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The Impact of Information and Communication Technology (ICT) on Economic Growth – The Case of Selected Arab Countries

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Abstract

Information and communication technology (ICT), population growth, gross capital formation, Openness, labour and inflation are frequently well-thought-out as important drivers of economic growth for all countries, so as for Arab countries in our case. This study aims to examine the effect of these factors on 18 selected Arab countries' economic growth, covering the period from 1995 to 2013, with the main interest of the impact of ICT. The results show positive and significant impact of ICT index (infodensity that represents the capital and labour stock of ICT) for each individual country (except for Djibouti with negative ICT index elasticity and UAE with insignificant impact) ranged from 0.10 for Lebanon to 0.469 point for Qatar. The panel regression results show that ICT positively and significantly affect the whole sample of 18 Arab countries' economic growth with 0.108 point, as well as GCF ratio with 0.129 impact, in addition to openness which encounters positive and significant impact with 0.054 point, and inflation with negative significant impact. These results are accommodated with many related studies. Population growth is insignificant to economic growth. The 18 Arab countries are divided into three sub groups according to their infodensity levels. The research results show that there is a relatively large gap between first and second groups of high and intermediate infodensity values in one side and the third group (with low infodensity and GDP per capita values) on the other side, which indicates that these countries of third group have a back seat to the other two groups regarding the spillover of ICT.

In order to verify further the results of positive and significant impact of ICT on economic growth, a second study model that depends on Cobb-Douglas production function is applied with ICT and non-ICT capital services and labour services. This second model is applied on five Arab countries that covers the period from 1993 to 2014 using ARDL method. The regressed results show a long run equilibrium cointegrated relationship between ICT and non-ICT capital services, in addition to labour services and GDP growth. The results tell a positive and significant elasticity of ICT capital services at short and long run, and this value is more than the ICT capital services compensation share, which indicates ICT spillover in

these Arab countries. Labour services impact on GDP growth is positive and significant on long run, but for non-ICT capital services, there is a negative and significant impact. So finally it is worth for the Arab countries to invest more and efficiently in ICT assets, in addition these countries have to efficiently use the available ICT resources.

Keywords: Information and Communication Technology (ICT), Population Growth, Gross Capital Formation, Openness, Inflation, Economic Growth, ARDL, ICT capital services, non-ICT capital services, Arab Countries.

Abstrakt

Informační a komunikační technologie (ICT), populační růst, tvorba hrubého kapitálu, otevřenost a inflace jsou nejčastěji dobře promyšlené, důležité faktory ekonomického růstu ve všech zemích, zejména v rozvojových a stejně tak v Arabských zemích, v našem případě. Tento článek zkoumá dopad těchto faktorů na ekonomický růst pro osmnáct vybraných arabských států v období 1995-2013, s hlavním zájmem o vlivu informačních a komunikačních technologií. Výsledky ukazují pozitivní a významný vliv ICT indexu (Info hustota, která reprezentuje kapitálu a pracovních sil zásoby ICT) pro jednotlivé země (s výjimkou Djibouti, který se setkal s negativním ICT indexem pružnosti a UAE s nevýznamným dopadem) se pohybovala v rozmezí od 0,10 (pro Libanon) do 0,469 (pro Qatar).

Výsledky panel regrese ukazují, že ICT pozitivně a významně ovlivňují ekonomický růst vliv na všech 18 arabských zemí s 0,108 bodu, stejně jako poměr GCF s 0,129 dopadu, kde se setká s otevřeností a pozitivní významný dopad na 0,054 bodu a inflace s negativním významným dopadem. Tyto výsledky jsou umístěny s mnoha souvisejících studií. Růst populace je nevýznamný k ekonomickému růstu. Všech 18 arabské země jsou rozděleny do tří podskupin podle jejich úrovně infodensity. Výsledky výzkumu ukazují, že existuje poměrně velký rozdíl mezi první a druhou skupinu hodnot vysoké a střední hustoty infodensity na jedné straně a třetí skupina (s nízkými hodnotami infodensity a GDP na jednoho obyvatele) na straně druhé.

Za účelem dalšího ověření výsledků pozitivní a významný vliv ICT na ekonomický růst, druhá studie model, který závisí na funkci Cobb-Douglasově produkční funkce se aplikuje s ICT a jiné kapitálových služby a pracovní služby. tento druhý model je aplikován na pěti arabských zemí v období od roku 1993 do roku 2014 použití metodou ARDL. Výsledky regrese ukazují dlouhý běh rovnováha kointegrované vztah mezi ICT a jiné investiční služby, navíc služeb práce a růst GDP. Výsledky ukazuji pozitivní a významný pružnost ICT kapitálových služeb na krátký a dlouhý doba, a tato hodnota je větší než kompenzace ICT investiční služby akcii, což znamená, přelévání a komunikačních technologií v těchto

arabských zemích. Služby vliv práce na Růst GDP je pozitivní a významný v dlouhodobém horizontu, ale pro jiné kapitálové služby , tam je negativní a významný vliv. Tak konečně je třeba pro arabské země, aby investovaly více a efektivněji do majetku informačních a komunikačních technologií, navíc tyto země mají k efektivnímu pomocí dostupných zdrojů ICT.

Klíčová slova: Informační a komunikační technologie (ICT), populační růst, Tvorba hrubého kapitálu, Otevřenost, inflace, ekonomický růst, ARDL, kapitálové ICT služby, kapitálové služby non-ICT, arabské země.

Declaration

I declare that the doctoral dissertation titled "The Impact of Information and Communication Technology (ICT) on Economic Growth – The Case of Selected Arab Countries" has been completed by me, without any other outside help and I have used only the sources mentioned at the end of the thesis. It is submitted in partial fulfilment of the requirements for the PhD degree at Czech University of Life Sciences Prague, Faculty of Economics and Management. It has not been submitted before for any degree or examination in any other University.

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Abbreviations

AR	Autoregressive
ARDL	Autoregressive-distributed lag
BoP	Balance of Payment
CIS	Commonwealth of Independent States
DOLS	Dynamic OLS
DSL	Digital Subscriber Line
EBA	Extreme Bounds and Analysis
EGP	Egyptian Pound
FE	Fixed Effects
FDI	Foreign Direct Investment
GB	Giga Byte
GCC	Gulf Cooperation Council
GCF	Gross capital formation
GDP	Gross Domestic Production
GNI	Gross National Income
ICT	Information and Communication Technology
ID	Infodensity
IDI	ICT Development Index
ITU	International Telecommunication Union
KSA	Kingdom of Saudi Arabia
MENA	Middle East and North Africa
NRI	Network Readiness Index
OECD	Organization for Economic Cooperation and Development
OLS	Ordinary Least Square
ORBICOM	International Network of UNESCO Chairs in Communications
ORM	Object Role Modelling
PALTEL	Palestine Telecommunications Company

PCBS	Palestinian Central Bureau of Statistics
PMA	Palestinian Monetary Authority
PMG	Pooled Mean Group
PNA	Palestinian National Authority
PPP	Purchasing Power Parity
R&D	Research and Development
RE	Random Effects
UAE	United Arab Emirates
UN	United Nations
UNCTAD	United Nations Conference on Trade and Development
VECM	Vector error correction model
WB	World Bank
WSIS	World Summit on the Information Society

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CHAPTER 1: INTRODUCTION

1.1 Introduction

The technology in the current era is considered to be the most important drivers of growth and development. Despite the differing objectives of various world countries but it seems that these countries agreed on that science and technology are the most effective tool for growth and development. Where most of the industrially developed countries harness the bulk of interest in the technological sphere on various fields such as energy, transportation and others, while developing countries focus their greatest attention in the field of science and technology to determine the particular needed quantity and quality of science and technology that may contribute more effectively than others to meet their development needs. Information and communication technologies (ICTs) are considered as the core components for technology deployment nowadays and as an enabling tools and techniques for exploiting the advances in technology and science.

The ever increasing value of ICTs in economic and social development arisen dramatically with high impressing position since the starting of rapid growth of these technologies and their market in the mid-nineties. The world as developed, emerging and developing communities started enormously to harness ICT for sustainable development and advance creative and innovative knowledge societies [Dedrick et al., 2003; Mansell and Wehn, 1998]. The important role of ICT is stemmed from enabling humans, governments and organizations to transform information into knowledge as a robust driver in evolving lasting change in the economy and society [Conole and Dyke, 2004; Gómez-Barroso and Pérez-Martínez, 2005; Kim, 2013; Lyon, 2013]. Given the importance of ICT development and innovation as a key factor in increasing productivity, growth rates, economic development and progress in all

areas, the developed countries have given great importance to adopt ICT drivers, tools and techniques to achieve continuous technology development, so as followed by developing countries.

The role of ICT in economic growth has an important place in economic research; Needed role of ICT is considered to be in fostering sustainable long-term growth through carefully designed ICT systems and deployment of ICT development programs [Avgerou, 2003; Zwass, 1996], such as investing in contemporary ICT infrastructure which advances sustainable economic growth and high standards of living, with an intelligent administration of natural resources [Caragliu et al., 2011]. Many studies investigated the impact of ICT on productivity such as Cardona et al. (2013), Jorgenson et al. (2007), Kim (2004), and Van Reenen et al. (2010). Other studies measured the impact of ICT on economic growth as this study do [BEN YOUSSEF and M'HENNI, 2003; Colecchia and Schreyer, 2002; Koutroumpis, 2009; Moshiri and Jahangard, 2004; Qiang et al, 2009; Sciadas, 2005]. A study by Sassi and Goaied (2013) investigated the impact of ICT on economic growth for 17 countries of the MENA region and found that there is positive relationship between ICT and economic growth using panel regression with several ICT measures such as telephone, Internet and mobile, where in this study thesis an ICT index that represents the ICT capital and labour stock is used to measure the impact of ICT on economic growth. Also ICT capital services are used for this purpose within Cobb-Douglas model (Cobb and Douglas, 1928). Also other studies examined the impact of ICT on productivity at the firm level such as Melville et al. (2004) and Becchetti et al. (2003).

Shahiduzzaman and Alam (2014) found that there is a long run positive impact of ICT and non-ICT capital on economic output of Australia after applying unit root, cointegration and Wald test as part of this study apply but with panel data for Arab countries. While the focus of these studies was mostly to identify the level of ICT effects on growth, more recent literature, however, places increasing weight to the role of ICT on technology and knowledge transfer and its potential role in stimulating economic growth [Roberts, 2000; Carayannis et al., 2006]. Many studies examines the impact of ICT on economic growth using a panel regression with several countries and found positive impact of ICT on economic growth such as Dewan and Kraemer (2000), Nour (2002), Seo, Lee, and Oh (2009) and Vu (2011).

Pohjola (2001) conducted a study on 39 countries covering the period from 1980 to 1995, where he found a positive impact of ICT on growth for a reduced model of 23 OECD economies. On the other side, several experimental works exhibited that ICT could cause negative effect impact on economic growth by affecting labour market and employment in developing economies such as Freeman and Soete (1997), and Aghion and Howitt (1998) as these studies argued that the fast accumulation of ICT eradicate unskilled labours and eliminate poor people resulting in poverty increase and income disparities.

Arab countries have realized that ICT is the most important knowledgeable element and the main pillar in the economic and social development, where these countries sought and still seeking to catch up with ICT succession countries using different available ways especially by increasing well planned investment in ICT capital and labour to be able to bridge the digital divide between them and the developed countries. From the development experiments practiced by the Arab Countries, these countries realized that there is a need to adopt ICT advances and simulate the experience of developed countries in this regard, as the shortest proposed ways and the most time preserving one, in addition to the need to work on absorbing, indigenization and developing ICT applications such as e-commerce, e-government, e-health and others.

The challenge facing Arab countries is their inability to effectively utilize the cutting-edge of ICT tools and applications, in addition to that what they get from ICT's does not fit economic and social reality in these countries because using this technology requires high technical skills that are not owned by the developing countries in many cases. Therefore, the massive gap of digital divide between developed and developing countries has widened. Despite all these constraints, many Arab countries have highly educated human resources with high percent of university education so as in ICT related fields. For Arab institutions to be competent in the field of ICT, they need advanced technologies and innovations to be adopted. Nowadays, Arabs are required to rise up and catch up with civilization. The horizontal ICT development and implementation represents the first step, if the best adaptation of ICT advances is used within the circumstances and capabilities of Arab nations. Measuring the effect of ICT for the country and set of related countries as a whole is critical and associated with complex factors. As evaluating the effect of ICT at country level is

challenging, the effect at the lower parts of the economy such as firms and individuals is also challenging. Intangible effects of ICT such as customer satisfaction and quality improvements for products and services encounters difficulties in measurement [Brynjolfsson and Hitt, 1998]. Facing the challenges and difficulties of measuring the intangible effect of ICT at the firm or individual level sums up at the country-level. Many international organizations proposed indices for measuring the productive or/and the consumption parts of ICT. International Telecommunication Union (ITU) and United Nations (UN) World Summit on Information Society developed a measurement index for ICT effects called "ICT Development Index" [WSIS, 2003]. ORBICOM proposed a main indicator for ICT which is Infostate, where ORBICOM followed a comprehensive approach to measure the spread and absorption of ICTs in all the world. ORBICOM led a conceptual framework that includes specific considerations of connection, e-readiness, as well as ICT skills, and how to use ICT by individuals and corporations. This index consists of two indices (infodensity and info-use) [Sciadas, 2005].

Although there is many research studies concerning the impact of ICT on economic growth. There is very few studies in this field covering cross section of Arab countries and using recent econometric approaches in analysis. This thesis uses two measures with two models in order to investigate the impact of ICT on economic growth. First this study examines the impact of ICT on panel set of 18 Arab countries that represent the majority of Arab world (listed in table 3.2) within the MENA region according to the availability of information, in order to investigate if the impact of ICTs is positive and significant to economic growth of these Arab countries and to what degree. We will represent economic growth by GDP per capita and ICT by infodensity index developed by ORBICOM. Also we will examine the impact of other variables on economic growth in addition to ICT such as population growth, openness, gross capital formation and inflation. Second as there is an everlasting increase of the emergence role of ICT capital services on economy, this study uses the Cobb-Douglas production function to investigate the impact of ICT and non-ICT capital services and labour services on GDP growth. We apply a simple and panel regression in our investigation including least squares, FE, RE, ARDL, VAR and DOLS regression methods according to data requirements. In this thesis current advances of econometric methods on cointegration

and causality investigation are used. Where cointegration examines the existence of long-run equilibrium relationship between the model variables. The lack of data related to ICT for Arab countries is a challenge facing this thesis.

1.2 Problem Statement

The impact of ICT on economic growth addresses several multi-faceted and issues. The effort to understand and straighten out this impact ultimately called for a detailed research causing in this dissertation which is a critical investigation of the manner by which ICTs can affect positively or negatively the economic growth for Arab countries and to what degree. The study reflects the current status of ICTs in Arab countries, and the impact of ICT on economic growth and hope to reveal to conclusion and recommendations as a starting point to advance policies and practices that are purposely intended at using ICTs for increasing economic growth. It covers the period from 1995 to 2013 when the real implantation and development of the ICT's took place.

There is no country in the world that completely depend on its own developed and innovated technology, where there is a need to utilize the foreign technology, but Arab World dependency is so high in all fields, especially in ICT sector on transferred ICT, in addition Arab countries do not give an importance to the research and development, also they do not pay a good attention to the absorption and indigenization of ICT in an efficient way and not trying to develop it locally. The used ICT in many cases does not fit Arab countries requirements, where they do not deeply study to what extent ICTs fit with their economic and social circumstances.

1.3 Research Importance

The importance of this research is stemmed from the important role of ICT in various development, economic and social sectors, as the promotion of investment in ICT infrastructure, tools and personnel will have a significant impact on the economic growth of the developing countries and especially Arab countries in our case. Here comes our study to thoroughly investigate the impact and the degree of this impact of ICT on Arab countries' economic growth, so as to understand where we are in Arab countries from the ICT

deployment to be able to take corrective actions in future about the needed polices for ICT investment and spillover. The ICT aspects have to be planned and applied in appropriate way for advancing economic growth. The process of applying and settlement of ICT in all country sectors has become a necessity in the Arab world. The importance of this study also comes from the significant role ICT plays in stimulating economic growth, developing a knowledge based economy and achieving better living standards. Also the importance of this study comes from the fact that there are few panel related studies about the impact of ICT on economic growth concerning Arab countries.

1.4 Research Objectives and Hypotheses

The main objective of this study is to investigate the impact of ICT on the economic growth of Arab countries and to analyse the degree of contribution that ICT has on economic growth. Achieving this goal presumes the quantifying measurements of the impact of various ICT components on economic growth. In addition we will investigate the impact of significant standardized macroeconomic control factors on economic growth and in comparable with the effect of ICT capital and labour.

As the part of the objective and discussions on this issue, we need to clear the related uncertainties and strength of confident relationships. To demonstrate these the following hypotheses are proposed:

- **The first hypothesis:** *The ICT capital and labour skills for each selected Arab country positively affect the economic growth of each Arab country. So influencing the drivers of ICT such as incentives, government and private polices results in forcing effective ICT spillover and thus economic growth.*
- **The second hypothesis:** *The impact of ICT on economic growth varies from one Arab country to another.*
- **The third hypothesis:** *The ICT capital and labour skills for the whole sample study of Arab countries positively affect their economic growth.*
- **The fourth hypothesis:** *Population growth for the whole sample study of Arab countries negatively affects their economic growth.*

- **The fifth hypothesis:** *Openness for the whole sample study of Arab countries positively affects their economic growth.*
- **The sixth hypothesis:** *Gross capital formation (GCF) for the whole sample study of Arab countries positively affects their economic growth.*
- **The seventh hypothesis:** *Inflation for the whole sample study of Arab countries negatively affects their economic growth.*
- **The eighth hypothesis:** *The impact of ICT on economic growth differ between various groups of Arab countries classified according to ICT infodensity.*
- **The ninth hypothesis:** *The ICT capital services for selected group study of Arab countries positively affect the economic growth of this group.*
- **The tenth hypothesis:** *The non-ICT capital services for selected group study of Arab countries positively affect the economic growth of this group.*
- **The eleventh hypothesis:** *The labour services for selected group study of Arab countries positively affect the economic growth of this group.*

The official goals of implementing ICT solutions to different Arabic sectors usually include relatively increasing country productivity, technology transfer, increasing exports, low unemployment and steady economic growth.

1.5 Research Methodology

Exploration of research field is performed using a combination of methods of logic, induction and deduction, analogy, application of basic impact of economic growth principles, actual results substantiate the conclusions of scientific research, logical construction of the connections and links, as well as the methods of narrative economic growth and impact of ICT, demonstrations on practical examples, description, comparison and relationship data analysis, graphical analysis, correlation and regression. Analysing ICT and its effects on Arab world economic growth presume using mainly quantitative methods.

Research methods will rely on the review of the relevant literature, documentary and statistical data. As much as possible, official primary data (for example, on ICT) will be gathered, collated and utilized in our analyses in contrast with data that is reported in

secondary sources. To make progress in this line of analysis, and where time series data is adequate, we will carry out simple and panel analysis, where panel analysis integrates time series and cross-section analysis.

Here we will use macro-analysis with cross-sectional or longitudinal approach. In a cross-sectional analysis method highly aggregate data for several countries such as telephone and internet usage and/or gross national product is related at a certain time. The typical approaches which are used are correlation and regression, in order to find the relation between dependent variable such as GDP per capita and independent variables such as ICT capital and labour, population growth, openness, capital formation, labour and inflation.

There is no one approach to perform impact analysis of ICT as it is a complex field. We are trying to evaluate the impact of ICT within its economic framework, to specify its uses and benefits. In this study we will use quantitative approaches to sightsee the relations between ICT and economic growth in Arab countries. The empirical analysis is used as a method to permit examination of the correlation between ICT and economic growth.

Most of researches conducted empirical studies using economic growth theory by means of statistical analysis that examines the related variables. Many researchers used this methodology of empirical studies, where they used extreme-bounds and analysis (EBA) [Levine and Renlt, 1992; Levine and Zervor, 1993]. EBA was deliberated in Leamer (1983, 1985), and Leamer and Leonard (1983), by investigating the economic variables for cross-countries analysis using regression methodology. Therefore, these empirical studies used the extreme-bounds and analysis general equation as follows:

$$Y = \alpha_i I + \alpha_m M + \alpha_z Z + \mu \qquad (1.1)$$

Where Y is per capita GDP growth or the part of investment in GDP, I represents the group of variables that are incorporated in the regression, M is the concerned variable where the standard hypothesis is not rejected, and Z is a group of variables selected from those of known past studies as significant descriptive variables of growth. As a starting point we select a variable of concern for the previous related empirical studies, M, then we do a "base" regression that contains only the variable of interest and the I-variables. After that we calculate the regression outcomes for all probable linear groupings to four Z-variables and recognise the highest and lowest values for the coefficient of concerned variable (α_m) where

it is not rejected at the level of 0.05 significance. The extreme upper bound is specified by the set of Z-variables as this set yields the maximum value of ($\alpha_{m)}$ in addition to two standard deviations, also from inferencing the extreme bound of (α_m) we can find the degree of confidence in the partial correlation between the Y and M, then if α_m stays significant with the same sign then the result is "robust" with reasonable quantity of confidence. In the other hand, if the coefficient is not significant or changed its sign then the result of the correlation between Y and M with less confidence and is regarded as "fragile". This EBA may present multicollinearity that can expands the factors standard errors, and accumulates the range of the constant of interest. Detailed methodology will be discussed in chapter four.

The dissertation proceeds as follows. The first is literature overview of the available theoretical insights on the ICT, economic growth models, economic impact of ICT and measurement approaches of ICT usage and development. It can be argued that this literature has not yielded many clear, testable implications. Despite the lack of clear testable implications, some empirical research has tried to shed some light on the relation between ICT and economic growth, which will be selectively reviewed in section. Presenting some evidence on the impact of ICT on economic growth, and also pay attention to the problems that they face.

After literature overview follows descriptive part of the dissertation thesis, where there will be descriptive Study for ICT and Economic Growth in Arab Countries. This third chapter about the situation of ICT infrastructure, tools and applications in Arab countries. Chapter four talking about the detailed methodology used in this study in addition to the sources of data that will be collected to be analysed and regressed. Chapter five encounters the main part of the thesis as it investigates the empirical findings with thoroughly analysis. This chapter illustrates the regression results about the impact of ICT on economic growth for Arab countries individually and as a one unit. It encounters the impact of significant standardized factors on economic growth. Also it illustrates the impact of ICT on economic growth according to infodensity classification for different groups of Arab countries. Another model relying on Cobb-Douglas production function is used to evaluate the impact of ICT capital services on economic growth for selected Arab countries. At the final we conclude our dissertation work and propose subject related recommendations.

CHAPTER 2: REVIEW OF LITERATURE

2.1 Introduction

This chapter starts with a review of some knowledge and concepts concerning the components that will be dealt with in this study. First, the readers will have a chance to gain needed knowledge with ICTs in order to understand the conceptual terms of ICT and their role and importance in daily life. Then we clarify the concepts and terms of economic growth. In this way we get a combined picture about ICT and economic growth in order to be able to relate them together. Then we illustrate an examination of the impact of ICT on economic growth relying on related studies.

2.2 Theoretical Background

Technological advance, latent in new knowledge and happening accidentally or automatically, appears to be the only likely counterbalance to the natural learning [Knight, 1944].

2.2.1 Information and Communication Technology (ICT)

2.2.1.1 Introduction

The vast evolution in information and communication technology and its applications in different areas is the most important distinguishing of developments through the last decades of the last century and the beginning of the new century. Information through the advances of electronic and digital developments has made a revolution in the global economy, particularly in the developed countries. The information revolution has changed (during the last four decades of the last century) the structure of wealth sources than the industrial

revolution itself. The source of wealth is no later physical but it has become an information or knowledge which is applied to work to serve a production with an economic value. The ICT formed a general economic trends including: mixing techniques of digital communication, strategic alliances in the field of information, the creation of a unified universal network of communications, and the increasing prevalence of personal, mobile and cloud computing devices linked to the network remotely specially through the web network applications.

The rapid change in the ICT in recent years has led to a revolutionary and radical changes in the processing and distribution of data, with a substantial impact on production, services and cultural values, economic development and community as a whole, not only this but ICT has led to the emergence of the knowledge economy, where Nations became measured by what produces of knowledge and its value added in production, business and economics. So this section arises to address the importance and quality of information, also address the most fundamental concepts of ICT and the reasons for giving attention and then investment in ICT. Also it illustrates the most important ICT components and its mechanism applied in economic institutions because it has become competitive strategic weapon at the hands of these institutions.

2.2.1.2 The Concept and Importance of Information

The age nowadays without any doubt is the information age, or as it is called the information revolution and these names came due to the role Information played and still plays to change the lives of organizations and communities, so in this section we will investigate the different terms concerning information and stand on its importance, types and sources and their role in achieving competitive advantage for business organizations.

When we talk about information, we illustrate the information cycle that starts from facts to data then information and after that knowledge. Facts are bunch of things proved by observation coincidence to the extent that human ability permit. Data group of raw Elements that are not treated or processed as an event in its raw shape where its origin is a result of a note or a measure where it can be qualitative such as red colour or quantitative such as the temperature. The data always characterized by objectivity.

Data is unstructured pieces of information that have been estimated from primary sources such as measurement devices, people or others and secondary sources such as reports, records, brochures or others. Data can be obtained from inside or outside the organization. This means that the data may reflect the numbers, words, symbols or facts, raw statistics that are not related to each other, and they are not reader used, so they have no real meaning and do not affect their action or behaviour of whom using them. Even though data are important for organizations because they are the basis of information generation.

Information are data that have been processed in a meaningful way to be a basis for decision-making and they are the result of data collected on a particular topic. If data are reorganized and arranged and processed correctly then they will work to change or modify the cognitive and knowledge status of the human being and thus will affect the decision whether to individuals or to practical organizations. The term information is linked to the term of data from one side, and to the knowledge on the other side. Knowledge is the final important use and investment of information by decision-makers and other users who turn information into knowledge toll.

Knowledge is a set of experiences, information, values and data correlated and combined with each other's in order to provide suitable environment that helps on evaluation, judgment, learning, self-evident and take advantage of the experience. Knowledge also can be considered as the possibilities and capabilities that relished by someone in the analysis, the ability to integrate information, deductive ability, the development of plans and find solutions to the proposed problems. Knowledge also stems from analytical capabilities, strategic abilities, independence, supervision, dialogue solutions to do certain things spontaneously and spontaneity.

2.2.1.3 ICT Concepts

ICT has become the era in which we live and behind every successor superiority achieved by individuals and organizations. The definition of technology means the industrial operation and the origin of the word technology refers to the Greek, which consists of two parts, first TECHNO it means the industrial operation and the second LOGOS which means the science and methodology, so knowledge means industrial operation. WEBSTER Lexicon defines

technology as the technical language, applied science and technical way to achieve practical purpose. In addition it is a group of methodologies and tools used to provide necessary issues for the people's lively hood and welfare. The concept of technology is mixed to the concept of science for its interaction in applied fields, so the technology is a knowledge of the way or methodology but the science tends to figure out the reasons where science comes with theories and general laws and technology transforms them to methods and applications in various activities. Science is considered the source of basic knowledge and essential foundation for Technology.

Numerous definitions dealt with the concept of information and communication technology, and these definitions can be illustrated in four groups as follows:

I. Concepts that are based on the devices covered by the ICT: The international economic report issued by the International Monetary Fund defines ICT that it includes computers, software programs and remote communication equipment's. Others define ICT as A combination of interrelated industries of physical components of the computer, the ready-made programs and services such as network services and maintenance of devices. ICT also can be considered as applied computer systems that include all of the hardware components of computers, computer programs and computer networks that exist in the business environment.

II. Concepts that are based on the activities of ICT without reference to the used devices: ICT can be considered as the processing, storage, transmission, display, management, organization and retrieval of information.

III. Concepts that are based on ICT devices and activities: ICT is defined as computer components and programs that are used in the collection, transmission, processing and distribution of data in the organization [World Bank, 2003][1]. ICT can be considered as the technology that based on electronics that could be used in the collection, storage, manipulation and situate this information in integrated packages to reach knowledge. Also ICT is applying modern technology systems in information processing, sending,

1 http://econ.worldbank.org/WBSITE/EXTERNAL/DATASTATISTICS/

receiving, storage and retrieval quickly, accurately and efficiently. These systems include computer hardware, software, databases and communications.

IV. Concepts that are based on the hardware, activities and human element at the same time: ICT includes all the information systems within the organization based on ICT components as well as all humans such as users, beneficiaries and developers, where here we start talking about information systems.

The use of ICT made it possible to improve many aspects of the nations and people's lives, where ICT opened new horizons of contemporary human and in various fields of business, from e-commerce to distance education to treatment and remote working to improve the competitive position of organizations, and increasing economic growth, where our study came from this point to investigate the impact of ICT on Arab economic growth. All these positive effects of ICT have led to increased investment in ICT, so as to boost the efficiency and effectiveness of internal and external systems and processes of the organization. The advantages of ICT are as follows:

I. Increase sales and profits: ICT increases sales through assisting the organization in satisfying the needs and desires of consumers, and the increase of sales improve profitability especially in light of cost reduction, which is achieved by using of ICT applications and solutions.

II. Achieving competitive advantages: Where many organizations are using ICT to improve their position in the competitive environment, and gain competitive advantage through the design of innovative programs and applications that allow those organizations to compete more effectively.

The role of ICT has evolved in all life aspects. On present time the dependency of countries being rich or poor increased on ICT tools and practices. Studies have shown that ICT contributes significantly in economic growth, increase productivity, sustainable development, job creation and consequently improving the quality of life [Grace et al., 2004; Kozma, 2005].In this section we will shed the light on the economic and social effects of

ICT depending on the International Telecommunication Union (ITU)[2], where it is an international recognized body that specialized in information and communication technologies.

2.2.1.4 Economic effects of ICT

ITU divides the effects of ICT into direct and indirect effects. The direct economic effect of ICT can be measured as a percent of GDP. This is done by calculating the overall returns from the production of ICTs, or revenue resulting from the delivery of services of these technologies. The revenues of ICTs is more for developed countries than developing ones and continue increasing, although some developing countries achieved increased revenues from ICTs [Wilson, 2004]. For returns of ICT services, it also continues to increase and higher than the returns of their produced sector itself. Since that access to ICT services is not restricted to the developed countries as the production of ICTs themselves, where the penetration rates to telecommunications and wireless services for developing countries exceeded developed countries and the revenues as a percentage of GDP resulting from access to these services, were in developing countries higher than in developed countries.

The information and communication technologies is a dynamic area for investment, due to the continuing decline of ICT equipment, tools and applications prices. In general ICT investment involves three parts computers and their peripherals, software, and telecommunications devices. The last three decades have seen a significant decrease in the price of computers and their components, and in the prices of communication equipment and networks. In the United States prices of computers and their peripherals fell at a rate of 12% per year during the period 1987-1995, then this rate of decline rose to 29% per year during the period 1996-1998 and the decline continues. The decline in the prices of computers reached 17.1% per year for the period from 1959 to 1995. After the year 1995 this drop has nearly doubled to 32.1% per year. The prices of software has been in horizontal level till the late 1980's where they began to fall [Jorgenson, 2001]. The prices of wireless and wires communication tools and equipment to fall every year by 2% since 1994.The households and

[2]http://www.itu.int/

governments consumption of capital services from computers and software declares price drops like computer investment. This decline has encouraged different types of enterprises to invest in ICTs to improve their performance and to gain other benefits of ICTs. In the United States the real investment in ICTs and software has increased from $ 243 billion in 1995 to $ 510 billion in 1999, and the software's share of this investment increased from $ 82 billion in 1995 to $ 149 billion in 1999 [Colecchia and Schreyer, 2002]. In Canada the evolution rate of investment for computers and associated devices has nearly double than that of software, and that of software has nearly doubled than that of telecommunications devices, where for the period from 1981-2007, real investment in computers increased at a 24.7% compound annual rate, compared to 13.5% for software and 5.4% for telecommunications devices [Sharpe and Arsenault, 2008].

ICT sector contributes in economy by creating work opportunities where this sector leads to create new job positions in the ICT production sector or ICT providing services. As an example the companies that provides mobile phone services by employing thousands of employees directly and indirectly. The report of ITU denotes that in Nigeria with high population density where the sector of wires and wireless communication is considered as the main sector that creates job positions specially the mobile phone sector. In march 2004 Nigerian Control communication (NCC) estimated that telecommunication sector led to employ 5000 new direct job positions driven by the evolving of the mobile phone sector, and at the same month there was a creation of 400000 new job positions indirectly resulting from the foundation of new businesses specialized in selling and maintaining mobile phones and their peripherals. Also ICT sector can facilitate the ways of searching for new jobs by using web applications and systems that facilitates recruitment process such as LinkedIn web system.

ICTs have many indirect effects stemmed from external impacts of ICTs such as their role in production and consumption management and control which leads to reduction in production costs and increase in productivity of various economic sectors. ICTs enhance and speedy the mechanism of communication between economic parties. Many new services or reshaped services arose from the ICTs applications such as electronic commerce, e-

government, distance working, electronic management, collaborative working and others [Buhalis and Law, 2008; Hossain and Wigand, 2004; Panzardi et al., 2002].

2.2.2 Economic Growth

2.2.2.1 Introduction

Economic growth is one of the most important economic variables which has gained the attention of various economists throughout different times, as it is a measure that reflects the achieved increase in the production of the country from various goods and services over time. Also it is one of the most important macro indicators for the economic activity of the country, which is reflected in the per capita income and prosperity. Therefore achieving high and sustainable rates of economic growth represents a central and essential objective in economic development plans of different countries, especially for developing ones.

As a consequence of this great importance of economic growth, economists have been interested in this issue across different economic schools theories and stages to investigate its determinants, and as a result of these in depth theoretical and practical research efforts, several economic theories have been emerged over time. These theories put different interpretations for the occurrence of growth and its determinants using multiple approaches in the analysis.

Economic growth theory passed two phases according to the used analysis approach. In the beginning economic growth theories depended on the theoretical analysis of the factors of economic growth where this analysis did not based on measurement studies, till the beginning of Keynesian theory. The acknowledgement to these theories in shedding the light about the most important factors for economic growth but did not try to interpret the relationship between these factors and economic growth. Theoretical Contributions to this phase has been embodied in the writings of Mercantilists who concentrated on how to increase the wealth of the country, and then natural Physiocrats ideas appeared and followed by the appearance of classical school ideas represented by the views of the most prominent thinkers Adam Smith, David Ricardo and Malthus.

The second phase, which is more accurate and objective in the interpretation of economic growth and the analysis of its determinants, began with the advent of the writings of Keynes, which led later to the emergence of new economic school of economic thought known as Keynesian school. Keynesian school founded a new methodology in the analysis of the economic growth phenomenon and diagnosis of determinants, and the development of quantitative models that explain the growth. The most known economists' contributors to this theory are Harrod-Domar model who are the most prominent Keynesians thinkers, where their writings led to the emergence of what is known as a Harrod-Domarmodel which is one of the most known models that explained economic growth and the requirements of its occurrence. This model was One of the most commonly used models in building development plans in developing countries, and it was used later in building and developing more accurate models and theories in analysing the sources of economic growth, especially Solow model which was developed by Robert Solow in 1956 and is known as the Traditional Neoclassical Growth Theory: exogenous growth, where his goal was to search for the reasons for the differences between countries in the degree of richness and poverty.

The Solow model is considered one of the most important contributions of the development thinking where it entered the technology in its model, but he considered the technological development as an unexplained external factor, called external growth model (exogenous growth), this model led to the emergence of new ideas in the eighties and the emergence of the modern theory in explaining the economic growth known as the New Growth Theory: Endogenous Growth. The most contributions to the Endogenous Growth theory was from the economist ROMER in 1986, and his model in 1990, in addition to the model of Lucas in the year 1988.

This section illustrates the concept of economic growth, and the evolution of this concept, types and methods of measurement, and distinguish it from the concept of development, starting from economic growth theories of Classical growth theory, Solow-Swan model, Endogenous growth theory, Unified growth theory, Schumpeterian growth and others. The most prominent theories and quantitative models for economic growth theories, and its evolution through time, from the writings of Keynes to the model of Harrod-Domarand the modern theories of growth, with a focus on the Solow model.

2.2.2.2 The Concept of Economic Growth

Economic growth is considered as the continuous increase in the production of quantities of goods and services in a country in a period of time usually one year, or it can be considered as an increase in the gross domestic product that leads to an increase in the average of individual share of the real income [Kaldor, 1961]. Economic growth as it results in an increase in the gross domestic product it also increases the individual real income meaning that the overall (national) income growth rate exceeds the population growth rate. The increase in individual money income is not realised as true economic growth, where money income means the number of money units an individual receives within a one year, for the products or services an individual provides, but the real increase in economic growth means the increase in the real individual income which equals the rate of money income to the general level of prices states that the quantity of goods and services an individual catches through spending his money income within one year or a specific period of time, that is, an economic growth will be achieved when the increase rate of money income exceed the inflation rate. Economic growth is sustainable and steady state situation not a passing phenomenon, so if a poor country received a financial aid from other country, this may increase the real income level for the poor country for a certain period of time and not at all, so it is not considered as a true economic growth. An increase in economic growth will provide an increasing and high standard level of living to guarantee supplementing individuals with better quality goods and services.

For a country to achieve an economic growth, the productive resources have to be amplified, these resources include the following: i) natural resources such as water, oil and metals; ii) capital such as machines, tools and supplies; iii) workforce includes the employed people and seeking job people with their education and experience; and vi) technology states using scientific research in work and applying inventions.

The Determinants of economic growth are as follows: i) investment or accumulation of physical capital is among the key determinants of the level of real output per capita. The increase of capital will be through private or public investment. Most quantitative studies have shown the positive impact of capital on economic growth in all countries. Investment

has a multiplier effect on the economy which leads directly to productivity increase of the institution or factory, and this impact is indirectly reflected on other institutions; ii) the human capital is an important determinant factor of economic growth in the long term. Many studies have shown that the training and rehabilitation of human capital technically in developed countries has helped to achieve high rates of economic growth, by increasing production and productivity. Many studies in developing countries have shown the negative impact of the shortage of qualified human resources on development plans. The investment in human is not only reflected on productivity but also in its ability to improve the quality of production and the efficient utilization of economic resources. The expected results of high qualified labour are to get the maximum possible production and reduce the final costs of production; iii) innovations are considered among the main drivers of economic growth, where they improve the ways and methods of management and the production of goods and services; and iv) investment in ICTs contributes to the overall increase of capital (substitution effect) and thus increases the productivity of labour. Also, the rapid technological advances in ICT knowledge and practices contribute to the very rapid growth of the total productivity factors.

There are two main indicators that are used in measuring the impact of economic growth as this impact can be quantified, the first one is Gross National Production (GNP) where this indicator measures locally the achieved productive expansion in the concerned country by its own currency compared to the achieved output in the past years, but internationally, GNP is calculated for several countries using a single currency to facilitate the comparison process. One of the disadvantages of this indicator, is that it is a monetary cash process and is exposed to the impact of inflation. The second index is per capita income which measures the evolution of the individual standard living in comparison with other countries, and identify the relationship between GDP and population growth, where we can measure the growth achieved by each individual in terms of his extra spending.

There are different measurements used to evaluate the economic growth, which is reflected by the national activity. The first way is using monetary averages of growth by converting the produced products and services to their equivalent value of current exchange of money after making the needed adjustments and taking into consideration the inflation and different

exchange rates among currencies. Exchange rates include current prices where the economic growth is measured using the annual published data of local currency for short periods of time. As there are increase in prices of goods and services, and accumulated inflation fixed prices of currencies as standardized prices are used after removing the effect of inflation to measure the rates of long terms economic growth. To compare international economic studies, international currency is used such as the American dollar and the local currency is evaluated and exchanged to its international currency equivalent using a unified international currency after excluding inflation. Second measure for economic growth is using the sampling way such as the average growth of GDP per capita which is used as an indicator for economic growth and its relation to population growth. Other measures are used for services such as number of physicians per 1000 population. Another way for measuring economic growth is using the purchasing power of products or services by the local currency. International Monetary Fund uses the purchasing power of national currency inside country boarders compared with the purchasing power of other countries' currencies as a standard measure.

2.2.2.3 Economic Development

The concept of economic development passed many stages, where it was initially focused on the side of economic growth and its achievements, that the development reflects the rapid and continuous increase in the level of income over a long period of time. Despite the importance of achieving other aspects such as illiteracy, the spread of education and the extermination of diseases, but the concentration was on the economic aspects by increasing production, and in this sense, the development is similar for rapid economic growth. This period from World War II until the middle of the sixth decade of the twenty century was characterized by relying on manufacturing to increase national income and improve the rapid rates of economic growth. After the failure of manufacturing policy, the countries followed strategies of external aids and foreign trade using exports. After this stage the concept of development started to be viewed as more comprehensive and associated with social dimensions, not as the first stage where it was only limited to economic dimensions. This broader view of economic development lasted from the end of the sixties and until the middle

of seventies and focused on addressing the problems of unemployment, poverty and inequality by using "Dudley Sears" model who stats that the objective of development is to decrease poverty, inequality, and unemployment [Seers, 1979; Nafziger, 2006]. This stage also reflected by "Todaro" model that determines the development in three dimensions: self-esteem, freedom of choice and satisfaction of basic needs [Todaro, 1969; Todaro, 1994].

Since the mid of seventies to mid of eighties of the twentieth century the concept of comprehensive development started, which means those interested in all aspects of community life and development, but within this stage each aspect and its problems were dealt with and solved separately from each other. After this the concept of sustainable development was augmented. The concept of sustainable development was identified for the first time in the report of the Brundtland Commission's report on the global environment and development in 1987, as a process that encounters the requirements of the present and at the same time not compromising the capability of future generations to achieve their desires [Burton, 1987; Redclift, 2005]. Development is a multidimensional process that involves significant changes in the social, economic and cultural structures. Nicholas Kaldor defined sustainable development as a set of procedures, policies and measures targeted to change the structure of the national economy to achieve a rapid and sustainable increase in average per capita income for an extended period of time, that benefit the vast majority of community members [Kaldor, 1961].

There are significant differences between economic growth and development where economic growth refers to the increase of various macroeconomic indicators, but the development involves much more dimensions as it is considered a multidimensional practise that involves significant changes in social, cultural, political, and economic structures. Economic development cannot be realized even when there is a rapid increase in average real per capita income, if this growth comes through relying on the outside aid which increases economic, technological and political dependency, where development requires getting rid of dependency restrictions and self-reliance. There is possible occurrence of rapid economic growth without achieving economic development, when an imbalance between the development of the economy and the needs of the community occurs. Economic growth does not necessarily associated with the occurrence of changes in structural economic or social

aspects but the development is a phenomenon include economic growth as one of the important elements, but it is combined with the occurrence of changes in economic, social, political and cultural structures.

2.2.2.4 Sources of Economic Growth

Understanding economic growth theory involves identifying the sources of this growth, and how to control these sources in order to increase the production process, where this process is based on the use of production elements. The produced output can be raised by increasing the used resources (production inputs), or by improving the productivity of these resources by enhancing the work quality, the use of machines or new technology, applying ICT tools and practices to work, better management systems and implementing of effective government policies. The economic growth resources are as follows: i) capital is divided into two parts: physical capital in the shape of machinery, equipment, and tools and materials used in production, it takes the form of productive capital, and the other part of capital is human capital of skilled workforce, which takes the form of the labour force; ii) the increase in population growth and consequently the labour force is considered a positive factor to induce economic growth. The Increase in labour force increases the number of productive workers on one hand, and on the other hand, population growth means an increase in consumption and thereby increasing the size of the market; and iii) The technology advancement is an important element that can raise the rate of economic growth in the community. Technology progress is the sum of modern systems and advanced technologies used in the production, which aims to produce a greater amount of product using the same amount of input, or produce the same amount of product using less quantities of inputs, namely that technical progress is working to increase the productivity of factors of production and optimally exploit each production element.

2.2.2.5 Economic Growth Models

In what follows we will illustrate the most known economic growth models starting from Mercantilists model to Endogenous Growth model.

2.2.2.5.1 Mercantilists Model

Mercantilists were the first who were interested in the issue of increasing the country wealth, and consequently achieving economic growth for political objectives. Merchants and statesmen assumed Mercantilism economic theory during the 16th and 17th centuries [Wallerstein, 2011]. Mercantilists believed that the economic power can be achieved by increasing the nation's wealth of precious metals of gold and silver and increasing population. As the wealth is considered the main supporting issue to achieve nation's power. Gold and silver can be gained by exporting more goods than importing for nations lacking mines. Mercantilists considered external trade as the only way to increase wealth, so they ensured the necessity of the government intervention to guide the trade with external world to achieve surplus in balance of payment. They concentrated on the economic growth to be at the level of total production and not individual production, where total production indicates the nation size and its political power without giving attention for the welfare of nation's individuals. Mercantilists considered the overall world wealth as constant, which means that what a country earns of this wealth is a loss at the same time to another country, and therefore Mercantilists advocated that every country has to seek to get gold and silver from other countries by foreign trade. Each country seeks to achieve its special economic interests, even though it was at the expense of another country. Mercantilists differentiated between the layers of society in terms of their share of the growth in production or income that occurs in the community, where the priority is given to the layer of merchants and manufacturers, as the primary productive level. Other layers have been neglected such as farmers. They called to decrease the wages of workers and increase working hours, In order to reduce costs and increase the overall size of production to increase exports and achieve a continuous surplus in balance of payment. Merchants claimed to get the attention of the industrial sector to achieve the robust economic objectives, in the other hand the role of the agricultural sector was limited to supply the industrial sector with cheap food to keep wages low, and thus lower production costs and consequently achieving high profits. Merchants gave the country an important role in economic life, with encouraging of foreign trade by imposing a tariff on imports, and encourage the industry by reducing tariffs on exports, and providing the necessary raw materials [Ekelund and Hébert, 2013].

2.2.2.5.2 Physiocrats Model

In the first half of the eighteenth century the philosophy of the natural economic growth was stated by the French doctor Kenai. He drew a map of the economy called "economic table," which illustrates the circular flow of goods and money in the economy [Cannan, 1964]. This table was seen as a depth sign of Kenai look for ideas brought by him, and their lasting until the mid of 20th century, where Professor Phillips came to translate the table data to inputs and outputs. According to this method the wealth is formulated from production, so agricultural sector is considered as the only productive sector in the community. Boiguilbert (1646-1714) has appealed that agriculture and rural life are superior to manufacture which should not be endorsed at the expenditure of the rural population. Cantillon's literatures also stated monetary thought with two rounded flows money and services running in the opposite direction. All of these are the basis of Physiocrats school [Steenge and Berg, 2008; Vaggi and Groenewegen, 2003]. Physiocrats considered that the agricultural layer is the layer in which the real surplus is happening, which is used in the community development process, through spending on land preparation, harvesting and others. Industry sector has been considered as an activity leads to convert raw materials into another different form without the increase in quantity as opposed to agriculture sector that produce tangible production, and therefore Physiocrats claimed that the industry maintains necessary things and help agricultural sector in achieving the surplus. The commercial sector has been considered a sterile sector that does not contribute to growth [Pasinetti, 1983]. Accordingly, this theory divided the society to three layers as follows: i) producers layer: This layer includes farmers who cultivate the land, in addition to the relevant works that exploit forests, mines and quarries, fishing and livestock; ii) owners class: They are the individuals who own the lands and are considered the basis of the natural system, because their work make the land suitable for cultivation, and Physiocrats entitled to respect their rights; and iii) Class Sterile: the layer that does not produce a net result and includes the manufacturers, merchants, professionals and members of the civil service. Natural theory in GDP growth depends mainly on the capital formation rate, which comes from the surplus agricultural sector, if this surplus has been distributed to the consuming classes, the reinvestment of this surplus will decrease and

then declining gross national production. According to Physiocrats the increase in the surplus of the agricultural sector refers to the use of technical tools and techniques in agricultural sector, the removal of tariff restrictions on domestic and foreign trade, Lower taxes rates on agriculture and Low interest rates [Coulomb, 2004].

2.2.2.5.3 Classical theory of economic growth

Classic economists focused on the causative factors of economic growth. The most important causes of economic growth are the division of labour, build-up of capital and profitability [Eagly, 1974]. They gave attention to the environment in which economic and non-economic (social and political) factors interacts. Classic economists claimed the principle of economic freedom and non-interference of the state, but in order to impose some taxes to finance its expenditures in the defence, justice and security. The classic analysis focused on the primary engine of economic growth which is the composition of capital which is stemmed from profits. As a result of increased profits savings will increase, thus lead to raise capital formation rate and the size of total production [Schumpeter, 1934].

Adam Smith in 1776 produced the production and income distribution between wages and profits through his article "Wealth of Nations". Smith presented the concept of increasing returns, established on the partition of labour. The main contribution was to the central powers which motivate the advance of economic dogma (Marx, K. 2012). In "Wealth of Nations" the technology was the most important factor which illuminated the countryside and state of the wealth of a nation (Barkai, 1969). Smith's theory depends on capital accumulation which is related to the advances of stocks as a located resource and income in the market and this accumulation of capital stocks advances the production of labour which plays a vital role in economic growth (Bowley, 1975). Smith concentrated on labour specialization and division and its role in accumulating real capital for advancing economic growth which is a fundamental tent of social and political environment. The accessing equations illustrates the growth production model as stated from Smith:

$$Y = f(L, k, T) \tag{2.1}$$

Where Y is output, L is labour where output is related to labour, K is capital and T is land where input is related to land. Output growth is measured by population, investment and land growth as shown in the following equation:

$$g_y = \phi(g_i + g_k + g_t) \quad (2.2)$$

Smith projected that the population growth and investment were endogenous, where investment was measured by the rate of saving. Land growth relied on fresh land or technological enhancement of ancient land. The technological advancement might also increase overall growth. Smith did not see growth as continually increasing. David Ricardo published “Principles of Political Economy and Taxation” In 1817 and his classical model is a function of capital accumulation where the capital accumulation be determined by reinvestment like Smith’s growth model. Karl Marx published “Das Kapital” in 1867 where he illustrated the fall of capitalism, and settled that as the economy raised the rate of profits on capital would be full. This projection is differed from that of Smith and Ricardo, who claimed that competition among capitalists’ results on deterioration in profits. Ricardo projected that shrinking returns to land and profits results on fall being forced between rate and wages which result on a standing state.

There are several criticisms of the classical school. The classical school Neglected the role of the middle class in the development process, although it has important and fundamental contributions to the Development process, where this school divided society to the capitalist class, land owners, and the working class. The theory of "Maltus" about the population could not be applied to developed countries, because mortality rates are decreasing associated with rising income levels, where in the third quarter of the nineteenth century the per capita income in developed countries exceeded much more the ordinary wages. Experience has proven that it is impossible to apply the "Maltus" theory in developed countries, because there is always a continuous increase in prices, and did not remain at the subsistence level, and this has not been reflected on the profit decline rates [Wrigley, 1988]. All Countries and especially the developing ones are in need of effective intervention of the government in order to develop plans and set development policies, through the activation and acceleration of capital accumulation. the classics do not give a big importance to the technological

progress, because the technical progress in their belief cannot eliminate the effect of diminishing returns, so it is only applied in the industrial sector, and cannot be applied or benefit from it in the agricultural sector characterized by outstanding declining revenues, however, refuted the fact that, developed countries have benefited from technical progress in the agricultural field and achieved through it a large surplus for exporting.

2.2.2.5.4 Keynesian school for Growth

2.2.2.5.4.1 Keynes Model

The crisis of the Great Depression during the period 1930-1939 hit the substrates and growth rules of the classical school, and this arose the need for a reconsideration of the issue of economic growth, and this was the beginning of the economic "Keynes" attention since 1939, who presented a range of views and ideas to try to find a solution to the current situation of Great Depression, at a time when classical school failed to give explanations to this crisis. The ideas of "Keynesian" can be represented as follows:

- "Keynes" focused on macroeconomic concerns other than the classical thinkers who have focused their attention on how to accumulate Capital through reducing the average cost unit and maximize the individual company profits, believing that their profits are a source of capital accumulation, which is the main engine of growth.
- Keynes claimed that effective demand occurs at any level of operation, and not necessarily only at full operation level. As stipulated in the "classic". He also believes that unemployment is caused by a lack of effective demand, and to get rid of it there must be an increase in spending, either by consumption or investment.
- Keynes realized the importance of the intervention of the state in economic activity in order to reach the full operation, where it cannot automatically happen unlike the classical school proposing. Also he believed that unemployment will remain a problem in the long term, if the government did not play a role in the national economy.
- Keynes considered that the Great Depression is a lack of demand and the crisis is not a crisis in supply surplus. So to solve the problem he claimed that there is a necessary

to move the demand in order to move the supply, thus restore the growth process. Accordingly, it requires, to identify the determinants of aggregate demand, where Keynes identify it as national income part that is spent on consumption and accumulation.

