A MODEL OF TELECOMMUNICATION SECTOR DEVELOPMENT AND ECONOMICAL GROWTH IN GCC COUNTRIES: A CASE STUDY OF UAE

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A MODEL OF TELECOMMUNICATION SECTOR DEVELOPMENT AND ECONOMICAL GROWTH IN GCC COUNTRIES:

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Shaima Yousef Amiri, Candidate for the Master of Science Degree

American University of Sharjah, 2006

ABSTRACT

Many studies were conducted in America, Europe and Africa with regard to the Economics of Telecommunication's infrastructure. However, studies with the similar subject were never found published about the GCC countries. This thesis studies the elements that affected the development of Telecommunication's infrastructure in GCC countries by modeling the Demand and Supply of sectors by two independent empirical models. A third model is developed to measure the economical growth in GCC in terms of telecommunication's infrastructure development factors. Accordingly, based on the developed models and their results, the thesis puts in hands the first attempt to identify elements shaping the Telecommunication market of GCC countries and promoting its growth. The thesis also provides a model that can act as a measure for the changes of telecommunication sector contribution toward the economy in the future.

The thesis employs econometric modeling techniques to develop empirical models and to test for their validity. Models were founded based on hypotheses that were derived from economic theories or proposed by other researches. Hypothesis testing was used to validate significance of variables in each model. The models employ economical, socio-economical and telecommunication indicators collected for

GCC countries from 1980 to 2003. The used models were simple regression equations applied on a panel of six GCC countries.

Results of this study showed that the demand of fixed-line in GCC countries is affected by the subscribers' income. For mobile service, countries with lower economical standing had higher growing demand over mobile service. On the other hand, supply responded dramatically to GCC infrastructure progress. The major finding of this study was that income generated from telecommunication sector is already taking place in promoting further economical growth in GCC countries.

In the case study of UAE, demand of mobile services increased dramatically after the introduction of new technology in the market. Likewise, supply of telecomm services responded strongly to the introduction of new technology into the market. Both demand and supply in UAE showed a growing pattern suggesting that there is room in the market for additional operators. Telecommunication infrastructure development started taking place in the UAE economical growth from 1986 up to 2003.

Additional studies are needed for GCC region to further investigate the economy of telecommunication sector in order to give telecomm operators, telecomm regulators and economy policy makers a clearer view of the interaction of different elements in the sector. This will help the policy makers to take better informed decisions to shape the future of this sector.

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ACRONYMS

2G – Second Generation Mobile Services

3G – Third Generations Mobile Services

GCC – Gulf Cooperative Council

GPRS – General Packet Radio Service

ITU – International Telecommunication Union

MMS – Multimedia Messaging Service

SMS – Short Messaging Service

UMTS – Universal Mobile Telecommunication Service

ABBREVIATIONS

GDPC – Gross Domestic Product per Capita

K – Gross Fixed Capital Formation

M – Dummy variable to represent the introduction of new technology

POP – Population

PEN – Number of fixed-phone per 100 inhabitant

PENM – Number of mobile-phone per 100 inhabitant

PENT – Number of total-phone per 100 inhabitant

Staf – Total full-time telecommunications staff

TD – Telecommunication Demand

TI – Telecommunication Investment

TP – Telecommunication Price

TS – Telecommunication Supply

TSQ –Telecommunication Service Quality

TTI – Annual Telecommunication Investment

TP – Residential Monthly Telephone Subscription Charges

TPM – Cellular Monthly Subscription Charges

TPT – Total Cellular and Residential Monthly Subscription Charges

TLF – Total Labor Force

WL – Waiting List for Fixed-line per 100 Inhabitant

ACKNOWLEDGEMENTS

I acknowledge the efforts of my advisors, Dr. Mohammed El Tarhuni and Dr. Muhammadou Kah, that helped me accomplish this research. I thank them for introducing me to the field of telecommunication management. I am also grateful to them for passing on to me the knowledge of academic researching approach.

DEDICATION

I thank God for all of his blessings and for surrounding me with wonderful people. I dedicate this work to every person added meanings and raptures in my life: my parents, my family and my friends. I also dedicate this research to all knowledge torch holders. A final inscribed word by Sydney Smith to everyone reads this work:

> "To do anything in this world worth doing, we must not stand back shivering and thinking of the cold and danger, but jump in and scramble through as well as we can."

CHAPTER 1
1. INTRODUCTION

1.1 Problem Statement and Background

The Telecommunication sector in the Gulf Cooperative Council (GCC) countries – Bahrain, Kuwait, Oman, Qatar, Saudi Arabia and United Arab Emirates - is getting ready to enter to a new era by moving from monopoly service provider to liberalized competitive market. The implications of this transformation are still ambiguous to consumers, governments and service providers.

Telecommunication sector is an important sector in every country and it is playing a major role in global economies. Many studies were established world wide to address the economy of telecommunication sector; however, no study was found addressing this issue in GCC countries. It is important to identify the elements that are shaping the telecommunication sector development in GCC countries. Moreover, there is a need to quantify the contribution of this sector into the economical growth of the Gulf region. Knowing these elements will provide better understanding of telecommunication market drivers to help policy makers and telecom operators in making informed decisions to further enhance the contribution of this sector into the economy.

1.2 Thesis Objectives

This research has strived upon achieving the following objectives:

- Study the elements that affected telecommunication infrastructure development in GCC countries. This objective was achieved through modeling the sector demand and supply in two independent empirical models.
- Identify the role that the telecommunication sector has been playing in GCC economies from 1980 to 2003. This objective was sustained by developing a third model to measure the economical growth in GCC countries in terms of telecommunication infrastructure development factors.
- Apply the developed models to UAE as a case study.

- To predict the effect of liberalizing the telecommunication sector based on the obtained results of major elements that contribute into demand and supply of telecommunication services.

1.3 Overview of GCC Economy

Most GCC countries have Oil dependent economies, where they own 45% of total world oil reserves and 14% of total world gas reserves [1]. On average, most GCC governments are still depending on oil revenues for more than 60% of their total revenues for the period between 1998 and 2002 as shown in Figure 1.1.

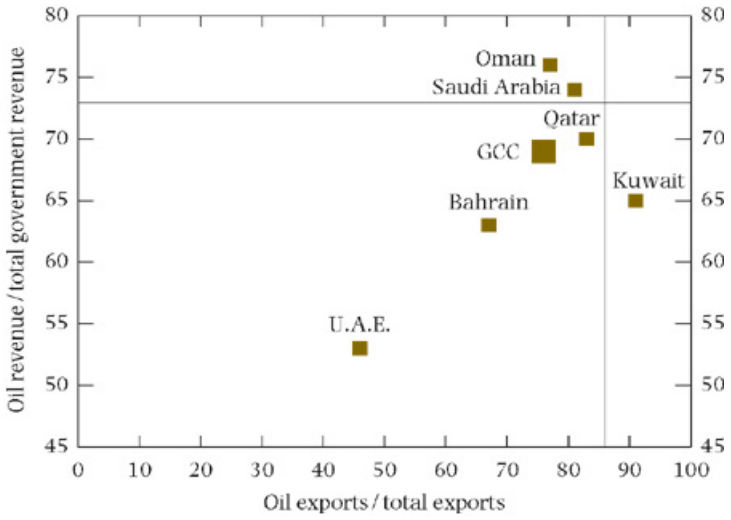

Figure 1.1: GCC Countries Oil Dependency Average for the Period 1998-2002 [2].

GCC countries cover a geographical area of 3.4 million square kilometers. Their total population reached 32.9 million in 2003 with an average growth rate of 9.8% a year between 1970 and 2003, as shown in Figure 1.2 [3 & 4].

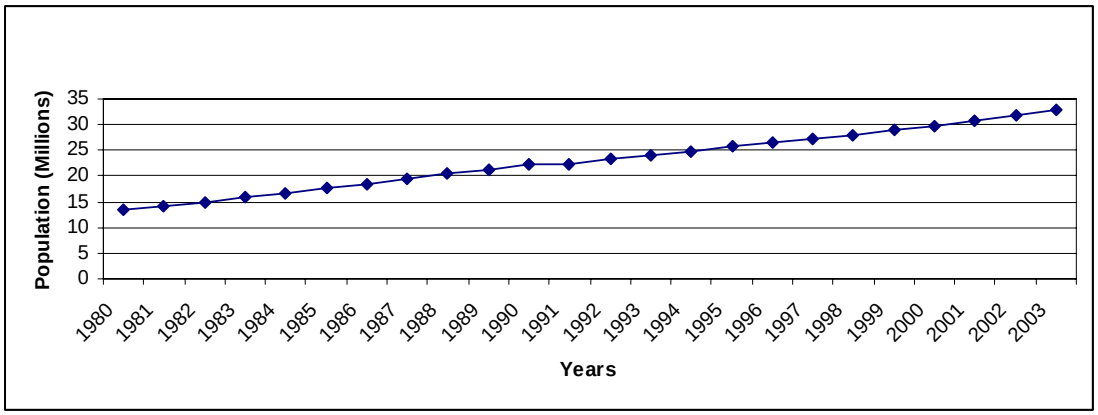

Figure 1.2: GCC Countries Total Population [4].

During the 1960s, GCC countries had a very low Gross Domestic Product (GDP). It began with 4.2 billion US$ and reached 8.7 billion US$ in 1969, as shown

in Figure 1.3. In the 1970s, almost all GCC countries began producing and exporting oil, therefore, their GDPs had a high growth rate. Their total GDP in 1970 was 10.3 billion US$ and reached up to 232 billion US$ in 1981. This growth was affected by the increase in oil production and the sudden increase in oil prices of the late 1970s and early 1980s, as depicted by world oil price in Figure 1.4. Starting from 1983 up to 1986, oil prices declined and accordingly GCC countries GDPs were affected. As GCC countries' GDP changes over the years, it is obvious that their economies were depending on oil production and prices in the periods of 1970s and 1980s.

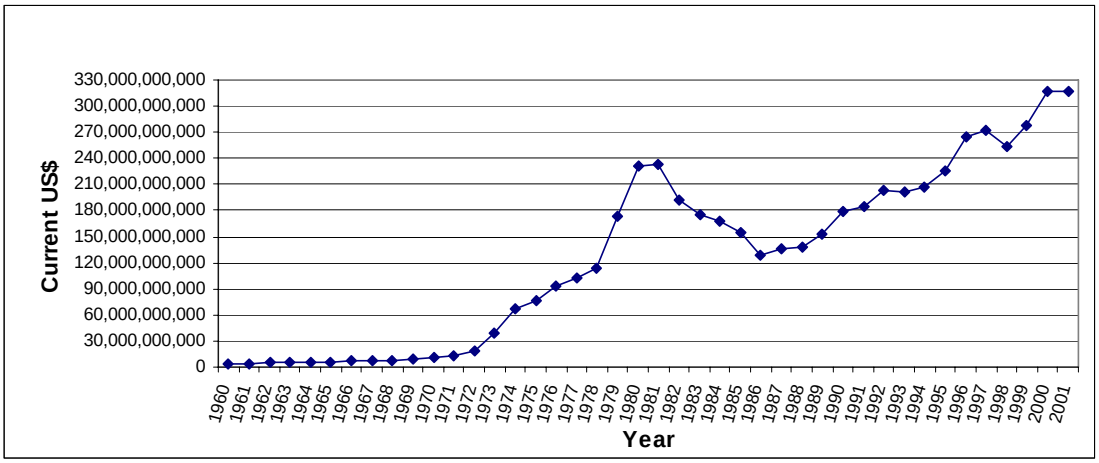

Figure 1.3: GCC Countries Total GDP (Current US$[1]) [4].

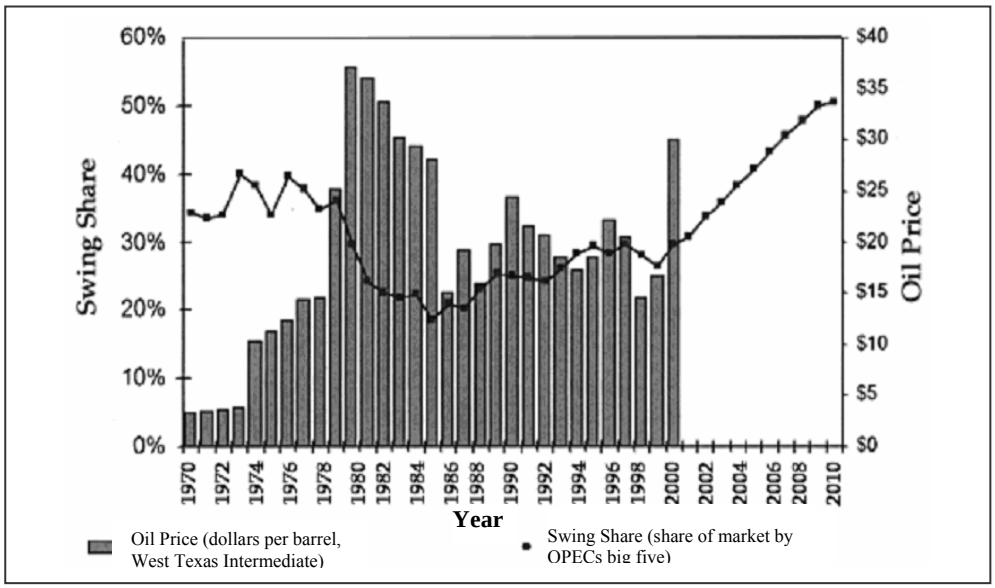

Figure 1.4: World Oil Price and OPEC Big Five Share of Market [5].

In early 1990s, GCC countries began realizing the importance of economical diversification to keep stable growth rate in the economy to reduce the effect of oil industry into causing fluctuations in their economies. As a reflection of their efforts,

[1] Current US$: The value of US$ in the same year it is reported in.

from 1990 up to 2001 their GDPs have been growing at an average rate of 7% per year raising from 169 billion US$ to 316 billion US$. While in the same duration, fluctuation in oil prices had minimal effect on the steady growth in their GDPs. This is demonstrated by the GCC GDP per capita shown in Figure 1.5. So by examining the forecasts in oil markets, GCC countries should be prepared for future decline in the oil industry. On the other hand, GCC countries are still heavily dependent on oil.

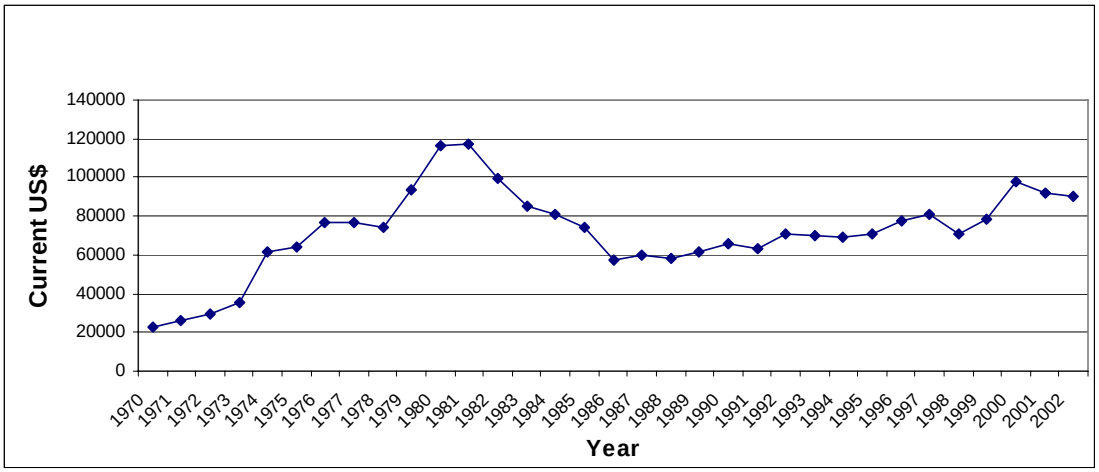

Figure 1.5: GCC Countries Total GDP per Capita[2] (Current US$)

The world had already consumed 45% from the oil it will ever hold by 1999, which makes the world countries at oil depletion midpoint. Most oil producers outside the Middle East have passed their midpoint and their production has entered a downturn. Accordingly, world production of conventional oil will start reduce by the end of this decade. World demand is expected to increase by 2 million barrels per day (mbpd) between 2006 and 2010 [5, 6 & 7]. At this stage, five Middle East countries, three of them being GCC countries, will be able to support any incline in world demand. These countries are Kuwait, Saudi Arabia, UAE, Iraq and Iran; they are considered the major oil suppliers in OPEC.

Recently in 2004, oil prices upsurge due to the demand of oil especially from countries with fast growing economies such as China. It is expected that, between now and 2008; global demand will rise by 3% a year. In response, major suppliers have been raising their share of supplied oil. This increment in world demand and price increase in oil market will have a positive reflection in GCC economies. Nevertheless, the concern of limited global spare oil capacity stands still in long term oil market prediction. With oil prices standing at high rates for long periods, world economy will decelerate and global demand for crude oil will deliberate [7].

[2] GDP per Capital developed by dividing GDP in Current US$ divided by Total Population of the same year using database of reference [4].

Consequently, GCC countries will witness an increase of their oil production revenues over the coming decades. By the end of the next decade, most Middle East countries will also pass their mid-depletion point and their oil revenue will decline. Thus it is best for GCC countries to use the high income age to diversify their revenue and to liberalize their economy which will allow for more solid economical base with an acceptable growth rate [6].

1.4 Telecommunication Industry Trends

Previously, oil prices had direct impact on the economy, while recently the elements affecting the global economy have changed. Therefore, new elements such as globalization, new technologies and capital mobility are playing a new role in new economies. Capital mobility is represented by world economy liberalization, based on the General Agreement on Tariffs and Trade (GATT) which was changed to the World Trade Organization (WTO) at the start of 1995. GATT is one of the international institutions which was established after World War II and has been promoting peace and economic prosperity. The main aim of this organization is to raise living standards and promote global economy growth. Member countries under the WTO have signed to liberalize their economy to foreign investment and ownership through lowering barriers against international trade and promoting fair international trade, with no prejudices, between member countries [6 & 8].

Free trade supports market efficiency, competition and boosts resource allocation where supply and demand reaches its natural equilibrium point in a certain market [9]. Most GCC countries are either member of WTO or in the process of applying to be members. Bahrain, Oman and Kuwait have already taken major steps to liberalize their economies; other GCC countries have made initiations in this path [6]. The international globalization and liberalization trends and benefits tempt GCC countries to open their economies. Foreign investments were allowed to develop economical sectors such as real states, tourism and trade. Recently, the international pressure and trends reached the telecommunication sectors of GCC countries and a movement of liberalization and opening the sector for foreign investments was witnessed.

Another trend in telecommunication sector is witnessed in the rapid emerging of mobile cellular services. Mobile phone cellular services have advanced enormously in coverage, service, technology, handsets and regulation, since its introduction in

early 1980s. As per International Telecommunications Union (ITU) statistics, the number of mobile subscribers exceeded the number of fixed-line subscribers as shown in Figure 1.6. By end of 2002, the number of mobile cellular subscribers was reported to be 1.155 billion compared to 1.129 billion of fixed-line subscribers. Many of new mobile subscribers are from developing countries where it was noticed, in some developed markets, that the number of mobile cellular subscribers has crossed 100% of country's population [10].

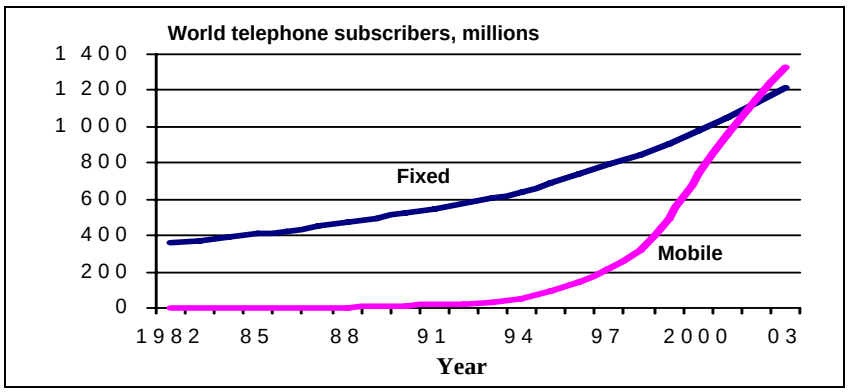

Figure 1.6: World Telephone Subscribers; Mobile vs. Fixed-Line, Millions [35]

Simultaneously to mobile cellular growth, Internet subscribers have grown beyond imagination since its introduction in telecommunication markets early 1990's. All world countries have access to the Internet, and at the beginning of 2003, the estimated number of Internet users around the world was 580 million as shown in Figure 1.7. The augmentation of Internet users is driving a demand for higher speed access. Accordingly, solutions of wired and wireless broadband access technologies have been presented by telecommunication development organizations and operators. Progresses were recorded in terms of various innovative broadband technologies, applications and pricing packages [10].

