15 [b]	5.6 [c (4)]	2 [(2)]
Qatar	3.5	3.6	Na	Na	0.06	591	0 [b]	0.1 [c (4)]	0
Average high income	3.6	2.83	10.87	11.4	0.09	803	44	9.3	3.5
Medium income									
Oman	3.1	4.2	11.1	Na	0.07	4	3 [b]	2	2
Saudi Arabia	6.5	9.5	17.8	Na	0.14	NA	103 [b]	0.1 [c (4)]	0.2 [c (5)]
Algeria	5.3	Na	21.1	Na.	Na	Na	Na.	0.0 [a (4)]	4 [(3)]
Egypt	3.7	Na	Na	Na	0.2	493	38 [b]	0.3 [a (4)]	1
Lebanon	Na	2.9	Na	11.1	Na	Na	Na.	..	3 [(2)]
Morocco	5.3	5.1	26.1	Na	Na	Na	Na	0.4 [c (4)]	11
Syria	4.1	4.0	17.3	11.1	0.2	29	3 [b]	0.2 [c (4)]	1
Tunisia	6.0	6.8	13.5	17.4	0.5	336	Na.	2	4
Libyan Arab Jamahiriya	Na	2.7	Na	Na	Na	361	Na	0	..
Jordan	8.4	4.6	17.1	20.6	6.3	1,948	Na	1	3
Djibouti	Na	Na	10.5	Na	Na	Na	Na	..	..
Average medium income	5.3	4.97	16.81	15.05	1.24	3171	147	6	29.2
Low income									
Sudan	0.9	Na	2.8	Na	Na	Na	0	..	7
Yemen	Na	10.0	Na	32.8	Na	Na	Na	..	..
Mauritania	Na	3.6	Na	Na	Na	Na	Na	0	..
Average low income	0.9	6.8	2.8	32.8			0	0	7
Total Mediterranean	4.88	4.7	19.5	13.2	0.3	858	41 [b]	2.9	24
Total Gulf	4	4.44	12.3	11.4	0.095	807	150 [b]	10.8	4.2
Average high income	3.6	2.83	10.87	11.4	0.09	803	44	9.3	3.5
Average medium income	5.3	4.97	16.81	15.05	1.24	3171	147	6	29.2
Average low income	0.9	6.8	2.8	32.8	Na	Na	0	0	7
Average Oil Economies	4	4.44	12.3	11.4	0.0917	807	150	11.4	5.7
Average Mixed Oil Economies	5.3	2.7	21.1			361		0	4
Average Diversified Economies (DE)	5.5	4.68	16.9	15.05	1.8	2806	41	3.9	23
Average Primary Exports Economies	0.9	6.8	2.8	32.8			0	0	7
Total/Average Arab	Na	Na	Na	Na	Na	Na	Na	..	2
Advanced Asian countries									
Korea, Rep. of	3.5	3.6	22.4	17.4	3	2880 - (2,319) [(1)]	931 [a]	18	32
Singapore	Na	3.7	Na	23.6	2.1	4,052 - (4,140) [(1)]	12 [a]	40	60
China	2.3	2.1	12.8	Na	1.1	584 - (545) [(1)]	793 [b]	..	23
Malaysia	5.2	7.9	18.3	20.0	0.4	160	160	38	58
India	3.9	4.1	12.2	12.7	1.2	157	0	2	5

Sources: (a) UNDP (2004), (b) US Patent and Trademark office web site: www.uspto.gov. (c) Haddad (2001) and (c) Lall (1999) computations based on UNCOMTRADE data 2000 and 1996 respectively.
Note: (1) data refer to scientist and engineers (2) data refer to 2001 (3) data refer to 2000 (4) data refer to 1985 (5) data refer to 1997 (6) data refer to total

Table 4.5 presents data on the distribution of R&D institutional units by types, it indicates that public sector is responsible from most of R&D activities and contribute by 81; 77; 66 and 100 per cent of total R&D institutions in all Arab, high, medium and low income countries respectively. Next to public sector, the universities sector contributes by 13; 10 and 28 per cent of total R&D institutions in all Arab high and medium income countries respectively. While, the minor contribution comes from the private sector, which accounts only for 6; 13 and 6 per cent of total R&D institutions in all Arab; high and medium income countries respectively. The low and high income countries appear to be more dependent on the public sector compared to the medium income countries. Therefore, our results in Table 4.5 imply that most of R&D and S&T activities in all Arab; high; medium and low income countries are mostly allocated within both public and university sectors. While, the private sector and hence, industry have minor contribution in total R&D activities compared to public and university sectors. When comparing between Arab countries according to the structure of the economy data on the distribution of R&D institutional units by types indicates that the public sector is responsible from most of R&D activities and contribute by 49, 80; 80 and 100 per cent of total R&D institutions in the oil economies, mixed oil economies; diversified economies and primary exports economies respectively. Next to the public sector, the universities sector contributes by 44; 20 and 13 per cent of total R&D institutions in the oil economies; the mixed oil economies and the diversified economies respectively. While, the minor contribution comes from the private sector, which accounts only for 7 and 7 per cent of total R&D institutions in the oil economies and diversified economies.

Table 4.5- Distribution of R&D Institutional Units and Full– Time Equivalent (FTE) Researchers by type of R&D Institution in the Arab countries in 1996(Defined by income level)

	Number of R&D institutions				Number of FTE Researchers			
Country/ area	Public	University	Private	Total	Public	University	Private	Total
High income								
Bahrain	3	1	0	4	27	59	0	86
Kuwait	11	0	4	15	334	83	23	440
Oman	6	0	0	6	56	26	0	82
United Arab Emirates	3	2	0	5	56	51	0	107
Average high income (%)	77%	10%	13%	100%	66%	31%	3%	100%
Medium income								
Qatar	0	6	0	6	4	30	0	34
Saudi Arabia	19	28	2	49	308	538	0	846
Egypt	48	10	6	64	8074	2384	286	10744
Lebanon	11	0	0	11	93	112	0	205
Syrian Arab Republic	19	3	0	22	210	146	0	356
Iraq	12	3	0	15	729	662	0	1391
Jordan	18	3	3	24	215	140	46	401
Average medium income (%)	66%	28%	6%	100%	69%	29%	2%	100%
Low income								
Yemen	7	0	0	7	204	66	0	270
Average Arab states	2.43	0.38	0.19		2.11	0.84	0.05	
Average high income	77%	10%	13%	100%	0.66	0.31	0.03	100%
Average medium income	66%	28%	6%	100%	0.69	0.29	0.02	100%
Average low income	100%	0	0	100%	0.76	0.24	0	100%
Average Arab states	81%	13%	6%	100%	0.7	0.28	0.02	100%
Total Mediterranean	78	13	6	97	8377	2642	286	11182
% Distribution Mediterranean.	80.41%	13.40%	6.19%	100%	74.92%	23.63%	2.56%	100%
Total Other Arab	159	56	15	230	10 310	4 297	355	14 962
% Distribution Other Arab	69.13%	24.35%	6.52%	100%	69%	29%	2%	100%
Total Gulf Oil Economies (OE)	42	37	6	85	785	787	23	1595
% Distribution Gulf Oil Economies (OE)	49%	44%	7%	100%	49%	50%	1%	100%
Total Mixed Oil Economies (MOE)	12	3	0	15	729	662	0	1391
% Distribution Mixed Oil Economies	80%	20%	0	100%	52%	48%	0	100%
Total Diversified Economies (DE)	96	16	9	121	8592	2782	332	11706
% Distribution Diversified Economies	80%	13%	7%	100%	73%	24%	3%	100%
Total Primary Exports Economies	7	0	0	7	204	66	0	270
% Distribution Primary Exports Economies	100%	0	0	100%	76%	24%	0	100%

Source: Adapted from ESCWA –UNESCO, Research and Development System in the Arab States: Development of Science and Technology Indicators 1998(E/ ESCWA/ TECH/ 1998/3)

Moreover, concerning human resources devoted to R&D, Table 4.5 shows the distribution of human resources available to R&D organizations, which is defined by the number of full-time equivalent (FTE)[19] researchers. Table 4.5 indicates that majority of FTE researchers are employed by public and university sectors, for instance, the percentage share of FTE researchers in the public sector estimated at 70; 66; 69 and 76 per cent of total FTE researchers in all Arab, high, medium and low income countries respectively. Next to the public sector, the percentage share of FTE researchers in the universities accounts for 28; 31; 29 and 24 per cent of total FTE researchers in all Arab; high; medium and low income countries respectively. While the percentage share of private sector is very marginal and accounts for 2; 3 and 2 per cent of total FTE researchers in all Arab; high and medium income countries respectively. The low and medium income countries appear to be little more dependent on the public sector compared to the high income countries. So, these results together with our results presented above imply the major share of both public and universities sectors and the minor contribution of the private sector in both R&D activities and FTE researchers in all Arab; high; medium and low income countries.

When comparing between Arab countries according to the structure of the economy data on the distribution of the number of full-time equivalent (FTE) researchers in the R&D institutional units by types indicates that public sector is responsible from employing most of R&D (FTE) researchers and contribute by 49, 52; 73 and 76 per cent of total R&D institutions in the oil economies; the mixed oil economies; the diversified economies and the primary exports economies respectively. Next to the public sector, the universities sector contributes by 50; 48; 24 and 24 per cent of the total number of full-time equivalent (FTE) researchers in the R&D institutions in the oil economies; the mixed oil economies; the diversified economies and the primary exports economies respectively. While, the minor contribution comes from the private sector, which accounts only for 1 and 3 per cent of total number of full-time equivalent (FTE) researchers in the R&D institutions in the oil economies and the diversified economies respectively.

4. 3. 3. S&T Output Indicator: Patent and Scientific Publications

From the last chapter and Table 4.4 on S&T output indicator measured by the number of patents awarded to firms and individuals, we observe that the total number for some of the Arab countries fall far below the world average and does not exceed similar figures from other developing countries. The poor performance and low patenting activities indicates the low innovative activities in the Arab countries compared to advanced and developing countries, particularly China and Korea.

Regarding S&T output indicator as measured by the number of scientific publications, when comparing the status of the high, medium and low income countries, our findings in Table 4.6 indicate that the medium income countries show better performance than the high and low income countries. This might be interpreted as a consequence of better performance of medium income countries compared to the high and low income countries in most of technology indicators, in particular, in terms of total expenditures on R&D, the number of R&D employees and R&D scientists and engineers. Therefore, on average both total number of publications and the percentage share in total Arab publications are higher in the medium income compared to the high and low income countries, despite the growing number of publications in the period (1970/1975–1990/1995) in high, medium and low income countries. Within the medium income

[19] The concept of full – time equivalent researcher is adopted by UNESCO statistics on R and D personnel.

countries, the performance in both Egypt and Morocco are relatively high compared to other Arab medium, high and low income countries.

When comparing between Arab countries according to the structure of the economy data on the percentage change in GDP Per capita; the total R&D spending (1996) and the total number of publications (1990-1995) indicate that the high performance in the diversified economies followed by the oil economies; the mixed oil economies and the primary exports economies respectively. In terms of both the percentage change in R&D spending (1992-1996) and the high share of high technology manufactures (1997) the performance are ranked as follows: the diversified economies; the oil economies; the primary exports economies and the mixed oil economies respectively.

Table 4.6- Change in R&D spending, the number of papers published in refereed international journals (number of publications) and the share of high technology manufactures exports in Arab countries (1970– 1997) (Defined by income level)

Country	Percentage change in GDP Per capita (1992–1996) [a]	Percentage change in R&D Spending (1992– 1996) [a]	R&D Spending (US$ Million) 1996[a]	Number of publications (1970–1975) [b]	(1990–1995) [b]	High technology manufactures [c, d] 1985	1997
High income							
United Arab Emirates	196.4	0.9	10.9	1	579	5.6	0.3
Bahrain	-3.7	94.7	3.7	Na	453	0.6	1.5
Kuwait	32.3	42.2	67.1	148	1936	Na.	Na.
Qatar	-32.4	27.9	5.5	Na	377	0.1	0.3
Total high income	192.6	165.7	87.2	149	3345	6.3	2.1
Medium income							
Oman	-9.6	83.1	10.8	1	466	1.2	1.6
Saudi Arabia	-5.0	49.6	196.1	126	8306	0.1	0.2
Algeria	-13.8	6.0	35.6	338	1431	0.0	0.0
Egypt	49.1	45.6	227.5	3261	12072	0.3	1.6
Lebanon	319.7	27.6	7.4	743	500	Na.	Na.
Morocco	12.3	5.9	74.8	96	2418	0.4	0.3
Syrian Arab Republic	25.5	64.6	24.2	38	471	0.2	0.2
Tunisia	37.2	75.2	28.9	145	1832	1.1	3.3
Palestine	Na	Na	Na	Na	51	Na	Na
Jordan	27.8	36.4	20.6	61	1936	14.4	5.6
Iraq	4.7	-16.6	27.6	380	931	Na	Na
Libyan Arab Jamahiriya	10.3	26.1	16.9	96	348	0.0	0.0
Total medium income	458.2	403.5	670.4	5285	30762	17.7	12.8
Low income countries							
Sudan	-60.3	13.6	10	426	690	Na.	Na.
Yemen	-64.8	56.1	10.3	4	155	0.0	0.1
Mauritania	Na	Na	Na	Na	27	Na.	Na.
Somalia	Na	Na	Na	1	79	Na	Na
Total low income	-125.1	69.7	20.3	431	951	0	0.1
Arab region	Na	Na	Na	5865	34594	1.85	1.15
Total high income	192.6	165.7	87.2	149	3345	6.3	2.1
Total medium income	458.2	403.5	670.4	5285	30762	17.7	12.8
Total low income	-125.1	69.7	20.3	431	951	0	0.1
Total Mediterranean	430	224.9	398.4	4621	18775	2	5.4
Total Gulf Oil Economies (OE)	178	298.4	294.1	276	12117	7.6	3.9
Total Mixed Oil Economies (MOE)	1.2	15.5	80.1	814	2710	0	0
Total Diversified Economies (DE)	471.6	255.3	383.4	4344	19280	16.4	11
Total Primary Exports Economies	-125.1	69.7	20.3	431	951	0	0.1

Source: (a) UNESCO: www.unesco.com, and (b) Zahlan (1999b), (c) Haddad (2001) and (d) Lall (1999) computations based on UNCOMTRADE data 2000 and 1996 respectively.

4. 3. 4 The diffusion and Spending on ICT in the Arab countries:

From the last chapter when measuring the diffusion of ICT by the percentage of population accessing the Internet, telephone and mobile, we find that the average percentages of Arab population with access to Internet, telephone and mobile are accounting only for 5.11%, 11.79% and 6.99%. That implies an inadequate diffusion of ICT, which is obviously falling far behind the comparable percentages or ranges for the advanced countries 53.23%-21.35%, 69.77-47.63%, and 50.39-13.32 and behind Singapore and Korea. Moreover, the status of ICT spending in the Arab states represented by Egypt and Gulf countries lag below the international level (cf. Nour, 2002b). When comparing between Arab countries according to the

structure of the economy in terms of high use of ICT, the rank of the Arab economies as follows: the oil economies; the diversified economies; the mixed oil economies and the primary exports economies.

Table 4.7 – Technology indicators: ICT in the Arab countries (1992–2002) ***(Defined by income level)***

Country	population accessing/ Internet users (per 1,000 people) [a]		Telephone mainlines (per 1,000 people) [a]		Cellular subscribers (per 1,000 people) [a]	
Year	1990 [a]	2002 [a]	1990 [a]	2002 [a]	1990	2002 [a]
High income						
Bahrain	0.0	245	191	261	10	579
Kuwait	0.0	105.8	188	204	12	519
UAE	0.0	313.2	224	291	19	647
Qatar	0.0	113.4	220	286	9	433
Average high income	0	194.35	205.75	260.5	12.5	544.5
Medium income						
Oman	0.0	70.0	60	92	2	183
Saudi Arabia	0.0	64.6	77	151	1	228
Algeria	0.0	16.0	32	61	(.)	13
Egypt	0.0	28.2	30	110	(.)	67
Lebanon	0.0	117.1	155	199	0	227
Morocco	0.0	23.6	16	38	(.)	209
Syria	0.0	12.9	41	123	0	23
Tunisia	0.0	51.7	37	117	(.)	52
Occupied Palestine Territories	0.0	30.4	..	87	0	93
Libyan Arab Jamahiriya	0.0	22.5	48	118	0	13
Djibouti	0.0	6.9	11	15	0	23
Jordan	0.0	57.7	72	127	(.)	229
Iraq	Na	Na	Na	Na	Na	Na
Average medium income	0	41.8	52.64	103.17	0.43	113.33
Low income						
Sudan	0.0	2.6	3	21	0	6
Yemen	0.0	5.1	11	28	0	21
Mauritania	0.0	3.7	3	12	0	92
Comoros	0.0	4.2	8	13	0.0	0.0
Average low income	0	3.9	6.25	18.5	0	39.67
Average high income	0	194.35	205.75	260.5	12.5	544.5
Average medium income	0	41.8	52.64	103.17	0.43	113.33
Average low income	0	3.8	5.67	20.33	0	39.67
Average Gulf Oil Economies (OE)	0	152	160	214.167	8.833	431.5
Average Mixed Oil Economies (MOE)		19.25	40	89.5	0	13
Average Diversified Economies (DE)	0	45.943	58.5	114.429		128.571
Average Primary Exports Economies	0	4.5	7.2	17.8		28.4
Arab states	0.0	28.0	79	81	(.)	85
Advanced countries						
Norway	7.1	502.6	502	734	46	844
Sweden	5.8	573.1	681	736	54	889
USA	8.0	551.4	547	646	39	906
UK	0.9	423.1	441	591	19	814
Japan	0.2	448.9	441	558	7	637
Korea, South	0.2	551.9	306	489	2	679
Singapore	0.0	504.4	346	463	17	796

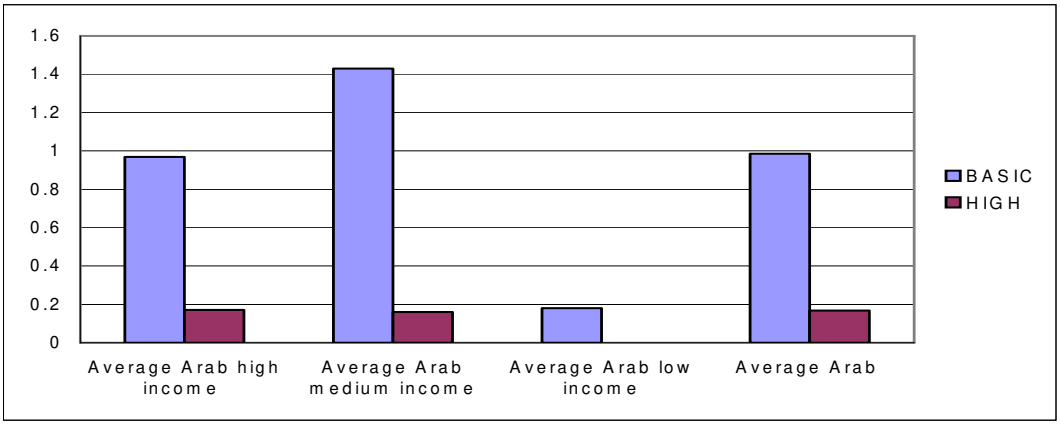
Sources: (a) UNDP Human Development Report (2004).