- Keynes claimed that the total income is a function in the operation level for any country, the more the size of operation volume the more the total income, and the actual demand determines the size of operation, and is achieved when aggregate demand equals aggregate supply. The operation and income depend on investment which is determined in one hand by the adequacy marginal rate of capital, or the expected return of new capital assets, and on the other hand it is determined by the interest rate, which in turn is determined by liquidity and money supply. The changes of income is determined by the increase in investment in accordance with the so-called Keynesian multiplier:

$$\Delta Y = M.\ \Delta I \qquad (2.3)$$

Where ΔY is the change in income, M is the multiplier and ΔI is the increase in investment.

2.2.2.5.4.2 The Harrod-Domar Growth Model

The British economists Roy Harrod and Domar wrote a classic article "An Essay in Dynamic theory" from which the modern growth theory took place and now it is known as the Harrod-Domar growth model. They united the Keynesian Analysis and the components of economic growth. The economic appliance of this growth model illustrated that more investments roads to more growth. The capitalist system is fundamentally unstable as Harrod and Domar illustrated, by means of the production function. Harrod and Domar illuminated how the aggregate supply expanded, where the investment has twofold influences, first to the aggregate demand crosswise as business spends further, and the second one to the aggregate supply part as more investment rises capital stock and yields more business as illustrated in what follows:

i) Production function

$$Y = a.K \quad (2.4)$$

Where (a) is the throughput of capital. The varying in capital will vary the income as:

$$\Delta Y = a.\ \Delta K \quad (2.5)$$

$$\Delta K = I \quad (2.6)$$

Where (I) is investment, (S) saving ratio, (s) is propensity to save of national income (Y) as:

$$S = sY \quad (2.7)$$

ii) The investment (I) is the change in the capital stock (K) as follows:

$$I = K \quad (2.8)$$

The total capital stock (K) is straight to the total national income/output (Y) as articulated by the capital-output ratio (k) as:

$$K = k\,\Delta Y \quad (2.9)$$

iii) National saving (S) ought to be equal investment (I), as follows:

$$S = I \quad (2.10)$$

From equations (2.7, 2.8, 2.9, and 2.10) we have:

$$sY = k\,\Delta Y \quad (2.11)$$

The growth rate in product equals the saving rates/investment rates divided by the incremental national capital output ratio as follows:

$$g = \frac{\Delta Y}{Y} = \frac{s}{K} \quad (2.12)$$

Where ($g = \frac{\Delta Y}{Y}$) is product growth rate which measures the growth of output, (s) is the saving rate, (k) the national capital output rate. From the Equation 2.12 the target strategy of economic growth is to rise the amount of national income saved, where (s) will increase and $\frac{\Delta Y}{Y}$ will increase at GDP rate. Economic growth deteriorates as a consequence of the deterioration of domestic savings or capital budget.

Developing countries face a difficulty of capital creation as they have low ability in accumulating accepted level of new capital, where the formation of new capital advances economic growth as stated in this theory. The capital limitation method to growth is also

impeded by the impeding polices of technology and capital transfer from developed to developing countries. The build-up of capital and the available quantity of labour advance the economic system growth rate, which is driven by increasing income and savings as the growth of the labour and technological development increase [Kaldor, 1955, 1956].

The neoclassical growth theory started from Harrod-Domar model, where neoclassical growth theory investigates the cause of growth for developed and developing nations using experimental models. The new growth theory projections and illustrations are stemmed from the neoclassical growth theory.

There are several criticisms of the Keynesian school. Lack of interest from Keynes in the issue of the creation of investment for productive energies, where attention was focused on the problem of full work utilization and the existing capital. The stability of the relationship between capital and output hypothesis is valid in the short term, but not in the mid and long term. Keynes did not take into consideration the fact that the investment results in increasing production capacity in the economy, and focused his attention on investment effects in total demand. The unrealistic hypothesis, which states the stability of interest rates, and the stability of the general price level. Harrod-Doumar model considers that income alone specifies savings (investment), but in fact the investment of most developing countries' economies depends in addition to income, on the volume of exports, which means that whenever the proportion of exports rose, the more able to raise its investments and the rate of economic growth. The invalidity of the hypothesis that the economy is closed, both for developing countries that export raw resources and import consumable goods, or for the developed countries that import raw materials and export consumable goods. Despite all this criticism to "Harrod-Doumar" model and other Keynesian models, their model is still used by those responsible for economic planning in the estimate of economic investments needed to implement economic plans.

2.2.2.5.5 Neoclassical growth models

In 1890, the static neoclassical value theory arise under the projection of several economics, where Alfred Marshall wrote "Principles of Economics", which considered growth and development a natural phenomenon. Young in 1928 pointed in the elder work of Marshall as

there was a relation between internal and external economies and agreed with Smith that division of labour roads to inventions which are constrained by the market level, where the increase in scale is achieved within growth context. Also Young underlined the role of technological change in economic growth.

The advance of the "neoclassical economic theory" rely on expectations and real business cycle to nearby the Keynesian model as nowadays many financial and social difficulties could be tackled such as monetary and fiscal policies, banking implications, securities, financial markets, multinational corporations, holding companies, business collaborations, etc.

Neoclassical theory concentrates on behaviour and using quantitative mechanism rather than qualitative one by implementing statistics in analysis. Although in the past the qualitative method is used in technological transformation impact, after Second World War this qualitative mechanism concerning technological change has been changed to static quantitative method to rise in inputs production, dignified by aggregating the economic growth level [Brinkman and Brinkman, 2001]. Neoclassical growth theory was experienced in 1960s and demonstrated growth in the long run compelled by increasing returns [Ramsey, 1928; Arrow, 1962; Cass, 1965; Koopmans, 1965 and Solow, 1956]. The neoclassical model proposes that the production of consumption increases as knowledge increases within constant level of return to labour and capital as inputs with smooth elasticity between inputs. Solow-Swan settled the foundation of the neoclassical growth model. This model rely on three projections depending on aggregate production as follows: i) the labour workforce raises at steady state exogenous rate; ii) output is function of capital and labour (Y = *F* (L, k)) where output is linked to constant rates of return iii) There is no independent investment (S = sY).

$$Y/L = F(1, K/L) \tag{2.13}$$

As $k = K/L$, then y = f (k), where $f(k)$ is the per capita of the production function $F(K/L)$, so we will rely on equilibrium state:

$$i = \mathrm{s}\, f(k) \tag{2.14}$$

If the equilibrium stays constant, such as (I=S), then $i = s\,f(k)$ denotes the actual investment per person. The neoclassical theory of growth project that the population raises exogenously at the rate (*n)*:

$$g_n = (\frac{dL}{dt})/L = n \tag{2.15}$$

If we have no investment, then capital has to raise at rate *n, as follows*:

$$gk^r = (\frac{dK}{dt})K = n \tag{2.16}$$

Where (r) is the capital growth rate which is needed to maintain the capital labour ratio constant, so the investment can be defined as ($I = (\frac{dK}{dt})$), then we have: ($i^r = nk$) in which we have the needed investment per capita to keep the steady state k. Neoclassical model shows how the economy will be in long run at the equilibrium steady state of capital labour ratio. The neoclassical model uses "Cobb-Douglas production function" with constant returns to scale, as follows:

$$\text{Y=b } K^{\alpha}L^{1-\alpha} \tag{2.17}$$

Where α and 1-α are the outputs with reference to capital and labour as one percent increase in labour and capital will result in one percent addition in scale. To have output per person we divide by L, as follows:

$$Y/L = (\frac{K}{L})^{\alpha} \tag{2.18}$$

$$\text{y} = (\frac{1}{s})K \tag{2.19}$$

Where the capital output ratio is steady. Here (s) is the saving ratio, (1/s) clarifies the rate of y that maintains capital per person constant and the level of K that maintains output per capita constant.

2.2.2.5.6 Schumpeter Model

"Joseph Schumpeter," is considered the founder of Kinetic economic analysis (dynamic) who overcame the neoclassical school, which was performing the economic analysis on the general economic equilibrium theory, and consider the economic activity as an process renewed in a static way and do not take changes into account, While "Schumpeter" shed the light to the development of the economic system and its variations, and the growth of the economy and its changes also thereby putting the principles of necessary kinetic analysis to interpretation changing laws. "Schumpeter" embraced the idea that the economic system when it is in the case of a balance between supply and demand, the entrepreneur is the one who breaks the case of the dominant economic system balance, and through the offer of new innovations, modern production methods, and new markets, where this was expressed by "Schumpeter" using the term "creative destruction". Entrepreneur can be able to break the constraints, incentives and the prevailing recession in the economic systems by proposing innovations and new systems methods, where others follow them causing positive economic shift. "Schumpeter" ideas can be illustrated as: i) the development under the capitalist system occurs in the form of intermittent leaps and inconsistent bursts accompanied by successive periods of short-term recession, Due to renovations and innovations caused by entrepreneurs and that will increase production and advance growth; ii) growth depends on entrepreneurs as key drivers for development and the bank credit, which provides entrepreneurs with innovation possibilities; iii) innovation plays a key role in the analysis of "Schumpeter" of economic growth, where these innovations are represented by Technical progress or the discover of new resources, or both, allowing the resulting in a change in the production function, which in turn lead to increased total output; and iv) developments caused by the entrepreneur affect the customs, traditions and tastes of consumers. Creativity can be classified according to Schumpeter to create new products, the introduction of a new method of production, open new markets, find new sources of raw materials, and finally the formation of a new business system.

There are several criticisms for "Schumpeter". "Schumpeter" model is not suitable to the current situation, where "Schumpeter" considers that the growth process is based on the innovative as a perfect person, while the function of innovation at the present time held by

the industries itself. Economic development depends on economic and social changes as well as innovations, while "Schumpeter" emphasizes that the innovations are the main factor for economic development. According "to Schumpeter," the development is the result of periodic process, while such fluctuations are not essential for development as Nurkse says that development refers to continuous changes [Nurkse, 1952]. "Schumpeter" gives a great importance in his theory to bank credit, but in the long term and when the need to capital increases significantly, the bank credit is not enough, but there is a need to other sources such as stock and bond issuing by financial markets.

2.2.2.5.7 New Endogenous Growth Theory

The new growth theory can be considered for starting in the mid of 1980s, as a new paradigm of research on the applied economies of growth. This research which is related to the new growth theory directed to the advance of the variation in the degrees of output growth and per capita income growth for the long run. Many authors shed the light of endogenous growth theory such as Romer (1986, 1990), Lucas (1988) and Rebelo (1991). These authors established models of non-decreasing returns to capital goods including human resources. The difference between Solow's model and Rebelo's is summarized in the requirement of the production function, showing output with capital in each period of time as follows:

$$Y_{t} = f(K_t) \tag{2.20}$$

WhereY_t and K_t represent the output and capital stock at time t. If we are talking about the output growth rate, then we have:

$$G_{t} = (dk_t/y_t) f(k_t) = S_t \varphi_t \tag{2.21}$$

Where (S) is the saving rate and (φ) is the marginal productivity of capital. If φ declining, G will goes to zero as K grows over time.

Romer (1986), updated the neoclassical theory through adding the aspect of learning by practice, as the company which rises its monetary capital intend to learn more effectively from production. This positive effect of experience by learning through production is designated as practice by investment. We can denote the available knowledge at the company as A_I, where the variable dA_i/dt represents the total knowledge of economy, which

accommodates with the variation in capital inventory (K_i), then the production function can be written as:

$$Yi = F\ (k_i, KL_i) \tag{2.22}$$

The marginal yield of capital or labour reaches infinity when the capital and labour approach zero. If (K) and (L_i) are constant, then each firm will be pointed to decreasing output of K_i. For a specified value of L_i, the production function is first degree first in K_i and K, and for the source of endogens growth with stability in output of capital. The production function can be written relying on Cobb Douglas equation as follows:

$$Y_i = \mathrm{A}\ ki^{\alpha}\ KLi^{1-\alpha} \tag{2.23}$$

Where $0<\alpha<1$

And by dividing by L to calculate per capita as follows: $k_i = K_i / L_i$, $y_i = Y_i / L_i$, $k = K/L$, *and assuming* $y_i = y$ *and* $k_i = k$, *rearranging the equation we have:*

$$y/k = f\ (L) = A\ .\ L^{1-\alpha} \tag{2.24}$$

In order to get marginal production of the capital we can use the derivative of the relation to K_i and Y_i and having K and L constant, also compensate for $k = k_i$ then we have:

$$dY_i / dK_i = \mathrm{A}.\ \alpha.\ L^{1-\alpha} \tag{2.25}$$

Learning by practice and spillover of knowledge will stops the decrease of output where $0<\alpha<1$.

Romer (1990) extended his model to contain a context of competition as a way to raise returns of scale, where the handling knowledge of stock is considered like dealing with physical capital which is proposed to be dependent from aggregated Research and Development (R&D) actions. This extended Romer model is united in endogenous technical change (ETC).

2.2.3 ICT Infrastructure

The US Office of Technology Assessment said that "the communications infrastructure is the combination of technological facilities which include constitutional and procedures that

support communications through the use of radio, video recordings, cables and others, where this definition includes not only the hardware components and information technology, but also includes people and procedures for the benefit of people.

Achieving a well-developed infrastructure is an important thing because it improves other services. A good infrastructure may mean achieving improvement in health care, progress in education and others. In some cases it is impossible to determine the benefits of investing in a particular service, for example, we can explain the health poverty costs through higher medical costs, but this is only a small dimensions of health care.

In the information age, preparing the enabling ICT infrastructure to achieve access to the global infrastructure of information technology, particularly through communication networks be one of the components of the national competition in the world environment. The World Summit on the Information Society (WSIS) have summarized the needed requirements for establishing a good infrastructure for investment in information and communications technology, as follows:

1. National Development Policy that Support an enabling and competitive environment for investment in infrastructure for information and communication technology in order to create new services.
2. National electronic strategy that plan a favourable policies for world-wide access and the way of implementing this access using indicators for ICT connectivity. Improve information access and connectivity using the appropriate ICT infrastructure for all schools, universities, health institutions, post offices and other institutions available to the public. Integrate all parties of the community in the information society through appropriate procedures that include educational, administrative and legislative procedures.
3. Develop strategies for advancing reasonable low cost worldwide connectivity so as to improve connectivity and access.
4. Develop and advance appropriate infrastructure for broadband networks at the national, regional and international level, using available and advance technologies such as satellite systems.

5. Support practical, supervisory and operational studies that are held by the International Telecommunication Union and other involved institutes.
6. Embolden the design and engineering of ICT devices and services to enable everybody to easily access ICT services at a rational cost.
7. Advance connectivity between major information networks by advancing creation and progress of centralized ICT networks and Internet exchange points at the regional and worldwide level, to reduce connectivity costs and advance broadband access.

In order to develop and advance appropriate ICT infrastructure to advance investment in ICT and efficiently using ICT services in all aspects of our life, the concerned parties must ensure their duties and roles, as follows: i) government has to play a core role in the development and implementation of a comprehensive and sustainable national-strategies in cooperation and advisory with private sector; ii) private sector has commitment to the development and dissemination of ICT in terms of infrastructure, content and applications, where private sector is not only market player, but also plays role in a wider context of sustainable development; iii) civil community participations equally important in creating an equitable Information Society, and the implementation of initiatives related to ICT for growth and development; and iv) international and regional organizations have a key role in incorporating the use of ICT in the improvement process and maintain necessary resources for building the information society and to assess the progress made.

2.2.4 Measurement indicators for ICT

ICT measurement indicators vary depending on the measurement method and the approving side. Many international parties proposed various indicators for measuring the information society, including the International Telecommunication Union (ITU), the World Bank, United Nations organizations, and the World Economic Forum. This task faced many difficulties such as the agreement on a set of appropriate indicators for measuring the information society, the development of precise definitions of these indicators, and the way to convince the world countries with different levels of development to follow the accurate standard methodologies in data collection deployed to support these indicators. The

indicators prepared and being developed and revised constantly by the ITU are considered the most important indicators in this area, where ITU is the world's major exclusive party that specializes in this area. In what follows we will illustrate the most important ICT indicators.

2.2.4.1 ORBICOM ICT indicators

Network of UNESCO Chairs in Communication (ORBICOM) proposed a main indicator for ICT which is Infostate, where ORBICOM followed a comprehensive approach to measure the spread, absorption rate and different effects of ICTs in all the world. ORBICOM led a conceptual framework that includes specific considerations of connection, e-readiness, as well as ICT skills, and how to use ICT by individuals and corporation. This index consists of two indices [Sciadas, 2005]:

1. **Infodensity**: the total stock of capital and labour linked to ICT and composed of networks and skills related to ICT.
   1.1 Networks: It consists of three key variables: the number of fixed telephone lines per 100 inhabitants, number of cell phones per 100 inhabitants and international bandwidth (kbs per inhabitant).
   1.2 Skills: It consists of two variables adult literacy rates and gross enrolment ratios that consists of primary education, secondary education and tertiary education.
2. **Info-use**: It is defined as the absorption and consumption rates in the field of ICTs and the intensity of their use. It includes two sub-indices.
   2.1 Uptake: This sub-index consists of number of TV equipped households per 100 households, number of residential phone lines per 100 households, number of PCs per 100 inhabitants and Internet users per 100 inhabitants.
   2.2 Intensity: It consists of the users of Broadband to the users of Internet, number of minutes of International outgoing telephone traffic per capita and the number of minutes of International incoming telephone traffic per capita.

2.2.4.2 International telecommunication Union (ITU) indicators

ITU has a long history in collecting international statistics information concerning ICTs and in coordination and dissemination of these information. The database of ICT information collected and organized by ITU started from the sixties of the last century. ITU has expressed the view that there is no specific ICT indicators that reflect completely ICTs measures, trends, usage and spread in the time and specific place, and can be relied upon. ITU introduced some of the variables individually such as wireless and wires telephony indicators and internet indicators. These indicators do not essentially monitor the overall progress achieved by countries towards the transition to the information society, and may be misleading, as the index which is based on individuals does not reflect the demographic and social structure of the country. In what follows we will illustrate some compound indicators that was proposed by ITU:

1. **ICT Development Index (IDI)**

   IDI is a tool to measure the standards related to ICT progress and track the progress of the countries towards ICT investment, and the conversion to the information society. IDI is an index that consists of eleven indicators (as shown in appendix 1) that cover access to ICT, its usage and related skills of ICT [ITU, 2009].The IDI was established by ITU in 2008 and earliest offered in the 2009 edition of Measuring the Information Society. This index has been created to measure the level of investment in ICT evolution through time, taking into account prevailing conditions of both developed and developing countries. The main objectives of the IDI are to measure the Level and evolution over time for the development and investment of ICT at the State level, and compared with other countries, also to measure the Progress and development in ICT in both developing and developed countries and the index must be comprehensive, and reflects all changes in the countries in various agencies concerning ICT growth and development, to measure The digital divide which means the differences between countries in terms of varying level of ICT development, in addition to measure The possible development of ICT, or the maximum possible

achievement for countries in the use of ICT in order to improve growth and development according to available skills and capabilities.

The IDI composes from three sub-indices (see table A.1, appendix 1) which are i) Access where this sub-index represents the ready state for ICT, and includes five indicators of access and infrastructure as fixed telephone, mobile phone, international broadband Internet, families with a computer, and families with Internet connectivity. ii) Usage this sub-index represents ICT intensity, and includes three indicators of the intensity and use as Internet users, fixed broadband subscription, and wireless broadband subscription. iii) Skills where this sub-index represents the use of ICT skills and includes three indicators as education among young people, total registrations at the secondary level, and total registrations in post-secondary level. This index has less weight than the previous two sub-indices.

The process of ICT development in countries investing in ICT s as follows: i) ICT Readiness which reflects the availability of good ICT infrastructure including provisions of networks and access to ICT. ii) ICT Intensity reflects the level and intensity of ICT usage. iii) ICT Impact reflects the results or outputs of the effective use of ICT.

The first two stages depend on the access and usability of ICT. The third stage depends on the skills of ICT usage which is accumulated in various parts of the community, where IDI includes the measurement of the ability to use ICT in an effective and efficient manner.

2. Digital Access Index

This index aims to measure the general ability of people in a country to access to ICT and use it. This index consists of eight key variables divided into five sub-indices as follows [Barzilai-Nahon, 2006; ITU, 2003]:

2.1 ICT Infrastructure: the number of fixed telephone lines subscribers per 100 inhabitants, and the number of mobile phone subscribers per 100 inhabitants.

2.2 Affordability: The cost of access to the Internet as a percentage of per capita income.

2.3 Knowledge: adult illiteracy rate, and enrolment rate in primary, secondary and university education.

2.4 Quality: the share per capita of internet international bandwidth, and the number of broadband subscribers per 100 inhabitants.

2.5 Usage: The number of Internet users per 100 inhabitants.

3. ICT opportunity Index (ICT-OI)

This index includes the following: i) network index that includes the number of fixed telephone lines subscribers per 100 inhabitants, and the number of mobile phone subscribers per 100 inhabitants; ii) skills index that includes adult illiteracy rate, and enrolment rate in primary, secondary and university education; iii) absorption index that includes the number of computers per 100 inhabitants, the number of internet subscribers per 100 inhabitants and the percentage of households that owns TV; and iv) infodensity that includes the number of broadband subscribers per 100 inhabitants and per capita bandwidth [Sciadas, 2005].

4. Digital Opportunity Index

This index consists of eleven indices within three sub-indices that include i) opportunity index as it is the proportion of the population covered by mobile phone networks, the use of mobile phone tariffs as a percentage of average per capita income, and tariff of cell phone use and the Internet use as a percentage of per capita income; ii) infrastructure index which includes the proportion of households that have a fixed telephone, the percentage of households that have an Internet connection, the number of subscribers that have wireless Internet service for every 100 inhabitants, the number of mobile phone subscribers for every 100 inhabitants, and the percentage of households with a computer of the total households; and iii) Optimal usage that includes the percentage of broadband fixed Internet subscribers to total fixed internet subscribers and the percentage of broadband wireless Internet subscribers to total wireless Internet subscribers.

2.2.4.3 United Nations Conference on Trade and Development (UNCTAD) Index

UNCTAD developed the ICT diffusion index in 2003 and later it was updated and adopted with new emerging technologies [Philippa, 2003]. This index contains two groups of connectivity and access with eight indicators as the number of computers per 100 inhabitants, the number of fixed phone subscribers for every 100 inhabitants, the number of mobile phone subscribers for every 100 inhabitants, the number of internet hosts per 10,000 inhabitants, the number of internet subscribers per 100 inhabitants, adult literacy percentage and cost of local communication to GDP per capita.

2.2.4.4 Index of the World Economic Forum

The network readiness index (NRI) was developed by World Economic Forum. NRI is proposed to quantify the propensity of world countries by means of ICT as a driver of economic sustainable development and advancing business competitiveness. This index is one of the most comprehensive indices to measure the information society, it contains three components concerning environmental, readiness and usage issues and distributed into 68 sub-indicators but the weakness point of this index is that 60% of theses sub-indices depend in personal opinions collected through questionnaires [Dutta and Jain, 2002].

2.2.4.5 Partnership on Measuring ICT for Development Indicators

The Partnership on Measuring ICT for Development was established after the World Summit on the Information Society in Geneva in 2003 and it was officially launched in the year 2004. The partnership includes ten regional and international organizations working in the field of measuring the information and communication technologies. The main achievements of the partnership was in determining the core list of indicators for ICT. In the meeting held in the year 2007 the United Nations Commission for Statistics proved the core list for ICT measurement. In 2013, ITU held the 11th World Telecommunication/ICT Indicators Symposium (WTIS-13) and issued a report entitled “Stocktaking and Assessment on Measuring ICT and Gender”. The Partnership on Measuring ICT for Development was held by the contribution of many international organizations and bodies such as: OECD, UNCTAD, UNDESA, UNESCO, ESCAP, ESCWA, Eurostat and others, where the

indicators were adopted and revised from the meeting held in 2007, where these measurements of ICT indicators are included in the issued report[3]. These indices are divided into six groups as follows: first indicators related to the structure of ICT and access to it; second group basic indicators related to the ICT access, penetration by families and individuals, and ICT usage; third group indicators related to ICT business sector; fourth group indicators related to ICT product; fifth group indicators related to the usage of ICT in education; and the sixth group indicators related to ICT for government services. From the ICT indictors list we note that ITU has done many efforts to reconcile many of the indicators in order to access to a comprehensive way to measure the extent of countries' investments in ICT, so as to achieve the various growth purposes in all aspects of life. The important thing in this partnership is to involve all of the national parties such as statistical offices of developed and developing countries. The statistics offices of developed countries offer their expertise and methodology in the collection, analysis and dissemination of ICT data. The national statistical offices in developing countries have illustrated the facing challenges and the requirements with respect to the measurement of ICTs. This partnership of different developed and developing countries' parties realizes practical forum of mutual benefits for the exchange of experiences.

2.2.5 Measurement indicators for Investment in ICT

ICT measurement indicators vary depending on the measurement method and the approving side. The most important measures of investment in ICT are as follows:

2.2.5.1 Indicators of OECD

OECD depends on many indicators as follows:

1. Access lines and access paths in total / per 100 inhabitants
2. Mobile subscriptions in total / per 100 inhabitants
3. Internet subscriptions in total for OECD
4. Broadband subscriptions per 100 inhabitants in OECD countries

3 http://www.itu.int/en/ITU-D/Statistics/Documents/events/wtis2013/001_E_doc.pdf

5. Availability of digital subscriber lines (DSL) in OECD countries
6. Percentage of fibre connections in total broadband
7. Households with access to a home computer
8. Households with access to the Internet in selected OECD countries
9. Households with access to broadband in selected OECD countries
10. Internet penetration by size class. Percentage of businesses with ten or more employees using the Internet
11. Internet selling and purchasing by industry
12. Business use of broadband
13. Share of ICT-related occupations in the total economy in selected countries, narrow definition
14. Share of ICT-related occupations in the total economy in selected countries, broad definition
15. Telecommunication services revenue in total for OECD
16. Mobile telecommunication services revenue in total for OECD
17. Telecommunication infrastructure investment in total for OECD
18. Share of ICT value added in the business sector value added
19. ICT Business R&D expenditures by selected ICT industries
20. Share of ICT employment in business sector employment
21. ICT-related patents as a percentage of national total (PCT filings)
22. Share of countries in ICT-related patents filed under the PCT
23. Trade in ICT goods
24. Top 250 ICT firms, 2000 and 2009
25. ICT contribution to labour productivity growth in total industries, 1995-2008
26. Contributions of ICT investment to GDP growth, 2000-09

2.2.5.2 World Bank (WB) indicators

World Bank depends on eleven ICT indicators included in ICT sections such as fixed telephone network, Mobile cellular network, Fixed Internet and Wireless broadband, public

payphones, computer users, televisions households, Internet bandwidth measures, Internet use prices, services by e-government applications, electronic business, ICT spending as a percentage of GDP. Some of these indicators are measured for each one hundred inhabitants such as telephone lines, computer use, mobile and Internet subscriptions. Some of them are measured by the cost in US Dollars or local country currency. Others are measured in bandwidth of data communication (binary digits per second).

2.2.6 Digital divide

The transition to the information society requires several conditions including advanced infrastructure, skilled ICT individuals, specialized education and others. The transition is achieved by fulfilment of these conditions. As the countries of the world are not with the same capabilities, differences appeared between these countries in the ownership, use and implementation of ICTs. There are countries as in the case of developed ones have made many advances in transforming their societies to informational ones, other countries as in the case of developing ones are still seeking the first steps in this direction, such as policies, strategic and operational plans, initiatives and projects concerning ICTs practices. The acquisition of ICTs and advanced ICT skills by developed industrial countries maintained economic and social advantage for these developed countries and created serious digital divide between them and the developing countries. For that developing countries have to get attention of the important role of ICTs, and take further practical planned steps in using and developing ICT solutions to achieve economic growth and social development.

The digital divide can be identified as the difference between the supply or the rich and impartiality or poverty of ICTs, particularly with regard to new technologies such as the Internet. There are several variables that can denote the digital divide, such as income, education, age, geographical position and demographic that play an important role in the penetration of Individuals to ICTs. The expression of digital divide was used in 1995 to denote the wide gap between who have modern tools and required skills to create, use and disseminate knowledge and who do not have these capabilities to create and own the needed level of knowledge for their interest and prosperity. This gap exists today between developed and developing countries, within the same country between rural and urban districts, and

within the same city between its riches and poor. Despite tremendous progress in ICTs in the past decade, many of the world's population still suffering from the digital divide in its simplest form such as inability to make a phone call. The digital divide has three interrelated and integrated dimensions, the technological dimension represented by ICTs infrastructure and their uses and applications, the political dimension represented by the development of national strategies and plans needed to improve the enabling environment, and the dimension of knowledge represented by the ICTs skills and qualifications. So in order to overcome the digital divide the country have to work in achieving progress in these three dimensions.

Digital divide has multi-dimensions and sometime we can describe some of its dimensions in qualitative mode and sometimes it is difficult to quantify the measurement of the digital divide. There are many indicators that measure some of the dimensions of the digital divide, but the indicators adopted internationally for the purpose of comparison are few. There are international initiatives that were held to identify, adopt and prove the most important general indicators to be used as standards for measurement and comparison of ICTs. All indications that we illustrated above can be used to measure the digital divide. Some of the international and most used indicators to measure ICT are infostate that was adopted by ORBICOM and ICT development index (IDI) which was adopted by ITU, where these indices contain several related variables, subjected to ICT penetration, usage and its associated skills.

We can record the largest differences between developed and developing countries in the sub-index of ICT use where developing countries are still lagging far behind the developed countries, particularly in the mobile and fixed broadband use. The Arab countries recorded a low fixed-broadband penetration with 3.1% by the end of year 2014, the second bottommost among all districts and significantly below the universal average of nearly 10% [ITU, 2014]. As shown in table A.2, appendix 2 and figure 2.1 concerning IDI values for most Arab countries from the period 2007 to 2013, in general there is an increasing of the IDI values from 2007 with average of 3.08 to the year of 2013 with an average of 4.61. United Arab Emirates has the highest average value of IDI between Arab countries reaching 5.64 for the period from 2007-2013, followed by Bahrain with 5.56.

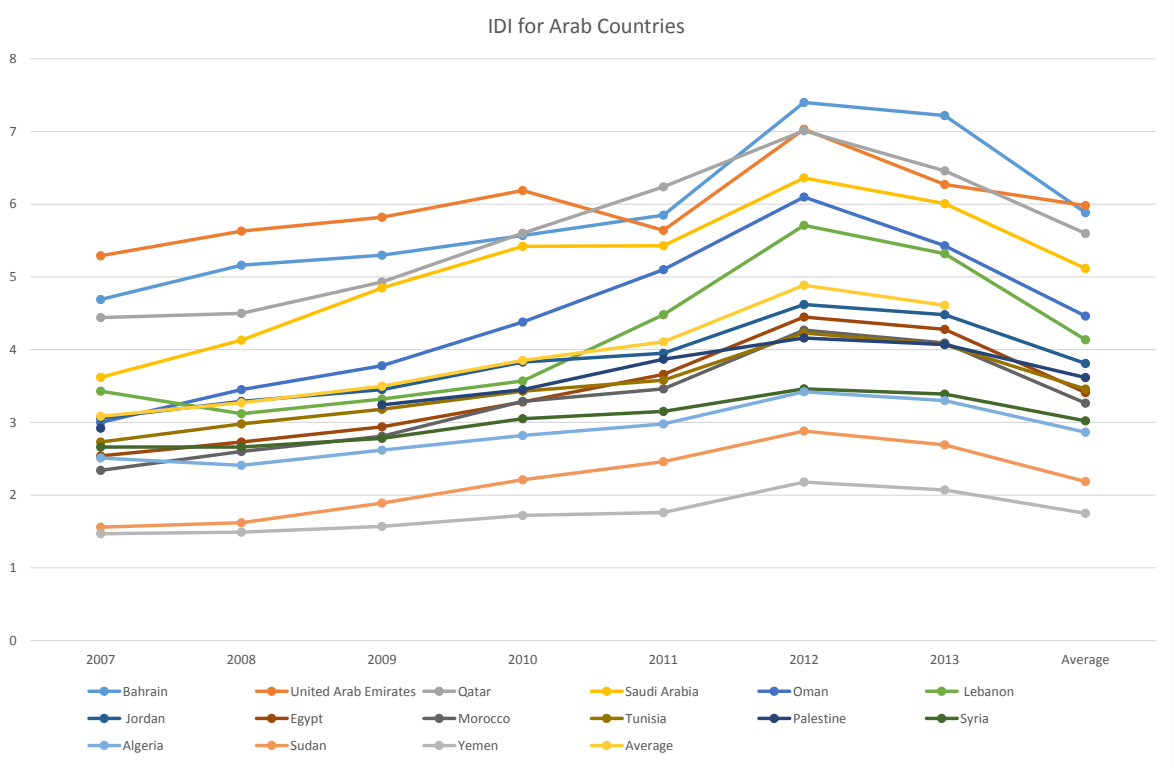


Figure 2.1 IDI values for most Arab countries (2007-2013)
Source: author depending on data from different ITU publications

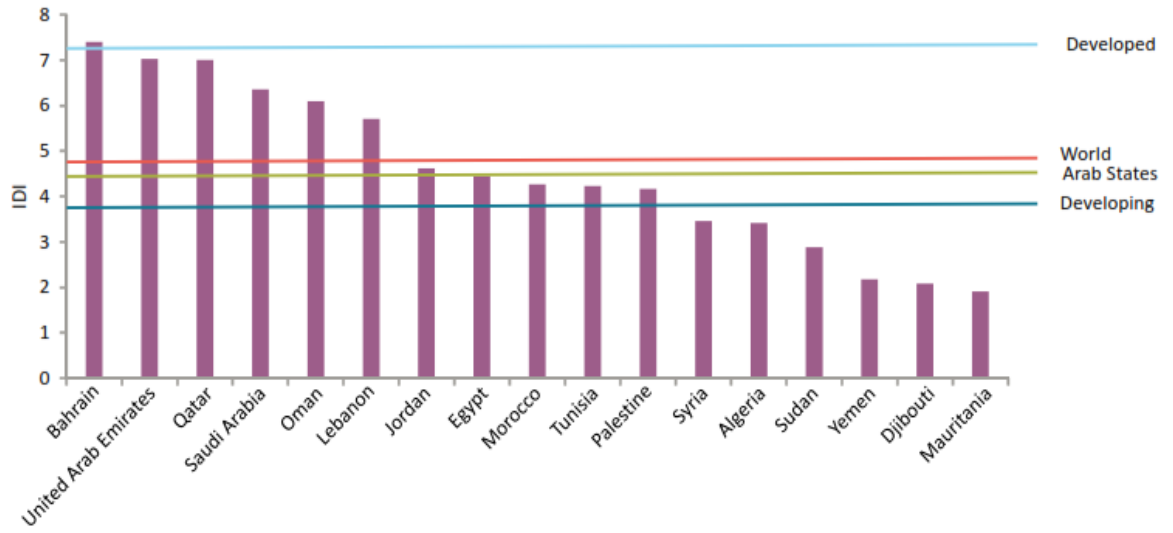


Figure 2.2 IDI values for Arab countries with developing/developed-country averages, 2013
Source: [ITU, 2014]

As shown in figure 2.2, the Arab states are below the average world of IDI levels that measures the ICT in these countries, but although the Arab countries are above the average

IDI levels of developing countries they are to some extent far away from the ICT levels of developed countries. So the Arab countries have much to do regarding enhancing ICT levels in their countries, starting from ICT infrastructure to advancing ICT solutions and practices to various life and work aspects.

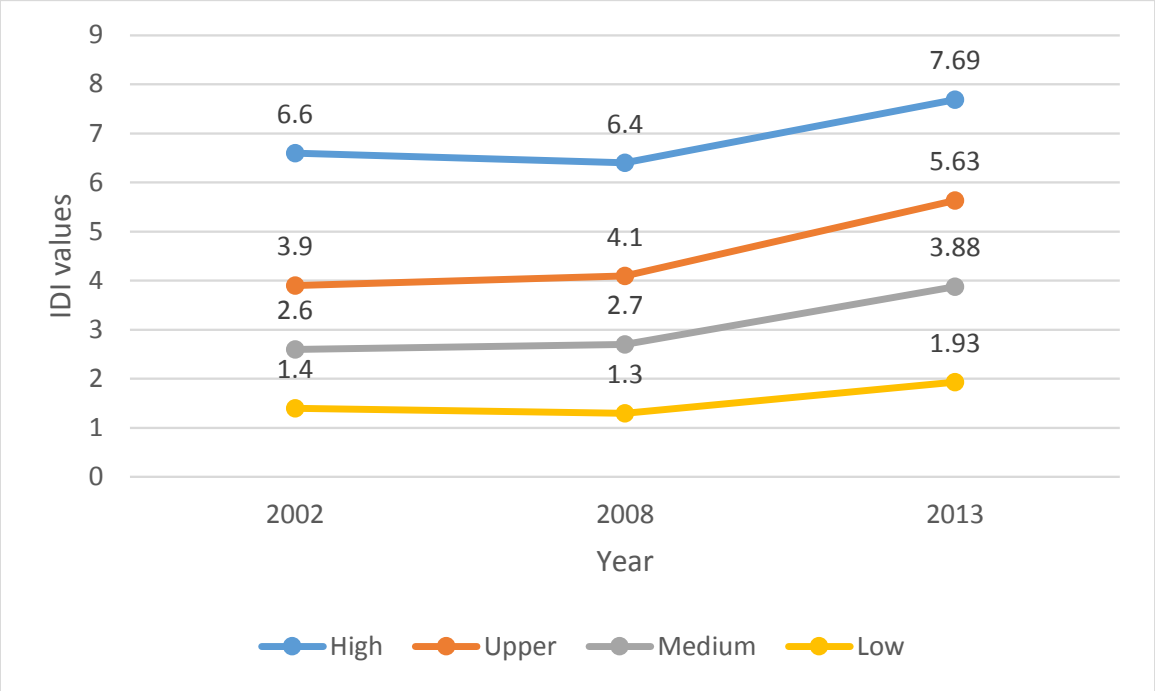


Figure 2.3 Digital divide changes between IDI groups, 2002-2008-2013
Source: data from [ITU, 2014]

To illustrate the contribution of IDI values in monitoring the digital divide, ITU classified the countries to four groups according to IDI values as high, upper, medium and low. As shown in figure 2.3 the charges by which the digital divides are terminating are not equal. The degree by which the gap between the "high" and "low" groups decreased from the year 2002 to 2008 but increased in the year 2013 compared to 2002 and 2008, indicating that the digital divide is getting larger in 2013 between the high and low levels despite the slowly decrease that was achieved in 2008 compared to 2002 from difference of 5.2 between high and low in 2002 to 5.1 in 2008, and to 5.76 in 2013. This different change in the levels between high and low groups and the slow decrease from 2002 to 2008 resulted from the constant growth of ICT in developed countries, but as in 2013 the gap increased then new advances in ICT was achieved by developed countries. The digital divide among countries

with “high” IDI ranks, and those with “upper” IDI ranks, is decreasing from year 2002 to 2008 and to 2013 where the decrease in the year 2013 is more than that of the year 2008 as compared to the year 2002, and this indicates that the countries within the upper group is doing well in ICT and did so much enhancements in ICT practices, resulting in decreasing the digital divide with the countries with the high digital divide group. The digital divide among countries with “upper” IDI ranks, and those with “medium” and “low” IDI ranks, is a little increasing. So according to this comparison shown in figure 2.3, the digital divide is increasing as in 2013, so the countries within the medium and low groups have to do their best to enhance using and implementing ICT infrastructure and practices in order to follow up the countries within the high and upper levels.

2.2.7 Related work

The important role of ICT as an enabling technology that efficiently contributes in production cost reduction and productivity enhancement of various business sectors and so as for all country sectors, which will be reflected positively on economic growth attracted the concerns of many parties such as researchers, international organizations and governments. In what follows we will discuss several research studies talking about the impact of ICT on economic growth using various models such as Cobb-Douglas model, extreme bound analysis, vector autocorrelation and others. The quantified part of ICT involved different measures such as ICT capital and investment, and indices such as infoststes by ORBICOM, opportunity index by ITU and others.

The study entitled “ICT Investment and Economic Growth in the 1990s” compared the impact of ICT investment on economic growth in 9 OECD countries[4]. The study results showed that ICT capital investment contributed between 0.2 and 0.5% points per year to economic growth according to the country. For the period from 1995-2000, ICT contributed higher percentage from the preceding period ranging from 0.3 to 0.9% points per year. Results showed that the United States was not the only country that gained benefits from the positive impacts of ICT capital build up on economic growth. Impacts have obviously been

[4] These countries include Australia, Canada, Finland, France, Germany, Italy, Japan, the United Kingdom and the United States

biggest in the United States, and then in Australia, Canada and Finland, but the countries Germany, Japan, Italy, and France recorded the bottommost contribution of ICT investment impact on economic growth among the nine studied countries. One of the most influential drivers of growth as ICT investment in the study case is preparing appropriate ICT framework conditions and not essentially in ICT sectors itself (Colecchia and Schreyer, 2002].

Becchetti et al. (2003) investigate the effect of investment in telecommunications and software on the productivity of Italian firms. They found that telecommunications positively impacts the formation of new products and practises, while software rises the request for skilled labours for advancing firms' productivity.

The researches Jorgenson et al. (2000), and Oliner and Sichel (2002) found that there is positive and significant impact of ICT on production in the United States in 1990s [Jorgenson et al., 2000; Oliner and Sichel 2002]. In addition, a study by Inklaar et al. (2005) form the year 1979 to 2000 found that there is a significant contribution of ICT to economic growth for the United States and European countries including Germany, France, Netherlands and UK, but the study found that United States outperforms the four European countries (included in the study) in ICT influences to economy. Also several cross country studies discovered the positive impact of ICT on labor output and indicating country differences regarding ICT impacts in developed economies [Van Ark et al., 2008]. The result of positive influence of ICT on economic growth disagree with a research conducted by Dewan and Kraemer (2000) from the year 1985 to 1993. This panel conducted study (includes fourteen developing countries and twenty two developed economies) found that ICT impact on economic growth was found positive for developed countries. The panel study was held on 36 countries for the period from 1985–1993. They also found insignificant impact of ICT in developing countries referencing this to low level of ICT investment, the deficiency of appropriate environment such as infrastructure and government policies, where this result is accommodated with Yousefi (2011) result for a research conducted from the year 2000 to the year 2006. The study also found that ICT impacts are significant for developed economies. The author clarified the insignificant influence of ICT as the lack of knowledge and skills of labor stock to exploit the ICT improvement power.

In a study of 15 European countries to examine how the infrastructure of broadband telecommunications penetration affects these countries' economic growth for the period 2003 to 2006, a macroeconomic production function was used. The consequences of this study show a significant positive relation between broadband investment and GDP, where these percent of effects ranged from 1.04% for Netherlands to 0.57% for Ireland with an average impact of 0.63% for the study sample of 15 EU countries. The impact of broadband infrastructure on GDP increases as the investment in broadband infrastructure increases and the highest level of impact was recorded to the Scandinavia countries (Netherlands, Denmark, Finland and Sweden) with high broadband penetration level more than 20% [Koutroumpis, 2009].

Many researches relied on Cobb Douglas production function to estimate the impact of ICT on economic growth. This used production function includes three independent variables which are labour, non-ICT capital, ICT capital and the constant that represents the other variables. The dependent variable here is GDP which represents economic growth. The challenge of using this model is the difficulty of specifying the ICT capital especially in developing countries, where in our case of study we faced this difficulty, in addition to the unavailability of these related information impeding us from using this model. Many studies used this model such as the study held by Ben Youssef on the case of Tunisia for the period from 1974 to 2001. He used the least squares model to estimate the related equation after adding a dummy variable that takes the value of zero for the period 1981 to 1989 and 1 for the remaining period. The results of this study are shown in the following equation

$$Log\,(Y) = 1.265 + 0.756\,\text{Log}\,(\text{L}) + 0.108\,\text{Log}\,(ICT\ capital) + 0.150\,\text{Log}\,(non - ICT\ capital) + \ - 0.02\,D_{80} + \varepsilon_t \quad (2.26)$$

Where Y represents GDP, L represents labour, D the added dummy variable and ε_t represents the random factor. All variables were significant and the model as a whole also was significant with 99.7 % R-squared that reflects the explanation rate of the model.

The results in the equation above illustrate that i) if labor work rises by 1%, then production will rise by 0.756% ii) if non-ICT capital rises by 1%, then the production will rise by 0.150 iii) if ICT capital increases by 1%, then production will increase by 0.108%. We note that the capital contribution of non-ICT is more than the capital contribution of ICT, and this is

present in the majority of developing countries because they still don't realize the importance of the ICT sector, and they are not effectively using these technologies in all sectors (BEN YOUSSEF and M'HENNI, 2003].

In a study of Khleifi (2010) about the relationship between the digital divide and development level, the sample included 17 states during the period 1995-2007. These states divided into two groups. The first group includes the countries Algeria, Tunisia, Marco, Egypt, Israel and Jordan of the MENA region. The second group includes the countries Bulgaria, Denmark, Finland, France, Germany, United Kingdom, Sweden, Italy, Holland, Spain, and Slovenia of the European Union. Author tried in this study to investigate the relationship between economic growth represented by GDP and the ICT spread indicators. Of all the ICT indicators author used the Internet usage index as it has the greatest impact on economic growth, as well as the digital divide appear more in the online index, this study was based on data scheduled methodology as follows:

$$Ln\ (GDP/capita_{t,i}) = \alpha_0 + \alpha_1\, ln(Inv_{t,i}) + \alpha_2\, ln(Int_{t,i}) + \alpha_4\, ln(H_{t,i}) + \varepsilon_t \qquad (2.27)$$

Where (GDP_t) represents GDP per capita over time, (Inv_t) represents investment measured by the percentage of private and public ICT capital investment to GDP per capita over time, (Int_t) represents Internet usage over time, H_t represents human capital, each (α) represents the elasticity of each variable, i represents corresponding country, and (ε_t) represents the random factor.

The model was estimated using generalized squares method applied to the three groups containing MENA region, European Union and the third group represents the whole sample. The elasticities of the variables of Internet usage and ICT investment were significant and positive, but the elasticity of human capital was negative and insignificant. However, these elasticities of internet and ICT investment that represent their impact on GDP per capita were more for the European countries than the MENA countries. The results for this study were as follows i) if the uses of Internet rises by 1%, then GDP per capita will rise by 0.026% for the whole group of MENA and European countries, and it rises by 0.27 for European Union and 0.07 for MENA countries ii) if ICT investment rises by 1%, then the GDP will rise by 0.018% for the whole group, 0.15% for European Union and 0.093% for MENA countries. This study concluded that the Internet usage index and ICT capital affect positively economic

growth, but it did not take into consideration the rest of the ICT indices such as mobile phone technology that frequent studies illustrated its positive impact on economic growth [KHELIFI, 2010]. This study will take several significant ICT indices into consideration, according to the classification of International ICT institutions such as International Telecommunication Union (ITU).

Some studies have used the technique of vector autocorrelation (VAR) through identifying a set of variables that are considered determinants of economic growth, which includes fixed and mobile phone penetration rates, Internet penetration, especially broadband internet, investment rates on ICT and others.

A study done by ITU about the impact of broadband as an ICT indication on economic growth of 120 country, mostly developing countries. The adopted model is composed of GDP per capita growth rate for the period 1980 to 2006, as a dependent variable, GDP per capita in 1980, investment to GDP ratio from 1980 to 2006, primary school enrollment rate, average penetration of broadband in addition to other telecommunication services for developed and developing countries between 1980 and 2006 and dummy variables for Latin America, sub Saharan and Caribbean countries. The results of this study showed that there is positive impact of ICT investment and broadband on GDP per capita, and the elasticities of these variables are significant. After that other ICT variables were added such as fixed telephone subscriptions and mobile phone subscribers. The results for this study were as follows i) if fixed-line penetration rate in countries with low and mid incomes rises by 1%, then the economic growth rises by 0.043%, and 0.073% in high-income countries ii) if mobile phone penetration increases by 1%, then the GDP per capita will increase by 0.06% for low and mid income countries, and 0.081% for countries with high income iii) if broadband penetration increases by 1%, then GDP per capita will increase by 0.121% for countries with low and mid incomes, and 0.138% for high income countries [Qiang et al, 2009].

International Network of UNESCO Chairs in Communications (ORBICOM) held a study for the impact of ICT on economic growth including 146 developed, emerging and developing countries, covering the period from 1995 to 2003. The main model that was adopted in this study includes GDP per capita as a dependent variable and ICT infodensity

index as an independent variable and transformed into logarithmic format. The details of this used model and the extended used model is illustrated later in the data and method section. The results found that ICT represented by infodensity index positively affect GDP per capita, where this impact rangers from 0.85% in the year 1995 with 146 economics in the study sample to 1.24% in 2003 with 134 economies in the sample in an increasing basis. The elasticity of the ICT index was significant for all years of study. Also the results showed that the impact of ICT varies between countries according to their stage of development and different infodensity levels, as the study found that there is a strong impact of ICT for countries with high levels of infodensity [Sciadas, 2005].

Vu (2011) studied panel set of 102 countries for the period from 1996 to 2005, where he found that internet subscription had a vital marginal impact on growth more than personal computers and mobiles phones. He recommended the elevation of e-business and e-government. In his study he examined three indicators (Internet, personal computers, and mobile phones) to quantify the ICT diffusion. The study used the outmoded panel regression approach and the system Generalized Method of Moment for dynamic panel figures examination.

In reference to above discussed related studies about their investigation to measure the impact of ICT on economic growth, and according to the availability of related ICT information we will use the ORBICOM model in our investigation of the effect of ICT on economic growth of Arab countries. Also as infodensity ICT index was used in ORBICOM model as an index that captures the ICT capital and labour stocks, where this index includes several significant sub-indices representing ICT capital such as fixed lines subscriptions, mobile phone subscriptions and bandwidth available for each internet user, and at the same time this index includes the various enrolment and literacy skills. Also the Cobb-Douglas production function will be used in this thesis in order to measure the impact of ICT and non-ICT capital services, in addition to labour services on GDP growth for selected Arab countries.

2.3 Chapter summary

In this chapter we start talking about the concepts and knowledge concerning information, technology, ICT, also we talked about the advantages of ICT and the economic impact of ICT. We reached a point that ICTs have positive economic impact, therefore countries have to get attention to advance ICTs practices in all work aspects.

Economic growth and development are concerned with an increase of per capita income, so they can be measured in a quantitative way. Growth can be measured by GDP and per capita income. Economic development can be measured by indicators proposed by the United Nations such as human development index and poverty index.

We talked about different theories concerning economic growth, where we talked about the classical school which proposed that trade freedom and accumulation of capital are the basis for the development process and the accumulation of capital will lead to economic steady state. The classical school faced many criticisms of the most was its ignorance of the important role of technology advancement in growth process. After the occurrence of the big recession crises (1930-1939), classical theory couldn't give an explanation for its causes. The economist Keynes came and gave explanations for the big recession crises through his assumptions. Keynes proposed that the economic balance doesn't occur automatically but it occurs in the case of long full deployment and assured that the changes in income happen by increasing investment as he called it the multiplier. We illustrated famous Keynesian theory Harrod-Domar who contributed to the economists about the estimation of the volume of the needed investment in order to implement these economic plans of full deployment. Because of some unrealistic assumptions of Keynesians assumptions such as the proposing of constant prices and the closed economy, many criticisms faced these theories. Then neoclassical theory arose, which was represented by an important model called Solow model. Solow tried to build a long growth model that proposed the possibility of substitution between the production factors labour and capital in reference to his assumptions that declared the perfect competition and that the technology is an external change. After Solow model the internal economic growth model arose, where this school pointed several criticisms to Solow model. One of these criticisms is stemmed from the observations in the eighties of last century, where in reality the gap between the rich and poor countries increased

not as Solow proposed about convergence between these countries, as the riches developed countries increased in development and richness and go far away from poor ones. The second criticism to Solow model was the proposing that the technology advancement is an external variable without explaining the way of development of this important factor. So the internal economic growth model arose and tried to propose solutions to problems facing external growth models such as Solow one. Concerning the convergence idea, the internal growth model related it to the idea of decreasing marginal production of classical model. The internal models proposed to cancel the proposition of decreasing production and considering technology advancement as an internal economic factor and the economy must work in the monopoly circumstances not in perfect competition. These models considered any policy that can positively affect research and development is accepted to advance the production factors. The country must be ready to intervene for helping and protecting the new innovations and discoveries, the country also has to develop and implement strategic plans concerning education, training, and knowledge building for its population. Internal growth models tried to reach sustainable growth by advancing the production factors, advanced technology and capital.

Through this chapter we recognize the importance of ICTs. ICTs have significant effects on social and economic growth and development, where the owning of ICTs and advances on them are considered as an important criteria and indications of the degree of development of countries and their abilities of gaining competitive advantages. ICTs infrastructure, , equipment, tools and practices acts as effective drivers that advance the work productivity, work cost reduction and enhance work environment. ICTs help also in creating direct and indirect work opportunities. Therefore all countries are trying to do their best to advance ICTs in all aspects of work and put strategic plans to effectively build information and knowledge society. Due to the varying capabilities of States to cope with the movement of developments in ICTs, the way to the information society carriages several challenges to developing communities, which are exposed to productivity reduction and economic capabilities shrinking, as the gap of development such as the digital divide increases between these developing and developed countries.