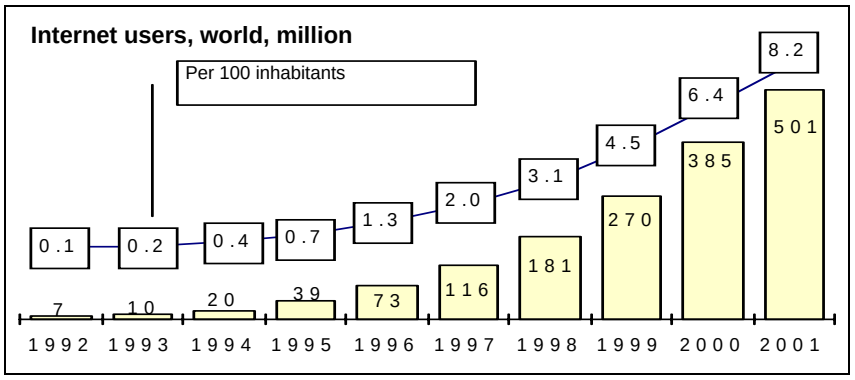

Figure 1.7**:** World Internet Users, Millions [10]

1.5 Shifting Towards Technology-Based Economy

Lately, GCC countries realized the importance of information based and knowledge intensive economies and have instituted economic policies to shift their focus towards them. Gulf countries have witnessed a dramatic growth in the information technology (IT) field, for instance, the number of Internet users, shown in Figure 1.8, has grown from 1700 subscribers in 1993 to 2.3 million subscribers in 2002. Similarly, in the telecommunication field, the number of telephone lines and mobile phone subscribers, demonstrated by Figure 1.9, has increased from 2.3 million subscribers to 15.2 million subscribers between 1990 and 2002. This represents an average annual growth of 45%.

Moreover, the total revenue from telecommunication services in GCC countries had grown from 2.7 billion US$ in 1990 to 9.3 billion US$ in 2001 with average annual growth rate of 22.3%, as in Figure 1.10. Figure 1.11 represents the annual number of telephone subscribers per 100 inhabitants (Teledensity). Teledensity has increased from 57 subscribers per 100 inhabitants to 332 subscribers per 100 inhabitants; as an average of 3.3 telephone services per one inhabitant. This growth has encouraged investment in telecommunication sector as reflected in Figure 1.12.

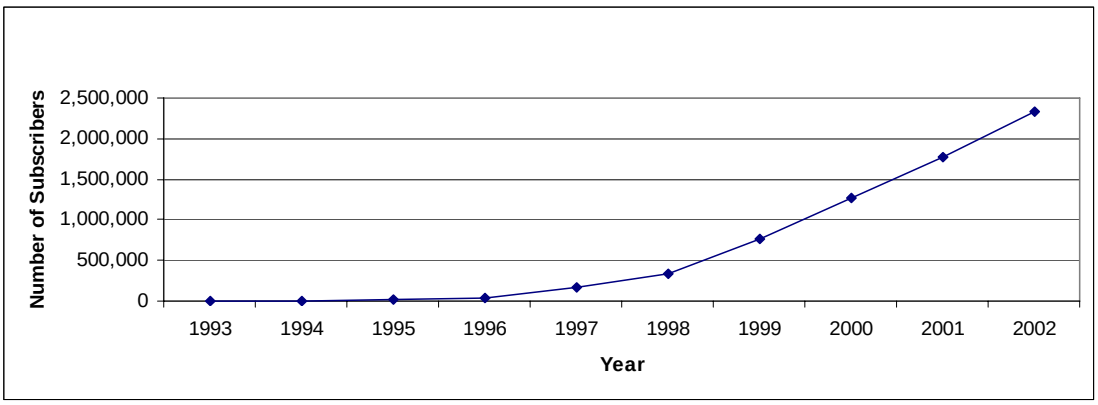

Figure 1.8: GCC Internet Users (ITU Estimate) [11].

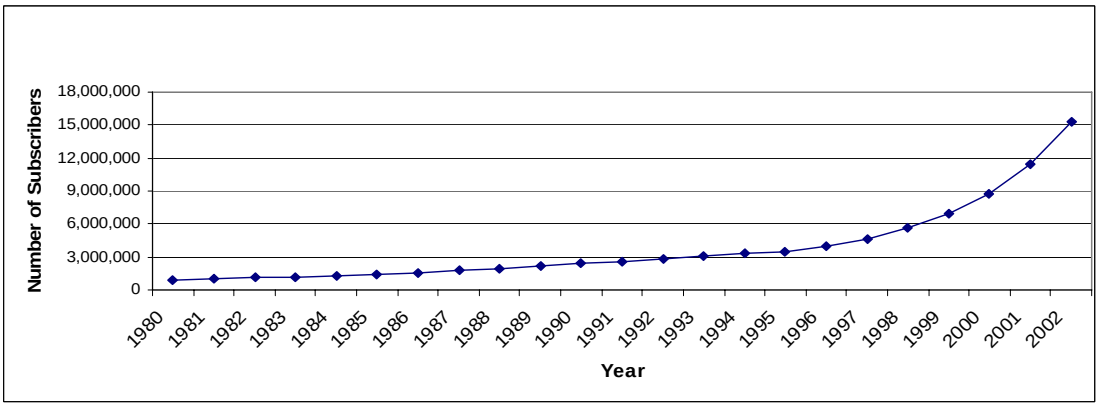

Figure 1.9: Total GCC Telephone Lines and Cellular Subscribers [11].

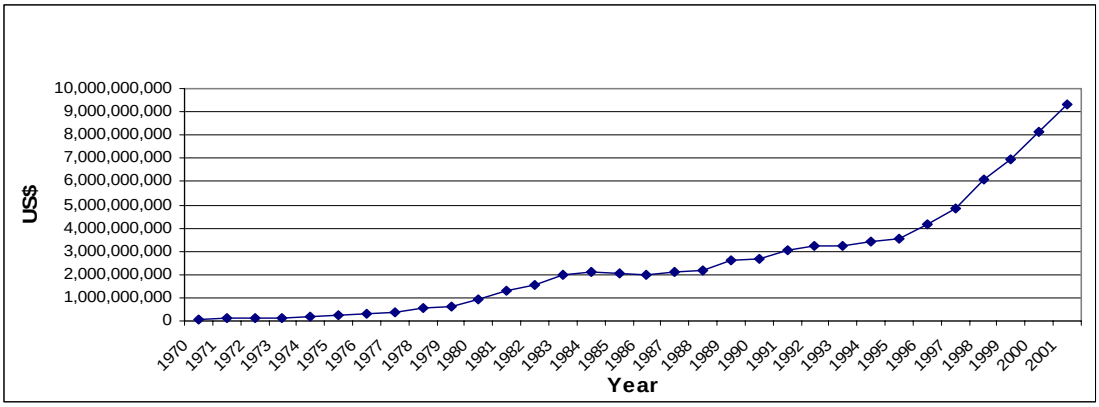

Figure 1.10: Total GCC Telecommunication Service Revenue [11].

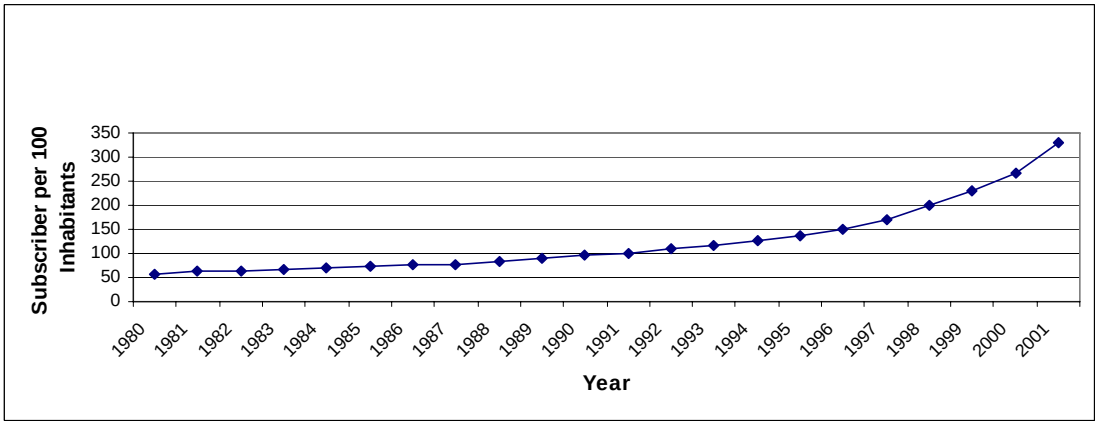

Figure 1.11: GCC Number of Telephone Subscribers per 100 Inhabitants (Teledensity) [11].

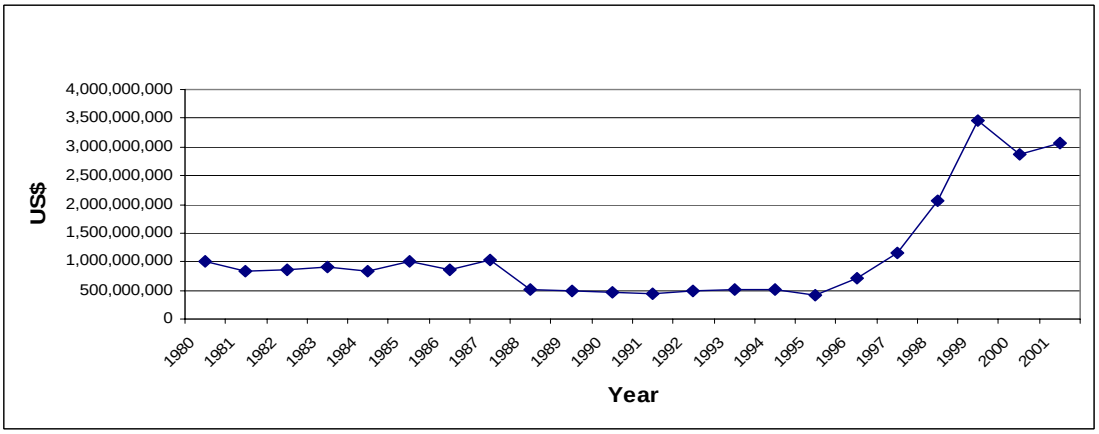

Figure 1.12: GCC Annual Telecommunication Investment [11]

From Figures 1.8 through 1.12, it is noticed that there is a sharp growth that occurred in Information Technology and Telecommunication sectors between 1995 and 2001. This is summarized in Table 1.1. This significant growth is due to introducing Internet services and second generation of mobile telecommunication services in GCC countries. The launching of these two services was associated with low service prices, cheap computers, and affordable mobile phones as a result of advancements in world technologies.

Table 1.1
Average Annual Growth Rates of Some Telecommunication Indicators [11]

Telecommunication Indicators	1995 Statistics	2001 Statistics	Average Annual Growth Rate
GCC Internet Users (ITU Estimate)	11,003	1,778,450	2677%
GCC Telephone Lines and Cellular Subscribers	3,524,225	11,450,098	37%
GCC Cellular Mobile Telephone Subscribers	316,706	6,118,779	305%
GCC Telephone Lines in Use	3,207,519	5,330,077	11%
GCC Telecommunication Service Revenue	3,554,250,000	9,328,010,000	27%
GCC Telecommunication Investment	411,559,283	3,062,584,243	107%

Telecommunication and IT technologies infrastructure of a nation are being used in the development of a network-based information economy. Therefore, it is important to know the factors responsible for the development of telecommunication technologies in any nation [12]. The World Bank Telecommunication Sector Reports of 1991 stated that "The establishment of a modern, reliable, and rapidly expanding telecommunication infrastructure contributes considerably to the promotion of a variety of economic expansion activities [13]."

1.6 Telecommunication Reforms

To become accustomed with the swiftly shifting communication environment, the majority of world countries have reformed or in the process of reforming their telecommunication sectors. Reforms have been done by privatizing the incumbent operators, opening the sector for competition, allowing foreign investors and establishing a regulatory authority as indicated by Figure 1.13 and Figure 1.14. The regulatory authority role is to encourage and maintain fair and transparent competition environment for all telecommunication players in the market. As a result of this action, telecommunication services access are being provided rapidly with higher technology and service level and with lower prices [10].

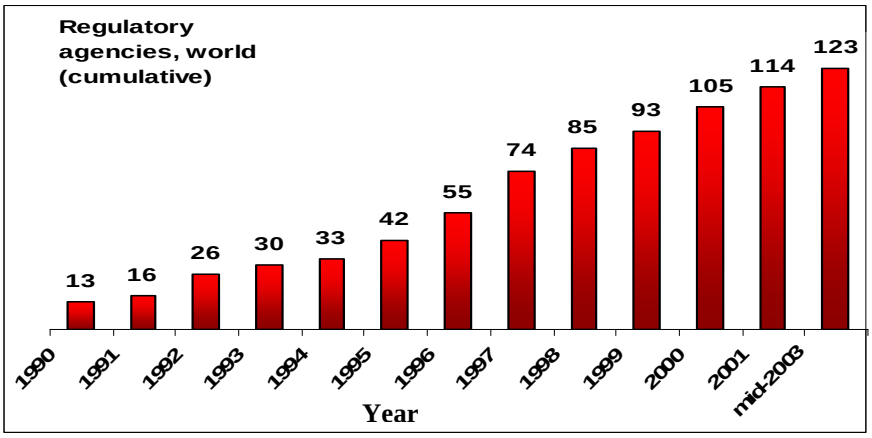

Figure 1.13: Number of World Regulatory Agencies [10]

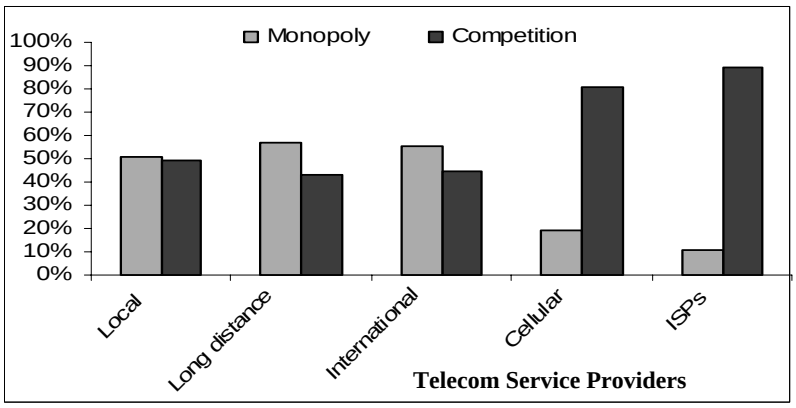

Figure 1.14: Percentage Liberalization Status of Different Telecom Service Providers[3] in 2003 [10].

World telecom reforms are presented in three forms: privatization, liberalization and deregulation. Privatization involves transforming the ownership of a productive asset of the government to private control. Liberalization of telecom sector is done by lowering the barriers to all or part of the market for new parties to compete with the incumbent operator. Deregulation is the process that governments follow to reduce their intervention with the telecommunication market. Liberalizing the telecom market gives room for healthy competitive market environment governed by supply and demand natural laws. Nevertheless, most telecommunication sectors needed re-regulation to achieve fair competition [14].

Liberalization of telecommunication sector is a new process to GCC countries. The process involves taking choices of opening the sector for foreign investment and establishing competitors for state owned telecommunication operators.

[3] Telecommunication Service Providers: Includes providers of fixed local phone calls, long distance calls provider, international calls providers, mobile cellular providers and Internet Service Providers (ISP).

1.7 Telecommunication Infrastructure and Global Economy

Human security is developed and guarded by the United Nation (UN) to focus on maximizing human needs satisfaction and the type of institutions and procedures to conceive this aim. The UN has launched the United Nations Development Program (UNDP), which articulates and monitors the progress of seven main categories for human security: food, health, personal, community, economic and political. Information and communication infrastructure is identified as a mean to implement and connect human security categories through political, economical and cultural hubs [10].

Informed citizenry is a major player in conveying human security and autonomy by taking part in decision making and acting upon political, economical and social activities. Reviewing the global information and communication production, we find a tendency to narrow down the ownership of these media. This is to guarantee the world citizens freedom in discussing and deciding on politic and economic life [10].

The communication industry consists of institutions providing news and entertainment as well as companies providing means of Information and Communication Technologies (ICT) including computing and telecommunication corporations. The communication industry became very important to the movement of global capital investments, where it provides the infrastructural services and goods. Companies around the world utilize ICT infrastructure to organize their activities and to coordinate their production. This makes the communication industry a major participant in the new global economy especially that the share of all corporations in the sector reached US$ 1.185 trillion in 1994, representing 9% of total world's economic output [10].

1.8 Telecommunication Infrastructure Overview

A typical telecommunication infrastructure is shown in Figure 1.15. Different telecommunication devices, such as telephone, fax, Computer's modem and mobile phone are using the telecommunication infrastructure to exchange information (voice, data and video) among the users. The infrastructure of telecommunication is based on wired and wireless networks. Wired services of voice, data and cable TV are provided through Public Switched Telephone Network (PSTN), Internet Network and Hybrid

Fiber Coax (HFC) network. The PSTN is formed by a set of switches and point to point connections. PSTN is used to provide fixed phone services and internet connection. The Private Branch Exchange (PBX) is connected to PSTN and it is owned by companies to offer private telephony services. HFC network is developed for video application. It is connected to residential buildings to broadcast cable television and to support broadband Internet connection [15].

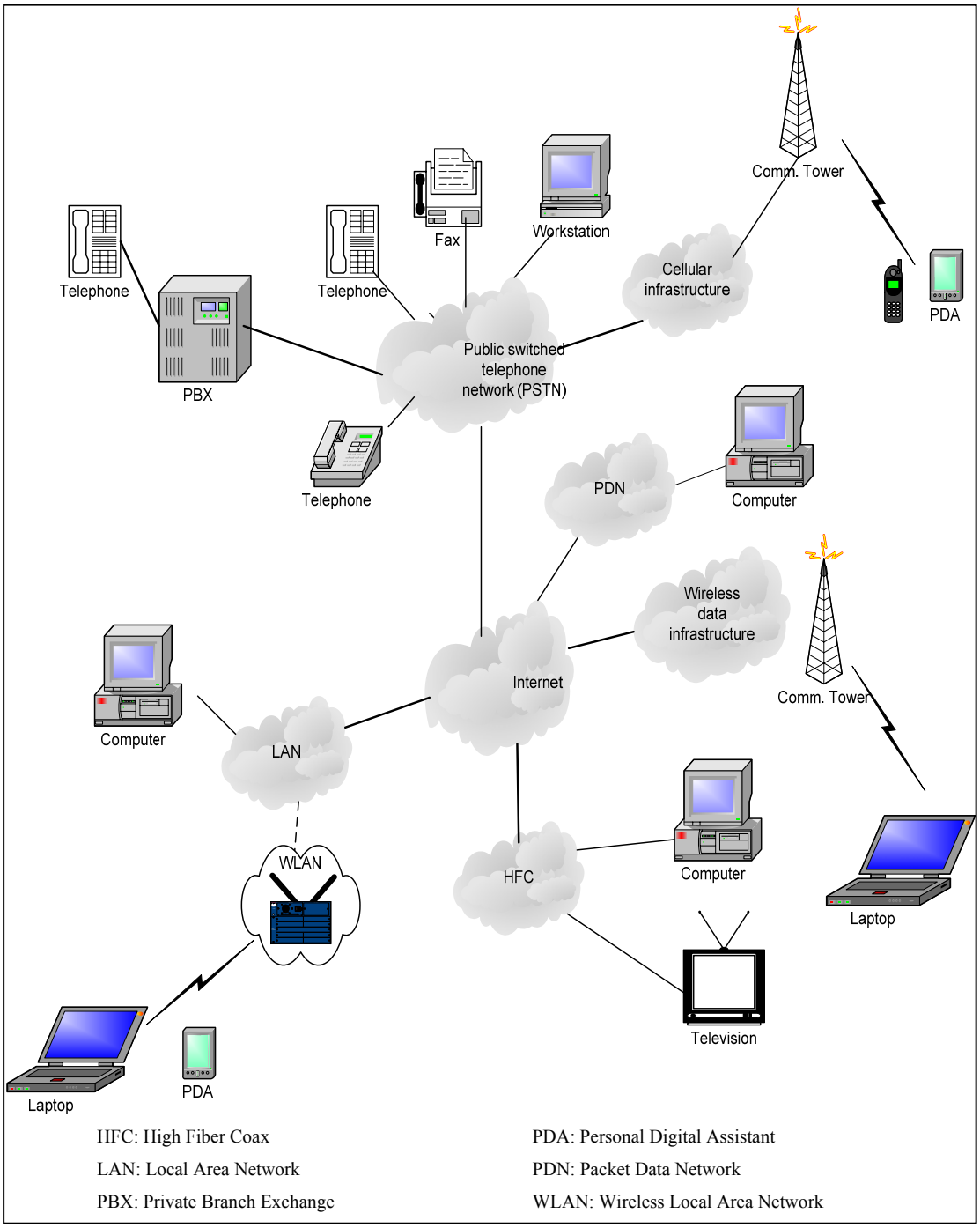

Figure 1.15: Typical Telecommunication Infrastructure [17]

The Internet infrastructure can support multimedia sessions (voice, video and data) where it is accessed through PSTN, HFC and cellular networks. Offices

environments are connected through wireless and wired Local Area Networks which in turn connected via broadband access to the Internet. The wireless telecommunication infrastructure consists mainly of the cellular network know as Public Land Mobile Network (PLMN). PLMN infrastructure formed by adjacent wireless access points connected to the wired network of switches that is connected to PSTN and Internet infrastructure. This network provides voice, data and video services to mobile subscribers [15].