From Table 4.7 we observe the enormous variation and large gap across the Arab high, medium and low income groups in terms of ICT diffusion, in particular, the Internet users, telephone mainlines and cellular subscribers. With respect to the Internet users in 2002 the average for high; medium and low income account for 194.35; 41.8 and 3.8 respectively. While, on average the telephone mainlines in 2002 for high; medium and low income account for 260.5; 103.17 and 20.33 respectively, whereas on average the cellular subscribers in 2002 for high; medium and low income account for 544.5; 113.33 and 39.67 respectively. When comparing between high, medium and low income groups, we observe that the Internet users in 2002 is high in the UAE and Bahrain, followed by Lebanon, Qatar, Kuwait, Oman, Saudi Arabia, Jordan and Tunisia. While, the telephone mainlines are high in the UAE and Qatar, followed by Bahrain, Kuwait, Lebanon, Saudi Arabia, Jordan, Syria, Libya, Tunisia, Egypt and Oman. Whereas, the cellular subscribers are high in the UAE and Bahrain, followed by Kuwait, Qatar, Jordan, Saudi Arabia, Lebanon, Morocco and Oman. Therefore, at the individual level, the average Internet users, telephone mainlines and cellular subscribers are high and concentrated in the Arab high income countries Gulf oil economies followed by

medium income countries (diversified and mixed oil economies respectively), while the average for low income countries (primary exports economies) is low. These results are not surprising since the use of ICT is often related to income level as reported in several studies in the literature (cf. Nour, 2002a; b)

Finally, from Figure 4.4 we observe the variation across the Arab high, medium and low income groups in terms of basic and high technology infrastructure, on average basic technology infrastructure is high in the medium income, while high technology infrastructure is high in the high income group. With respect to the basic technology infrastructure in 1992 the average for high; medium and low income account for 0.968; 1.43 and 0.18 respectively. While, on average the high technology infrastructure in 1994 for high and medium income account for 0.17 and 0.16 respectively.

Figure 4.4: Average ratios of basic and high technological infrastructure across Arab countries



Source: Adapted from Rasiah (2002)

4. 4. Conclusions

In this chapter we present a comparative assessment and overview of knowledge across the Arab countries, we discuss and compare the various indicators of knowledge including the levels of education, literacy, skills, ICT diffusion across the Arab countries. In Section two we present and compare the socio-economic and development characteristics of Arab countries. In Section three we discuss and compare the various indicators of knowledge including levels of education, literacy, skills, ICT diffusion across the Arab states.

In investigating the status of knowledge we use a certain criteria, mainly the classification of Arab countries according to income level. The selection of this criteria is based on/consistent with the conventional view concerning the positive relationship between knowledge and income and the view that knowledge is concentrated in high income countries as indicated in numerous studies (cf. World Bank Report, 1999; OECD European Second Report on S&T Indicators, 1997). Our analysis of knowledge in the Arab region is more comprehensive since we compare the results using different classification of Arab countries defined by the income level, the geographic location and the structure of the economy.

We show the great diversity amongst the Arab countries in terms of size of the country, demographic structure and both socio-economic and development indicators, including GDP per capita, HDI, life expectancy, combined enrolment ratios and poverty rate. The medium income group is coming first in terms of the size of land and population, but reached second following the high income group in terms of level of GDP per capita, HDI, life expectancy, combined enrolment ratio and literacy rate. The high income group is leading and coming first in terms of high level of GDP per capita, HDI, life

expectancy, combined enrolment ratio and literacy rate, but in contrast it is coming last with the smallest tiny sizes of population and area. The low income group, is coming first in terms of poverty rate, coming second in terms of size of population and area, but coming last in terms of socio-economic and development indicators: GDP per capita, HDI, life expectancy, combined enrolment ratio and literacy rate.

We realize the great differences in the literacy rates across the Arab countries, especially between the high and low income groups, our result implies that literacy rate related to or increasing in income level. When comparing across Arab countries we find that at the individual level, the highest literacy rates are reported in two medium income countries rather than high income countries, which are coming next.

We observe the variation across Arab high, medium and low income groups concerning skills indicators defined by the percentage share of gross enrolment ratio in tertiary education, the share of tertiary students in science, math and engineering, school life expectancy, Harbison Myers Index, Technical enrolment index and Engineering enrolment index. While, the average for high and medium are close to each other, but the gap between them and low income is high. When comparing skill indicators between the individual high, medium and low income countries, we observe that the highest school life expectancy, gross enrolment in tertiary education and Technical enrolment index are reported in two medium income countries rather than high income countries. While, the highest Harbison Myers Index and Engineering enrolment index are reported in one medium income followed by high income countries.

We show enormous variation/gap between high, medium and low income groups in terms of S&T input-output indicators, public spending on education as percentage of GDP and government expenditure, public spending on R&D as percentage of GDP, total number of researchers, S&E, patents and high technology exports. From our results, it is surprising that with respect to all S&T input-output indicators the medium income countries show higher performance than the high income countries. It is surprising that the highest priority for public spending on education as percentage of GDP and total government expenditures is reported for a low income country exceeding the average levels for both high and medium income countries. We compare spending on education and S&T indicators between individual high, medium and low income countries. We observe that at the individual level, the highest spending on R&D as percentage of GDP, the total number of researchers, S&E in research and total number of patents are reported in one or two medium income countries rather than high income countries. The highest public spending on education as percentage of GDP and total government expenditures and the high technology exports are reported in one medium and one low income countries respectively rather than high income countries.

Regarding S&T output indicator as measured by the number of scientific publications, our findings indicate that the medium income countries show better performance than the high and low income countries. This might be interpreted as a consequence of better performance of medium income countries compared to the high and low income countries in terms of most of science and technology indicators, in particular, in terms of total expenditures on R&D, the number of R&D employees and R&D scientists and engineers. Our results imply that most of R&D, FTE researchers and S&T activities in all Arab, high, medium and low income countries are mostly allocated within both public and university sectors. While, the private sector and hence, industry have minor contribution in total R&D activities.

We observe the enormous variation and large gap across the Arab high, medium and low income groups in terms of ICT diffusion, in particular, the Internet users, telephone mainlines and cellular

subscribers. When comparing between high, medium and low income groups, we observe that at the individual level, the highest Internet users, telephone mainlines and cellular subscribers are concentrated in the Arab high income countries (Gulf oil economies) followed by medium income countries (diversified and mixed oil economies), the low income countries (primary exports economies) have low shares. These results are not surprising since the use of ICT is often related to income level as reported in the literature.

When comparing between Arab countries according to the structure of the economy we find that the Arab countries show great diversity: in terms of total number of population the rank of Arab economies are as follows: the primary exports; the mixed oil economies, the diversified economies and the oil economies, in terms of the total area of land the rank of Arab economies are as follows: the primary exports; the mixed oil economies, the oil economies and the diversified economies. In terms of the average high GDP per capita and high HDI and low poverty rate the rank of Arab economies are as follows: the oil economies; the mixed oil economies, the diversified economies and the primary exports. In terms of the life expectancy and literacy rate the rank of Arab economies are as follows: the oil economies; the diversified economies, the mixed oil economies and the primary exports. In terms of the combined enrolment ratio the rank of Arab economies are as follows: the mixed oil economies; the diversified economies, the oil economies and the primary exports economies.

In terms of skill indicators: the high Harbison Myers Index the rank of the Arab economies as follows; the diversified economies; the oil economies, the mixed oil economies and the primary exports economies. In terms of school life expectancy, gross enrolment in tertiary education, Engineering and Technical enrolment index the rank of Arab economies are as follows: the mixed oil economies; diversified economies; the oil economies and the primary exports economies, in terms of the share of tertiary students in science, math and engineering the rank of the Arab economies as follows: the mixed oil economies; the oil economies; the diversified economies and the primary exports economies.

The rank of the Arab economies In terms of S&T indicators we observe that the public spending on education as a percentage of GDP and as a percentage of government expenditure is high in the primary exports economies followed by diversified economies and the oil economies respectively, the lowest public spending on education as a percentage of GDP is reported in the mixed oil economies. The public spending on R&D as percentage of GDP is high in the diversified economies followed by the oil economies, the total number of researchers, S&E in research are high in the diversified economies followed by the oil economies and the mixed oil economies; and the primary exports, in terms of the total number of patents the rank of the Arab economies as follows: the oil economies, the diversified economies and the primary exports economies. The high technology exports are reported in the diversified economies, the primary exports economies; the oil economies and the mixed oil economies.

Concerning the distribution of R&D and the number of full-time equivalent (FTE) researchers in the R&D institutional units by types, the public sector is responsible from most of R&D activities and contribute by 49, 80; 80 and 100 per cent of total R&D institutions in the oil economies; the mixed oil economies; diversified economies and the primary exports economies respectively. The public sector is responsible from employing most of R&D (FTE) researchers and contributes by 49, 52; 73 and 76 per cent of total R&D institutions in the oil economies; the mixed oil economies; the diversified economies and the primary exports economies respectively. Next to the public sector, the universities sector contributes by 44;

20 and 13 per cent of total R&D institutions in the oil economies; the mixed oil economies and the diversified economies respectively. The universities sector contributes by 50; 48; 24 and 24 per cent of the total number of full-time equivalent (FTE) researchers in the R&D institutions in the oil economies; the mixed oil economies; the diversified economies and the primary exports economies respectively. While, the minor contribution comes from the private sector, which accounts only for 7 and 7 per cent of total R&D institutions in the oil economies and diversified economies and accounts only for 1 and 3 per cent of total number of full-time equivalent (FTE) researchers in the R&D institutions in the oil economies and the diversified economies respectively. The high performance in the percentage change in GDP Per capita; the total R&D spending and the total number of publications in the diversified economies followed by the oil economies; the mixed oil economies and the primary exports economies respectively. In terms of both the percentage change in R&D spending and the high share of high technology manufactures the performance are ranked as follows: the diversified economies; the oil economies; the primary exports economies and the mixed oil economies respectively. In terms of high use of ICT, the rank of the Arab economies as follows: the oil economies; the diversified economies; the mixed oil economies and the primary exports economies.

Therefore, these results confirm earlier findings that despite the great heterogeneous performance across the Arab states, it was evident that none of the Arab states presents a sufficient, convincing and coherent performance. While, the Arab high and Gulf (oil economies) are leading the Arab states in terms of GDP per capita, human development indicators, spending and diffusion of ICT. They fail to present a convincing and coherent performance in the new economy and failed to promote efficient educational system, skills, technological capabilities and infrastructure necessary for building the knowledge economy.

Hence, for an efficient integration and benefit from the new economy, the Arab countries need to create the most appropriate economic, political, social and scientific institutions. Mainly to improve the performance of educational and training systems, local and regional knowledge and S&T institutions, attract both financial and human investment to build local technological capabilities, particularly, basic and high technology infrastructure, ICT infrastructure, skill levels and competitiveness and to learn from the experiences of the other nations to create a wider range of technological capabilities to promote the long-run harmonious development in the region and so integration in and benefit from the new economic system.

Chapter 5

Empirical Analysis of the Incidence and Impacts of Knowledge in the Arab Countries

Introduction

In Chapter 3 we discuss the status of knowledge in the Arab countries compared to the other world countries. Next in Chapter 4 we present a comparative assessment and overview of knowledge across Arab countries, in particular, we discuss and compare the various elements or indicators of knowledge including levels of education, literacy, skills, ICT diffusion across the Arab countries. Before presenting the conclusions and policy implications in Chapter 6, it is convenient in this Chapter 5 to discuss the impacts/ importance of the components of knowledge across the Arab countries. The rest of this Chapter is organized in the following way, section one describes the variables and data, section two reports on estimation results and discusses the empirical findings, finally, section three provides the conclusions and policy implications.

5. 1. Definition and Source of Data

First, we support modern innovation theory and new growth literature in viewing knowledge in a more broad/diffuse way. Therefore, we define knowledge as decomposed of: (1) Tacit knowledge, which we define by the percentage share of high skilled people in total population, (2) Codified knowledge, which we define by embodied knowledge distributed in many aspects including total spending on education, R&D and ICT. Second, we use the linear and log linear OLS regression technique to test our hypotheses on the impact/ importance of the incidence of knowledge and ways of enhancing the components of knowledge. And then we draw the major policy implications and conclusions based on the empirical findings.

At the aggregate level, Table 5.1 presents the secondary aggregate/ macro data that we collected from various sources and used in our discussion. First, we define tacit knowledge by tacit skills (the share of high skilled people in total population), which we define by both enrolment in tertiary education and the number of researchers or full time equivalent researchers (FTER). Codified knowledge is calculated as a total of the share of public spending on education, ICT and R&D spending as percentage of GDP. In addition we use several variables and many other indicators in relation to the components of knowledge, such as the number of full time equivalent researchers (FTE), number of publications, scientific cooperation as measured by joint publications, total spending on R&D, patents and average schooling years across Arab countries. Based on this framework, it is possible to assume that at the aggregate level the incidence or components of knowledge across Arab countries are most likely related to several variables. Such as skill level; the share of public expenditure on education (especially on higher education) as percentage of GDP; the share of public expenditure on R&D as percentage of GDP; networks organization, co-ordination and co-operation, for example between universities (O); and the information and communication system (ICT). Based on our earlier framework and the literature we test the hypotheses that across the Arab countries:

1. The components of knowledge show positive correlation and hence can be used to enhance economic growth and promote human capital across the Arab countries.
2. The components of knowledge can be enhanced by skill upgrading across the Arab countries.

3. The components of knowledge can be enhanced by institutional support in the form of subsidies and incentives to knowledge components across the Arab countries.
4. Tacit and codified knowledge are complement to each other.

Table 5.1- Components of knowledge across Arab countries (1990–2002) (defined by income level and structure of economy)

(A) The components of knowledge across Arab countries (1990 – 2002) (Defined by Income Level)

Country	GDP [a]	Schooling [b]	Enrolement in teritary [b]	FTER1 [a]	Publications [c]	Cooperation [d]	Share of public spending on R&D % GDP (1996)[a],(1996-2002)[j]	Share of public spending on education % GDP	Spending on ICT [e]	Codified knowledge 1: the share of education and R&D in GDP	Codified knowledge 2: the share of education, R&D and ICT in GDP
	2002	2000	1998	1996	(1990–1995) [c]	1995	(1996)[a],(1996-2002)[j]	(1995-1997) [a]	2001		
High income										codk1rded	codk2rdedict
Bahrain	7.7	13	21	86 [h]	453	29	0.06 [j]	3	2.0	3.06	5.06
Kuwait	35.4	8.7	21	212 [a]	1936	117	0.20 [j]	5	2.73	5.2	7.93
United Arab Emirates (UAE)	71	10.7	10	107 [h]	579	55	0.02 [j]	1.9	1.77	1.92	3.69
Qatar	17.5	13.1	23	591 [a]	377	36	0.06 [j]	3.6	Na	3.66	3.66
Average (total) high income	**32.9**	11.38	18.75	**(996)**	(3345)	**(237)**	0.09 [j]	**3.375**	**2.17**	3.465	5.6316667
Medium income											
Oman	20.3	8.7	7	82 [h]	466	37	0.07 [j]	4.2	Na	4.27	4.27
Saudi Arabia	188.5	9.5	22	846 [h]	8306	294	0.14 [j]	9.5	7.6	9.64	17.24
Algeria	55.9	12	15	100	1431	227	0.33 [g]	5.3	Na	5.63	5.63
Egypt	89.9	10.3	38	493 [a]	12072	Na	0.2 [a]	3.7	1.19	3.9	5.09
Lebanon	17.3	13	45	205 [g]	500	Na	0.03 [g]	2.9	Na	2.93	2.93
Morocco	36.1	8	10	120	2418	395	0.3 [g]	5.1	Na	5.4	5.4
Syrian Arab Republic	20.8	9	6	29 [a]	471	Na	0.2 [a]	4	Na	4.2	4.2
Tunisia	21.0	14	23	336 [a]	1832	147	0.5 [a]	6.8	Na	7.3	7.3
Palestine	3.4	13	31	Na	51		Na	Na	Na		
Libyan Arab Jamahiriya	19.1	16	58	361 [a]	348	35	0.22 [b]	2.7	Na	2.92	2.92
Jordan	9.3	13	31	1,948 [a]	1936	Na	6.3 [a]	4.6	6	10.9	16.9
Iraq	29.95	9	14	1391 [g]	931	Na	Na		Na		Na
Djibouti	0.6	4	1	Na	Na	Na		3.5	Na	3.5	Na
Average (total) medium income	**39.39615**	**10.73**	**23.155**	**(5911)**	**(30762)**	**(1532)**	1.24	**4.75455**	**4.93**	5.5082	**7.188**
Low income countries											
Sudan	13.5	5	7	Na	690	Na.	Na.	0.9	Na.	0.9	0.9
Yemen	10.0	8	11	270 [h]	155	Na	Na	10	Na	10	10
Mauritania	1.0	7	4	Na	27	Na	Na	3.6	Na	3.6	3.6
Somalia	Na	Na	Na	Na	79	Na	Na	Na	Na		
Comoros	0.3	7	1	Na	Na			3.8		3.8	3.8
Average (total) low income	6.2	6.75	5.75	270	951	Na	Na	**4.575**	Na	**4.575**	**4.575**
Total Gulf	56.733	10.617	17.333	(1924)	(12117)	(568)	0.09167	4.5333	3.525	4.625	6.975
Average (total) Mediterranean	32.9375	11.9135	28.25	(1644)	(19123)	(1201)	0.2542857	4.3571429	1.19	4.6114286	4.7814286
Average (total) Arab region	26.165383	9.62	15.885	(7177)	(35058)	(1769)	0.665	4.23485	3.55	4.575	5.7982222
Average (total) high income	32.9	11.38	18.75	(996)	(3345)	(237)	0.09 [j]	3.375	2.17	3.465	5.6316667
Average (total) medium income	39.39615	10.73	23.155	(5911)	(30762)	(1532)	1.24	4.75455	4.93	5.5082	7.188
Average (total) low income	6.2	6.75	5.75	(270)	(951)	Na	Na	4.575	Na	4.575	4.575