Various challenges that impede the developing countries in their direction towards the information society, led to the appearance of what is known as digital divide between them and the developed countries. The wideness of digital divide stimulated all countries specially the developing ones to take practical steps to narrow this digital divide. Several conferences were held to study the digital divide and attributing statistical indicators to assist on monitoring and exploring the causes of this digital divide. The goal of conferences and conducting related researches is to reduce the digital divide by increasing awareness of the benefits of the information society and to provide mechanisms that will help developing countries to launch and advance Information and knowledge Society. At the end of this chapter we illustrated several related studies covering developed, developing and some Arab countries concerning the impact of ICT on economic growth.

CHAPTER 3: DESCRIPTIVE STUDY

3.1 Introduction

This chapter starts with a description of ICT in Arab countries including ICT infrastructure, capital and usage such as fixed lines and their subscribers, Internet access and users, fixed broadband and mobile phone subscription. First, the readers will have a chance to gain needed information about ICT infrastructure, capital and usage in order to take a clear view about the situation of ICT in Arab countries. Then we proceed with Palestine and Egypt as a sample of Arab countries describing in more details the ICT and economic situation in it.

3.2 ICT in Arab Countries

Since the beginning of the twenty one century, Arab countries began the planning and developing of strategies to reach certain levels in terms of the deployment and the provision of online Arabic, English and other contents. Arab countries represented by public and private institutes tried to simulate the developed countries in the adoption of Internet and ICT applications in various economic, social and scientific activities. Statistics of ITU indicate that the percentage of the citizens of the Arab world who have already used the Internet, does not exceed 1% in the year 2001, despite that the Arab world's 287 million people make up 5% of the total world population at the time, but after this the percentage of the citizens of the Arab world who have used the Internet reached 5.61% in the year 2014, with Arab world's 360 million population that make up 5.38% of the total world population[5]. This is a good pre indication of the involvement of Arab population in Internet usage in recent years. In the light of the rapid and successive developments in ICTs and their robust positive impact in

[5] http://data.worldbank.org/indicator

economic and social fields, the involvement of Arab nations in the information society has become essential.

In 2015, Arab countries overdo the international IDI average of 5.03 with 5.10 (compared with 2010 with 3.88) as for Americas, but less than Europe that has the utmost average IDI value with 7.35, and more than Africa that has the lowest average with 2.53 (see figure 3.1). The top countries concerning the IDI values are Bahrain (7.63), Qatar (7.44), Oman (6.33), United Arab Emirates (7.32) and Saudi Arabia (7.05) among the Arab countries, where all these Gulf countries are oil and gas exporting countries encountering IDI values more than 6.5 in average. From 2010 to 2015, Bahrain, UAE and KSA feature among the most dynamic countries in the IDI values. Bahrain has the highest IDI value change with 2.22 from 2010 to 2015 with 21 rank change, followed by Lebanon with 2.12 with 21 rank change, Saudi Arabia with 2.09, United Arab Emirates with 1.94 and Oman with 1.92 encountering 14 change in rank. From 2010 to 2015, Kuwait, Oman and Saudi Arabia improved their segment of households with a computer by more than 25%, which is a relatively high value and good indication of increasing ICT usage [ITU, 2015]. For the same period from 2010 to 2015, the most dynamic positive performance in the ICT use sub index is recorded to four of Arab countries, Bahrain, UAE, Lebanon and Saudi Arabia, with 4.91, 3.76, 3.66, and 3.43 use sub-index change, encountering 18, 22, 43 and 37 use rank respectively in 2015. For the same period from 2010 to 2015, Bahrain, UAE and Saudi Arabia have levitated from the upper to the high quartile according to ITU classification, at the top of the distribution. Djibouti and Mauritania have the least IDI values with 2.19 and 2.07 respectively in the year 2015. The IDI for Syria has dropped considerably in the rankings since 2010 as it has encountered civil war. Figure 3.2 shows the values of sub indicators that compromise the IDI for Arab countries. The figure shows that the value of fixed broadband contributions is relatively low, and this is a negative indication where the broadband penetration has an important role in ICT spillover.

The internet penetration is represented by the percentage of a population using the internet as stated by the internet users indicator defined by ITU through the HH7 indicator which defines internet users as Internet use in the previous 12 months from any location by in-scope individuals (Core ICT Indicators 2010).

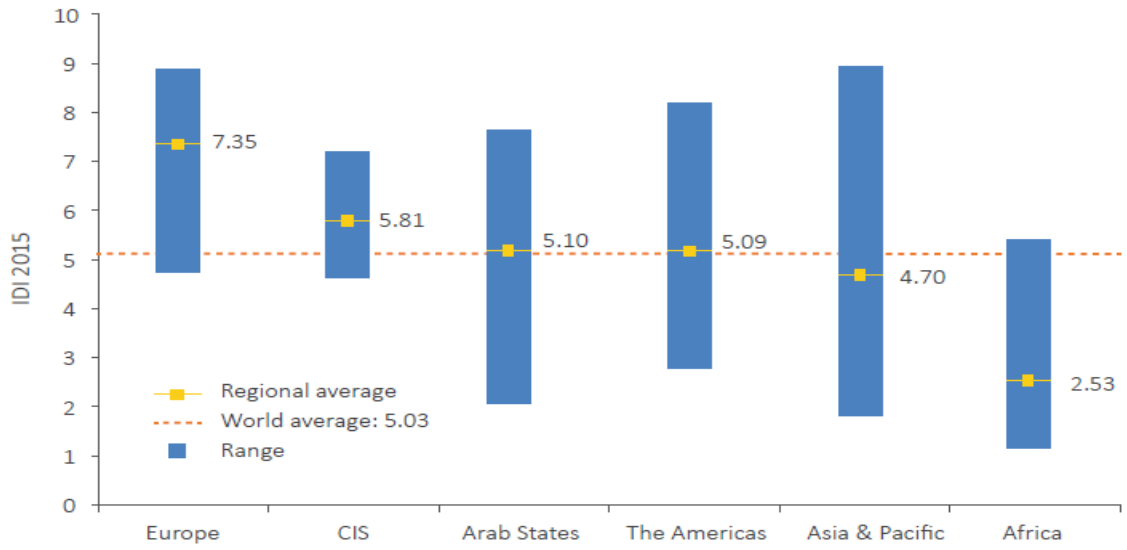


Figure 3.1 IDI for world regions, 2015

Source: [ITU, 2015]

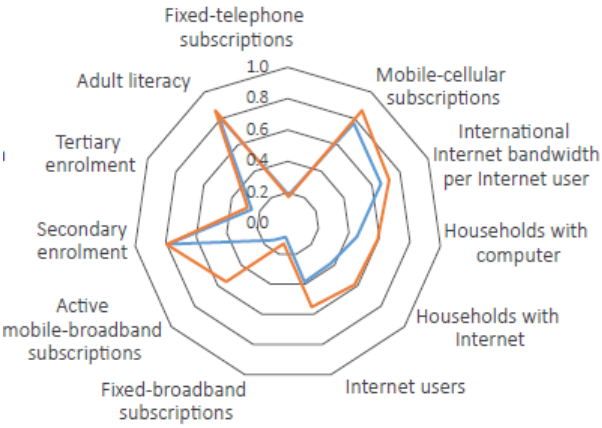


Figure 3.2 Average IDI rating for each index indicator, Arab countries, 2010 and 2015

Note: blue line for 2010 and orange line for 2015

Source: [ITU, 2015]

Arab countries as other countries differ in their implementation of internet user parameters, such as for Qatar which collected data for internet penetration for the age 15 and more without considering the labour camps so as for other gulf states that have high foreign labour population compared to their original population except for Saudi Arabia and Oman. Jordan considers the age 5 and more for internet penetration calculations while UAE follows the criteria of ITU. The source of internet penetration shown in table 3.1 is from ITU in order to be able to compare between different Arab countries. As we clarify from table 3.1 Bahrain

has the highest internet penetration between other Arab countries with 90% in the year 2013, followed by UAE and Qatar with 88% and 85.3% respectively.

Table 3.1 Internet Users, penetration and literacy rates for the year 2013

Country	Population[6]	Internet users[7]	Internet penetration[7]	Literacy rate
Qatar	2101288	1792399	85.30%	97%
Jordan	6460000	2855320	44.20%	96.70%
Kuwait	3593689	2711798	75.46%	96%
Palestine	4169506	1942990	46.60%	96%
Bahrain	1349427	1214484	90%	95.70%
Oman	3906912	2596143	66.45%	94.80%
Saudi Arabia	30201051	18271636	60.50%	94%
Lebanon	4493438	3167874	70.50%	93.90%
UAE	9039978	7955181	88%	93.80%
Libya	6265987	1033888	16.50%	90%
Syria	21789415	5708827	26.20%	86.40%
Tunisia	10886500	4768287	43.80%	81.80%
Algeria	38186135	6300712	16.50%	80.20%
Iraq	33781385	3107887	9.20%	79%
Egypt	87613909	43421453	49.56%	75%
Sudan	38515095	8742927	22.70%	74%
Morocco	33452686	18733504	56%	72.40%
Yemen	25533217	5106643	20%	68%
Mauritania	3872684	240106	6.20%	-
Total	3.65E+08	139672059	47.04%	87%

Source: Collected data from World Bank (2014); ITU (2014); and UNESCO Institute for Statistics (2015).

The gulf Arab states have the highest internet penetration as these rich oil countries invest more in Internet technology infrastructure; in addition to Lebanon with 70% in the year 2013. The lowest internet penetration rate is for Iraq and Mauritania with 9.2% and 6.2% respectively. In our 18 Arab countries sample study the least amount of internet penetration is for Algeria and Libya with 16.5% for each.

6 http://data.worldbank.org/country/
7 http://www.itu.int/ITU-D/ict/statistics/index.html

3.2.1 Fixed Line Subscriptions

Despite the emergence of the mobile phone and the great demand for its use, the need still exists for the expansion of fixed telephone stations and lines to meet the increasing demands of subscribers, where the mobile phone does not completely replace the fixed telephone, in many cases, such as the use of the fax, the Internet through fixed broadband lines and others. The fixed telephone subscriptions reached 8.7% per 100 inhabitants by the end of year 2014 [ITU, 2014]. As shown in table 3.2 and 3.3, the amount of fixed line subscribers reached 30,935,487 in 2013 for the sample study of 18 Arab countries, with a decline from 32,814,426 in 2012. For the year 2011 the fixed line subscribers declined from 31,676,236 to 31,335,377. Although in 2012 there was a health recovery increase in fixed line subscriptions by 32,814,426 from 31,335,377 in 2011, in general there was a decrease in fixed line subscription from 31,676,236 in 2010 to 30,935,487 in 2013 accounting for a total decrease by 2.3%. UAE is the highest country in fixed line penetration with 22.32% in the year 2013, at the other hand the lowest rate of penetration is recorded for Sudan with 1.09%. As we see from table 3.2, the top countries in the rate of fixed line penetration is recorded for the oil rich countries including the six Arab gulf countries and Libya, in addition to Lebanon. The topped country in increasing growth of fixed line subscription is accounted for UAE with 42.78% between the years 2010 and 2013 and it also topped first in the penetration scale. The reason that UAE has the top rank in fixed line penetration and growth, although it has a dramatically decrease in 2008- 2010, as the 2008 economic crises resulted in terminating down of many businesses in 2009-2010, meaning that many fixed-lines were disconnected in that period. Year 2011, perceived a recovery in the economy which resulted into a well regret in businesses and increase demand for fixed-lines till 2013. Also the high competition between different telecom companies in UAE resulted in offering competitive bundled fixed-lines packages with low fees. Fixed lines Subscription in UAE grew from 1,460,985 in 2010 to 2,086,000 in 2013, representing 625,015 more subscribers than the year 2010. In the second rank of penetration index of year 2013, Bahrain perceived a relatively high amount in fixed-line penetration. The country recorded an increase in fixed-lines growth between the years 2010 and 2013 adding 64,146 subscribers to its base, positioning the country in the third spot on the fixed-line growth index as shown in table 3.4.

For the penetration index, in the third position is Syria with 20.22% in the year 2013, and achieving slightly increase from 19.3% in the year 2012, and in the other hand recording a decrease from previous year 2011 with a rate of 20.49%. For the growth index, Syria settled in the ninth position with growth rate 8.8% between the years 2010 and 2013, adding 358,051 subscribers to its fixed-line base.

Table 3.2 Fixed line subscriptions and penetration for Arab countries 2013

Rank	Country	Population	Subscriptions	Penetration
1	UAE	9,039,978	2086000	22.32
2	Bahrain	1,349,427	291499	21.88
3	Syria	21,789,415	4428800	20.22
4	Qatar	2,101,288	412584	19.02
5	Lebanon	4,493,438	870000	18.04
6	Saudi Arabia	30,201,051	4939700	17.13
7	Kuwait	3,593,689	508000	15.08
8	Libya	6,265,987	789000	12.72
9	Oman	3,906,912	351411	9.67
10	Palestine	4,169,506	403025	9.32
11	Tunisia	10,886,500	1022000	9.29
12	Morocco	33,452,686	2924900	8.86
13	Egypt	87,613,909	6820900	8.31
14	Algeria	38,186,135	3130000	7.98
15	Jordan	6,460,000	378411	5.2
16	Yemen	25,533,217	1143000	4.68
17	Djibouti	864,554	20686	2.37
18	Sudan	38,515,095	415571	1.09
Total		328422787	30935487	11.8433333

Source: collected data from World Bank and ITU (2014)

Eight countries from the 18 Arab study sample countries of MENA region recorded negative growth between the years 2010 and 2013 as shown in the growth table index in table 3.3. These countries are Kuwait, Lebanon, Tunisia, Jordan, Morocco, Sudan, Egypt and Libya

with a decrease starting from 2.2% reaching 35.72%. The first country achieving the lowest negative growth rate is Kuwait from 519,418 subscribers in 2010 to 508,000 subscribers in 2013, recording a 2.2% decrease rate, this decrease is due to the increase growth of mobile phone subscription which reached 25.65% from 2012 to 2013 replacing this country in the second mobile phone growth index as shown in table 3.6.

Table 3.3 Fixed line growths for Arab countries by country, 2010-2013

		Subscriptions				Growth
Rank	Country	2010	2011	2012	2013	2010, 2013
1	UAE	1,460,985	1,825,496	1967500	2086000	42.78%
2	Qatar	291,478	305,969	394407	412584	41.55%
3	Bahrain	227,353	242,407	299416	291499	28.21%
4	Oman	281,000	287,323	304545	351411	25.06%
5	Saudi Arabia	4,130,000	4,633,100	4801800	4939700	19.61%
6	Djibouti	18,474	18,442	19955	20686	11.97%
7	Palestine	363,000	385,057	393880	403025	11.03%
8	Yemen	1,046,200	1,075,412	1104000	1143000	9.25%
9	Syria	4,070,749	4,381,100	4254000	4428800	8.80%
10	Algeria	2,922,731	3,153,500	3289400	3130000	7.09%
11	Kuwait	519,418	523,161	510000	508000	-2.20%
12	Lebanon	889,700	912,132	867000	870000	-2.21%
13	Tunisia	1,289,585	1,217,781	1098900	1022000	-20.75%
14	Jordan	485,000	424,000	434437	378411	-21.98%
15	Morocco	3,749,364	3,566,076	3279100	2924900	-21.99%
16	Sudan	544,684	483,617	424586	415571	-23.70%
17	Egypt	9,620,000	8,714,200	8557500	6820900	-29.10%
18	Libya	1,227,500	1,012,100	814000	789000	-35.72%
Total	Total	31676236	31335377	32814426	30935487	2.65%

Source: collected data from World Bank and ITU (2014)

For Kuwait fixed-line penetration rate in 2013 reached 15.08% placing this country in the seventh position of penetration index. Egypt has the second highest negative growth index

with 29.1% rate from 9,620,000 subscribers in 2010 to 6,820,900 subscribers in 2013 subtracting 2,799,100 subscription from its fixed-line base, where Egypt has the highest value of subscribers as it possesses the highest amount of population among the 18 Arab sample countries.

For the penetration index Egypt seated in the thirteenth position with a rate of 8.31% in the year 2013. The highest negative rate in fixed line subscription growth is recorded for Libya as last country in the fixed-line index with a decrease of 35.72% between the year 2010 and 2013, subtracting 438,500 fixed-line subscription. Penetration rate for Libya reached 12.72% in 2013, placing it in the eighth position on the penetration index.

Figure 3.3 shows the number of fixed-line subscribers for the 18 Arab sample study countries belonging to the years 2010, 2011, 2012 and 2013. The sequence by country is organized according to the growth of fixed-line subscription for the years 2010 and 2013. As shown in the figure UAE has the highest growth rate and Libya has the lowest growth rate. Egypt has the highest number of fixed-line subscription according to the highest population among these 18 countries.

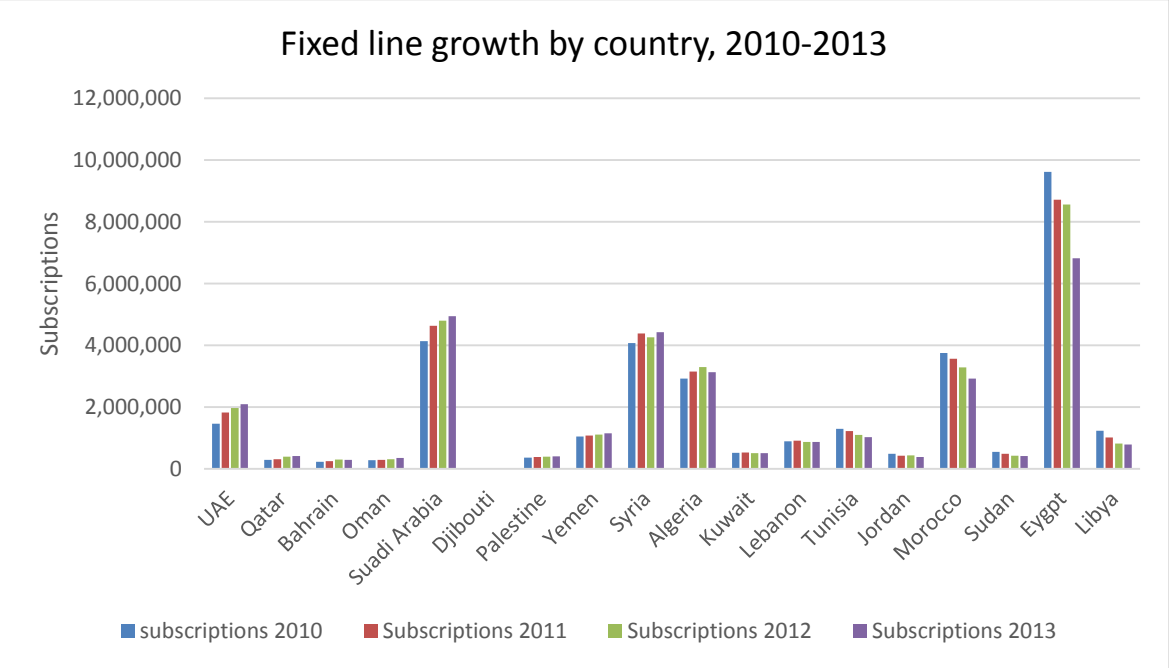


Figure 3.3 Fixed line growth by country, 2010-2013

Source: author with collected data from World Bank and ITU (2014)

3.2.2 Internet Users

The 18 Arab economies of the study accumulated for a number of internet users with 136,403,604 in 2013 arising from 122,268,327 in 2012 and achieving an increase rate of 12.55%. As shown in figure 3.4 the highest Internet penetration rate is recorded for the six Gulf countries beside Lebanon. There is a big gap of internet penetration rate between Arab countries with the highest rate recorded for Bahrain with 90% in 2013 and the lowest one with Djibouti recording 9%, followed by Libya as the second lowest internet penetration rate with 16.5%.

Table 3.4 Internet users' growth for Arab countries, 2012-2013

Rank	Country	Internet users		Growth
		2012	2013	2012-2013
1	Qatar	1,396,827	1792398.664	28.32%
2	Oman	2,127,115	2596143.024	22.05%
3	Yemen	4,342,047	5106643.4	17.61%
4	Libya	879,676	1033887.855	17.53%
5	Lebanon	2,719,946	3167873.79	16.47%
6	Egypt	37,690,797	43421453.3	15.20%
7	Saudi Arabia	15,927,865	18271635.86	14.71%
8	Djibouti	70,549	79538.968	12.74%
9	Kuwait	2,409,095	2711797.719	12.57%
10	Palestine	1,756,355	1942989.796	10.63%
11	Algeria	5,702,025	6300712.275	10.50%
12	Sudan	7,919,608	8742926.565	10.40%
13	Jordan	2,590,380	2855320	10.23%
14	Syria	5,206,799	5708826.73	9.64%
15	Tunisia	4,466,196	4768287	6.76%
16	UAE	7,609,661	7955180.64	4.54%
17	Bahrain	1,173,548	1214484.3	3.49%
18	Morocco	18,279,838	18733504.16	2.48%
Total	Total	122,268,327	136,403,604	12.55%

Source: collected data from ITU (2014, 2015)

The low internet penetrated countries such as Yemen and Libya with positions fifteen and seventeen in the penetration index, have highest internet growth rate with 17.61% and 17.53% respectively replacing them in the third and fourth ranks in the growth index, increasing the number of internet subscribers of Arab countries. Egypt has the highest internet users' number with 43,421,453.3 in 2013 achieving an increase in internet growth rate with 15.20% from the year 2012 with 37,690,797 internet users. For internet penetration rate Egypt is in the ninth place of the year 2013.

Morocco possesses the second highest number of internet users in 2013 with 18,733,504.16, although it has the lowest growth rate of internet users from the year 2012 to 2013 with 2.48%. Morocco is positioned in the eighth place in the internet penetration index with 56%. Saudi Arabia comes in the third highest number of internet users with 18,271,635.86 in 2013, which is positioned in the seventh internet growth index with 14.71%. Saudi Arabia has the same place of internet penetration index, as the internet growth index (with 61% penetration rate in the year 2013) increased from the rate of 54% in 2012. The highest second country in penetration rate is UAE with 88% in 2013 arising from 85% in 2012 (see figure 3.4).

More than 2.7 billion people are using the Internet, which represents 39% of the world's population. For our study sample of Arab countries, average internet penetration rate increased from 45.2% in the year 2012 to 49.3% in 2013, and this is relatively low compared with Europe that has the highest rate with 75% and Americas with 61%, but it is more than the average rate of developing countries with 31% and Africa with 16% compared with developed countries with 77% [Sanou, 2013]. So, Arab countries still need to work more to catch up with developed countries regarding Internet penetration rates, as a good indication of ICT usage.

The Internet penetration in households for Arab countries reached 33% in 2013, and this rate is less than that of Europe with 77%, Americas with 61% and more than that of Africa with 7%. The growth rate of internet penetration in households for Arab countries between the years 2009 and 2013 reached 15% compared with Africa with 27%. For Arab countries, in the year 2015, the households with Internet access reached 40.3% compared with the year 2014 with 36%. This percentage of households with Internet access for Arab countries is still

relatively low compared with developed countries with 80% and more, and this is relatively good percentage compared with developing countries with 34% and least developed countries with 7%, but sure it lags the world average with 46%, and the highest percentage of households with internet access recorded for Europe with 82.1% and 60% for Americas [TU, 2015].

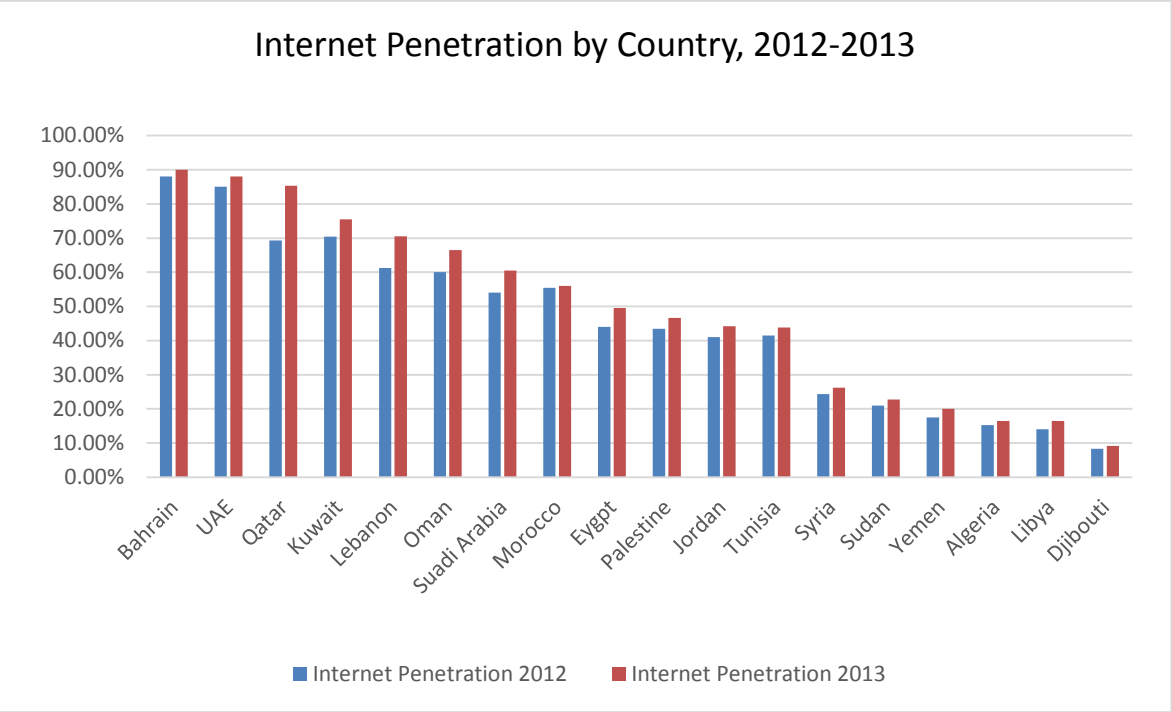


Figure 3.4 Internet penetrations by country, 2012-2013
Source: author depending on data of table 3.4

3.2.3 Broadband Connection

For broadband connection, ITU considers the speeds more than 256 Kbit/s as broadband and below 256 Kbit/s as narrowband, but some Arab countries consider all DSL connections as broadband.

As shown in table 3.5, the total number of fixed broadband subscribers for the 18 Arab countries involved in the study reached 9,395,755 in 2012 with an average penetration rate of 4.3%, and the subscription number increased to 10,645,288 in 2013 with an average growth rate of 18.72%, accounting for an increase of average penetration of 4.61% in 2013. Sudan has the highest fixed broadband growth rate with 80.17% increasing from 24,789 broadband subscribers in 2012 to 44,662 in 2013, with the lowest penetration rate ranging

from 0.07% in 2012 to 0.12% in 2013, placing this country in the last rank of fixed broadband penetration list. Yemen has the second highest broadband growth with 53.5%, arising from 167,300 subscribers in 2012 to 256,800 in 2013 adding extra 89,500 broadband subscription in year 2013 to its fixed broadband base. Libya recorded the least amount of broadband subscription growth with a negative value of 3.86% from 2012 to 2013. Libya also has a relatively low broadband subscription numbers and broadband penetration rates, starting from 67,300 subscribers in 2012 with penetration rate of 1.09% and ending with 64,700 subscribers representing 1.04% broadband penetration rate. Libya is the only country from the 18 Arab countries that has a negative broadband growth rate, where this negative rate may be accounted to the unstable situation facing this country.

As illustrated in figure 3.5, the two countries that represent the highest number of broadband subscribers are Egypt and Saudi Arabia with 2,674,800 and 2,120,000 in 2013 respectively. The broadband growth rank place of Egypt is the eighth one accounted from the year 2012 to 2013, with a rate of 15.95%. Saudi Arabia place of broadband growth rank is the twelfth one accounted from the year 2012 to 2013, with a rate of 7.84%. Syria is placed third in broadband growth rate of 42.94% by a total of 346,146 subscribers representing 1.58% penetration rate in 2013, up from 242,154 representing 1.11% penetration rate in 2012.

Kuwait is in the seventeenth place in broadband growth list with 0.0% rate and same number of subscribers reaching 47,000, and with decreasing penetration rate from 1.45% in 2012 to 1.4% in 2013. Arab countries stand out as the states with the fewest fixed-broadband subscriptions per 100 inhabitants, at 3.7% in 2015 compared with Europe with 29.6%, Americas with 18%, and Asia and Pacific with 8.9%, but more than Africa with 0.5%. This is a drawback indication where fixed-broadband services are significant driver of economic growth [Koutroumpis, 2009]. Mobile-broadband penetration level reached 40.6 active subscriptions per 100 populations compared with Europe at 78.2, the Americas at 77.6, Asia and Pacific at 42.3 and Africa at 17.4 in 2015 (TU, 2015). The growth of mobile broadband for Arab states from the year 2014 to 2015 is relatively high from 25% to 40.6%.

Table 3.5 Fixed broadband subscription growth by country, 2012-2013

		2012		2013		Growth
Rank	Country	Subscribers	Penetration	Subscribers	Penetration	2012- 2013
1	Sudan	24,789	0.07%	44,662	0.12%	80.17%
2	Yemen	167,300	0.70%	256,800	1.05%	53.50%
3	Syria	242,154	1.11%	346,146	1.58%	42.94%
4	Oman	71,214	2.15%	95,248	2.62%	33.75%
5	Morocco	681,568	2.10%	836,110	2.53%	22.67%
6	Djibouti	14,907	1.73%	17,707	2.03%	18.78%
7	Qatar	183,680	8.96%	215,487	9.94%	17.32%
8	Egypt	2,287,200	2.83%	2,674,800	3.26%	16.95%
9	Palestine	186,380	4.42%	213,065	4.92%	14.32%
10	Algeria	1,154,700	3.00%	1,280,000	3.26%	10.85%
11	UAE	951,785	10.34%	1,038,800	11.11%	9.14%
12	Saudi Arabia	1,965,800	6.95%	2,120,000	7.35%	7.84%
13	Lebanon	451,000	9.71%	480,000	9.95%	6.43%
14	Jordan	197,095	2.81%	205,532	2.83%	4.28%
15	Tunisia	527,915	4.85%	533,989	4.86%	1.15%
16	Bahrain	173,968	13.20%	175,242	13.15%	0.73%
17	Kuwait	47,000	1.45%	47,000	1.40%	0.00%
18	Libya	67,300	1.09%	64,700	1.04%	-3.86%
Total	Total	9,395,755	4.30%	10,645,288	4.61%	18.72%

Source: author with collected data from World Bank and ITU (2014, 2015)

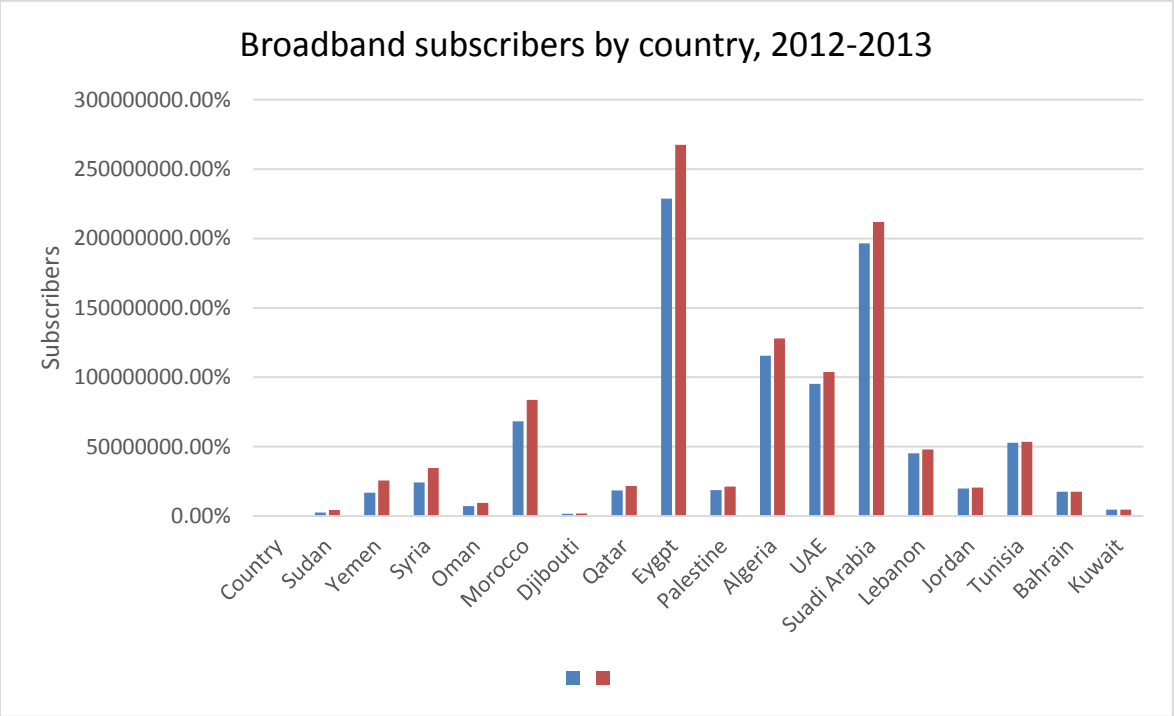


Figure 3.5 Broadband subscribers by country, 2012-2013
Source: author depending on data of table 3.5

3.2.4 Mobile Phone Subscriptions

The total number of subscriptions for the first study sample of 18 Arab countries is 365,492,900 excluding Djibouti with average mobile penetration rate of 126.13% in 2013 increasing from 347,571,068 with average mobile penetration rate of 113.79% in 2012, achieving an average mobile growth rate of 8.91%. Qatar has the highest mobile penetration rate reaching 27.26% and arising from 2,601,200 mobile subscribers in 2012 to 3,310,400 subscribers in 2013. The mobile penetration rate for Qatar increased from 126.86% in 2012 to 152.64% in 2013. Kuwait has the second place of mobile growth rate with 25.69% arising from 5,100,000 mobile subscribers in 2012 to 6,410,000 subscribers in 2013, with the highest mobile penetration rate reaching 190% in the year 2013, which increased from 156.86% in 2012. Saudi Arabia has the highest mobile penetration rate with 185.78% in average for the years 2012 and 2013, although this country has a small mobile growth rate with 0.2% placing it fifteenth in the mobile growth list. Saudi Arabia penetration rate decreased from 187.36%

in 2012 to 184.2% in 2013. Twelve countries out of the 18 Arab study countries have mobile penetration rates more than 100%.

Table 3.6 Mobile phone subscription growths by country, 2012-2013

		2012		2013		Growth
Rank	Country	Subscribers	Penetration	Subscribers	Penetration	2012- 2013
1	Qatar	2,601,200	126.86%	3,310,400	152.64%	27.26%
2	Kuwait	5,100,000	156.90%	6,410,000	190.29%	25.69%
3	Yemen	13,900,000	58.28%	16,844,700	69.01%	21.18%
4	UAE	13,775,300	149.64%	16,063,500	171.87%	16.61%
5	Jordan	8,984,300	128.17%	10,314,000	141.80%	14.80%
6	Palestine	2,885,000	70.12%	3,190,200	73.74%	10.58%
7	Morocco	39,016,300	119.97%	42,423,800	128.53%	8.73%
8	Libya	9,587,000	155.77%	10,235,300	165.04%	6.76%
9	Oman	5,277,600	159.25%	5,617,400	154.65%	6.44%
10	Algeria	37,527,700	97.52%	39,517,000	100.79%	5.30%
11	Bahrain	2,123,900	161.17%	2,210,200	165.91%	4.06%
12	Lebanon	3,755,200	80.81%	3,884,800	80.56%	3.45%
13	Egypt	96,798,800	119.92%	99,705,000	121.51%	3.00%
14	Tunisia	12,387,700	118.11%	12,712,400	115.60%	2.62%
15	Saudi Arabia	53,000,000	187.36%	53,104,000	184.20%	0.20%
16	Sudan	27,658,600	74.36%	27,659,000	72.00%	0.00%
17	Syria	12,980,000	59.30%	12,291,200	56.13%	-5.31%
18	Djibouti	212,468	24.72%	NA	NA	-
Total	Total	347,571,068	113.79%	365,492,900	126.13%	8.91%

Source: collected data from ITU (2014)

These rates show the increasing demand for mobile phone lines and the ease availability of these lines in addition to competitive offers from the mobile phone operators in these countries, ranging from two to four operators for each country.

Figure 3.6 shows the number of mobile phone subscribers of the 18 Arab countries in the sample study arranged according to the mobile growth rates from the largest to the smallest from the year 2012 to 2013. As illustrated in the figure Egypt and Saudi Arabia have the largest amount of mobile subscribers with 99,705,000 and 53,104,000 respectively, followed by Morocco with 42,423,800 subscribers in 2013.

Globally mobile phone penetration reached 100% with market penetration saturation. For Arab countries mobile phone penetration reached 105% in 2013, which is less than that of developed countries with 128% and more than developing countries with 89% [Sanou, 2013]. In the year 2014, mobile-broadband subscriptions for Arab countries reached 25% and this is relatively low compared with develop countries with 82%, and Europe with 64%, Americas wit 59%, and this percentage is more than that of Asia and Pacific with 23% [Data, 2014].

3.2.5 ICT basket prices

The ICT basket price which consists of the prices of services for fixed telephone, mobile-cellular and fixed broadband is considered one of the significant complementary indicators used to monitor and measure the digital divide and predict its future. This indicator reflects the size of the differences between the countries regarding the liberalization of the ICT sector level and the degree of competition between operators and companies. There is a reverse relationship between the prices and the development index of ICT, where when the basket prices of these services decreases, it means that larger numbers of individuals, institutions, companies and households are enabled to access to these services which will improve the location of this country and its ranking in ICT global classifications and then narrowing the digital gap between this developing country and the developed countries.

The high values for the development of ICT index indicate lower costs of ICT services that lead to increase the ICT development index. In the year 2013, the economies with ICT index more than 5 compared with the highest value achieved by Denmark with 8.86, the value of ICT basket price for these countries was less than 2% of monthly GNI per capita, in the other hand the countries with ICT index less than 3 corresponded with the value of ICT basket price more than 10% of GNI per capita.

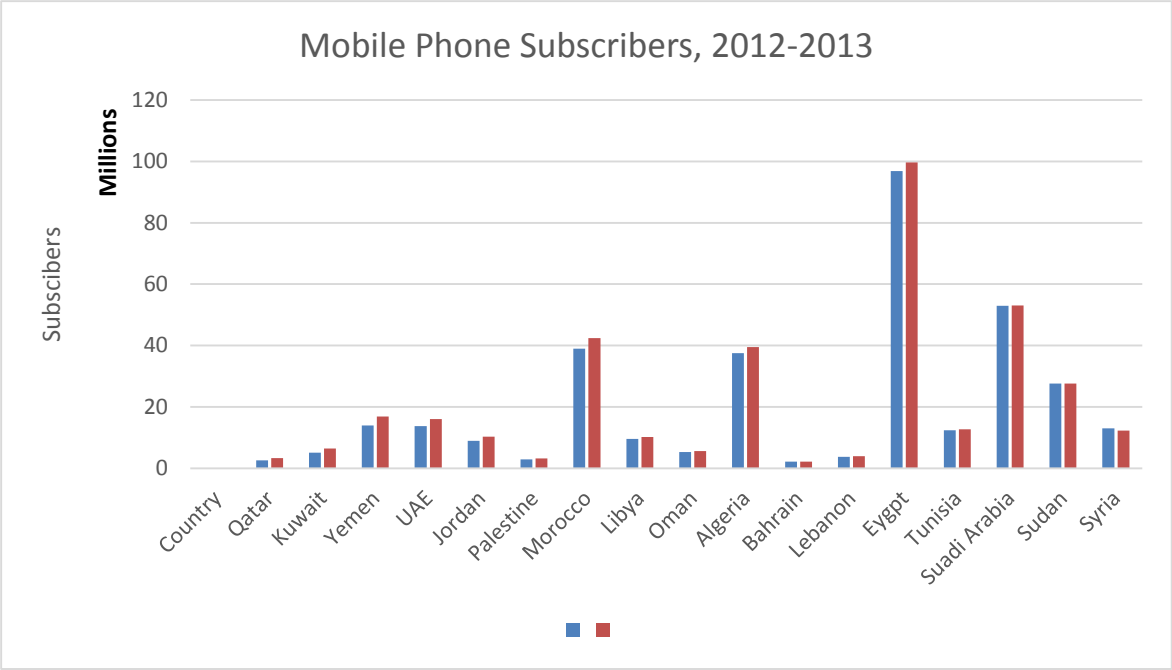


Figure 3.6 Mobile phone subscribers by country, 2012-2013
Source: author depending on data of table 3.6

The people in developed countries pay less than 4.2% from their monthly income on ICT services compared with the average payment in developing countries with 17.5% which ensures that the prices of ICT services are a significant factor that contributes in ICT development and narrowing the digital divide. The prices of ICT services dropped by 15% between the years 2008 and 2009. The prices of fixed broadband decreased by a larger value with 42% compared with the decrease of mobile phone services with 25% and the fixed line with 20% [ITU, 2009]. In the year 2008, ICT price basket value represents up to 15% of countries' average GNI per capita. This value differs from 1.6% in developed countries to 20% in developing ones.

Most Arab countries encountered decrease in ICT basket prices for the period (2009-2014). In 2009, the ICT basket prices corresponded to an average of 13% of gross national income per capita. Kuwait was the only Arab country among the ten economies of the lowest ICT services basket prices. Mobile phone service prices decreased significantly in Arab countries compared to the other sub-ICT baskets in developing countries. There is a gap in communication price services between developed and developing countries, while mobile

phone service prices were 1.1% of their monthly GNI per capita in Europe they were 17.7% in Africa, 3% in Americas and Asia and Pacific, and 4.6% in the Arab countries. Although the wide spread of Internet broadband high speed service, the price of this intermediate service is still to this day higher by about 500% of the average per capita income in Africa and 71% in the Arab region and 46% in Asia, compared with 10% in the Americas and 2% only in the west Europe. There is a significant differences in ICT services prices between Arab countries. The GCC countries reduced ICT prices significantly, as Kuwait with the lowest prices, followed by UAE, Bahrain, Qatar and Saudi Arabia respectively, where the highest prices were in the poor Arab countries such as Sudan, Mauritania and Yemen. Data of ICT basket prices are summarized in table 3.7 for the years 2013 and 2014.

In the year 2013, Arab countries encountered less prices for Fixed-broadband as a percentage of GNI per capita than that of the years 2008 with 71%, where the percentage prices were 4.1% compared with Europe with 1.4%, the Americas 9% and Asia and Pacific with 23.7%. In the year 2013, the GCC countries in addition to Tunisia have the cheapest fixed broadband prices ranging from 0.4% for Kuwait to 1.8% for Saudi Arabia as percent of GNI per capita. Tunisia Telecom bids frequent advertisings for ADSL services with cheap prices in the region reaching 6.1 US dollar monthly as the cheapest price promoted in the Arab countries for Internet access at speeds more than 512 kb/s. The good indication of relatively low fixed-broadband penetration in Tunisia with 1.7% by end of 2013, encounters that in order to advance ICT usage works need to be attentive on increasing the spread of the ADSL network to extra areas, and on enhancing ICT skills and endorsing applicable home-grown Arabic content.

In the year 2013, Arab countries handset-based mobile-broadband prices are less than 5% within average, and prices are a little more the prices of computer based mobile-broadband services, and these values is more than the case of Europe with an average of 1.3%, and less the values of Africa, Asia and Pacific [ITU, 2014]. In the Arab countries mobile broadband is cheaper than fixed broadband.

Basic fixed-broadband services are affordable for 90% of the Tunisia and Jordan inhabitants in contrast of mobile broadband services that cost more than 10% for more than 50% of population, while they are more expensive in Sudan and Egypt with more than 5% of

household consumption expenditure. in Sudan and Egypt the cost of a elementary fixed-broadband service denotes less than 2.5% of family consumption expenditure for the richest who represents 20% of the people, as in contradiction of more than 10% of family expenditure for the poorest (20% of the people). Figure 3.7 shows the prices of fixed-broadband for various world regions, where Arab countries have in average 62.1 PPP$ which is a relatively high prices compared with Europe, CIS, Americas, and Asia and Pacific.

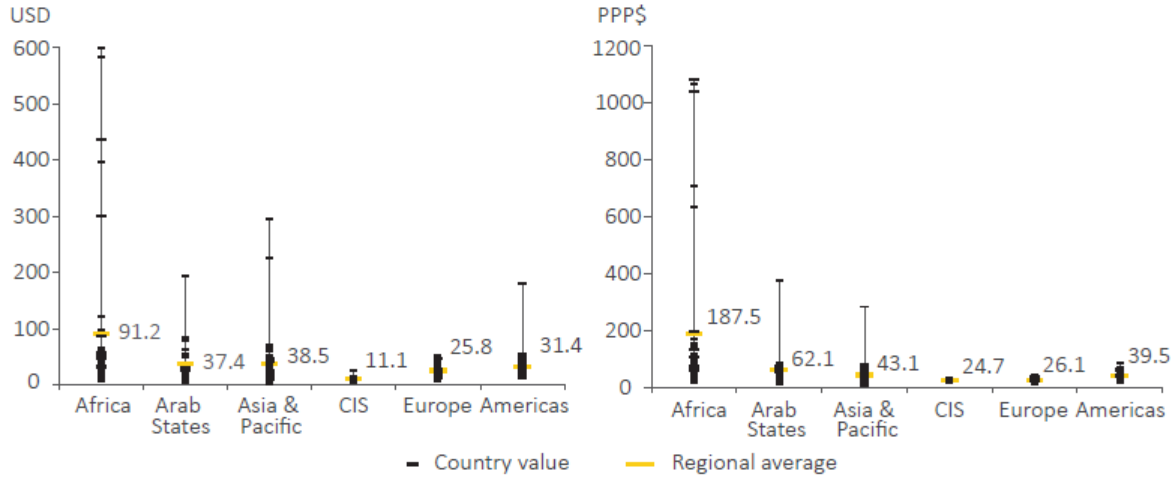


Figure 3.7 Fixed-broadband prices for different world regions, 2014
Source: [ITU, 2015]

In 2014, mobile-cellular prices reached 3.63% (percentage of GNI per capita) compared with Europe at 1.47%, Americas at 3.9%, Asia and Pacific at 3.63%, CIS at 3.6% and Africa at 17.91%. In 2014, mobile-cellular prices for most Arab countries match to less than 5% of GNI p.c., therefore the service is fairly inexpensive, costing from PPP$ 10 to PPP$ 30 [ITU, 2015]. Fixed broadband prices reached 9.2% as a share of GNI per capita for Arab countries. In 2014, more than that of Europe with 1.3%, CIS with 3.6%, Americas with 7.4% and less than that of Asia and Pacific with 16% and Africa with 178.3%. In 2014, fixed-broadband prices in Arab countries reached an average value of 62.1 PPP US Dollar, compared with Europe at 26.1 and Asia and Pacific at 43.1 PPP US Dollar. There is a large variations in the prices of fixed-broadband between Arab countries as the income varies where oil-exporting Gulf countries have higher income than other Arab countries. In the six Gulf Arab countries fixed-broadband prices are cheap representing less than 2% of GNI per capita, so as for

Tunisia with 1.7%. In Lebanon, Morocco, Algeria, Libya, Egypt, and Sudan the prices are less affordable but still relatively cheap less than 5% of GNI per capita. In Iraq the price is so expensive reaching 34.5%. Several Arab countries offer limited data capacities for fixed-broadband services such as Lebanon with 40 GB, Bahrain with 25 GB, Libya with 20 GB, Jordan with 10 GB, Yemen with 9 GB, Egypt with 5 GB and Sudan with 2 GB. Other Arab countries offer unlimited capacities of fixed-broadband services such as Qatar, Kuwait, Saudi Arabia, UAE, Oman, Tunisia, Morocco and Algeria. The prices of fixed-broadband services for Arab countries range from 0.3% (percent of GNI per capita) for Kuwait to 9.5% for Yemen and 34.5% for Iraq. The fixed-broadband speeds range from 256 Kb/s to 50 Mb/s.

In the year 2012, regarding the prices of mobile-broadband services, Arab countries come in the second place after Europe regarding the lower expenses of mobile-broadband services. The prepaid handset-based with 500 MB data reached 5.7% of monthly GNI of Arab countries, which is more than Europe with 1.1% and less than Americas, Asia and the Pacific with 5.9%, and Africa with 38.8%. For post-paid handset-based with 500 MB data, Arab countries reached 2.2% of monthly GNI, for prepaid computer-based with 1 GB data, they reached 7.4% and for post-paid computer-based with 1 GB data, they reached 2.5%, again more expensive than Europe and less expensive than Americas, Asia, the Pacific and Africa. This is relatively a good opportunity for Arab countries to have relatively cheaper mobile-broadband services, where as many studies illustrated mobile-broadband services do influence economic growth positively, but efficient utilization is needed in this case [Sanou, 2013]. In 2014, there was a relatively more reduction in the cost of mobile broadband services and this is a good indication of ICT efficient usage, which is needed to positively influence economic growth.

In the year 2014, the prepaid handset-based with 500 MB data reached an average of 5.22% of monthly GNI per capita of Arab countries, that is more than Europe with 0.82%, the Americas, Asia and the Pacific, and less than Africa with 15.2%. For post-paid handset-based with 500 MB data, Arab countries reached 5.15% of monthly GNI per capita, for prepaid computer-based with 1 GB data they reached 6.07% and for post-paid computer-based with 1 GB data they reached 7.93%, again more expensive than Europe, Americas, Asia and Pacific. So the average cost of mobile broadband services is more than 5% of per capita

income. In 2014, prepaid handset-based prices reached less than 5% of per capita income in most Arab countries, and less than 1% in Arab Gulf countries. This proves that the prices in the majority of Arab countries are relatively inexpensive.

There is a positive correlation between the liberalization of the telecommunications sector on one hand, and lower telecommunications services prices in the other hand, which result in high access rates to fixed telephone, mobile and broadband Internet service, where the more competition in the market, the more quality of services and lower prices.

Table 3.7 ICT basket prices by country, 2013-2014

Global Rank	Country	ICT price basket		Fixed basket % GNI per capita		Mobile basket % GNI per capita		Fixed broadband % GNI per capita		GNI per capita 2014*$
		2013	2014	2013	2014	2013	2014	2013	2014	
2	Kuwait	0.3	0.3	0.3	0.2	0.4	0.4	0.4	0.3	46046
5	Qatar	0.4	0.4	0.1	0.1	0.3	0.3	0.8	0.9	86703
20	Oman	0.7	0.7	0.5	0.5	0.4	0.4	1.2	1.2	25381
24	UAE	0.8	0.8	0.3	0.3	0.3	0.3	1.7	1.7	38713
21	Bahrain	0.9	0.7	0.3	0.3	0.7	0.7	1.6	1.1	19881
27	KSA	1.2	0.8	1.2	0.6	0.6	0.6	1.8	1.2	26234
61	Tunisia	1.6		1.4		1.6		1.7		4360
81	Egypt	1.8	2.3	1.0	1.0	2.1	2.0	2.5	4.1	3137
70	Lebanon	2.2	1.9	1.4	1.1	3.0	2.5	2.1	2.1	9860
91	Algeria	2.9	2.8	1.3	1.3	2.9	2.9	4.4	4.4	5325
102	Jordan	2.9	3.5	2.3	1.9	1.9	1.2	4.6	7.3	4945
108	Morocco	3.6	4	0.9	2.6	5.2	4.7	4.7	4.7	3017
88	Sudan	4.6	2.8	3.9	2.3	3.9	2.6	6.1	3.5	1548
149	Mauritania	19.4	20.9	18.7	32.3	16	16	23.7	14.2	1059
121	Yemen		6		0.9		7.6		9.5	1329

Note: * Data match the GNI per capita in 2014, accustomed with the worldwide inflation rates. GNI per capita and PPP$ prices according to World Bank data. Source [ITU, 2014, 2015]

Increasing per capita income enables people to obtain ICT services affordably and cheaply, and vice versa. World ICT basket prices in the foreseeable future tend to decrease with the entry of national and foreign private sector companies, where this decline will benefit peoples of the low and middle income countries and this will lead to narrow the digital divide in access and prices for ICT indicators, but the gap remains longer in digital usage and content.

3.2.6 ICT in Palestine

After the establishment of the Palestinian Authority (PA) in 1994 and its resulting responsibility in managing the Palestinians issues such as the telecommunications sector, where this ICT sector encountered a strong start and development. After Oslo Agreement and the evolving development of the social, economic, private and public areas there was an increased request for technology in Palestinian territories, especially from PA that contributed a vast part of demand from software applications, information systems solutions, computers hardware and peripherals for its different departments and establishments. Palestinian Authority realized the important role of ICT in advancing development process. Palestinian Authority made so much efforts to promote and encourage the spread of ICTs, and has taken a series of procedures and policies concerning the establishment of relevant government departments such as the Ministry of Communications and Information Technology, which is responsible for regulating the telecommunications and IT sector in the Palestinian territories. PA also updated a set of laws governing the work environment and regulations for the ICT sector in the Palestinian territories. The privatization of ICT sector as PA did, led to the promotion of development for this sector and consequently the other sectors affected by ICT. PA worked to improve infrastructure services through the development of programs, plans and projects for advancing ICT sector and allocated hundreds of millions of dollars from the PA budget and from the international aid to implement those projects.