1.8 Literature Review on Telecommunication Infrastructure Economy

Many studies lately investigated the effect of information and telecommunication augmentation on developed and developing countries' economies. This is due to the last movements in many developing countries toward liberalizing their telecommunication sectors. Another factor in performing these studies was the realization of these countries to the importance of adopting information and telecommunication-based economy into their Gross Domestic Products (GDPs).

Recent studies found strong correlation between growth in telecommunication infrastructure and growth in a nation's economic power as in [16] and [17]. In these studies, which were conducted over middle and low-income countries, the growth of telecommunication infrastructure was measured by Teledensity, which is the relationship between country population and number of fixed telephone lines [18]. While economic power is measured by Gross Domestic Product (GDP) per capital. GDP per capital is gross domestic product divided by midyear population. Whereas 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 [4].

An empirical study conducted over Latin America and the Caribbean (LAC) showed that telephone and cell phone adaptation is affected by economic conditions and privatization [19]. It was noted previously that fixed phone and mobile phone penetration has grown faster in high GDP nations. The research found using its empirical model that economic factors, represented by GDP of LAC countries, played a major role in the adoption of telephone services. Moreover, it was shown that privatization in the telecommunication sector has a significant impact on fixed phone and mobile phone adoption. On the other hand, privatization opens the door for

competition which in turn drives service prices down and accordingly increases Teledensity.

Another study by Mbarika and others, focused on predictors of growth of Teledensity in developing countries. The study examined investment in the telecommunication sector [16]. It has been reported that increased investment in telecommunication infrastructure growth may not improve the growth of Teledensity. The research also reflects on the amount of investment a country should invest into its telecommunication infrastructure in order to improve its Teledensity and hence boost its economy.

Cronin and others in [20] found that the annual Gross National Product and the sum of outputs of all industries in the United States has strong correlation with the annual amount of US telecommunication infrastructure growth represented by Teledensity. According to the study finding, Teledensity can be considered as a main predictor of national productivity in the US.

Another research on Telecommunication for Development, took France and Spain as case studies [16]. This study showed that the growth of Teledensity proceeded economic development. One more study cited in [16] proved that the growth of Teledensity introduced social and economic benefits in rural sub Sahara in Africa. Social benefits included infrastructure, health services, education, development projects and response to natural and social disasters. Another study reported in [16] investigated information economies and the development of Pacific countries and found that investment in information oriented industries in most economies would boost the overall demand on other sectors.

1.9 Research Method and Materials

This research presents an empirical study to find the elements contributing to towards telecommunication sector changes in GCC countries over the years from 1980 to 2003. Telecommunication infrastructure development is represented by the demand and the supply of telecommunication market in GCC countries. The research then proposes a model to show a relationship between the telecom infrastructure, represented by its demand and supply, with the economical growth of the GCC countries. Furthermore, from the obtained results the study answers the question of how the sector liberalization will bring benefit to further telecommunication development and future economical growth.

To investigate the association between telecommunication infrastructure investment and aggregate output, data of general economic variables and socio-economical variables were used. In addition, data on a number of telecommunication developments indicators were collected for GCC countries over the time span from 1980 to 2003.

Finally, three different Econometric Models[4] were developed. The first two models study the micro-economy of telecommunication infrastructure that represented by the demand and the supply of telecommunication infrastructure. The third model is developed to measure the contribution of telecommunication infrastructure development into the economical growth of GCC countries. The research will later uses the same three developed models to focus on UAE telecommunication sector as a case study.

1.10 Significance of the Research

The Telecommunication and Information Technology sector is one of the most highly appreciated engineering sectors world wide. This is supported by the UNDP Human Development Report "Technology is like education – it enables people to lift themselves out of poverty. Thus technology is a tool for, not just a reward of, growth and development [21]." Out of this UN vision the ITU, which is the UN body for regulating the telecommunication sectors around the globe, has been working hard on improving telecommunication services. The ITU has focused its effort in the past years on the progress of the telecommunication sectors in developing countries to ensure the right of access to information and outreach of people around the world is extended to every human [22].

Since the 1980s, many developing countries with state owned telecommunication service providers have issued new legislations as steps to liberalize the sector. In GCC countries, recently all member countries have liberated one after the other. Regulatory committees are already established to regulate competition in telecommunication sector. Almost all of GCC countries have allowed for second operators to enter their telecom market.

From this prospective, it is important to understand the elements that affect telecommunication infrastructure development. In addition, it is also vital to

[4] **Econometric Model:** it is an expression of economical theory or hypotheses based on economical theory in a mathematical form or equation [23].

investigate the involvement of telecommunication sector in the economical growth of GCC countries; especially that not many researchers have tried to discover this in the Gulf region. This study is necessary to forecast further positive contributions of the telecommunication sector in regard to the economical growth of GCC countries.

The earlier international studies discussed in the literature review, focused on the effect of different elements on telecommunication services penetration or pricing of demand while other studies addressed the causal effect between penetration rate, represented by number of telecomm services per 100 inhabitants, and GDP per capital. This study introduces a new contribution over the previous works by proposing a model for demand and a model for supply of telecommunication services in GCC countries to measure the telecommunication infrastructure development. Also, the research introduces a third model of economical growth based on telecommunication sector development parameters.

This research is believed to be new in the area of telecommunication sector management in GCC countries. The study addresses the sector modeling from the prospective of sector demand and sector supply. Finally, it measures the contribution of telecommunication development into the economical growth in the Gulf region.

1.11 Research Results and Summary of Key Findings

This study found that the demand of fixed line services in GCC countries was affected by population growth and reduction of services price. However; introducing the Internet did not increase demand over fixed line services. On the other hand, demand of mobile services showed that GCC countries with lower economical standing and lower GDP per capita, such as in Saudi Arabia and Bahrain, have high growing rate of demand over mobile services. Demand of telecommunication service is showing a growing trend over time and there is an increasing demand over new technologies in telecommunication sector especially for mobile based applications.

Through studying the supply of telecommunication market, it showed that the network infrastructures of GCC telecom operators were expanded in response to the infrastructure growth of GCC and towards introducing new technologies to the market.

The economical growth of GCC countries was pushed forward due to labor production. Another two elements that played major role over the past period in GCC

economical growth are income generated from telecommunication sector and introduction of new technology in telecommunication infrastructure.

One of the main findings in the case study of UAE is that the demand of telecommunication services was not affected by the country economical standing. Another finding was that the market supply neither responded to UAE infrastructure growth nor to the economical standing. Supply was found responding to introducing new technologies. In general, demand and supply of telecommunication market had a growing pattern indicating that UAE market has not reached yet a saturation point. This finding also indicates that the telecommunication market can accommodate additional operators. One major finding of UAE case study is that the telecommunication sector development has been taking place in the economical growth of the country starting from 1986.

CHAPTER 2
2. RESEARCH METHODOLOGY

2.1 Econometric Overview

Econometric methodology was adopted to reach research objectives. Econometric has been defined as "the social science in which the tools of economic theory, mathematics, and statistical inference are applied to the analysis of economic phenomenon [23]." Although econometric methods were first developed to better understand a certain behavior or to explain an observed phenomenon in economics, the uses of their techniques extends beyond economic applications. Econometric modeling is currently used for issues related to management, marketing, finance, accounting, and politics.

Econometric modeling is deeply used and relied on by many disciplines due to the following features [23]:

- Use of previous observations or experiments to provide empirical significance to many economic or other discipline theories.
- Provide quantitative values for qualitative theories.
- Provide numerical estimates of relationship between two or more variables.
- Use given and uncontrolled data that are subjected to measurement errors, but methods to eliminate the effect of these errors were developed.
- Set future policies, decisions and strategies.

2.2 Econometric Methodology

Any Econometric study is done based on the following steps:

1. Formulate a statement of theory or hypothesis
2. Gather necessary data sets
3. Designate the mathematical model of theory
4. Specify the economical or statistical model of theory
5. Estimate the parameters of the chosen econometric model
6. Verify the adequacy of specified model
7. Test the hypothesis formulated from the model

8. Utilize the model for analysis or prediction

These steps were employed in the methodology of this research.

2.3 Statement of Theory

The hypotheses of this research are based on microeconomic demand and supply theory. The basic theory was used as a foundation to form the hypotheses and the models of both demand for and supply of the telecommunication sector.

Demand on a certain product or service is set by individual performance. Certain market demand is the sum of all individual demands. Demand is affected by several factors such as price of goods, products availability, social and individual tastes and some other influences, such as the number of international conferences and exhibitions case of telecommunication sector [8].

Likewise, supply of goods and services represents production and selling of business producers. Market supply is also affected by various aspects among them price of final product, price of input commodities, prices of related goods, cost of production, technological development, government policies and other influences [8]. Hypothesizes of this research are based on basic demand and supply theories taking into consideration specific elements related to telecommunication sector of GCC countries.

On Macro-economical level, the ultimate goal of economists is to achieve high level of output, low unemployment and stable prices. A comprehensive measure of a nation output is Gross Domestic Product (GDP). GDP is defined as the measure of the market value of all final goods and services such as cars, crops, health care, transportation services, etc. produced in a country during a year. On the long run, economists focus on economical growth that is based on four major pillars: natural resources, human resources, capital formation[5] and technology [8]. The last three elements were employed to develop the Economical Growth equation of GCC countries. This model captures the effect of Telecommunication sector demand and supply on aggregate economical development in the region.

[5] Capital Formation is defined as [4] “Gross Capital Formation 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."

2.4 Data Source and Data Construction

The data used in this research are those reported for GCC countries by World Bank (2004) [4] and ITU (2004) [11]. Datasets spans the six GCC countries covering the period 1980 – 2003. Moreover, the Economical and Socio-Economical indicators are collected from the World Bank database, where Telecommunication indicators were composed from the ITU reports.

One major research limitation appeared during the data collection phase is that many GCC countries had missing data for different indicators over different time periods. Around 14.7% of indicators statistics were found missing for all GCC countries. Nonetheless, the incomplete data was not an obstacle to start an empirical study over telecommunication sector. Missing data were completed, after investigating their trend, using trend-line extrapolating equations such as linear, logarithmic, exponential or moving average.

The data of every variable is collected over a period of time. In the analysis, pooled data is used containing cross sectional time series data of more than one variable for all GCC countries.

The Economical Indicators used are:

- Gross Domestic Product per Capita
- Gross Fixed Capital Formation

The Socio-Economical Indicators used are:

- Total Labor Force
- Population

The Telecommunication Indicators used are:

- Number of fixed-phone per 100 inhabitant
- Number of mobile-phone per 100 inhabitant
- Waiting List for fixed-line service
- Residential monthly telephone subscription
- Mobile phone monthly subscription
- Total full-time telecommunications staff

Logarithm of independent and dependent variables was used to keep the error of data under control. Logarithm of variables was also used to scale down the magnitude of large variables, for instance Gross Fixed Capital Formation and Population, and keep them in range with variables of small magnitude in order to avoid biasing the

results. Table A.1 and Table A.2 in Appendix A show abbreviations, descriptions and units of all used indicators.

2.5 Development of Research Hypotheses

The research is structured to investigate how telecommunication sector affects economic growth in GCC countries. To find a conclusion to this main objective, the research strives to answer the following questions: What is the behavior of Demand and Supply of telecommunication services in current GCC telecommunication Market? How the telecommunication infrastructure affects the economic growth in GCC countries? The research will then use the results of these questions to study the facts and build upon them the future expectation of how the Telecommunication Sector will behave in microeconomic and in macroeconomic growth levels under sector liberalization and competition.

In this research, the same indicators proven to be relevant to telecommunication service penetration are used. In addition, indicators used in earlier studies are reintroduced to model demand and supply of telecommunication sector separately. Since countries differ in so many ways, some fixed-effects of economical and socio-economical indicators were employed in the models to control for unobserved country-specific factors of GCC countries. In this context the models developed in this thesis is not an exact replica of any of the covered literature review models. Rather, they are new contributions that can be tested later on different countries to compare their outcomes with the outcomes found in GCC countries.

One economical indicator relevant to GCC countries is the high investment in infrastructure projects and this is captured by the Gross Fixed Capital Formation indicator. Other socio-economic specific indicators are the population growth and labor force growth.

The research investigates the demand and supply of fixed-line and mobile services separately and then jointly. First, the fixed-line indicators are used in the models then the mobile indicators are used in the same models. Next, summation of both services' indicator is placed in the models. The aim of this modeling process is to study the telecommunication market behavior of fixed-line and mobile individually. Then fixed-line and mobile are treated as one variable in the assumption that both services represent the full capacity of services offered by telecommunication operators and consumed by customers.

The following items are beyond the research scope of work and can be developed based on this study as part of future works in the area of telecommunication management research:

- The effect of mobile on fixed-line services and vice versa is beyond the scope of this study, accordingly the models do not capture this effect.
- The effect of prices inflation according to inflation rate of each GCC country.
- Effect of supply on demand and vice versa was not considered in any of demand or supply models.

After that a macro-economic growth model is developed to incorporate the effect of demand and supply of telecommunication market on GCC economy. This model incorporates variables with short term and long term effects on the economic growth. The short term variables are demand and supply of telecommunication, whereas, the long term variables are related to economic production improvement.

2.6 Research Hypotheses

In this section, different hypotheses proposed by this research are presented and discussed as they will be used as foundation of constructed models. After obtaining the results from developed models based on available GCC countries' data, these hypotheses will be tested for their correctness.

2.6.1 Hypothesis 1

GCC countries have a specific socio-economical factor of growing population. It is expected that as population grows the number of buyers demanding telecommunication services increases, accordingly the first hypothesis is:

H1: There is a positive relationship between GCC population and demand on telecommunication services.

2.6.2 Hypothesis 2 and Hypothesis 3

Demand on telecommunication services may increase when customers have higher income. Similarly, as the economical level of the country increases, the telecommunication operators will have more income too and will invest more in the telecommunication infrastructure to develop their networks.

H2: There is a positive relationship between GDP per capita and demand on telecommunication services.

H3: There is a positive relationship between GDP per capita and supply of telecommunication services.

2.6.3 Hypothesis 4

The higher the number of telecommunication staff the better the quality of service is provided to customers and accordingly the demand on telecommunication services will increase.

H4: There is a positive relationship between the number of telecommunication staff and the demand on telecommunication services.

2.6.4 Hypothesis 5 and Hypothesis 6

It was found that monthly residential connection charges and monthly residential subscription charges are positively correlated with Teledensity [27]. In this research we investigate the effect of price on both demand and supply. Usually customers buy more of a product when its price is low. Economists define demand response to price changes as the Price Elasticity of Demand. Demand is elastic if quantity demanded responds significantly to changes in price. On the other hand, supply increases when the price of the offered services decreases or when the input prices of their raw material, in this case the purchased telecommunication equipment, decreases [9].

H5: There is a negative relationship between price of telecommunication services and demand on telecommunication services.

H6: There is a negative relationship between price of telecommunication services and supply of telecommunication services.

2.6.5 Hypothesis 7

GCC countries have high investment in their infrastructure especially over the period of study in this research. This investment is captured by the Gross Fixed Capital Formation indicator. Investment in the infrastructure requires expansion in providing telecommunication services.

H7: There is a positive relationship between investment in GCC infrastructure and supply of telecommunication services.

2.6.6 Hypothesis 8 and Hypothesis 9

The introduction of new telecommunication services will tend to change customer behavior which will increase demand on telecommunication service. In the same way, as new technology is introduced worldwide the telecommunication operators will invest more to supply this technology in the local market.

H8: There is a positive relationship between the introduction of new technology and the demand on telecommunication services.

H9: There is a positive relationship between the introduction of new technology and the supply of telecommunication services.

2.6.7 Hypothesis 10 and Hypothesis 11

The demand and supply of telecommunication services is expected to change over time due to change in customer behavior, prices of services, and introduction of new technology in addition to other market specific reasons.

H10: There is a positive relationship between time trend and demand of telecommunication services.

H11: There is a positive relationship between time trend and supply of telecommunication services.

2.6.8 Hypothesis 12 and Hypothesis 13

Gross Domestic Product is taken as a measure of economical growth. GDP is defined by economist as "The market value of the final goods and services produced by workers and other resources located within the borders of a nation over a period of one year." The components of GDP are consumption, investment, government spending and net exports. GDP per capita is being used as a measure of economic well-being of a society. The higher the GDP per capita enjoyed by an average person the higher the expenditure. Consumption is the spending of households on goods and services, whereas, investment is the purchase of goods that will be used in the future

to produce more goods and services. An increase in consumption and investments structures an increase in GDP [9].

Teledensity is taken here as a measure of consumption for telecommunication services or income generated from telecom sector. On the other hand, total telecommunication investment is taken as a measure of sector investment in the GDP of GCC countries. Notice that the model incorporates the effect of demand by using Teledensity only without the waiting list, where GDP takes into accounts only the value of final goods and services. The model also integrates the supply of telecommunication services represented by the investment of telecommunication operators.

H12: There is a positive relationship between the income generated from telecommunication sector and the economical growth represented by GDP per capita.

H13: There is a positive relationship between the investments placed to develop telecommunication sector and the economical growth represented by GDP per capita.

2.6.9 Hypothesis 14 and Hypothesis 15

The economic growth on the long run is dependent on the productivity of workers. The economy production of goods and services depends on stock of human capital, stock of physical capital, stock of natural resources and technological knowledge. Stock of human capital is represented by skilled and educated workers [9].

Complete indicator of educated labor was not available for GCC countries in World Bank. Therefore to include the effect of human capital along with the effect of physical capital, the Gross fixed capital formation is considered and it is divided by number of total labor force to find the production per labor. The higher the production rate the higher the growth that can be measured in GDP per capita. Another element that can affect economical growth is by technological development. In the case of telecommunication sector, the introduction of Internet and second generation mobile services may have a positive effect on economical growth.

H14: There is a positive relationship between stock of capital (Gross Fixed Capital Formation) per labor, forming the labor production rate, and economical growth.

H15: There is a positive relationship between the introduction of new technology in telecommunication sector and the economical growth.

2.7 Specification of Research Mathematical Models

This research employs a multiple linear regression model to quantify the relationship between the dependent variables and the independent variables. The dependent variables in our models are demand for telecomm, supply of telecomm and GDP per capita. An additive regression model is used to show how the independent variables influence the response of the dependent variable, where the effect of the first independent variable adds to the effect of the second independent variable and so on.

Using linear regression model explains the behavior of dependent variable in relation to the behavior of the independent variables allowing the factor of inexact relationship between them. The estimated dependent variable produced by the regression equation is based on the variation suggested by independent variables. In general, regression analysis helps in testing hypotheses suggested by the underlying theory. Also it helps in estimating and forecasting the mean value of dependent variable given the values of independent variables [23].

The study employs a log linear regression equation for an added attractive feature. Log-linear equation measures the percentage change of dependent variable with respect to a percentage change in independent variable [23]. Accordingly it will be possible to quantify the effect on telecommunication demand, supply and economical growth with a percentage change in any of the independent variables. Moreover, as indicated in section 2.4, the logarithm of variables controls for inherent data errors.

It is worth mentioning that the established relationship from the regression equation does not suggest causation between dependent and independent variables no matter how strong the statistical results [23]. Causality is to be established through theory or other methods that are beyond the study of this research and can be taken as future work for further study.

An error term is added to all regression equations to represent the inherent randomness in the system. More often there would be errors of assigning values, measurement and observation associated with human limitation and world event limitation of data collection. In addition, the error term adjust for the equation limitation where it captures only a subset of the entire effects of the studied

population. Usually the reason of constructing econometric model is not to capture the effect of all elements affecting the dependent variable. Doing so will produce unwieldy regression equation that is difficult to study. Accordingly the error term is added to represent all other forces and elements that affect the dependent variable but were not explicitly introduced in the model [16, 23].

2.8 Proposed Regression Models

In order to include the telecommunication sector into an aggregate economy, a micro-model of supply and demand is specified first. Then an economical growth model is specified to integrate the effect of telecommunication sector development.

2.8.1 Model 1: Telecommunication Infrastructure Demand Equation

Telecommunication Demand is denoted by TD and specified based on a function of Population (POP), GDP per capita (GDPC), telecommunication service quality (TSQ), Telecommunication Price (TP), introduction of new Technology (M) and time trend (TD_{t-1}). Table 2.1 shows hypotheses to be proven by Model 1.

Table 2.1
Hypotheses of Model 1 (Demand Model)

Hypothesis Number	Description
H1	There is a positive relationship between GCC population and demand on telecommunication services.
H2	There is a positive relationship between GDP per capita and demand on telecommunication services.
H4	There is a positive relationship between the number of telecommunication staff and the demand on telecommunication services.
H5	There is a negative relationship between price of telecommunication services and demand on telecommunication services and supply of telecommunication services.
H8	There is a positive relationship between the introduction of new technology and the demand on telecommunication services.
H10	There is a positive relationship between time trend and demand of telecommunication services.