Country	RD total [h] RDTOTAL1	FTER2: Researchers total [h]	RD total [I] RDTOTAL2	FTER3: Researchers total [i]	Patent [f, g]
High income	1996	1996	1996	1996	1991-1999
Bahrain	3.7	86	3.7	143	2
Kuwait	67.11	440	67.1	1130	27
UAE	10.89	107	10.9	313	15
Qatar	5.46	34	5.5	74	0
Total high income	87.16	667	87.2	1660	44
Medium income					
Oman	10.76	82	10.8	382	3
Saudi Arabia	196.09	846	196.1	2421	103
Algeria	Na	Na	35.6	2588	3 [g]
Egypt	227.5	10744	227.5	37073	38
Lebanon	7.45	205	7.5	444	3 [g]
Morocco	Na	Na	74.9	7329	12 [g]
Syrian Arab Republic	24.18	356	24.2	2105	3
Tunisia	Na	Na	28.9	1132	5 [g]
Libyan Arab Jamahiriya	Na	Na	16.9	903	
Jordan	20.62	401	20.6	1471	13
Iraq	27.57	1391	27.6	2840	Na
Total medium income	514.17	14025	670.6	58688	183
Low income countries					
Sudan	Na	Na	10	2047	Na
Yemen	10.3	270	10.3	1041	2
Mauritania	Na	Na	4.3	509	Na
Total low income	10.3	270	24.6	3597	2

Total Arab region	611.63	14962	782.4	63945	229
Total high income	87.16	667	87.2	1660	44
Total medium income	514.17	14025	670.6	58688	183
Total low income	10.3	270	24.6	3597	2
Total Gulf	**294.01**	**1595**	**294.1**	**4463**	**150**
Total Mediterranean	259.13	11305	415.5	51574	**64**

(B) The components of knowledge across Arab countries (1990 – 2002) (Defined by the Structure of the Economy)

Country	GDP [a]	Schooling [b]	Enrolement in teritary [b]	FTER1 [a]	Publications [c]	Cooperation [d]	Share of public spending on R&D % GDP (1996)[a],(1996-2002)[j]	Share of public spending on education % GDP	Spending on ICT [e]	Codified knowledge 1: the share of education and R&D in GDP (codk1rded)	Codified knowledge 2: the share of education, R&D and ICT in GDP (codk2rdedic)
	2002	2000	1998	1996	(1990–1995) [c]	1995	(1996)[a],(1996-2002)[j]	(1995-1997) [a]	2001		
Oil Economies (GCC)											
Bahrain	7.7	13	21	86 [h]	453	29	0.06 [j]	3	2.0	3.06	5.06
Kuwait	35.4	8.7	21	212 [a]	1936	117	0.20 [j]	5	2.73	5.2	7.93
UAE	71	10.7	10	107 [h]	579	55	0.02 [j]	1.9	1.77	1.92	3.69
Qatar	17.5	13.1	23	591 [a]	377	36	0.06 [j]	3.6	Na	3.66	3.66
Oman	20.3	8.7	7	82 [h]	466	37	0.07 [j]	4.2	Na	4.27	4.27
Saudi Arabia	188.5	9.5	22	846 [h]	8306	294	0.14 [j]	9.5	7.6	9.64	17.24
Average (total) OE	**56.733**	**10.617**	**17.333**	**(1924)**	**(12117)**	**(568)**	**0.09167**	**4.5333**	**3.525**	**4.625**	**6.975**
Mixed Oil Economies (MOE)											
Algeria	55.9	12	15	100	1431	227	0.33 [g]	5.3	Na	5.63	5.63
Libyan Arab Jamahiriya	19.1	16	58	361 [a]	348	35	0.22 [b]	2.7	Na	2.92	2.92
Iraq	29.95	9	14	1391 [g]	931	Na	Na	Na	Na	Na	Na
Average (total) l MOE	**34.983**	**12.333**	**29**	**(1852)**	**(2710)**	**(262)**	**0.275**	**4**		**4.275**	**4.275**
Diversified Economies (DE)											
Egypt	89.9	10.3	38	493 [a]	12072	Na	0.2 [a]	3.7	1.19	3.9	5.09
Lebanon	17.3	13	45	205 [g]	500	Na	0.03 [g]	2.9	Na	2.93	2.93
Morocco	36.1	8	10	120	2418	395	0.3 [g]	5.1	Na	5.4	5.4
Syrian Arab Republic	20.8	9	6	29 [a]	471	Na	0.2 [a]	4	Na	4.2	4.2
Tunisia	21.0	14	23	336 [a]	1832	147	0.5 [a]	6.8	Na	7.3	7.3
Palestine	3.4	13	31	Na	51	Na	Na	Na	Na	Na	Na
Jordan	9.3	13	31	1,948 [a]	1936	Na	6.3 [a]	4.6	6	10.9	16.9
Average (total) DE	**28.257**	**11.471**	**26.286**	**(3131)**	**(19280)**	**(542)**	**1.255**	**4.5167**	**3.595**	**5.7717**	**6.97**
Primary Exports Economies (PEE)											
Dijouti	0.6	4	1	Na		Na.		3.5	Na.	3.5	3.5
Sudan	13.5	5	7	Na	690	Na	Na.	0.9	Na	0.9	0.9
Yemen	10.0	8	11	270 [h]	155	Na	Na	10	Na	10	10
Mauritania	1.0	7	4	Na	27	Na	Na	3.6	Na	3.6	3.6
Somalia	Na	Na	Na	Na	79		Na	Na			
Comoros	0.3	7	1	Na		Na		3.8	Na	3.8	3.8
Average (total) PEE	**5.08**	**6.2**	**4.8**	**270**	**951**	**Na**	**Na**	**4.36**	**Na**	**4.36**	**4.36**

Country	RD total [h] RDTOTAL1	FTER2: Researchers total [h]	RD total [I] RDTOTAL2	FTER3: Researchers total [I]	Patent [f, g]
Oil Economies (OE)	1996	1996	1996	1996	1991-1999
Bahrain	3.7	86	3.7	143	2
Kuwait	67.11	440	67.1	1130	27
UAE	10.89	107	10.9	313	15
Qatar	5.46	34	5.5	74	0
Oman	10.76	82	10.8	382	3
Saudi Arabia	196.09	846	196.1	2421	103
Total OE	**294.01**	**1595**	**294.1**	**4463**	**150**
Mixed Oil Economies (MOE)					
Algeria	Na	Na	35.6	2588	3 [g]
Libyan Arab Jamahiriya	Na	Na	16.9	903	
Iraq	27.57	1391	27.6	2840	Na
Total MOE	**27.57**	**1391**	**80.1**	**6331**	3
Diversified Economies (DE)					
Egypt	227.5	10744	227.5	37073	38
Lebanon	7.45	205	7.5	444	3 [g]
Morocco	Na	Na	74.9	7329	12 [g]
Syrian Arab Republic	24.18	356	24.2	2105	3
Tunisia	Na	Na	28.9	1132	5 [g]
Jordan	20.62	401	20.6	1471	13
Total DE	**279.75**	**11706**	**383.6**	**49554**	**74**
Primary Exports Economies (PEE)					
Sudan	Na	Na	10	2047	Na
Yemen	10.3	270	10.3	1041	2
Mauritania	Na	Na	4.3	509	Na
Total PEE	**10.3**	**270**	**24.6**	**3597**	**2**
Total Arab region	611.63	14962	782.4	63945	229

Sources: (a) UNDP – HDR (2004), (b) UNESCO (2004): www.unesco.org, most recent data on schooling, gross enrollment in tertiary education and R&D, (c) AHDR - UNDP (2002), (d) Zahlan (1999b), (e) ESCWA Profiles (2003), (f) US Patent and Trademark office web site: www.uspto.gov, (g) OECD – ESRS&T (1997), (h) Adapted from ESCWA –UNESCO (1998), (i) ERF (2002), (j) Calculated from Qasim (1998) and GOIC (2000)

From Table 5.1 above we find that somewhat surprising the classification of Arab countries by income level is inconclusive in terms of the capacity to create knowledge. For instance, the performance of Arab high income falls behind Arab medium income in terms of knowledge (codified knowledge, number of publications and patents) and the capacity to create knowledge (enrolment in tertiary education, FTER, total spending and spending on R&D as a percentage to GDP). These results probably can be interpreted along with the classification of Arab countries according to the structure of the economy, for instance, the high income are Gulf oil based economies, while the majority of the medium income are Mediterranean and diversified economies. This result confirms the importance of diversification for the Arab economies.

5. 2. Empirical results on the incidence and impacts of knowledge across the Arab countries

We apply the OLS regression using the data described above and then we present and discuss our estimation results below.

Table 5.2 presents the results with respect to the relationship between schooling, GDP, tacit knowledge defined by the share of tertiary school enrolment ratio and codified knowledge defined by the share of education, R&D and ICT in GDP across the Arab countries defined by income level and other classifications: geographic location and structure of the economy. Our results show that the degree of significance of the positive correlation between tacit knowledge defined by the share of tertiary school enrolment ratio and schooling varies across the Arab countries. For instance, it seems highly significant only across all Arab and medium income countries and to some extent across Mediterranean countries but insignificant for the primary exports economies. Table 5.2 indicates that part of codified knowledge defined by the share of spending on education in GDP indicates positive significant correlation with schooling only across Arab low income countries and to some extent the primary exports economies, but insignificant for the diversified economies. Part of codified knowledge defined by the share of spending on education in GDP indicates positive significant correlation with GDP across all Arab countries, but it indicates somewhat less significant correlation with tacit knowledge as defined by the share of tertiary school enrolment ratio only across Arab high income countries. Moreover, part of codified knowledge defined by the share of spending on ICT in GDP indicates positive but insignificant correlation with GDP across all Arab countries. While, the correlation between tacit knowledge defined by the share of tertiary school enrolment ratio and GDP is positive and significant across only Arab low income countries. Therefore, the correlation between tacit knowledge and schooling is significant for all Arab, medium income rather than high and low income and Mediterranean rather than Gulf countries and the correlation with GDP is significant across only Arab low income countries.

As for the correlation between GDP and codified knowledge defined by the share of education, R&D and ICT in GDP, Table 5.2 shows that the correlation with GDP vary across Arab countries. For instance, codified knowledge defined by the share of education, R&D and ICT in GDP indicates positive significant correlation with GDP across only all Arab, medium income and Gulf countries and oil economies. While, on the other hand, codified knowledge defined by the share of education and R&D in GDP (excluding the share of ICT in GDP) indicates positive significant correlation with GDP only across Arab Gulf oil economies, but indicates positive insignificant correlation across all Arab, Mediterranean, ESCWA, medium and low income countries. It is surprising that codified knowledge defined by the share

of education, R&D and ICT in GDP (and also when excluding the share of ICT in GDP) has negative insignificant correlation with GDP across Arab high income countries. Therefore, the correlation between codified knowledge and GDP is significant for all Arab, medium income rather than high and low income and Gulf rather than Mediterranean countries.

Table 5.2- Correlation between schooling, enrolment, tacit and codified knowledge

Independent variable		Constant	Tacit knowledge1	Codified knowledge	R^2	N
Dependent variable		Coefficient (t-value)	Coefficient (t-value)	Coefficient (t-value)		
Schooling	All Arab countries	6.964 (9.957)	0.165**[1] (5.650)		0.627	21
	Arab high income	9.428 (2.019)	0.104[1] (0.432)		0.085	4
	Arab medium income	7.220 (7.651)	0.152**[1] (4.538)		0.652	13
	Arab low income	6.461 (4.605)	0.050[1] (0.245)		0.029	4
	Arab Gulf	8.479 (3.485)	0.123[1] (0.936)		0.180	6
	Arab Mediterranean	9.238 (5.874)	0.087*[1] (1.527)		0.318	7
	Primary Exports Economies (PEE)	5.330 (4.430)	0.181[1] (0.924)		0.222	5
	Diversified Economies (DE)	9.412 (2.263)		0.399 [4] (0.450)	0.048	6
	Primary Exports Economies (PEE)	4.746 (4.358)		0.333* [4] (1.622)	0.467	5
	Arab low income	5.436 (8.709)		0.287** [3] (2.605)	0.772	4
ENROLLEMENT	Arab high income	7.511 (0.953)		3.330* [3] (1.502)	0.530	4
ENROLLEMENT	Oil economies (OE)	5.782 (0.872)		1.753* [1] (1.574)	0.553	4
ENROLLEMENT	Oil economies (OE)	1.399 (0.220)		0.322 [2] (0.936)	0.180	6
ENROLLEMENT	Diversified Economies (DE)	6.332 (1.327)		0.025 [2] (0.153)	0.006	6
GDP	All Arab countries	24.491 (1.573)	0.387[1] (0.595)		0.018	21
GDP	Arab low income	-0.753 (-0.164)	1.209*[1] (1.798)		0.618	4
GDP	All Arab countries	24.723 (0.500)		11.905 [4] (1.030)	0.210	6
GDP	All Arab countries	-2.759 (-0.129)		8.176* [3] (1.897)	0.175	19
GDP	All Arab countries	10.391 (0.495)		4.721 [1] (1.251)	0.084	19
GDP	All Arab countries	10.219 (0.494)		5.061* [2] (1.952)	0.241	14
GDP	Arab high income	62.144 (1.294)		-8.452 [1] (-0.644)	0.172	4
GDP	Arab high income	42.783 (0.818)		-1.944 [2] (-0.200)	0.020	4
GDP	Arab medium income	-0.283 (-0.008)		7.954 [1] (1.295)	0.157	11
GDP	Arab medium income	9.809 (0.359)		5.288* [2] (1.704)	0.266	10
GDP	Arab low income	5.847 (0.857)		0.077 [1] (0.064)	0.002	4
GDP	Arab Gulf Oil economies (OE)	-37.218 (-0.939)		20.314** [1] (2.685	0.643	6
GDP	Arab Gulf Oil economies (OE)	-23.921 (-0.971)		11.563** [2] (3.978)	0.798	6
GDP	Arab Mediterranean	51.535 (1.113)		-2.323 [1] (-0.256)	0.16	6
GDP	Arab Mediterranean	25.216 (0.502)		2.936 [2] (0.308)	0.023	6
GDP	Arab ESCWA	25.497 (0.759)		3.027 [1] (0.569)	0.031	12

Correlation is significant * at the 0.05 level (one tailed) and ** at the 0.01 level (one tailed)
Note: (1) Codified knowledge 1: the share of education and R&D in GDP, (2) Codified knowledge 2: the share of education, R&D and ICT in GDP, (3) Codified knowledge 3: ICT/GDP and (4) Codified knowledge 4: EDU/GDP. Tacit knowledge1: (tertiary school enrolment ratio)

Table 5.3 illustrates the results concerning the relationship between patent, tacit knowledge defined by the FTER and codified knowledge defined by the share of education, R&D and ICT in GDP across Arab countries defined by income level, geographic location and structure of the economy. We observe that tacit

knowledge defined by the FTER indicates positive significant correlation with patent across all Arab, medium, Gulf and Mediterranean countries and oil economies and diversified economies. As for the correlation between patent and codified knowledge defined by the share of education, R&D and ICT in GDP, Table 5.3 shows that the correlation with patent vary across Arab countries. For instance, codified knowledge defined by the share of education, R&D and ICT in GDP indicates positive significant correlation with patent across all Arab, medium and high income and Gulf countries and oil economies but insignificant for the diversified economies. Codified knowledge defined by the share of education and R&D in GDP (excluding the share of ICT in GDP) shows positive significant correlation with patent only across Arab Gulf and oil economies, but indicates insignificant correlation across all Arab, high and medium income and even negative correlation within Mediterranean countries. It is surprising that tacit knowledge defined by the FTER and codified knowledge defined by the share of education and R&D in GDP (excluding the share of ICT in GDP) has negative insignificant correlation with patent across Arab high income countries. Therefore, the correlation between tacit knowledge defined by the FTER and patent is significant for all Arab, medium rather than high income and Mediterranean then Gulf countries, oil economies and the diversified economies respectively. While, the correlation between codified knowledge and patent is significant for all Arab, medium income then high income and Gulf rather than Mediterranean countries and oil economies rather than the diversified economies respectively.