PA did not have a predetermined, obvious plan and road map to support the spread of ICT and advancing the knowledge society, as for other Arab countries [PTC, 2010]. Despite of

this, there was the national technology strategy which was adopted and approved in 2004 by the Ministry of Communications and Information Technology and the e-learning initiative in 2006, in which, they played an important role in the development of of ICT tools and access in the Palestinian territories. Palestinian territories Lacked organized regulatory and legal structure, there is no law to protect intellectual property rights and copyright. Also there is general lack of a regulatory framework governing the work and control of ICT and related subjects such as regulating Internet usage, and conducting security and consumer privacy.

Palestinian Telecommunications Company (PALTEL) was established in 1995 as a public shareholding company and began its work on the first of January 1997, where it has obtained an exclusive franchise for 20 years to provide fixed line and mobile services in the Palestinian territories. The company has built an infrastructure and equipping an advanced digital network for connecting Palestine with the world using a high quality communication network. PALTEL began offering Internet services to local companies, public and private institutions directly through the phone service. In addition to that it has introduced the Mobile Palestinian Cellular Communications Company (JAWAL) in the year (2000), which has the right of franchise for a period of 5 years. After this an agreement was signed with the Mobile International Company (WATANYA) as the second operator of cellular communications in Palestinian territories. The company actually began its work in the middle of October of the year 2009.

In the year 2015, the total number of Internet companies according to the Ministry of Telecommunications were 56 companies with 40 Companies that provide wireless connection to the Internet (WIFI), 6 companies provide voice over IP (VOIP) services, and 10 companies with Broadband Internet connection. Also, there is 40 companies which work in importing communications' equipment. In 2014 the number of fixed telephone lines reached 403,100 in Palestine. The number of mobile phone subscribers exceeded 3.1 million in the year 2014. Also in the year 2014, the number of ADSL subscribers exceeded 235,000. The number of computers for Palestinian families was estimated at 1.1 million computer[8].

8 http://www.pcbs.gov.ps/portals/_pcbs/PressRelease/Press_En_IntDyInfoSoc2015E.pdf

The rank of Palestine in terms of Facebook users is in the 62 position in the world with 37% of the inhabitants using the social networking sites, as compared to Jordan and Lebanon, where they are in 68 and 69 positions with percent's of 35% and 35% correspondingly. For the purposes of using Internet in Palestine, the statistics show that 85.7% for access to information, 79.3% for entertainment, 69.1% for communication, 49.3% for studying and 18.2% for work [The Portland Trust, 2012].

3.2.6.1 Fixed telephone line market

The number of fixed telephone subscribers in Palestine reached 403,025 subscribers in 2009, where the number was 110,893 in 1997, an average increase of 16.06%, and in respect of rates of penetration of fixed-line that is the fixed-telephone subscriptions per 100 inhabitants, we find that they have perceived during the same period a kind of fluctuations from 8.39% in 2009 to 9.41% in 2009 and 9.09% in 2014. These rates are low compared to the fast increasing rates in Mobile-cellular subscriptions per 100 inhabitants, this happened as a result of opening mobile phone market (JAWAL) on the internal and external competition in the year 2000, which has led citizens to replace the mobile phone for fixed line because of the advantages valued by the mobile and the various services it provides.

The number of main telephone lines in the Palestinian territories has increased between 1997 and 2006 by more than three times from 110,893 lines, to 337,025 lines, due to the ongoing work of the Palestinian Telecommunications Company and the lack of satisfaction of the Palestinian market before the year 1997 because of the complexities and the delay for the installation requests which is implemented by the Israeli company (Bezeq). In 2014 about 39.8% of families own a fixed telephone versus 50.8% in 2006, meaning that there is a kind of decline since 2006 and this is due to the orientation of families to use the mobile phone, where the participation in the fixed-line is for the Internet, as a large percentage of Internet service provided by using ADSL through fixed telephone lines. The households' telephone lines in Palestine represent 90% of the total fixed lines [PCBS, 2012a].

3.2.6.2 Mobile phone market

The number of subscribers using the Israeli mobile phones in the Palestinian territories per 100 of the population in the period between the years 1995 - 1999 was low, but this number increased continuously from 0.86% in 1995 to 3.3% in 1999 as there were no any legal mobile communications company operating in the Palestinian territories at that time. The percentage of households with a mobile phone reached 43.7% of the total Palestinian families in the year 2000, surpassing the percentage of households that have a fixed telephone line, which amounted to% 42.1 in the same year. The number of mobile phone subscribers reached 8.19% for 100 inhabitants in the same year. After the establishment of the Palestinian mobile phone company (JAWAL) in the year 2000 legally, the increase in the number of mobile subscribers continued rapidly reaching 72.08% per 100 inhabitants in 2014, as also in 2009 the Mobile International Company (WATANYA) began its work in the Palestinian territories. In year 2009 the percentage of households with a mobile phone reached 92.4% of the total Palestinian families, exceeding in a high rate the percentage of households that have a fixed telephone line, which amounted to 47.5% in the same year [ITU, 2009].

3.2.6.3 Computer market

Palestinian territories perceived a rapid growth in the proportion of households who own computers. The percent of households that own computers raised from 10.8% in the year 2000 to 63.1% in the year 2014.The individuals who own computers in Palestine raised from 35.7% per 100 inhabitants in the year 2004 to 60.2% in 2014. The percentage of individuals using computers after the age of 10 years is 53.7% in the year 2011where this percent increased from 37.4% in the year 2004 [PCBS, 2014].

3.2.6.4 Internet penetration

The percentage of Palestinian households that have access to Internet at home reached 2 % in the year 2000, but it reached the percent of 9.2% in 2004. After this year the percent of households who have internet connection increased rapidly reaching 32.1% in 2012, and in the year 2014 this percent reached 48.3%. The percentage of individuals who use the internet is also low starting from 1.11% in the year 2000 for 100 inhabitants to 46.6% in 2013, where

the usage of computers and internet is considered part of education necessities and an important measure for the illiteracy percent in a society. The percent of individuals (10 years and above) who used computer for the purpose of using Internet reached 53.7% in Palestine. Internet users for both males and females in the year 2014 in Palestine reached 59.6% and this is a high increased percent compared to the year 2000 where the percent reached 7.9% for males. The percent of using internet by females in the year 2014 reached 47.5% compared to the percentage of 2.8 % in the year 2000, where the gap of usage between males and females receded. One of the important and most used ways to access the internet by Palestinian households is ADSL using the fixed telephone line, where the percent reached 41.2% in the year2009 and the number of ADSL subscribers exceeded 235 thousands in the year 2014. The traditional way for internet connection is using the fixed telephone line, but this way deteriorated for the favour of ADSL as its requirements for connection is similar to that of fixed telephone line. In addition using the wireless communication to access internet such as Wi-Fi spread and also using the mobile phone, where using this method is expected to increase as recently Israel allowed the mobile companies to use 3G mobile communication mechanism.

3.2.6.5 E-commerce in Palestine

E-commerce includes all activities of selling, buying and exchanging of products, services and information over computer networks such as Internet technology [Turban and King, 2011]. E-commerce involves ongoing interacting between customers and suppliers mainly over web applications under online basis. E-commerce encompasses investigating market associated information, promoting goods and services, processing electronic orders of goods and services, settling financial transactions for these orders and undertaking after sales services. Many researchers consider E-commerce in developing countries as being in its earliest stages encountering weakness and primitiveness [Kshetri, 2008; Poon and Swatman, 1999]. There are many reasons that are barring E-commerce from thriving in developing countries so as for Palestine such as deficiency of compatible ICT infrastructure, lack of electronic payment services, lack of distribution logistic, and lack of organizational,

technical, and environmental reasons [Kapurubandara and Lawson, 2006; Lawrence and Tar, 2010].

We investigate the most decisive factors for successful enactment in adopting electronic commerce transactions for enterprises business in Palestine. The results of the study emboldened the most critical factors to advance electronic commerce adoption that include 19 factors prearranged in descending order using three tiers [Hodrob et al., 2014]. All the factors were in route with similar studies and cited literatures. The worldwide progressed adoption of e-commerce services as a forceful method for enlightening enterprises competitiveness and efficiency shaped a requisite for the instigation of this empirical investigation. The challenges showed extreme more than just challenging in developing countries where the knowledge and practice of e-commerce services are in the very early stages. The consequences of this exploration propose that lecturing nineteen critical e-commerce adoption factors that increase the likelihoods of realisation of applying e-commerce practices in the Palestinian context. The investigation of the results discloses that ten out of the nineteen critical e-commerce adoption factors which are recognised in this inquiry pooled most values covered by key values adopted by interrelated studies, as follows:

- Perceived usefulness as enterprise' clients are appealed to implement e-commerce services, when they feel that these services are useful to them.
- Designing and developing the e-commerce tools and web systems that are easy to use.
- Overwhelming security risk matters and concerns which are visible from enterprises customers' awareness.
- Overwhelming enactment risk topics to resolve the enterprises customer's doubts for a prospect of the outflow of personal data.
- Comforting the creditability of e-commerce enterprises' services, so that no money will be gone.
- Generating E-commerce services that are free of cost.

Enterprises need to develop systems for determining crucial indicators that stimulus the way the enterprise adds value by using e-commerce services, and to advance a system using tools such as dash boards for evaluating key indicators of the level of observed security and

performance risk that come upon e-commerce system. E-commerce features and functions that endorsed usefulness, ease of use, security and performance risk concerns need to be confirmed by setting fruitful role models.

For the measures of using and conducting computers, internet and electronic commerce transactions by different types of Palestinian enterprises, the survey study held by PCBS titled business survey on ICT in the year 2011 illustrates these findings of figures as shown in table 3.8. The survey sample contained 3,006 enterprises where 2,366 enterprises completed the interview, of which 1,796 enterprises were in the West Bank and 570 enterprises in the Gaza Strip with 84.9% response rate. These enterprises include industrial representing 14.4% of business according to the held survey, constructions representing 0.5%, internal Trade representing 57.9%, transportation and storage representing 0.9%, financial intermediation representing 0.8%, services representing 25.1% and information and communication representing 0.4%.

Table 3.8 Some selected ICT measures for Palestine, 2011

Percentage of enterprises Using Computer	47
Percentage of enterprises connected to the Internet	39
Percentage of enterprises conducted E-commerce transactions	11.2
Percentage of enterprises owning a website	4.8
Percentage of enterprises involved in research and development in IT	2.5
Number of computers to 100 employees	22.3
Number of landline per 100 employees	25.9
number of employee using computer per 100 employees	47.9
Number of employees using the Internet per 100 employees	42.9
Number of IT specialist per 100 employees	5.2

Source: PCBS, 2012.

Some of the results of the Survey shown in table 3.8, exposed that 47.0% of all enterprises owned computers in the year 2011, and this percentage increases as the enterprise size represented by number of employee goes up [PCBS, 2012a]. The percentage of computer ownership by enterprises with employees' size more than 10 touched 92.4%. In respect to the Internet access, overall 40.6% of enterprises connected to Internet, with 80.6% of enterprises with size above 10 employees. The purpose of about 80% of all enterprises who own computers was to connect to the Internet. The survey revealed that 66.1% of all enterprises own a fixed telephone. Regarding mobile phone 100% of enterprises own at least one, regardless to their sizes.

The survey outcomes showed that enterprise size and the nature of economic activity conducted by these enterprises are considered among the most important parameters that governs the degree of commitment towards using ICT, whereas the size of enterprise increases the using of ICT solutions such as conducting electronic commerce transactions of promoting, selling and buying of goods and services [PCBS, 2012b]. For the nature of economic activity held by Palestinian enterprises and its impact in the degree of usage of computer, internet and e-commerce transactions, the financial intermediation reached the highest with 97.1% followed by ICT and service sectors, whereas the lowest usage verified by the industrial sector with 26.3%. This can be devoted to the nature of goods and services as being touchable or non-touchable, as the enterprises with service oriented business have higher diffusion to ICT practices. Enterprises in Palestine with Internet connection that placed at least one purchase or received at least one selling order through the Internet order reached 28.5%, using email or any other online solutions. Therefore, for implementing e-commerce by Palestinian enterprises the online purchase is done at about 1.5% of all enterprises with employment size more than 4 and Internet banking is used by 1.2% of all enterprises connected to the Internet [PCBS, 2012b], and these figures are so low compared to other countries such as the United Kingdom (UK) with 10.7%, Germany with 8.0%, Switzerland with 7.4% and Denmark with 7% regarding the online share of retail trade in the year 2010 compared with 2014 with percentage shares of 13.5% for UK and 10.0% for

Germany[9], so Palestinian community needs so much efforts to be ready to benefit from e-commerce practices effectively.

3.3 Directions of Economic Growth related to ICT in Arab countries

In 2014, GDP of Arab countries at market prices with current US$ reached 2.846 trillion US Dollar. In the same year population of Arab world reached 385.3 million. Table 3.9 shows the composition of GDP by sector for Arab countries ranked globally according to GDP, where Saudi Arabia is in the nineteenth global rank according to its GDP with 777,900 million US Dollar, followed by United Arab Emirates and Egypt. The tables shows the shares of the three main sectors (services, industry and agriculture) that compose the GDP of Arab countries. Figure 3.8 shows the average of GDP composition of all Arab countries by sector in the year 2014, where the main contribution comes from services (43.08%) and industry (53.04), and the least contribution for the agricultural sector (5.49%). ICT is part of services and it affects all other sectors as it is needed and embedded in all systems concerning all business sectors.

As shown in table 3.10 the percentage of ICT expenditures of GDP in 2005 and 2006 for Jordan is more than that of other countries such as Turkey, Ireland and India and also more than that of the world, but for the other selected Arab countries in the same table the percentage of ICT expenditures of GDP is less than that of the world and other world countries which are shown in the table for the same period. Egypt and Kuwait have the least percentage of ICT expenditures of GDP in 2005 and 2006 compared with the world and other Arab and world countries shown in the table below, and this is not a good sign as the importance of investment in ICT for economic growth. As we note from the table Turkey expends more in ICT than the selected Arab countries (32,967 million $ in 2006), nearly 23 times more than Egypt. Figure 3.9 shows the exports of computer, communications, ICT and other forms of commercial services are less than that of the world, as a percentage of total commercial services exports. The same thing for imports less difference between Arab world and the world as shown in figure 3.10.

9 http://www.retailresearch.org/onlineretailing.php

Table 3.9 Arab countries GDP composition by sector, 2014

Global Rank	Country /Economy	GDP (millions of $)	Agriculture		Industry		Services	
			GDP	Share %	GDP	Share %	GDP	Share %
19	KSA	777,900	15,558	2.0	464,406	59.7	297,936	38.3
29	UAE	416,400	2,498	0.6	245,261	58.9	168,642	40.5
41	Egypt	284,900	41,595	14.6	110,826	38.9	132,479	46.5
47	Iraq	232,200	7,663	3.3	149,769	64.5	74,768	32.2
51	Qatar	212,000	212	0.1	144,161	68.0	67,628	31.9
59	Kuwait	179,300	53, 800	0.3	88,574	49.4	90,009	50.2
63	Morocco	112,600	15,764	14.0	28,037	24.9	68,799	61.1
67	Oman	80,540	1,047	1.3	44,458	55.2	35,035	43.5
72	Sudan	70,030	18,768	26.8	24,931	35.6	26,401	37.7
74	Syria	64,700	10,611	16.4	14,687	22.7	39,402	60.9
87	Libya	49,340	987	2.0	22,598	45.8	25,755	52.2
88	Tunisia	49,120	4,273	8.7	14,245	29.0	30,602	62.3
91	Lebanon	47,500	2,993	6.3	10,023	21.1	34,485	72.6
92	Yemen	45,450	4,181	9.2	12,181	26.8	29,088	64.0
96	Jordan	36,550	1,170	3.2	10,709	29.3	24,635	67.4
99	Bahrain	34,050	102	0.3	16,038	47.1	17,910	52.6
192	Djibouti	1,582	46	2.9	263,000	16.6	1,274	80.5
154	West Bank	6,641	193	2.9	1,567	23.6	4,881	73.5
230	Gaza Strip	-	-	5.7	-	16.9	-	77.4

Source: collected data from World Bank World Development Indicators (WDI) (2014)

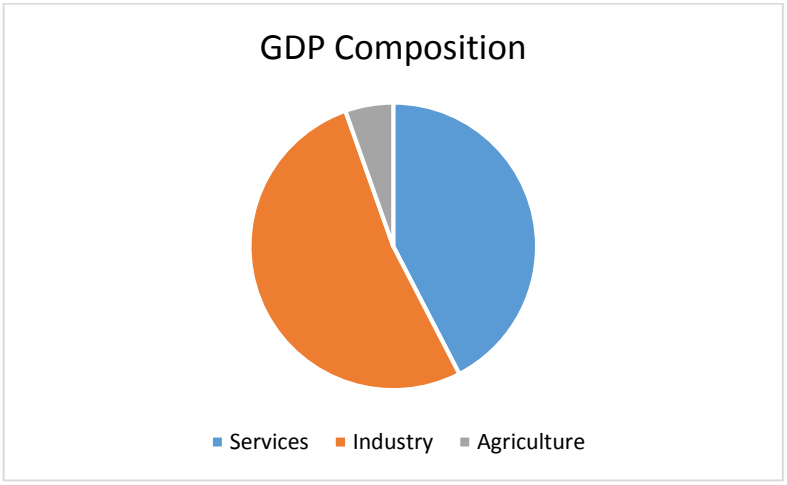


Figure 3.8 GDP composition of Arab countries by sector, 2014
Source: World Bank (2014)

Table 3.10 ICT expenditures, 2005 - 2006

Country/world	GDP		ICT expenditures			
	Millions of US dollars		Millions of US dollars		Percentage of GDP	
	2005	2006	2005*	2006	2005	2006
Jordan	12 611	14 101	1 067	1 128	8.5	8.0
UAE	129 702	129 702	4 658	5 101	3.6	3.6
Tunisia	28 683	30 298	1 672	1 823	5.8	6.0
Algeria	101 786	114 727	2 503	2 797	2.5	2.4
Kuwait	80 781	101 904	1 109	1 212	1.4	1.4
Egypt	89 686	107 484	1 324	1 460	1.5	1.4
Morocco	58 956	65 401	3 267	3 637	5.5	5.6
Saudi Arabia	315 580	349 138	6 992	7 290	2.2	2.1
Ireland	200 426	220 137	8 848	9 419	4.4	4.3
Turkey	363 370	402 710	28 517	32 967	7.8	8.2
India	805 732	911 813	46 438	55 304	5.8	6.1
World	44 983 465	4 846 854	3 042 129	3 254 541	6.8	6.7

Source: World Bank (2007)

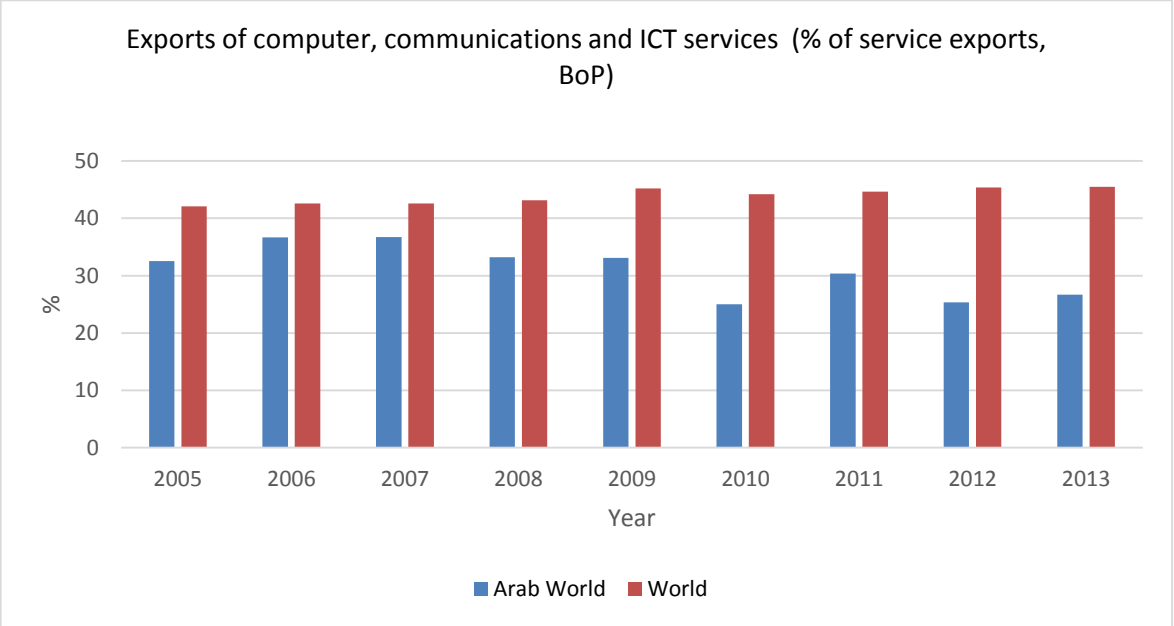


Figure 3.9 Exports of computer, communications and ICT services, Arab World, World
Source: author depending on data from World Bank (2007, 2014)

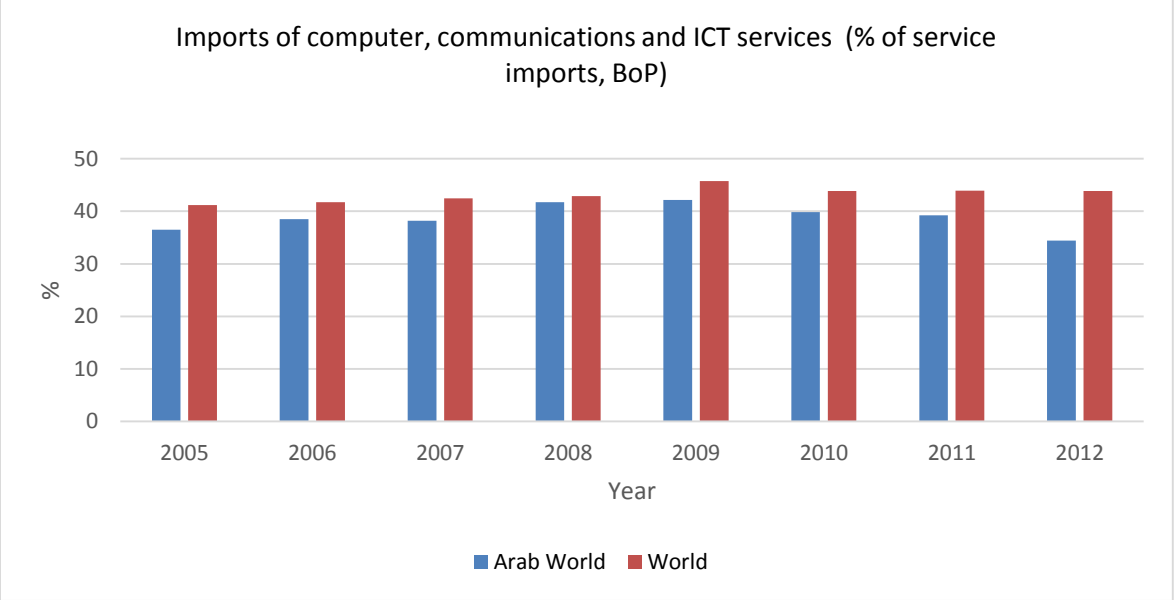


Figure 3.10 Imports of computer, communications and ICT services, Arab World, World
Source: author depending on data from World Bank (2007, 2014)

3.3.1 The role of Egypt's ICT market in economy

ICT sector in Egypt became a main economic sector in 2000's, targeted by FDI. The ICT market made returns of nearly 65 billion (EGP) in the year 2011, with a rise of about 55%

compared to the year 2005. Exports of ICT increased from EGP 1,442 million in 2005 to 7,891 million in 2012 [MCIT, 2014]. The number of ICT companies in Egypt grown 15% in 2012. The number of ICT firms increased to more than 5,000 in 2012, in comparison to 500 ICT companies in the year 2000. As shown in figure 3.11, the share of ICT sector to the GDP in Egypt reached 3.3% in 2013 compared with 2.4% in the year 2006. As illustrated in figure 3.12, the number of employees in ICT sector (encountered as in the ICT sector only) reached 115,000 employee in 2000, while in 2012 the number of employees increased to nearly 283,000 employees. The importance of ICT software and services firms is reflected in the employment data as well, of this number nearly half of them involved in the work of the ICT software and services in local and foreign firms.

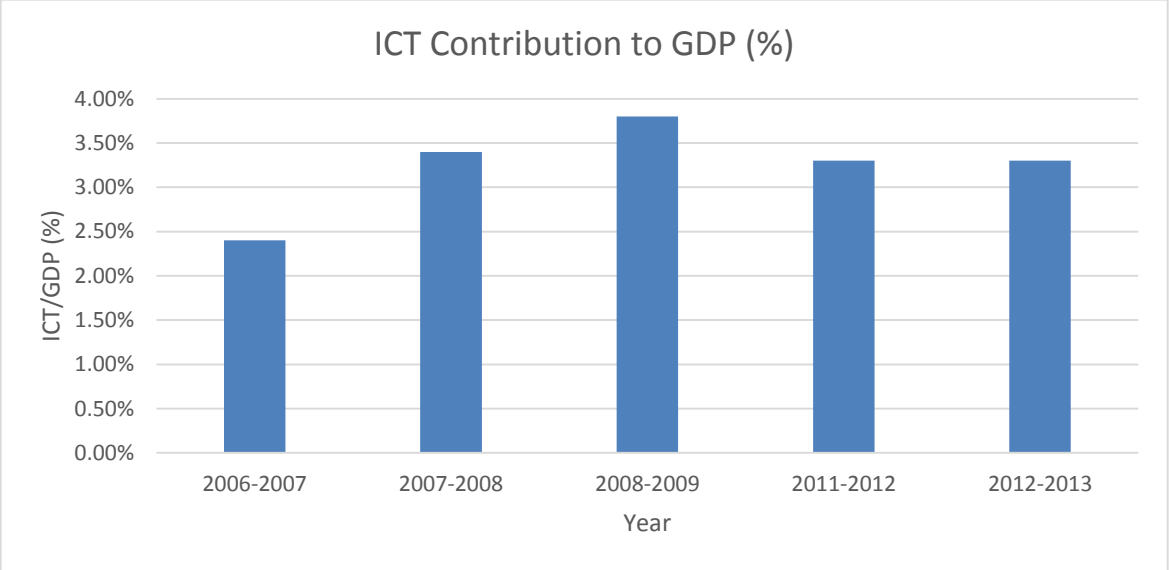


Figure 3.11 ICT contribution to GDP (%) for Egypt, 2006-2013
Source: MCIT (2014)

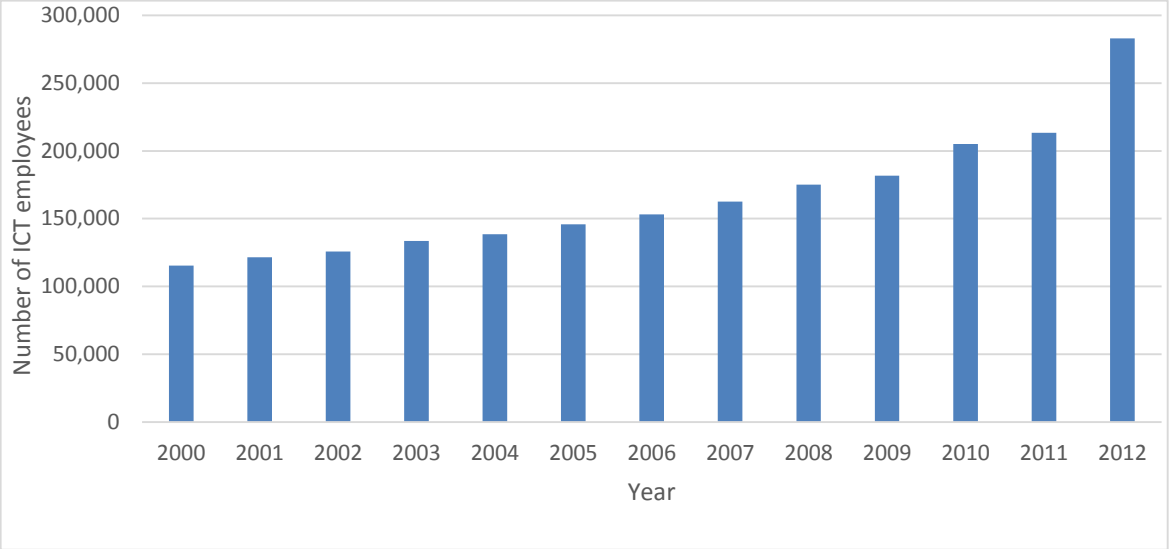


Figure 3.12 Number of ICT employees in Egypt, 2000-2012
Source: MCIT (2014)

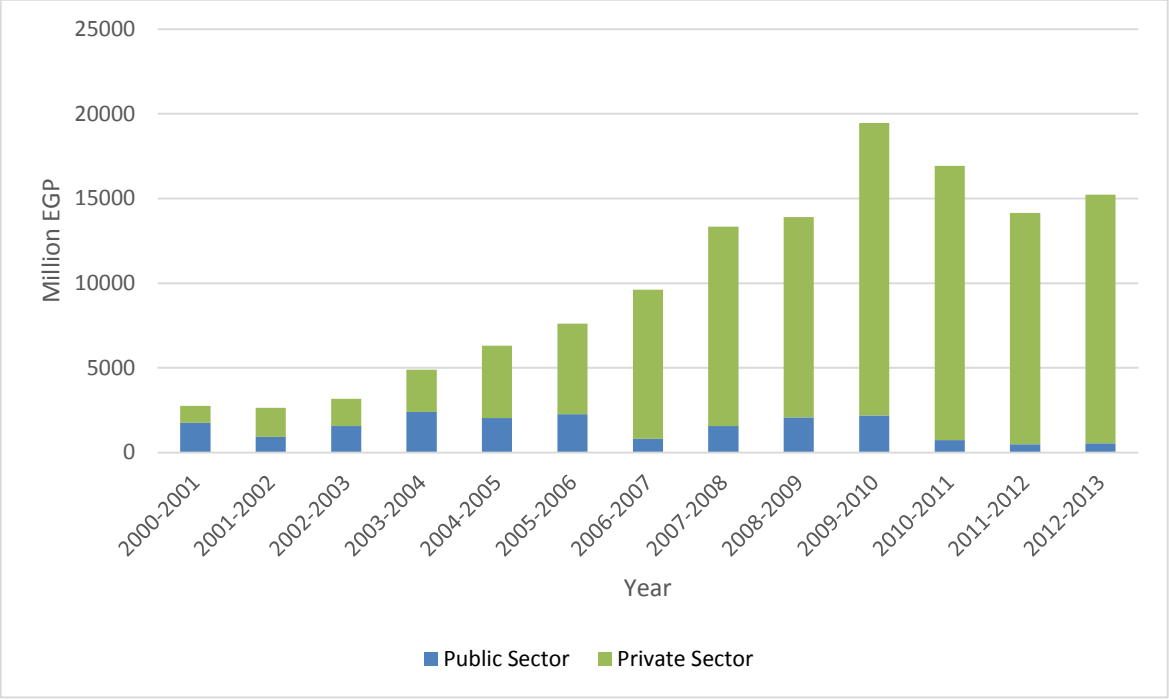


Figure 3.13 Investment in the ICT market of Egypt (EGP in million), 2001-2013
Source: MCIT (2014)

Public and private sectors in Egypt contribute to the investment in ICT sector. The ICT investment of private sector is more than that of public sector, where the private sector

investment increased dramatically from the year 2001 to 2013 contributing enormously in the growth of ICT investment as shown in figure 3.13. In 2001 the investment of private firms in the ICT sector reached a contribution of 65%, and increased dramatically in the year 2013 to reach the share of 96% of the whole investment. This is a twofold indication, first the increasing volume of investment in ICT sector and second the significant contribution of private sector in ICT investment.

3.3.2 Directions of Economic Growth in Palestine (1995-2014)

As shown in table 3.11 a gross domestic product achieved during the period 1995 to 2014 with average annual growth of 5.93% was caused mainly by the services sector and then the industry sector as they contribute to nearly 80% in the domestic product.

As shown in Table 1 the average GDP growth in the Palestinian territories reached 16.46% during the period from 1995 to 1999 which reflects the financial support of the international community to the Palestinian Authority for the rehabilitation of infrastructure, and institutional building to drive the Palestinian economy forward, as a result of the Oslo agreement in 1993. This consequently has driven the increasing confidence of private sector resulting in increasing the investment of private sector in different Palestinians sectors, which reflected positively on economic indicators. Also Palestinian economy was enabled by the creation and development of financial market, trained human capital and accumulated capital, however many growth embedding factors arose in Palestinian economy such as political and economy instability, especially after the second Intifada starting from 28.09.2000, where the situation has become in a different negative direction. The Palestinian economy deteriorated in all economic fields, due to bad consequences of Intifada such as destroying the plants, the closure of border crossings, preventing goods, commodities and raw materials movement to Palestinian territories, which reflected negatively on the performance of the Palestinian economy, with an average GDP growth rate 5.92% during the period (2000 - 2002), as this period was characterized by high unemployment rates, higher final consumption, low investment in the Palestinian territories and low contribution of the productive sectors in the gross domestic product.

During the period 2003-2005 the average GDP growth reached (9.71%), where this period faced many of the political and economic conversions such as facilitation restrictions on the movement of goods and releasing money withheld by the Israeli side. The GDP growth rate during the year 2005 reached (11.05%) as a result of the relative situation settlement this year.

During the period 2006-2008, gross domestic product growth rate was (-4.98%), where the legislative elections which was held in 25 January 2006 consequent negative issues on the overall political, economic and social conditions. There was deterioration in this year and the following two years, especially in light of the position of the international community to halt international aid, and the imposition of the comprehensive siege on the Gaza Strip, and the dismemberment of the cities in the West Bank. In addition to Israel's taboo to convert tax revenues owed to the Palestinian Authority. This deterioration in the performance of the Palestinian economy, inserted it into a deep crisis reflected negatively in the gains within the years (2005-2004), and also in the following years.

In the last two years 2013-2014, The Palestinian economy deteriorated as the unemployment rates increased, the delay in releasing tax returns to Palestinian authority, low investment in the Palestinian territories resulted from the stop of peace negotiations between Palestinians and Israelis and low contribution of the productive sectors in the gross domestic product, which reflected negatively on the performance of the Palestinian economy, with an average GDP growth rate – 2.89%.

During the years (2009-2012) the region encountered a state of political stability, and Israel's release of the tax returns to the Palestinian Authority, which led to a higher average GDP rate of 11.41% during these four years. he highest GDP growth rate was achieved in the year 2009 by (20.94%) due to the financial and economic reforms carried Palestinian government and supported by subsidized foreign aid that have contributed to improvement of the investment climate. Also there were less restrictions on the internal movement of goods and people.

Average output growth for the agriculture sector, which was estimated in this period by 13.27%, and this is weak and not enough to improve social indicators and people's living standard. The national economy is still in this period related to services sector. Below, we

will talk about the most prominent sectors contributing to the gross domestic product achieved in this period with ICT sector.

The contribution of economic sectors in GDP is very important in stimulating economic growth, where the contribution of the productive sectors is of greater effectiveness in motivating the economy and accomplishing economic growth. Economic sectors have varied relatively in the degree of importance in composing GDP in the Palestinian territories. The services sector contributes GDP more than half of the sectoral structure with a rate of (65.89%) during the period 1995-2014. The productive sectors have a share of (34.11%) to GDP. These shares were distributed among industrial sector by (25.43%) and agriculture by nearly (8.68%).

The services sector remains at the top sectors contributing to economic growth, where as shown in Table 4 shows us that the added value represents majority added value for the whole economy. In 2014, the value added amounted to services sector % 72.11 while the value added amounted to other sectors during the same year is % 27.89.

Industrial production fluctuated in value added from 31.93% in 1995 to 23.87% in 2014. The average value added for industrial sector is 25.43%. The industry sector recorded the minimum contribution in GDP in 2002 by (21%) during the period of the second intifada, and this is due to many implications exposed to the industrial sector such as the imposition of the blockade, the closure of Palestinian areas and prevent the necessary access of production requirements for the operation of industrial units, as well as prevent the exports to access markets [UNESCO, 2014].

In 2000 the added value of the agricultural sector amounted to 517.3 million dollar (4.02% of GDP), but it registered a decline of 1.4% compared to last year. The decline continued from year 1996 with the value added as percent of GDP of 14.59% to 4.02% in 2014, where this decline happened in compared of the increasing growth of other sectors as for services and industry without increasing of the growth of agricultural sector. Despite the improvement in the contribution of agriculture sector in GDP in 2008 as the ratio was (7.51%), but it remains below the level achieved in 1996 of $ (14.59%).

Table 3.11 GDP annual growth and value added of economic sectors for Palestine, 1995-2014

Year	GDP growth (annual %)	Agriculture, value added (% of GDP)	Industry, value added (% of GDP)	Services, etc., value added (% of GDP)
1995	7.12	12.78	31.93	55.29
1996	7.27	14.59	29.80	55.62
1997	24.01	13.10	26.64	60.26
1998	25.93	13.54	26.57	59.89
1999	17.97	12.39	28.78	58.83
2000	-9.88	11.24	24.95	63.81
2001	-6.42	9.48	26.88	63.64
2002	-1.47	8.77	21.91	69.32
2003	9.21	7.74	25.72	66.54
2004	8.88	7.89	25.06	67.05
2005	11.05	6.06	26.82	67.12
2006	-4.54	6.27	24.24	69.49
2007	-1.77	7.44	23.23	69.32
2008	-8.63	7.51	22.75	69.75
2009	20.94	7.12	23.32	69.55
2010	2.34	6.64	24.07	69.29
2011	7.89	6.89	23.36	69.75
2012	14.48	5.33	25.07	69.60
2013	-4.28	4.83	23.57	71.60
2014	-1.50	4.02	23.87	72.11

Source: World Bank (2014)

Among the reasons for this decline is the fluctuation of production, where there is a high competition from other agricultural production sources specially the Israeli ones, and on the other hand due to the lack of mechanization and condensation methods that increase productivity, and this in turn see the (lack of any condensation methods) to the high prices of equipment, fertilizers and so on, sector in this period suffered from a lack of funding problems due to high interest rates and difficult conditions set by banks on loans. Another reason for the decline in the contribution of agriculture sector in GDP is the Israeli practices, which have been preventing some farmers from reaching their land, in addition to the

deduction of large quantities of agricultural land for the purposes of separation wall established in the West Bank and the buffer zone in the Gaza Strip. Also there is no real strategic planned support from the government to the agricultural sector where the part of government budget directed to agriculture is so low, and here is no insurance fund that supports the agricultural needs and compensates the farmers against any losses in their agricultural production. The is a lack in using new ways for maintaining and packaging the agricultural production so as to be able to promote and market this production to new channels and markets. There is a need to give more importance for the agricultural sector and conducting strategic plans to support and develop this important sector.

To clarify in more details the contribution of various economic sectors in the GDP of Palestine, these contributions are shown in table 3.12. The GDP for Palestine touched the value of 7,477.0 million $ in the year 2013, compared with the value of 4,165.3 million $ in the year 2003.As we note from the figures, agricultural sector continue to decrease from 422.1 million $ in 2003 to 286.1 million $ in 2008 reaching a contributed share in GDP with 5.9% in the year 2008.The services sector has the largest contribution in GDP reaching 1,007.0 million $ with 20.9% and 19.8% in the year 2013. Some of the sectors fluctuated in their value such as services, constructions and public administration and defence. We clarify that the GDP did not show any significant improvement in the period between 2003 and 2007 and kept fluctuating following the political spheres, as well as other external factors like international donations and access to labour market inside Israel (see table 3.12). In reference to 2005, a significant drop in gross production is witnessed in the year 2006, and 2008, due to the international restriction enforced and the stop of international financial aid cause of political situation, and the creation of the separation wall between Israel and the Palestinian territories. But after 2008 the Palestinian economy started improving reaching 7,477.0 million $ in the year 2013 with an increase of 79.5% compared to 2003 year, due to reconstituting of the peace process and the international financial aid. One can notice a minor recovery between 2003 and 2005 where the economy started to recover with an increase of about 8.1% in GDP in 2005 compared to 2003. This gain was vanished in 2006, which carried the economy back to 2003 levels.

Table 3.12 GDP by economic sector, 2003-2007 (constant Prices, Million USD, Base 1997)

Economic activity	Year 2003	2004	2005	2006	2007	2008*	% of GDP/ 2008
Agriculture & Fishing	422.1	319.0	312.6	334.0	340.8	286.1	5.9
Manufacturing & Mining	489.7	564.3	564.8	531.1	527.3	717.5	14.9
Construction	145.2	103.7	119.4	104.0	103.8	314.4	6.5
Wholesale & Retail Trade	378.6	359.0	373.9	382.7	415.2	497.5	10.3
Transport and Storage	378.5	444.4	461.5	466.0	478.5	345.5	7.1
Financial Intermediation	139.6	170.0	187.4	186.7	192.5	280.0	5.8
Services	975.5	1,047.2	1,100.2	940.2	914.7	1,007.0	20.9
Public Administration and Defence	647.6	736.4	796.1	552.7	598.8	685.2	14.2
Other**	588.5	503.7	586.7	609.6	564.2	687.7	14.3
Gross Domestic Product	4,165.3	4,247.7	4,502.6	4,107.00	4,135.8	4,820.9	100

*Base year 2004

** Other includes: Public owned enterprises plus Households with employed persons minus FISIM plus VAT on imports, net plus Customs duties.

Source: PCBS (2008, 2010a)

Table 3.13 GDP by economic sector 2009-2013 (constant Prices, Million USD, Base 2011)

Economic activity	Year 2009	2010	2011	2012	2013	% of GDP/2008
Agriculture & Fishing	293.2	314.9	342.5	339.1	309.1	4.1
Manufacturing & Mining	690.0	742.5	807.5	1,091.6	1,158.5	15.5
Construction	387.7	557.9	606.7	715.1	758.7	10.1
Wholesale & Retail Trade	536.3	538.8	585.9	1,304.9	1,295.1	17.3
Transportation and storage	133.5	118.7	129.1	115.1	127.6	1.7
Financial and insurance activities	269.0	279.1	303.5	249.0	252.6	3.4
Information and communication	379.9	388.1	422.1	468.3	452.7	6.1
Services	1,150.9	1,267.5	1,378.4	1,416.9	1,477.5	19.8
Public Administration and Defence	750.7	782.1	850.5	897.1	928.3	12.4
Households with employed persons	4.6	5.2	5.7	3.9	3.8	0.1
Other*	643.5	759.5	826.0	713.1	712.3	9.5
Gross Domestic Product	5,239.3	5,754.3	6,257.9	7,314.8	7,477.0	100

* Other includes: custom duties and net VAT on imports minus financial intermediation services indirectly measured. Source: PCBS (2012a, 2015)

The ICT sector in Palestine evolved and its contribution in GDP increased from 379.9 million $ in the year 2009 to 452.7 million $ in 2013 reaching 6.1% contribution to GDP (see table 3.13), where the tools and practices of ICT sectors are needed to support the various economic sectors by developing ICT solutions to the challenges facing other economic sectors.

3.4 Toward a Knowledge-based System for agriculture cultivation, production and marketing: the case of using ICT in advancing farmer's Knowledge and practices on irrigated vegetables production, and value chain system in Palestinian north region

In this section, the effects of farmer's knowledge, attitudes, characteristics and practices on production and marketing system were investigated in the agricultural community of irrigated vegetables, in Palestinian north region. Here, we shed the light in the farmer's part of vegetables production and value chain. Palestinian north region is accounted for 80% of total vegetables produced in West Bank. A standardized questionnaire was completed by 200 farm workers aged >18 years old. The average age of the studied population was 48.6 years with 32% female and 68% male. Results showed that no significant differences between applied technology levels, according to gender, or according to the type of proprietorships. However, significant differences exist between applied technology levels, according to education levels. A negative significant correlation does exist between the levels of technology applied by vegetables farmers and the existence of other livelihood sources. A positive significant correlation exists between the levels of technology applied by vegetables farmers and the returns from them. Results showed significant differences between the levels of technology applied by farmers according to the sources of agricultural information. Also, a positive significant correlation exists between number of experience years in vegetables farming and the levels of modern agricultural technology applied in vegetables farms. It can be said that, vegetables farmers are facing a number of constraints. To improve vegetables production in the area, several intervention measures were highlighted and recommended. In this context, a framework using ICT applications is proposed to advance the knowledge and practices of farmers of vegetables to increase cultivation productivity and revenues.

Due to the important role vegetables play in human world consumption, many researchers, concerned institutions and countries examined and developed new trends in vegetables market with new technological tools and techniques to increase vegetables production, continuous improvement in quality of vegetables products, development of well-integrated marketing chains (superstores etc.), improvements in the value chains, greater integration of farms with the markets, and prolonged existence of the fresh vegetables in the markets [Pineiro and Diaz Rios, 2004].

Demand for the vegetables all over the world including both developed and the developing countries has increased, where statistics tell that per capita food consumption is shifting to fruits and vegetables for developing countries (World Bank, 2007, p. 60). The increase in vegetables production is driven by to the raise in cultivation districts and transform in consumer preference towards more health and convenience food consumption in addition to incomes raising. Increasing the consumption of fruits and vegetables drives raising their production by developing countries and consequently their exports from just US$ 20 billion in 1980 to around US$70 billion in 2004 (World Bank, 2007, p. 61). To accommodate with the increase in demand for fruits and vegetables there is a need to continuously develop this sector to help in banging poverty and also increase in consumption of fruits and vegetables by poor. As family income rises the consumption of fruits and vegetables rises [Dong and Lin, 2009)], and as a consequence of increasing income, there is a need to increase and develop the production of fruits and vegetables. As vegetables production and marketing is an important source of income for farmers and traders, it is also a good source of revenues for government.

The north part of West Bank including the areas of Jenin, Tulkarm, Qalqylya and Tubas are the most important cultivated areas of the West Bank in terms of the size, quality of the soil, and irrigation water availability in addition to the abundance of labour. These areas are considered as the Palestinian food basket. The main vegetables producing Palestinian areas are Jenin, Tulkarm, Qalqylia and Tubas accounting for 80% of total Palestinian vegetables production. Orchard area is estimated by Palestinian Central Statistics [PCBS, 2010b; UNCTAD, 2015] to be 490,119 (1,000 square metres), with an increase of 4% during 2000-

2010. The majority number of farmers has small farms that are planted with various vegetables types.

There is a problem in the value chain system of vegetables including randomness in decisions concerning cultivation vegetables types, marketing and selling distribution channels, and others. A value chain includes input (e.g. seed suppliers), farmers, traders, processors, transporters, wholesalers, retailers and final consumers. The conceptualization philosophy of the value chain with the integration of its functional activities exceeds the production focus to the diverse set of activities that construct the chain. Therefore, constraints for value chain development are related to market access, local, regional, international and market orientation [Grunert et al. 2005; Spiegel van der, 2004].

The marketing of vegetables products is still traditional in Palestine causing wastage of time and higher transport expenses and commissions for farmers, where small-scale farmers, classically transport small lorry loads (which are owned and administered by persons other than farmers) to urban wholesale markets several times per week. There is a need to activate the roles of cooperation societies that service the majority of farmers to facilitate the distribution of vegetables to urban markets and reduce the cost of transportation and commotions. The existing situation of vegetables marketing process has the following disadvantages: i) high unit cost of vegetables transportation driven by the small quantities marketed and transported in small trucks, resulting that every farmer has to take time regularly investigating market conditions to ensure delivering the crop to the most profitable market by the most appropriate transporter; ii) weak bargaining market power of farmer, where the system depends heavily on personal negotiations of selling prices; iii) low professional approach of grading and preparation of the product, where it takes place by the farmer on every farm rather than at specialized facilities; iv) insufficient vegetables quantities for sale at a preferable exporting or processing point of time, to enable farmers to contract with the exporter or processor to purchase from them directly. This lessens the bargaining power of farmers with vegetables retailers or wholesalers; as a result there is a need to conduct farmers' associations.

The nature of vegetables products constraints their marketing, where vegetables is a fragile crop that can only be stored for short period of time resulting in incapability to carry over

stocks of vegetables over long periods of time, in contrast to other time lasting commodities such as wheat. To come over this constraint it is necessary that all vegetables production is sold during a crop short time, or part of the yield is manufactured as for the coming years. This, in turn, results in fluctuations of vegetables prices in the domestic market to bring the quantity supplied by farmers to the quantity demanded. This is indeed what happens in Palestinian areas, where there is no effective Government intervention to control vegetables prices and no healthy value chain. In this situation, a surplus in quantity supplied will be observed only if domestic market prices are insufficient to cover farmers' harvesting and marketing costs, resulting in leaving vegetables crop to spoil on the farm. Most of the vegetables production is consumed locally in the domestic market in fresh form, small quantities are utilized for domestic processing, and small quantities, only 5%, are exported to other countries such as Jordan or Israeli market. The Palestinian Government and exporters are required to have clear and adequate knowledge on the detailed structure and operation available regional markets, their development trends, and the degree of potential competition from other suppliers. Improvements in the profitability of vegetables farming requires increases in efficiency throughout the improvements of production and enhancement of vegetables value chain, starting from input suppliers to farmers and final domestic and export markets.

Encouraging competition in the domestic market between exporters themselves and with traders, will result in improvements in exporting efficiency leading to higher domestic market prices and thus to higher prices at the farm gate and to improvements in the profitability of farming.

The results of the used survey that includes 200 farmer showed that 14 percent of vegetables farmers were of age less than 25. Almost 86.5 percent of the cultivators were up to age 55 (see table 3.14). Out of these 32% were female and 68% were male. It showed that both male and female farmers are actively involved in vegetables farming in north region of West Bank (Table 3.14). For education level 66% of farmers were of high school and more level of education which indicates that most of farmers are able to be accommodated with ICT agricultural applications. There is positive correlation between level of education and the adoption of new technologies, therefore, it indicates that vegetables cultivators are dispose

to adopt new technologies. Furthermore, age profile indicates that 86.5% of respondents were less than 55 years, which is a further supportive matter for those farmers to adopt new technologies and ICT applications.

Agricultural experience is another significant factor for developing profile of the respondents. More than 90.245 of the sample study of farmers were described to have farming experience of less than 26 years, while the rest have experience more than 26 years (Table 3.14). As shown in table 3.14, 47.425 of the vegetables cultivators did not have any occupation other than farming.

As illustrated in table 3.14, most of the firms are of very small size. A big amount (67.17%) of the sampled vegetables farms was of size up to only 6 (1,000 square metres). Small sized farms are not economically feasible and very difficult for them to adopt capital intensive in new technologies, but one choice could be to promote the system of cooperative farming so that plantations become viable business units.

There are numerous matters related with fertility management of soil. For organic fertilizer 67.5% of the respondents declared that they used to apply some quantity of organic fertilizer in the farms (Table 3.15). This is a good mark of applying organic fertilizers in practice. A majority of the small proportion of the respondents reported that they were unable to apply organic fertilizer in their farms mainly because of non-availability of organic components, and a small proportion of them indicated that it was difficult to prepare organic fertilizer. 82.65% of respondents applied less than 5 tons of organic fertilizer in one (1,000 square metres) per year. As indicated in table 3.15, 87.31% of the farmers study sample indicated that it was very easy, easy, or just okay to the Availability of industrial fertilizer.

Appropriate plant protection measures (PPMs) can ensure higher and also can lead to enhancement in the quality of vegetables and then competitiveness in the regional market is enhanced. PPMs are also needed where importing nations impose assured quality desires. Embracing of Integrated Pest Management (IPM) is determined by three aspects: i) requirements of the importers, especially regarding the insecticide remainder protocols; ii) increases of the confrontation of pests to pesticides; and iii) responsibilities of environment on the portion of vegetables farmers (Urquhart, P. 1999).

Table 3.14 Farmer profile

Item	Parameter	Frequency	Percent
Gender	Male	136	68
	Female	64	32
	Total	200	100
Age of vegetables farmers	Up to 25	28	14
	26-35	61	30.5
	36-45	47	23.5
	46-55	37	18.5
	above 55	27	13.5
	Total	200	100
Education of farmers	Primary	29	14.5
	Middle	39	19.5
	High school	78	39
	Faculty	25	12.5
	Undergraduate or more	29	14.5
	Total	200	100
Experience in farming (years)	Up to 5	23	11.79
	6-15	88	45.13
	16-25	65	33.33
	above 26	19	9.74
	Total	195	100
other occupation	no other occupation	92	47.42
	Business	22	11.34
	Government	40	20.62
	Labour	21	10.82
	Private	19	9.79
	Total	194	100
Vegetables orchard size (1,000 square metres)	Up to 2	32	16.16
	2 - 6	101	51.01
	6.5 - 15	47	23.73
	15.5 - 25	10	5.05
	Above 25	8	4.04
	Total	198	100

Source: author using excel

For the Pest management methods and as stated in table 3.16, 82.74% of the respondents stated that they were applying only chemical methods to resist the pests/insects (by using the pesticides, insecticides and/or fungicides). Nearly one percent of respondents reported that they were applying biological approaches to fight the pests. The number of sprays applied on vegetables crops throughout a season testified by the respondents ranged from 1 to more than 8 times. As illustrated in table 3.16, around 67% of respondents indicated that they have applied more than 4 sprays during previous season.