The model function and equation are given below:

$TD = f(POP, GDPC, STAF, TP, M, TD_{t-1})$

$$Log(TD_{it}) = \beta_1 + \beta_2 \log (POP_{it}) + \beta_3 \log (GDPC_{it}) + \beta_4 \log (TSQ_{it}) + \beta_5 \log (TP_{it}) + \beta_6 M_t + \beta_7 \log (TD_{i,t-1}) + \varepsilon_{it} \quad \text{(Eq-1)}$$

Where *i* is an index that represents the six GCC countries and *t* is the time from 1980 to 2003. β_2 through β_7 are the independent variables coefficient that will be estimated as a result of applying the model over the data sets. β_1, the coefficient of Eq-1 intercept will be also estimated, however, it usually does not carry any econometrical meaning since it is the value of the dependent variable when all other independent variables has a value of zero, which is rarely the case in reality.

The demand model is replicated three times to study fixed line services, mobile services and total telecommunication services. Segregation between the three equations is done according to different TD and Telecommunication Price (TP) indicators as shown in Table 2.2. Table A.2 in Appendix A contains definition of used acronyms.

Table 2.2
Specific Demand Model Changed Variables

Cases	Model	TD Indicators	TP Indicators
Case 1	Demand of Fixed Line Service	PEN + WL	TP
Case 2	Demand of Mobile Services	PENM	TPM
Case 3	Demand of Telecommunication Services	PENT + WL	TPT

2.8.2 Model 2: Telecommunication Infrastructure Supply Equation

Telecommunication Investment (TTI) is used as our proxy for telecommunication infrastructure supply (TS). The supply model is represented as function of Gross fixed Capital Formation (K), GDP per Capita, Telecommunication Price, introduction of new technology and time trend. The following are TS function and model equation.

$$TS = f(K, GDPC, TP, M, TS_{t-1})$$

$$Log (TS_{it}) = \varphi_1 + \varphi_2 \log (K_{it}) + \varphi_3 \log (GDPC_{it}) + \varphi_4 \log (TP_{it}) + \varphi_5 M_t + \varphi_6 \log (TS_{i,t-1}) + \varepsilon_{it} \quad \text{(Eq-2)}$$

Where *i* is an index that represents the six GCC countries and *t* is the time from 1980 to 2003. φ_2 through φ_6 are the independent variables coefficient that will be estimated from the model. φ_1 will also be estimated, however, its value has no econometrical justification. Table 2.3, shows hypotheses represented by Model 2.

Table 2.3
Hypotheses of Model 2 (Supply Model)

Hypothesis Number	Description
H3	There is a positive relationship between GDP per capita and supply of telecommunication services.
H6	There is a negative relationship between price of telecommunication services and supply of telecommunication services.
H7	There is a positive relationship between investment in GCC infrastructure and supply of telecommunication services.
H9	There is a positive relationship between the introduction of new technology and the supply of telecommunication services.
H11	There is a positive relationship between time trend and supply of telecommunication services.

Supply model is also repeated three times to study supply in terms of fixed line services, mobile services and total telecommunication services. Differentiation between the three equations is done according to different Telecommunication Price (TP) indicators as illustrated in Table 2.4.

Table 2.4
Supply Model Specific Changed Variables

Cases	Model	TP Indicators
Case 1	Supply Model with Fixed Line Service effect	TP
Case 2	Supply Model with Mobile Service effect	TPM
Case 3	Supply Model with Total Telecom services effect	TPT

2.8.3 Model 3: Economical Growth Equation

We assume that the national aggregate economic activity growth represented by GDP per capita (GDPC) is specified as follows:

$GDPC = f(K/TLF, TI, TS, M)$

$$Log(GDPC_{it}) = \alpha_1 + \alpha_2 \log(K_{it}/TLF_{it}) + \alpha_3 \log(TI_{it}) + \alpha_4 \log(TTI_{it}) + \alpha_5 M_t + \varepsilon_{it} \quad \text{(Eq-3)}$$

Where:

K/TLF: a measure of labor productivity; Stock of Capital per worker – Gross Fixed Capital Formation is used as an indicator for stock of physical capital of the country. It is taken here per labor capita to show the productivity of the labor force on the GDP.

TI: Telecommunication Income is measured by Teledensity to capture the income generated from telecommunication services.

TTI: Telecommunication Investment is used to capture the effect of telecom sector investment into the economical growth.

M: A dummy variable for the introduction of new technology; internet and second generation of mobile phones.

Table 2.5, states hypotheses tested by Model 3.

Table 2.5
Hypotheses of Model 3 (Economical Growth Model)

Hypothesis Number	Description
H12	There is a positive relationship between the income generated from telecommunication sector and economical growth represented by per capita.
H13	There is a positive relationship between the investments placed to develop telecommunication sector and the economical growth represented by GDP per capita.
H14	There is a positive relationship between stock of capital (Gross Fixed Capital Formation) per labor, forming the labor production rate, and the economical growth.
H15	There is a positive relationship between the introduction of new technology in telecommunication sector and the economical growth.

Once more the economical growth equation is replicated three times to study the effect that Telecommunication income plays on the growth with respect to fixed line, mobile and total telecommunication services. Table 2.6 shows the variables altered in equation (Eq-3).

Table 2.6
Economic Growth Model Specific Changed Variables

Cases	Model	TI Indicators
Case 1	Economical Growth Model with Fixed Line Income effect	PEN
Case 2	Economical Growth Model with Mobile Income effect	PENM
Case 3	Economical Growth Model with Total Telecom Income effect	PENT

CHAPTER 3
3. RESULTS AND ANALYSIS OF GCC MODELS

This chapter presents econometric methods used to obtain results applied to the GCC region from the three developed models of the thesis. EViews 4.1 [28], which is a quantitative software used for econometric studies, was utilized to develop the thesis models and to apply various econometric tools. Least Square was first used to find the independent variables coefficients (β, φ and α) of Eq-1, Eq-2 and Eq-3. Then the models were checked for goodness using econometric techniques. Also, hypothesis testing was used to measure the strength of the contribution that each independent variable has reflected on the dependent variable. The chapter will finally present analysis of GCC models' results.

3.1 Performance Measure and Model Validation

Least Square (LS) method was used to estimate the models' parameters due to its strength as stated by Gauss-Markov Theorem:

> "Given the assumption of classical linear regression model, the LS estimators, in the class of unbiased linear estimators, have minimum variance, that is, they are best linear unbiased estimator. [23]"

In estimating the mean coefficients of independent variables (explanatory variables), the following properties are desirable in the estimated coefficient:

1. Linear: An estimated value is linear if it is a linear function of the observation where it appears in the power of one.
2. Unbiased: An estimator is unbiased if the estimated mean value agree with the true value of the parameter.
3. Efficient: Taking in account unbiased estimators, the one with the least variance is the efficient one.

Thus, the Best Linear Unbiased Estimator (BLUE) is the one that is linear, unbiased and with minimum variance. LS minimizes the sum of square errors between the actual variable and the estimated variable to provide BLUE. In other words LS chooses coefficient so that residual sum of squares is the smallest value.

After regression equation coefficients are obtained it is necessary to check for regression equation accuracy. The developed models should be tested for there main

problems that may arise in econometric models. These three problems are: multicollinearity between independent variables, heteroscedasticity in error term and autocorrelation in the error term. The following subsections provide further details on their nature, their effect on models estimation and methods followed to adjust for their existence.

3.1.1 Variables Multicollinearity

Multicollinearity happens when there is dependence between explanatory variables which opposes the assumption of linear regression equation that there is no exact linear relationship between independent variables. Perfect collinearity is rarely encountered by regression equation and it prevents estimate of individual regression coefficients or their standard errors. Most likely, perfect collinearity will not take place; rather high level of Multicollinearity would be found in regression equation. In this case, large value of standard deviation error of one or more coefficients will result compared to coefficient values. Symptom of multicollinearity is when the regression equation Adjusted R^2 is found to be high but very few independent variables are found significant [23].

Multicollinearity is a nature of used sample not of total population. Therefore when a model is checked for its existence, it is a matter of multicollinearity degree. Therefore testing for its presence is typically not done; rather its degree of presence is measured. One way to measure the degree of multicollinearity is by using Auxiliary Regression by regressing every independent variable on other independent variables. F-statistics and its probability were calculated for every independent variable. The probability of F-statistics tests for null hypothesis of multicollinearity. If the F-statistics value was found above 5% level of significance, the null hypothesis is accepted. To measure the strength of multicollinearity of certain variable to other variables in the model Adjusted R^2 value of above 0.8 was taken as strong indication [23].

In models involving aggregated (pooled) GCC data sets, the situation of multicollinearity was found in Model 1 Case 3 (Demand of Telecommunication Services). Adjusted R^2 was 0.99 while test of F-statistics found that only two variables are significant. Auxiliary Regression results are presented in Table 3.1.

Table 3.1
Auxiliary Regression Results of Model 1- Case 3

Regressed Independent Variable	Adjusted R^2	F-Statistics	Prob.(F-statistics)
Population	0.88	197.53	0.0000*
GPD per capita	0.52	30.97	0.0000*
Telecommunication quality	0.85	151.56	0.0000*
Telecommunication Price	0.33	14.55	0.0000*
New Technology	0.56	35.98	0.0000*
Time Trend	0.69	62.93	0.0000*

Note. * indicates statistical significance less than 5%.

The above results of auxiliary regression show that population and telecommunication quality indicating strong multicollinearity with other variables. In Table 3.1, population a telecommunication had significant probability of F-statistics indicating that they are collinear and the strength of their collinearity with other variables are 0.88 and 0.85. Results of Model 1 Case 3 will still be valid in the analysis due to the following:

- Multicollinearity is a nature of certain used data in the model not a nature of total population.
- Applying specified Model 1 to Case 1 and Case 2 provided reliable results.
- Population and telecommunication price were removed individually and simultaneously from the model and the significance of the remaining independent variables did not change. Moreover, the sum square of residuals was at its least value considering population and telecommunication price in the model. More results are provided in Appendix B, Table B.1

3.1.2 Residuals Heteroscedasticity

Another assumption of linear regression model is that the error term distributed with the same variance along the observations. Residuals are known as homoscedastic in this case. On the other hand, if error variance is changing from one observation to the other, then heteroscedasticity is present. Its presence causes unreliable results for hypothesis testing of variables because of over estimation of biased error variance.

As reported by [23], cross-sectional data most probably encounter heteroscedasticity in their error terms due to differences of measuring scales between

variables. In pooled models of GCC countries, independent variables included in the models have different scales and the fact of applying the model on more than one country at the same time results in a natural existence of heteroscedasticity in the pooled models. The problem was resolved by using White's Heteroscedasticity corrected standard errors and t-statistics [2]. This correction technique uses an estimation procedure to generate standard errors for regression coefficient considering and adjustment for heteroscedasticity effect.

3.1.3 Residuals Autocorrelation

Usually in time serial regression the residuals are correlated with their own lagged values. This correlation violates the assumption of regression theory of having the residuals independent of each other in the equation. This correlation in the residual can be exploited by adding it to the original equation and produce better estimation of the dependent variable.

In GCC pooled models, Durbin-Watson (DW) test [28] was used to measure the linear association between adjacent residuals from a regression model. DW test is usually used for large number of observation and it became a standard measure to detect residual autocorrelation in many econometric studies [23]. If no correlation is present, the DW will be around 2. In case of positive correlation DW is between 2 and 0, whereas, for negative correlation DW takes values between 2 and 4 [28].

To extract the effect of correlation from the residual and add it into the regression equation, an Autoregressive (AR) Model is used. The AR integrates the residual from the past observation into the regression model for the current observation [23]. To adjust for the results, first order AR(1) and second order AR(2) were used to get DW value around 2. No further AR orders were considered because it reduces the number of observation in the regression equations.

3.2 Significance Measures

All models are solved using Eviews 4.1 quantitative Software. To define coefficient significance, t-distribution is used. Two tail hypothesis testing is conducted for every independent variable with the assumption of null hypothesis that the coefficient mean is zero. Null hypothesis is rejected if probability of t-statistics is less than 14%. Level of confidence interval of this study was lowered to 86% because

of the relatively small amount of data involved in developing the models. There levels of significance were considered while analyzing the results. Table 3.2 indicates the used levels and their corresponding level of confidence (α).

Table 3.2
Results Significance Levels

Level of Significance	Level of Confidence (α)
Not Significant	Prob.(t-statistics) > 14%
Weakly Significant	10% < Prob.(t-statistics) ≤ 14%
Significant	5% < Prob. (t-statistics) ≤ 10%
Strongly Significant	Prob. (t-statistics) ≤ 5%

3.3 Demand Model Results and Analysis

Detailed results of Demand Model (Model 1) described by Eq-1 are presented in Appendix B in Table B.2. Hypothesis testing results for fixed-line, mobile and total telecom services are indicated in Tables 3.3, 3.4 and 3.5. Each table shows the coefficient value of variable representing each hypothesis along with the probability of t-statistics stated as (P-Value).

Table 3.3
Model 1 – Case 1 Result (Demand of Fixed Line Services)

Hypothesis	Variable	Coefficient P-Value	Observation	Hypothesis Test
H1	Population	0.133113 (0.0583**)	Significant	Satisfied
H2	GPD per capita	0.006919 (0.8870)	Not Significant	Not Satisfied
H4	Telecommunication quality	-0.263923 (0.0000***)	Strongly Significant	Not Satisfied – Negative correlation
H5	Telecommunication Price	-0.167628 (0.1274*)	Weakly Significant	Satisfied
H8	New Technology	-0.012764 (0.5214)	Not Significant	Not Satisfied
H10	Time Trend	0.124208 (0.2081)	Not Significant	Not Satisfied

Note. *, ** and *** indicates statistical significance at the 14%, 10% and 5%, respectively.

Table 3.4

Model 1- Case 2 Results (Demand of Mobile Services)

Hypothesis	Variable	Coefficient P-Value	Observation	Hypothesis Test
H1	Population	-0.078992 (0.1121*)	Weakly Significant	Not Satisfied – Negative correlation
H2	GPD per capita	-0.125771 (0.0953**)	Significant	Not Satisfied – Negative correlation
H4	Telecommunication quality	0.065932 (0.3684)	Not Significant	Not Satisfied
H5	Telecommunication Price	-0.203717 (0.0019***)	Strongly Significant	Satisfied
H8	New Technology	0.453098 (0.0257***)	Strongly Significant	Satisfied
H10	Time Trend	0.886252 (0.0000***)	Strongly Significant	Satisfied

Note. *, ** and *** indicates statistical significance at the 14%, 10% and 5%, respectively.

Table 3.5

Model 1 – Case 3 Results (Demand of Telecommunication Services)

Hypothesis	Variable	Coefficient P-Value	Observation	Hypothesis Test
H1	Population	0.007349 (0.7094)	Not Significant	Not Satisfied
H2	GPD per capita	-0.001480 (0.9466)	Not Significant	Not Satisfied
H4	Telecommunication quality	-0.007369 (0.7366)	Not Significant	Not Satisfied
H5	Telecommunication Price	0.004765 (0.7197)	Not Significant	Not Satisfied
H8	New Technology	0.085766 (0.0004***)	Strongly Significant	Satisfied
H10	Time Trend	0.988349 (0.0000***)	Strongly Significant	Satisfied

Note. *, ** and *** indicates statistical significance at the 14%, 10% and 5%, respectively.

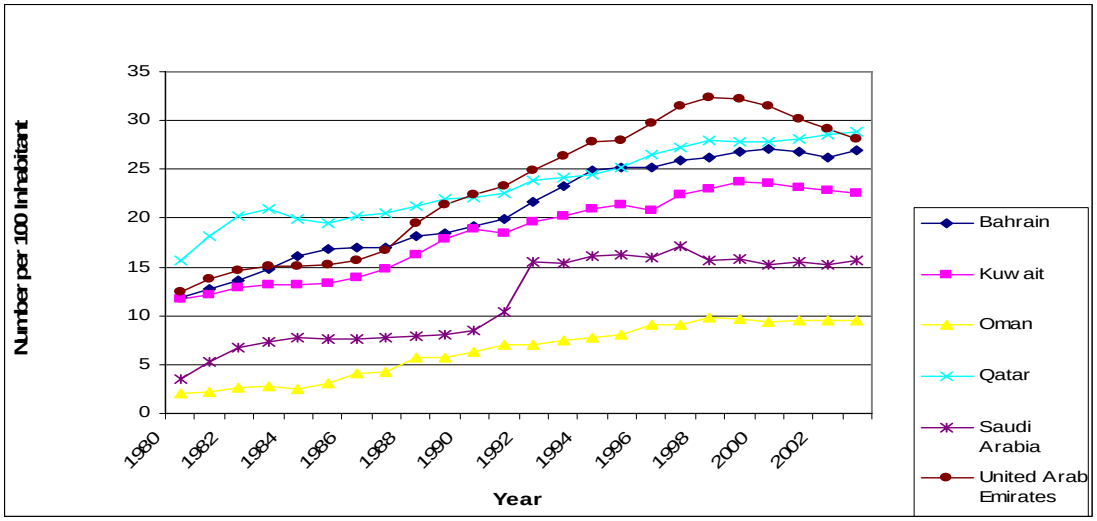

Figure 3.1: Demand of Fixed Line Services in GCC Countries.

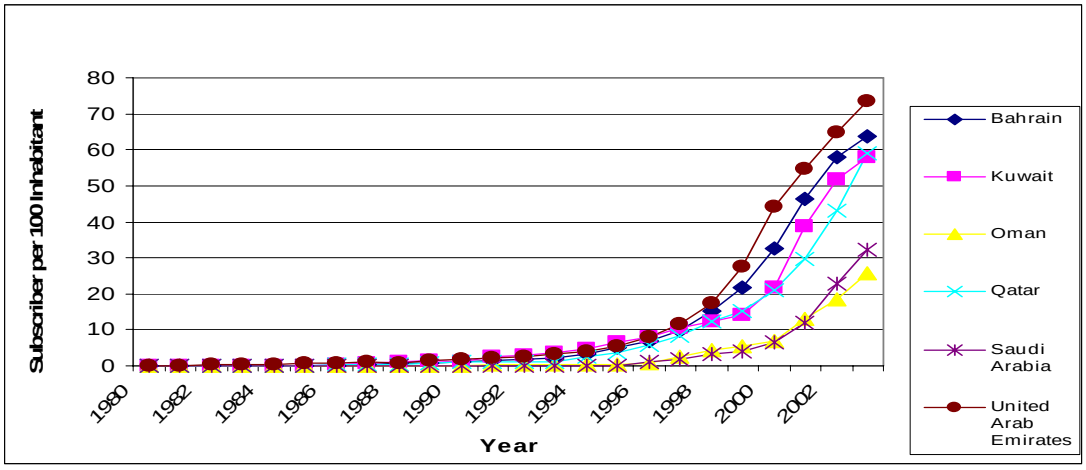

Figure 3.2: Demand of Mobile Services in GCC Countries

3.3.1 Hypothesis 1 Result

Population was found significant for fixed phone services as shown in Table 3.3. This finding supports Hypothesis 1. As a result, a 1 percent increase in population will cause a 0.133% increase in demand over fixed line services. On the other hand, population was weakly significant to demand on mobile and with negative correlation, which is not expected by H1. This indicates that demand growth rate is not catching up with population growth rate in GCC countries.

Moreover, investigating source population data indicate that GCC countries with lower population have higher demand for mobile services than countries with high population. Demand on mobile services, for GCC countries, is showed in Figure 3.2 and population depicted by Figure 3.3. Saudi Arabia has the highest population and it is the second least GCC country in mobile demand. On the other hand, UAE, Bahrain and Kuwait have much lower population compared to Saudi Arabia but they are among highest level of mobile demand in GCC countries. Accordingly explanatory variable coefficient showed a negative correlation between population and demand.

Population coefficient was found not significant for total demand on telecommunication services. GCC telecommunication operators have to consider the rate of population growth as their potential buyers. If population growth was higher than the increase in demand, this will reduce telecom services penetration rate. Therefore, it is essential to provide packages to attract new customers in GCC countries.

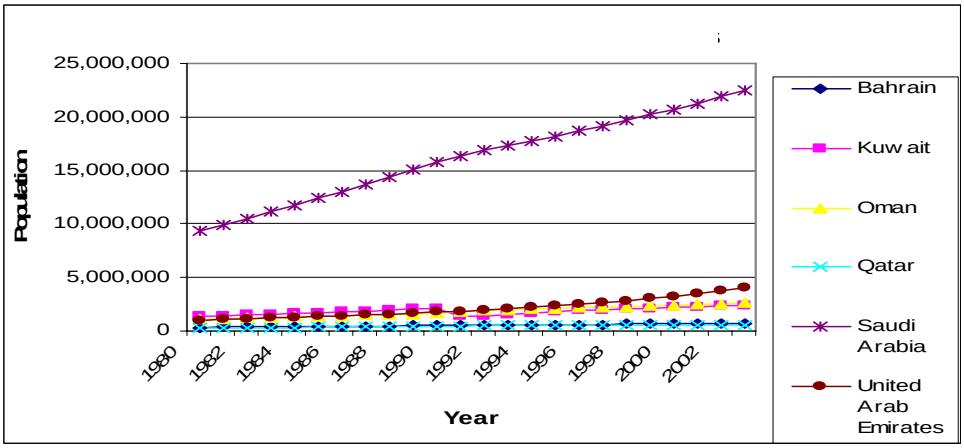

Figure 3.3: Population of GCC Countries.