Table 5.3- Correlation between patent, tacit and codified knowledge

Independent variable:	Constant	Tacit knowledge2	Codified knowledge	R^2	N
Dependent variable: Patent	Coefficient (t-value)	Coefficient (t-value)	Coefficient (t-value)		
All Arab countries	-6.450 (-0.761)	0.086**[21] (3.607)		0.542	13
Arab high income	16.212 (1.446)	-0.021[21] (-0.600)		0.153	4
Arab medium income	-11.453 (-1.591)	0.118**[21] (6.221)		0.866	8
Arab Mediterranean	-2.506 (-0.368)	0.062**[21] (2.400)		0.590	6
Arab Gulf (OE)	-3.932 (-0.217)	0.090**[21] (2.164)		0.539	6
Arab Gulf (OE)	-6.755 (-1.074)	0.119** [22] (7.502)		0.934	6
Arab Gulf (OE)	-6.736 (-1.251)	0.043** [23] (8.803)		0.951	6
Diversified Economies (DE)	-2.217 (-0.246)	0.061*[21] (1.947)		0.558	5
Diversified Economies (DE)	5.333 (1.608)	0.003**[22] (4.942)		0.924	4
Diversified Economies (DE)	4.950 (2.510)	0.001**[23] (7.013)		0.925	6
All Arab countries	-2.572 (-0.160)		3.397 [1] (1.309)	0.125	14
All Arab countries	-9.603 (-0.876)		3.940** [2] (2.963)	0.444	13
Arab high income	-3.262 (-0.153)		4.122 [1] (0.709)	0.201	4
Arab high income	12.522 (-0.780)		4.626* [2] (1.548)	0.545	4
Arab medium income	-13.422 (-0.506))		5.608 [1] (1.385)	0.215	9
Arab medium income	-9.778 (-0.612)		3.930** [2] (2.269)	0.424	9
Arab Mediterranean	21.097 (0.952)		-2.131 [1] (-0.490)	0.057	6
Arab Mediterranean	7.282 (0.294)		0.665[2] (0.141)	0.005	6
Arab Gulf (OE)	-37.080 (-2.379)		13.423** [1] (4.512)	0.836	6
Arab Gulf (OE)	-26.259 (-4.109)		7.349** [2] (9.745)	0.960	6
Diversified Economies (DE)	11.249 (1.026)		0.156 [2] (0.119)	0.004	6

Correlation is significant * at the 0.05 level (one tailed) and ** at the 0.01 level (one tailed)

Note: (1) Codified knowledge 1: the share of education and R&D in GDP, (2) Codified knowledge 2: the share of education, R&D and ICT in GDP. Tacit knowledge2: (FTER): (21) FTER1 (22) FTER2 and (23) FTER3.

Table 5.4- Correlation between publication, tacit and codified knowledge

Independent variable:	Constant	Tacit knowledge2	Codified knowledge	R^2	N
Dependent variable: Publications	Coefficient (t-value)	Coefficient (t-value)	Coefficient (t-value)		
All Arab countries	1197.917 (0.977)	2.736[21] (1.108)		0.086	15
All Arab countries	854.449 (1.833)	0.306**[23] (5.914)		0.686	18
Arab high income	985.221 (1.404)	-0.598[21] (-0.274)		0.036	4
Arab high income	210.504 (3.476)	1.508**[23] (14.735)		0.991	4
Arab medium income	1863.102 (1.029)	2.560[21] (0.801)		0.074	10
Arab medium income	1232.812 (1.570)	0.292**[23] (4.285)		0.671	11
Arab low income	-241.930 (-2.416)	0.444** [23] (6.023)		0.973	3
Arab Mediterranean	-1350.488 (-0.674)	20.910**[21] (2.770)		0.657	6
Arab Mediterranean	501.323 (1.631)	0.310**[23] (15.636)		0.984	6
Arab Gulf (OE)	-400.722 (-0.299)	7.547** [21] (2.453)		0.601	6
Arab Gulf (OE)	-477.469 (-0.866)	9.393**[22] (6.729)		0.919	6
Arab Gulf (OE)	-479.587 (-1.004)	3.360** [23] (7.818)		0.939	6
Diversified Economies (DE)	-1656.003 (-0.631)	21.617** [21] (2.369)		0.652	5
Diversified Economies (DE)	624.125 (1.362)	1.066** [22] (12.516)		0.987	4
Diversified Economies (DE)	690.854 (1.855)	0.304** [23] (12.645)		0.976	6
All Arab countries	684.451 (0.421)		261.750 [1] (0.925)	0.054	17
All Arab countries	480.684 (0.305)		286.222 [2] (1.447)	0.149	14
All Arab countries	3527.762 (0.900)		193.303 [3] (0.211)	0.011	6
Arab high income	-629.010 (-0.726)		423.485* [1] (1.786)	0.615	4
Arab high income	-912.627 (-1.841)		343.929** [2] (3.727)	0.874	4
Arab medium income	1371.737 (0.437)		281.356 [1] (0.562)	0.038	10
Arab medium income	1196.534 (0.551)		247.839 [2] (1.006)	0.112	10
Arab Mediterranean	5836.234 (0.810)		-554.952 [1] (-0.392)	0.037	6
Arab Mediterranean	1203.183 (0.152)		376.593 [2] (0.250)	0.015	6
Arab Gulf (OE)	-3071.647 (-3.106)		1100.789** [1] (5.831)	0.895	6
Arab Gulf (OE)	-2085.340 (-5.776)		588.508** [2] (13.814)	0.979	6
All Arab countries	-129.118 (-0.657)		47.613** [5] (18.512)	0.955	18
Arab high income	307.494 (7.866)		24.255** [5] (21.189)	0.996	4
Arab medium income	-169.839 (-0.542)		48.582** [5] (14.784)	0.960	11
Arab low income	-233.832 (-0.329)		63.963 [5] (0.780)	0.378	3
Arab Mediterranean	-440.235 (-1.041)		53.601** [5] (12.686)	0.976	6
Arab Gulf (OE)	12.876 (0.055)		40.938**[52] (14.935)	0.982	6
Arab Gulf (OE)	13.685 (0.059)		40.934** [51] (14.922)	0.982	6
Diversified Economies (DE)	56.525 (0.108)		52.736** [51] (11.616)	0.985	4
Diversified Economies (DE)	-118.703 (-0.233)		51.984** [52] (10.155)	0.963	6
Arab Gulf (OE)	-1945.295 (-8.016)		1351.431** [3] (23.683)	0.996	4

Correlation is significant * at the 0.05 level (one tailed) and ** at the 0.01 level (one tailed)

Note: (1) Codified knowledge 1: the share of education and R&D in GDP, (2) Codified knowledge 2: the share of education, R&D and ICT in GDP. (3) ICT/GDP and (5) Codified knowledge 5: total R&D spending: (51) RDTOTAL1 (52) RDTTOTAL2. Tacit knowledge2: (FTER): (21) FTER1 (22) FTER2 and (23) FTER3.

Table 5.4 presents the results regarding the relationship between publication, tacit knowledge defined by the FTER and codified knowledge defined by the share of education, R&D and ICT in GDP across Arab countries defined by income level, geographic location and structure of the economy. We observe that tacit knowledge defined by the FTER shows positive significant correlation with publication across all Arab, high, medium, low, Gulf and Mediterranean countries and oil and diversified economies. As for the correlation with codified knowledge defined by the share of education, R&D and ICT in GDP, Table 4 shows that the correlation with publication vary across Arab countries. Codified knowledge defined by the share of education, R&D and ICT in GDP and codified knowledge defined by the share of education and R&D in GDP (excluding the share of ICT in GDP) show positive significant correlation with publication only across Arab high income and Gulf countries and oil economies. But indicates insignificant correlation across all Arab and medium income and even shows negative correlation within Mediterranean countries. Moreover, part of codified knowledge defined by the total spending on R&D shows positive significant correlation with publication across all Arab, high and medium income, Gulf and Mediterranean countries respectively and oil and diversified economies, but the correlation is positive insignificant for the low income countries. Part of codified knowledge defined by the share of spending on ICT relative to GDP shows positive significant correlation with publication across only Arab Gulf countries and oil economies. Therefore, the correlation between tacit knowledge defined by the FTER, codified knowledge defined by total spending on R&D and publication is significant for all Arab, high, low and medium income respectively and Mediterranean and Gulf countries respectively and oil and diversified economies respectively. While, the correlation between codified knowledge defined by share of education, R&D and ICT in GDP and codified knowledge defined by the share of education and R&D in GDP (excluding the share of ICT in GDP) and publication is significant only for Arab high income and Gulf rather than medium income and Mediterranean countries and oil rather than the diversified economies.

Table 5.5 presents the results with respect to the relationship between cooperation, tacit knowledge defined by the FTER and codified knowledge defined by the share of education, R&D and ICT in GDP across Arab countries defined by income level and other classifications. We observe that tacit knowledge defined by the FTER shows positive significant correlation with cooperation across all Arab, high and medium income, Gulf and Mediterranean countries and oil economies. As for the correlation between cooperation and codified knowledge defined by the share of education, R&D and ICT in GDP, Table 5 shows that the correlation vary across Arab countries. Codified knowledge defined by the share of education, R&D and ICT in GDP shows positive significant correlation with cooperation only across Arab high income and Gulf countries and oil economies. Codified knowledge defined by the share of education and R&D in GDP (excluding the share of ICT in GDP) indicates positive significant correlation with cooperation only across all Arab and Gulf countries and oil economies. But shows insignificant correlation across Arab high and medium income and even shows negative correlation within Mediterranean countries. Moreover, part of codified knowledge defined by the total spending on R&D shows positive significant correlation with cooperation across all Arab, high income, Gulf and oil economies and Mediterranean countries respectively. Part of codified knowledge defined by the share of spending on ICT relative to GDP shows positive significant correlation with cooperation across only Arab Gulf countries and oil economies. Therefore, the correlation between tacit knowledge defined by the FTER and cooperation is significant for

all Arab, high and medium income respectively and Gulf (and oil economies) and Mediterranean countries respectively. While, the correlation between codified knowledge and cooperation is significant only for Arab high income and Gulf and oil economies rather than medium income and Mediterranean countries.

Table 5.5- Correlation between cooperation, tacit and codified knowledge

Independent variable	Constant	Tacit knowledge2	Codified knowledge1	R^2	N
Dependent variable	Coefficient (t-value)	Coefficient (t-value)	Coefficient (t-value)		
All Arab countries	165.474 (2.455)	-0.018 [21] (-0.095)		0.001	11
All Arab countries	6.434 (1.845)	0.056** [23] (4.048)		0.645	11
Arab high income	25.508 (5.075)	0.081** [23] (9.573)		0.979	4
Arab medium income	226.924 (2.520)	-0.030 [21] (-0.126)		0.003	7
Arab medium income	103.257 (1.583)	0.048** [23] (2.375)		0.530	7
Arab Gulf Oil Economies (OE)	17.937 (0.390)	0.239** [21] (2.263)		0.561	6
Arab Gulf Oil Economies (OE)	11.036 (1.156)	0.112** [23] (13.090)		0.977	6
Arab Mediterranean	401.429 (5.345)	-0.752* [21] (-1.860)		0.634	4
Arab Gulf Oil Economies (OE)	17.937 (0.390)	0.239** [21] (2.263)		0.561	6
Arab Gulf Oil Economies (OE)	10.640 (0.928)	0.316** [22] (10.884)		0.967	6
Arab Gulf Oil Economies (OE)	11.036 (1.156)	0.112** [23] (13.090)		0.977	6
Arab Mediterranean	198.007 (1.954)	0.028 [23] (1.141)		0.394	4
Arab Mediterranean	113.115 (6.737)	0.039** [23] (10.503)		0.991	3
All Arab countries	-4.040 (-0.040)		34.087* [1] (1.795)	0.264	11
All Arab countries	81.557 (1.001)		12.955 [2] (1.146)	0.127	11
Arab high income	-11.492 (-0.212)		20.446 [1] (1.377)	0.487	4
Arab high income	-26.733 (-0.663)		16.909** [2] (2.255)	0.718	4
Arab medium income	101.098 (0.581)		20.943 [1] (0.721)	0.094	7
Arab medium income	161.523 (1.471)		8.546 [2] (0.628)	0.073	7
Arab Gulf Oil Economies (OE)	-70.903 (-2.045)		35.799** [1] (5.410)	0.880	6
Arab Gulf Oil Economies (OE)	-39.469 (-2.873)		19.231** [2] (11.864)	0.972	6
Arab Gulf Oil Economies (OE)	-70.903 (-2.045)		35.799** [1] (5.410)	0.880	6
Arab Gulf Oil Economies (OE)	-39.469 (-2.873)		19.231** [2] (11.864)	0.972	6
Arab Mediterranean	747.401 (1.484)		-80.315 [1] (-0.816)	0.399	3
Arab Mediterranean	770.974 (3.921)		-85.126** [2] (-2.485)	0.755	4
All Arab	-26.365 (-1.021)		42.586** [3] (7.013)	0.961	4
All Arab countries	102.181 (2.026)		1.359* [5] (1.850)	0.275	11
Arab high income	30.946 (5.518)		1.298** [5] (7.906)	0.969	4
Arab medium income	164.234 (2.112)		0.987 [5] (1.042)	0.178	7
Arab Gulf Oil Economies (OE)	28.395 (8.013)		1.352** [51] (32.390)	0.996	6
Arab Gulf Oil Economies (OE)	28.420 (8.026)		1.352** [51] (32.409)	0.996	6
Arab Mediterranean	193.945 (1.243)		2.385 [51] (0.696)	0.195	4
Arab Mediterranean	23.755 (0.497)		5.005** [51] (5.305)	0.966	3
Arab Gulf Oil Economies (OE)	-26.365 (-1.021)		42.586** [3] (7.013)	0.961	4

Correlation is significant * at the 0.05 level (one tailed) and ** at the 0.01 level (one tailed)

Note: (1) Codified knowledge 1: the share of education and R&D in GDP, (2) Codified knowledge 2: the share of education, R&D and ICT in GDP, (3) ICT/GDP and (5) Codified knowledge 5: total R&D spending: (51) RDTOTAL1 (52) RDTTOTAL2. Tacit knowledge2: (FTER): (21) FTER1 (22) FTER2 and (23) FTER3.

Table 5.6: Correlation between tacit and codified knowledge FTER and R&D

	Independent variable	Constant	Tacit knowledge2	Codified knowledge1	R^2	N
Dependent variable	Dependent variable	Coefficient (t-value)	Coefficient (t-value)	Coefficient (t-value)		
Codified Knowledge 2: (RD+ ED+ICT/GDP)	All Arab countries	3.131 (2.397)	0.010**[21] (2.677)		0.395	13
	Arab high income	5.674 (3.038)	-0.002[21] (-0.407)		0.077	4
	Arab medium income	2.320 (1.557)	0.013**[21] (3.351)		0.616	9
	Arab Mediterranean	4.570 (4.232)	0.002[21] (0.600)		0.083	6
	Arab Gulf	3.147 (1.129)	0.012**[21] (2.129)		0.531	6
	Diversified Economies (DE)	27.024 (0.086)	42.050 [21] (0.692)		0.138	5
Codified Knowledge1: COD1 (RD+ ED/GDP)	All Arab countries	3.803 (3.884)	0.004*[21] (1.585)		0.173	14
	Arab high income	3.026 (2.396)	0.002[21] (0.444)		0.090	4
	Arab medium income	3.722 (3.844)	0.005*[21] (1.918)		0.344	9
	Arab Mediterranean	4.849 (4.083)	0.000[21] (0.046)		0.001	6
	Arab Gulf	2.559 (2.204)	0.006**[21] (2.414)		0.593	6
	Diversified Economies (DE)	181.214 (0.583)	11.187 [21] (0.187)		0.012	5
Codified knowledge 3: ICT/GDP	All Arab countries	51.746 (0.304)	97.140**[21] (2.190)		0.615	5
	Arab Gulf (OE)	-148.045 (-6.445)	130.1722**[21] (24.202)		0.997	4
Tacit knowledge 21: FTER1	All Arab countries	0.849 (0.649)		0.006** [3] (2.190)	0.615	5
	All Arab countries	76.210 (0.552)		39.570* [1] (1.585)	0.173	14
	All Arab countries	38.873 (0.375)		40.662** [2] (2.677)	0.395	13
	Arab high income	71.094 (0.168)		51.418 [1] (0.444)	0.090	4
	Arab high income	413.476 (0.968)		-32.345 [2] (-0.407)	0.077	4
	Arab medium income	-72.624 (-0.361)		69.834* [1] (1.918)	0.344	9
	Arab medium income	1.963 (0.019)		46.459** [2] (3.351)	0.616	9
	Arab Gulf	-104.979 (-0.526)		92.031** [1] (2.414)	0.593	6
	Arab Gulf	10.184 (0.057)		44.514** [2] (2.129)	0.531	6
	Arab Gulf (OE)	2.559 (2.204)		0.006** [1] (2.414)	0.593	6
	Arab Gulf (OE)	3.147 (1.291)		0.012** [2] (2.129)	0.531	6
	Arab Gulf (OE)	1.141 (8.203)		0.008**[3] (24.202)	0.997	4
Tacit knowledge 22: FTER2	Arab Gulf (OE)	2.543 (4.161)		0.008** [1] (5.061)	0.865	6
	Arab Gulf (OE)	2.690 (3.978)		0.016** [2] (9.415)	0.957	6
Tacit knowledge 23: FTER3	Arab Gulf (OE)	2.530 (4.675)		0.003** [1] (5.783)	0.893	6
	Arab Gulf (OE)	2.727 (4.163)		0.006** [2] (9.689)	0.959	6
	Diversified Economies (DE)	4.513 (2.975)		0.001 [1] (0.187)	0.012	5
	Diversified Economies (DE)	4.209 (3.095)		0.003 [2] (0.692)	0.138	5
	Diversified Economies (DE)	51.746 (0.304)		97.140** [3] (2.190)	0.615	5
	Arab Mediterranean	201.181 (0.707)		2.586 [1] (0.046)	0.001	6
	Arab Mediterranean	41.566 (0.140)		33.833 [2] (0.600)	0.083	6
	All Arab	-26.365 (-1.021)		42.586** [3] (7.013)	0.961	4

Correlation is significant * at the 0.05 level (one tailed) and ** at the 0.01 level (one tailed)

Note: (1) Codified knowledge 1: the share of education and R&D in GDP, (2) Codified knowledge 2: the share of education, R&D and ICT in GDP. (3) Codified Knowledge 3: ICT/GDP. (1) Tacit knowledge1: tertiary school enrolment ratio, (2) Tacit knowledge2: (FTER): (21) FTER1 (22) FTER2 and (23) FTER3.