Table 3.15 Fertility Management

Item	Parameter	Frequency	Percent
Application of organic fertilizer	Yes	135	67.5
	No	65	32.5
	Total	200	1
Reasons for a low knowledge of how to use organic fertilizer	Non-availability	159	80.30
	Difficult to prepare	34	17.17
	Both	5	2.52
	Total	198	100
Annual application of organic fertilizer (tons per 1,000 square metres)	up to 1	113	57.65
	1 – 5	49	25
	6 – 9	21	10.71
	more than 10	13	6.63
	Total	196	100
Availability of industrial fertilizer	Very Easily available	24	12.18
	Easily available	44	22.33
	Just available	104	52.79
	Difficult	16	8.12
	Very difficult	9	4.56
	Total	197	100

Source: author using excel

Regarding the knowledge of farmers for nursery, fertility management, plant protection management and measures, the related survey outcomes disclose that the respondents have significant but low knowledge about the issues related to nursery and soil health management as stated in table 3.17. Results propose that more awareness and knowledge need to be made regarding micronutrients deficiency, soil salinity and pH value management.

For the organic fertilizer, the study sample of farmers have low and significant knowledge about how to prepare organic fertilizer. So there is a prerequisite for capability building of the vegetables farmers in the arena of organic fertilizer preparation and solicitation. Therefore a knowledge based information system can provide these needed guiding information. This is vital mainly as organic vegetables are becoming very widespread and favoured in the world.

Table 3.16 Plant protection management and measures

Item	Parameter	Frequency	Percent
The pest management methods	Cultural	15	7.61
	Chemical	163	82.74
	Biological	2	1.01
	Physical	4	2.03
	Cultural + chemical	9	4.56
	Cultural + chemical + Biological	2	1.01
	cultural + Biological + Physical	2	1.01
	Total	197	100
Number of sprays per season	1-2	26	13.19
	3-4	39	19.79
	5-6	68	34.51
	7-8	43	21.82
	>8	21	10.65
	Total	197	100

Source: author using excel

Regarding the knowledge of diseases, results show that farmers have relatively low knowledge about the diseases of vegetables. Deficiency of good knowledge about diseases marks in unselective practice of pesticides, which lead to not only disaster in attaining the resolve but also to damage of vegetables quality, indicating that the vegetables farmers required to promote their knowledge relating to diseases management.

Some insects are beneficial to vegetables crops, where knowledge of beneficial insects is relatively low as shown in table 3.17. Therefore, shortage of knowledge near the beneficial insects may push farmers to practice pesticides extensively, resulting in the killing of beneficial insects as well. Pest management knowledge is low except for relatively accepted knowledge about using chemical treatment as shown in table 3.17. Low knowledge of farmers is encountered for packaging and appearing vegetables. Therefore there is a need to use ICT application to increase the awareness of farmers regarding the above mentioned issues. Stable usage of fertilizers is very vital for preserving the fertility of the soil. Lot of factors is involved in deciding how much, when, and how to apply various types of fertilizers. So the question is what are sources of information relating to fertilizer use? Responses of the

respondents on the importance of the sources of fertilizers were sought on a scale of 5 ranging from 1 (in case of least used) to 5 (most commonly used). Results reveal that agricultural companies and other farmers appeared as paramount significant source of information, with average value of 3.67 and 3.79 respectively as shown in table 3.18.

Table 3.17 Rating knowledge of Nursery, fertility management, plant protection and marketing

		T-Test (Test Value = 3)						Averages and standard deviations (mean value =5)		
Knowledge Area		T-value	DF	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference		Mean Value	Standard Deviation	Number of missing values
						Low	High			
Nursery	Nursery	18.199	195	.000	0.91111	.9053	1.0870	2.5111	.80869	4
Soil	soil management	21.737	193	.000	1.03093	1.0342	1.2357	3.3309	1.04687	6
	Water logging	18.681	191	.000	.95858	.8199	1.0273	3.9886	1.01121	8
	Soil Salinity	9.518	188	.000	.56517	.4498	.6805	2.5652	1.13820	11
	pH	-.684	186	.334	-.07515	-.0983	.0580	2.3549	1.16184	13
	Micronutrient deficiency	-.646	189	.495	-.04153	-.1350	.0919	2.5685	1.19648	10
	water lodging	24.062	194	.000	1.01298	.8394	1.0986	3.8160	.81187	5
Fertilizer	prepare organic fertilizer	17.230	192	.000	.85763	.7363	.9687	2.9876	1.05673	7
	use organic fertilizer	9.325	193	.000	.59773	.4252	.6942	3.9977	.95739	6
	Use chemical fertilizer	18.119	193	.000	.96762	.8427	1.0725	3.9877	1.10827	6
Plant protection	disease knowledge	5.342	194	.001	.21225	.0933	.3112	3.1432	1.21678	5
pest management	Cultural	-3.980	190	.000	-.22472	-.3316	-.1129	2.6982	1.15935	9
	Chemical	13.293	195	.000	.73783	.6463	.8295	3.7379	1.14052	4
	Biological	-.680	188	.439	-.05082	-.1523	.0857	2.9132	1.29898	11
	Physical	-4.102	187	.000	-.23222	-.3399	-.1226	2.7188	1.18347	12
	beneficial insects	9.878	191	.000	.56482	.4451	.6753	3.5446	1.17889	8
Packaging	Packaging	-4.202	189	.000	-.24252	-.3279	-.1243	2.7245	1.14546	10
	Appearance	-.692	189	.359	-.06022	-.1423	.0787	2.7132	1.39898	10

Source: author using SPSS

Regarding the sources of information relating to practice pesticide, the highest used information source is recorded to pesticides companies and other farmers' sources. There is a low knowledge of farmers about the real time prices of vegetables at retailers and wholesalers.

In this context, unlike traditional approaches that rely on a single data source for constructing agricultural sources, we will exploit various data sources such as textual Web documents, domain-dependent textual resources, existing agricultural sources that describe the domains of interest, and other image and video captions that can be automatically extracted from Web resources.

Table 3.18 Sources of information related to use of fertilizer, pesticides and prices

		T-Test (Test Value = 3)						Averages and standard deviations (mean value =5)		
Information source		T-value	DF	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference		Mean Value	Standard Deviation	Number of missing values
						Low	High			
use of fertilizer	Self-decision	-4.402	193	.000	-.25652	-.3179	-.1233	2.6975	1.13276	6
	Agriculture department	-3.962	191	.000	-.26152	-.3327	-.1343	2.7975	1.11223	8
	Agriculture companies	9.718	192	.000	.56517	.4498	.6805	3.6652	1.08820	7
	Farmers field schools	-.594	188	.424	-.06515	-.0887	.0453	2.2897	1.24586	11
	Other farmers	9.925	194	.000	.53773	.4022	.7144	3.7987	.93637	5
	Radio	-.784	189	.384	-.08535	-.0996	.0540	2.1949	1.24784	10
	TV	-.686	191	.395	-.05153	-.1541	.0869	2.2485	1.21648	8
use of pesticides	Self-decision	-.692	192	.457	-.07012	-.1523	.0683	2.6832	1.29798	7
	Agriculture department	-4.362	193	.000	-.29152	-.3627	-.1463	2.8475	1.18523	6
	pesticides companies	16.119	194	.000	.92361	.7867	1.1065	3.9868	1.07823	5
	Farmers field schools	-.686	191	.504	-.07515	-.0987	.0526	2.3193	1.26756	8
	Other farmers	8.335	191	.000	.56373	.4082	.6872	3.9634	.98768	8
	Radio	-.574	190	.476	-.07835	-.0984	.0673	2.1949	1.24784	9
	TV	-.756	192	.374	-.06243	-.1437	.0789	2.2485	1.21648	7
Real time prices	Prices at wholesalers	-4.01	188	.000	-.24232	-.346	-.1243	2.6988	1.16347	11
	Prices at retailers	-3.96	191	.000	-.23452	-.327	-.1239	2.6762	1.15434	8

Source: author using SPSS

In this context, the lack of knowledge of the farmers concerning nursery, fertilizing management, plant protection, marketing and others, a framework is proposed for designing and developing an indicator system using domain specific modelling language (DSML) for data analytics, which enables developing a performance managing system for enhancing cultivation process and marketing to assist farmers to increase produces, decrease costs and save time by proposing predictions, warnings, and recommendations.

Through this indicator system the farmers' advisors and agricultural policymakers will define indicators in a qualitative or quantitative way. The proposed system will automatically calculate the values of these defined indicators that will recommend a set of actions to assist the involved farmers to take the appropriate decision, so as to advance cultivation and marketing. This information system will classify and cluster the farmers according to their knowledge levels and interests using different data mining techniques such as classification, clustering, machine learning and others. Another part of this proposed framework is to construct knowledge-based data sources related to advanced agricultural techniques from heterogeneous agricultural data sources available in the web.

Clearly, one or more different techniques are required to handle each of the targeted data sources. For instance, to extract background knowledge from textual documents, several Natural Language Processing (NLP) tools, syntactic and semantic parsing techniques are required. On the other hand, different automatic Web crawling algorithms are also needed to extract captions attached to images and videos on different Web-pages. Starting from this position, we aim to build an integrated framework where in the various techniques are combined to work cooperatively for extracting background knowledge from various agricultural resources. Furthermore, the proposed framework will be used to i) find mappings between already existing agricultural sources; ii) combine heterogeneous sources that tackle the same domain into a single coherent source; and iii) gather every related data from each farm and apply analytics, The knowledge integration will enable data sharing and system interoperability for enhancing cultivation-marketing process. The proposed framework of integrated agricultural knowledge system in the context of data analytics is shown in figure 3.14.

Data Analytics for agricultural knowledge-based information system as an iterative continuous process starts from i) data collection and structuring into an informational environment system to be usable by farmers, cultivation advisors or experts, agricultural retailers and wholesalers centres, system engineers, mentors and agricultural policy makers at different levels; ii) measurement, monitoring, analysis, assessments, feedback of indicators and metrics; and iii) adjustment, adaptation and personalization of the agricultural information system environment. The aim is to design an indicator system as a core of knowledge-based system that helps the farmers and agricultural related parties to take the needed decisions concerning cultivation and marketing in order to enhance agricultural productivity and economic growth.

Domain Specific Modelling Languages can be used to help in designing and developing the needed electronic agricultural advisory System. DSMLs provide a group of graphical notations through which the domain experts can use to represent a specific problem dedicated to a specific domain in order to help them in solving the intended problem.

Once the problem is modelled using DSML, the model can be transformed into a generated lower level executable code. Additionally this indicator system will help in integrating various farming data sources according to the needs of farmers. Also this indicator system can act as a guidance for constructing data sources for a specific domain of interest from heterogeneous agricultural data sources available in the Web into a cloud knowledge-based system.

Data Integration is the ability to process (query) data apparently across various heterogeneous data sources. Where there are many methods to integrate data for querying and insertion of data into different data sources. These data sources may be relational databases, XML data sources, data sources in form of subject, predict, object and others. It is meaningless to reconstruct new unified database from various heterogeneous databases, where it is effort and time consuming.

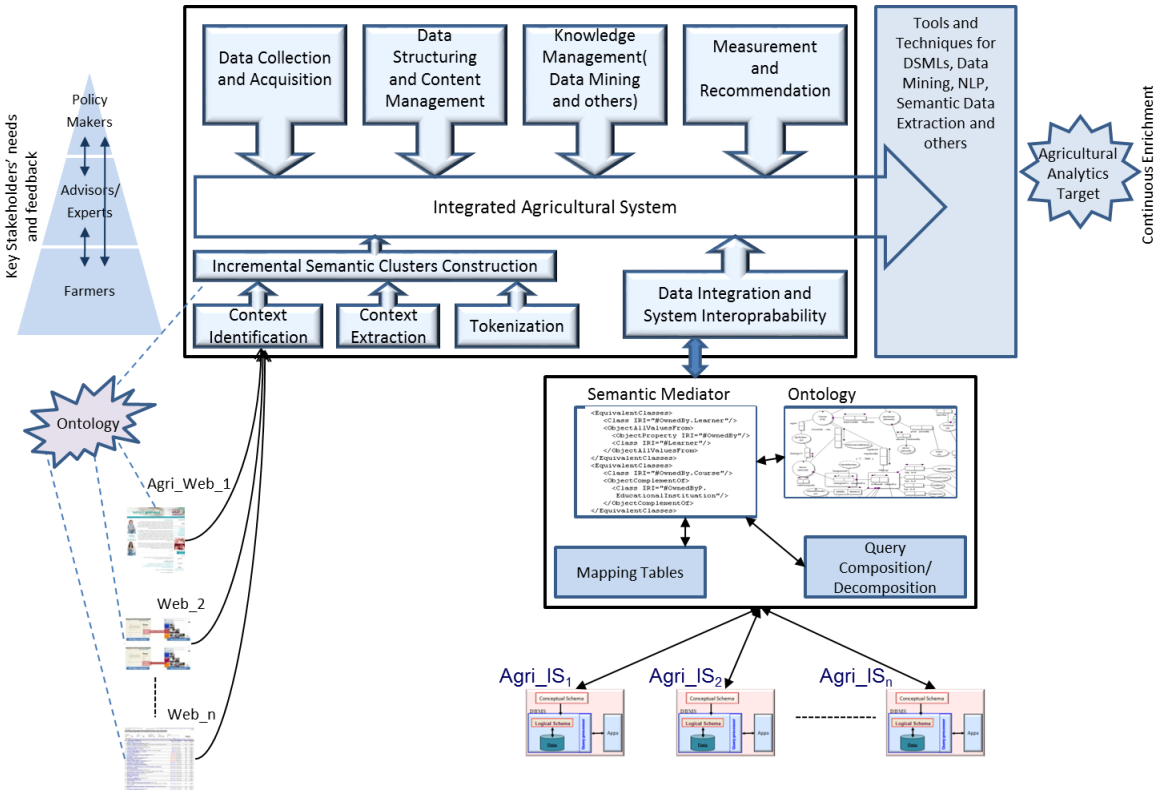


Figure 3.14 Proposed knowledge-based agricultural framework in data analytics context
Source: author

Semantic data integration depends in common understanding structure (conceptualization representation) of data to eliminate different types of heterogeneities. An effective way for data integration is using ontology [Bouras et al., 2007; Cui and Wu, 2005] as a common share understanding for the semantic and syntactic terms of the different data sources to integrate between them, where the intended terms of learning domain will be structurally represented into concepts, relations, constraints and others. This representation will be used as a reference semantic terms to integrate various data sources and can be described using web ontology language (OWL 2 [Bao et al., 2009]). In order to specify the impact meanings and differentiate various semantic terms, these terms will be represented in a common agreed vocabulary, where part of them will be represented according to meanings from WordNet [Fellbaum, 1998] as a common international reference. Other meanings not represented in WordNet will be developed by us or from other resources. This gloss will be a shared understanding for the semantic syntactic vocabulary of the ontology. In addition ontology is

used in knowledge management [Jurisica et al., 2004] where it can help us in sharing and managing agricultural cultivation, production and value chain knowledge.

A semantic mediator will be used between the ontology connected with the mapping tables and different data sources, through which the integration for messaging between various data sources will be achieved. The global query will be formulated and decomposed by the semantic mediator to a set of sub queries to acquire the needed data from various data sources and vice versa.

We will use domain specific modelling language methodology, tools and techniques to design an indicator system that automatically capture and restructure the indicators (which are needed and defined by the key stakeholders) of agricultural information system to adjust, adapt and personalize the agricultural system environment. Knowledge management techniques such as data mining, classification algorithms and others can be used to help in developing the functions of the agricultural indicator system. The conceptual modelling of agricultural analytics which includes an indicator system is shown in figure 3.15. Object Role Modelling is used in modelling this proposed system, where ORM is a conceptual modelling approach that allows the semantics of a Universe of Discourse (UoD) to be modelled at a highly conceptual level and in a graphical manner [Halpin and Morgan, 2008].

Then multiple automatic data extraction and knowledge acquisition techniques guided and recommended by the agricultural indicator system are used for extracting background knowledge from the heterogeneous data agricultural sources. First, the data extraction techniques will be run to extract potential sources of information that can be further processed by the knowledge acquisition techniques. Then, knowledge entities such as concepts, instances, and relations are to be acquired and stored in the system.

The system will process the extracted entities and construct knowledge triples in the form of subject-predicate-object. The constructed knowledge triples will be linked together forming a seed semantic learning network where in nodes of the network represent (subjects and objects of the triples) and connections between those nodes are the triples' predicates. An important constituent of the system will be the ontology mapping component. We need this component to find mappings between already existing domain-specific agricultural sources that describe knowledge about certain domains of interest.

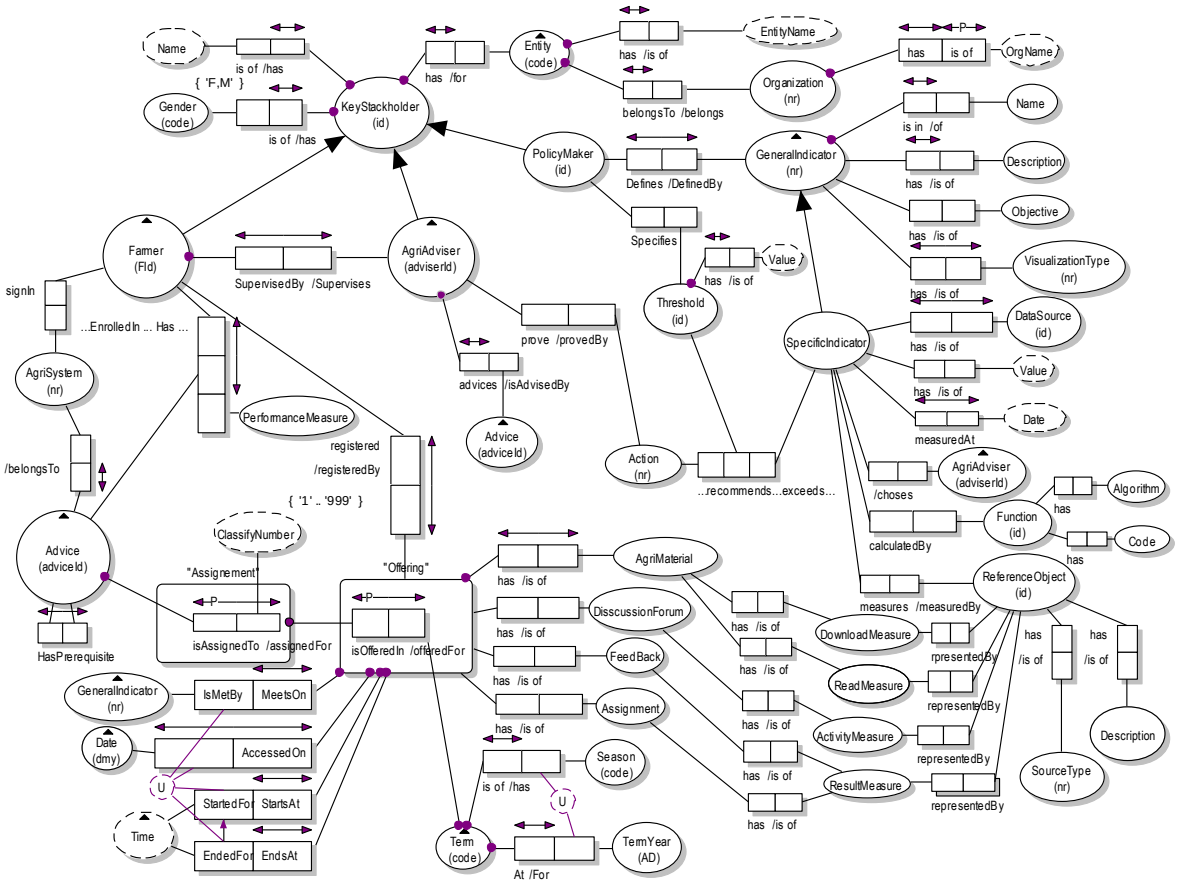


Figure 3.15 Agricultural knowledge and analytics conceptual modelling using ORM
Source: author

Finding mappings between such agricultural sources enables us to seamlessly integrate them into a single coherent agricultural source. By doing so, we will be able to link the produced seed semantic agricultural networks from the proceeding phase with the combined agricultural sources. Then the connections between existing domain-specific learning sources and seed learning sources which are produced by the construction step take place.

The use of modern levels of applied technologies with the aid of agricultural analytics information system for production, cultivation management and marketing of vegetables crops by concerned farmers in West Bank, has positive significant correlation with the returns of vegetables production. As the results of the survey indicate that there is a lack in farmers' knowledge concerning nursery, fertility, pest management and marketing of

vegetables, there is a need to advance the knowledge and awareness of concerned farmers using ICT application of agricultural analytics knowledge based information system.

The positive relation between applied technologies and returns of vegetables indicates the importance of applying good technological techniques and practices such as pesticides, fertilizing, trimming and pruning to increase the production and consequently the profitability of vegetables farms. Although the government such as the agriculture ministry and non-government institutions are involved in vegetables farming, these institutions are not transforming the needed knowledge and information into practical actions to farmers, resulting in a lower level of production improvement.

As the study shows an existing of farmers knowledge gaps driven specially from proposed sources of information, so it is recommended to develop a knowledge and information network system based on ICT to connect and integrate the various actors in value chain of vegetables production (i.e. farms, agriculture ministry, research and supporting institutions) to convey the needed knowledge and information practically, especially those related to modern applied technologies of vegetables cultivation, production and marketing to farmers in an effective and efficient way. The educational and technical supports provided by the proposed knowledge system have to take into account cultural and socioeconomic aspects of vegetables population to be aware of the importance of adopting good agricultural practices. One of the major reason for the knowledge gaps is the lack of integration among the various institutions involved in the farming system, where ICT can play an instrumental role in catalysing the process of integration among these institutions and help in boosting productivity in both production and marketing system.

3.5 Chapter summary

This chapter talks about the situation of ICT in Arab countries, where thoroughly investigation about the ICT indicators is done. The fixed telephone subscriptions reached 8.7% per 100 inhabitants by the end of year 2014. The Arab countries varies in the fixed telephone subscriptions values. UAE is the highest country with 22.32% in the year 2013, at the other hand the lowest rate for Sudan with 1.09%. The top countries in the rate of fixed line penetration is recorded for the GCC countries, in addition to Lebanon. There is a big gap

of internet penetration rate between Arab countries with the highest rate recorded for Bahrain with 90% in 2013 and the lowest one with Djibouti recording 9%. Average internet penetration rate increased from 45.2% in the year 2012 to 49.3% in 2013, and this is relatively low compared with Europe that has the highest rate with 75% and Americas with 61%. So, Arab countries still need to work more to catch up with developed countries regarding Internet penetration rates, as a good indication of ICT access. The average mobile penetration rate reached 126.13% in 2013 for Arab countries which outperforms the world average value of 97%. Although Arab countries achieved a significant progress in mobile penetration rate but it still lags the world in mobile and fixed-broadband penetration.

In 2009, the ICT basket prices corresponded to an average of 13% of GNI per capita for Arab countries. Mobile phone service prices decreased significantly in Arab countries compared to the other sub-ICT baskets in developing countries, but these prices still relatively high in Arab countries with 4.6% of monthly GNI per capita compared with Americas, Asia and Pacific with 3% and Europe with 1.1%. Although the wide spread of Internet broadband, the price of this intermediate service is still to this day higher by about an average of 71% in the Arab region and 46% in Asia, compared with 10% in the Americas and 2% only in the west Europe. There is a significant differences in ICT services prices between Arab countries. The GCC countries reduced ICT prices significantly, where the highest prices were in the poor Arab countries such as Sudan, Mauritania and Yemen.

The GDP composition of Arab countries by sector in the year 2014 includes services (43.08%), industry (53.04%), and the least contribution for the agricultural sector (5.49%). ICT is part of services sector and it affects all other sectors. Arab countries still lag spending on ICT compared to world and other developing countries, and this is not a good sign as the investment in ICT is significant for economic growth. As an example Turkey expends more in ICT than Arab countries, nearly 23 times more than Egypt in the year 2006. The exports/imports of computer, communications, ICT and other ICT related services are less than that of the world, as a percentage of total commercial services exports/imports. ICT contribution to GDP is still relatively low compared to world and specially developed countries, where for Egypt the contribution percentage reached 3.3% in 2013 and in Palestine this contribution reached 6.1%.

CHAPTER 4: METHODOLOGY AND DATA

4.1 Introduction

In this chapter, we introduce the methodology which has been used in this study. It entails the research design models and the study population. The methodology illustrates the sources of used data and the way of collecting them. It also describes the instruments used for data analysis. It settles with the models components and equations including dependent and independent variables.

4.2 The Basic Study Model (the first study model)

The dominant target of a society is to advance the quality of life and increase the standards of living of its people, where here the economy acts the important role, within the context of socio-economic, geopolitical and cultural issues. Nowadays ICTs have a great impact in every aspect of our life, as an economic and social actuality. There is a difference between consumptive and productive functions. As the economic theory states that the standard living of the people is subjected to consumption, but over time we must challenge the difficult of increasing the production competences of a country in a sustainable approach, if so economic growth can be advanced and extended to economic development.

There are twofold of ICT nature, the productive side (infodensity) and the consumption one (info-use). Infodensity denotes to the portion of a country's whole capital and labour stocks related to ICT and represent the productive side. Info-use denotes to the ICTs consumption side. In principle, the two can be combined to represent the amount of a country's 'ICT-ization', or infostate. The difference in infostates among economies can relatively measure the Digital Divide.

ORBICOM model is provided by specialized institution as ORBCOMM network which is the "Global Network of UNESCO Chairs communications Telecommunications and the

International Telecommunication Union", the model, based on one explained variable that is information density and technical progress. The factors of production in a country by their twofold quality and quantity specifies its productive capacity so as infodensity. Infodensity is the compound of all ICT factors of capital and labour. The productive capacity is fixed at any particular argument in time, as the pooled factor stocks and technology are fixed, but they can expand as time passes. The advancing of Factor production, productivity and technological perfections are instrumental and all of them are influenced by ICTs. ICT and non-ICT factor inputs are collectively used to yield both ICT and non-ICT products and services, without a similarity contribution. Some of the final production will be ICT products or services, which will be consumed as final demand, or will be part of the capital stock, the same principle goes for ICT skills. ICT capital consists of network infrastructure and ICT machinery and equipment. ICT labour is accounted as the stock of the ICT skills. Output production will be accumulative function of ICT factors of various arrangements which are comprised from capital and labour [Jensen and Mahan, 2007].

For Info-use the readiness of ICT goods is crucial for the consumption of ICT services that would fulfil eventual needs, and constructing ‘consumptive capacity’ is a requirement to generating ingesting drifts. There is a difference between ICT uptake and ICT intensity of use, where uptake refers to ICT goods and intensity of use to ICT services. Uptake and intensity of use are subject to the level of classification according to obtainability of statistical data, such as investigating measures and analysis according to sectors, where Industries can be divided by size or type, and governments by level such as local, regional and national, and type of organization. Also, clusters of individuals can be distinguished by gender, metropolitan and rural positions, level of education and others significant for the investigating of digital divides core to an economy. When we are talking about growth and consequently development, the important issue of utilization arises rather than the availability of productive factors, so ICT stock is subject to the level of utilization to advance growth and development. Underutilization of ICT infrastructure, tools, equipment, communication networks and labour skills will not advance productive volume. ID and info-use increase over time [Sciadas, 2005].

The aggregate production function that encounters the relationship between the economic growth as output and the degree of ICT practices as input which can be represented by the production part of ICT (networks and skills) is complex, with connectedness prompting and being induced by the nature and degree of growth of a country. In an introductory effort to estimate the strength of this connection, we inspect the effect of ID on GDP per capita as ID captures the ICT per capita stock of capital and labour skills and GDP per capita measures the cumulative per capita output as a representation for growth. The per capita conversion of networks and skills in the calculation of the ID index is not identical to the per capita transformation of GDP. In the ID index the capital stock is measured per 100 persons in some suitcases and per household in other cases. In the GDP per capita calculation, GDP is divided by the population. A subsequent and more detailed examination of the relationship between ID and GDP per capita might perfectly explore the sensitivity of the results to these data differences [Sciadas, 2003].

The relationship between GDP per capita and ID is linear, and there is strong correlation between them, that is, over time as ID increases, GDP per capita increases. Also this relation can be proved by Granger causality test. The Study will test the null hypothesis "H_0: log GDP per capita does not Granger cause log Info density (ID)", we also test the opposite null hypothesis "H_0: log Info density (ID) does not Granger cause log GDP per capita". For the first hypothesis we accept it as the level of acceptance more than 0.05, meaning that GDP per capita does not cause ID. As for the second hypothesis, we reject it if the significance value is less than 0.05, meaning that ID cause GDP per capita.

This model can be expressed as follows:

$$\text{Log}\,(GDP_{i,t}) = \log\,(A) + \alpha_1\,\text{Log}\,(ID_{i,t}) + \varepsilon_{i,t} \qquad (4.1)$$

Where is ($GDP_{i,t}$) represents GDP per capita for country (i) over time (t), ($ID_{i,t}$) represents infodensity for country (i) over time (t) in annual sequence, (α_1) represents the elasticity of infodensity of GDP per capita and (ε_t) represents the random factor. The model can be estimated using the panel regression using least squares, fixed effects and random effects approaches. The model can be used to estimate the sensitivity of per capita GDP to variations in Infodensity for each individual country within the study sample.

The calculations of infodensity according to ORBICOM [Sciadas, 2005] is as follows:

$$\text{ID} = \sqrt[k]{\prod_{i=1}^{k} I_{n,t}^{i,j(c)}} \tag{4.2}$$

With Π representing product and n the number of each component's individual indices. I represents the guide value and i represents the used indexes. In 2001, for networks n=5 (fixed, mobile, cable, Internet and bandwidth), for skills n=2 (literacy and gross enrolment) and for uptake n=4 (television, residential lines, PCs and Internet users). With k=2, Networks and skills are united into the ID index.

$$\text{ID} = \sqrt[2]{networks * skills} \tag{4.3}$$

$$\text{Networks} = \sqrt[3]{fixed/100\ inhabitants * mobile/100\ inhabitants * bandwidth(b/s)/internet\ user} \tag{4.4}$$

$$I^{gross\ enrolment} = (\text{primary} + 2 \times \text{secondary} + 3 \times \text{tertiary})/6 \tag{4.5}$$

$$\text{Skills} = \sqrt[2]{literate\ rate * I^{grossenrolment}} \tag{4.6}$$

4.3 The Extended Study Model and Dependent and Independent Variables

The above conceptual model may overvalue the degree of the effect because a number of significant variables are not considered, even though the conceptual model accurately captures the way of Infodensity's impact on per capita GDP. The estimated extended model [Sciadas, 2005] is as follows:

$$\begin{aligned} Log\ (GDP/capita_{i,t}) = {} & \alpha_0 + \alpha_1\ Population\ Growth_{i,t} + \alpha_2 \left(\frac{GCF}{GDP}\right)_{i,t} + \alpha_3\ Openness_{i,t} \\ & + \alpha_4\ Inflation_{i,t} + \alpha_t\ Log(ID)_{i,t} + \varepsilon_{i,t} \end{aligned} \tag{4.7}$$

The dependent Variable which is represented by the GDP per capita$_{i,\,t}$ reflects the economic growth for country (i) over time (t) in annual sequence. We will use the natural logarithmic format for the Average per capita of the gross domestic product according to purchasing

power parity (PPP) (constant 2011 international $). GDP per capita based on (PPP). PPP GDP is gross domestic product converted to international dollars using purchasing power parity rates. An international dollar has the same purchasing power over GDP as the U.S. dollar has in the United States. GDP is the sum of gross value added by all resident producers in the economy plus any product taxes and minus any subsidies not included in the value of the products. It is calculated without making deductions for depreciation of fabricated assets or for depletion and degradation of natural resources. Data are in constant 2011 international dollars. $\varepsilon_{i,t}$ is the error term.

The independent variables are divided into two types, first the main independent variable which is the infodensity index that represents the ICT as illustrated before, and it is expressed in the model by the natural logarithmic format. The other types of independent variables are the standardized macroeconomic control variables. These variables are:

A. Population growth which reflects the percent annual growth of the population of the country.
B. Openness which are the sum of exports and imports of goods and services divided by GDP in current US $. Exports of goods and services represent the value of all goods and other market services provided to the rest of the world. They include the value of merchandise, freight, insurance, transport, travel, royalties, license fees, and other services, such as communication, construction, financial, information, business, personal, and government services. They exclude compensation of employees and investment income (formerly called factor services) and transfer payments. Data are in current U.S. dollars. Imports of goods and services represent the value of all goods and other market services received from the rest of the world. They include the value of merchandise, freight, insurance, transport, travel, royalties, license fees, and other services, such as communication, construction, financial, information, business, personal, and government services. They exclude compensation of employees and investment income (formerly called factor services) and transfer payments. Data are in current U.S. dollars.
C. Investment proxy which is represented by Gross capital formation (GCF) as percent of GDP. Gross capital formation (formerly gross domestic investment) consists of

outlays on additions to the fixed assets of the economy plus net changes in the level of inventories. Fixed assets include land improvements (fences, ditches, drains, and so on); plant, machinery, and equipment purchases; and the construction of roads, railways, and the like, including schools, offices, hospitals, private residential dwellings, and commercial and industrial buildings. Inventories are stocks of goods held by firms to meet temporary or unexpected fluctuations in production or sales, and "work in progress." According to the 1993 SNA, net acquisitions of valuables are also considered capital formation.

D. Inflation, GDP deflator (annual %) where Inflation is measured by the annual growth rate of the GDP implicit deflator shows the rate of price change in the economy as a whole. The GDP implicit deflator is the ratio of GDP in current local currency to GDP in constant local currency.

Investment represented by capital formation is an important element of economic growth (Nafziger, 1984; Solow, 1956]. The use of the capital formation as an independent variable refers to its significant impact on GDP per capita as that positively cumulate the volume of output needed for production, then value added and productivity will increase, and consequently will be positively reflected on GDP per capita. Openness (that represents the overall bulk of trade in GDP) as a standardized control factor of growth positively stimulates economic growth (Bahmani-Oskooee and Niroomand, 1999; Dollar, 1992; Harrison, 1996]. Via exports openness is traditionally related to economic growth, where exports advance total factor productivity, advance technical progress, increase saving, enhance credit rating and increase country's income (Balassa, 1978; Krueger, 1988; Colombatto, 1990]. Lower levels of inflation will decrease the cost of production in real terms and this will positively affect economic growth, as the economic proxies properly realize the actual prices to be able to take coherent investment decisions leading to more efficient use of resources, increase in total factor productivity and consequently increase in output growth (Harberger, 1998).

4.4 The Second Study Model (Cobb-Douglas production function)

In order to further verify the study work the production function of Cobb-Douglas will be used as a second study model. The production level in the economy depends on factors of

production that are domestic capital (k), human capital (H) and labour (L), the capital is divided into two parts one representing the ICT capital services and the other representing the non-ICT capital services. This model depends on the new growth theory named Endogenous growth theory which was used in several past studies [Balasubramanyam et al, 1996]. The production function estimated using capital services (ICT and non-ICT), labour quantities as production factors. We distinguished between ICT capital services (KS_{ICT}) and non-IT capital (KS_{NICT}) as independent factors.

$$GDP = f(K, L, \varepsilon) \tag{4.8}$$

GDP: $total\ domestic\ production.$

K: capital services of ICT and non-ICT.

L: $labour\ quantittes\ measered\ by\ total\ number\ of\ employees.$

ε: $error.$

$$GDP = f(ICT)\, f(K, L, \varepsilon) \tag{4.9}$$

$f(ICT)$ Represents cumulative effects of the shift of production function over time from the ICT change.

$$GDP = a_0 CS(IT)^{a_1} {K_{IT}}^{a_2} {K_{NIT}}^{a_3} L^{a_4} e^{\varepsilon} \tag{4.10}$$

Where $a_1 + a_2 + a_3 + a_4 = 1$

A change in labour and capital inputs represents a movement along the production function. In the other hand ICT capital services change represent a shift in the production function [Solow, 1957; Jorgenson & Stiroh, 1999]. The production function satisfies certain economic neutrality conditions. The growth rate (in the log change format) is used in this model for GDP, capital services for ICT and non-ICT (KS_{ICT} andKS_{NICT}) and labour quantity, as shown in the equation below. The equation also includes the time dummies (λ_t) and error term ($\varepsilon_{i,t}$). We can write equation 4.10 after adjustment as:

$$\Delta\log(GDP_{t,i}) = \alpha_0 + \alpha_1 \Delta\log(KS_{ICT})_{i,t} + \alpha_2 \Delta\log(KS_{NICT})_{i,t} + \alpha_3 \Delta\log L_{i,t} + \lambda_t + \varepsilon_{i,t} \tag{4.11}$$

This model helps to avoid the problem of heterogeneity of variance, which means that the heterogeneity existence cause the change of variance as views change. Which leads to inefficient results that do not help in captivating correct decisions concerning hypotheses checking. This model also assistances to evade the problem of multiple linear correlation, where its attendance means that there is a correlation between the used variables in explanation of the dependent variable.

4.5 Data Collection

The data sources of independent control variables and dependent variable of GDP per capita are from the World Bank database[10] where the data set contains anual data for each Arab country such as GDP per capita, population growth, gross capital formation, Openness and inflation. According to the avilability of information we choosed 18 arab countries as they represent the majority of arab countries for the period from 1995 to 2013. Some figures for Palestine are extracted from Palestinian Monetary Authority (PMA)[11]. The data sources for the variables of infodensity are as follows: i) for Palestine the infodensity index for the years 1995 2013 was calculated by the author as illustrated in this chapter of methodology depending in the information for the concerned network sub index variables from International Telecommunication Union (ITU)[12] and the information for skills index from different PCBS[13] bulletins. ii) for the rest of sample study of 17 Arab countries the Infodensity index data for the years from 1995-2003 are from ORBICOM study [Sciadas, 2005], the index for the years 2004-2013 was calculated depending on the data from ITU, World Bank and UNESCO bulletins, in addition to using information from different Arab statistics centres such as Jordanian Department of Statistics[14] and Qatar Ministry of Development Planning Statistics[15]. All related data for the 18 Arab countries of the study sample are shown in table A.3, Appendix 2. The data for the second study model are obtained

10http://databank.worldbank.org/ddp/home.do.
11http://www.pma.ps/Default.aspx?tabid=202&language=en-US
12http://www.itu.int/ITU-D/ict/statistics/index.html
13http://www.pcbs.gov.ps/default.aspx
14http://web.dos.gov.jo/?lang=en
15http://www.qsa.gov.qa/eng/index.htm

from the conference board economic database[16] concerning growth rate of GDP, capital services (ICT and non-ICT) and labour quantities for the period from 1995 to 2013. The data concerning the contribution of capital services delivered by ICT and non-ICT assets and labour quantity to GDP growth for the same period are also obtained from the conference board.

4.6 Chapter summary

In this chapter the two study models are illustrated, where the first study model has been explained in its basic form containing an independent input variable of ICT capital and labour stock calculated from the ICT networks and skills as proposed by ORBICOM and the dependent variable that is GDP per capita (PPP$). The extended model contains other independent variables that represent the standardized control macroeconomic variables. The second used model depends on Cobb-Douglas production function including ICT and non-ICT capital services stemmed from ICT and non-ICT assets, in addition to the labour variable. The data needed to apply the two models are obtained from various available resources such as WB, ITU, PCBS, Conference board and several related bulletins from concerned statistics centres.

16 https://www.conference-board.org/data/economydatabase/index.cfm?id=27762

CHAPTER 5: EMPIRICAL FINDINGS AND ANALYSIS

5.1 Introduction

In this chapter we shortly describe the study related data and then try to assess and test the two model equations, and analyse the results to stand on accepting or rejecting the research hypothesis. We estimated the above described model using STATA 14.1 and EVIEWS 9 statistics programs.

5.2 Descriptive Statistics

Figure 5.1 shows the changes of the average of GDP per capita starting from the year 1995 to the year 2013 for the 18 Arab countries covered in our study. From the figure we see that the GDP per capita is increasing from the year 1995 to the year 2008 and then it starts to slightly decrees till the year of 2011 affected from the economic crises in the world at that period, then the GDP starts to slightly increase for the year 2012 and 2013 but still less than that of the immediately preceding years of 2008. Figure 5.2 shows the average GDP per capita for the sample study of 18 Arab countries starting from the year 1995 to 2013. The highest GDP per capita average is for Qatar with 107,570.41 US Dollars and the lowest GDP average is for Djibouti with 2354.26 US Dollars. As we see from figure 5.2 the gulf countries (GCC) have the highest averages of GDP per capita as they are rich of oil resources.

Figure 5.3 and 5.4, show the statistics of ICT index which is infodensity in our case for the 18 Arab countries. Figure 5.3 shows the average of infodensity values for the years from

1995 to 2013 for the Arab countries which increase from the starting point of 1995 to 2012 and slightly decreases for the year 2013. Figure 5.4 shows the average of infodensity values for the 18 Arab countries where the highest average value is for Qatar and the lowest one is for Djibouti. This is a good indication of the ICT index increase, where the investment in ICT networks and skills is increasing due to the important role of the ICT in all life aspects.

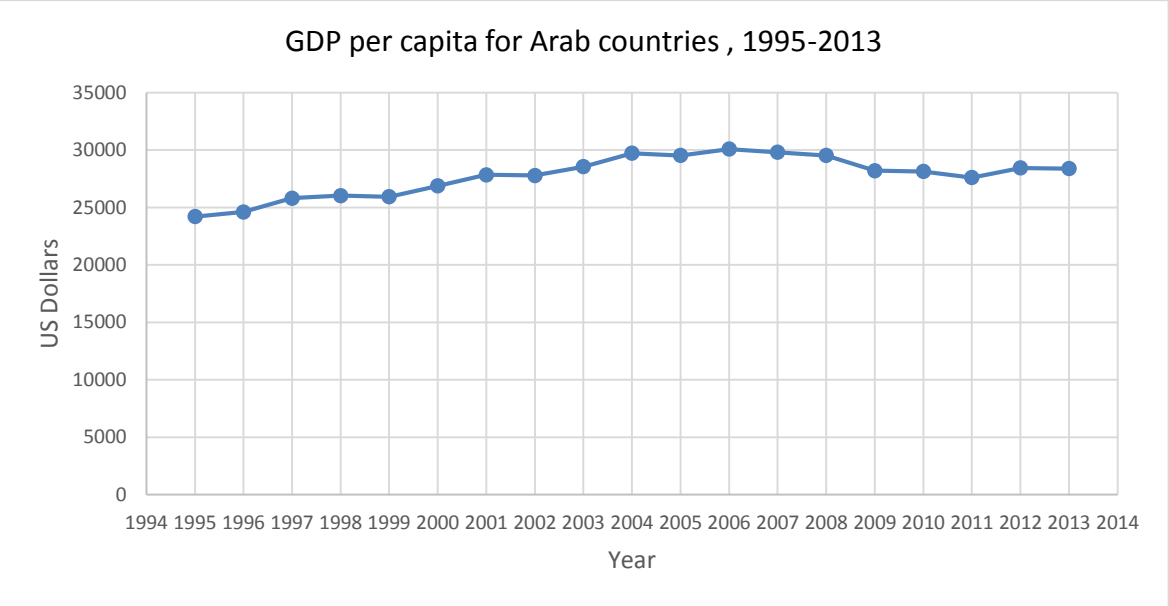


Figure 5.1 GDP per capita for Arab countries, 1995 to 2013
Source: own calculations depending on World Bank data (2014)

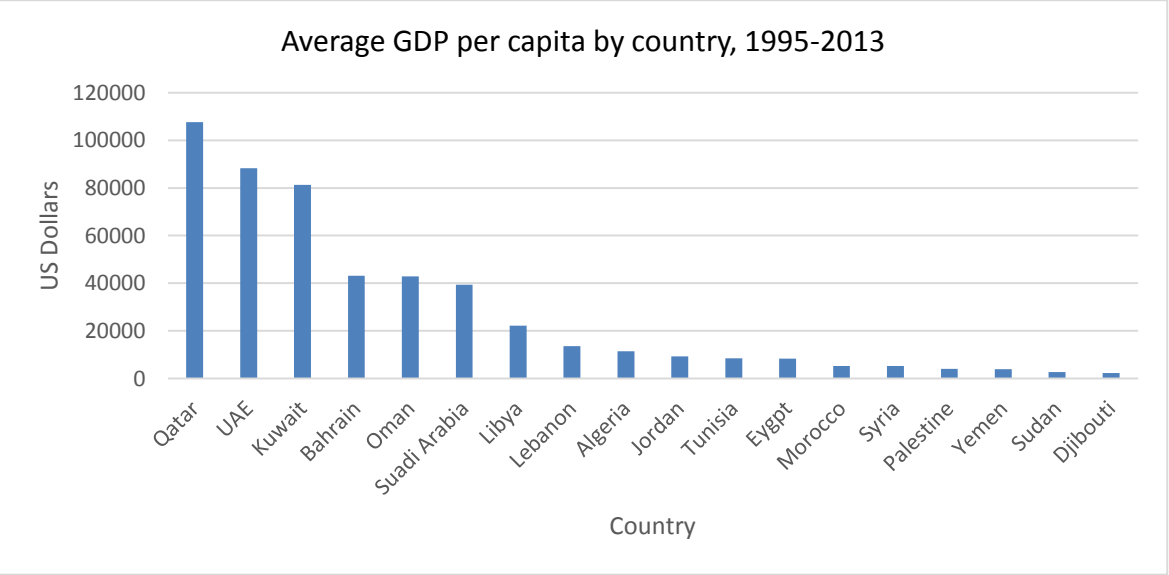


Figure 5.2 Average GDP per capita for Arab countries, 1995 to 2013
Source: own calculations depending on World Bank data (2014)

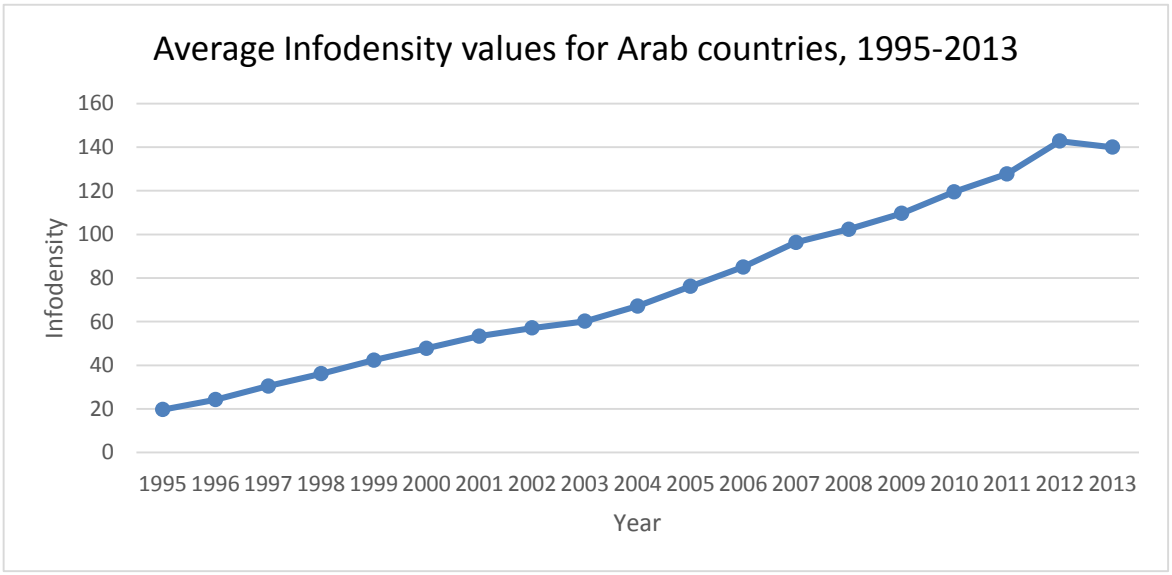


Figure 5.3 Average infodensity values for Arab countries from year 1995 to 2013
Source: ORBICOM and own calculations

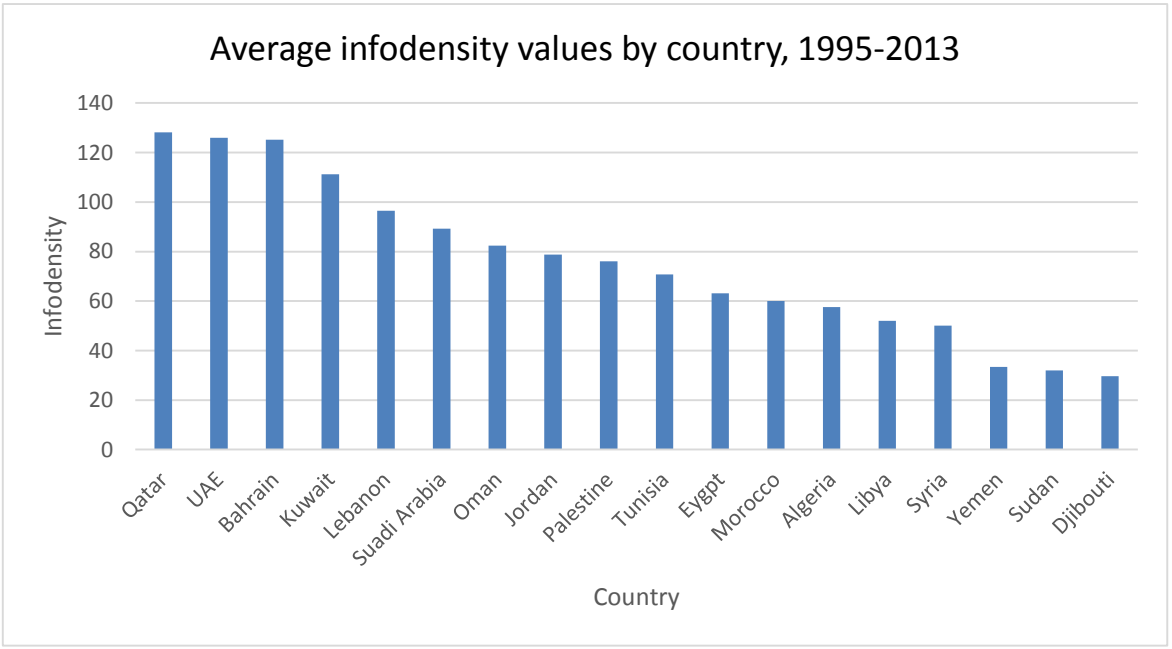


Figure 5.4 Average infodensity values by country from year 1995 to 2013
Source: ORBICOM and own calculations

As we clarify from figure 5.5, the relationship between the average values of log (GDP per capita) and log (infodensity) is linear with strong correlation. As the average value of the

ICT index (represented by the infodensity) increases the average value of GDP per capita also increases for the period from 1995 to 2013.

Table 5.1 shows Granger causality test result and according to the result in this table we test the null hypothesis as follows:

"H_0: Log (GDP per capita) does not granger cause of Log (Infodensity)"

"H_0: Log (Infodensity) does not granger cause of Log (GDP per capita)"

The first hypothesis is accepted because the significance level is 0.225 which is more than the significance level of 0.05, so Log (GDP per capita) does not cause Log (ID). For the second null hypothesis it is rejected as the significance level 0.0457 is less than 0.05, so the ICT index (Log (ID)) does cause Log (GDP per capita) according to granger causality test.

Table 5.1 Granger causality Wald tests between Log (GDP per capita) and Log (ID)

Equation	Excluded	F	df	df_r	Prob> F
Log(GDP per capita)	Log(ID)	4.0098	3	9	0.0457
Log(GDP per capita)	ALL	4.0098	3	9	0.0457
Log (ID)	Log (GDP per capita)	1.7577	3	9	0.2249
Log (ID)	ALL	(0.000)	3	9	0.2249

Source: author using STATA 14.1

Table 5.2 shows the descriptive statistics of the 18 Arab countries for the period from 1995 to 2013. The average gross domestic product (GDP) per capita is 27,742.14 US Dollars with the minimum value for Sudan in 1995 reaching 1922.78 US Dollars, and the maximum value for Qatar in 2013 approaching 135798.39 US Dollars.

The main variable for interest is ICT index (represented by infodensity) which represents ICT capital and labour stock with an average value of 75.6, the minimum value for Sudan with 1.5 in 1995, and the maximum value for Bahrain with 212 in the year 2012.