3.3.2 Hypothesis 2 Result

Result of *H2* was not satisfied for fixed line services and for total telecommunication services. This hypothesis captures the income elasticity of demand. Income elasticity shows how much the demand is affected by a change in income for the buyer. Regardless of customers' income level, demand on fixed line and on telecommunication services is not affected by buyer income. This finding is opposit what was found in [19] and in [16] where hypothesis of positive correlation between GDP per capita and penetration rate of fixed line services was supported.

On the other hand, considering results of mobile services, income was found elastic to mobile services but surprisingly with negative relationship. GDP per capita of GCC countries was compared to percentage increase in mobile demand from 1990 to 2003 of GCC countries in Figure 3.4. Total percentage change and average percentage increase in demand over mobile phones in GCC countries is also calculated in Table 3.6. It is noticed that countries with the lowest GDP per capita, Bahrain Oman and Saudi Arabia, are demanding mobile services more rapidly than countries with higher income. Similar result was found for cell phone adaptation in Latin America and the Caribbean (LAC) where poorer LAC countries were adopting cell phone services more rapidly [19]. Our results suggest that mobile networks are more attractive to be demanded by customers in rural and poor areas since they are easily deployed and less expensive than fixed line networks.

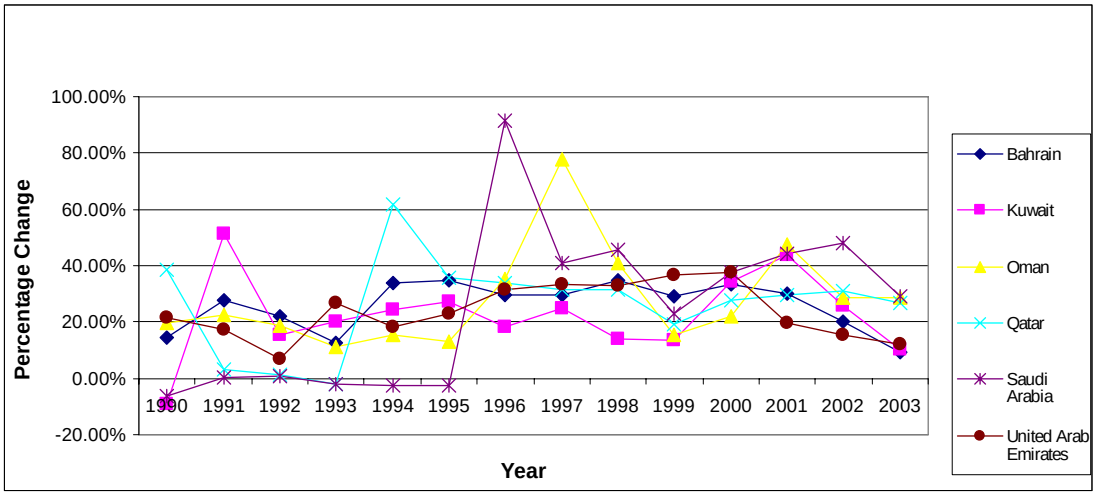

Figure 3.4: Percentage Change in Mobile Services Demand.

Table 3.6
Percentage Increase in Mobile Service Demand of GCC Countries (1990-2003)

Country	Total Percentage Increase from 1990 to 2003	Average Percentage Increase per Year
Bahrain	361.66%	25.83%
Kuwait	313.91%	22.42%
Oman	396.99%	28.36%
Qatar	369.97%	26.43%
Saudi Arabia	347.99%	24.86%
United Arab Emirates	332.72%	23.77%

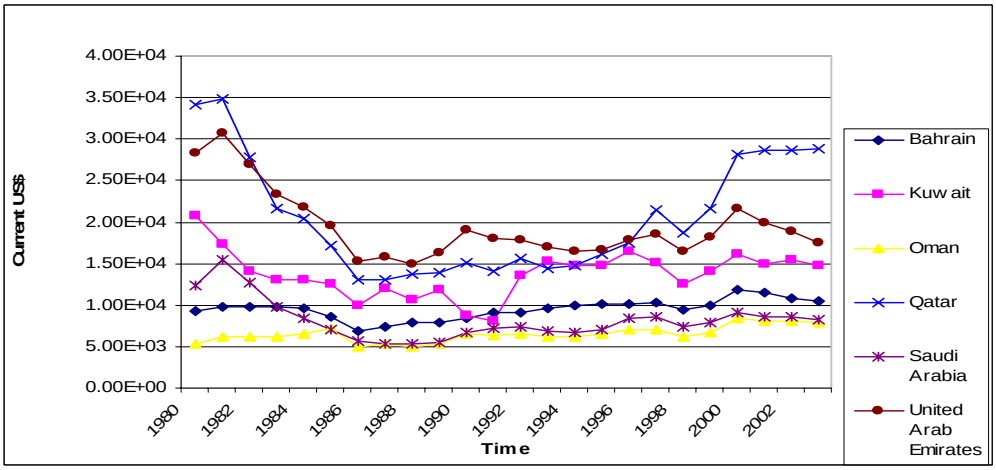

Figure 3.5: GDP per Capita of GCC Countries.

In year 2000 it was argued that mobile phones are used as substitute for fixed-line phones in developing countries. On the other hand, it may be used as a complementary service to fixed-line [12]. The ITU, in its 2002 World

Telecommunication Report [29], highlighted that mobiles are becoming as a substitute to fixed-line telephones not only in developing countries but in developed countries too. The report categorizes subscribers using mobiles as a substitute for a fixed-line telephone into four categories: students, the unemployed, single person households or those frequently moving residence. With the exception of probably the last category, the rest are with low income scale. Accordingly even new studies and empirical researches supports the negative correlation finding between GDP per capita and mobile services demand.

3.3.3 Hypothesis 4 Result

Hypothesis 4 was not satisfied for all three cases; fixed line, mobile and total telecom services. Nevertheless, strong negative correlation was found between telecommunication quality and demand of fixed lines. This indicates that demand on fixed line services is higher in countries with lower number of telecommunication staff. The result also points out that the GCC countries with higher number of telecommunication staff are not necessarily providing high quality of service to customers. Considering GCC telecommunication staff statistics in Figure 3.6, we notice that Saudi Arabia has the highest number of staff, almost twice all other GCC countries but with the lowest demand as shown in Figure 3.1. Therefore, the result of this coefficient is relatively biased toward Saudi Arabia especially that the second and third countries are UAE and Kuwait with highest fixed line penetration in GCC.

Number of telecommunication staff was also found not significant to adoption of telecommunication service in the study of [16]. Non significance of telecommunication quality for both mobile and total telecom services, as found by our results, indicates that the measure of telecommunication quality is not only quantified by number of telecommunication staff. It should also consider the quality of training and retaining highly qualified administrative and technical telecommunication staff.

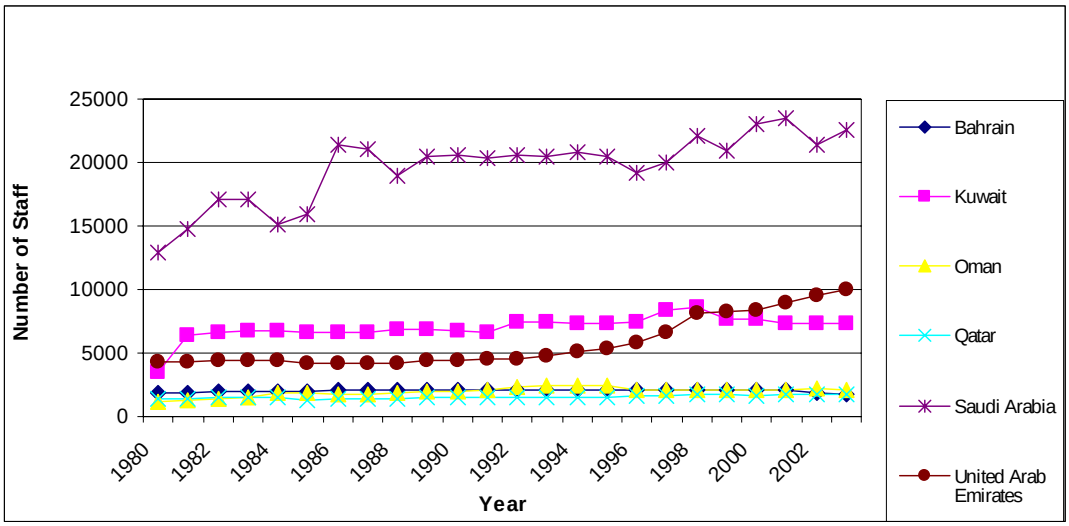

Figure 3.6: Telecommunication Staff of GCC Countries.

3.3.4 Hypothesis 5 Result

Moving to the result of *H5* that considers the effect of price on demand, it is shown that the fixed line case supports the hypothesis weakly while mobile case supports it strongly. Demand is elastic to prices changes, where reduction in the prices increased the demand on both, fixed line and mobile services. However, *H5* was not supported in the case of total telecommunication services. The effect of price reduction was not reflected strongly in the result of fixed line services because most GCC countries did not introduce much change in their fixed line pricing over the study period, as can be seen from Figure 3.7. While in mobile services, monthly subscription charges was reduced with higher amount in most GCC countries as shown in Figure 3.8.

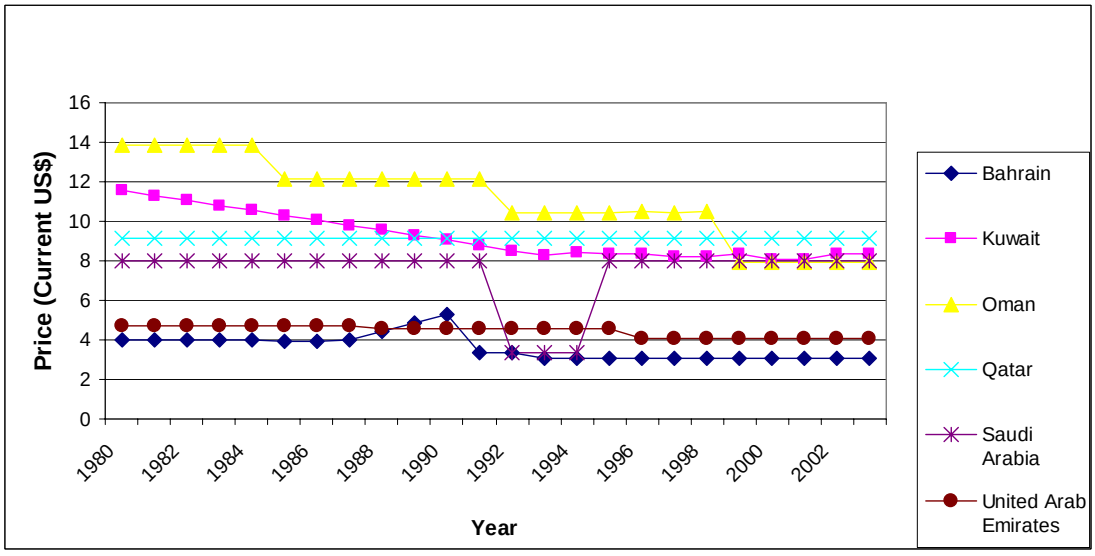

Figure 3.7: Fixed Line Monthly Subscription Charges.

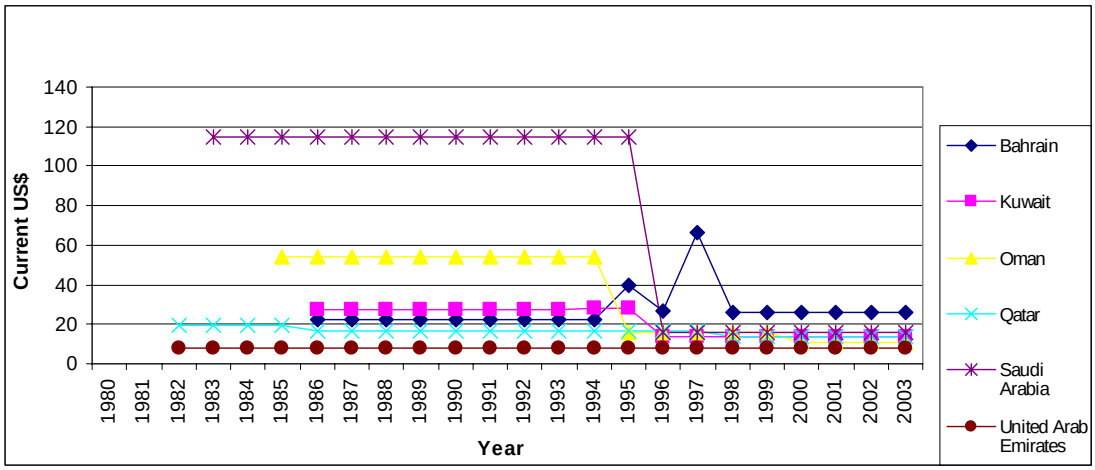

Figure 3.8: Mobile Service Monthly Subscription Charges.

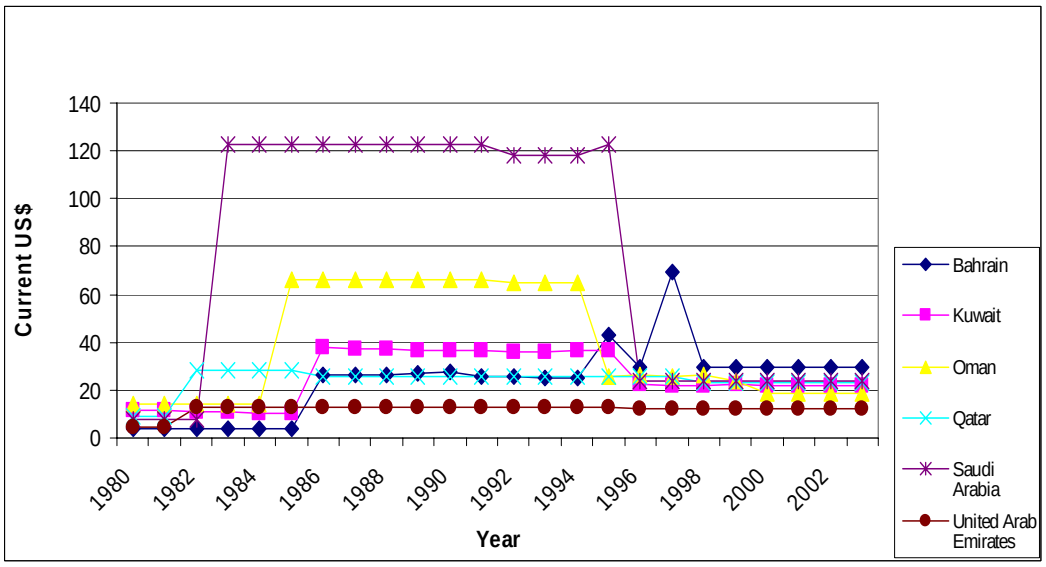

Figure 3.9: Telecommunication Services Monthly Subscription Charges.

3.3.5 Hypothesis 8 Result

The introduction of new technology, represented by Internet access using Dial-up option, was found not significant to fixed line services. Nevertheless, *H8* had a strong significance in cases of mobile and total telecommunication services. This indicated that the effect of introducing second generation of mobile services promoted demand over mobile services, while introducing internet access over fixed-lines did not have effect on fixed line demand. This finding may also indicate that new fixed line subscribers might have switched from fixed line services to mobile services. This result is supported by Figure 3.1 and 3.2 where demand on fixed line service has been decreased in the last 5 years in most GCC countries, as in UAE and Kuwait while mobile demand kept increasing sharply.

3.3.6 Hypothesis 10 Result

Time trend variable showed a strong positive relationship with demand on telecommunication services, pointing to an increase of demand over time for mobile and total telecommunication services. However, in the case of fixed line demand, it was insignificant; indicating that demand over fixed line is not having a constant increase over time. This could be attributed to the fact that not much innovation was added to fixed line services in a way that attracts customers to demand this service. This indicates that customer started to lose interest in fixed line service and operators should start working on making it more attractive to customers. It is noticed that GCC countries are still in a growing phase of telecommunication services and they have not reached saturation level. Therefore, there is still a lot of room in the market for competition and for private investment to satisfy the growing demand.

3.4 Supply Model Results and Analysis

Detailed results of Supply Model (Model 2) described by Eq-2 are presented in Appendix B, Table B.3. Hypothesis testing results fixed-line, mobile and total telecom services are indicated in Tables 3.7, 3.8 and 3.9.

Table 3.7
Model 2 - Case 1 Results (Supply of Telecom with Fixed Line Services Effect)

Hypothesis	Variable	Coefficient P-Value	Observation	Hypothesis Test
H7	GCC Infrastructure Investment	0.420866 (0.0000***)	Strongly Significant	Satisfied
H3	GPD per capita	-0.083850 (0.5898)	Not Significant	Not Satisfied
H6	Telecommunication Price	-0.277579 (0.0428***)	Strongly Significant	Satisfied
H9	New Technology	0.513697 (0.0001***)	Strongly Significant	Satisfied
H11	Time Trend	0.337551 (0.0056***)	Strongly Significant	Satisfied

Note. *, ** and *** indicates statistical significance at the 14%, 10% and 5%, respectively.

Table 3.8

Model 2 - Case 2 Results (Supply of Telecom with Mobile Services Effect)

Hypothesis	Variable	Coefficient P-Value	Observation	Hypothesis Test
H7	GCC Infrastructure Investment	0.435293 (0.0000***)	Strongly Significant	Satisfied
H3	GPD per capita	-0.388318 (0.1010**)	Significant	Not Satisfied – Negative correlation
H6	Telecommunication Price	-0.189635 (0.0546**)	Significant	Satisfied
H9	New Technology	0.419732 (0.0012***)	Strongly Significant	Satisfied
H11	Time Trend	0.260883 (0.0392***)	Strongly Significant	Satisfied

Note. *, ** and *** indicates statistical significance at the 14%, 10% and 5%, respectively.

Table 3.9

Model 2 - Case 3 Results (Supply of Telecom Services)

Hypothesis	Variable	Coefficient P-Value	Observation	Hypothesis Test
H7	GCC Infrastructure Investment	0.404929 (0.0000***)	Strongly Significant	Satisfied
H3	GPD per capita	0.024135 (0.9018)	Not Significant	Not Satisfied
H6	Telecommunication Price	0.078757 (0.3883)	Not Significant	Not Satisfied
H9	New Technology	0.546750 (0.0001***)	Strongly Significant	Satisfied
H11	Time Trend	0.345233 (0.0069***)	Strongly Significant	Satisfied

Note. *, ** and *** indicates statistical significance at the 14%, 10% and 5%, respectively

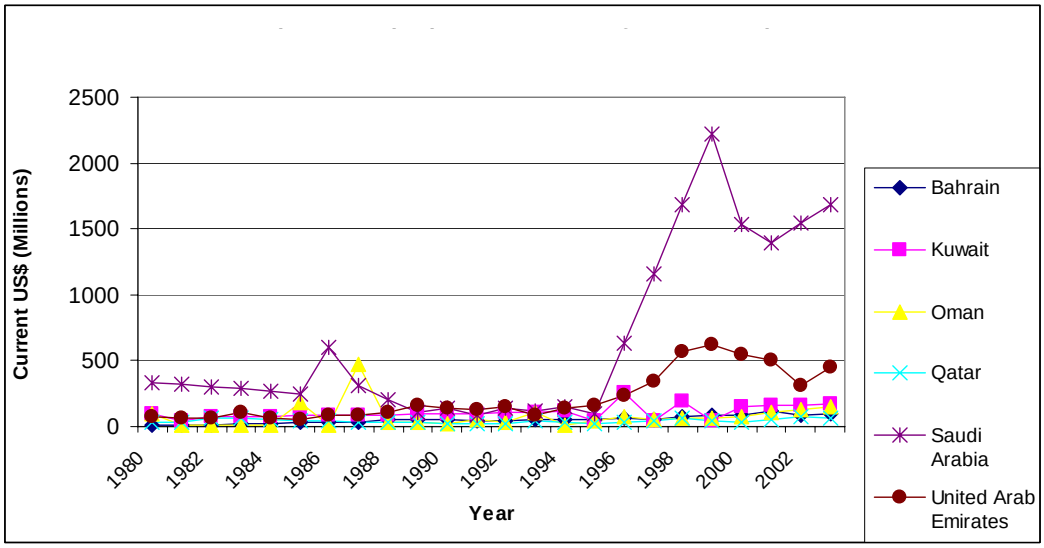

Figure 3.10: Telecommunication Investments of GCC Countries.

3.4.1 Hypothesis 7 Result

GCC countries infrastructure growth represented by gross fixed capital formation was highly significant to telecommunication supply with positive effects. Hypothesis 7 is supported under the effect of fixed line, mobile and total telecommunication services prices. It appears that telecommunication supply is driven by the infrastructure growth, especially under monopoly. Telecommunication operators had no choice but to invest to meet infrastructure expansion.