Table 5.6 presents the results concerning the relationship between tacit knowledge defined by the FTER and codified knowledge defined by the share of education, R&D and ICT in GDP across Arab countries defined by income level, geographic location and structure of the economy. Tacit knowledge defined by FTER shows positive significant correlation with codified knowledge defined by the share of education, R&D and ICT in GDP and the share of education and R&D in GDP (excluding the share of ICT in GDP) and the share of ICT in GDP, across only all Arab, medium income and Gulf countries and oil economies but not in diversified economies. As for the correlation between codified knowledge defined by the share of education, R&D and ICT in GDP and tacit knowledge defined by the FTER, Table 5.6 shows that their correlations vary across Arab countries. Codified knowledge defined by the share of education, R&D and ICT in GDP and the share of education and R&D in GDP (excluding the share of ICT in GDP) show positive significant correlation with tacit knowledge defined by FTER only across all Arab, medium income and Gulf countries and oil economies. But shows insignificant correlation across Arab high income and Mediterranean countries and diversified economies. In addition we observe positive complementary relationship between tacit knowledge defined by the FTER and part of codified knowledge defined by the share of ICT in GDP across all Arab countries. The correlation between ICT GDP and FTER is highly significant for all Arab countries, the Gulf countries (oil economies) and diversified economies. Therefore, the interaction between tacit knowledge defined by the FTER and codified knowledge defined by either by the share of education, R&D and ICT in GDP or the share of education and R&D in GDP (excluding the share of ICT in GDP) is significant only for all Arab, medium income and Gulf oil economies rather than high income and Mediterranean countries and diversified economies.

Table 5.7 presents the results with respect to the relationship between tacit knowledge defined by the total R&D Personnel (FTER) and codified knowledge defined by the total spending on R&D across Arab countries defined by income level, geographic location and structure of the economy. We observe positive significant complementary relationship between tacit knowledge defined by total R&D Personnel (FTER) and codified knowledge defined by the total spending on R&D across all Arab, high, medium income, Gulf, Mediterranean and ESCWA countries and oil and diversified economies. Moreover, the correlation between the total R&D Personnel (FTER) and part of codified knowledge defined by the total spending on R&D is significant for all Arab, high, medium income, Mediterranean, Gulf and ESCWA countries respectively diversified and oil and mixed oil economies respectively, but insignificant for the primary exports economies (ERF, 2002 data on total R&D Personnel (FTER) total spending on R&D). The correlation between FTER and RD/GDP is insignificant in the oil economies and mixed oil economies.

Table 5.7: Correlation between tacit knowledge (FTER) and codified knowledge (share of R&D in GDP)

Independent variable	Constant	Tacit knowledge2: (FTER)	Codified knowledge: R&D	R^2	N
Dependent variable	Coefficient (t-value)	Coefficient (t-value)	Coefficient (t-value)		
All Arab countries	-791.415 (-0.481)	99.937**[21] (4.636)		0.573	18
All Arab countries	23.088 (2.069)		0.006**[5] (4.636)	0.573	18
Arab high income	-3.840 (-1.132)	0.062**[21] (10.774)		0.983	4
Arab high income	68.127 (1.351)		15.912**[5] (10.774)	0.983	4
Arab medium income	32.125 (1.762)	0.005**[21] (3.414)		0.564	11
Arab medium income	-1028.467 (-0.352)		104.386**[5] (3.414)	0.564	11
Arab low income	-194.785 (-0.144)	169.974[21] (1.086)		0.541	3
Arab low income	4.382 (1.101)		0.003[5] (1.086)	0.541	3
Arab ESCWA	26.804 (1.606)	0.019**[21] (3.653)		0.572	12
Arab ESCWA	-256.483 (-0.353)		29.495**[5] (3.653)	0.572	12
Arab Mediterranean	18.105 (3.459)	0.006**[21] (16.940)		0.986	6
Arab Mediterranean	-3004.078 (-2.950)		172.940**[5] (16.940)	0.986	6
Arab Gulf	165.092 (2.489)	11.807**[21] (15.112)		0.983	6
Arab Gulf	-12.898 (-2.107)		0.083**[5] (15.112)	0.983	6
Arab Gulf (OE)	181.271 (0.712)		1520.676 [6] (0.654)	0.097	6
Arab Gulf (OE)	0.071 (1.686)	0.00006359[21] (0.654)		0.097	6
Arab Gulf (OE)	-13.202 (-1.702)		0.234** [51] (11.915)	0. 973	6
Mixed Oil Economies (MOE)	10.910 (2.623)	0.020**[22] (26.093)		0.997	4
Mixed Oil Economies (MOE)	-530.725 (-2.438)		49.433** [51] (26.093)	0.997	4
Mixed Oil Economies (MOE)	187.674 (1.075)		198.884 [6] (0.330)	0.035	5
Arab Gulf (OE)	165.092 (2.489)	11.807**[23] (15.112)		0.983	6
Arab Gulf (OE)	-12.898 (-2.107)		0.083** [52] (15.112)	0.983	6
Mixed Oil Economies (MOE)	10.774 (0.999)	0.008*[23] (1.594)		0.718	3
Mixed Oil Economies (MOE)	-428.305 (-0.258)		95. 080*[52] (1.594)	0.718	3
Diversified Economies (DE)	16.224 (3.084)	0.006**[23] (16.990)		0.986	6
Diversified Economies (DE)	-2657.316 (-2.660)		170.745** [52] (16.990)	0.986	6
Primary Exports Economies (PEE)	4.382 (1.101)	0.003[23] (1.086)		0.541	3
Primary Exports Economies (PEE)	-194.785 (-0.144)		169.974 [52] (1.086)	0.541	3

Correlation is significant * at the 0.05 level (one tailed) and ** at the 0.01 level (one tailed)
Note: (5) Codified knowledge 5: total R&D spending: (51) RDTOTAL1 (52) RDTTOTAL2 and (6) Codified knowledge 6: the share of R&D in GDP: R&D/GDP. Tacit knowledge2: (FTER): (21) FTER1 (22) FTER2 and (23) FTER3.

Table 5.8 presents the results concerning the relationship between publication and cooperation across Arab countries defined by income level and other classifications. We observe positive significant complementary relationship between publication and cooperation across only all Arab, high income and Gulf countries and oil economies, i.e. positive significant complementary relationship between publication and cooperation across only high income rather than medium income and Gulf rather than Mediterranean countries.

Table 5.8- Correlation between publication and cooperation

Independent variable	Constant	Publication	Cooperation	R^2	N
Dependent variable	Coefficient (t-value)	Coefficient (t-value)	Coefficient (t-value)		
All Arab countries	140.167 (0.152)	12.204** (2.434)		0.426	10
All Arab countries	73.925 (1.770)		0.035** (2.434)	0.426	10
Arab high income	14.773 (1.849)	0.053** (7.006)		0.961	4
Arab high income	-234.159 (-1.323)		18.066** (7.006)	0.961	4
Arab medium income	834.055 (0.413)	6.158 (0.795)		0.112	7
Arab medium income	179.100 (2.300)		0.018 (0.795)	0.112	7
Arab Gulf Oil Economies (OE)	29.063 (3.678)	0.032** (14.403)		0.981	6
Arab Gulf Oil Economies (OE)	-839.539 (-3.003)		30.201** (14.403)	0.981	6
Arab Mediterranean	1149.519 (1.577)	2.903 (1.101)		0.548	3
Arab Mediterranean	-101.125 (-0.305)		0.189 (1.101)	0.548	3

Correlation is significant * at the 0.05 level (one tailed) and ** at the 0.01 level (one tailed)

5.3. The Incidence and Transfer of Knowledge within the Arab Gulf Societies

The availability of data and the results presented above suggest that it may be useful to give more in-depth analysis of the incidence and transfer of knowledge within the Arab Gulf societies. In this section we discuss the following hypotheses:

1. The incidence and transfer of knowledge within the Gulf society show positive correlation and hence can be used to enhance economic growth (GDP) technology indicators (R&D) skills level (schooling) and upskilling (education).
2. Tacit and codified sources of knowledge within the Gulf society are positively correlated with each other and with the transfer of knowledge/ knowledge spillover at the macro level.
3. A. The incidence and transfer of knowledge within the Gulf society show positive correlation and can be enhanced by increasing skills level.

   B. The incidence and transfer of knowledge within the Gulf society can be enhanced by institutional support in the form of subsidies for enhancing education to motivate skills upgrading.

Similar to the methodological approach and analysis presented above, first, we support modern innovation theories and the new growth literature in viewing knowledge in a more broad/diffuse way. Therefore, we define knowledge as decomposed of: (1) Tacit knowledge, which we defined by the percentage share of high skilled labour in total employment/population (Nelson and Winter, 1982; Freeman and Soete, 1997). (2) Codified knowledge[20], which we defined by embodied knowledge distributed in many aspects including total spending on education R&D, and ICT (David and Foray, 2001; Freeman and Soete, 1997). To define knowledge spillover or knowledge transfer from high skilled to both medium and low skilled, we use the ratio of high skilled to medium and low skilled. We follow the systemic approach used by Cowan, Soete

[20] Smith (2002) uses the concept of a distributive knowledge base, which includes R&D, ICT and capital investment. David and Foray (2001) distinguish intangible capital in the form of investment geared to the production and dissemination of knowledge that includes training, education, R&D, information and coordination. The definition of codified knowledge for some other studies include publication and patent (David and Foray, 1995).

and Tchervonnaya (2001), in viewing the transfer of knowledge from knowledge holders (high skilled) to knowledge recipients (low skilled).[21]

We use the data presented in Nour (2003), Table 5.9 presents these data and several variables and indicators that might influence knowledge components at the macro/aggregate level in the Gulf countries.

Table 5.9 - The Determinant of Knowledge in the Gulf societies

Variable/ Country	UAE	Kuwait	Bahrain	Oman	Qatar	Saudi Arabia
Spending on R&D [a]	10.890000	67.110000	3.740000	10.760000	5.460000	196.049000
FTER [b]	107	440	86	82	34	846
Schooling years [c]	10.5	9	6.09	9	5.8	9.5
Publication [d]	579	1936	453	466	377	8306
Public spending on Education [e]	1.7	5.0	4.4	4.5	3.4	7.5
Cooperation [f]	55	117	29	37	36	294
Spending on ICT/ GDP [g]	1.76	10.83	0.60	1.74	0.88	31.66
Other social cultural factor Foreign/ Local [h]	0.82	0.83	0.60	0.64	0.82	0.63
GDP [d]	47.20	25.20	5.30	15.00	9.20	128.90
High skilled [I]	0.18	0.21	0.21	Na.	0.17	0.18
High skilled/ medium and low skilled [I]	0.22	0.27	0.27	Na.	0.20	0.22
Codified Knowledge (EDU+R&D+ICT)	12.72	72.35	9.27	15.66	9.51	203.60

Sources: Data from (a), (b) and (f) data from ESCWA/ UNESCO (1998), (c) Barro and Lee (2001), Economic Trends in MENA Region (2002) and UNESCO, (d) UNDP (2002) "Arab Human Development Report", (e) UNDP (2002) "UNDP Human Development Report", (g) WISTA (2002) and ESCWA/ UNESCO (1998), (h) Girgis (2000), (i) Data calculated for Bahrain, Qatar and Saudi Arabia data from GOIC (1998) and (2000) "Gulf Statistical Profile", UAE data from Ministry of Planning (1987 –1997) "Population Census data of 1985 and 1995", Kuwait data from Kuwait Institute of Banking Studies (2000) in Wadia (2001).

Tables 5.10-5.11 present our results, which indicate the significance of tacit, codified and transfer of knowledge at the macro (aggregate) level, these results are consistent with the findings in the literature (cf. Abramovitz and David, 1996; 1998; David and Foray, 2001; Loof and Heshmati, 2002). For instance, Tables 5.10 and 5.11 illustrate the significant effect of knowledge at the aggregate/macro level, these results are consistent with the findings in the general literature. For instance, Table 5.11 indicates that both tacit and transfer of knowledge induce positive significant effect on the promotion of average years of schooling and positive effect on GDP, while, codified knowledge shows significant positive effect on GDP. In addition, Table 5.11 shows that tacit, codified and transfer of knowledge show significant positive correlation with the promotion of the share of public spending on education and R&D, scientific publication and scientific cooperation. Furthermore, Table 5.11 illustrates significant positive complementary relation between the share of public spending on R&D, number of publications and cooperation and between them and the share of public spending on education, number of FTER, tacit, codified and the transfer of knowledge. Therefore, these results verify our first hypothesis, which indicates that at the macro/ aggregate level knowledge induces positive effects on the promotion of GDP (economic growth), average years of schooling (skill), the share of spending on education (upskilling) and on R&D (technology) in the Gulf countries.

[21] At the aggregate/ macro level, our definition of tacit knowledge by tacit skills defined by occupation status, we use ISC criteria, which defines high skilled as workers within the occupation category that includes professional, technical and related workers, administrative and managerial workers. We define the transfer of knowledge/ knowledge spillover by the ratio of high skilled workers to all other categories (medium and low) skilled workers. Our definition of codified knowledge includes the share of public spending on education as percentage of GDP, the share of total spending on ICT as percentage of GDP and the share of total spending on R&D as percentage of GDP. In addition, we use several variables related to the incidence and transfer of knowledge, such as the number of full time equivalent researchers (FTE), number of publication, scientific cooperation as measured by joint publications and average years of schooling in the Gulf societies. Finally we add the effect of others variables to test the effect of social and cultural variables represented by the share of foreign population to total population.

Table 5.10 -The significance of tacit, codified and transfer of knowledge for enhancing skills (schooling) and GDP

Independent Variable	Constant	Ln (TACITK= H)	Ln (TRANSK=H/L)	Ln (CODK)	R^2
Dependent Variable	Coefficient (t-value)	Coefficient (t-value)	Coefficient (t-value)	Coefficient (t-value)	R^2
Ln (Schooling)	7.797 (2.416)	3.312*[1] (1.729)			0.749
	5.821 (3.155)		2.428*[1] (1.954)		0.792
Ln (GDP)	27.522 (3.521)	2.022[1] (0.436)			0.160
	25.370 (2.989)		0.532[1] (0.093)		0.004
	10.968 (2.626)			6.121**[1] (3.137)	0.766

Correlation is significant * at the 0.05 level (one-tailed) ** at the 0.01 level (one-tailed). Note: ([1]) Log regression

Table 5.11 – The Significance of tacit, codified and transfer of knowledge for enhancing education (upskilling), R&D (technology), publication and cooperation in the Gulf countries:

Expenditures on Education and R&D (Skills and Technology Indicators)								
Dependent Variable	Education		R&D		Publication		Cooperation	
Independent Variable	Coefficient (t-value)	R^2	Coefficient (t-value)	R^2	Coefficient (t-value)	R^2	Coefficient (t-value)	R^2
Education expenditures			1.419**[1] (3.938)	0.795	1356.647** (2.829)	0.727	43.246** (2.751)	0.716
R&D expenditures	2159.825* (1.950)	0.487			909818.18** (3.255)	0.841	44030.303** (2.334)	0.732
Number of FTER	0.005** (2.979)	0.747	0.00000365** (3.165)	0.834	9.449** (5.649)	0.914	0.312** (9.220)	0.966
Number of publication	0.001** (2.829)	0.727	0.00000092** (3.255)	0.841			0.032** (13.977)	0.985
Scientific cooperation	0.017** (2.751)	0.716	0.0000166** (2.334)	0.732	30.889** (13.977)	0.985		
Tacit knowledge	6.584**[1] (9.167)	0.988	10.866*[1] (1.678)	0.738	40419.231** (8.079)	0.985	5.436**[1] (10.140)	0.990
Codified knowledge	2.248**[1] (25.221)	0.995	3.846**[1] (3.981)	0.841	3.710** (2.161)	0.609	40.030** (2.734)	0.882
Transfer of knowledge	4.956**[1] (9.167)	0.988	8.179*[1] (1.678)	0.783	23207.692** (6.133)	0.974	1173.077** (18.216)	0.997

Correlation is significant * at the 0.05 level (one-tailed) ** at the 0.01 level (one-tailed). Note ([1]) Log regression

In addition, our results in Table 5.12 illustrates the complementary relationships between tacit, codified and transfer of knowledge at the macro level, these results are consistent with the literature on the complementary relation between knowledge components (cf. Winter, 1987; Brusoni et al., 2002). In particular, we find that tacit knowledge and the transfer of knowledge show strong positive and significant complementary relationships with each other at the macro level. Therefore, society with intensive tacit knowledge would have strong potential to enhance the transfer of knowledge and having positive knowledge spillover effect, which in turn induces further effects on learning and tacit knowledge within the entire society. Hence these results verify our second hypothesis, which implies the positive complementary relationships between knowledge components at the macro (aggregate) level.

Moreover, our results in Table 5.12 shows the determinants and factors/ways of enhancing of tacit, codified and the transfer of knowledge at the macro level. For instance, Table 5.12 shows that tacit, codified and transfer of knowledge are positively correlated with each other and also with average schooling years, the share of public spending on education and R&D, number of FTER, publications, cooperation and other variable.[22] Hence, these results verify our third hypothesis that at the aggregate level, the incidence and transfer of knowledge are positively correlated (determined) and therefore could be enhanced by raising average schooling years, the share of public spending on education, R&D, the number of FTER, scientific publications and scientific cooperation. Therefore, from Table 5.12 we conclude that at the macro level the transfer of knowledge can be enhanced by tacit knowledge/skills, codified knowledge,

[22] We define other variable by the share of foreigners in total population.

average schooling year, public spending on education and R&D, number of FTER, number of publication and scientific cooperation.

Table 5.12 – The Determinant and ways of enhancing tacit, codified and transfer of knowledge in the Gulf countries

Dependent Variable	Tacit knowledge		Codified knowledge		Transfer of knowledge	
Independent Variable	Coefficient (t-value)	R^2	Coefficient (t-value)	R^2	Coefficient (t-value)	R^2
Average Schooling years	0.250*[1] (1.706)	0.593	0.045[1] (0.099)	0.002	0.326*[1] (1.954)	0.792
Public spending on Education	0.027** (2.502)	0.862	0.488**[1] (15.465)	0.984	0.046** (2.502)	0.862
Public spending on R&D	21.053** (2.309)	0.842	5105.790** (10.743)	0.975	31.189* (1.927)	0.650
Number of FTER	0.0000959** (13.654)	0.995	0.004** (4.788)	0.920	0.118**[1] (6.737)	0.978
Number of publication	0.00002437** (8.079)	0.985	0.001** (2.829)	0.727	0.00004197** (6.133)	0.974
Scientific cooperation	0.182**[1] (10.140)	0.990	0.014** (5.333)	0.934	0.001** (18.216)	0.997
Other variables	3.500** (4.041)	0.942	245.155* (1.665)	0.735	6.000** (3.464)	0.923
Tacit knowledge/ skills			100.035** (5.763)	0.971	1.714** (46.476)	0.999
Codified knowledge	0.010** (5.763)	0.971			0.016** (5.763)	0.971
Transfer of knowledge	0.583** (46.476)	0.999	60.021** (5.763)	0.971		

Correlation is significant * at the 0.05 level (one-tailed) ** at the 0.01 level (one-tailed). Note ([1]) Log regression

Moreover, when we interpret the share of high skilled group in total employment and total population as a source or holder of knowledge, our results in Table 5 illustrate the major significance of knowledge holders in enhancing the transfer process at the macro level. These results are consistent with the findings in the literature (cf. Cowan, Soete and Tchervonnaya, 2001). Thus, our findings in Table 5.13 indicate that the transfer of knowledge from high skilled to medium and low skilled at the macro level could be enhanced by increasing the share of high skilled group in total population.