The average population growth for Arab countries is 3%, ranging from -0.3% for Libya in the year 2013, to 17.6% for Qatar in the year 2007. The average value of gross capital formation as a percent of GDP is 23.9%, with the minimum value of 7.9% for Bahrain in 1999, and the maximum value of 47% for Algeria in the year 2009.

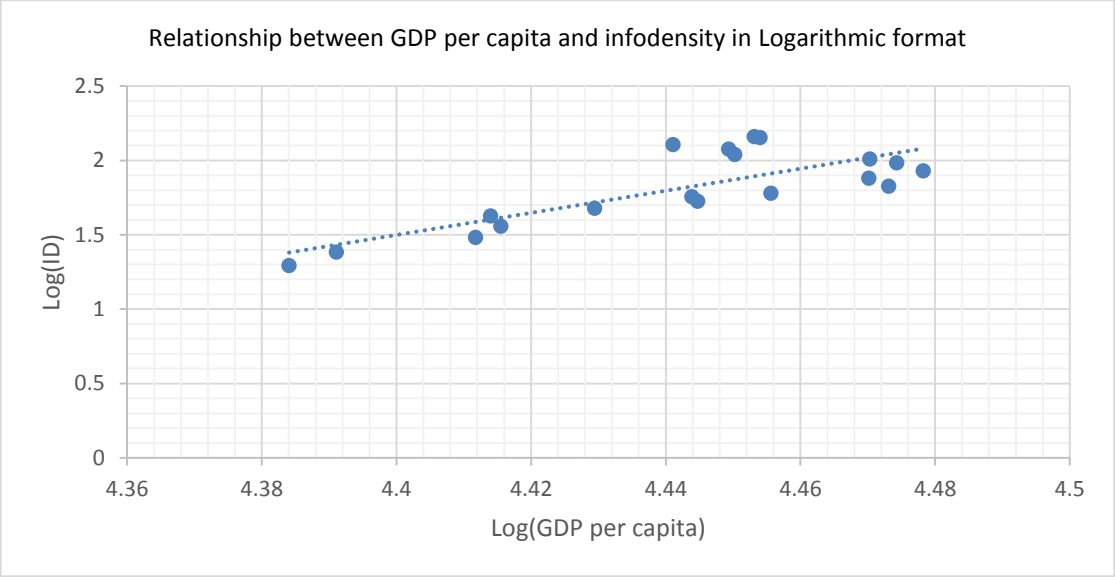


Figure 5.5 Relationship between averages of GDP per capita and infodensity, 1995-2013
Source: author

The average value of openness (the sum of exports and imports of goods and services divided by GDP) is 87.3%, with the minimum value of 34.8% for Libya in the year 1999 and the maximum value 176.1% for UAE in the year 2013. The average value of inflation is 4.6%, with the minimum value of -25.1% for Oman in the year 2009, and the maximum value of 55.1% for Yemen in the year 1995.

Tables 5.3, shows descriptive figures of the five Arab country sample group for the period 1993 to 2014, which are used in the estimation of the second study model of augmented Cobb-Douglas production function. The average growth rate of GDP is 3.89% in log change. ICT capital services as the main variable of interest shows an average growth rate of 14.954%, much higher than those of non-ICT capital services with 3.108%. The labor quantity growth rates approach 3.814%.

The average ICT compensation share reaches 0.0487 (contribution of ICT capital services to GDP growth/Δ Log (ICT capital services), the compensation share for the non-ICT approaches 0.485 and that of labor share approaches 1.4. These numbers of compensation shares of ICT, non-ICT and labor are close to corresponding numbers of developing countries according to conference board data [Niebel, 2014].

Table 5.2 Summary statistics: Arab countries, 1995-2013

Factor	N	Minimum	Maximum	Mean	Std. Deviation
GDP per capita, PPP	341	1922.78	135798.39	27742.1386	33095.40498
Infodensity	341	1.50	212.00	75.665	51.24112
Log(GDP/capita)	341	3.284	5.133	4.13605	.528061
Log(ID)	341	.176	2.326	1.74550	.389056
population growth	341	-.003	.176	.03005	.026477
GCF/GDP	341	.079	.470	.23928	.074032
Openness	341	.348	1.761	.87312	.264486
Inflation	341	-.251	.551	.04598	.068041
Valid N (list wise)	337				

Source: ITU, World Bank (2014) and own calculations depending on different Arab statistics institutes bulletins.

Table 5.3 Summary statistics for second model variables, 1993-2014

Measure	GDP growth	ICT growth	Non-ICT growth	Labour growth	Compensation of ICT	Compensation of non-ICT	Compensation of labour
Mean	3.889616	14.95446	3.108144	3.147962	0.048736	0.484564	0.466683
Median	3.873114	14.72535	2.974492	2.861585	0.044909	0.481857	0.484829
Maximum	13.41284	28.67203	8.068590	20.59258	0.128885	0.605144	0.533639
Minimum	-6.805885	6.093689	-0.598963	-17.48654	0.001601	0.391260	0.342120
Std. Dev.	2.763488	5.522159	1.954707	4.913426	0.027585	0.053953	0.055665
Observations	125	125	125	125	125	125	125

Source: Conference Board economic database with own calculations

5.3 The Impact of ICT on economic growth using the basic model

5.3.1 The Impact of ICT on economic growth for Qatar

The estimated results that represent the impact of ICT represented by infodensity on economic growth for Qatar represented by GDP per capita are shown in table 5.4.

The validity of the estimated model can be proved through statistically evaluation method as follows:

- F-test (Fisher test): The significance for the model as a whole is explained as the calculated F-statistics (471.21) is greater than the tabular one (F= 4.45), so the alternative hypothesis is accepted and the whole model is significant. Also the level of fisher significance is zero (Prop (F-statistic) =0.0).
- Significance of model parameters: The t-test (Student's-t Distribution) value for log (infodensity) is 21.70 which is more than the tabular one which is 2.11at 5% confidence level so as for the constant with t-statistic equal 90.09 greater than tabular value, so the parameters are significant.
- Confidence interval: significance of infodensity parameter can be assured by the confidence interval $\alpha \in$ [0.469303-2.11*0.021620, 0.469303+2.11*0.021620] = [0.424, 0.515], we see that zero doesn't belong to the confidence interval. Significance of constant parameter can be assured by the confidence interval $\alpha \in$ [4.029014-2.11*0.021620, 4.029014+2.11*0.021620] = [3.983, 4.075], where zero doesn't belong to the confidence interval.
- Determination coefficient: the value of R-square is 96.5% which means that ICT explains 96.5% of the changes that occur in the dependent variable.
- Durbin Watson (DW): As the DW statistic value 1.483 is more than the DW tabular value 1.401 at 5% confidence level, then we accept the null hypothesis and conclude that there is no positive autocorrelation between the residuals.
- Normality test: The results of this test are shown in figure 5.6, this test depends on Jarque-Bera statistic that is calculated from skewness and kurtosis statistics ($J - B_{test} = (\frac{n-k+1}{6}) \cdot \left[(skewness)^2 + \frac{(kurtosis-3)^2}{4}\right]$) where n is the number of observations and k is the number of input variables in the regression equation. The hypothesis of this test are as follows: H_0 : Errors are normally distributed and H_1 : Errors are not normally distributed. The results show a low value of Jarque-Bera statistic (J-B=0.12) which is less than the critical value of chi-square χ^2 (2)=5.99, with the Jarque-Bera probability (94.03 %) that is higher than 5 %; then, the null hypothesis is not rejected implying that there is non-normality problem and the error is common.

Table 5.4 Results of estimated model for the impact of ICT on GDP per capita for Qatar

Dependent Variable: LOG_GDP_C
Method: Least Squares
Date: 10/19/15 Time: 23:07
Sample: 1 19
Included observations: 19

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOG_ID_	0.469303	0.021620	21.70731	0.0000
C	4.029014	0.044722	90.09065	0.0000

R-squared	0.965179	Mean dependent var	4.993396
Adjusted R-squared	0.963130	S.D. dependent var	0.116453
S.E. of regression	0.022361	Akaike info criterion	-4.663731
Sum squared resid	0.008500	Schwarz criterion	-4.564316
Log likelihood	46.30544	Hannan-Quinn criter.	-4.646906
F-statistic	471.2073	Durbin-Watson stat	1.482819
Prob(F-statistic)	0.000000		

Source: author using Eviews 9

- Parameter stability: As illustrated in table, the parameters are stable, where Ramsey's test is used for this issue with the null hypothesis that proposes the stability of the model coefficients if the probability is more than 5%. As shown in table 5.5 Log likelihood probability is 6.9%, then null hypothesis is accepted indicating that the model coefficients are stable. Also the probability associated with F-statistic 11.92%, which is more than 5 %, then we accept the null hypothesis and the model is well specified.
- Heteroscedasticity test: As illustrated in table 5.6. The two associated probabilities are more than 5 %, hence, we accept the null hypothesis of homoscedasticity of errors. Also the model is serial independent as clarified from table 5.5

The positive and significant impact of ICT is obvious, where the result shows that ICT elasticity is 0.469, which means that any increase of domestic ICT by 10% leads to increase in GDP per capita by 4.69% where it is a positive with proportional impact.

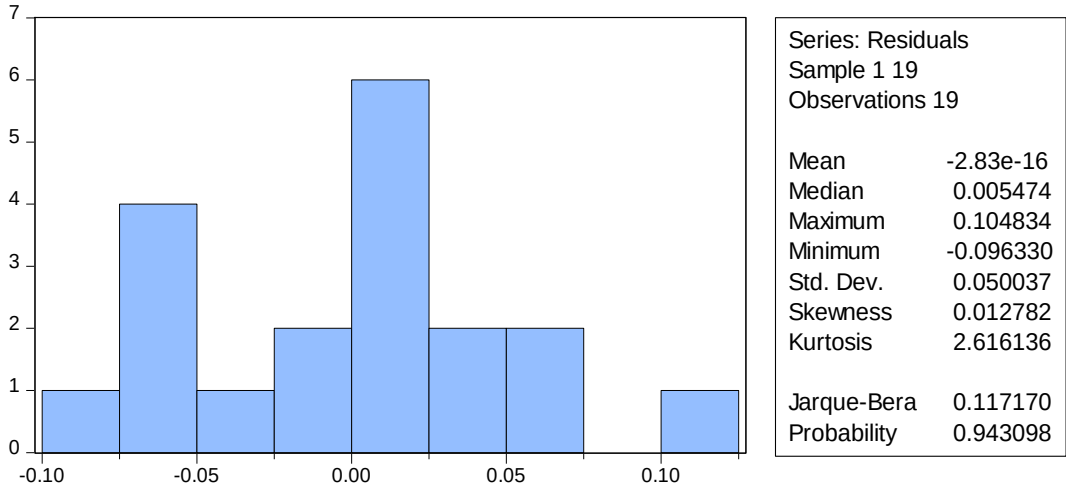


Figure 5.6 Actual fitted graph for Qatar
Source: author using EVIEWS 9

As we recognize from table A.3 in Appendix 2, there are comparatively low GDP per capita growth together with high Infodensity growth rates. This might be due to incompetent investments, which may delay these developing Arab countries ilustrated in this study from gaining the benefits of ICT contributions, so there is a need for adequate edge of Infodensity. Also this delay of benefiting from ICT externalities may be due to the extra time needed to accumulate ICT experience for these Arab countries. Other factors impede the economy from growing are various economic policies (financial policy, investment, trade, monetary policy and others), in addition to geopolitical issues and others.

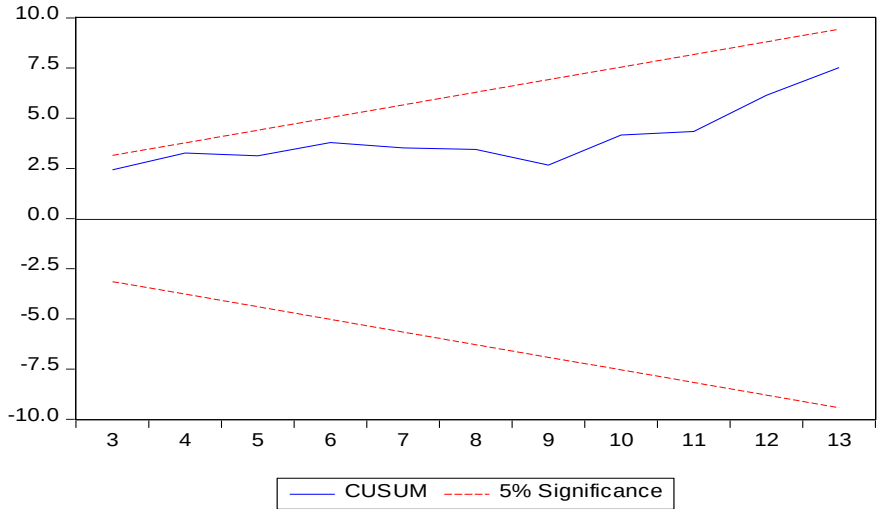


Figure 5.7 CUSUM graph for Qatar
Source: author using EVIEWS 9

Date: 10/20/15 Time: 10:34
Sample: 1 19
Included observations: 19

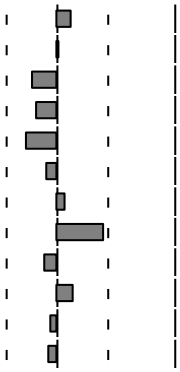
Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.13...	0.13...	0.380...	0.53...
		2	0.01...	0.00...	0.390...	0.82...
		3	-0.2...	-0.2...	1.591...	0.66...
		4	-0.1...	-0.1...	2.438...	0.65...
		5	-0.2...	-0.2...	4.495...	0.48...
		6	-0.0...	-0.0...	4.704...	0.58...
		7	0.07...	0.03...	4.886...	0.67...
		8	0.41...	0.32...	11.11...	0.19...
		9	-0.1...	-0.3...	11.52...	0.24...
		10	0.14...	0.16...	12.40...	0.25...
		11	-0.0...	0.01...	12.58...	0.32...
		12	-0.0...	-0.0...	12.86...	0.37...

Figure 5.8 Autocorrelation graph for Qatar
Source: author using EVIEWS 9

Table 5.5 Ramsey and serial correlation test for Qatar

Ramsey RESET Test
Equation: UNTITLED
Specification: LGDPC LID C
Omitted Variables: Squares of fitted values

	Value	df	Probability
t-statistic	1.703760	10	0.1192
F-statistic	2.902797	(1, 10)	0.1192
Likelihood ratio	3.313167	1	0.0687

Breusch-Godfrey Serial Correlation LM Test:

F-statistic	0.279804	Prob. F(2,9)	0.7623
Obs*R-squared	0.761004	Prob. Chi-Square(2)	0.6835

Source: author using EVIEWS 9

Table 5.6 Heteroskedasticity test

Heteroskedasticity Test: Breusch-Pagan-Godfrey

F-statistic	3.891482	Prob. F(1,17)	0.0650
Obs*R-squared	3.539153	Prob. Chi-Square(1)	0.0599
Scaled explained SS	2.289486	Prob. Chi-Square(1)	0.1303

Source: author using EVIEWS 9

5.3.2 The Impact of ICT on economic growth for Tunisia

The two variables of the conceptual model are cointegrated. The least squares method is used to estimate the regression results. The results show low DW value of 0.815 which indicates a problem of positive autocorrelation between the residuals. To solve this constraint we use quasi-differences by converting existing time series to new time series as:

$$Log\ (GDP/capita_t) = Log\ (GDP/capita_t) - \rho.Log\ (GDP/capita_{t-1}) \quad (5.1)$$

$$Log\ (ID_t) = Log\ (ID_t) - \rho.Log\ (DI_{t-1}) \quad (5.2)$$

$$Log\ (GDP/capita_t) = \alpha_0 + \alpha_1\ Log(ID)_t + v_t \quad (5.3)$$

So, we can estimate the equation using the least squares method as v_t subject to classical hypothesis for estimation, where:

$$v_t \quad \varepsilon_t - \rho\ \varepsilon_{t-1} \quad (5.4)$$

Where (v_t) is the random error.

The steps which are used to solve the problem of autocorrelation of residuals are as follows:

- Specify initial value for (ρ) using several ways as i) direct estimation using DW (ρ=1-(DW/2) (1-0.815/2= 0.5925)); and ii) estimation by applying regression on the residuals as shown in table 5.7.
- Apply regression on the equation of quasi-differences model (see equation 5.5).

$$Log\ (GDP/capita_t) - \rho.Log\ (GDP/capita_{t-1})) = \alpha_0\ (1-\rho) + \alpha_1\ (Log\ (IDt) - \rho.Log\ (DIt-1))_t + v_t \quad (5.5)$$

  Where $\alpha_0 = (b_o / (1-\rho))$, then we estimate the coefficients ($\check{\alpha}_0$, $\check{\alpha}_1$).
- Re-estimate the value of (ρ) by doing regression on the new residuals ($Log\ (GDP/capita_t) - \check{\alpha}_0 - \check{\alpha}_1\ Log\ (IDt)$).
- Apply new regression on quasi-differences model with the new estimated value of (ρ), then we repetitively repeat the second and third steps till the estimated coefficients become stable. We estimate the model using AR (1). Then we create new time series using the new estimated (ρ) according to the value of estimated AR (1) and we apply regression on these time series data. The final results of regression are shown in table 5.8.

Table 5.7 Residual regression

Dependent Variable: E
Method: Least Squares
Date: 10/20/15 Time: 09:53
Sample (adjusted): 2 19
Included observations: 18 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
E(-1)	0.605886	0.216220	2.802171	0.0122

Source: author using EVIEWS 9

Table 5.8 Results of estimated model for the impact of ICT on GDP per capita for Tunisia

Dependent Variable: LG7
Method: Least Squares
Date: 10/20/15 Time: 11:22
Sample (adjusted): 2 19
Included observations: 18 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	2.893756	0.039096	74.01671	0.0000
ID7	0.370611	0.023161	16.00150	0.0000

R-squared	0.941187	Mean dependent var	3.511182
Adjusted R-squared	0.937511	S.D. dependent var	0.106876
S.E. of regression	0.026717	Akaike info criterion	-4.302612
Sum squared resid	0.011421	Schwarz criterion	-4.203682
Log likelihood	40.72351	Hannan-Quinn criter.	-4.288971
F-statistic	256.0480	Durbin-Watson stat	1.705082
Prob(F-statistic)	0.000000		

Source: author using EVIEWS 9

The validity of the estimated model can be proved as follows:

- F-test (Fisher test): The significance for the model as a whole is explained as the calculated F-statistics (256) is greater than the tabular one (see table 5.8), where according to the table of F-distribution, the critical value of F-distribution at the 5% significance level is (F= 4.45), so the alternative hypothesis is accepted and the whole model is significant. This indicates that ICT index (ID) predicts GDP per capita. Also the level of fisher significance is zero (Prop (F-statistic) =0.0) which also means that GDP per capita is anticipated with 100% probability by ID and demonstrates a statistically significant relationship between them. So, the F-value verifies that there is a significant relationship between the economic growth valuated by GDP per capita and ICT which is represented by ID.

- Significance of model parameters: The t-test (Student's-t Distribution) value for log (ID) is 16.0 which is more than the tabular value of 2.11 ($t_{n-k-1}^{\alpha/2} = t_{17}^{\alpha/2} = 2.11$) at 5% confidence level, so as for the constant with t-statistic equal 74 greater than tabular value, so these parameters are significant. Therefore the two variables (constant and ID) are statistically significant.
- Confidence interval: significance of ID parameter can be assured by the confidence interval as confidence interval for α (ID coefficient): $L, U = \alpha_1 \pm t_{n-2}^{\alpha/2}$ se(b_1), where sample statistic $b_1$and se(b_1)*:* standard error of the sampling distribution of b_1, then α_1 ϵ = [0.321, 0.420], we see that zero does not belong to the confidence interval. Significance of constant parameter can be assured by the confidence interval c ϵ = [2.81, 2.98], where zero does not belong to the confidence interval. That is confidence is 95% that the population slope parameter α_1 is between 0.321 and 0.420, and so as for the constant coefficient.
- Determination coefficient: the value of R-square is 94% which means that ICT explains 94% of the changes that occur in the dependent variable (GDP per Capita).
- Durbin Watson (DW): The test of autocorrelation of errors using Durbin Watson statistical method measures the first order of autocorrelation, where the residuals are independent. first-order autoregressive errors with equally spaced time intervals are $\varepsilon_t = \rho\varepsilon_{t-1} + a_t$, where ε_t is at time interval t, a_t is an NID $(0,\sigma_a^2)$ random variable, and ρ ($|\rho| < 1$) is the autocorrelation parameter. As we use time series data in our case of regression that show positive autocorrelation, the hypothesis of DW test is as follows: $H_0 : \rho = 0$ (serial correlation) and $H_1 : \rho > 0$ (no serial correlation). As the DW statistic value 1.705 is more than the DW tabular value 1.401 (D_L = 1.180 and D_U = 1.401) at 5% confidence level, then we reject the null hypothesis and conclude that there is no positive serial correlation between residuals.
- Normality test: The results of this test are shown in figure 5.9. The results show a low value of Jarque-Bera statistic (J-B=0.52) which is less than the critical value of chi-square χ^2 (2) =5.99, with the Jarque-Bera probability (77 %) that is higher than 5%;

then, the null hypothesis is not rejected implying that there is non-normality problem and the error is common.

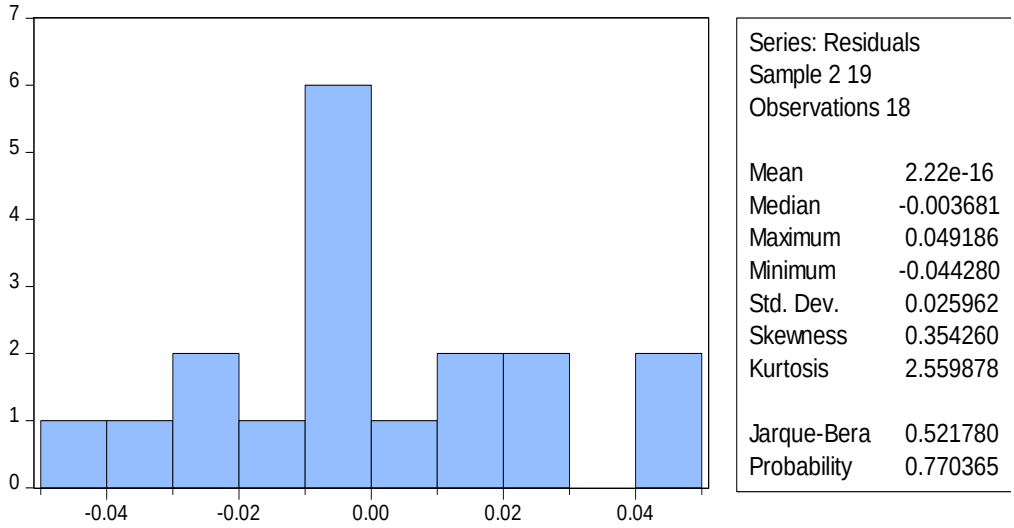


Figure 5.9 Actual fitted graph for Tunisia model
Source: author using EVIEWS 9

- Parameter stability: As illustrated in table 5.9, the parameters are stable, where Ramsey's test indicates that the probability associated with F-statistic 8.5%, which is more than 5%, then we accept the null hypothesis and the model is well specified.
- Heteroscedasticity test: As illustrated in table 5.10. The two associated probabilities are more than 5%, hence, we accept the null hypothesis of homoscedasticity of errors. As shown in figure 5.10, the errors are serially independent as the residuals are within the critical limits. Also as illustrated in table 5.11, there is no problem of serial correlation.

Table 5.9 Ramsey test for Tunisia model

Ramsey RESET Test
Equation: UNTITLED
Specification: LG3 C ID3
Omitted Variables: Squares of fitted values

	Value	df	Probability
t-statistic	1.844210	15	0.0850
F-statistic	3.401109	(1, 15)	0.0850
Likelihood ratio	3.678493	1	0.0551

Source: author using EVIEWS 9

Table 5.10 Heteroscedasticity test for Tunisia model

Heteroscedasticity Test: Breusch-Pagan-Godfrey			
F-statistic	0.033462	Prob. F(1,16)	0.8572
Obs*R-squared	0.037566	Prob. Chi-Square(1)	0.8463
Scaled explained SS	0.023150	Prob. Chi-Square(1)	0.8791

Source: author using EVIEWS 9

Date: 11/09/15 Time: 14:22
Sample: 1 25
Included observations: 24
Q-statistic probabilities adjusted for 1 dynamic regressor

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob*
		1	-0.1...	-0.1...	0.650...	0.42...
		2	-0.0...	-0.1...	0.911...	0.63...
		3	-0.0...	-0.0...	0.985...	0.80...
		4	-0.0...	-0.0...	1.004...	0.90...
		5	0.09...	0.07...	1.327...	0.93...
		6	0.00...	0.02...	1.327...	0.97...
		7	0.08...	0.11...	1.598...	0.97...
		8	-0.0...	-0.0...	1.775...	0.98...
		9	-0.0...	-0.0...	1.815...	0.99...
		10	-0.1...	-0.2...	3.197...	0.97...
		11	-0.0...	-0.1...	3.541...	0.98...
		12	0.13...	0.01...	4.553...	0.97...

*Probabilities may not be valid for this equation specification.

Figure 5.10 Autocorrelation graph
Source: author using EVIEWS 9

Table 5.11 Serial correlation test for Tunisia

Breusch-Godfrey Serial Correlation LM Test:			
F-statistic	0.021990	Prob. F(2,14)	0.9783
Obs*R-squared	0.056368	Prob. Chi-Square(2)	0.9722

Source: author using EVIEWS 9

In reference to coefficients values, the positive impact of ICT is evident, where the results show that ICT elasticity is 0.371, which means that any increase of domestic ICT by 10% leads to increase in GDP per capita by 3.71% where it is positive and proportional impacted.

5.3.3 The Impact of ICT on economic growth for Palestine

The conceptual model was transformed to the linear mode using logarithmic transformation (table A.3, Appendix 2). The model variables are cointegrated and with level and first

difference stationary, where this case permits to implement dynamic OLS (DOLS) which was proposed by Stock and Watson (1993), where they promoted a parametric method for approximating long run balances in models that might contain variables integrated of altered orders and cointegrated. Also this approach is practical for small samples. The likely of simultaneity partiality integrated and small sample unfairness between the regressors is treated by the insertion of lagged and led values of the variation in the independent variables. The regression results using DOLS model is shown in table 5.12.

The equation that represents the impact of ICT represented by infodensity on economic growth in Palestine reflected by GDP per capita is as follows:

$$\log(GDP/C) = 6.61 + 0.372 \log(ID) \quad (5.6)$$

$$R\ squared\ (R^2) = 70.4\% \qquad adjusted\ R^2 = 59.65\%$$

Table 5.12 DOLS regression results for Palestine model

Dependent Variable: LGDPC
Method: Dynamic Least Squares (DOLS)
Date: 10/20/15 Time: 23:42
Sample (adjusted): 3 18
Included observations: 16 after adjustments
Cointegrating equation deterministics: C
Fixed leads and lags specification (lead=1, lag=1)
Long-run variance estimate (Bartlett kernel, Newey-West fixed bandwidth = 3.0000)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LID	0.371723	0.081834	4.542380	0.0008
C	6.609442	0.357277	18.49951	0.0000

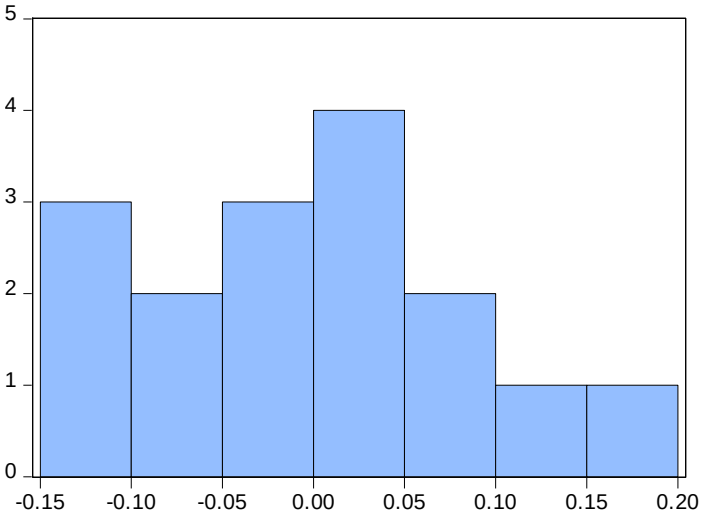
R-squared	0.704068	Mean dependent var	8.188795
Adjusted R-squared	0.596456	S.D. dependent var	0.159812
S.E. of regression	0.101521	Sum squared resid	0.113371
Long-run variance	0.012270		

Source: author using EVIEWS 9

As shown in table 5.12, the t-test (Student's-t Distribution) value for ICT index is 4.54 which is more than the tabular one which is 2.11 at 5% confidence level so this parameter is significant in addition to the constant one. The value of R-square is 70.4%.

For the normality test, the results of this test are shown in figure 5.11, where they show a low value of Jarque-Bera statistic (J-B=0.798) which is less than the critical value of chi-square χ^2 (2) =5.99, with the Jarque-Bera probability (67.1 %) that is higher than 5%; then,

the null hypothesis is not rejected implying that there is non-normality problem. Also as shown in figure 5.12, the errors are serially independent as the residuals are within the critical limits.



Series: Residuals	
Sample 3 18	
Observations 16	
Mean	8.78e-16
Median	-0.000540
Maximum	0.160162
Minimum	-0.114210
Std. Dev.	0.086937
Skewness	0.352638
Kurtosis	2.162784
Jarque-Bera	0.798896
Probability	0.670690

Figure 5.11 Actual fitted graph for Palestine model

Source: author using EVIEWS 9

In reference to coefficients values, the positive and significant impact of ICT is evident, where the results show that ICT elasticity is 0.372, which means that any increase of domestic ICT by 10% leads to increase in GDP per capita by 3.72%.

Sample: 1 19
Included observations: 16

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob*
		1	0.316	0.316	1.9193	0.166
		2	-0.347	-0.496	4.3902	0.111
		3	-0.616	-0.435	12.798	0.005
		4	-0.382	-0.340	16.306	0.003
		5	0.085	-0.258	16.496	0.006
		6	0.396	-0.201	21.012	0.002
		7	0.341	-0.190	24.725	0.001
		8	-0.019	-0.324	24.738	0.002
		9	-0.169	-0.079	25.915	0.002
		10	-0.201	-0.192	27.861	0.002
		11	-0.059	-0.110	28.060	0.003
		12	0.028	-0.236	28.118	0.005

*Probabilities may not be valid for this equation specification.

Figure 5.12 Autocorrelation graph

Source: author using EVIEWS 9

5.3.4 The Impact of ICT on economic growth for remaining Arab countries

The impact of ICT represented by the infodensity on economic growth reflected by GDP per capita for each Arab country is shown in table 5.13. All 18 Arab countries of the study sample individually has positive and significant impact caused by ICT index on GDP per capita except for Djibouti where its ICT index has negative impact on GDP per capita and UAE that encounters insignificant impact of ICT. The impact of ICT on GDP per capita ranges from 0.430 for Morocco to 0.100 for Lebanon.

Therefore, the alternative hypothesis (the first one) is accepted for 16 Arab countries out of 18 of the sample study as H 1 proposes that *there is significant and positive relationship between ICT and economic growth*. Also the alternative hypothesis (the second one) is accepted as H 1 proposes *the impact of ICT on economic growth varies from one Arab country to another*.

Table 5.13 Impact of ICT on GDP per capita for each Arab country

Country	Parameters	Coefficients	Standard Error	t Stat	P-value	Adj R^2
Lebanon	Log(ID)	0.100	0.032	7.08	0.000	0.731
	_cons	2.101	0.136	22.66	0.000	
Qatar	Log(ID)	0.469	0.022	21.707	0.000	0.963
	_cons	4.029	0.045	90.091	0.000	
Palestine	Log(ID)	0.371	0.082	4.523	0.000	0.596
	_cons	6.609	0.357	18.499	0.000	
Jordan	Log(ID)	0.323	0.047	8.95	0.000	0.8148
	_cons	3.122	0.087	35.72	0.000	
Morocco	Log(ID)	0.430	0.023	18.429	0.000	0.9744
	_cons	2.945	.0275	72.93	0.000	
Tunisia	Log(ID)	0.371	.023	16.001	0.000	0.937
	_cons	2.894	.039	74.016	0.000	
Egypt	Log(ID)	0.365	0.023	15.608	0.000	0.969
	_cons	3.253	0.025	78.82	0.000	
Kuwait	Log(ID)	0.311	0.093	3.345	0.004	0.553
	_cons	4.236	0.117	22.16	0.000	
Sudan	Log(ID)	0.323	0.055	5.882	0.000	0.855
	_cons	6.751	0.183	36.74	0.000	
Algeria	Log(ID)	0.277	0.007	35.12	0.000	0.9855
	_cons	3.543	0.039	205.24	0.000	
Djibouti	Log(ID)	- 0.209	0.011	18.18	0.000	0.650

	_cons	2.953	0.183	47.87	0.000	
KSA	Log(ID)	0.248	0.017	14.04	0.000	0.784
	_cons	4.067	.0579132	70.23	0.000	
Bahrain	Log(ID)	0.194	0.016	12.06	0.000	0.733
	_cons	4.173	0.033	125.40	0.000	
Oman	Log(ID)	0.192	0.031	6.19	0.000	0.786
	_cons	9.720	0.132	72.41	0.000	
Yemen	Log(ID)	0.182	0.023	7.78	0.000	0.848
	_cons	7.545	0.079	94.84	0.000	
Syria	Log(ID)	0.117	0.048	3.82	0.035	0.784
	_cons	3.516	0.225	36.48	0.000	
Libya*	Log(ID)	0.200	0.059	3.393	0.004	0.609
	_cons	4.107	0.224	40.31	0.000	
UAE	Log(ID)	-0.045	0.144	-0.211	0.836	0.642
	_cons	5.866	0.162	33.63	0.009	

* The year 2011 is dropped as outlier

Source: author using Eviews 9 and STATA 14.1

5.4 The Impact of ICT on economic growth with full sample panel regression

In what follows we will assess the model equations, and investigate the results to reach the result point of accepting or rejecting the research hypothesis. We quantitated the research model using the econometric program STATA 14.1 and EVIEWS 9. The research results were estimated for the full sample representing 18 Arab countries for the period from 1995 to 2013 using panel regression. The unit root test was held for the dependent variable log (GDP) per capita and the independent one log (ID), and these variables are stationary according to Levin, Lin and Chu (2002), Im, Pesaran and Shin (2003) and Choi (2001). We estimated the impact of ICT using the pooled ordinary least square model (OLS), the random effects (RE) and the fixed effects (FE) as shown in table 5.14. Fixed effects allow for heterogeneity between the samples of Arab countries through permitting to have their own intercept value. The fixed effects are time invariant as intercept does not vary over time although it may differ across countries. For the random effects model the 18 Arab countries have a shared mean value for the intercept. In order to investigate which model fit our data, the fixed effects or random effects we apply Hausman test [Hausman, 1978]. Hausman test illustrates that for the null hypothesis the random effects model is the appropriate, and the alternative hypothesis illustrates that the fixed effects model is the suitable one. After

choosing the appropriate model we apply diagnostic checking for serial correlation in the residual by using Pasaran cross sectional dependence test to investigate if the residuals are correlated across the countries. The null hypothesis illustrates that there is no serial correlation between the entities; otherwise the alternative hypothesis proposes that there is serial correlation. For heteroscedasticity test we apply Modified Wald test, where the null hypothesis illustrates that residuals are homoscedastic, otherwise the alternative hypothesis concluded that residuals are heteroscedastic. Using POLS approach the elasticity approaches 0.816 which is significant as the P-value is zero. Using the FE approach the elasticity of ICT is 0.208 and it is significant as the P-value is zero. This elasticity means that if the ICT index increases by 1% then the GDP per capita will increase by 0.208% which is a positive indication of the impact of ICT on economic growth represented by GDP per capita. The RE approach indicates that the elasticity of ICT is 0.221 and it is significant as the P-value is zero. The two models used (FE and RE) approximately give the same output elasticity for the effect of ICT on GDP per capita for the full sample of the 18 Arab countries.

Table 5.14 Impact of ICT on GDP per capita, 1995-2013, full sample

Variables	POLS	Adjusted FE	RE
Constant	2.689	3.705	3.67
Std. Err.	(0.125)	(0.014)	(0.075)
P-value	(0.000)	(0.000)	(0.000)
Log(ID)	0.816	0.208	0.221
Std. Err.	(0.060)	(0.030)	(0.016)
P-value	(0.000)	(0.000)	(0.000)
Adjusted R	0.35	0.52	0.522
Observations	342	324	342
Countries	18	18	18

$p<0.05$

Source: author using STATA 14.1

The base model for the impact of ICT on economic growth is expresses as follows (according to Hausman test FE is the appropriate one):

$$\log(GDP/C) = 3.705 + 0.208 \log(ID) \quad (5.7)$$

The result in equation 5.7, illustrates the positive impact of ICT on GDP per capita, although this is a positive indication of ICT impact, it is less than that of world average value ranged from 0.85 to 1.24 as the results of ORBICOM showed. This positive impact of ICT on economic growth is stemmed from the importance of ICT productive components such as broadband which is considered as an enabling tool for the development of human capital as the human capital is an important driver of economic growth [Qiang et al., 2009]. Also the positive impact of ICT components is revealed by Baliamoune-Lutz (2003), where this study found that personal computers and Internet hosts devise a positive relationship with revenue. Therefore, the alternative hypothesis (the third one) is accepted as H 1 proposes that *there is significant and positive relationship between ICT and economic growth for the full study sample of 18 Arab countries*.

5.5 The Impact of ICT and other variables on economic growth with full sample

Although the previous used model reflects our main goal to measure the impact of ICT on economic growth represented by GDP per capita measured in purchasing power parity, there are other significant macroeconomic control variables that may affect the GDP per capita. We included these variables depending on the model proposed by ORBICOM. This extended model is illustrated in the previous section.

In order to test if the model encounters multicollinearity problem, the correlation between the illustrative variables is done. As illustrated in the matrix which is shown in table 5.15, the correlation between the model variables is not strong and therefore the multicollinearity problems are not numerous. The correlation between the variables is less than 0.8 which indicates that there is no multicollinearity problem [Kennedy et al., 2008] in this used study model. Openness and inflation are stationary according to tests of Levin, Lin and Chu (2002), Im, Pesaran and Shin (2003) (W-stat) and Choi (2001) (ADF - Fisher Chi-square). GCF/GDP is stationary according to tests of Levin, Lin and Chu (2002) and Breitung (1999). Also population growth is stationary according to tests of ADF - Fisher Chi-square and PP - Fisher Chi-square.

After applying panel regression using the three mentioned models before (POLS, FE and RE), the obtained results are shown in table 5.23 below. In order to reflect the nature of panel data we use models that reflect the differences between various 18 Arab countries such as data heterogeneity between different countries or if the time is invariant it may differ across countries. A dummy variable is added to the model to adjust the outliers, missed values and other error variables.

Table 5.15 Correlation matrix

	Log(ID)	*population growth*	*GCF/GDPc*	*Openness*	*Inflation*
Log(ID)	1				
population growth	0.341246	1			
GCF PERCENT	0.278058	0.144083	1		
Openness	0.446377	0.279658	0.1792	1	
Inflation	-0.02122	0.102588	0.081226	-0.03023	1

Source: author using STATA 14.1

POLS result shows that population growth positively affect economic growth with 7.379 and GCF negatively affecting economic growth (table 5.16). But, the predictable perception and economic theories illustrate that this is not the situation. So, the outcome that was found from this approach cannot dependably reflects the real causation among the illustrative variables and economic growth. Therefore, using fixed effects and random effects are desirable.

Using the FE approach the elasticity of ICT (log (ID)) approaches 0.251 which is significant as the P-value is zero, meaning that if the ICT index increases by 1% then the GDP per capita will increase by 0.255% which is a positive indication of the impact of ICT on economic growth. The elasticity of gross capital formation as percent of GDP approaches 0.166 which is significant as the P-value is 0.000 less than 5%, meaning that if the GCF/GDP increases by 1% then the GDP per capita will increase by 0.166% which is a positive indication of the impact of GCF/GDP on economic growth. The elasticities of population growth, openness and inflation are insignificant. The overall model is significant as the F-value is 803.17 more than the tabular value. The adjusted R-squared for the model is 0.607 which reflects the explanation rate of the model (table 5.17).

Table 5.16 POLS result for economic growth

Source	SS	df	MS	Number of obs	=	339
				F(6, 332)	=	52.97
Model	47.1829528	6	7.86382546	Prob > F	=	0.0000
Residual	49.2913758	332	.148468	R-squared	=	0.4891
				Adj R-squared	=	0.4798
Total	96.4743286	338	.285427008	Root MSE	=	.38532

lgdpc	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
lid	0.704	0.064	10.95	0.000	0.577	0.830
popg	7.379	0.876	8.42	0.000	5.655	9.103
gcfg	-1.196	0.299	-4.00	0.000	-1.784	-0.608
Opennes	0.010	0.090	0.12	0.907	-0.167	0.188
Inflation	-0.497	0.339	-1.47	0.143	-1.164	0.169
d	0.031	0.081	0.38	0.704	-0.129	0.191
_cons	2.903	0.126	22.98	0.000	2.655	3.152

Source: author using STATA 14.1

Table 5.17 FE results for economic growth

Fixed-effects (within) regression — Number of obs = 339
Group variable: CountryID — Number of groups = 18

R-sq:
within = 0.6671
between = 0.6070
overall = 0.3227

Obs per group:
min = 18
avg = 18.8
max = 19

F(6,315) = 105.22
corr(u_i, Xb) = 0.4234 — Prob > F = 0.0000

lgdpc	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
lid	.2508105	.0120538	20.81	0.000	.2270944	.2745267
popg	.0671212	.1799044	0.37	0.709	-.286845	.4210874
gcfg	.1668034	.06754	2.47	0.014	.0339169	.29969
Opennes	-.0347309	.0254434	-1.37	0.173	-.0847913	.0153296
Inflation	-.0061795	.0593575	-0.10	0.917	-.1229668	.1106078
d	.0335125	.0136288	2.46	0.014	.0066976	.0603274
_cons	3.599808	.0238691	150.81	0.000	3.552845	3.646771
sigma_u	.49485146					
sigma_e	.05940259					
rho	.9857948	(fraction of variance due to u_i)				

F test that all u_i=0: F(17, 315) = 803.17 — Prob > F = 0.0000

Source: author using STATA 14.1

The results of RE approach illustrates that the elasticity of ICT index approaches 0.252 which is significant. The other elasticities of the model are insignificant. The adjusted R-squared for the model is 61% (table 5.18).

In order to investigate which model is fit for our data FE or RE, we apply Hausman test, the result shows a statistically significant P-value, and so the FE is the appropriate model.

chi2 (6) = (b-B)'[(V_b-V_B) ^ (-1)] (b-B)
= 25.52
Prob>chi2 = 0.0003

To validate the findings, tests for cross-sectional dependence, heteroscedasticity, serial correlation will be done. The test of serial correlation using Wooldridge test for autocorrelation is conducted. The null hypothesis shows that there is no first-order autocorrelation (table 5.19).

Table 5.18 RE results for economic growth

```
Random-effects GLS regression                   Number of obs     =       339
Group variable: CountryID                       Number of groups  =        18

R-sq:                                           Obs per group:
     within  = 0.6671                                        min =        18
     between = 0.6151                                        avg =      18.8
     overall = 0.3284                                        max =        19

                                                Wald chi2(6)      =    600.41
corr(u_i, X)   = 0 (assumed)                    Prob > chi2       =    0.0000
```

lgdpc	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
lid	.2520858	.0124258	20.29	0.000	.2277317	.2764399
popg	.1010894	.1853601	0.55	0.586	-.2622097	.4643884
gcfg	.1577458	.0695569	2.27	0.023	.0214168	.2940748
Opennes	-.0319575	.0261776	-1.22	0.222	-.0832647	.0193496
Inflation	-.0076238	.0612011	-0.12	0.901	-.1275758	.1123281
d	.0331517	.0140528	2.36	0.018	.0056087	.0606948
_cons	3.599299	.0838513	42.92	0.000	3.434953	3.763644
sigma_u	.3297692					
sigma_e	.05940259					
rho	.9685716	(fraction of variance due to u_i)				

Source: author using STATA 14.1

Table 5.19 Wooldridge test for autocorrelation in panel data

H0: no first-order autocorrelation
F (1, 17) = 1.369
Prob > F = 0.2581

Source: Author using STATA 14.1

The other test is for homoscedasticity, where this test finds the causality between the explanatory variable and economic growth, if it is spurious (false causality) or not. Thus, the null hypothesis of homoscedasticity is tested. The test illustrates that there is heteroscedasticity in the variances, as the null hypothesis is rejected ($p<0.05$), which indicates that there may be a false causality between descriptive factors and economic growth. This problem can be resolved via Huber/White or sandwich estimators. The command 'robust' is used to emanate up with heteroscedasticity-robust standard errors.

Table 5.20 Modified Wald test for GroupWise heteroscedasticity in fixed effect model

H0: sigma (i) ^2 = sigma^2 for all i
chi2 (18) = 8108.97
Prob>chi2 = 0.0000
Source: Author using STATA 14.1

The test for correlation using Pesaran cross-sectional dependence (CD test). The null hypothesis indicates that the residuals are correlated, since the P-value < 0.05, so we reject the null hypothesis. The result means that the residuals are correlated.

Table 5.21 Pesaran CD check for economic growth

Pesaran's test of cross sectional independence = 2.971, Pr = 0.0030
Average absolute value of the off-diagonal elements = 0.486
Source: Author using STATA 14.1

Then, we have to estimate the appropriate fixed effects approach taking into account that the residuals are correlated. This is done by applying auto regressive function AR (1) by using 'xtregar' command in STATA. Thus, the adjusted fixed effects results are shown in table 5.22.

Table 5.22 Adjusted FE result for economic growth

```
FE (within) regression with AR(1) disturbances  Number of obs     =        321
Group variable: CountryID                       Number of groups  =         18

R-sq:                                           Obs per group:
     within  = 0.1350                                         min =         17
     between = 0.5096                                         avg =       17.8
     overall = 0.3124                                         max =         18

                                                F(6,297)          =       7.72
corr(u_i, Xb)  = 0.4378                         Prob > F          =     0.0000
```

lgdpc	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
lid	.1084315	.0375165	2.89	0.004	.0345996	.1822633
popg	.0541235	.2308124	0.23	0.815	-.4001114	.5083585
gcfg	.1297711	.0601418	2.16	0.032	.0114129	.2481292
Opennes	.0684747	.0260755	2.63	0.009	.0171585	.1197908
Inflation	-.0888295	.0305331	-2.91	0.004	-.148918	-.028741
d	.0350775	.0076363	4.59	0.000	.0200493	.0501057
_cons	3.809745	.01324	287.75	0.000	3.783689	3.835801
rho_ar	.83589879					
sigma_u	.51293057					
sigma_e	.03414661					
rho_fov	.99558778	(fraction of variance because of u_i)				

```
F test that all u_i=0: F(17,297) = 75.82                     Prob > F = 0.0000
```

Source: Author using STATA 14.1

According the results of adjusted FE approach are as follows:

$$Log\ (GDP/capita) = 3.809 - 0.054\ Population\ Growth + 0.129\ (\frac{GCF}{GDP}) - 0.068\ Openness - 0.089\ Inflation + 0.108\ Log(ID) + 0.035\ \text{dummy} \quad (5.8)$$

From the above equation and as our main concern is the impact of ICT, we recognize the positive impact of ICT on GDP per capita with a weight of 0.108, this result accommodates with many related studies [BEN YOUSSEF and M'HENNI, 2003; Colecchia and Schreyer, 2002; Koutroumpis, 2009; Nour and Satti, 2002; Qiang et al, 2009; Sciadas, 2005]. The positive impact of ICT index that contains both the labour and capital stocks, giving indication that it is worth to continue on and increase the investment and adopting of ICT's in various sectors of Arab countries. So it is important to continue and increase the investment on ICT capital stock Internet, broadband and mobile infrastructure and related systems, in the other hand it is important to invest more in augmenting labour skills related

to ICT. The impact of ICT for Arab countries is less than the average value of different world countries such as the result of ORBICOM, where ICT impact ranged from 0.85 to 1.24 according to different years.

Table 5.23 Impact of ICT and other variables on GDP per capita, 1995-2013, full sample

Variables	POLS	Adjusted FE	RE
Constant	2.903	3.81	3.600
Std. Err.	0.126	0.013	0.083
P-value	(0.000)	(0.000)	(0.000)
Log (ID)	0.704	0.108	0.252
Std. Err.	0.064	0.037	0.012
P-value	(0.000)	(0.004)	(0.000)
Population Growth	7.378	0.054	0.101
Std. Err.	0.876	0.231	0.185
P-value	(0.000)	(0.815)	(0.586)
GCF/GDP	-1.196	0.129	0.158
Std. Err.	0.299	0.060	0.069
P-value	(0.000)	(0.032)	(0.023)
Openness	0.015	0.068	-0.032
Std. Err.	0.090	0.026	0.026
P-value	(0.907)	(0.009)	(0.222)
Inflation	-0.497	-0.089	-0.008
Std. Err.	0.338	0.032	0.061
P-value	(0.143)	(0.030)	(0.901)
Adjusted R	0.48	0.51	0.615
Observations	339	321	339
Countries	18	18	18

$p<0.05$

Source: author using STATA 14.1

Gross capital formation positively affects economic growth and this is similar to many research studies such as Artelaris et al. (2006). Solow (1962) proposed that capital formation and investment are significant to growth. The positive impact of openness on GDP per capita

agree with many related researches that propose a positive effect of openness on economic growth rate at the long run [Romer, 1992; Barro and Sala-i-Martin, 1995]. This suggestion stems from the propose that production increase of domestic products for external exports and the increase of imports availability in local markets will stimulate local companies that face the pressure of competitiveness to adopt new technologies or innovate new efficient ways of production, so as to increase productivity and lower the cost of production, and this will be reflected positively on economic growth. The research results show that inflation rates has slightly negative impact on economic growth which are accommodated to some related research results [Fischer, 1993, Barro, 1996, Guerrero, 2006]. Some of the research results concerning the impact of inflation levels on economic growth propose that this impact depends on the countries within the study sample and/or the period of the study [Sarel 1996, Ghosh and Phillips, 1998]. Population growth positively affect GDP per capita, this positive impact is accommodated with the new endogenous growth theory [Howitt, 1999], but population growth is insignificant to GDP per capita.

Therefore, the alternative hypothesis (the fifth one) is accepted as H 1 proposes that *openness for the whole sample study of Arab countries positively affects their economic growth*. The alternative hypothesis (the sixth one) is accepted as H 1 proposes that *GCF for the whole sample study of Arab countries positively affects their economic growth, so as for the hypothesis related to inflation*. The fourth alternative hypothesis is violated as the variable is insignificant.

5.6 The Impact of ICT and other variables on economic growth by country group

In what follows we will assess the model equations, and investigate the results by classifying the sample study of Arab countries into groups according to infodensity index values. ORBICOM classified the world countries into five levels according to their ICT infostate values for analysis purposes. The first group contains the countries with high values of infodensity which include Qatar, Bahrain, UAE, Kuwait, Saudi Arabia and Oman and at the same time they have the highest GDP per capita among the other Arab countries. The second group with mid infodensity values that includes Jordan, Lebanon, Tunisia, Palestine, Egypt, Morocco, Algeria, Libya and Syria. The third group is the low one according to infodensity

values that includes Yemen, Sudan and Djibouti. In what follows we will analyse these three groups using panel regression with FE and RE approaches.

5.6.1 First group results

The research results for the first group are estimated (the period from 1995 to 2013) and shown in table 5.24. According to Hausman test the appropriate approach is FE. According to FE ICT index positively and significantly impacts GDP per capita with 0.264 point.

Table 5.24 Impact of ICT and other variables on GDP per capita), first group, 1995-2013

Variables	FE	RE
Constant	4.556	4.635
Std. Err.	0.069	0.083
P-value	(0.000)	(0.000)
Log(ID)	0.264	0.336
Std. Err.	0.023	0.021
P-value	(0.000)	(0.000)
Population Growth	-0.016	0.980
Std. Err.	0.395	0.356
P-value	(0.968)	(0.000)
GCF/GDP	0.363	0.336
Std. Err.	0.134	0.183
P-value	(0.026)	(0.014)
Openness	-0.515	-0.618
Std. Err.	0.091	0.053
P-value	(0.000)	(0.000)
Inflation	0.198	-0.067
Std. Err.	0.170	0.155
P-value	(0.248)	(0.667)
Adjusted R	0.930	0.457
Observations	107	107
Countries	6	6

$p<0.05$

Source: author using STATA 14.1

The elasticity of gross capital formation as percent of GDP approaches 0.363 which is significant as the P-value is 0.026 less than 5%. The elasticity of population growth approaches -0.016 which is insignificant. The elasticity of openness approaches -0.515, and it is significant as the P-value is 0.000, meaning that if the openness increases by 1% then the GDP per capita will decrease by 0.515% which is a negative indication of the impact of openness on economic growth. The constant value is 4.556 and significant. Inflation is insignificant. The overall model is significant as the F-value is 167.64 and it is more than the tabular significant value. The adjusted R-squared for the model is 0.93 which reflects the explanation rate of the model.