3.4.2 Hypothesis 3 Result

GDP per capita is found to be not significant to both fixed line and total telecom supply; while it was found to be weakly significant for mobile service. It appears that GDP level has no effect on the investment placed by the telecommunication operators on fixed line projects. Incumbent telecom operators, of GCC countries, enjoyed a monopoly state during most of the study period. These companies income was not affected and accordingly level of their yearly investment was not affected as well. It is rather noticed that due to the absence of competition, most operators kept a constant level of investment with minimal increase over the years, as can be seen in the case of Kuwait, Oman and Qatar.

In the case of mobile services, there is negative correlation with weak significance. Countries with lower GDP per capita invests more in mobile infrastructure as found true in the case of Saudi Arabia but not true in the case of Oman. The result is biased to Saudi Arabia because their investment value is much higher than the rest of GCC countries over most of the years, as shown in Figure 3.10. The sharp increase in investment of Saudi Arabia after 1995 indicates their high investment in their mobile service infrastructure to cover a wider geographical area compared to other GCC countries. Oman has not shown similar investment to expand their mobile network over the same period.

3.4.3 Hypothesis 6 Result

Price of telecommunication service is significant to its supply with negative effect for fixed-line and mobile services. Thus, H6 is supported and supply is elastic to price of telecommunication services. Lower prices which telecommunication

operators can offer, means more customers can afford having the service and accordingly more revenue. Regardless of the high investment telecommunication operators would decide to place, they should make sure that their investment provides income. From Figure 3.8, one can notice that Saudi Arabia, Kuwait and Oman had a sharp decrease in the price of their mobile services. Right after this decrease an increase in the amount of investment by these countries was monitored.

Interestingly in the UAE supply example, the incumbent telecommunication operator, Etisalat, did not use its monopoly to raise the prices of mobile services since 1982. Although they increased the mount of their supply starting from 1996 up to present time, their price decreased minimally over this period of time. Etisalat have been offering its mobile service at the lowest rate among all other GCC countries since 1980 up to now but at almost a static rate. This policy by Etisalat was fruitful for UAE where it has the highest fixed line and mobile services penetration over all other GCC countries.

3.4.4 Hypothesis 9 Result

H9 is supported in all cases of supply model. The coefficient of the new technology dummy variable captured a highly significant increase of investment in fixed line as well as in mobile services. Telecommunication operators in GCC countries are working on introducing the latest technologies to the local markets. This kept the GCC telecommunication infrastructure at state of art with world latest technology. The adoption of new technology may vary in the response of the telecommunication operator form one country to the other. Introducing competition in the market will prompt GCC operators to get the latest technology promptly to increase their sales and increase their customer base.

3.4.5 Hypothesis 11 Result

The time trend coefficient showed a strong evidence of growth of telecommunication investment in GCC countries to improve and increase their infrastructure. H11 is supported by all cases of supply model. In average, every three months (1% change in time over the study period of 23 years), telecommunication operators increase their investment in telecommunication by 0.31 percent.

3.5 Economical Growth Model Results and Analysis

Detailed results of Economical Growth Model (Model 3) described by Eq-3 are presented in Appendix B, Table B.4. Hypothesis testing results fixed-line, mobile and total telecom services are indicated in Tables 3.10, 3.11 and 3.12.

Table 3.10
Model 3 - Case 1 Results (Economical Growth with Fixed-Line Income Effect)

Hypothesis	Variable	Coefficient P-Value	Observation	Hypothesis Test
H14	Gross Fixed Capital Formation per Labor	0.095656 (0.0898**)	Significant	Satisfied
H12	Telecommunication Income (Demand)	0.866719 (0.0000***)	Strongly Significant	Satisfied
H13	Telecommunication Investment (Supply)	-0.046238 (0.0721**)	Significant	Not Satisfied – Negative correlation
H15	New Technology	0.125689 (0.0184***)	Strongly Significant	Satisfied

Note. *, ** and *** indicates statistical significance at the 14%, 10% and 5%, respectively.

Table 3.11
Model 3 - Case 2 Results (Economical Growth with Mobile Income Effect)

Hypothesis	Variable	Coefficient P-Value	Observation	Hypothesis Test
H14	Gross Fixed Capital Formation per Labor	0.104102 (0.1981)	Not Significant	Not Satisfied
H12	Telecommunication Income (Demand)	0.095998 (0.0257***)	Strongly Significant	Satisfied
H13	Telecommunication Investment (Supply)	-0.135023 (0.0092***)	Strongly Significant	Not Satisfied – Negative correlation
H15	New Technology	0.141144 (0.0201***)	Strongly Significant	Satisfied

Note. *, ** and *** indicates statistical significance at the 14%, 10% and 5%, respectively.

Table 3.12
Model 3 - Case 3 Results (Economical Growth with Total Telecom Income Effect)

Hypothesis	Variable	Coefficient P-Value	Observation	Hypothesis Test
H14	Gross Fixed Capital Formation per Labor	0.136573 (0.1179*)	Weakly Significant	Satisfied
H12	Telecommunication Income (Demand)	0.272836 (0.0035***)	Strongly Significant	Satisfied
H13	Telecommunication Investment (Supply)	-0.090298 (0.0463***)	Strongly Significant	Not Satisfied – Negative correlation
H15	New Technology	0.156854 (0.0066***)	Strongly Significant	Satisfied

Note. *, ** and *** indicates statistical significance at the 14%, 10% and 5%, respectively.

3.5.1 Hypothesis 14 Result

Production of labor capital in term of stock of capital found significant and weakly significant, when the effect of fixed line income was considered in case 1 and case 3 of Model 3 results. H14 supported for cases 1 and 3, while it was not supported when mobile income effect was considered in model 3. The effect of income generated from Mobile service is higher than the income generated from fixed line services. Therefore, the result found here suggests GDP per capita started not to be dependent on labor production in GCC countries and this finding appears when stronger telecommunication income contribution is considered in Model 3.

3.5.2 Hypothesis 12 Result

Incomes generated by fixed line, mobile and total telecommunication services are highly significant to GDP per capita. The more the income generated by these services the higher the level of economical growth would be obtained by GCC countries. An increase of 1 percent in number of fixed line subscribers will cause an increase of 0.87% in economical growth. While in the cases of mobile services and total telecommunication services, a one percent increase will cause an increase of 0.096% and 0.27% consecutively. Although, mobile contribution in to the economical growth of GCC countries is less than fixed line, it is expected to exceed the fixed line effect in the next few years. The reason is that income generated from mobile service started to take place later than fixed line services. Moreover, introduction of competition into the mobile market will expedite its effect toward additional growth of GCC countries. Based on the above, H12 is highly supported and it indicates that income generated by telecommunication sector is already part of GCC countries economy and any increase in the income generated by this sector would contribute to their economical growth.

Liberalizing telecommunication sectors of GCC countries would attract more foreign and private investments in the sector. This high investment placed in the sector would be an element of economical growth in GCC countries. Competition will also change the pricing criteria in the telecommunication market. Instead of having the prices decided by the monopoly telecommunication operator, prices will be decided by the supply and demand natural competitive market interaction. In state of monopoly, suppliers have to keep prices above their marginal benefit cost which is

above the demand cost to avoid losses. However, under competition, telecommunication suppliers can sell all the quantity they have at the demand price. Therefore, penetration on telecommunication services would increase rapidly under competition driving up with it the income generated and the economic growth.

3.5.3 Hypothesis 13 Result

Hypothesis 13 was not supported by model 3. Nevertheless, the coefficient of telecommunication investment explanatory variable was found significant in case 1 and strongly significant in cases 2 and 3, but with negative correlation. As was seen previously from supply model, Saudi Arabia which has a fairly low GDP per capita, compared to other GCC countries, placed huge amount of investment from 1996 to 2003. This amount of investment did not have a significant effect to boost economical growth. The negative effect of monopoly market state prevented investment of telecommunication operators to be part of economical growth in GCC countries since the supply of telecommunication is not demand driven. Telecommunication companies of GCC countries have not been placing much investment over marketing their services. This is also expected to change under competition state and more emphasis and resources will be invested to gain customers. It would be interesting to know how investment will take place into economical growth of GCC countries over the next decade under competitive market. Although H13 did not hold in our model for the time being but it is expected to hold after few years from this study period.

3.5.4 Hypothesis 15 Result

H15 was found strongly significant in all cases of Model 3. Introduction of new telecommunication technologies lead to increase in GDP per capita. Based on model results we can say that introducing a new technology to the fixed line and to mobile services will cause an increase of 0.126% and 0.14%, consecutively, to GDP per capita of GCC countries every year.

CHAPTER 4
4. UAE CASE STUDY

In the case study of UAE, the research seeks to investigate the Demand on and the Supply of telecommunication services in the local telecommunication market. Also, the study would investigate the effect of the strong infrastructure of UAE into the economical growth of the country. Before starting to investigate and analyze the results of UAE case study, this chapter will provide an overview of UAE telecommunication sector evolution and current infrastructure.

4.1 UAE Telecommunication Sector History and Evolution

Right up to the 1950s, distance communication in UAE was a traditional mail services and the occasional radio. In 1951 & 1952 two British Telecommunication Companies started their business in separate Emirates of UAE. Cable & Wireless company, which was established in Sharjah and Ras Al Khaima, provided telephony and telegraph services. International Aeradio Limited (IAL), in Abu Dhabi and Dubai, provided post office and telegraph services.

In 1971 the UAE Federation took place and in the process of laying the country foundation toward future challenges, the government of UAE issued the Federal Decree No. 78 of 1976 to establish the Emirates Telecommunication Corporation Limited (EMIRTEL). EMIRTEL was an amalgamation of the government, Cable & Wireless and IAL. The dividend of shares was 60% Government and 20% for each of the previously mentioned companies. The decree gave Emirtal the exclusive right to provide telecommunication services and equipment using its facilities.

UAE government started to buy the British shares by 1979 and registered names of interested UAE nationals as owners in the process to nationalize the corporation ownership. The following years between 1980 to 1983 the government continued distributing/selling shares to UAE nationals until EMIRTEL became 100% national where 60% still owned by the government and 40% owned by nationals. Ras Al Khaima did not joint EMIRTEL until 1980 where it used to have a strong infrastructure in its time. EMIRTEL changed its name to Etisalat in 1986 in a move to

nationalize the corporation short name and the name became Emirates Telecommunication Corporation.

In 1991 the Federal Act number 1 of 1991 in respect of Emirates Telecommunication Corporation came to strengthen the monopolistic position of the corporation in UAE. The Act provided Etisalat with ultimate rights to issue licenses and permissions for ownership, importation, manufacturing and operation of telecommunication equipment. It also placed Etisalat in charge of telecommunications traffic between UAE and the outside world.

In 1993, Etisalat announced its policy of liberalizing the market of telecommunication equipment and since then it was no longer the provider of all telecommunication devices in the market. This policy by Etisalat was a natural response to the large expansion in the devices market world wide. Private businesses have been competing to provide the various types of customer apparatus.

On April 2004 a the federal decree No.3 of 2003 was issued to liberalize the UAE's Telecommunication market and to reorganize the telecommunication sector. The decree initiated two bodies: The Supreme Committee to oversee the telecommunication sector. The second body is the Regulatory Authority with a mission of regulating the sector and assuring fair competition in the market. The Regulatory Authority will work under the guidance and the direction of the Supreme Committee to supervise and regulate the telecommunication services in UAE. This law repealed the exclusive power granted to Etisalat by Law No.1 of 1991.

Etisalat started taking new route of exploring the international markets in 2004. In August, 2004 Etisalat won the operation of the second mobile telephone license in Saudi Arabia and it is currently operating there under Etihad Etisalat. Etihad Etisalat was awarded to operate GSM, 2.5G and 3G mobile networks at a bid offer of $3.25 billion. This remarkable achievement of Etisalat was followed by the award of wining the operation of the second fixed line services in Sudan through a 40% stake in the Kanartel consortium [30]. The liberalization movement in UAE and in the Arab World helped Etisalat to explore other markets than UAE and from to strong foundation they have established in UAE, gave them a force to explore investing in international markets.

The Telecommunication Regulatory Authority approved the establishment of a new telecommunication company in May 2005. Forty percent of the new company is held by the General Pensions and Social Security and other private shareholders. The remaining stack will be allocated for private sector and public.

4.2 UAE Telecommunication Infrastructure

The UAE took a major leap to diversify and liberalize its economy. UAE was ranked as the twenty fourth country, worldwide, in the index of Economic Freedom in 2002 by the Heritage Foundation and the Wall Street Journal. Government incentives have moved country into and information and knowledge based society. Based on the Information Society Index (ISI), published by the United States' IDC Group, UAE is ranked the twenty seventh out of fifty five countries among the top information technology users in the world. The ISI index measures the achievements of the country in Information and Communication Technologies (ICTs), the level of use and ability to handle with IT development. The UAE is the most wired nation in the Arab World and it is one of the top countries of the internet users in the region where it has around 25 percent of the internet users [31].

Etisalat which is the incumbent telecommunication operator of UAE is set in a corporation format where it has the characteristic of a private company and the government owns 60% of its shares. Etisalat was set away from the government control since its establishment in 1976. Etisalat ownership setting allowed it to invest and expand its network away from government bounds and made it adopt a profit maximization approach as any private company.

Fixed telephone, mobiles and data services are three main services provided by Etisalat. In year 2004, fixed line subscribers reached 1.188 Million subscribers, while mobile subscribers reached 3.683 million subscribers achieving a penetration rate of 88%. The number of internet subscribers in dialup service reached 362.93 thousand subscribers, while for Al Shamil and Business 1 the number of subscribers were 44.9 and 10.64 thousands consecutively. Accordingly, the number of internet users in UAE is estimated to be 1.7 million achieving a penetration rate of 41%. Figure 4.1 shows UAE infrastructure subscribers' progress from 1990 to 2004. In 2003, 36% of national calls were initiated from fixed lines and 12% of mobile calls were terminated on fixed lines. The number of payphones by end of 2003 was 26,718 [30, 32].

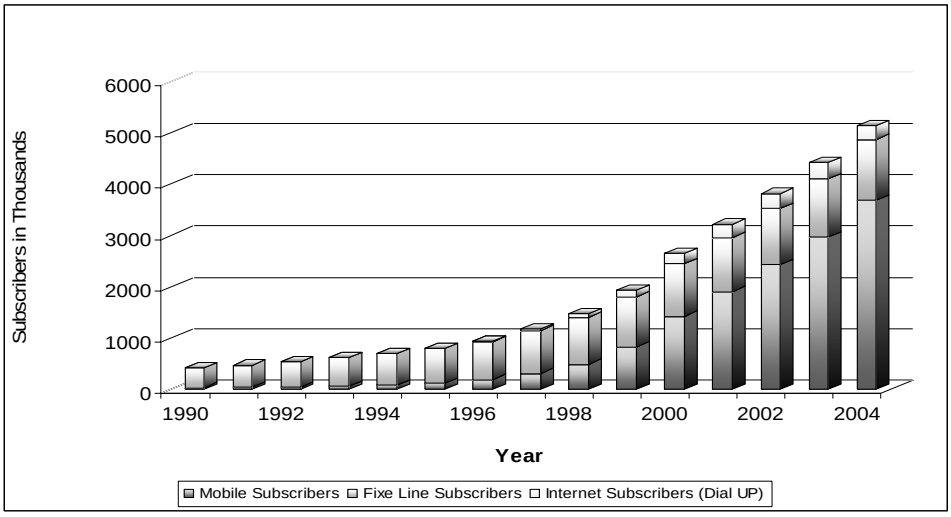

Figure 4.1: Subscribers of Etisalat Services

Etisalat was one of the first operators to introduce mobile phone services in the Middle East in 1982. Mobile phone is the most popular way of communication in UAE. It has been growing at high rate since it was introduced. Mobile service provided by Etisalat covers SMS, MMS, Internet and email availability over EWAP or the faster GPRS as MNET. GPRS introduced IP capability to GSM mobile network delivering data at speed up to 115 kbps. Early 2003 Etisalat launched third generation (3G) mobile system (UMTS) which offers the capability of video calls as well as broadband wireless packet services.

Data service is growing with the growth of Internet and e-commerce. Etisalat's data services revenue is generated from leased line, ISDN facility, voice mail and text messaging. The net revenue of 2004 for Etisalat was 2.843 billion US$. Figure 4.2 shows the break down of this revenue in term of Etisalat's main services [30].

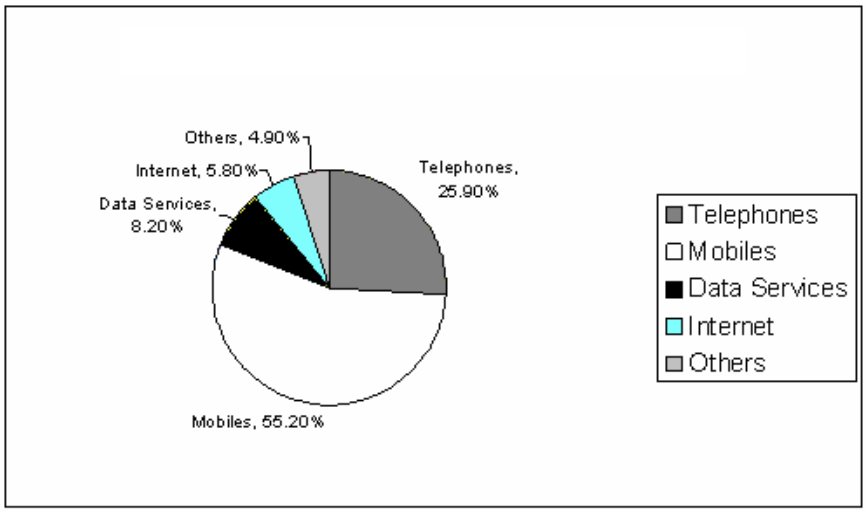

Figure 4.2: Break-Down of Net Revenue of Etisalat for the Year 2004 [30]

4.3 Performance Measure and Models Validation

The models that are considered for UAE case study are the same three Models and Cases of each model that were stated in Chapter 2, Section 2.8. The models presented in Eq-1, Eq-2 and Eq-3 were applied only to UAE data sets. To estimate the mean coefficients of independent variables, Least Square (LS) method was used. Then the models were checked for regression equation goodness by investigating and adjusting for multicollinearity, residuals heteroscedasticity and residuals autocorrelation.

4.3.1 Variables Multicollinearity

In UAE case study, many cases of the applied models showed symptoms of multicollinearity. It was noticed that there is high level of model correlation, represented by Adjusted R^2, but very few variables were significant as can be seen in Appendix C, Tables C.1, C.2 and C.3 for Model 1, Model 2 and Model 3, respectively.

Models with multicollinearity problem are:

- Model 1 - Case 2 and Case 3
- Model 2 - All Cases
- Model 3 - All Cases

The following steps were followed to further investigate and adjust for the problem.

1. Find Auxiliary Regression results of model by regressing every independent variable on other model's variables. This method was explained in Chapter 3, Section 3.1.1.
2. Investigate correlation strength between variables.
3. Adjust the model by removing variables with high correlation and observe changes in variables significance.

To demonstrate the procedure followed to adjust for multicollinearity that appeared in UAE models, only Model 1 will be discussed in the following section. Details on how Model 2 and Model 3 were adjusted are summarized in Appendix C.

4.3.1.1 Auxiliary Regression Results

Tables 4.1 through 4.7 show Auxiliary Regression of models' independent variables. The results found in these tables support the finding of multicollinearity between variables in UAE case study models. As indicated in Chapter 3 Section 3.1.1, significant probability of F-statistics along with Adjusted R^2 value higher than 0.8 indicates strong presence of multicollinearity in the model [23]. Table 4.1 and Table 4.2 show the auxiliary regression results of Model 1, Case 2 and Case 3 consecutively.

Table 4.1
Auxiliary Regression Results of Model 1- Case 2

Regressed Independent Variable	Adjusted R^2	F-Statistics	Prob.(F-statistics)
Population	0.99	532.63	0.0000*
GPD per capita	0.10	1.43	0.2714
Telecommunication quality	0.93	56.38	0.0000*
Telecommunication Price	0.17	14.98	0.1686
New Technology	0.78	14.98	0.0000*
Time Trend	0.99	554.15	0.0000*

Note. * indicates statistical significance at the 5%.

Table 4.2
Auxiliary Regression Results of Model 1- Case 3

Regressed Independent Variable	Adjusted R^2	F-Statistics	Prob.(F-statistics)
Population	0.99	2425.24	0.0000*
GPD per capita	0.45	3.34	0.0290*
Telecommunication quality	0.98	134.91	0.0000*
Telecommunication Price	0.88	21.83	0.0000*
New Technology	0.86	18.57	0.0000*
Time Trend	0.99	541.79	0.0000*

Note. * indicates statistical significance at the 5%.

Auxiliary regression results of Model 2 and Model 3 can be found in Appendix C, from Table C.4 to Table C.8.

4.3.1.2 Variables Correlation and Models Re-specifications

In this section, the correlation strength between models variables is calculated. Then variables with high correlation were pointed out and models were re-specified

accordingly. During the model re-definition process, only one variable with the highest correlation was taken out of the model at a time. Then auxiliary regression was recalculated without this variable. If the recalculation of the auxiliary regression showed no indication of multicollinearity, only this variable will be removed from the model without removing any other variable with high correlation. On the other hand, if removing one variable did not reduce multicollinearity then a second variable will be removed from the model.

4.3.1.2.1 Adjusted Model 1 for UAE Case Study

Table 4.3 shows calculated correlation between variables used in Model 1.