Table 5.13 - The determinants and ways of enhancing the transfer of knowledge within the Gulf countries

Log regression	(1)	(2)	(3)	
Independent Variable	Constant	the Share of High Skilled group in total population	Ln the share of Medium and low Skilled groups on total population	R^2
Dependent Variable	Coefficient (t-value)	Coefficient (t-value)	Coefficient (t-value)	R^2
Ln(TRANSK= H/L)	0.851 (12.637)	1.383**[1] (34.238)		0.997
	- 2.680 (-49.105)		-5.824** [1] (-22.619)	0.994
	7.756 (2329839.3)	4.086**[1] (3134951.7)	11.405**[1] (2074534.1)	1.000

Correlation is significant * at the 0.05 level (one-tailed) ** at the 0.01 level (one-tailed). Note ([1]) Log regression.

5. 4. Summary and Conclusions

In this Chapter we discuss and test the hypotheses concerning the incidence and impact/ importance and ways of enhancing of the components of knowledge across the Arab countries defined by income level and other classification: geographic location and the structure of the economy. First we define the variables and data used in our analysis, next we report on estimation results and discuss the empirical findings.

From Table 5.1 above we find that somewhat surprising the classification of Arab countries by income level is inconclusive in terms of the capacity to create knowledge. For instance, the performance of Arab high income falls behind Arab medium income in terms of knowledge (codified knowledge, number of publications and patents) and the capacity to create knowledge (enrolment in tertiary education, FTER, total spending and spending on R&D as a percentage to GDP). These results probably can be interpreted along with the classification of Arab countries according to the structure of the economy, for instance, the

high income are Gulf oil based economies, while the majority of the medium income are Mediterranean and diversified economies. This result confirms the importance of diversification for the Arab economies.

Our findings indicate that the correlation between codified knowledge and GDP is significant for all Arab, medium income rather than high and low income and Gulf rather than Mediterranean countries. Part of codified knowledge defined by the share of spending on education in GDP shows positive significant correlation with schooling only across Arab low income countries and to some extent the primary exports economies, and with GDP across all Arab countries. Moreover, part of codified knowledge defined by the share of spending on ICT in GDP shows positive but insignificant correlation with GDP across all Arab countries. While, the correlation between tacit knowledge defined by the share of tertiary school enrolment ratio and GDP is positive significant across only Arab low income countries. We show that the correlation between tacit knowledge defined by the share of tertiary school enrolment ratio and schooling is positive significant for all Arab, medium income rather than high and low income and Mediterranean rather than Gulf countries (oil economies), but insignificant for the primary exports economies. (cf. Table 5.2). Theses results support the first hypothesis that the components of knowledge show positive correlation and hence can be used to enhance economic growth and promote human capital across the Arab countries. Our findings corroborate the second and third hypotheses that the components of knowledge can be enhanced by skill upgrading and also institutional support in the form of subsidies and incentives to knowledge components across the Arab countries.

Our results show that the correlation between tacit knowledge defined by the FTER and patent is significant for all Arab, medium rather than high income and Mediterranean then Gulf countries and oil economies and diversified economies respectively. While, the correlation between codified knowledge and patent is significant for all Arab, medium income then high income and Gulf rather than Mediterranean countries and oil economies but rather insignificant for the diversified economies (cf. Table 5.3).

We find that the correlation between tacit knowledge defined by the FTER and publication is significant for all Arab, high, low and medium income respectively and Mediterranean and Gulf countries and oil and diversified economies respectively. While, the correlation between codified knowledge and publication is significant only for Arab high income and Gulf and oil economies rather than medium income and Mediterranean countries. Moreover, part of codified knowledge defined by the total spending on R&D shows positive significant correlation with publication across all Arab, high and medium income, Gulf and Mediterranean countries respectively and oil and diversified economies, but the correlation is positive insignificant for the low income countries.

Our findings indicate that the correlation between tacit knowledge defined by the FTER and cooperation is significant for all Arab, high and medium income respectively and Gulf and Mediterranean countries respectively and oil economies. While, the correlation between codified knowledge and cooperation is significant only for Arab high income and Gulf rather than medium income and Mediterranean countries and oil economies rather than the diversified economies. Part of codified knowledge defined by the share of spending on ICT relative to GDP shows positive significant correlation with publication and cooperation across only Arab Gulf countries and oil economies (cf. Tables 5.4 -5.5).

We find positive complementary relationship between tacit knowledge defined by the FTER and part of codified knowledge defined by the share of ICT in GDP across all Arab countries. The positive

complementary relationship between tacit knowledge defined by the FTER and codified knowledge defined by both the share of education and R&D in GDP and the share of education, R&D and ICT in GDP is significant only for all Arab, medium income and Gulf and oil economies. But shows insignificant correlation across Arab high income and Mediterranean countries and diversified economies. In addition, we show a positive significant complementary relationship between tacit knowledge defined by total R&D Personnel (FTER) and codified knowledge defined by the total spending on R&D across all Arab, high, medium income, Gulf, Mediterranean and ESCWA countries and oil and diversified economies. Moreover, the correlation between the total R&D Personnel (FTER) and part of codified knowledge defined by the total spending on R&D is significant for all Arab, high, medium income, Mediterranean, Gulf and ESCWA countries respectively diversified and oil and mixed oil economies respectively, but insignificant for the primary exports economies. The correlation between FTER and RD/GDP is insignificant in the oil economies and mixed oil economies. We find significant positive complementary relationship between tacit knowledge defined by the FTER and part of codified knowledge defined by the share of ICT in GDP across all Arab countries, the Gulf (oil economies) and diversified economies. (cf. Table 5.6 and Table 5.7). These findings corroborate our fourth hypothesis that tacit and codified knowledge are complement to each other.

Finally, we find positive significant complementary relationship between publication and cooperation across only all Arab, high income rather than medium income and Gulf rather than Mediterranean countries and the oil economies rather than the diversified economies (cf. Table 5.8).

Next we discuss the importance, determinants and ways of enhancing tacit, codified and the transfer of knowledge at the macro levels in the Gulf countries. First, we illustrate the importance of tacit, codified and transfer of knowledge on promoting the share of expenditure on R&D (technology indicators), share of expenditure on education (upskilling), average schooling years (skills level) and GDP (economic growth). Second, we show the complementary relation between knowledge components, in particular between tacit knowledge and the transfer of knowledge at the macro level. Therefore, this implies that society with intensive tacit knowledge would have strong potential to enhance the transfer of knowledge and having positive knowledge spillover effect, which in turn induces further effects on learning and tacit knowledge within the entire society. Third, we illustrate the significance of knowledge holders for enhancing the transfer of knowledge at the macro level (cf. Tables 5.10-5.13). We illustrate that at the macro level the transfer of knowledge can be enhanced by increasing tacit knowledge/ tacit skills, codified knowledge, average schooling year, public spending on education and R&D, the number of FTER, number of publication and scientific cooperation. Our results show significant positive complementary relation between the share of public spending on R&D, publication and cooperation and between them and the number of FTER, the share of public spending on education, tacit, codified and the transfer of knowledge (cf. Tables 5.11-5.12). Our result in this section prove the hypotheses that the incidence and transfer of knowledge in the Gulf show positive correlation and hence can be used to enhance economic growth (GDP) technology indicators (R&D) skills level (schooling) and upskilling (education). Tacit and codified sources of knowledge within the Gulf society are positively correlated with each other and with the transfer of knowledge/ knowledge spillover at the macro level. The incidence and transfer of knowledge within the Gulf society show positive correlation and can be enhanced by increasing skills level and can be enhanced by institutional support in the form of subsidies for enhancing education to motivate skills upgrading.

Chapter 6

Summary, Conclusions and Recommendations

6.1 Introduction: structure of the research

This research discusses the impacts, importance and ways of enhancing the incidence and transfer of knowledge within the Arab societies. It is composed of six chapters that organized in the following way: Chapter 1 is an introductory chapter presents the definition of the research problem, aims, hypotheses to be tested, methodology and structure of the research. Chapter 2 provides the conceptual and theoretical frameworks that show the definition and the importance and sources of knowledge in the new growth literature and the relevance of these literatures to the Arab societies. Chapter 3 discusses the status of knowledge in the Arab countries compared to other world countries. Chapter 4 presents a comparative assessment and overview of knowledge across Arab countries, in particular, discusses and compares the various elements or indicators of knowledge including levels of education, literacy, skills, ICT diffusion across the Arab countries. Chapter 5 describes the variables and data and reports on estimation and discusses the empirical findings on the impacts/ importance of the component of knowledge across the Arab countries defined by income level and other classification: the geographic location and the structure of the economy. Finally, Chapter 6 provides the conclusions policy implications and recommendations.

6. 2. Main findings of the research:

Chapter 1 is an introductory chapter presents the definition of the research problem, aims, hypotheses to be tested, methodology and structure of the research. Chapter 2 provides the conceptual and theoretical frameworks that show the definition and the importance and sources of knowledge in the new growth literature and the literature addressing and highlighting the knowledge economy. In Section 1 we present the definition, nature, and characteristics of knowledge based on the distinction between codified and tacit knowledge and between embodied flows and disembodied flows of knowledge and based on the nature and characteristics of knowledge as non-rival and non-excludable commodity. In Sections 2 and 3 we discuss the literature on the importance and impacts of knowledge creation, accumulation and acceleration on enhancing scientific and technological progress, productivity and economic growth and human development, particularly within the framework and recent debate in the new growth literature. In Section 4 we illustrate the concepts of knowledge gaps, information problem and policies to narrow knowledge gap based on the World Bank report on knowledge for development. In Section 5 we indicate the institutional settings concerning both the provision and transfer of knowledge based on the nature and characteristics of knowledge as non-rival and non-excludable commodity. In Section 6 we discuss the literature on the transfer of knowledge, indicating the importance of transfer of knowledge and the channels and ways of enhancing the transfer of knowledge.

In Chapter 3 we discuss the status of knowledge in the Arab countries compared to other world countries. We show that the new economy, which is characterizing by the rapid diffusion of ICT, advanced knowledge system and the recent trend of globalization and their various influences in different economic systems and global prosperity seems to have passed the Arab countries. We find that the Arab countries are not benefiting yet from the advantages of the new economic system because they manifestly lagged behind

the developed and developing countries in terms of knowledge, skills, technological capabilities, spending and diffusion of ICT, competitiveness, integration in the world economy and average growth rate. Consequently, the poor performance leads to insignificant share of Arab states in the new/global economic system, poor technology achievement index, poor absorptive capacity and capacity to create knowledge.

We observe that despite, the great heterogeneous performance across the Arab states, however, it was evident that none of the Arab states presents a sufficient, convincing and coherent performance. While, the Arab Gulf countries are leading the Arab states in terms of GDP per capita, human development indicators, spending and diffusion of ICT. However, like most other Arab countries they fail to present a convincing and coherent performance in the new economy.

In Chapter 4 we present a comparative assessment and overview of knowledge across the Arab countries, we discuss and compare the various indicators of knowledge including the levels of education, literacy, skills, ICT diffusion across Arab countries. In Section 2 we present and compare the socio-economic and development characteristics of Arab countries. In Section 3 we discuss and compare various indicators of knowledge including levels of education, literacy, skills, ICT diffusion across Arab states.

In investigating the status of knowledge we use a certain criteria, mainly the classification of Arab countries according to income level. The selection of this criteria is based on/consistent with the conventional view concerning the positive relationship between knowledge and income and the view that knowledge is concentrated in high income countries as indicated in numerous studies (cf. World Bank Report, 1999; OECD European Second Report on S&T Indicators, 1997). Our analysis of knowledge in the Arab region is more comprehensive since we compare the results using different classification of Arab countries defined by the income level, the geographic location and the structure of the economy.

We show the great diversity amongst the Arab countries in terms of size of the country, demographic structure and both socio-economic and development indicators, including GDP per capita, HDI, life expectancy, combined enrolment ratios and poverty rate. The medium income group is coming first in terms of the size of land and population, but reached second following the high income group in terms of level of GDP per capita, HDI, life expectancy, combined enrolment ratio and literacy rate. The high income group is leading and coming first in terms of high level of GDP per capita, HDI, life expectancy, combined enrolment ratio and literacy rate, but in contrast it is coming last with the smallest tiny sizes of population and area. The low income group, is coming first in terms of poverty rate, coming second in terms of size of population and area, but coming last in terms of socio-economic and development indicators: GDP per capita, HDI, life expectancy, combined enrolment ratio and literacy rate.

We realize the great differences in the literacy rates across the Arab countries, especially between the high and low income groups, our result implies that literacy rate related to or increasing in income level. When comparing across Arab countries we find that at the individual level, the highest literacy rates are reported in two medium income countries rather than high income countries, which are coming next.

We observe the variation across Arab high, medium and low income groups concerning skills indicators defined by the percentage share of gross enrolment ratio in tertiary education, the share of tertiary students in science, math and engineering, school life expectancy, Harbison Myers Index, Technical enrolment index and Engineering enrolment index. While, the average for high and medium are close to each other, but the gap between them and low income is high. When comparing skill indicators between the

individual high, medium and low income countries, we observe that the highest school life expectancy, gross enrolment in tertiary education and Technical enrolment index are reported in two medium income countries rather than high income countries. While, the highest Harbison Myers Index and Engineering enrolment index are reported in one medium income followed by high income countries.

We show enormous variation/gap between high, medium and low income groups in terms of S&T input-output indicators, public spending on education as percentage of GDP and government expenditure, public spending on R&D as percentage of GDP, total number of researchers, S&E, patents and high technology exports. From our results, it is surprising that with respect to all S&T input-output indicators the medium income countries show higher performance than the high income countries. It is surprising that the highest priority for public spending on education as percentage of GDP and total government expenditures is reported for a low income country exceeding the average levels for both high and medium income countries. We compare spending on education and S&T indicators between individual high, medium and low income countries. We observe that at the individual level, the highest spending on R&D as percentage of GDP, the total number of researchers, S&E in research and total number of patents are reported in one or two medium income countries rather than high income countries. The highest public spending on education as percentage of GDP and total government expenditures and the high technology exports are reported in one medium and one low income countries respectively rather than high income countries.

Regarding S&T output indicator as measured by the number of scientific publications, our findings indicate that the medium income countries show better performance than the high and low income countries. This might be interpreted as a consequence of better performance of medium income countries compared to the high and low income countries in terms of most of science and technology indicators, in particular, in terms of total expenditures on R&D, the number of R&D employees and R&D scientists and engineers. Our results imply that most of R&D, FTE researchers and S&T activities in all Arab, high, medium and low income countries are mostly allocated within both public and university sectors. While, the private sector and hence, industry have minor contribution in total R&D activities.

We observe the enormous variation and large gap across the Arab high, medium and low income groups in terms of ICT diffusion, in particular, the Internet users, telephone mainlines and cellular subscribers. When comparing between high, medium and low income groups, we observe that at the individual level, the highest Internet users, telephone mainlines and cellular subscribers are concentrated in the Arab high income countries (Gulf oil economies) followed by medium income countries (diversified and mixed oil economies), the low income countries (primary exports economies) have low shares. These results are not surprising since the use of ICT is often related to income level as reported in the literature.

When comparing between Arab countries according to the structure of the economy we find that the Arab countries show great diversity: in terms of total number of population the rank of Arab economies are as follows: the primary exports; the mixed oil economies, the diversified economies and the oil economies, in terms of the total area of land the rank of Arab economies are as follows: the primary exports; the mixed oil economies, the oil economies and the diversified economies. In terms of the average high GDP per capita and high HDI and low poverty rate the rank of Arab economies are as follows: the oil economies; the mixed oil economies, the diversified economies and the primary exports. In terms of the life expectancy and literacy rate the rank of Arab economies are as follows: the oil economies; the diversified

economies, the mixed oil economies and the primary exports. In terms of the combined enrolment ratio the rank of Arab economies are as follows: the mixed oil economies; the diversified economies, the oil economies and the primary exports economies. In terms of skill indicators: the high Harbison Myers Index the rank of the Arab economies as follows; the diversified economies; the oil economies, the mixed oil economies and the primary exports economies. In terms of school life expectancy, gross enrolment in tertiary education, Engineering and Technical enrolment index the rank of Arab economies are as follows: the mixed oil economies; diversified economies; the oil economies and the primary exports economies, in terms of the share of tertiary students in science, math and engineering the rank of the Arab economies as follows: the mixed oil economies; oil economies; diversified economies and primary exports economies.

Regarding the rank of the Arab economies in terms of S&T indicators we observe that the public spending on education as a percentage of GDP and as a percentage of government expenditure is high in the primary exports economies followed by diversified economies and the oil economies respectively, the lowest public spending on education as a percentage of GDP is reported in the mixed oil economies. The public spending on R&D as percentage of GDP is high in the diversified economies followed by the oil economies, the total number of researchers, S&E in research are high in the diversified economies followed by the oil economies; the mixed oil economies; and the primary exports, in terms of the total number of patents the rank of the Arab economies as follows: the oil economies, the diversified economies and the primary exports economies. The high technology exports are reported in the diversified economies, the primary exports economies; the oil economies and the mixed oil economies.