The equation that represent the impact of ICT reflected by infodensity, and other impacted control variables on GDP per capita is as follows:

$$Log\,(GDP/capita) = 4.556 - 0.016\,Population\ Growth + 0.363\left(\frac{GCF}{GDP}\right) - 0.515\ Openness + 0.198\,Inflation + 0.264\ Log(ID) \quad (5.9)$$

5.6.2 Second group results

The regression results for the second group of intermediate infodensity values are shown in table 5.25. According to Hausman test (see table 5.26) the appropriate approach is RE. According to RE the results show positive and significant impact of ICT index on GDP per capita with 0.308 point and this value is more than that of first group value. The elasticity of openness approaches 0.254, and it is significant, meaning that if the openness increases by 1% then the GDP per capita will increase by 0.254% which is a positive indication of the impact of openness on economic growth. Elasticity of inflation is negative and significant with 0.310 impact. The elasticities of GCF and population growth are insignificant.

The equation that represent the impact of ICT, and other variables on GDP per capita using RE method is as follows:

$$Log\,(GDP/capita) = 4.313 - 1.229\,Population\ Growth + 0.030\left(\frac{GCF}{GDP}\right) + 0.254\ Openness - 0.310\,Inflation + 0.308\,Log(ID) \quad (5.10)$$

Table 5.25 Impact of ICT and other variables on GDP per capita, second group, 1995-2013

Variables	FE	RE
Constant	3.601	4.313
Std. Err.	0.076	0.306
P-value	(0.000)	(0.000)
Log(ID)	0.309	0.308
Std. Err.	0.016	0.147
P-value	(0.000)	(0.005)
Population Growth	-1.114	-1.229
Std. Err.	0.278	1.53
P-value	(0.001)	(0.262)
GCF/GDP	0.036	0.030
Std. Err.	0.219	0.219
P-value	(0.868)	(0.893)
Openness	0.253	0.254
Std. Err.	0.079	0.079
P-value	(0.002)	(0.001)
Inflation	-0.390	-0.310
Std. Err.	0.0486	0.196
P-value	(0.406)	(0.049)
Adjusted R	0.944	0.758
Observations	165	165
Countries	9	9

$p<0.05$
Source: author using EVIEWS 9

Table 5.26 Hausman test for second group

Correlated Random Effects - Hausman Test
Equation: Untitled
Test cross-section random effects

Test Summary	Chi-Sq. Statistic	Chi-Sq. d.f.	Prob.
Cross-section random	1.694429	5	0.8896

Source: author using EVIEWS 9

5.6.3 Third group results

The regression results for the third group which is characterised by low infodensity values are shown in table 5.20. This group also characterized by low GDP per capita compared to other Arab countries of the sample study. The model variables are not cointegrated, so the suitable approach is the unrestricted vector autoregressive model (VAR) [Sims, 1980].

The results show low positive and significant impact of ICT index on GDP per capita with 0.015 point indicating slow spillover of ICT in these countries. The elasticity of openness approaches -0.104, and it is significant, meaning that if the openness increases by 1% then the GDP per capita will decrease by 0.104% which is a negative indication of the impact of openness on economic growth. The elasticity of GCF is positive and significant with 0.326 impact. The elasticities of inflation and population growth are insignificant. The overall model is significant as the F-value is 1056.3 and it is more than the tabular significant value. The adjusted R-squared for the model is 0.98. According to all associated values in table 5.27 the model is valid.

Table 5.27 Third group regression results, 1995-2013

Dependent Variable: LNGDPC
Method: Panel Least Squares
Date: 10/26/15 Time: 13:57
Sample (adjusted): 1996 2013
Periods included: 17
Cross-sections included: 3
Total panel (balanced) observations: 54
LNGDPC = C(1)*LNGDPC(-1) + C(4)*LNID(-2) + C(8)*OPENNES(-2) + C(10)*GCF(-2) + C(13)

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	0.929190	0.021593	43.03263	0.0000
C(4)	0.015608	0.008669	1.800566	0.0483
C(8)	-0.103699	0.035815	-2.895401	0.0058
C(10)	0.326599	0.084443	3.867703	0.0003
C(13)	0.565042	0.159437	3.543974	0.0009

R-squared	0.989230	Mean dependent var	7.870091
Adjusted R-squared	0.988294	S.D. dependent var	0.320453
S.E. of regression	0.034672	Akaike info criterion	-3.792898
Sum squared resid	0.055297	Schwarz criterion	-3.603504
Log likelihood	101.7189	Hannan-Quinn criter.	-3.720525
F-statistic	1056.301	Durbin-Watson stat	1.714405
Prob(F-statistic)	0.000000		

Source: author using EVIEWS 9

5.7 The Impact of ICT capital services, non-ICT capital services and labour on economic growth for five selected Arab countries using Panel ARDL regression

Depending on Cobb-Douglas production function we estimate the impact of ICT capital services, non-ICT capital services and labour capital on GDP per capita for five Arab countries according to the availability of information from the conference board. Many researches used physical capital stocks such as ICT capital stocks to assess the impact of ICT on economic growth [Colecchia and Schreyer, 2002; Koutroumpis, 2009; Nour and Satti, 2002; Qiang et al, 2009], where here in this model we will use capital services such as ICT and non-ICT in assessing their impact on economic growth as capital services are a more fitting measure than capital stocks, where these shorter lived assets have more effect on production as nowadays the economy is a service based one [Inklaar and Timmer, 2013]. ICT and non-ICT capital services are premeditated, where the growth rates of the stocks of single assets (ICT hardware and software) evaluated by their factor portions in total ICT or non-ICT capital compensation. The labor input factor is the growth rate of labor services representing the amount of the growth rate of the labor composition index and labor quantity. The growth rate of labor quantity based on the employment growth rate as we are talking about developing countries. The measures which are used in the model are the growth rates of the capital services provided by ICT and non-ICT assets in addition to the growth of labor services. All three input factors of growth rates are given in log change.

In order to test if the model encounters multicollinearity problem, the correlation between the explanatory variables is done. As illustrated in the matrix which is shown in table 5.28, the correlation between the model variables is not strong and therefore the multicollinearity problems are not numerous.

Table 5.28 Correlation matrix

Factor	*ICT capital services gr*	*Non-ICT capital services gr*	*Labor services gr*
ICT capital services gr	1		
Non-ICT capital services gr	0.065653	1	
Labor services gr	0.03966	0.145032	1

Source: author using STATA 14.1

The research results were estimated for the full sample of five Arab countries namely Jordan, Algeria, Egypt, Morocco and Tunisia for the period from 1993 to 2014 using panel regression. As shown in tables A.4, A.5, A.6 and A.7 in Appendix 3, the unit root tests indicate that the second study used model variables encounter either I (0) or I (1) and these variables are cointegrated (see table A.8, Appendix 3), where this sequence of stationary at level or with first difference level of integration permits to implement the Panel autoregressive-distributed lag (ARDL) method away from traditional static approach [Pesaran and Shin, 1998]. ARDL also reliably and normally estimate long-run factors regardless of whether the core regressors are stationary at level or first difference as in our case [Pesaran, Shin and Smith, 1999]. This approach allows to estimate both short and long run association with error correction. Asteriou and Monastiriotis (2004), used this Panel ARDL method to estimate the long-run association between trade unionism and productivity for 18 OECD countries. The second model of this study is estimated based on (PMG) which captures the short-run factors with intercept. Also this estimator allows hetregoniaty of error variances hold country by country, in the other hand it restricts the long run slop factors to be homogeneous across economies.

For PMG estimator to be valid and consistent, it needs the followings i) the model variables must have a long-run association, where the error correction term coefficient has to be negative with no less than -2 as proved in table 5.29 with -1.414 value; ii) the error-correction approach residual necessity to be serially uncorrelated, to achieve this ARDL (p,q) lags ((p) the dependent and (q) the independent variables) are counted in the error-correction formula; iii) the size of T such as countries and N such as years has to be reasonably adequate, so as to practise dynamic panel technique; and iv) the long run balance associations between variables are expected to be similar across the countries of the model, where these five countries have similar levels of infostates, income, ICT and non-ICT services, and the labour factor. The short run relationships are permitted to be country specific through their corresponding coefficients, as there are diverse influence of susceptibility to financial and environmental crises.

Figure 5.13, shows the results of normality test that indicate a low value of Jarque-Bera statistic (J-B=1.593), with the Jarque-Bera probability (45.08 %), then the null hypothesis is not rejected implying that there is non-normality problem.

We estimated the impact of ICT and non-ICT capital services, and labour services using the PMG/ARDL approach as shown in table 5.29. There is a long run equilibrium association between the three regressors and the GDP growth as proved by Wald test (see table A.9, Appendix 3). The impact of ICT capital services growth rate is significant and positive in the short run as well as in the long run and this impact reached 0.153.

Table 5.29 Long and short run Impact of ICT and others on GDP, Panel ARDL, 1993-2014

Dependent Variable: D(GDPG)
Method: ARDL
Date: 11/09/15 Time: 15:18
Sample: 1993 2014
Included observations: 110
Maximum dependent lags: 3 (Automatic selection)
Model selection method: Akaike info criterion (AIC)
Dynamic regressors (3 lags, automatic): ICTG NICTG LTG
Fixed regressors: C
Number of models evalulated: 9
Selected Model: ARDL(2, 3, 3, 3)
Note: final equation sample is larger than selection sample

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
Long Run Equation				
ICTG	0.153130	0.015429	9.925010	0.0000
NICTG	-0.559222	0.072260	-7.739010	0.0000
LTG	0.382447	0.049652	7.702476	0.0000
Short Run Equation				
COINTEQ01	-1.250280	0.184799	-6.765607	0.0000
D(GDPG(-1))	0.159627	0.113618	1.404944	0.1674
D(ICTG)	0.634963	0.253423	2.505543	0.0162
D(ICTG(-1))	-0.418890	0.192782	-2.172871	0.0355
D(ICTG(-2))	0.312707	0.255677	1.223053	0.2281
D(NICTG)	1.452164	0.349984	4.149232	0.0002
D(NICTG(-1))	1.336260	0.735014	1.818007	0.0762
D(NICTG(-2))	0.553596	0.589586	0.938958	0.3531
D(LTG)	-0.251628	0.080287	-3.134124	0.0031
D(LTG(-1))	-0.079064	0.065876	-1.200194	0.2368
D(LTG(-2))	0.025550	0.033832	0.755190	0.4543
C	2.050817	1.596120	1.284876	0.2059

*Note: p-values and any subsequent tests do not account for model selection.
Source: author using EVIEWS 9

The elasticities of non-ICT capital services is also significant and positive at the short run but it is negative at the long run with -0.599 point, which indicates inefficient accumulation of non-ICT capital services at the long run. The impact points for labor services represented by the coefficients is positive and significant at the long run with 0.382 point, and negative at the short run indicating unproductive labor capital at the short run and as labor quantities are based on the number of employees and not on the desirable measure of total hours in work that may result in measurement error.

The ICT capital services' elasticity is larger than ICT compensation share for the sample of five Arab countries, where this indicate high spillover of ICT. The non-ICT capital services encounter negative impact indicating incompetent non-ICT capital services.

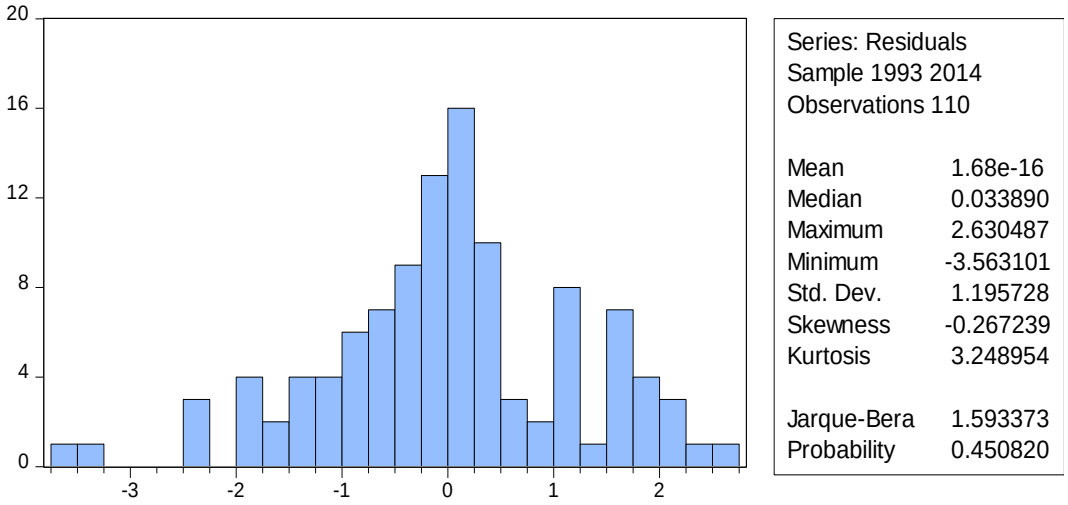


Figure 5.13 Actual fitted graph for five Arab countries sample

Source: author using EVIEWS 9

The positive and significant impact of ICT capital services growth on GDP growth is accommodated with several related growth studies that economically tell positive and significant influences of ICT capital on economic growth on the period of mid 1990s till nowadays in developed and developing economies. The regression results accommodated with the study results of Shahiduzzaman and Alam (2014) where they found that there is a long run cointigrated positive impact of ICT capital on economic output of Autralia. Also the result of positive and significant impact of ICT on economic growth matches what

researches conducted for the ICT effects on production, labour and economic growth [Inklaar et al., 2005; Jorgenson et al., 2000; Oliner and Sichel 2002; Van Ark et al., 2008].
Therefore, the alternative hypothesis (the ninth one) is accepted as H 1 proposes that *the ICT capital services for selected group study of Arab countries positively affect its economic growth*. The alternative hypothesis (the tenth one) is rejected as H 1 proposes that *the non-ICT capital services for selected group study of Arab countries positively affect its economic growth*. The alternative hypothesis (the eleventh one) is accepted as H 1 proposes that *the labour services for selected group study of Arab countries positively affect its economic growth.*

5.7.1 The Impact of ICT capital services and others on Tunisian economic growth

The descriptive figures for the related variables and the contribution of ICT, non-ICT and labour are shown in table 5.30.

Table 5.30 Descriptive figures for Tunisia model

	GDP growth	ICT growth	Non-ICT growth	Labour growth	Compensation of ICT	Compensation of non-ICT	Compensation of labour
Mean	4.143805	14.60395	2.554653	2.142696	0.036289	0.491451	0.472259
Median	4.209476	14.72535	2.734898	2.575394	0.033208	0.495472	0.473267
Maximum	7.595956	20.92760	3.912922	6.058556	0.057315	0.515982	0.505358
Minimum	-1.935189	9.264027	0.817525	-4.289132	0.024977	0.468483	0.444151
Std. Dev.	2.106938	3.348878	0.782938	2.268252	0.009252	0.015623	0.017697
Observations	25	25	25	25	25	25	25

Source: author using EVIEWS 9

As shown in tables A.10, A.11, A.12 and A.13 in Appendix 3, the unit root tests indicate that the Tunisia study used model variables encounter either I (0) or I (1) and these variables are cointegrated (see table A.14, Appendix 3), where this sequence of stationary at level or with first difference of integration permits to implement ARDL method [Pesaran and Shin, 1998]. The results using ARDL approach is shown in table 5.31, where 81 models were evaluated by this ARDL method.

The validity of the estimated model can be proved through statistically evaluation method as follows:

- F-test (Fisher test): The significance for the model as a whole is explained as the calculated F-statistics (4.86) is greater than the tabular one, where according to the table of F-distribution, the critical value of F-distribution at the 5% significance level is (F= 3.4), so the alternative hypothesis is accepted and the whole model is significant. Also the level of fisher significance is nearly zero (Prop (F-statistic) =0.004) which also means that GDP growth is anticipated with 100% probability by the independent variables and demonstrates a statistically significant relationship between them.

Table 5.31 ARDL model results for Tunisia, 1990-2014

Dependent Variable: GDPG
Method: ARDL
Date: 11/9/15 Time: 12:36
Sample (adjusted): 2 25
Included observations: 24 after adjustments
Maximum dependent lags: 3 (Automatic selection)
Model selection method: Akaike info criterion (AIC)
Dynamic regressors (2 lags, automatic): ICTG NICTG LTG
Fixed regressors: C
Number of models evaluated: 81
Selected Model: ARDL(2, 1, 1, 2)
Note: final equation sample is larger than selection sample

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
GDPG(-1)	-0.384003	0.174744	-2.197521	0.0431
ICTG	0.802411	0.264551	3.033110	0.0079
ICTG(-1)	-0.500640	0.252512	-1.982636	0.0648
NICTG	1.372711	0.749952	1.830397	0.0859
NICTG(-1)	-3.159197	0.745101	-4.239961	0.0006
LTG	0.479483	0.131945	3.633956	0.0022
LTG(-1)	0.206516	0.148013	1.395261	0.1820
C	3.887856	1.845508	2.106660	0.0513

R-squared	0.680065	Mean dependent var	3.999966
Adjusted R-squared	0.540094	S.D. dependent var	2.022983
S.E. of regression	0.371914	Akaike info criterion	3.731493
Sum squared resid	30.11437	Schwarz criterion	4.124177
Log likelihood	-36.77791	Hannan-Quinn criter.	3.835672
F-statistic	4.858597	Durbin-Watson stat	2.175010
Prob(F-statistic)	0.004239		

*Note: p-values and any subsequent tests do not account for model selection.
Source: author using EVIEWS 9

- Significance of model parameters: The t-test (Student's-t Distribution) value for ICT capital services is 3.03, so as for the other variables, so these parameters are significant.
- Confidence interval: significance of ID parameter can be assured by the confidence interval, where zero doesn't belong to the confidence interval for ICT and labour capital services.
- Determination coefficient: the value of R-square is 68% which means that independent variables explains 68% of the changes that occur in GDP growth, while the rest percent 32% refers to the other variables including the random error.
- Durbin Watson (DW): As the DW statistic value 2.17 is more than the DW tabular value 1.65 (D_L = 1.123 and D_U = 1.654) at 5% confidence level, then we accept the null hypothesis and conclude that there is no positive autocorrelation between residuals.

As exposed in figure 5.31, ARDL (2, 1, 1, and 2) was selected out of 81 model specifications using AIC selection criteria. "Bounds Test" is used in order to find if there is long run association between the model variables, as GDP growth, ICT capital services, non-ICT capital services and labour services in our case. The null hypothesis proposes that there is no long run association between the model variables. The results of this test are shown in table 5.32, where as we realise the F-statistic value for the Bounds Test reaches 12.56, and this obviously surpasses the 1 percent critical value for the upper bound. Therefore, we intensely reject the null hypothesis and hence there is long relationship between the model variables and this is a desirable result.

The output for modified ARDL estimation is shown in table 5.33 that includes first difference results as the model takes the first difference of variables to be all stationary for correct estimation. ARDL model estimates the short and long run relation between the variables as the relation between independent variables and dependent one, this option is inherited in EVIEWS 9 program, the result is shown in table 5.34, where as illustrated the error-correction coefficient is with negative sign (-1.38), as desired, and is very significant. The

long-run coefficients from the cointegrating equation are shown in table 5.28, where they are all significant as the P-values are less than the significance level of 5%.

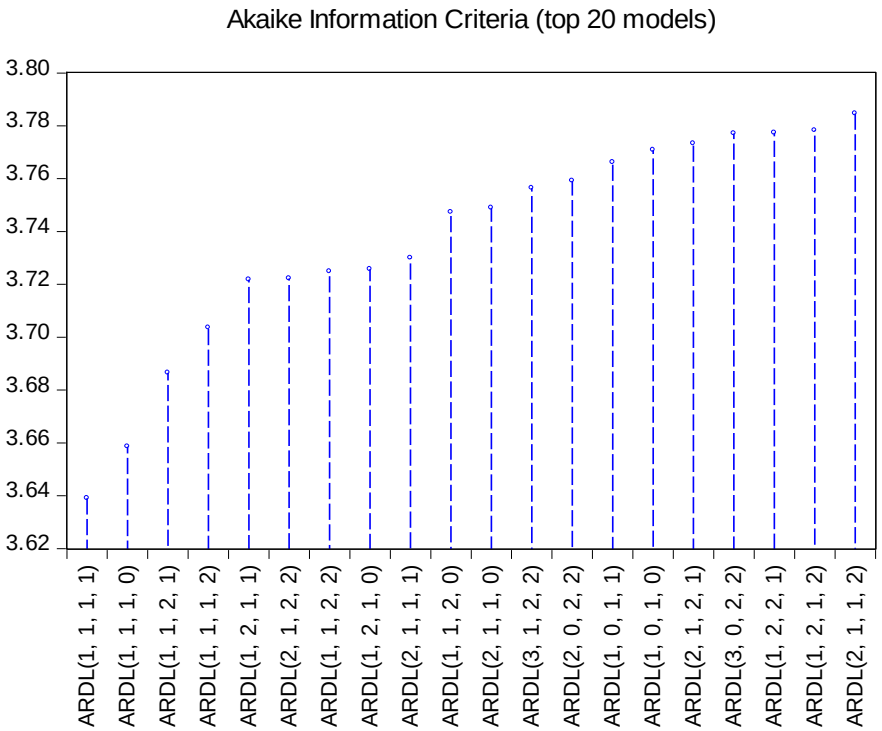


Figure 5.14 ARDL model selection

Source: author using EVIEWS 9

Table 5.32 ARDL Bound Test for Tunisia, 1990-2014

ARDL Bounds Test
Date: 11/09/15 Time: 14:18
Sample: 2 25
Included observations: 24
Null Hypothesis: No long-run relationships exist

Test Statistic	Value	K
F-statistic	12.85595	3

Critical Value Bounds

Significance	I0 Bound	I1 Bound
10%	2.37	3.2
5%	2.79	3.67
2.5%	3.15	4.08
1%	3.65	4.66

Source: author using EVIEWS 9

There is a long run equilibrium association between ICT capital services, non-ICT capital services and labour services growth, and GDP growth of Tunisia as resulted from Bound Test shown in table 5.35, and from Wald test illustrated in table 5.36. Also there is short run relationship between each independent variable and GDP growth, so ICT, non-ICT and labour capital services cause GDP growth as resulted from Wald tests illustrated in tables 5.37, 5.38 and 5.39. There is a fairly rapid adjustment in the GDP growth when the capital services of ICT, non-ICT and labour change.

Table 5.33 Modified ARDL estimation for Tunisia, 1990-2014

Test Equation:
Dependent Variable: D(GDPG)
Method: Least Squares
Date: 11/09/15 Time: 14:28
Sample: 2 25
Included observations: 24

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(ICTG)	0.802411	0.264551	3.033110	0.0079
D(NICTG)	1.372711	0.749952	1.830397	0.0859
D(LTG)	0.479483	0.131945	3.633956	0.0022
C	3.887856	1.845508	2.106660	0.0513
ICTG(-1)	0.301772	0.107495	2.807300	0.0126
NICTG(-1)	-1.786487	0.529876	-3.371518	0.0039
LTG(-1)	0.686000	0.206354	3.324384	0.0043
GDPG(-1)	-1.384003	0.174744	-7.920191	0.0000

R-squared	0.831110	Mean dependent var	-0.216993
Adjusted R-squared	0.757221	S.D. dependent var	2.784335
S.E. of regression	0.371914	Akaike info criterion	3.731493
Sum squared resid	30.11437	Schwarz criterion	4.124177
Log likelihood	-36.77791	Hannan-Quinn criter.	3.835672
F-statistic	11.24806	Durbin-Watson stat	2.175010
Prob(F-statistic)	0.000039		

Source: author using EVIEWS 9

The estimation result illustrates that 10% variation in the ICT capital services will result in a long run change of 2.18% of GDP growth and this value is more than the compensation of capital Services provided by ICT Assets to GDP growth of 0.0363 as shown in table 5.30. The positive and significant impact of ICT capital services is obvious, where the results show that ICT elasticity at the long run is 0.218, and this result is accommodated with many related studies mentioned in this thesis. Also, in the long run there is positive and significant impact

of labour capital services on economic growth with 0.496 impact. The non-ICT capital services has negative impact on economic growth which is unexpected result which may be referred to misuse of non-ICT capital services in this Arabic country or the incompetency of these resources.

Table 5.34 ARDL cointegrating result for Tunisia, 1990-2014

ARDL Cointegrating And Long Run Form
Dependent Variable: GDPG
Selected Model: ARDL(1, 1, 1, 1)
Date: 11/09/15 Time: 14:51
Sample: 1 25
Included observations: 24

Cointegrating Form

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(ICTG)	0.802411	0.205722	3.900470	0.0013
D(NICTG)	1.372711	0.548604	2.502190	0.0236
D(LTG)	0.479483	0.082914	5.782884	0.0000
CointEq(-1)	-1.384003	0.154399	-8.963799	0.0000

Cointeq = GDPG - (0.2180*ICTG -1.2908*NICTG + 0.4957*LTG + 2.8091)

Source: author using EVIEWS 9

Table 5.35 ARDL long run result for Tunisia, 1990-2014

Long Run Coefficients

Variable	Coefficient	Std. Error	t-Statistic	Prob.
ICTG	0.218043	0.074857	2.912788	0.0102
NICTG	-0.290811	0.358226	-3.603349	0.0024
LTG	0.495664	0.133702	3.707215	0.0019
C	2.809139	1.274659	2.203835	0.0425

Source: author using EVIEWS 9

Table 5.36 Wald long run relationship for Tunisia

Wald Test:
Equation: Untitled

Test Statistic	Value	df	Probability
F-statistic	6.158585	(3, 16)	0.0055
Chi-square	18.47576	3	0.0004

Null Hypothesis: C(2)= C(4)= C(6)=0
Null Hypothesis Summary:

Normalized Restriction (= 0)	Value	Std. Err.
C(2)	0.802411	0.264551
C(4)	1.372711	0.749952
C(6)	0.479483	0.131945

Restrictions are linear in coefficients.
Source: author using EVIEWS 9

Table 5.37 Wald short run relationship, ICT capital services and GDP growth, Tunisia

Wald Test:
Equation: Untitled

Test Statistic	Value	df	Probability
F-statistic	6.515222	(2, 16)	0.0085
Chi-square	13.03044	2	0.0015

Null Hypothesis: C(2)= C(3)=0
Restrictions are linear in coefficients.
Source: author using EVIEWS 9

Table 5.38 Wald short relationship, non-ICT capital services and GDP growth for Tunisia

Wald Test:
Equation: Untitled

Test Statistic	Value	Df	Probability
F-statistic	11.04589	(2, 16)	0.0010
Chi-square	22.09179	2	0.0000

Null Hypothesis: C(4)= C(5)=0
Restrictions are linear in coefficients.

Source: author using EVIEWS 9

Table 5.39 Wald short run relationship, labour capital services and GDP growth for Tunisia

Wald Test:
Equation: Untitled

Test Statistic	Value	Df	Probability
F-statistic	7.202729	(2, 16)	0.0059
Chi-square	14.40546	2	0.0007

Null Hypothesis: C(6)= C(7)=0
Restrictions are linear in coefficients.
Source: author using EVIEWS 9

5.7.2 The Impact of ICT capital services and others on Jordanian economic growth

The descriptive figures for the related variables and the contribution of ICT, non-ICT and labour are shown in table 5.40. The unit root tests indicate that Jordan study model variables encounter either I (0) or I (1) and these variables are cointegrated, where ARDL method can be used. The modified results using ARDL approach is shown in table 5.41.

The significance for the model as a whole is explained as the calculated F-statistics (15.1) is greater than the tabular one (F= 3.4. The t-test (Student's-t Distribution) value for ICT capital services is 2.48 which is more than the tabular one, also the other parameters are significant. The value of R-square is 86.9%. The results show a low value of Jarque-Bera statistic (J-B=1.36) with the Jarque-Bera probability (50.6.1 %) that is higher than 5%; then, the null hypothesis is not rejected implying that there is non-normality problem as. The parameters are stable, where Ramsey's test is used for this issue as the F-statistical probability is more than 5%, also it is proved by CUSUM test illustrated in figure 5.15. The two associated probabilities of Heteroscedasticity test are more than 5%, hence, we accept the null hypothesis of homoscedasticity of errors.

Table 5.40 Descriptive figures for Jordan model

	GDP growth	ICT growth	Non-ICT growth	Labour growth	Compensation of ICT	Compensation of non-ICT	Compensation of labour
Mean	4.721843	10.74689	4.646394	4.226618	0.083169	0.439941	0.476891
Median	4.158017	10.02041	4.448418	3.332919	0.070556	0.449679	0.483452
Maximum	13.41284	15.47903	8.068590	15.28639	0.128885	0.492979	0.496911
Minimum	-0.128194	6.093689	1.948121	-0.332048	0.049021	0.391260	0.451019
Std. Dev.	2.848292	3.371171	1.667457	3.889362	0.025359	0.035075	0.015247
Observations	25	25	25	25	25	25	25

Source: author using EVIEWS 9

"Bounds Test" results are shown in table 5.42, where as we realise the F-statistic value for the Bounds Test reaches 42.074, and this obviously surpasses the 1% critical value for the upper bound. The error-correction coefficient is with negative sign (-1.742), as desired, and is significant.

Table 5.41 Modified ARDL and long run results for Jordan

ARDL Cointegrating And Long Run Form
Dependent Variable: GDPG
Selected Model: ARDL(2, 1, 2, 1)
Date: 11/16/15 Time: 20:40
Sample: 3 24
Included observations: 22

Cointegrating Form

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(GDPG(-1))	0.570903	0.092132	6.196558	0.0001
D(ICTG)	0.817516	0.241547	3.384502	0.0069
D(NICTG)	-0.780896	0.272700	-2.863572	0.0169
D(NICTG(-1))	2.670038	0.289396	9.226255	0.0000
D(LTG)	0.378787	0.075167	5.039248	0.0005
CointEq(-1)	-1.742446	0.101532	-17.161548	0.0000

Cointeq = GDPG - (0.1669*ICTG -0.5344*NICTG + 0.5112*LTG + 3.7335)

Long Run Coefficients

Variable	Coefficient	Std. Error	t-Statistic	Prob.
ICTG	0.166936	0.050516	3.304623	0.0080
NICTG	-0.534357	0.217279	-2.459313	0.0337
LTG	0.511176	0.117560	4.348218	0.0014
C	3.733531	0.924511	4.038386	0.0024

Source: author using EVIEWS 9

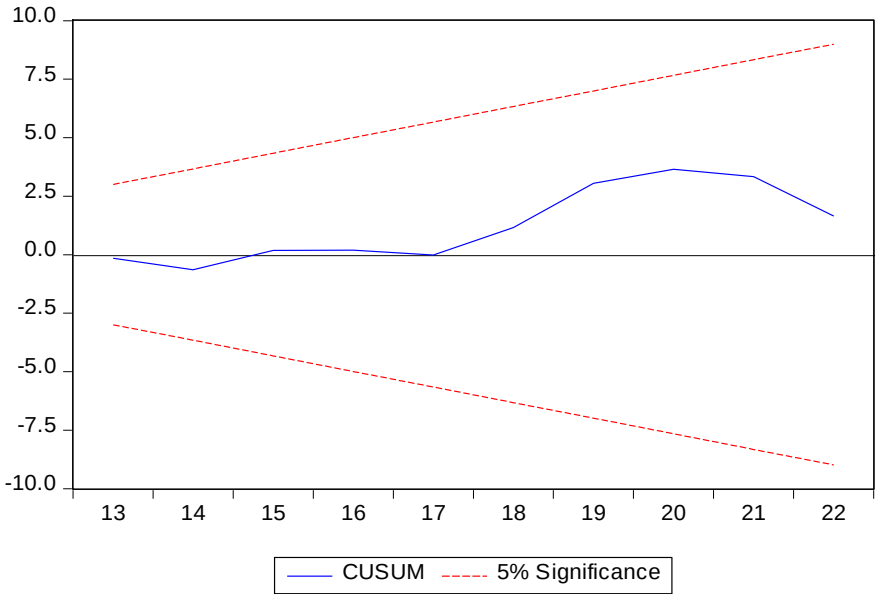


Figure 5.15 CUSUM test for Jordan model

Source: author using EVIEWS 9

There is a long run equilibrium association between ICT capital services, non-ICT capital services and labour capital services growth, and GDP growth of Jordan as resulted from Bound Test shown in table 5.42. The estimation result illustrates that 1% variation in the ICT capital services will result in a long run change of 0.167% of GDP growth and this value is more than the compensation of ICT of 0.083% as shown in table 5.40 indicating increased spillover of ICT capital services. Also, in the long run there is positive and significant impact of labour capital services. The non-ICT capital services has negative and significant impact on economic growth.

Table 5.42 ARDL bound test for Jordan

ARDL Bounds Test
Date: 11/16/15 Time: 21:07
Sample: 3 24
Included observations: 22
Null Hypothesis: No long-run relationships exist

Test Statistic	Value	K
F-statistic	42.07410	3
Critical Value Bounds		
Significance	I0 Bound	I1 Bound
10%	2.37	3.2
5%	2.79	3.67
2.5%	3.15	4.08
1%	3.65	4.66

Source: author using EVIEWS 9

5.7.3 The Impact of ICT capital services, non-ICT capital services and labour capital on economic growth for Algeria

The descriptive figures for the related variables and the contribution of ICT, non-ICT and labour are shown in table 5.43.

The unit root tests indicate that Algeria study model variables encounter either I(0) or I(1) and these variables are cointegrated so ARDL method is used [Pesaran and Shin, 1998]. The long run result of ARDL model is shown in table 5.44.

Table 5.43 Descriptive figures for Algeria model

	GDP growth	ICT growth	Non-ICT growth	Labour growth	Compensation of ICT	Compensation of non-ICT	Compensation of labour
Mean	2.673846	19.89481	1.506443	3.514034	0.014746	0.485172	0.500000
Median	3.149866	19.20496	0.746378	3.103370	0.009713	0.490290	0.500000
Maximum	6.952606	28.19969	4.723793	15.41951	0.048165	0.498398	0.500000
Minimum	-2.124907	12.20822	-0.598963	-3.179642	0.001601	0.451759	0.500000
Std. Dev.	2.284189	4.372513	1.901208	3.749143	0.012927	0.013064	0.000000
Observations	25	25	25	25	25	25	25

Source: author using EVIEWS 9

Table 5.44 ARDL long run results for Algeria

Long Run Coefficients				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
ICTG	0.061786	0.085757	4.218719	0.0005
NICTG	0.600807	0.238524	2.518849	0.0214
LTG	-0.132974	0.102299	-1.299851	0.2101
C	-4.975165	1.830337	-2.718169	0.0141

Source: author using EVIEWS 9

The significance for the model as a whole is explained as the calculated F-statistics (3.97) is greater than the tabular one (F= 3.4. The t-test (Student's-t Distribution) value for ICT capital services is 2.3 which is more than the tabular one which is 2.06, so the parameter of non-ICT is significant. The value of R-square is 52.4%. DW statistic value 1.83 is more than the DW tabular value 1.65 at 5% confidence level, then we accept the null hypothesis and conclude that there is no positive autocorrelation between the residuals. The results show a low value of Jarque-Bera statistic (J-B=0.122) with the Jarque-Bera probability (94.1 %) that is higher than 5%; then, the null hypothesis is not rejected implying that there is non-normality problem (see figure 5.15). As illustrated in table 5.45, the parameters are stable, where Ramsey's test is used for this issue as the F-statistical probability is more than 5%, also it is proved by CUSUM test illustrated in figure 5.17. As illustrated in table 5.46 the two associated probabilities are more than 5%, hence, we accept the null hypothesis of homoscedasticity of errors. Also as shown in figure 5.18, the errors are serially independent.

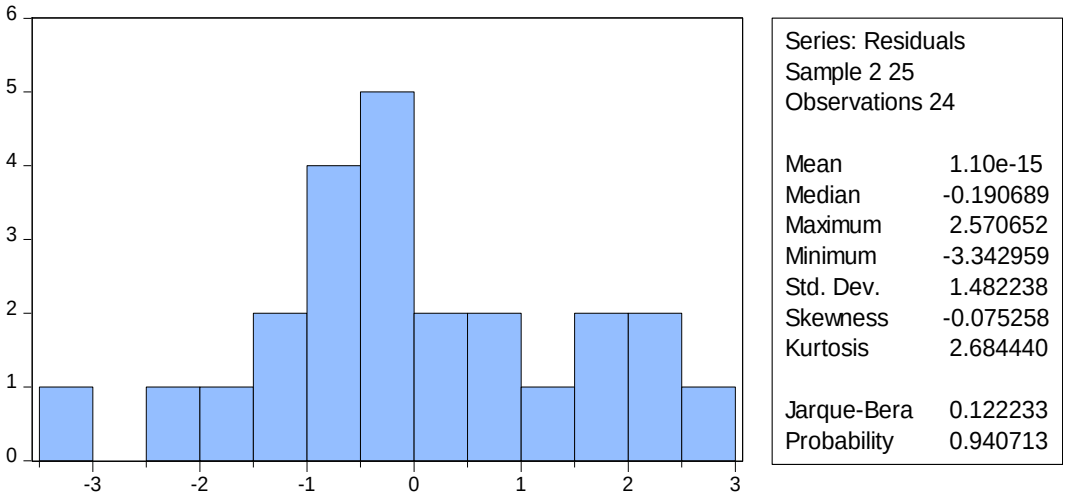


Figure 5.16 Actual fitted graph for Algeria model

Source: author using EVIEWS 9

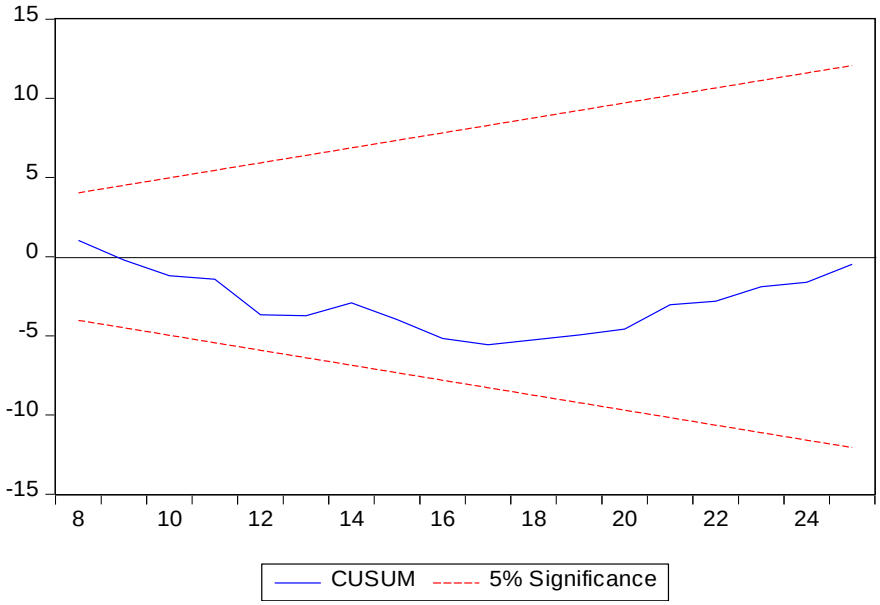


Figure 5.17 CUSUM test for Algeria model

Source: author using EVIEWS 9

As shown in figure 5.19, ARDL (1, 2, 0, and 2) was selected out of 500 model specifications. "Bounds Test" results are shown in table 5.47, where as we realise the F-statistic value for the Bounds Test reaches 3.932, and this obviously surpasses the 5% critical value for the upper bound.

Table 5.45 Ramsey test for Algeria model

Ramsey RESET Test
Equation: UNTITLED
Specification: GDPG GDPG(-1) ICTG ICTG(-1) NICTG LTG C
Omitted Variables: Squares of fitted values

	Value	Df	Probability
t-statistic	0.613655	17	0.5476
F-statistic	0.376572	(1, 17)	0.5476

Source: author using EVIEWS 9

Table 5.46 Heteroskedasticity test for Tunisia model

Heteroskedasticity Test: Breusch-Pagan-Godfrey

F-statistic	1.759806	Prob. F(5,18)	0.1722
Obs*R-squared	7.880013	Prob. Chi-Square(5)	0.1630
Scaled explained SS	3.733146	Prob. Chi-Square(5)	0.5884

Source: author using EVIEWS 9

Date:11/12/15 Time: 00:07
Sample: 1 25
Included observations: 24
Q-statistic probabilities adjusted for 1 dynamic regressor

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob*
		1	0.030	0.030	0.0247	0.875
		2	-0.011	-0.012	0.0282	0.986
		3	0.036	0.037	0.0669	0.995
		4	-0.071	-0.073	0.2235	0.994
		5	-0.232	-0.229	1.9966	0.850
		6	-0.031	-0.024	2.0292	0.917
		7	-0.069	-0.071	2.2026	0.948
		8	-0.110	-0.103	2.6721	0.953
		9	-0.226	-0.277	4.8049	0.851
		10	-0.067	-0.152	5.0037	0.891
		11	-0.107	-0.185	5.5496	0.902
		12	0.105	0.029	6.1230	0.910

*Probabilities may not be valid for this equation specification.

Figure 5.18 Autocorrelation graph

Source: author using EVIEWS 9

The error-correction coefficient is with negative sign (-0.983), as desired, and is significant. There is a long run equilibrium association between ICT capital services, non-ICT capital services and labour capital services growth, and GDP growth of Algeria as resulted from Bound Test shown in table 5.40. The estimation result illustrates that 1% variation in the ICT capital services will result in a long run change of 0.062% of GDP growth and this value is

more slightly than the compensation of ICT of 0.049% as shown in table 5.36 indicating increased spillover of ICT capital services. Also, in the long run there is positive but not significant impact of labour capital services. The non-ICT capital services has positive and significant impact on economic growth.

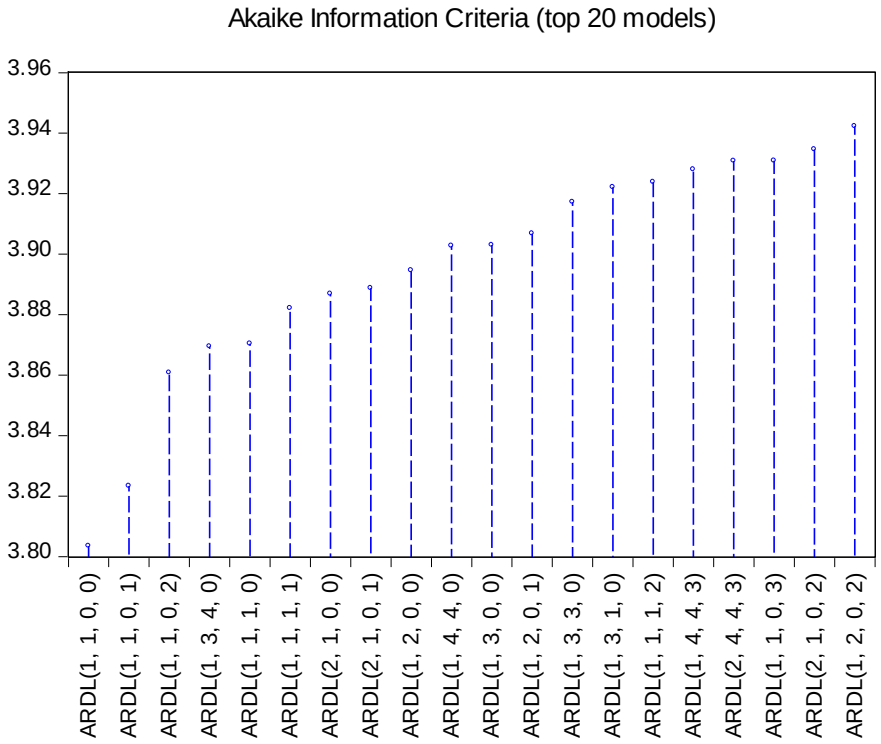


Figure 5.19 ARDL model selection

Source: author using EVIEWS 9

Table 5.47 ARDL Bound Test for Algeria

ARDL Bounds Test
Date: 11/12/15 Time: 00:15
Sample: 2 25
Included observations: 24
Null Hypothesis: No long-run relationships exist

Test Statistic	Value	K
F-statistic	3.923252	3
Critical Value Bounds		
Significance	I0 Bound	I1 Bound
10%	2.37	3.2
5%	2.79	3.67
2.5%	3.15	4.08
1%	3.65	4.66

Source: author using EVIEWS 9

5.7.4 The Impact of ICT capital services, non-ICT capital services and labour capital on economic growth for Morocco

The descriptive figure for the related variables and the contribution of ICT, non-ICT and labour are shown in table 5.48.

Table 5.48 Descriptive figures for Morocco model

	GDP growth	ICT growth	Non-ICT growth	Labour growth	Compensation of ICT	Compensation of non-ICT	Compensation of labour
Mean	3.565298	16.06033	3.912354	2.588385	0.046170	0.434681	0.519144
Median	3.710193	14.14570	3.549208	1.079731	0.043346	0.430060	0.522697
Maximum	11.52665	28.67203	6.987122	20.59258	0.075942	0.466413	0.533639
Minimum	-6.805885	7.911795	0.528160	-17.48654	0.037242	0.417927	0.489821
Std. Dev.	4.134112	6.258751	2.010076	8.880059	0.010623	0.013435	0.014957
Observations	25	25	25	25	25	25	25

Source: author using EVIEWS 9

The unit root tests encounter either I (0) or I (1) and these variables are cointegrated, where in this case DOLS method is used. The regression results using DOLS model are shown in table 5.49.

As shown in table 5.49, the t-test (Student's-t Distribution) value for ICT capital services is 2.87 which is more than the tabular one which is 2.06 at 5% confidence level so this parameter is significant, also labour is positive and significant, but the non-ICT parameter is insignificant.

For the normality test, the results of this test are shown in figure 5.20, where they show a low value of Jarque-Bera statistic (J-B=0.606), with the Jarque-Bera probability (73.8%) that is higher than 5%; then, the null hypothesis is not rejected implying that there is non-normality problem. Also as shown in figure 5.21, the errors are serially independent as the residuals are within the critical limits.

The estimation result illustrates that 1% variation in the ICT capital services will result in positive change of 0.201% of GDP growth which is more than the compensation of capital services provided by ICT assets to GDP as shown in table 5.49. There is significant and

positive impact of labour services on economic growth, but insignificant impact of non-ICT capital services.

Table 5.49 DOLS regression results for Morocco model

Dependent Variable: GDPG
Method: Dynamic Least Squares (DOLS)
Date: 11/15/15 Time: 07:50
Sample (adjusted): 3 24
Included observations: 22 after adjustments
No cointegrating equation deterministics
Fixed leads and lags specification (lead=1, lag=1)
Long-run variance estimate (Bartlett kernel, Newey-West fixed bandwidth = 3.0000)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
ICTG	0.200937	0.101353	2.870526	0.0167
NICTG	-0.373675	0.384809	-0.971066	0.3544
LTG	0.41104	0.187761	0.218917	0.0311

Source: author using EVIEWS 9

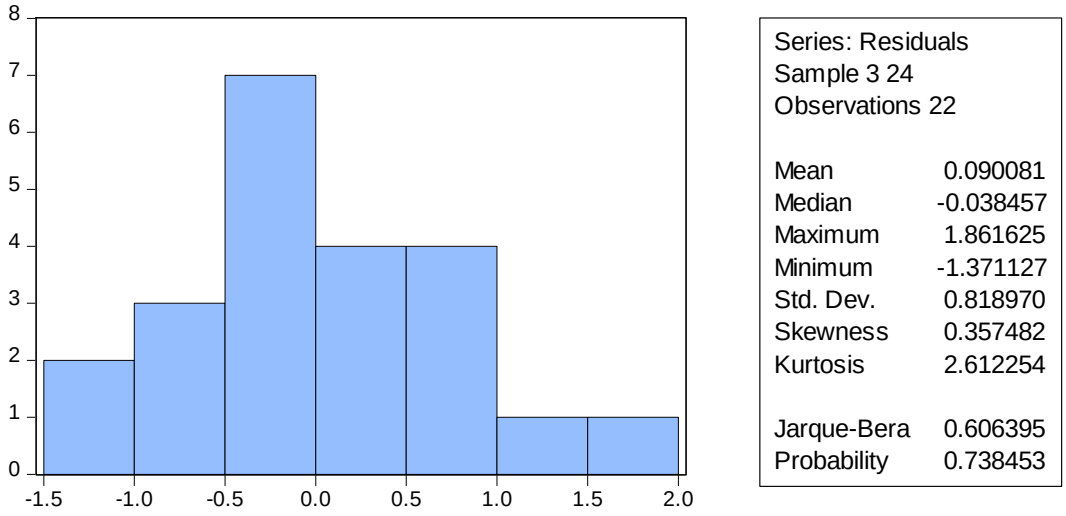
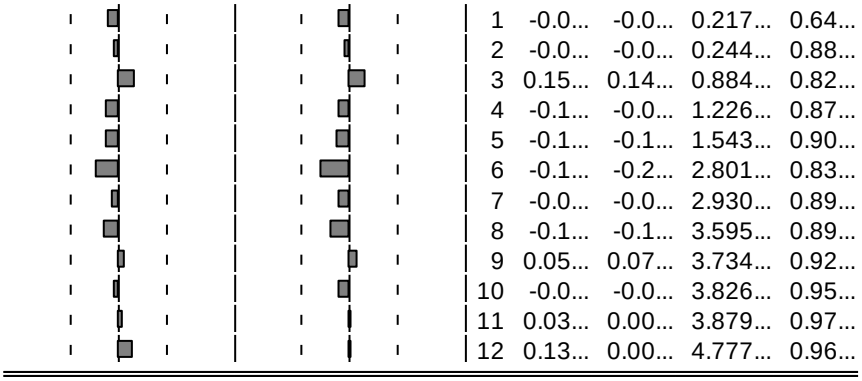


Figure 5.20 Actual fitted graph for Morocco model
Source: author using EVIEWS 9

Date: 11/15/15 Time: 07:57
Sample: 1 25
Included observations: 22



Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob*
		1	-0.0...	-0.0...	0.217...	0.64...
		2	-0.0...	-0.0...	0.244...	0.88...
		3	0.15...	0.14...	0.884...	0.82...
		4	-0.1...	-0.0...	1.226...	0.87...
		5	-0.1...	-0.1...	1.543...	0.90...
		6	-0.1...	-0.2...	2.801...	0.83...
		7	-0.0...	-0.0...	2.930...	0.89...
		8	-0.1...	-0.1...	3.595...	0.89...
		9	0.05...	0.07...	3.734...	0.92...
		10	-0.0...	-0.0...	3.826...	0.95...
		11	0.03...	0.00...	3.879...	0.97...
		12	0.13...	0.00...	4.777...	0.96...

*Probabilities may not be valid for this equation specification.

Figure 5.21 Autocorrelation graph
Source: author using EVIEWS 9

5.7.5 The Impact of ICT capital services, non-ICT capital services and labour capital on economic growth for Egypt

The descriptive figures for the related variables and the contribution of ICT, non-ICT and labour are shown in table 5.50. The unit root tests indicate that the Egypt study model variables encounter I (0), where we can use OLS for regression. The regression results are shown in table 5.51.

Table 5.50 Descriptive figures for Egypt model

	GDP growth	ICT growth	Non-ICT growth	Labour growth	Compensation of ICT	Compensation of non-ICT	Compensation of labour
Mean	4.343290	13.46631	2.920877	3.268078	0.063307	0.571575	0.365119
Median	4.615144	13.26792	2.407916	2.967561	0.062286	0.583489	0.359634
Maximum	6.880338	22.31186	5.779385	14.22604	0.091566	0.605144	0.397089
Minimum	1.967028	6.432778	0.285676	-2.382341	0.052737	0.511345	0.342120
Std. Dev.	1.394405	5.395263	1.589439	2.967040	0.009746	0.024739	0.018189
Observations	25	25	25	25	25	25	25

Source: author using EVIEWS 9

As shown in table 5.51, the t-test (Student's-t Distribution) value for ICT capital services is 2.33 which is more than the tabular one, so this parameter is significant in addition to the constant one, but the non-ICT and labour parameters are insignificant. The value of R-square is 84%. The significance for the model as a whole is explained as the calculated F-statistics (14.89) is greater than the tabular one. Also the level of fisher significance is almost zero. The DW statistic value 1.97 is more than the DW tabular value, then there is no positive autocorrelation between the residuals. The parameters are stable as proved by CUSUM test illustrated in figure 5.22. For the normality test, the results show a low value of Jarque-Bera statistic (J-B=0.887), with the Jarque-Bera probability (64.2%) that is higher than 5%; then, the null hypothesis is not rejected implying that there is non-normality problem. Also as shown in figure 5.23, the errors are serially independent as the residuals are within the critical limits. The two associated probabilities of Heteroscedasticity test are more than 5%, hence, we accept the null hypothesis of homoscedasticity of errors. Also there is no problem of serial correlation according to Breusch-Godfrey LM Test.