Table 4.3
Model 1 Variables Correlation

	Log (GDPC)	***Log (POP)***	***Log (staf)***	***Log (pen+wl)***	***Log (penm)***	***Log (pent+wl)***	***Log (TP)***	***Log (TPM)***	***Log (TPT)***
log(GDPC)	1								
log(POP)	-0.45111	1							
log(staf)	-0.12139	**0.90383**	1						
log(pen+wl)	-0.51767	**0.93268**	0.75611	1					
log(penm)	-0.18115	**0.99548**	**0.93707**	0.8985502	1				
log(pent+wl)	-0.32187	**0.98458**	**0.95229**	0.880697	0.989028	1			
Log(TP)	0.232797	**-0.9053**	**-0.9258**	**-0.847844**	-0.91959	-0.91986	1		
Log(TPM)	0.274827	-0.4105	-0.2382	-0.649857	-0.37358	-0.31	0.36691	1	
Log(TPT)	-0.69292	0.40104	0.16957	0.4512919	-0.92114	0.325187	-0.2223	0.37699	1
M	-0.16606	**0.84723**	**0.89436**	0.7676317	**0.860683**	**0.854064**	**-0.9128**	-0.3252	0.16939

Note. Values in Bold, represent correlation level higher than 0.8 between variables of Model 1.

From variables correlation results of Model 1 the followings are noticed:

- *Case 2:* population, telecommunication staff and new technology had high correlation with demand of mobile services.
- *Case 3:* population, telecommunication staff and new technology had high correlation with demand of total services.
- Population and Telecommunication Staff will be removed from model 1 for cases 2 and 3. Testing the auxiliary regression of remaining variable after removing population and staff was below 0.80 for remaining independent variables indicating that the effect of multicollinearity was taken from the model. Accordingly the dummy variable of introduction of new technology will remain in the model regardless its high correlation with the dependent variable.

New Model 1 for UAE case study would be as follows for Case 2 and Case 3:

$$Log(TD_t) = \beta_1 + \beta_2 \log (GDPC_t) + \beta_6 \log (TP_t) + \beta_7 M + \beta_8 \log (TD_{t-1}) + \varepsilon_t \quad \text{(Eq-4)}$$

Table 4.4 shows specific demand model changed variables of the new cases of Model 1.

Table 4.4
Specific Demand Model New Cases and Changed Variables

Cases	Model	TD Indicators	TP Indicators
Case I	Demand of Fixed Line Service	PEN + WL	TP
Case II	Demand of Mobile Services	PENM	TPM
Case III	Demand of Telecommunication Services	PENT + WL	TPT

4.3.1.2.2 Adjusted Model 2 for UAE Case Study

Calculated correlation between Model 2 variables are stated in Appendix C, Table C.9

The following are concluded from variables correlation results:

- Gross fixed capital formation and GDP per capita are highly correlated with each other. Thus, they will be removed alternatively from the model.
- Telecommunication Price of fixed line service is highly correlated with telecommunication investment. Taking it out of the model will give us a model of general telecommunication investment without any services price effect. Therefore, the case of telecommunication supply with fixed-line price effect will be canceled for UAE case study.
- Although, new technology dummy variable is highly correlated with Telecommunication Investment, it will not be removed from the model. The reason is that after removing the previously mentioned variables, the auxiliary regression of model's variables produced an Adjusted R^2 less than 0.8 for all variables. This is an indication that the effect of multicollinearity was removed from the models and there is no need to reduce additional independent variable.

New Model 2 for UAE case study would be represented by the following equations:

$$Log (TS_t) = \varphi_1 + \varphi_2 \log (K_t) + \varphi_3 M_t + \varphi_4 \log (TS_{t-1}) + \varepsilon_t \quad \text{(Eq-5A)}$$

$$Log (TS_t) = \varphi_1 + \varphi_2 \log (GDPC_t) + \varphi_3 M_t + \varphi_4 \log (TS_{t-1}) + \varepsilon_t \quad \text{(Eq-5B)}$$

$$Log (TS_t) = \varphi_1 + \varphi_2 \log (K_t) + \varphi_3 \log (TP_t) + \varphi_4 M_t + \varphi_5 \log (TS_{t-1}) + \varepsilon_t \quad \text{(Eq-6A)}$$

$$Log (TS_t) = \varphi_1 + \varphi_2 \log (GDPC_t) + \varphi_3 \log (TP_t) + \varphi_4 M_t + \varphi_5 \log (TS_{t-1}) + \varepsilon_t \quad \text{(Eq-6B)}$$

Table 4.5 shows Model 2 Cases and specific changed variables.

Table 4.5
Supply Model Specific Changed Variables

Cases	Model	Specific Variable	TP Indicators
Case I - A	Supply Model without Price Effect	K	No Price
Case I - B	Supply Model without Price Effect	GDPC	No Price
Case II - A	Supply Model with Mobile Service price effect	K	TPM
Case II - B	Supply Model with Mobile Service price effect	GDPC	TPM
Case III - A	Supply Model with Total Telecom services price effect	K	TPT
Case III - B	Supply Model with Total Telecom services price effect	GDPC	TPT

4.3.1.2.3 Adjusted Model 3 for UAE Case Study

Table C.10 in Appendix C, shows calculated correlation between Model 3 variables. The following are observed from variables correlation results:

- Variables representing telecommunication income and telecommunication investment are highly correlated; however, they are not correlated with the dependent variable. Their effect on the dependent variable will be tested individually.
- Dummy variable of new technology is highly correlated with telecom income and investment. Similar to Model 2 after removing telecommunication income and telecommunication investment from the Model 3 simultaneously, the auxiliary regression test showed that there is no strong presence in multicollinearity in the model. Therefore, the dummy variable of new technology was not removed from Model 3.

New Model 3 for UAE case study would be represented by the following equations:

$$\text{Log}(GDPC_t) = \alpha_1 + \alpha_2 \log (K_t/TLF_t) + \alpha_3 \log (TI_t) + \alpha_4 M_t + \varepsilon_t \quad \text{(Eq-7A)}$$

$$\text{Log}(GDPC_t) = \alpha_1 + \alpha_2 \log (K_t/TLF_t) + \alpha_3 \log(TS_t) + \alpha_4 M_t + \varepsilon_t \quad \text{(Eq-7B)}$$

Table 4.6 shows Model 3 Cases and specific changed variables.

Table 4.6
Economic Growth Model Specific Changed Variables

Cases	Model	TI Indicators
Case I - A	Economical Growth Model with Fixed Line Income effect	PEN
Case I - B	Economical Growth Model with Mobile Income effect	PENM
Case I - C	Economical Growth Model with Total Telecom Income effect	PENT
Case II	Economical Growth Model with Telecommunication Investment effect	TTI

4.3.2 Residuals Heteroscedasticity

In the case study of UAE, the same correction method reported in section 3.1.2 was used for adjusting for heteroscedasticity in the model. However, due to the less number of observations available, White Heteroscedasticity Residual Test was used to detect the presence of heteroscedasticity in the model. The technique is a test of null hypothesis of no heteroscedasticity. The test statistic is generated from an auxiliary regression of squared residuals on all original variables, their squared value and their cross product. The obtained R^2 follows the chi-square (X^2) distribution [23, 28].

4.3.3 Residuals Autocorrelation

In models of UAE case study, the Breusch-Godfrey Lagrange multiplier (LM) is used instead of DW because of the small data set available. LM test is preferred over DW because it offers more accurate testing of no serial correlation in the residual. DW is usually used for sample sizes above 40 observations and is considered as a general test in econometric [23, 28]. However, LM method is more specific in detecting autocorrelation by testing its presence for every level separately [23]. For instance, LM tests for first order autocorrelation of residual error to decide on adding AR(1); then it tests again for second order autocorrelation to decide on adding AR(2); etc.

4.4 Demand Model Results

Detailed results of UAE Demand Model (Model 1) described by Eq-1 for Case I and by Eq-4 for Cases II and III are presented in Appendix C, Table C.11. Hypothesis testing results fixed-line, mobile and total telecom services are indicated in Tables 4.7, 4.8 and 4.9.

Table 4.7

Model 1 – Case I Result (UAE Demand of Fixed Line Services)

Hypothesis	Variable	Coefficient P-Value	Observation	Hypothesis Test
H1	Population	0.021784 (0.8706)	Not Significant	Not Satisfied
H2	GPD per capita	-0.145840 (0.0500***)	Strongly Significant	Not Satisfied – Negative Correlation
H4	Telecommunication quality	-0.228863 (0.0576**)	Significant	Not Satisfied – Negative correlation
H5	Telecommunication Price	-0.996125 (0.0015***)	Strongly Significant	Satisfied
H8	New Technology	-0.035937 (0.1916)	Not Significant	Not Satisfied
H10	Time Trend	0.999740 (0.0000***)	Strongly Significant	Satisfied

Note. *, ** and *** indicates statistical significance at the 14%, 10% and 5%, respectively.

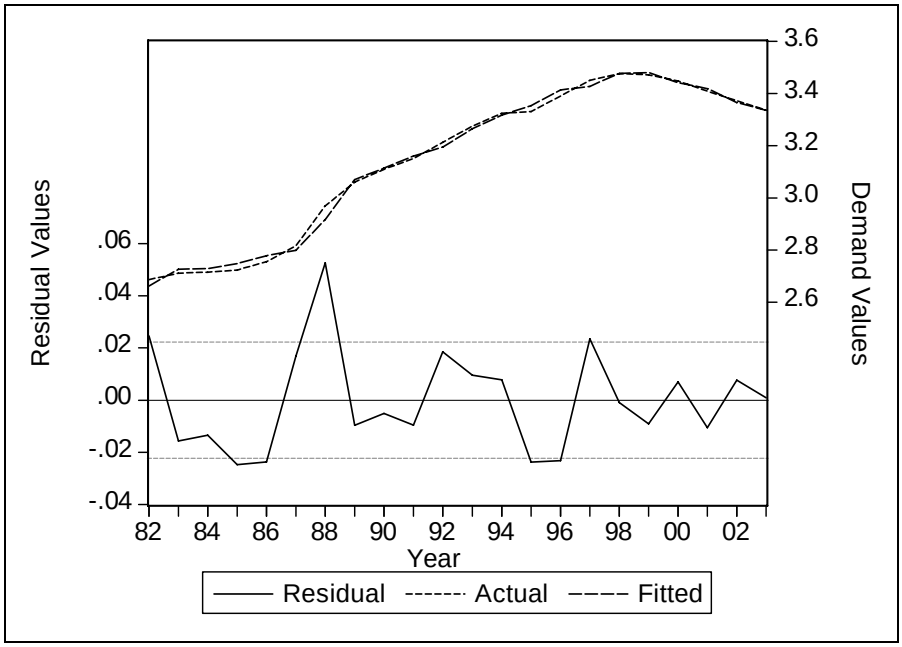

Figure 4.3: Demand of Fixed-Line Services Model Fitted Results

Table 4.8

Model 1- Case II Results (UAE Demand of Mobile Services)

Hypothesis	Variable	Coefficient P-Value	Observation	Hypothesis Test
H2	GPD per capita	0.275186 (0.3284)	Not Significant	Not Satisfied
H5	Telecommunication Price	-51.81741 (0.7311)	Not Significant	Not Satisfied
H8	New Technology	0.226867 (0.0726*)	Significant	Satisfied
H10	Time Trend	0.941125 (0.0000**)	Strongly Significant	Satisfied

Note. *, ** and *** indicates statistical significance at the 14%, 10% and 5%, respectively.

Table 4.9

Model 1 – Case III Results (UAE Demand of Telecommunication Services)

Hypothesis	Variable	Coefficient P-Value	Observation	Hypothesis Test
H2	GPD per capita	-0.056344 (0.4373)	Not Significant	Not Satisfied
H5	Telecommunication Price	-3.935543 (0.0036**)	Strongly Significant	Satisfied
H8	New Technology	-0.039956 (0.3303)	Not Significant	Not Satisfied
H10	Time Trend	0.958390 (0.0000***)	Strongly Significant	Satisfied

Note. *, ** and *** indicates statistical significance at the 14%, 10% and 5%, respectively.

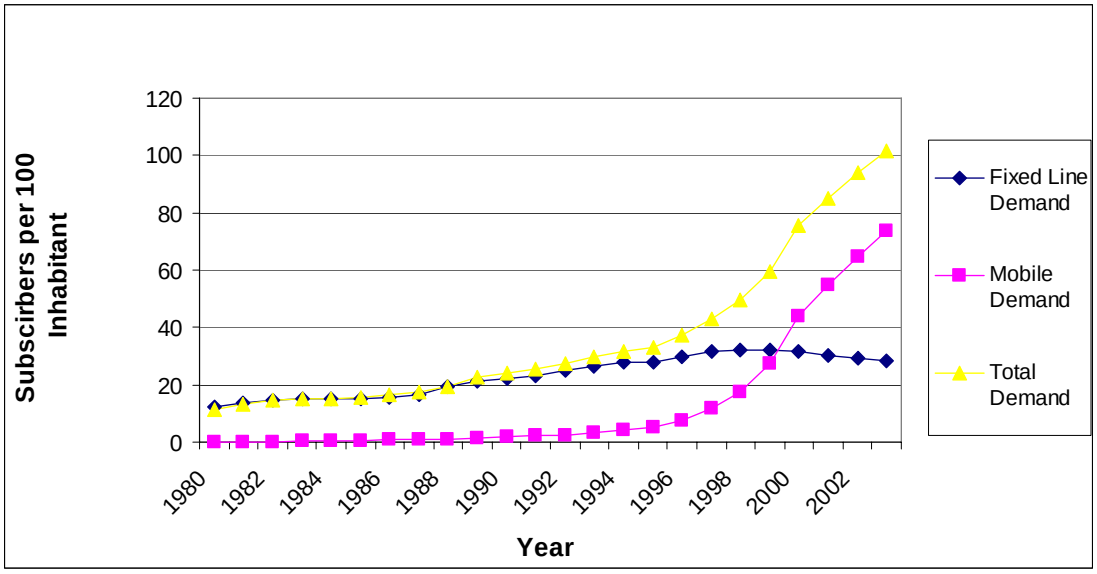

Figure 4.4: Actual Demand of UAE Telecommunication Services

Population was found not significant to demand on fixed line. Demand is growing in UAE regardless of the growth of the number population willing to subscriber to fixed-line services. H1 was not satisfied for Fixed-line services.

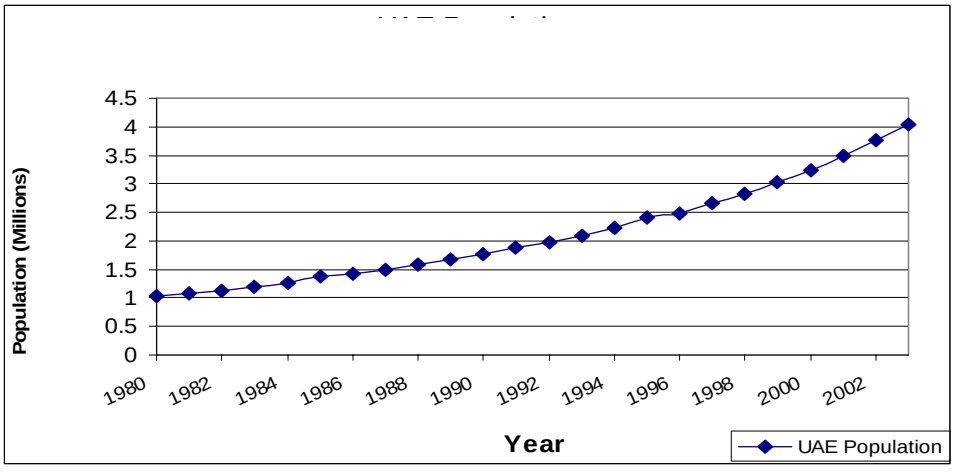

Figure 4.4: UAE Population

Demand of fixed line services is elastic to income. There is a negative relationship between GDP per capita and demand of fixed lines. When GDP per capita decreases by 1 percent, demand on fixed-line services would increase by 0.146 %. Examining GDP per capita of UAE in Figure 4.5, shows that UAE had high GDP in 1981 and started decreasing till 1986. In the same period, demand of fixed-line was increasing. Similar behavior noticed from 1991 to 1999. Accordingly obtained result of negative relationship is justified leading to conclusion that GDP per capita has no effect on increasing demand over all telecommunication services in UAE. H2 not supported for UAE market demand over telecommunication services.

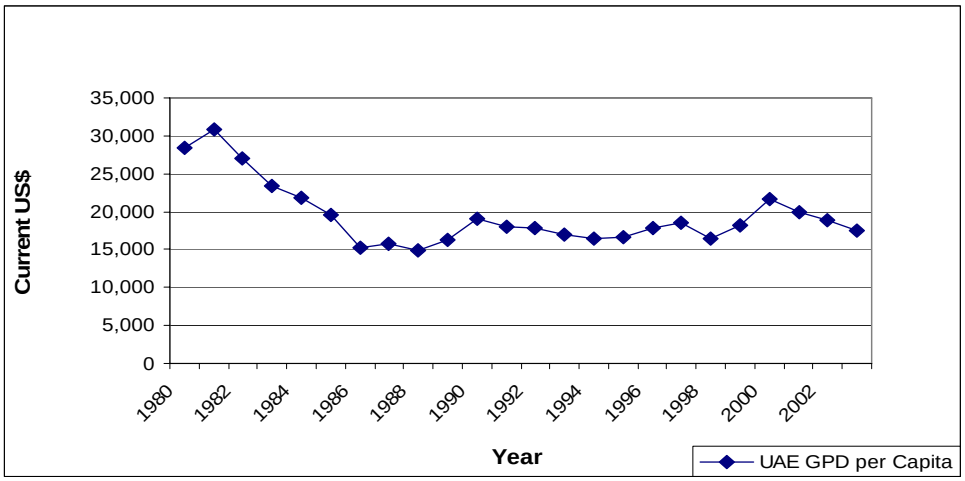

Figure 4.5: UAE GDP per Capita

Quality of telecommunication service is negatively significant to demand on fixed line service. This indicates that the increase of staff affected the demand negatively. This is not true because the period where demand over fixed line started to reduce is the same period where demand on mobile services started increasing sharply in UAE. Starting 1998 demand on fixed line starting decreasing while demand on mobile started increasing since 1996. In the same period of mobile demand increase, number of telecommunication staff started increasing to provide better mobile services, as shown in Figure 4.6. Hypothesis 4 was found not significant to fixed line services indicating that the increase of telecommunication staff added more value to introduction of second generation of mobile services.

It was not possible to test H4 for mobile service and total telecommunication service because of high correlation (above 0.9) between the dependent model variable and independent variable of Telecommunication staff. Nevertheless, the fact that there is high correlation between these two variables strongly indicates that the increase in

Quality of service represented in increase of telecommunication staff affected the demand growth over mobile services and overall telecommunication service in UAE.

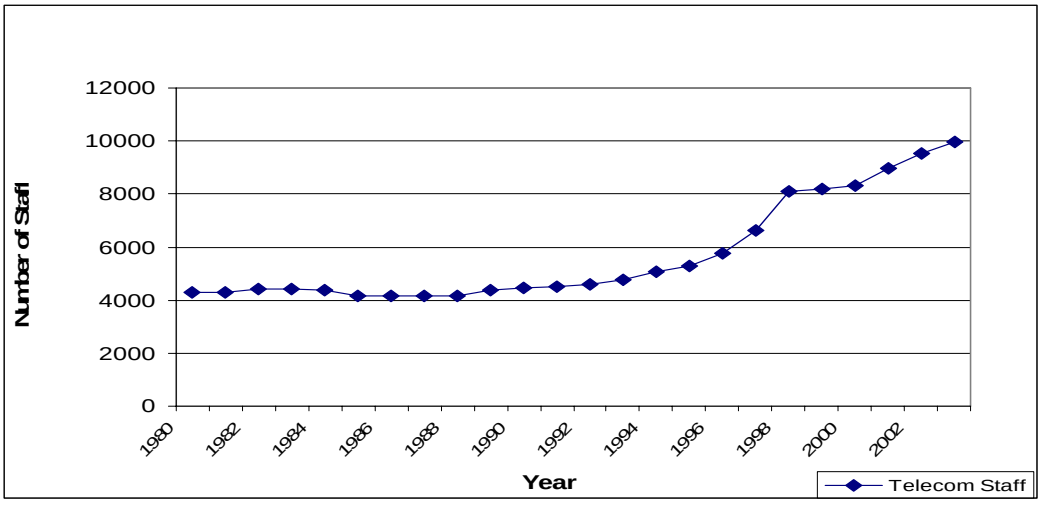

Figure 4.6: UAE Telecommunication Staff

Price of telecommunication service is highly significant to fixed line demand and to total telecommunication services. Hypothesis 5 is satisfied for fixed line and for total telecommunication services. A one percent decrease in price will cause a 0.996% increase in demand over fixed-line services and a 3.94% increase in Demand over total telecommunication services in UAE market.