Concerning the distribution of R&D and the number of full-time equivalent (FTE) researchers in the R&D institutional units by types, the public sector is responsible from most of R&D activities and contribute by 49, 80; 80 and 100 per cent of total R&D institutions in the oil economies; the mixed oil economies; diversified economies and the primary exports economies respectively. The public sector is responsible from employing most of R&D (FTE) researchers and contributes by 49, 52; 73 and 76 per cent of total R&D institutions in the oil economies; the mixed oil economies; the diversified economies and the primary exports economies respectively. Next to the public sector, the universities sector contributes by 44; 20 and 13 per cent of total R&D institutions in the oil economies; the mixed oil economies and the diversified economies respectively. The universities sector contributes by 50; 48; 24 and 24 per cent of the total number of full-time equivalent (FTE) researchers in the R&D institutions in the oil economies; the mixed oil economies; the diversified economies and the primary exports economies respectively. While, the minor contribution comes from the private sector, which accounts only for 7 and 7 per cent of total R&D institutions in the oil economies and diversified economies and accounts only for 1 and 3 per cent of total number of full-time equivalent (FTE) researchers in the R&D institutions in the oil economies and the diversified economies respectively. The high performance in the percentage change in GDP Per capita; the total R&D spending and the total number of publications in the diversified economies followed by the oil economies; the mixed oil economies and the primary exports economies respectively. In terms of both the percentage change in R&D spending and the high share of high technology manufactures the performance are ranked as follows: the diversified economies; the oil economies; the primary exports economies and the mixed oil economies respectively. In terms of high use of ICT, the rank of the Arab economies as follows: the oil economies; the diversified economies; the mixed oil economies and the primary exports economies.

Therefore, these results confirm earlier findings that despite the great heterogeneous performance across the Arab states, it was evident that none of the Arab states presents a sufficient, convincing and coherent performance. While, the Arab high and Gulf (oil economies) are leading the Arab states in terms of GDP per capita, human development indicators, spending and diffusion of ICT. They fail to present a convincing and coherent performance in the new economy and failed to promote efficient educational system, skills, technological capabilities and infrastructure necessary for building the knowledge economy.

In Chapter 5 we discuss and test the hypotheses concerning the incidence and impact/ importance and ways of enhancing of the components of knowledge across Arab countries defined by income level and other classification: geographic location and the structure of the economy. First we define the variables and data used in our analysis, next we report on estimation results and discuss the empirical findings.

From Table 5.1 above we find that somewhat surprising the classification of Arab countries by income level is inconclusive in terms of the capacity to create knowledge. For instance, the performance of Arab high income falls behind Arab medium income in terms of knowledge (codified knowledge, number of publications and patents) and the capacity to create knowledge (enrolment in tertiary education, FTER, total spending and spending on R&D as a percentage to GDP). These results probably can be interpreted along with the classification of Arab countries according to the structure of the economy, for instance, the high income are Gulf oil based economies, while the majority of the medium income are Mediterranean and diversified economies. This result confirms the importance of diversification for the Arab economies.

Our findings indicate that the correlation between codified knowledge and GDP is significant for all Arab, medium income rather than high and low income and Gulf rather than Mediterranean countries. Part of codified knowledge defined by the share of spending on education in GDP shows positive significant correlation with schooling only across Arab low income countries and to some extent the primary exports economies, and with GDP across all Arab countries. Moreover, part of codified knowledge defined by the share of spending on ICT in GDP shows positive but insignificant correlation with GDP across all Arab countries. While, the correlation between tacit knowledge defined by the share of tertiary school enrolment ratio and GDP is positive significant across only Arab low income countries. We show that the correlation between tacit knowledge defined by the share of tertiary school enrolment ratio and schooling is positive significant for all Arab, medium income rather than high and low income and Mediterranean rather than Gulf countries (oil economies), but insignificant for the primary exports economies. (cf. Table 5.2). Theses results support the first hypothesis that the components of knowledge show positive correlation and hence can be used to enhance economic growth and promote human capital across the Arab countries. Our findings corroborate the second and third hypotheses that the components of knowledge can be enhanced by skill upgrading and also institutional support in the form of subsidies and incentives to knowledge components across the Arab countries.

Our results show that the correlation between tacit knowledge defined by the FTER and patent is significant for all Arab, medium rather than high income and Mediterranean then Gulf countries and oil economies and diversified economies respectively. While, the correlation between codified knowledge and patent is significant for all Arab, medium income then high income and Gulf rather than Mediterranean countries and oil economies but rather insignificant for the diversified economies (cf. Table 5.3).

We find that the correlation between tacit knowledge defined by the FTER and publication is significant for all Arab, high, low and medium income respectively and Mediterranean and Gulf countries and oil and diversified economies respectively. While, the correlation between codified knowledge and publication is significant only for Arab high income and Gulf and oil economies rather than medium income and Mediterranean countries. Moreover, part of codified knowledge defined by the total spending on R&D shows positive significant correlation with publication across all Arab, high and medium income, Gulf and Mediterranean countries respectively and oil and diversified economies, but the correlation is positive insignificant for the low income countries.

Our findings indicate that the correlation between tacit knowledge defined by the FTER and cooperation is significant for all Arab, high and medium income respectively and Gulf and Mediterranean countries respectively and oil economies. While, the correlation between codified knowledge and cooperation is significant only for Arab high income and Gulf rather than medium income and Mediterranean countries and oil economies rather than the diversified economies. Part of codified knowledge defined by the share of spending on ICT relative to GDP shows positive significant correlation with publication and cooperation across only Arab Gulf countries and oil economies (cf. Tables 5.4 -5.5).

We find positive complementary relationship between tacit knowledge defined by the FTER and part of codified knowledge defined by the share of ICT in GDP across all Arab countries. The positive complementary relationship between tacit knowledge defined by the FTER and codified knowledge defined by both the share of education and R&D in GDP and the share of education, R&D and ICT in GDP is significant only for all Arab, medium income and Gulf and oil economies. But shows insignificant correlation across Arab high income and Mediterranean countries and diversified economies. In addition, we show a positive significant complementary relationship between tacit knowledge defined by total R&D Personnel (FTER) and codified knowledge defined by the total spending on R&D across all Arab, high, medium income, Gulf, Mediterranean and ESCWA countries and oil and diversified economies. Moreover, the correlation between the total R&D Personnel (FTER) and part of codified knowledge defined by the total spending on R&D is significant for all Arab, high, medium income, Mediterranean, Gulf and ESCWA countries respectively diversified and oil and mixed oil economies respectively, but insignificant for the primary exports economies. The correlation between FTER and RD/GDP is insignificant in the oil economies and mixed oil economies. We find significant positive complementary relationship between tacit knowledge defined by the FTER and part of codified knowledge defined by the share of ICT in GDP across all Arab countries, the Gulf (oil economies) and diversified economies. (cf. Table 5.6 and Table 5.7). These findings corroborate our fourth hypothesis that tacit and codified knowledge are complement to each other.

Finally, we find positive significant complementary relationship between publication and cooperation across only all Arab, high income rather than medium income and Gulf rather than Mediterranean countries and the oil economies rather than the diversified economies (cf. Table 5.8).

Next we discuss the importance, determinants and ways of enhancing tacit, codified and the transfer of knowledge at the macro levels in the Gulf countries. First, we illustrate the importance of tacit, codified and transfer of knowledge on promoting the share of expenditure on R&D (technology indicators), share of expenditure on education (upskilling), average schooling years (skills level) and GDP (economic growth). Second, we show the complementary relation between knowledge components, in particular between tacit

knowledge and the transfer of knowledge at the macro level. Therefore, this implies that society with intensive tacit knowledge would have strong potential to enhance the transfer of knowledge and having positive knowledge spillover effect, which in turn induces further effects on learning and tacit knowledge within the entire society. Third, we illustrate the significance of knowledge holders for enhancing the transfer of knowledge at the macro level (cf. Tables 5.10-5.13). We illustrate that at the macro level the transfer of knowledge can be enhanced by increasing tacit knowledge/ tacit skills, codified knowledge, average schooling year, public spending on education and R&D, the number of FTER, number of publication and scientific cooperation. Our results show significant positive complementary relation between the share of public spending on R&D, publication and cooperation and between them and the number of FTER, the share of public spending on education, tacit, codified and the transfer of knowledge (cf. Tables 5.11-5.12). Our result in this section prove the hypotheses that the incidence and transfer of knowledge in the Gulf show positive correlation and hence can be used to enhance economic growth (GDP) technology indicators (R&D) skills level (schooling) and upskilling (education). Tacit and codified sources of knowledge within the Gulf society are positively correlated with each other and with the transfer of knowledge/ knowledge spillover at the macro level. The incidence and transfer of knowledge within the Gulf society show positive correlation and can be enhanced by increasing skills level and can be enhanced by institutional support in the form of subsidies for enhancing education to motivate skills upgrading.

6. 3. Policies and recommendations to narrow knowledge gaps, information problem and improve institutional settings of IPRs and patents

Therefore, in this concluding chapter it is relevant to show the major policy implications and recommendations. From our findings in this research the major policy implication is that for an efficient integration and benefit from the new economy, the Arab countries need to create the most appropriate educational, scientific, economic, political, social and scientific institutions. Mainly to improve the performance of educational and training systems, local and regional knowledge and S&T institutions, attract both financial and human investment to build local technological capabilities, particularly, basic and high technology infrastructure, ICT infrastructure, skill levels and competitiveness and to learn from the experiences of the other nations to create a wider range of technological capabilities to promote the long-run harmonious development in the region and so integration in and benefit from the new economic system.

It may be useful to recall some useful insights indicated by the World Bank Development Report (1999), knowledge is often costly to create, and that is why much of it is created in industrial countries. But developing countries can acquire knowledge overseas as well as create their own at home. The report suggests three lessons of particular importance to the welfare of the people in the developing countries: First, developing countries must institute policies that will enable them to narrow the knowledge gaps that separate them from rich countries. Examples of such policies include making efficient public investments in lifelong education opportunities, maintaining openness to the world, and dismantling barriers to competition in the telecommunication sector. Second, developing- country governments, bilateral donors, multilateral institutions, non-governmental organizations, and the private sectors must work together to strengthen the institutions needed to address information problems. Third, no matter how effective we are in these endeavors, problems with knowledge will persist. We cannot eliminate knowledge gaps and

information failures, but by recognizing that knowledge is at the core of all our development efforts, we will sometimes discover unexpected solutions to seemingly intractable problems. Closing knowledge gaps will not be easy. Developing countries are pursing a moving target, as the high-income industrial countries constantly push the knowledge frontier outward. Indeed, even greater than the knowledge gap is the gap in the capacity to create knowledge. Differences in some important measures of knowledge creation are far greater between rich and poor countries than differences in income, for instances figures on R&D spending and GDP per capita indicates that inequalities in the capacity to create knowledge exceed even those in income. But developing and poorer countries, rather than re-create existing knowledge, have the option of acquiring and adapting much knowledge already available in the richer countries, which might be more cheaper, particularly with the declining ICT costs. The report examines three critical steps that developing countries must take to narrow the knowledge gaps. First, acquiring knowledge involves tapping and adapting knowledge available elsewhere in the world- for example, through an open trading regime, foreign investment, and licensing agreements- as well as creating knowledge locally through R&D and building on indigenous knowledge. Second, absorbing knowledge involves, for example ensuring universal basic education, with special emphasis on extending education to girls and other traditionally disadvantaged groups; creating opportunities of lifelong learning; and supporting tertiary education, especially in science and engineering. Third, communication of knowledge involves taking advantage of new information and communication technology- through increased competition, private sector provision, and appropriate regulation- and ensuring that the poor have access. But even if knowledge gaps could be closed entirely, with everyone in developing countries enjoying access to the same know-how as well – educated people in the industrial countries, developing countries would still be at a disadvantage in another respect: knowledge about attributes. The report shows that know- how is only one part of what determines society's well - being. Information problems lead to market failures and impede efficiency and growth. The reports indicates that international institutions can help the poor to bridge knowledge gaps and resolve information problems, by creating new knowledge, transferring and adapting knowledge to the needs of developing countries, and managing knowledge so that it kept accessible and constantly refreshed. The government of the developing countries can narrow knowledge gaps, address information problems, and design policies that take into account the reality that information and markets are always imperfect. Development institutions have three roles in reducing knowledge gaps: to provide international public goods, to act as intermediaries in the transfer of knowledge, and to manage the rapidly growing body of knowledge about development. The World Bank Development Report (1999) indicates that the two properties of knowledge, the main characteristics of public goods: nonrivalrous and nonexcludable, often makes it possible for people to use knowledge without paying for it. This reduces the gain to innovators from creating knowledge- and in no small measure. The inability to appropriate all the returns to knowledge is the disincentive to its private supply. If anyone can use innovation, the returns are diluted, and innovators have no incentive to invest in the costly research and development (R&D) to generate in the first place. There will thus be too little investment in the creation of knowledge. Precisely because knowledge is underprovided, governments often set up institutions to restore the incentives to create it. These take the

form of patents, copyright, and other forms of intellectual property rights (IPRs), all of which are designed to provide innovators an opportunity to recoup the costs of creating knowledge and to earn a fair return. [23]

Cowan, Soete and Tchervonnaya (2001) indicate that the institutional setting, specially, effective system of intellectual property rights protection motivates the creation and diffusion of new knowledge. So, a government can stimulate innovativeness of local firms and knowledge transfer from foreign knowledge holders by ensuring such protection on its territory. In addition, Verspagen and Schoenmakers (2000) indicate that one of the institutions that have been developed to remedy this incentive problem is the patent system. That solves the incentive paradox by granting a temporary monopoly to part of the knowledge that has been developed by the patent applicant, while leaving other aspects of this knowledge for public use.

Therefore, the Arab countries should pay more attention to all these elements and institutions and incentives for protecting the patents and intellectual property rights (IPRs) to create more incentives for the creation and transfer of knowledge and to learn from the international experience of the other nations.

A part from the role of Arab governments, it is essential and useful for Arab societies to support the culture aimed at fostering and enhancing the incidence and transfer of knowledge.

[23] This section is adapted from the World Bank Development Report (1999).

References

Abramovitz, M and David, P.A. (1996). "Technological Change and the Rise of Intangible Investments: the US Economy's Growth –Path in the Twentieth Century" in D. Foray and B. A. Lundvall (eds.) "Employment and Growth in the Knowledge based Economy". OECD Documents. Paris. OECD.

Abramovitz, M and David, P.A. (1998) "American Macro Economic Growth in the Era of Knowledge Based Progress: The Long –Run Perspective" in S. L. Engerman and R. E. Gallman, (eds.) "An Economic History of the United States: the Twentieth Century". Vol. 3, New York: Cambridge University Press, pp. 1-92. "

Abdelkarim, A. and Ibrahim, S. (2001) "Productivity Problems in the UAE: The Role of Productivity organization". Centre for Labour Market Research and Information. Policy Research Series No. 4 - Dubai – UAE – December (2001).

Acemogul, D. (1998) "Why Do New Technologies Complement Skills? Directed Technical Change and Wage Inequality," *The Quarterly Journal of Economics*. Volume 113. Issue No. 4. November 1998. Pages 1055-1089.

Acts, Z. J., D. B. Audretsch and M.P Feldman. (1992) "Real Effects of Academic Research" American Economic Review, 82:363-67.

Adams, J.D. (2001) "Comparative localization of academic and industrial spillovers," NBER Working Paper Series 8292, NBER Cambridge, 2001.

Aghion, P. and Howitt, P. (1998) "Endogenous Growth Theory," MIT Press, Cambridge MA, London, England (1998)

Ajeeb Research Unit (2001): "Number of Internet Subscribers and Users in the Arab Region". March 2001, in www.ajeeb.com. :http://eit.ajeeb.com/ViewArticle.asp?Article_ID=28132.

Ali, A. A.G. (2001) "Internal Sustainability and Economic Growth in the Arab States," API/WPS 0102- Arab Planning Institute- Kuwait.

Ali, A. A. G. (2004), "Poverty in the Arab Region: A Selective Review" Arab Planning Institute *Working Paper Series 2004 WPS/0402*-Kuwait. P. 11: http://www.arab-api.org/wps0402.pdf.

Ali, A. A.G. and I. Elbadawi (2000) "Poverty in the Arab World: The Role of Inequality and Growth"; paper presented to the 6th Annual Conference of ERF, Cairo.

Arundle, A. and Geuna A. (2001). "Does Proximity Matter for Knowledge Transfer from Public Institute and Universities to Firms?"- SPRU Electronic Working Paper Series No. 73, University of Sussex.

Barro, R. J. and Lee, J. W. (2001), "International Data on Educational Attainment: Updates and Implications", *Oxford Economic Papers,* 53(3), 541 – 63.

Belkacem, L.(2002) "Arab Competitiveness: Indicators of Arab Competitiveness" E-conference on Arab competitiveness – Arab Planning Institute – Kuwait- June (2002).

Bresnahan, T. F. Brynjolfsson, E. and Hitt, L. M. (1999) " Information Technology, Workplace Organization, and the Demand for Skilled Labour: Firm Level Evidence ". NBER Working Paper No. 7136.

Brusoni, S. Prencipe, A. and Pavitt, K. (2001) "Knowledge Specialization, Organizational Coupling, and the Boundaries of the Firms: Why Do Firms Know More Than They Make?" Administrative Science Quarterly, 46: 597-621.

Brusoni et al., (2002) "The Role of Codified Sources of Knowledge in Innovation: Empirical Evidence from Dutch Manufacturing, " SPRU Electronic Working Paper Series No. 80, University of Sussex.

Brynjolfsson, E., and S.Yang (1996). "Information Technology and Productivity: A review of the literature". Advances in Computers 43: 179-214.

Bunge, M. (2000) "Ten Model of Individualism- Non of Which Work- And Their Alternatives". Philosophy of the Social Sciences 30 (3): 384-406.

Caniels, M.C. J. (1999) "Regional Growth Differentials," Maastricht, Universitaire Pers, Maastricht.

Cohen, W. M. and D. A. Levinthal (1989) “Innovation and learning: The Two Faces of R&D,” Economic Journal 99: 569-596.

Colecchia, A. and Papaconstantinou, G. (1996). “ The Evaluation of Skills in OECD Countries and the Role of Technology, ” STI Working Paper 1996/6.