The estimation result illustrates that 1% variation in the ICT capital services will result in positive change of 0.149% of GDP growth which is more than the ICT compensation share as shown in table 5.50, indicating more spillover of ICT in Egypt. The impact of labour services are positive and significant on economic growth, but there is insignificant impact of non-ICT capital services. Therefore, Egypt has to invest more in ICT assets.

Table 5.51 Regression results for Egypt model

Dependent Variable: GDPG
Method: Least Squares
Date: 11/21/15 Time: 11:30
Sample: 3 24
Included observations: 22

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	2.208251	0.462225	4.777435	0.0004
ICTG	0.149227	0.063970	2.332763	0.0364
LTG	0.113259	0.047640	2.377390	0.0335
NICTG	0.088232	0.220549	0.400058	0.6956

R-squared	0.774678	Mean dependent var	4.740844
Adjusted R-squared	0.722680	S.D. dependent var	1.115036
S.E. of regression	0.587191	Akaike info criterion	1.975391

Sum squared resid	4.482313	Schwarz criterion	2.171441
Log likelihood	-12.79082	Hannan-Quinn criter.	1.994879
F-statistic	14.89839	Durbin-Watson stat	1.968711
Prob(F-statistic)	0.000169		

Source: author using EVIEWS 9

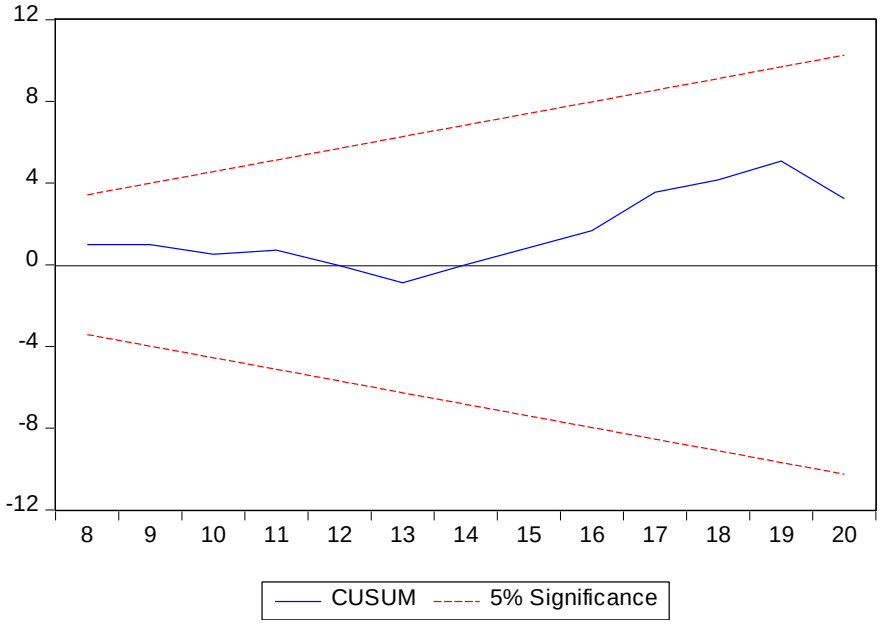


Figure 5.22 CUSUM graph

Source: author using EVIEWS 9

Date: 11/21/15 Time: 17:44
Sample: 3 24
Included observations: 22

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	-0.1...	-0.1...	0.688...	0.40...
		2	-0.0...	-0.0...	0.728...	0.69...
		3	-0.1...	-0.1...	0.993...	0.80...
		4	-0.1...	-0.1...	1.316...	0.85...
		5	-0.0...	-0.1...	1.416...	0.92...
		6	-0.0...	-0.1...	1.595...	0.95...
		7	0.24...	0.13...	3.608...	0.82...
		8	0.09...	0.12...	3.908...	0.86...
		9	-0.3...	-0.3...	8.421...	0.49...
		10	-0.0...	-0.1...	8.429...	0.58...
		11	0.00...	-0.0...	8.431...	0.67...
		12	-0.0...	-0.1...	8.811...	0.71...

Figure 5.23 Autocorrelation graph

Source: author using EVIEWS 9

5.8 Chapter Summary

As a result of this applied study on the Arab states that includes 18 Arab countries representing most of the Arab world, the investigation of the impact of ICT's on economic growth for the period from 1995 to 2013 was performed. The information density that consists of network and skills sub-indices is used as an indicator of ICT, where this ICT index has interpreted the impact on GDP per capita. First we analysed the impact of ICT index on GDP per capita for each Arab country individually using ICT index as the explanatory variable. The impact of ICT index on GDP per capita for each country is positive for all sample study except for Dijibouti which is negative and UAE which is insignificant. The positive elasticities that represent the impact of ICT on GDP per capita for each Arab country of the sample study range from 0.100 for Lebanon to 0.430 for Morocco.

The basic model is used for investigating the impact of ICT on economic growth that includes the main independent variable ID for the whole 18 Arab sample study using panel regression with three approaches POLS, FE and RE. The Result for the three approaches showed positive impact of ICT on economic growth for the Arab world. Applying Hausman test FE was the appropriate model which indicates a positive and significant impact of ICT on economic growth with 0.208 point using adjusted FE approach.

The extended model of the basic one includes other significant macroeconomic control variables. Using the extended model and applying panel regression we found that as information density increases by 10%, GDP per capita increases significantly by 1.08% using adjusted FE approach (the appropriate approach) by applying AR(1) function. The elasticity of GCF ratio approaches 0.301 which is significant. The elasticity of openness is significant and approaches -0.058. The elasticities of population growth and inflation are insignificant.

For further analysis and as the Arab countries have different ICT abilities we classified the 18 Arab countries into three sub groups according to infodensity levels. The research results showed that the first group with relatively high infodensity values and GDP per capita encounters a ICT impact of 0.264 point less slightly than the impact of ICT of the second group (with intermediate values of infodensity)with 0.310 point. The gap of ICT impact between the first and second group from one side and the third group (with low infodensity values and GDP per capita) with 0.015 point of ICT impact on the other side is relatively

large indicating that these countries of third group have a back seat to the other two groups regarding the spillover of ICT.

The second methodology in this thesis uses Cobb-Douglas production function with ICT and non-ICT capital variables, and labour services as independent variables. The results show a positive and significant impact of ICT on economic growth at the short and long run. For non-ICT capital services there is negative and significant impact at the long run and positive impact at the short run on GDP growth, but the labour impact on GDP growth was positive on long run. We estimated the impact of capital services also on each Arab country of this model. The results show that impact of growth of capital services provided by ICT assets is positive and significant for this study sample of five Arab countries. The impact of growth of capital services provided by non-ICT assets is positive and significant for Algeria where the impact is negative and significant for Tunisia and Jordan, and insignificant for Moroco and Egypt. The impact of growth of labour services is positive and significant for Tunisia, Jordan, Egypt and Morocco where the impact is insignificant for Algeria.

As stated from our analysis and other related empirical work (e.g. Roeger, 2001; Pilat, 2003) advocate a positive effect on economic growth from ICTs. The integration of ICTs in all aspects of life work in a pervasive mechanism nowadays is essential to make the production processes more cost efficient resulting in enhancing productivity levels, and resulting in the need for more ICT investments to achieve more technological advancement. So it is important to invest more in ICT tools, practices and knowledge, in the context of building enhanced ICT infrastructure to reduce business transaction expenses and increases the size of trade between different countries (Freund and Weinhold 2002). Although ID values of some Arab countries such as the first and second group in this study are above the average world values, ICT still has relatively low impact on economic growth for these countries compared to other world countries with above average ID values, so ICT have to be embedded within the context of overall growth exertions, as ICT facilitates the work of all growth aspects.

CHAPTER 6: CONCLUSIONS AND RECOMONDATIONS

6.1 Conclusions

Depending on a sample of 18 Arab countries that represents the majority of Arab world, we investigated the effect of ICT on economic growth for the period from 1995 to 2013. The main issue in this study is to examine whether the accumulation of ICT labour and capital positively affect economic growth for these Arab countries and to what extent.

First we analysed the impact of ICT index (represented by infodensity that signifies the production part of ICT and proposed by ORBICOM) on GDP per capita individually for each Arab country. The results showed positive impact of ICT index for each individual country (except for UAE which encountered insignificant ICT index elasticity and Djibouti with negative and significant impact) ranged from 0.10 for Lebanon to 0.469 for Qatar.

A penal regression is used in this study with 341 observations for the base model and 331 observations for the extended model which includes other standardized significant macroeconomic control variables. The panel regression results showed that ICT has a positive and significant impact on GDP per capita for the whole study sample of 18 Arab countries with impact of 0.208 using the FE model as an appropriate model (according to Hausman test). This result is accommodated with other research results illustrated in this study. The extended model showed that ICT positively and significantly affects GDP per capita with impact of 0.108, in addition, GCF have positive and significant effect on GDP per capita with elasticity of 0.129. Openness has positive and significant impact on economic growth with 0.068 point and inflation with negative and significant impact of 0.088 point. Population growth is insignificant to economic growth.

The 18 Arab countries were divided into three sub groups according to their infodensity levels. The research results showed that the first group with relatively high infodensity values and GDP per capita encounters an ICT impact of 0.264 point less slightly than the impact of ICT of the second group (with intermediate values of infodensity) with 0.310 point. The gap of ICT impact between the first and second group from one side and the third group (with low infodensity and GDP per capita values) on the other side is relatively large indicating that these countries of third group have a back seat to the other two groups regarding the spillover of ICT.

The second model of this study uses Cobb-Douglas production model and applied using ARDL approach to investigate the importance of ICT capital services for economic growth depending on five Arab countries (according to the availability of data) for the period from 1993 to 2014. The main issue we investigated using this model is whether the investments on ICT assets are positive on economic growth and to what extent. The regression result tells a positive and significant elasticity of ICT capital services at short and long run where there is a cointegration relationship between ICT capital services and GDP growth, and indicates that ICT capital services causes economic growth as Wald test proves, and this value is more than the compensation share of ICT capital services, which indicates ICT spillover in these Arab countries. Labour services impact on GDP growth was positive and significant on long run, but for non-ICT capital services there is negative and significant impact at the long run. The results also show that the impact of capital services provided by ICT assets on economic growth is positive and significant for each individual country of the second sample study.

Our significant concluded point that it is worth for the Arab countries to efficiently invest more in ICT assets as they have positive impact on economic growth with restructured and adjusted ICT strategies and policies.

6.2 Recommendations

Although this study captures the impact and degree of impact of ICT and other sources of capital and labour on economic growth and not the underlying ways for this impact improvements, some general recommendations can be suggested in the light of this study results as follows:

- There is a need for Arab countries to plan efficiently to invest more in ICT parts such as networks and skills.
- There is a need to establish a competent ICT infrastructure, where as illustrated from the study, Arab countries still lag developed countries in ICT infrastructure components especially in fixed and mobile broadband internet penetration. Increasing the investment in broadband internet penetration is worth and advances the establishment of an appropriate competitive industries in the ICT and non-ICT fields, helps in developing various ICT services and applications in different fields such as e-government, e-health, e-education, e-business and so on, and allows to raise productivity and increase economic growth rates.
- As the ICT basket price is relatively higher than that of developed and emerging countries, which may impede the spillover of ICT in the Arab society, so the Government policies for ICT have to be adjusted to efficiently influence the ICT public and private institutions to offer competent prices.
- There is a need to embed the education and training of ICT knowledge and practice in different educational institutions so as to accumulate the labour skills for beter utilization of ICTs.
- There is a need to establish ICT training centres that promote the ICT practices in various life and work applications and incubate ICT innovative projects that advances ICT spillover.
- As the impact of ICT capital and labour in Arabic countries less than that of other countries, it is important to restructure the strategies and policies concerning the investment and adoption of ICT in these countries. Also as the impact of growth of capital services delivered by ICT Assets is more than the compensation share of ICT capital services to GDP growth, it is important to continue on investment on ICT assets efficiently so as to advance the ICT spillover.

References

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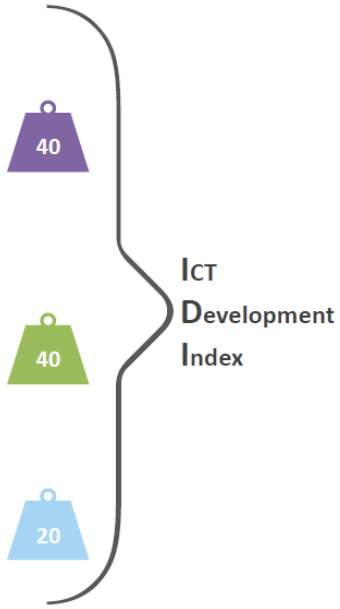
Appendices

Appendix 1

Table A.1 ICT Development Index: indicators, reference values and weights

ICT access	Reference value	(%)
1. Fixed-telephone subscriptions per 100 inhabitants	60	20
2. Mobile-cellular telephone subscriptions per 100 inhabitants	120	20
3. International Internet bandwith (bit/s) per internet user	962'216*	20
4. Percentage of households with a computer	100	20
5. Percentage of households with Internet access	100	20
ICT use	**Reference value**	**(%)**
6. Percentage of Individuals using the Internet	100	33
7. Fixed-broadband subscriptions per 100 inhabitants	60	33
8. Active mobile-broadband subscriptions per 100 inhabitants	100	33
ICT skills	**Reference value**	**(%)**
9. Adult literacy rate	100	33
10. Secondary gross enrolment ratio	100	33
11. Tertiary gross enrolment ratio	100	33



Note: * This corresponds to a log value of 5.90, which was used in the normalization step.

Source: ITU

Appendix 2

Table A.2 Information Development Index (IDI) for most Arab countries

Year/Country	2002	2007	2008	2009	2010	2011	2012	2013	Average
Bahrain	3.3	4.69	5.16	5.3	5.57	5.85	7.4	7.22	5.5613
UAE	3.27	5.29	5.63	5.82	6.19	5.64	7.03	6.27	5.6425
Qatar	2.82	4.44	4.5	4.93	5.6	6.24	7.01	6.46	5.25
Saudi Arabia	2.13	3.62	4.13	4.85	5.42	5.43	6.36	6.01	4.7438
Oman	2.12	3	3.45	3.78	4.38	5.1	6.1	5.43	4.17
Lebanon	2.53	3.43	3.12	3.32	3.57	4.48	5.71	5.32	3.935
Jordan	2.36	3.06	3.29	3.45	3.83	3.95	4.62	4.48	3.63
Egypt	1.81	2.54	2.73	2.94	3.28	3.66	4.45	4.28	3.2113
Morocco	1.37	2.34	2.6	2.81	3.29	3.46	4.27	4.09	3.0288
Tunisia	1.86	2.73	2.98	3.18	3.43	3.58	4.23	4.07	3.2575
Palestine	2.2	2.92		3.24	3.45	3.87	4.16	4.07	3.4157
Syria	1.69	2.66	2.66	2.78	3.05	3.15	3.46	3.39	2.855
Algeria	1.61	2.51	2.41	2.62	2.82	2.98	3.42	3.3	2.7088
Sudan	1.03	1.56	1.62	1.89	2.21	2.46	2.88	2.69	2.0425
Yemen	1.04	1.47	1.49	1.57	1.72	1.76	2.18	2.07	1.6625
Average	2.08	3.08	3.27	3.499	3.85	4.11	4.89	4.61	

Source: ITU

Table A.3 First study model related data for Arab countries

Country	Year	GDP per capita, PPP	Infodensity	population growth	GCF/GDP	Opennes	Inflation
Qatar	1995	55561,0	26,8	0,0117	0,3500	0,8767	0,0296
Qatar	1996	57754,0	42,0	0,0214	0,3600	0,8351	0,0490
Qatar	1997	73907,0	58,6	0,0314	0,3500	0,8445	0,0483
Qatar	1998	79939,0	71,9	0,0379	0,3200	0,9106	0,0295
Qatar	1999	81416,0	81,4	0,0394	0,1900	0,8573	0,0218
Qatar	2000	88998,9	92,6	0,0392	0,2000	0,8961	0,0165
Qatar	2001	90950,2	106,7	0,0336	0,2900	0,9497	0,0147
Qatar	2002	95710,7	119,8	0,0331	0,3300	0,8847	0,0024
Qatar	2003	95919,1	131,7	0,0519	0,3500	0,9016	0,0226
Qatar	2004	107237,1	136,0	0,0914	0,3200	0,9037	0,0680
Qatar	2005	104078,3	142,0	0,1338	0,3400	0,9475	0,0881
Qatar	2006	114601,8	149,0	0,1664	0,4200	0,9857	0,1184
Qatar	2007	116381,2	156,7	0,1762	0,4700	0,9611	0,1376

Qatar	2008	118513,1	161,0	0,1639	0,4100	0,8943	0,1505
Qatar	2009	116703,6	168,0	0,1359	0,4400	0,8045	-0,0486
Qatar	2010	124272,7	176,0	0,1040	0,3800	0,8374	-0,0243
Qatar	2011	134117,4	195,0	0,0763	0,3100	0,9746	0,0192
Qatar	2012	135649,5	209,0	0,0562	0,2900	1,0442	0,0187
Qatar	2013	140296,1	210,0	0,0416	0,2800	1,0622	0,0313
UAE	1995	77466,4	42,8	0,0488	0,1910	0,7530	0,0391
UAE	1996	79479,6	54,8	0,0488	0,1940	0,7770	0,0577
UAE	1997	83164,4	58,5	0,0504	0,1980	0,8010	-0,0095
UAE	1998	80039,4	81,8	0,0520	0,1930	0,8280	-0,0425
UAE	1999	79261,6	88,2	0,0536	0,1910	0,8520	0,0844
UAE	2000	84974,0	99,5	0,0559	0,2171	0,8770	0,1146
UAE	2001	83532,7	102,3	0,0535	0,2178	0,8986	-0,0235
UAE	2002	82368,8	106,6	0,0533	0,2144	0,9307	0,0377
UAE	2003	85562,8	107,6	0,0660	0,1931	1,0230	0,0407
UAE	2004	87842,8	119,0	0,0922	0,1924	1,1662	0,0850
UAE	2005	84337,5	142,9	0,1198	0,1820	1,1955	0,1653
UAE	2006	82753,4	150,5	0,1431	0,2436	1,1948	0,1196
UAE	2007	75426,0	143,8	0,1503	0,2369	1,3680	0,1254
UAE	2008	69123,7	160,5	0,1381	0,2973	1,4851	0,1853
UAE	2009	59099,8	171,7	0,1104	0,2567	1,5346	-0,1518
UAE	2010	56244,9	185,7	0,0779	0,2270	1,5100	0,1100
UAE	2011	57417,0	173,7	0,0475	0,2250	1,6313	0,1581
UAE	2012	59693,3	204,0	0,0246	0,2263	1,7329	0,0237
UAE	2013	63116,6	200,0	0,0097	0,2305	1,7607	0,0272
Bahrain	1995	31529,0	53,1	0,0262	0,1461	1,5246	0,0270
Bahrain	1996	32494,6	59,4	0,0282	0,1441	1,6412	-0,0045
Bahrain	1997	33048,3	64,7	0,0305	0,1745	1,4858	0,0243
Bahrain	1998	33861,9	73,1	0,0333	0,2142	1,2849	-0,0037
Bahrain	1999	34580,0	83,1	0,0363	0,0791	1,4183	-0,0129
Bahrain	2000	35792,0	87,5	0,0397	0,1658	1,3581	-0,0070
Bahrain	2001	36005,8	92,2	0,0412	0,1571	1,2703	-0,0121
Bahrain	2002	36288,5	95,5	0,0429	0,2325	1,3061	-0,0050
Bahrain	2003	37374,9	97,8	0,0487	0,2374	1,2809	0,0159
Bahrain	2004	38724,5	113,6	0,0591	0,2052	1,4074	0,0235
Bahrain	2005	39770,8	121,7	0,0705	0,2674	1,4831	0,0259
Bahrain	2006	40220,9	134,2	0,0817	0,3039	1,4710	0,0201
Bahrain	2007	40979,9	152,6	0,0872	0,3471	1,3779	0,0326
Bahrain	2008	40843,8	169,8	0,0833	0,3517	1,4588	0,0353
Bahrain	2009	39343,2	175,4	0,0701	0,2614	1,1796	0,0280
Bahrain	2010	39423,7	186,0	0,0525	0,2729	1,2047	0,0196
Bahrain	2011	39676,7	196,6	0,0348	0,1636	1,2681	-0,0036
Bahrain	2012	40973,7	212,0	0,0209	0,2005	1,2216	0,0275

Bahrain	2013	43289,3	209,4	0,0118	0,2130	1,2139	0,0319
Lebanon	1995	8934,3	35,1	0,0196	0,3646	0,7314	0,1059
Lebanon	1996	9447,7	47,4	0,0123	0,3479	0,6810	0,0769
Lebanon	1997	9323,7	57,1	0,0070	0,2922	0,6209	0,1536
Lebanon	1998	9696,8	65,0	0,0069	0,2840	0,5472	0,0409
Lebanon	1999	9668,0	72,2	0,0136	0,2283	0,5081	0,0074
Lebanon	2000	9777,1	78,1	0,0246	0,2041	0,5012	-0,0209
Lebanon	2001	10010,1	83,2	0,0378	0,2281	0,5556	-0,0163
Lebanon	2002	10020,6	84,6	0,0474	0,1875	0,5104	0,0497
Lebanon	2003	10042,1	86,3	0,0495	0,1916	0,5409	0,0157
Lebanon	2004	10625,5	90,6	0,0428	0,2272	0,9453	-0,0292
Lebanon	2005	10914,5	101,0	0,0315	0,2272	0,9637	-0,0109
Lebanon	2006	11232,5	106,9	0,0174	0,2037	0,9465	0,0077
Lebanon	2007	12528,2	115,6	0,0070	0,2411	1,0129	0,0307
Lebanon	2008	13854,8	104,8	0,0058	0,2769	1,0951	0,0752
Lebanon	2009	15131,6	111,7	0,0175	0,2631	0,9275	0,1050
Lebanon	2010	15948,5	120,7	0,0365	0,2483	0,9812	0,0016
Lebanon	2011	16409,3	147,8	0,0118	0,2674	1,0040	0,0337
Lebanon	2012	16871,1	165,6	0,0118	0,2940	1,3355	0,0548
Lebanon	2013	17073,9	159,6	0,0118	0,3041	1,2803	0,0174
Kuwait	1995	58116,1	53,1		0,1475	0,9432	0,0269
Kuwait	1996	59503,3	61,6	0,0005	0,1510	0,9147	0,0355
Kuwait	1997	60240,4	63,7	0,0291	0,1364	0,9245	0,0068
Kuwait	1998	60265,3	65,7	0,0463	0,1845	0,9495	0,0013
Kuwait	1999	57274,8	69,2	0,0480	0,1456	0,8537	0,0299
Kuwait	2000	58902,4	74,1	0,0404	0,1067	0,8662	0,0181
Kuwait	2001	58837,4	80,2	0,0309	0,1431	0,8684	0,0130
Kuwait	2002	59960,3	83,3	0,0259	0,1713	0,8123	0,0089
Kuwait	2003	69907,2	84,6	0,0260	0,1663	0,8656	0,0096
Kuwait	2004	76976,2	90,0	0,0330	0,1819	0,8930	0,0125
Kuwait	2005	83700,9	110,0	0,0439	0,1643	0,9224	0,0414
Kuwait	2006	87873,1	122,0	0,0541	0,1616	0,8971	0,0306
Kuwait	2007	90001,2	133,1	0,0605	0,2046	0,9173	0,0548
Kuwait	2008	88247,5	148,0	0,0636	0,1763	0,9268	0,1058
Kuwait	2009	77580,0	159,0	0,0630	0,1798	0,8886	0,0461
Kuwait	2010	72202,3	165,0	0,0600	0,1766	0,9703	0,0450
Kuwait	2011	76306,4	174,0	0,0571	0,1355	0,9912	0,0491
Kuwait	2012	78454,1	185,0	0,0542	0,1284	1,0101	0,0320
Kuwait	2013	76886,1	192,0	0,0497	0,1385	0,9811	0,0270
Jordan	1995	5480,2	16,9	0,0320	0,3300	1,2459	0,0188
Jordan	1996	5525,4	22,6	0,0310	0,3100	1,3104	0,0206
Jordan	1997	5649,4	28,5	0,0270	0,2600	1,2089	0,0123
Jordan	1998	5727,1	35,7	0,0270	0,2200	1,0920	0,0602

Jordan	1999	5863,9	44,8	0,0250	0,2200	1,0462	-0,0040
Jordan	2000	6099,1	56,0	0,0310	0,2200	1,1049	-0,0041
Jordan	2001	6406,7	64,7	0,0300	0,2100	1,0944	0,0078
Jordan	2002	6716,6	68,6	0,0289	0,2000	1,1419	0,0092
Jordan	2003	6961,6	69,3	0,0278	0,2100	1,1586	0,0214
Jordan	2004	7580,6	77,0	0,0267	0,2700	1,3482	0,0309
Jordan	2005	8274,0	85,0	0,0256	0,3400	1,4691	0,0202
Jordan	2006	9010,3	92,0	0,0249	0,2800	1,4563	0,1065
Jordan	2007	9785,4	99,6	0,0241	0,3000	1,4175	0,0505
Jordan	2008	10467,8	106,0	0,0234	0,3000	1,2559	0,1987
Jordan	2009	10882,3	110,0	0,0226	0,2600	1,1726	0,0282
Jordan	2010	11028,4	117,0	0,0216	0,2400	1,2151	0,0841
Jordan	2011	11292,2	126,0	0,0220	0,2500	1,2051	0,0641
Jordan	2012	11543,8	136,0	0,0220	0,2700	1,1444	0,0450
Jordan	2013	11782,5	141,0	0,0220	0,2800	1,1249	0,0560
Suadi Arabia	1995	25755,4	12,1	0,0258	0,1979	0,6545	0,0487
Suadi Arabia	1996	26443,1	17,0	0,0250	0,1810	0,6704	0,0122
Suadi Arabia	1997	26926,7	18,6	0,0244	0,1830	0,6557	0,0006
Suadi Arabia	1998	27311,4	27,7	0,0246	0,2242	0,5647	-0,0036
Suadi Arabia	1999	26829,6	43,1	0,0255	0,2114	0,5812	-0,0135
Suadi Arabia	2000	28013,2	51,4	0,0268	0,1871	0,6855	-0,0112
Suadi Arabia	2001	28002,6	58,6	0,0284	0,1888	0,6395	-0,0111
Suadi Arabia	2002	27639,7	64,2	0,0296	0,1967	0,6495	0,0023
Suadi Arabia	2003	29453,8	67,2	0,0300	0,1982	0,7023	0,0059
Suadi Arabia	2004	32105,4	73,3	0,0294	0,1986	0,7508	0,0033
Suadi Arabia	2005	34552,3	81,5	0,0283	0,2017	0,8195	0,0070
Suadi Arabia	2006	36601,9	89,9	0,0269	0,2222	0,8994	0,0221
Suadi Arabia	2007	38814,5	102,2	0,0258	0,2647	0,9486	0,0417
Suadi Arabia	2008	41853,1	122,7	0,0250	0,2730	0,9610	0,0987
Suadi Arabia	2009	41897,9	146,5	0,0246	0,3172	0,8486	0,0507
Suadi Arabia	2010	43351,7	160,4	0,0245	0,3074	0,8277	0,0534
Suadi Arabia	2011	47474,0	162,4	0,0245	0,2678	0,8576	0,0582
Suadi Arabia	2012	49706,7	206,1	0,0243	0,2634	0,8374	0,0289
Suadi Arabia	2013	50585,1	191,1	0,0236	0,2624	0,8297	0,0351
Oman	1995	28090,3	13,7	0,0242	0,1498	0,7959	0,0176
Oman	1996	29103,9	14,7	0,0127	0,1370	0,8558	0,0742
Oman	1997	31277,7	40,2	0,0035	0,1765	0,8863	-0,0224
Oman	1998	32491,6	43,8	-0,0012	0,2398	0,9169	-0,1335
Oman	1999	32939,4	45,7	0,0003	0,1485	0,8625	0,1167
Oman	2000	35287,9	47,6	0,0062	0,1537	0,7959	0,1781
Oman	2001	37159,9	51,8	0,0147	0,1721	0,8104	-0,0456
Oman	2002	36501,4	53,9	0,0220	0,1900	0,7702	0,0470
Oman	2003	35295,7	55,0	0,0263	0,2320	0,8255	0,1035

Oman	2004	35787,7	61,3	0,0261	0,2790	0,9025	0,1301
Oman	2005	36972,7	67,9	0,0237	0,2143	0,8934	0,2246
Oman	2006	39424,8	84,0	0,0184	0,2715	0,8784	0,1363
Oman	2007	41618,1	101,9	0,0157	0,3428	0,9647	0,0826
Oman	2008	44900,8	110,4	0,0223	0,3649	0,9566	0,3375
Oman	2009	46098,9	117,2	0,0406	0,2821	0,8528	-0,2513
Oman	2010	45885,0	140,2	0,0637	0,2542	0,8982	0,1564
Oman	2011	42479,2	158,1	0,0866	0,1907	1,0310	0,1713
Oman	2012	41925,7	183,0	0,0993	0,2499	1,0007	0,0494
Oman	2013	40121,7	175,9	0,0972			-0,0144
Palestine	1995	2033,1	28,4	0,0448	0,3808	0,9149	0,0778
Palestine	1996	2123,4	30,4	0,0448	0,3648	0,8927	0,0262
Palestine	1997	2561,1	42,2	0,0448	0,3504	0,9034	-0,0383
Palestine	1998	3178,0	49,4	0,0256	0,3447	0,8899	-0,0537
Palestine	1999	3710,4	61,5	0,0256	0,4287	0,9635	-0,0303
Palestine	2000	3333,6	60,8	0,0256	0,3148	0,8764	0,1044
Palestine	2001	3110,1	59,6	0,0256	0,2955	0,8273	0,0234
Palestine	2002	3032,9	57,2	0,0256	0,2616	0,7625	0,0149
Palestine	2003	3292,9	59,6	0,0256	0,2887	0,7640	-0,0213
Palestine	2004	3591,1	60,9	0,0256	0,2661	0,8629	-0,0112
Palestine	2005	4012,2	62,8	0,0256	0,2568	0,8894	0,0073
Palestine	2006	3848,0	61,9	0,0256	0,2350	0,9001	0,0575
Palestine	2007	3782,4	98,1	0,0256	0,2187	0,9718	0,0520
Palestine	2008	3423,6	104,6	0,0288	0,2056	0,8707	0,1426
Palestine	2009	4053,0	102,0	0,0289	0,2070	0,8360	0,0023
Palestine	2010	4078,5	118,0	0,0290	0,2156	0,7440	0,1344
Palestine	2011	4358,7	126,6	0,0300	0,1781	0,7188	0,0445
Palestine	2012	4928,7	129,2	0,0301	0,2109	0,7244	0,0141
Palestine	2013	4647,2	132,0	0,0298	0,2170	0,7114	0,0821
Tunisia	1995	4414,6	13,8	0,0194	0,2470	0,9371	0,0624
Tunisia	1996	4746,5	15,8	0,0146	0,2501	0,8572	0,0373
Tunisia	1997	5021,1	17,5	0,0137	0,2446	0,8050	0,0365
Tunisia	1998	5250,9	23,4	0,0128	0,2492	0,7998	0,0313
Tunisia	1999	5580,7	26,2	0,0131	0,2462	0,7791	0,0269
Tunisia	2000	5916,1	30,8	0,0102	0,2608	0,8246	0,0296
Tunisia	2001	6241,3	38,1	0,0102	0,2618	0,8955	0,0198
Tunisia	2002	6380,9	40,7	0,0101	0,2381	0,8534	0,0272
Tunisia	2003	6794,9	46,7	0,0093	0,2332	0,8239	0,0271
Tunisia	2004	7305,1	61,0	0,0094	0,2328	0,8695	0,0363
Tunisia	2005	7752,7	72,5	0,0097	0,2168	0,9025	0,0202
Tunisia	2006	8360,1	85,8	0,0098	0,2345	0,9394	0,0449
Tunisia	2007	9030,3	103,1	0,0096	0,2384	1,0408	0,0342
Tunisia	2008	9546,7	101,3	0,0101	0,2594	1,1540	0,0492

Tunisia	2009	9860,6	111,3	0,0107	0,2500	0,9437	0,0352
Tunisia	2010	10200,3	123,8	0,0102	0,2649	1,0486	0,0442
Tunisia	2011	10235,0	130,3	0,0119	0,2358	1,0557	0,0354
Tunisia	2012	10799,5	154,8	0,0097	0,2429	1,0754	0,0514
Tunisia	2013	11124,3	146,9	0,0101	0,2203	1,0315	0,0580
Eygpt	1995	4680,8	12,3	0,0188	0,2015	0,5025	0,1574
Eygpt	1996	4912,7	13,9	0,0184	0,1813	0,4695	0,0719
Eygpt	1997	5176,8	19,7	0,0181	0,1756	0,4374	0,0463
Eygpt	1998	5347,7	21,5	0,0179	0,2150	0,4193	0,0387
Eygpt	1999	5658,9	28,7	0,0179	0,2162	0,3836	0,0308
Eygpt	2000	5989,3	34,2	0,0180	0,1955	0,3902	0,0268
Eygpt	2001	6227,1	39,5	0,0183	0,1826	0,3981	0,0227
Eygpt	2002	6353,1	42,2	0,0186	0,1800	0,4099	0,0274
Eygpt	2003	6562,8	44,4	0,0187	0,1689	0,4618	0,0451
Eygpt	2004	6890,6	52,5	0,0185	0,1694	0,5782	0,1127
Eygpt	2005	7296,9	60,2	0,0181	0,1798	0,6295	0,0487
Eygpt	2006	7895,4	69,6	0,0176	0,1873	0,6152	0,0764
Eygpt	2007	8531,2	83,2	0,0173	0,2085	0,6508	0,0932
Eygpt	2008	9158,9	90,1	0,0175	0,2239	0,7168	0,1832
Eygpt	2009	9484,7	100,0	0,0184	0,1919	0,5655	0,1176
Eygpt	2010	9897,2	105,0	0,0197	0,1950	0,4794	0,1127
Eygpt	2011	10071,2	120,8	0,0211	0,1710	0,4526	0,1005
Eygpt	2012	10247,6	133,5	0,0221	0,1638	0,4328	0,0712
Eygpt	2013	10382,9	128,4	0,0225	0,1418	0,4284	0,0942
Morocco	1995	2787,9	14,0	0,0154	0,2397	0,5382	0,0612
Morocco	1996	3174,3	16,4	0,0144	0,2264	0,4866	0,0299
Morocco	1997	3120,5	20,5	0,0136	0,2357	0,5327	0,0104
Morocco	1998	3362,3	22,6	0,0127	0,2600	0,5252	0,0275
Morocco	1999	3390,2	26,7	0,0119	0,2480	0,5596	0,0068
Morocco	2000	3482,2	34,2	0,0111	0,2553	0,6133	0,0189
Morocco	2001	3788,9	37,3	0,0103	0,2615	0,6135	0,0062
Morocco	2002	3933,5	38,7	0,0097	0,2593	0,6241	0,0280
Morocco	2003	4222,4	40,8	0,0093	0,2735	0,6016	0,0117
Morocco	2004	4501,1	49,5	0,0094	0,2913	0,6369	0,0149
Morocco	2005	4735,3	55,7	0,0097	0,2880	0,7023	0,0098
Morocco	2006	5204,3	62,4	0,0100	0,2943	0,7388	0,0328
Morocco	2007	5428,4	71,0	0,0104	0,3248	0,8061	0,0204
Morocco	2008	5778,9	80,6	0,0109	0,3812	0,8835	0,0371
Morocco	2009	6028,0	89,9	0,0116	0,3564	0,6840	0,0099
Morocco	2010	6245,0	102,0	0,0123	0,3503	0,7631	0,0099
Morocco	2011	6603,2	111,4	0,0131	0,3595	0,8426	0,0092
Morocco	2012	6805,5	132,4	0,0138	0,3527	0,8622	0,0128
Morocco	2013	7107,7	134,2	0,0141	0,3416	0,8051	0,0189

Libya	1995	17025,0	5,8	0,0192	0,1216	0,5159	0,0724
Libya	1996	17461,0	5,9	0,0187	0,1550	0,5255	0,0403
Libya	1997	17365,0	14,2	0,0183	0,1236	0,4863	0,0355
Libya	1998	17173,0	19,2	0,0179	0,1196	0,4025	0,0371
Libya	1999	16730,9	20,5	0,0176	0,0948	0,3480	0,0265
Libya	2000	17435,8	29,2	0,0174	0,1184	0,4528	-0,0290
Libya	2001	17225,0	33,9	0,0169	0,1075	0,4317	-0,0881
Libya	2002	17039,1	36,8	0,0165	0,1352	0,7886	-0,0980
Libya	2003	19322,9	38,6	0,0163	0,1936	0,9074	-0,0219
Libya	2004	20398,0	40,5	0,0166	0,1164	0,9613	-0,0220
Libya	2005	23154,4	50,5	0,0171	0,0952	0,9086	0,0265
Libya	2006	24962,8	61,0	0,0180	0,2103	1,0186	0,0146
Libya	2007	26753,9	78,3	0,0186	0,2610	1,0222	0,0625
Libya	2008	27525,1	86,0	0,0173	0,2983	1,0149	0,1036
Libya	2009	27135,4	91,0	0,0139	0,3020	1,0206	0,0246
Libya	2010	28583,5	95,0	0,0091	0,3150	1,0770	0,0280
Libya	2011	11023,4	98,0	0,0037	0,3200	0,9962	0,1552
Libya	2012	22965,3	94,0	-0,0008	0,2800	1,1432	0,0606
Libya	2013	20204,8		-0,0028	0,2700	1,3526	0,0261
Algeria	1995	6779,7	9,5	0,0189	0,3091	0,5519	0,2978
Algeria	1996	7062,5	11,7	0,0174	0,2568	0,5371	0,1868
Algeria	1997	7146,8	13,5	0,0161	0,2245	0,5224	0,0573
Algeria	1998	7480,4	14,9	0,0149	0,2715	0,4509	0,0495
Algeria	1999	7728,4	20,2	0,0141	0,2849	0,5049	0,0265
Algeria	2000	7970,2	23,6	0,0135	0,2502	0,6253	0,0034
Algeria	2001	8418,0	25,8	0,0130	0,2684	0,5871	0,0423
Algeria	2002	8913,0	30,7	0,0126	0,3065	0,6113	0,0142
Algeria	2003	9623,6	36,0	0,0126	0,3034	0,6212	0,0427
Algeria	2004	10180,7	46,9	0,0130	0,3326	0,6570	0,0396
Algeria	2005	10977,5	56,6	0,0136	0,3166	0,7128	0,0138
Algeria	2006	11342,9	84,5	0,0144	0,3017	0,7073	0,0231
Algeria	2007	11860,6	87,0	0,0151	0,3447	0,7194	0,0367
Algeria	2008	12140,5	91,1	0,0159	0,3735	0,7668	0,0486
Algeria	2009	12221,1	99,3	0,0168	0,4688	0,7132	0,0573
Algeria	2010	12590,1	101,5	0,0178	0,4143	0,6987	0,0391
Algeria	2011	12964,8	105,8	0,0187	0,3772	0,6771	0,0452
Algeria	2012	13370,1	119,7	0,0195	0,3941	0,6686	0,0889
Algeria	2013	13676,5	115,5	0,0197	0,4297	0,6342	0,0325
Syria	1995	4202,0	3,7	0,0277	0,2720	0,6898	0,0798
Syria	1996	4299,0	3,8	0,0278	0,2390	0,6991	0,0825
Syria	1997	4223,0	5,1	0,0278	0,2110	0,6622	0,0189
Syria	1998	4400,0	5,7	0,0271	0,2207	0,6142	-0,0080
Syria	1999	4223,0	13,3	0,0256	0,1877	0,6431	-0,0370

Syria	2000	4306,0	18,4	0,0236	0,1727	0,6397	-0,0385
Syria	2001	4445,0	25,9	0,0206	0,2034	0,6461	0,0300
Syria	2002	4649,0	31,6	0,0180	0,2032	0,6861	-0,0013
Syria	2003	4512,0	34,8	0,0179	0,2324	0,6204	0,0580
Syria	2004	4806,0	44,0	0,0210	0,1766	0,7987	0,0443
Syria	2005	5101,0	59,8	0,0257	0,1841	0,8201	0,0724
Syria	2006	5389,0	67,5	0,0323	0,1885	0,7823	0,1002
Syria	2007	5705,0	82,1	0,0366	0,2780	0,7648	0,0391
Syria	2008	5930,0	77,1	0,0340	0,2820	0,7480	0,1575
Syria	2009	6175,0	82,0	0,0231	0,2880	0,7460	0,0292
Syria	2010	6375,0	94,6	0,0074	0,2920	0,7620	0,0440
Syria	2011	6675,0	97,7	0,0168	0,2960	0,7470	0,0475
Syria	2012	6720,0	103,8	0,0168	0,2710	0,6010	0,3670
Syria	2013			0,0168	0,2620	0,5710	
Djibouti	1995	1695,4	5,2	0,0171	0,0844	0,9036	0,0489
Djibouti	1996	1625,5	8,7	0,0182	0,0907	0,8890	0,0351
Djibouti	1997	1611,2	9,5	0,0183	0,0957	0,8916	0,0252
Djibouti	1998	1600,8	9,6	0,0182	0,1219	0,9390	0,0220
Djibouti	1999	1631,8	13,0	0,0176	0,0862	0,8567	0,0202
Djibouti	2000	1648,2	13,2	0,0166	0,0879	0,8544	0,0240
Djibouti	2001	1693,3	23,7	0,0158	0,0787	0,8307	0,0176
Djibouti	2002	1737,4	30,0	0,0154	0,1005	0,8232	0,0063
Djibouti	2003	1801,7	32,2	0,0149	0,1441	0,8898	0,0197
Djibouti	2004	1894,6	33,1	0,0144	0,2151	0,9114	0,0313
Djibouti	2005	1989,6	34,0	0,0139	0,1898	0,9158	0,0312
Djibouti	2006	2120,5	34,6	0,0134	0,2956	0,9722	0,0353
Djibouti	2007	2258,3	35,2	0,0131	0,3749	1,3424	0,0493
Djibouti	2008	2405,0	37,0	0,0128	0,3760	1,3430	0,1137
Djibouti	2009	2512,0	39,0	0,0128	0,3780	1,3470	0,1429
Djibouti	2010	2621,6	45,0	0,0130	0,3790	1,3540	-0,0988
Djibouti	2011	2783,0	49,0	0,0132	0,3810	1,3230	0,0418
Djibouti	2012	2879,5		0,0133	0,3820	1,3260	0,0605
Djibouti	2013	3027,7		0,0134	0,3880	1,3300	0,0246
Sudan	1995	1401,9	1,5	0,0258	0,1979	0,6545	0,0487
Sudan	1996	1467,9	3,2	0,0250	0,1810	0,6704	0,0122
Sudan	1997	1604,0	6,7	0,0244	0,1830	0,6557	0,0006
Sudan	1998	1644,2	8,7	0,0246	0,2242	0,5647	-0,0036
Sudan	1999	1673,6	11,3	0,0255	0,2114	0,5812	-0,0135
Sudan	2000	1769,7	14,7	0,0268	0,1871	0,6855	-0,0112
Sudan	2001	1873,7	19,5	0,0284	0,1888	0,6395	-0,0111
Sudan	2002	1968,1	22,5	0,0296	0,1967	0,6495	0,0023
Sudan	2003	2101,9	27,6	0,0300	0,1982	0,7023	0,0059
Sudan	2004	2180,5	29,5	0,0294	0,1986	0,7508	0,0033

Sudan	2005	2351,1	31,7	0,0283	0,2017	0,8195	0,0070
Sudan	2006	2591,9	34,7	0,0269	0,2222	0,8994	0,0221
Sudan	2007	2883,7	38,4	0,0258	0,2647	0,9486	0,0417
Sudan	2008	3080,8	40,5	0,0250	0,2730	0,9610	0,0987
Sudan	2009	3116,2	47,4	0,0246	0,3172	0,8486	0,0507
Sudan	2010	3175,3	56,6	0,0245	0,3074	0,8277	0,0534
Sudan	2011	3478,3	64,5	0,0245	0,2678	0,8576	0,0582
Sudan	2012	3871,8	77,2	0,0243	0,2634	0,8374	0,0289
Sudan	2013	3974,9	70,7	0,0236	0,2624	0,8297	0,0351
Yemen	1995	2614,0	6,3	0,0424	0,2175	0,6433	0,5508
Yemen	1996	2685,1	7,1	0,0366	0,2304	0,8594	0,3073
Yemen	1997	2783,4	9,1	0,0320	0,2463	0,8138	0,0218
Yemen	1998	2897,5	10,5	0,0289	0,2365	0,7371	0,0598
Yemen	1999	2969,2	12,5	0,0278	0,1871	0,7200	0,0866
Yemen	2000	3135,6	14,0	0,0280	0,1893	0,7544	0,0459
Yemen	2001	3236,1	17,2	0,0283	0,1956	0,7089	0,1191
Yemen	2002	3319,7	20,3	0,0283	0,1848	0,7473	0,1224
Yemen	2003	3414,5	23,0	0,0284	0,2073	0,7438	0,1083
Yemen	2004	3545,7	30,1	0,0284	0,2028	0,7185	0,1252
Yemen	2005	3756,5	34,5	0,0283	0,1853	0,7677	0,1181
Yemen	2006	3883,0	40,6	0,0283	0,1638	0,8208	0,1084
Yemen	2007	4004,2	51,9	0,0284	0,1750	0,8220	0,0791
Yemen	2008	4128,4	50,7	0,0282	0,1780	0,8250	0,1898
Yemen	2009	4212,6	51,8	0,0279	0,1860	0,8310	0,0541
Yemen	2010	4286,4	58,5	0,0274	0,1880	0,8360	0,1117
Yemen	2011	3616,2	61,6	0,0269	0,1890	0,8130	0,1954
Yemen	2012	3673,9	69,8	0,0264	0,1910	0,7930	0,0989
Yemen	2013	3784,6	64,2	0,0258	0,1920	0,7420	0,1097

Source: World Bank, ORBICOM, ITU, UNESCO and own calculations

Appendix 3

Table A.4 Level Panel unit root test for GDP growth of second study model, 1990-2014

Panel unit root test: Summary
Series: GDPG
Date: 11/09/15 Time: 06:11
Sample: 1993 2014
Exogenous variables: Individual effects
Automatic selection of maximum lags
Automatic lag length selection based on SIC: 0 to 4
Newey-West automatic bandwidth selection and Bartlett kernel

Method	Statistic	Prob.**	Cross-sections	Obs
Null: Unit root (assumes common unit root process)				
Levin, Lin & Chu t*	-1.96026	0.0250	5	111
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	-4.48871	0.0000	5	111
ADF - Fisher Chi-square	39.1921	0.0000	5	111
PP - Fisher Chi-square	64.7627	0.0000	5	120

** Probabilities for Fisher tests are computed using an asymptotic Chi -square distribution. All other tests assume asymptotic normality.
Source: author using EVIEWS 9

Table A.5 Panel unit root test for ICT capital services of second study model, 1990-2014

Panel unit root test: Summary
Series: D(ICTG)
Date: 11/09/15 Time: 06:13
Sample: 1990 2014
Exogenous variables: Individual effects, individual linear trends
Automatic selection of maximum lags
Automatic lag length selection based on SIC: 1 to 3
Newey-West automatic bandwidth selection and Bartlett kernel

Method	Statistic	Prob.**	Cross-sections	Obs
Null: Unit root (assumes common unit root process)				
Levin, Lin & Chu t*	-3.89655	0.0000	5	107
Breitung t-stat	-0.72865	0.2331	5	102
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	-3.04909	0.0011	5	107
ADF - Fisher Chi-square	29.3421	0.0011	5	107
PP - Fisher Chi-square	8.31969	0.5976	5	115

** Probabilities for Fisher tests are computed using an asymptotic Chi -square distribution. All other tests assume asymptotic normality.
Source: author using EVIEWS 9

Table A.6 Level Panel unit root test for non-ICT capital services, second model, 1990-2014

Method	Statistic	Prob.**	Cross-sections	Obs
Null: Unit root (assumes common unit root process)				
Levin, Lin & Chu t*	-1.34730	0.0889	5	109
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	-1.66415	0.0480	5	109
ADF - Fisher Chi-square	21.7890	0.0162	5	109
PP - Fisher Chi-square	5.98794	0.8163	5	120

** Probabilities for Fisher tests are computed using an asymptotic Chi -square distribution. All other tests assume asymptotic normality.
Source: author using EVIEWS 9

Table A.7 Level Panel unit root test for labor services of second study model, 1990-2014

Method	Statistic	Prob.**	Cross-sections	Obs
Null: Unit root (assumes common unit root process)				
Levin, Lin & Chu t*	-10.7305	0.0000	5	120
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	-10.5046	0.0000	5	120
ADF - Fisher Chi-square	88.4764	0.0000	5	120
PP - Fisher Chi-square	88.7343	0.0000	5	120

** Probabilities for Fisher tests are computed using an asymptotic Chi -square distribution. All other tests assume asymptotic normality.
Source: author using EVIEWS 9

Table A.8 Panel cointegration test for second study model, 1990-2014

Pedroni Residual Cointegration Test
Series: GDPG NICTG ICTG LTG
Date: 11/09/15 Time: 06:57
Sample: 1990 2014
Included observations: 120
Cross-sections included: 5
Null Hypothesis: No cointegration
Trend assumption: No deterministic trend
Automatic lag length selection based on SIC with a max lag of 4
Newey-West automatic bandwidth selection and Bartlett kernel

Alternative hypothesis: common AR coefs. (within-dimension)

	Statistic	Prob.	Weighted Statistic	Prob.
Panel v-Statistic	0.319717	0.3746	-1.246336	0.8937
Panel rho-Statistic	-2.058566	0.0198	-2.554757	0.0053
Panel PP-Statistic	-5.175421	0.0000	-5.483355	0.0000
Panel ADF-Statistic	-4.741497	0.0000	-5.610472	0.0000

Alternative hypothesis: individual AR coefs. (between-dimension)

	Statistic	Prob.
Group rho-Statistic	-1.475686	0.0700
Group PP-Statistic	-6.347381	0.0000
Group ADF-Statistic	-4.605968	0.0000

Source: author using EVIEWS 9

Table A.9 Wald test for second Panel study model

Wald Test:
Equation: Untitled

Test Statistic	Value	df	Probability
F-statistic	50.33255	(3, 97)	0.0000
Chi-square	150.9977	3	0.0000

Null Hypothesis: C(1)=C(2)=C(3)=0
Null Hypothesis Summary:

Normalized Restriction (= 0)	Value	Std. Err.
C(1)	-0.035877	0.037043
C(2)	0.102373	0.117055
C(3)	0.424155	0.036140

Restrictions are linear in coefficients.
Source: author using EVIEWS 9

Table A.10 Unit root test for GDP growth of Tunisia, 1990-2014

Null Hypothesis: GDPG has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic - based on SIC, maxlag=5)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-4.963202	0.0029
Test critical values:	1% level	-4.394309	
	5% level	-3.612199	
	10% level	-3.243079	

*MacKinnon (1996) one-sided p-values.
Source: author using EVIEWS 9

Table A.11 Unit root test for ICT capital services of Tunisia, 1990-2014

Null Hypothesis: D(ICTG) has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 1 (Automatic - based on SIC, maxlag=5)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-5.360218	0.0015
Test critical values:	1% level	-4.440739	
	5% level	-3.632896	
	10% level	-3.254671	

*MacKinnon (1996) one-sided p-values.
Source: author using EVIEWS 9

Table A.12 Unit root test for non-ICT capital services of Tunisia, 1990-2014

Null Hypothesis: NICTG has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 1 (Automatic - based on SIC, maxlag=5)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-4.004007	0.0235
Test critical values:	1% level	-4.416345	
	5% level	-3.622033	
	10% level	-3.248592	

*MacKinnon (1996) one-sided p-values.
Source: author using EVIEWS 9

Table A.13 Unit root test for labor capital services of Tunisia, 1990-2014

Null Hypothesis: LTG has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic - based on SIC, maxlag=5)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-4.685284	0.0053
Test critical values:	1% level	-4.394309	
	5% level	-3.612199	
	10% level	-3.243079	

*MacKinnon (1996) one-sided p-values.
Source: author using EVIEWS 9

Table A.14 Cointegration test for Tunisia model variables, 1990-2014

Date: 11/09/15 Time: 12:20
Sample (adjusted): 3 25
Included observations: 23 after adjustments
Trend assumption: Linear deterministic trend
Series: GDPG ICTG NICTG LTG
Lags interval (in first differences): 1 to 1
Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.738444	54.88921	47.85613	0.0095
At most 1	0.463317	24.04372	29.79707	0.1986
At most 2	0.213946	9.729703	15.49471	0.3021
At most 3 *	0.166649	4.192915	3.841466	0.0406

Trace test indicates 1 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values
Source: author using EVIEWS 9