Collins, H. (1985) “Changing Order: Replication and Induction in Scientific Practice,” London.

Cowan, R. and Foray, D. (1997) **“**The changing economics of codification and the diffusion of knowledge,” Industrial and Corporate Change 6 (3): 595-622.

Cowan, R., David, P. A., and Foray, D. (1997) **“**The Explicit Economics of Knowledge Codification and Tacitness,” Industrial and Corporate Change 9 (2): PP. 211-253.

Cowan, R. Soete, L. and Tchervonnaya, O. (2001) “Knowledge Transfer and the Services Sector in the Context of the New Economy,” MERIT-INFONOMIC Research Memorandum 2001-021, Maastricht University, Maastricht. p. 9

CIA World Fact Book (2001): www.globastat.com.

Dasgupta, P., David, P. (1994) “Toward a new economics of science,” Research Policy 23 (5): 487-521.

David, P.A. and Foray, D. (1994), "Dynamics of competitive technology diffusion through local network structures," in Leydesdorff and Van den Besselaar (eds.), Evolutionary Economics and Chaos Theory, Pinter.

David, P. A., Foray, D. (1995) “Accessing and Expanding the Science and Technology Knowledge Base,” STI Review, OECD, Paris.

David, P. A. and Foray, D. (2001) “An Introduction To the Economy of the Knowledge Society.” December 2001. Merit –Infonomics Research Memorandum Series No. 2001- 041.

Drucker, P (1998) “From Capitalism to Knowledge Society,” in D. Neef (ed.) “The Knowledge Economy” Woburn MA: Butterworth (1998). P. 15.

Ducatel, K. (1998) “Learning and Skills in the knowledge Economy,” DRUID Working Paper No. 98-2 (1998).

European Commission (2000) “Innovation Policy in a Knowledge – based Economy”. A MERIT Study commissioned by the European Commission. Luxembourg: Office for Official Publications of the European Communities.

The Economic Research Forum for the Arab Countries, Iran and Turkey (ERF) (2002), “Economic Trends in MENA Region 2002”, Chapter Five: Labor Market and Human Resource Development: The GCC Labor Market: Private vs Public”, The ERF and the American University in Cairo.

Elbadawi, I. (2002) “Reviving Growth in the Arab World,” API/WPS 0206, Arab Planning Institute, Kuwait.

ESCWA Profile (2003), “The Profile of the Information Society in the Kingdom of Bahrain” ESCWA, 2003.

ESCWA Profile (2003), “The Profile of the Information Society in the Kingdom of Saudi Arabia” ESCWA, 2003.

ESCWA Profile (2003), “The Profile of the Information Society in the United Arab Emirates” ESCWA, 2003.

ESCWA Profile (2003), “The Profile of the Information Society in the Arab Republic of Egypt” ESCWA, 2003.

ESCWA Profile (2003), “The Profile of the Information Society in the Hashemite Kingdom of Jordan” ESCWA, 2003.

ESCWA Profile (2003), “The Profile of the Information Society in the State of Kuwait” ESCWA, 2003.

ESCWA Profile (2003), “ Regional Profile of the Information Society in Western Asia” ESCWA, 2003.

ESCWA “ Review of Science and Technology in ESCWA Member Countries” Issue No. 1. 1999 (E/ ESCWA/ TECH/ 1999/Rev. 1). January 1999: pp.3 - 4.

ESCWA –UNESCO, Research and Development System in the Arab States: Development of Science and Technology Indicators 1998(E/ ESCWA/ TECH/ 1998/3)

Foray, D. and Lundvall, B.A. (1996), "From the economics of knowledge to the learning economy", in Foray and Lundvall (eds.) “Employment and growth in the knowledge-based economy, OECD Gibbs (1994), "The crisis in software", Scientific American.

Freeman, C. (1987) “Technology Policy and Economic Performance: Lessons from Japan,” London Printer.

Fergany, N. (1999) "Science and Research for Development in the Arab Region" (February 1999).

Freeman, C. and L. Soete, (1985) "Information Technology and Employment: An Assessment," SPRU Sussex . UK. April 1985.

Freeman, C. and L. Soete (1994) "Work for all or Mass Unemployment ? Computerized Technical Change into the Twenty – first Century," London, Printer, 1994.

Freeman, C. and L. Soete (1997), "The Economic of Industrial Innovation," 3rd ed. London and Washington Printer. PP. 404-405.

Gallouj, F. (2000). "Knowledge- Intensive business services: processing knowledge and producing innovation/ Proceedings of the International Conference," The Economics and Socio Economics of Services: International Perspectives" (LILLE- Roubiax, 22 and 23 June 2000), vol.2: 57-76.

Girgis, M. (2000) In "Economic Research Forum (ERF): Economic Trends in the MENA Region, Cairo (2000) "Chapter Five: Labor Market and Human Resources Development: Overview of the Labor Market in the GCC Region". In ERF (2000)" http://www.erf.org.eg

Griliches, Z (1979) "Issues in Assessing the Contribution of Research and Development to Productivity Growth," The Bell Journal of Economics 10:92-116

Grossman, G. M and E. Helpman, (1991) "Innovation and Growth in the Global Economy," Cambridge MA, MIT Press.

Grossman and Helpman, (1994) "Endogenous Innovation in the Theory of the Growth," Journal of Economic Perspectives 8 (1):23-44.

GOIC (1998) "Gulf Statistical Profile (1998)," GOIC Data Base, Doha (1998).

GOIC (2000) "Gulf Statistical Profile (2000)," GOIC Data Base, Doha (2000).

Haddad, M. (2001) "Export Competitiveness: where does the Middle East and North Africa Region Stand?" Background paper to Economic Trends in the MENA Region, Cairo: Economic Research Forum (ERF). In ERF (2002)

Hagedoorn, J., A.N. Link and N. Vonortas (2001) "Research Partnership," Research Policy, 29:567-86.

Hitt. L. and E. Brynjolfsson(1996) "Productivity, business profitability, and consumer surplus: Three different measures of information technology value". MIS Quarterly 20:121-42.

Hwang, Gyu-heui (2000) " Diffusion of Information and Communication Technologies and Changes in Skills," September 2000, SPRU Electronic Working Paper No. 48.

Jaffe, A.B. (1989) "Technology Opportunities and Spillovers of R&D: Evidence from firms' patents, profits and market value." American Economic Review 76:984-1001.

Jaffe, A.B., M. Trajtenberg and R. Henderson (1993) "Geographical Localization of knowledge spillovers as evidenced by patent citations". The Quarterly Journal of Economics CIIX: 577-598.

Jorgenson, D. W., and K. Stiroh (1995)"Computers and growth". Economics of Innovation and New Technology 3:295-316

Keller, W. (1996) "Absorptive Capacity: On the creation and acquisition of Technology in Development," Journal of Development Economics 49 (1): 199-227.

Kenny, C. (2002) "The Internet and Economic Growth in Least Developed Countries". Wider Discussion Paper series: DP2002/75, August (2002).

Klepper, S. and K. Simons (1997) "Technological Extinctions of Industrial Firms: An Enquiry into their Nature and Causes," Industrial Corporate Change, 6: 379-460.

Klette, J. and Griliches, Z. (1998) "Empirical Patterns of Firm growth and R&D Investment: A quality Ladder model interpretation," NBER Working Paper No. 6753, 1998.

Kline, S. and N. Rosenberg (1986) "An Overview of Innovation," In Landau R. (ed.), "*The positive Sum Strategy.*

Harnessing Technology for Economic Growth," National Academy Press, Washington D.C. (1986).

Lall, S. (1999), "Competing with Labour: Skills and Competitiveness in Developing countries," *Issues in Development Discussion Paper* No. 31. Development Policies Department– ILO - Geneva. p. 17.

Langlois, R. N. (2001) "Knowledge, consumption, and endogenous growth," Journal of Evolutionary Economics 11:77-93.

Levin, R; Cohen, W M and Mowery, D C (1985) "R&D appropriability, opportunity and market structure: new evidence on some Schumpeterian hypotheses," American Economic Review 75: 20-24.

Llerena, P. (2003) "Codification and Distribution of Knowledge: Policy Aspects," Lecture note on the ETIC European Doctoral Training Programme- Maasticht – the Netherlands. October 2003.

Lööf, H and A. Heshmati (2002). "Knowledge Capital and Performance Heterogeneity: A firm- Level Innovation Study," International Journal of Production Economics 76 (2002) 61-85.

Lucas, R. E. (1988) "On the Mechanics of Economic Development," *Journal of Monetary Economics 22,* North Holland.

Lundvall, B-Å (ed.) (1992) "National Systems of Innovation: Towards a theory of Innovation and Interacting Learning," London: Printer Publishers.

Lundvall, B.A. and Johnson, B. (1994), " The learning economy", Journal of Industry Studies, vol.1(2).

Lundvall, B-Å (1996) "The Social Dimension of the Learning Economy". DRUID Working Paper 96-1, University of Aalborg.

Makdisi, S. Fattah, Z and Limam, I. (2003) "Determinants of Growth in the MENA Countries". API/WPS 0301- Arab Planning Institute- Kuwait.

Malo, S. and A. Geuna. (2000) "Science- Technology Linkages in an Emerging Research Platform: The case of Combinatorial Chemistry and Biology". Scientometrics, 47: 303-21

Mansfield, E. (1991) " Academic Research and Industrial Innovation: An Update of Empirical Findings," Research Policy, 26:773-76.

Mansfield, E. and J. – Y. Lee (1996) "The Modern University: Contributor to Industrial Innovation and Recipient of Industrial R&D Support, " Research Policy, 25:1047-58.

Muysken, Joan and Nour, Samia (2006),"Deficiencies in Education and Poor Prospects for Economic Growth in the Gulf Countries: The Case of the UAE," Revised version of paper presented at the ETIC European Doctoral Training Programme, Maastricht, October 2003. (forthcoming: the Journal of Development Studies, 2006, Taylor and Francis Ltd., UK).

Nanoka, K. (1991) "The Knowledge Creating Company" Harvard Business Review, November- December.

Narin, F., K. S. Hamilton, and D. Olivastro (1997) "The Increasing Linkage between US. Technology and Public Science". Research Policy, 26:317-20.

Narin, F. and D. Olivastro (1992) "Status Report: Linkage between Technology and Science". Research Policy, 21:237-49.

Nelson, R. (ed.) (1993) "National Innovation Systems: A comparative Study". New York: Oxford University Press.

Nelson, R. (2000) "Different Perspectives on Technological Evolution" in J. Ziman (ed.) Technological Innovation as an Evolutionary Process, Cambridge UP, Cambridge.

Nelson, R. and Winter, S.G. (1982) "An Evolutionary Theory of Economic Change," Cambridge MA: Harvard University Press.

Nour, Samia (2002a), "ICT Opportunities and Challenges for Development in the Arab World," Paper prepared for the UNU/WIDER Conference on the New Economy in Development, 10-11 May 2002, Helsinki, UNU-WIDER Discussion Paper DP2002/83. Helsinki. (forthcoming as Chapter 8 in A. P. D'Costa (ed) "The New

Economy in Development: ICT Challenges and Opportunities: series of Technology, Globalization, and Development, Vol. 2" Palgrave Macmillan's, 2006)."

Nour, Samia (2002b), "The Impact of ICT on Economic Development in the Arab World: A comparative study of Egypt and the Gulf countries," Paper prepared for the Ninth Annual Conference of the Economic Research Forum (ERF) - 26-28 October 2002, Sharjah – UAE. The Economic Research Forum for the Arab Countries, Iran and Turkey, ERF Working paper series WP Number: 200237, Cairo 2002.

Nour, S. (2003a) "Science and technology (S&T) development indicators in the Arab region: a comparative study of Arab Gulf and Mediterranean countries" - Paper prepared for the Tenth Annual Conference of the Economic Research Forum for the Arab Countries, Iran and Turkey (ERF). Morocco, Marrakesh, December/ 2003. http://www.erf.org.eg.

Nour, S. (2003b) "The Incidence and Transfer of Knowledge within the Arab Gulf Societies," - Paper prepared for the Tenth Annual Conference of the Economic Research Forum for the Arab Countries, Iran and Turkey (ERF). Morocco, Marrakesh, December/ 2003. http://www.erf.org.eg.

Nour, Samia, (2005a), "Technological Change and Skill Development in the Arab Gulf Countries," Doctoral Dissertation, Maastricht University, November 2005.

Nour, Samia (2005b), "Science and technology (S&T) development indicators in the Arab region: a comparative study of Arab Gulf and Mediterranean countries," UNU -INTECH Discussion Paper 2005-3, Maastricht, August 2005. Published in The Journal of Science, Technology and Society (SAGE Publications), Vol.10; No. 2; July-December 2005; pp. 249-274.

OECD (1997) "The European Second Report on S&T Indicators" (1997). OECD. Paris.

OECD (1999) "The Knowledge Based Economy: A set of Figures and Facts," OECD. Paris.

OECD (1999). "L'économie fondée sur le savoir: des faits et des chiffres". Paris. OECD.

Pavitt, K. (1991) "What Makes Basic Research Economically Useful". Research Policy, 20: 109-199

Pavitt, K. (2002): "knowledge about knowledge since Nelson and Winter: amixed record"

Pohjola, M. (2002) "New Economy in Growth and Development" Wider Discussion Paper series: DP2002/67, July (2002).

Pohjola, M. (2000) "Information Technology and Economic Growth: A Cross- Country Analysis". WIDER/ UNU Working Paper series: WP173, January 2000.

Pohjola, M. (ed.) (2001) "Information Technology, Productivity and Economic Growth: International Evidence and Implications for Economic Growth". Oxford University Press April 2001.

Qasem, S. (1998) "Research and Development in the Arab States: Development of Science and Technology Indicators ," (ESCWA and ROSTAS, 1998), and UNDP, Human Development Report 1999.

Rasiah, R. (2002) "TRIPs and Capability Building in Developing Economies". UNU/INTECH DP 2002- 1 March (2002).

Romer, P M (1993) "Implementing a national technology strategy with self-organizing industry boards" Brooking papers Microeconomics 2, 345-399.

Romer, P. M. (1994) "The origin of Endogenous Growth," Journal of Economic Perspectives 8:3-22

Saxenian, A. (1994) "Regional Advantage. Culture and Competition in Silicon Valley and Route 128," Cambridge MA, Harvard University and London.

Sjoholm, F. (1996). "International transfer of knowledge: the role of international trade and geographical proximity." Weltwirtschaftliches Archiv 132:97-115.

Senker, J. (1995), "Tacit knowledge and models of innovation", Industrial and Corporate Change, 4(2)

Salter, A. J. and B. R. Martin, (2001). "The Economic Benefits of Publicly Funded Basic Research," A Critical Review Research Policy 30:509-32

Smith. K. (2002) "What is Knowledge Economy'? Knowledge Intensity and Distributed Knowledge Bases," UNU/ INTECH Discussion Paper Series No. 2002-6. June (2002).

The IMF "World Economic Outlook: WEO" in the Middle East and North Africa Regional Outlook September (2002)

The UAE data from Ministry of Planning (1987 –1997) "Population Census data of 1985 and 1995"

The World Bank (1999) "World Development Report: Knowledge for Development 1998/1999," New York: Oxford University Press.

UNCTAD (2002) "International Investment Report (2002),"

UNDP (2002), "Human Development Report (2002): Deepening Democracy in a fragmental World," UNDP- New York- Oxford- Oxford University Press (2002).

UNDP-AHDR (2002) "Arab Human Development Report (2002),"

UNDP (2004), "Human Development Report (2004): Cultural Liberty in Today's Diverse World"

UNDP-AHDR (2003), "Arab Human Development Report (2003): Building a Knowledge Society"

UNESCO Data/Statistics (1996), "UNESCO Statistical Yearbook": UNESCO Statistics: www.unesco.org

UNESCO Data/ Statistics (1999), "*UIS–UNESCO Statistical Yearbook (1999)": www.unesco.org*

UNESCO: UIS (2002): www.unesco.org.

UIS- UNESCO (2000a) "World Education Report (2000): UNESCO's World Education Indicators,": http://www.unesco.org/education/information/wer/htmlENG/tablesmenu.htm

UNESCO (2000b) "World Conference on Science: Science for the Twenty-first Century," A new Commitment Proceedings of World Conference on Science, Budapest, Hungary 26 June – 1 July 1999. Published by Banson, London.

UNESCO Institute of Statistics (UIS) (2003): www.uis.unesco.org

UNESCO Institute of Statistics (UIS) (2004) : Country Profile: www.uis.unesco.org

US Patent and Trade mark office web site: www.uspto.gov.

Wadi, M. A. (2001) "Education and Labour Market: The need for reform: The case of Kuwait," API/WPS 0104- Arab Planning Institute- Kuwait.

Winter, S.G. (1987). "Knowledge and Competence as strategic assets," in Teece D J (ed.): "The Competitive Challenge: Strategies for Industrial Innovation and Renewal". Cambridge MA. Ballinger Publishing Company: 159-184.

WITSA: The World Information Technology and Services Alliance (2002), Digital Planet 2002: "The Global Information Economy," Arlington – USA. February (2002)

Zahlan, A., B. (1999) "Arabs and the challenge of Science and Technology, Progress without Change," Center for Arab Unity Studies (CIUS), Beirut, March 1999.

Zahlan, A. B. (1999), "Science Policy for the Twenty-First Century: Mobilization and Development", in "ESCWA Proceedings of the Expert Group Meeting on Science and Technology Policies and Strategies for the Twenty-First Century," ESCWA, Beirut, 10-12 March 1999: pp. 14-16.

Zon Van, A. (2001) "ICT - Investment, Knowledge Accumulation and Endogenous Growth," Merit –Infonomics Research Memorandum Series No. 2001- 038.

Verspagen, B. (1999) "Large Firms and Knowledge Flows in the Dutch R&D System: A case Study of Philips Electronics," Technology Analysis and Strategic Management, 11: 211- 33.

Verspagen, B. and Schoenmakers, W. (2000) "The Spatial Dimension of Knowledge Spillovers in Europe: Evidence from Firm Patenting Data," Paper Prepared for AEA Conference on Intellectual Property Econometrics, 19-20 April 2000, Alicante, Spain.

Von Hippel, E. (1988) "The Sources of Innovation," Oxford University Press.

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