However, price was found not significant to mobile demand. Figure 4.4 and Figure 4.7 show that regardless of demand increase over mobile service, mobile monthly subscription charges was kept at almost the same level throughout the study period The model here does not capture the effect of two witnessed elements of mobile price elasticity. The first element is Wasel prepaid GSM service offered by Etisalat at lower monthly charges because the measured price indicator is only for postpaid mobile services. Etisalat have also announced several reductions in the price of minute talk over GSM services and over Wasel services but did not reduce much the monthly subscription of GSM.

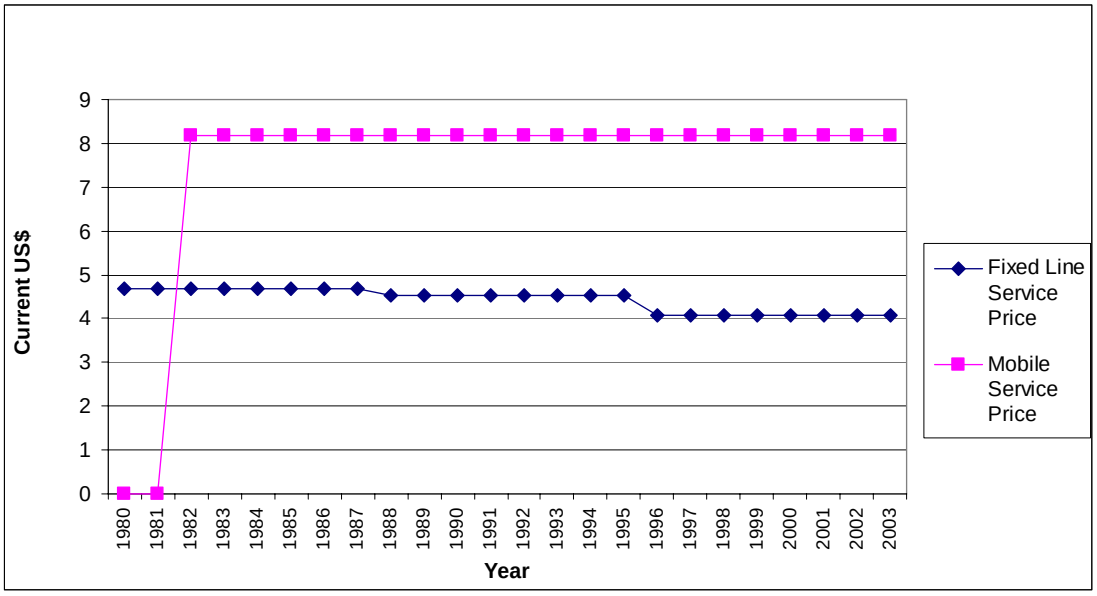

Figure 4.7: Fixed Line and Mobile Services Monthly Subscription Charges

The introduction of new technology was found not significant to fixed-line services; not supporting H8. The effect of introducing Internet did not contribute to increasing demand over fixed-line services because Etisalat offers many internet options only Dial-up internet access is based on fixed-line connections. Other broadband services such as ISDN access, Al-Shamel Cable connection and business one are offering internet access independently from fixed line. No international indicators were available to measure this effect on accessing the internet to consider its effect in the model. It is worth mentioning that considering 20% degree of significant, there is a negative correlation between introduction of new technology and demand of fixed line services. This negative effect can be related to the introduction of second generation of mobile services and having people demanding mobile services over fixed line.

The dummy variable of the introduction of second generation mobile services was found significant to demand of mobile services. H8 is supported for demand over mobile service. An introduction of new technology in mobile services will cause demand over it increase by an average of 0.227% every 3 months (calculation of 1% increase in time over model's study period of 23 years).

Time trend variable is found highly significant to demand of telecommunication services in UAE which indicates an increase on demand over time. H10 is supported for all demand cases. Based on the result of H10, UAE demand over telecommunication is growing indicating a need for more advanced telecommunication services in the market. It also indicates that introduction of new

operator in the market will be welcomed by customers who are looking for competitive offers from service providers. Thus, liberalization of the sector will promote increased supply in the sector to satisfy the increasing demand.

4.5 Supply Model Results

Detailed results of UAE Supply Model (Model 2) of Case I, Case II and Case III are presented in Appendix C, Table C.12, Table C.13 and Table C.14 consequently. Hypothesis testing results of Case I-A, and Case I-B of model 2 are listed in Tables 4.10 and 4.11. Results of Case II are listed in Table 4.12 and Table 4.13. While tables 4.14 and 4.15 has results summary of Case III.

Table 4.10
Model 2 - Case I-A Results (Supply of Telecom without Price Effect)

Hypothesis	Variable	Coefficient P-Value	Observation	Hypothesis Test
H7	UAE Infrastructure Investment	-0.108790 (0.2783)	Not Significant	Not Satisfied
H9	New Technology	0.621634 (0.0454***)	Strongly Significant	Satisfied
H11	Time Trend	0.634999 (0.0011***)	Strongly Significant	Satisfied

Note. *, ** and *** indicates statistical significance at the 14%, 10% and 5%, respectively.

Table 4.11
Model 2 - Case I-B Results (Supply of Telecom without Prices Effect)

Hypothesis	Variable	Coefficient P-Value	Observation	Hypothesis Test
H3	GPD per capita	-0.551468 (0.1294)	Not Significant	Not Satisfied
H9	New Technology	0.546412 (0.0248***)	Strongly Significant	Satisfied
H11	Time Trend	0.623934 (0.0004***)	Strongly Significant	Satisfied

Note. *, ** and *** indicates statistical significance at the 14%, 10% and 5%, respectively.

Table 4.12

Model 2 – Case II-A Results (UAE Supply of Telecom with Mobile Services Price Effect)

Hypothesis	Variable	Coefficient P-Value	Observation	Hypothesis Test
H7	UAE Infrastructure Investment	-0.069954 (0.8656)	Not Significant	Not Satisfied
H6	Telecommunication Price (TPM)	-277.2547 (0.3993)	Not Significant	Not Satisfied
H9	New Technology	0.575549 (0.0710**)	Significant	Satisfied
H11	Time Trend	0.607103 (0.0025***)	Strongly Significant	Satisfied

Note. *, ** and *** indicates statistical significance at the 14%, 10% and 5%, respectively.

Table 4.13

Model 2 - Case II-B Results (UAE Supply of Telecom with Mobile Services Price Effect)

Hypothesis	Variable	Coefficient P-Value	Observation	Hypothesis Test
H3	GPD per capita	-0.516901 (0.2977)	Not Significant	Not Satisfied
H6	Telecommunication Price TPM	-169.4814 (0.6087)	Not Significant	Not Satisfied
H9	New Technology	0.531268 (0.0385***)	Strongly Significant	Satisfied
H11	Time Trend	0.618550 (0.0009***)	Strongly Significant	Satisfied

Note. *, ** and *** indicates statistical significance at the 14%, 10% and 5%, respectively.

Table 4.14

Model 2 - Case III-A Results (UAE Supply of Telecom with Total Services Price Effect)

Hypothesis	Variable	Coefficient P-Value	Observation	Hypothesis Test
H7	UAE Infrastructure Investment	-0.054662 (0.9072)	Not Significant	Not Satisfied
H6	Telecommunication Price TPT	0.218698 (0.1491)	Not Significant	Not Satisfied
H9	New Technology	0.601813 (0.0953*)	Significant	Satisfied
H11	Time Trend	0.618284 (0.0004***)	Strongly Significant	Satisfied

Note. *, ** and *** indicates statistical significance at the 14%, 10% and 5%, respectively.

Table 4.15
Model 2 - Case III-B Results (UAE Supply of Telecom with Total Services Price Effect)

Hypothesis	Variable	Coefficient P-Value	Observation	Hypothesis Test
H3	GPD per capita	-0.613927 (0.1721)	Not Significant	Not Satisfied
H6	Telecommunication Price (TPT)	-0.089122 (0.7379)	Not Significant	Not Satisfied
H9	New Technology	0.541809 (0.0356**)	Strongly Significant	Satisfied
H11	Time Trend	0.627970 (0.0004***)	Strongly Significant	Satisfied

Note. *, ** and *** indicates statistical significance at the 14%, 10% and 5%, respectively.

UAE infrastructure expansion and GDP per capita have no effect on the supply of telecommunication services. H7 and H9 were not supported for supply of Telecommunication Services in UAE. Etisalat is operating in a typical monopoly market and it decides the quantity it should supply at any instant of time. What helped supporting this standing of Etisalat is the high income it generates yearly and its income is not affected by fluctuations in the GDP. Accordingly Etisalat was able to sustain and expand its telecommunication infrastructure with leading technology at international standards and with high quality of service.

Hypothesis 6 was not supported for mobile and total telecommunication services. Price of offered telecommunication services does not affect supply of telecommunication service in UAE market. Etisalat was supplying telecommunication service regardless of considering the price of offered services. This could be due to the monopoly position of the company. Customers are using the services where it is a needed service regardless of its price, therefore Etisalat is ensuring an income to invest regardless of the prices that services are offered with.

Introduction of new technology was significant to supply of all telecommunication services. H9 is supported for UAE market. Etisalat is focusing on supplying cutting edge technologies and services to UAE customers since its early establishment.

Time trend was found to be significant to telecommunication supply. Supply of telecommunication is increasing over time and this supply would increase as the market transforms into competition. On average, there is a need to increase supply of telecommunication services by 0.63% every 3 months. Therefore, it is expected that the increase in number of players in UAE telecommunication market guarantees additional a faster supply growth in the telecommunication market. This supply

increase is needed over the coming year because demand has also shown a growing trend indicating that UAE telecommunication market have not yet reached saturation level.

4.6 UAE Economic Growth Model Results

Detailed results of UAE Economical Growth Model (Model 3) described by Eq-7 are presented in Appendix C, Table C.15 and Table C.16. Hypothesis testing results of Model 3 Case I are presented in Tables 4.16, 4.17 and 4.18. Case II results are listed in Table 4.19.

Table 4.16
Model 3 - Case I-A Results (UAE Economical Growth with Fixed-Line Income Effect)

Hypothesis	Variable	Coefficient P-Value	Observation	Hypothesis Test
H14	Gross Fixed Capital Formation per Labor	0.591675 (0.0165**)	Strongly Significant	Satisfied
H12	Telecommunication Income (Fixed-line Demand)	-0.097398 (0.5972)	Not Significant	Not Satisfied
H15	New Technology	-0.058550 (0.5941)	Not Significant	Not Satisfied

Note. *, ** and *** indicates statistical significance at the 14%, 10% and 5%, respectively.

Table 4.17
Model 3 - Case I-B Results (UAE Economical Growth with Mobile Income Effect)

Hypothesis	Variable	Coefficient P-Value	Observation	Hypothesis Test
H14	Gross Fixed Capital Formation per Labor	0.632549 (0.0001**)	Strongly Significant	Satisfied
H12	Telecommunication Income (Mobile - Demand)	-0.00005 (0.9985)	Not Significant	Not Satisfied
H15	New Technology	-0.105266 (0.3021)	Not Significant	Not Satisfied

Note. *, ** and *** indicates statistical significance at the 14%, 10% and 5%, respectively.

Table 4.18

Model 3 - Case I-C Results (UAE Economical Growth with Total Telecom Income Effect)

Hypothesis	Variable	Coefficient P-Value	Observation	Hypothesis Test
H14	Gross Fixed Capital Formation per Labor	0.602481 (0.0168**)	Strongly Significant	Satisfied
H12	Telecommunication Income (Total Telecom Demand)	-0.023897 (0.7918)	Not Significant	Not Satisfied
H15	New Technology	-0.071548 (0.5571)	Not Significant	Not Satisfied

Note. *, ** and *** indicates statistical significance at the 14%, 10% and 5%, respectively.

Table 4.19

Model 3 - Case II Results (UAE Economical Growth with Telecom Investment Effect)

Hypothesis	Variable	Coefficient P-Value	Observation	Hypothesis Test
H14	Gross Fixed Capital Formation per Labor	0.555474 (0.0441***)	Strongly Significant	Satisfied
H13	Telecommunication Investment (Supply)	-0.044987 (0.4621)	Not Significant	Not Satisfied
H15	New Technology	-0.033709 (0.7473)	Not Significant	Not Satisfied

Note. *, ** and *** indicates statistical significance at the 14%, 10% and 5%, respectively.

Hypothesis 14 was supported for UAE economical growth model and labor production was found significant to more growth. However, both telecommunication income and telecommunication investment represented by H12 and H13, were not supported toward building higher economical development of UAE. This finding seems contradicting to the witnessed economical development in UAE which has a high level of telecommunication infrastructure that attracts foreign investment and facilitates all economical activities in the country.

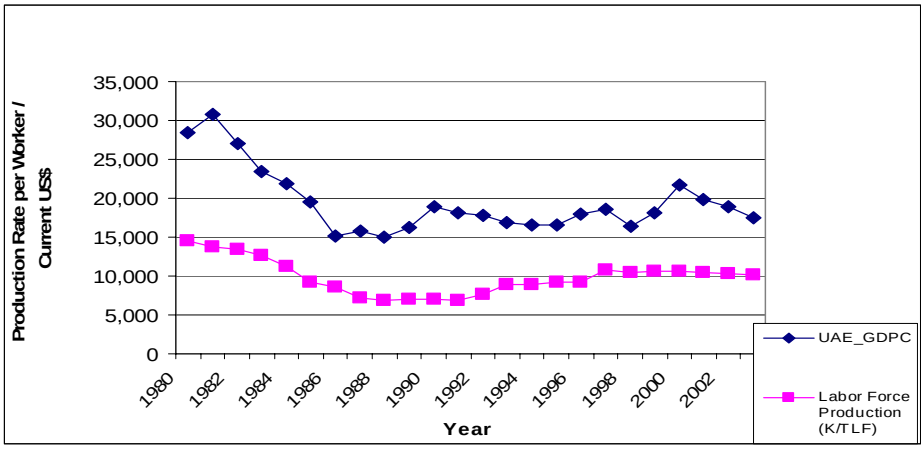

Figure 4.8: Labor Production vs. GDP per Capita in UAE

To further understand the reason that previous finding does not support current reality, the behavior of GDP per Capita of UAE was compared versus Labor production in Figure 4.8. It is noticed that GDP per capita had a high rate of decrease starting from 1981 to 1986. This decline rate was also associated with reduction in labor force production in about the same period of time. Accordingly, Eq-7 was repeated again considering study period from 1986 to 2003 to take out the effect of this sharp incline in GDP per Capita from the model. Taking out the period of sharp decline in GDP per capita will help us investigate other elements contributed into economical growth starting from 1986 and onward.

Table C.17 and Table C.17 in Appendix C, contain detailed results of Eq-7 for the period 1986-2003. Hypothesis testing results are listed in Tables 4.20 through 4.23.

Table 4.20
Model 3 - Case I-A Results (1986-2003: UAE Economical Growth with Fixed-Line Income Effect)

Hypothesis	Variable	Coefficient P-Value	Observation	Hypothesis Test
H14	Gross Fixed Capital Formation per Labor	-0.092899 (0.7052)	Not Significant	Not Satisfied
H12	Telecommunication Income (Fixed-Line Demand)	0.278336 (0.0700**)	Significant	Satisfied
H15	New Technology	0.026338 (0.7452)	Not Significant	Not Satisfied

Note. *, ** and *** indicates statistical significance at the 14%, 10% and 5%, respectively.

Table 4.21
Model 3 - Case I-B Results (1986-2003: UAE Economical Growth with Mobile Income Effect)

Hypothesis	Variable	Coefficient P-Value	Observation	Hypothesis Test
H14	Gross Fixed Capital Formation per Labor	-0.210514 (0.3805)	Not Significant	Not Satisfied
H12	Telecommunication Income (Mobile Demand)	0.067749 (0.0182***)	Strongly Significant	Satisfied
H15	New Technology	-0.021998 (0.7826)	Not Significant	Not Satisfied

Note. *, ** and *** indicates statistical significance at the 14%, 10% and 5% respectively.

Table 4.22
Model 3 - Case I-C Results (1986-2003: UAE Economical Growth with Total Telecom Income Effect)

Hypothesis	Variable	Coefficient P-Value	Observation	Hypothesis Test
H14	Gross Fixed Capital Formation per Labor	-0.140141 (0.5564)	Not Significant	Not Satisfied
H12	Telecommunication Income (Total Telecom Demand)	0.144765 (0.0321***)	Strongly Significant	Satisfied
H15	New Technology	-0.000742 (0.9926)	Not Significant	Not Satisfied

Note. *, ** and *** indicates statistical significance at the 14%, 10% and 5% respectively.

Table 4.23
Model 3 - Case II Results (1986-2003: UAE Economical Growth with Telecom Investment Effect)

Hypothesis	Variable	Coefficient P-Value	Observation	Hypothesis Test
H14	Gross Fixed Capital Formation per Labor	-0.000170 (0.9994)	Not Significant	Not Satisfied
H13	Telecommunication Investment (Supply)	0.092039 (0.1184*)	Weakly Significant	Satisfied
H15	New Technology	-0.015293 (0.8740)	Not Significant	Not Satisfied

Note. *, ** and *** indicates statistical significance at the 14%, 10% and 5%, respectively.

Repeating Model 3 for the period 1986 – 2003 has changed the previous findings. H14 was not supported indicating that although labor production had high impact of UAE economical growth this fact have changed over the period later than 1986. The reason is that economical growth in UAE has started to consider other sources to enhance its growth other than labor production.

Hypothesis 12 was strongly supported considering different income generated from telecommunication sector. A one percent increase in demand of fixed line services will cause an economical growth of 0.293% increase in economical growth. While a percent increase in income generated from mobile services will case an increase of 0.064% in economical growth. The income generated from mobile services did not show high effect on growth that was shown from fixed line services because it started taking real effect only from 1996. It is expected, due to the higher income generated from mobile services that it will contribute more strongly in economical growth within the coming decade.

Likewise H13 was also supported and an increase of one percent in telecommunication investment will cause an economical growth of 0.087%. The

amount of this contribution can be increased by introducing competition into the market and allowing foreign and private investments to work in increasing the effect of telecommunication into the growth of UAE economy.

CHAPTER 5
5. CONCLUSION AND RECOMMENDATIONS

5.1 Summary of Methodology

This study investigated the interaction taking place in the Telecommunication market of GCC countries by studying the elements affecting the Demand and Supply of telecommunication services. The effect of the telecommunications sector on the economical growth of GCC countries in general and UAE in particular has also been studied. The research proposed three models to test for Demand, Supply, and Economical growth. The models were based on hypotheses developed using micro-economical theories of Demand and Supply as well as using macro-economical growth theory. Econometric methodology was employed to investigate the results of models' hypotheses. Aggregate data from all GCC countries were used to develop and test the models. Finally, the same models were applied on UAE data sets to focus on the UAE telecommunication market characteristics.

5.2 Main Findings and Recommendations of GGC Countries Models

The elements that played a role on demand of fixed line services of GCC countries are population growth and reduction of services prices. Demand on fixed line was found inelastic to buyer's income. Introducing Internet as dial-up option did not promote additional demand over fixed line services. Moreover, demand for fixed line services is not showing a steady growing trend. Telecommunication operators of GCC countries need to work on making fixed-line service more attractive to their subscribers to gain back and increase the demand for fixed-line services. One of the solutions that can be adopted is introducing IP-Telephony technology and its applications into fixed line service. Another possibility is to work on bundling fixed line services with other services such as mobile on internet broadband access.

Interestingly enough, the Demand of mobile services showed that countries with lower economical standing and lower GDP per capita, such as in Saudi Arabia and Bahrain, have high growing rate for mobile services. Also, reduction in prices and/or introduction of new technology into mobile services in GCC countries will increase the demand for the service. The demand for mobile services is growing

tremendously over time. This growth indicates the market readiness to accept new mobile-based application and to accommodate new operators competing to provide mobile services. With regard to the Demand of total telecommunication services, the study found strong significance of the increase of demand with the introduction of new technology. Also to the general growing demand trend found in the model results, telecommunication operators of GCC countries can expect demand over any new service if marketed correctly with proper pricing mechanism. This makes the GCC market attractive to new investors, where revenue can be generated because of growing demand and high buyer's interest to acquiring state of the art technologies.

Studying the supply of telecommunication market results showed that GCC telecom operators were expanding their networks infrastructure in response to the infrastructure growth of GCC countries. Economical standing of GCC countries and prices of offered services did not affect investment of telecom operators. On the other hand, GCC operators showed great investment response in new technologies to sustain a modern telecom infrastructure. Moreover, there is a growing interest from operators to work on expanding the supply of their networks over time.

Labor production in GCC countries is one of the elements that helped push forward their economical growth. Another important finding of this study is that income generated from telecommunication sector is already taking place in pushing the economical growth of GCC countries. Also, introducing new technology into telecommunication sector helped towards further economical growth. However, telecommunication investment did not have effect in GCC countries over the period between 1980 and 2003. It is expected that within the next decade or so, because of moving the market into competition state, existing telecommunication operators and new operators will be competing to increase their supply and to attract more customers. As a result of this trend, the telecommunication investment will show an additional increase over the coming years and will also play a stronger role into the economical growth for GCC countries.

It worth mentioning that examining some results of GCC countries, such as the effect of telecommunication staff on demand, Saudi Arabia seems to have biased the results due to its larger area and much higher population over other GCC countries. Although the effect of Saudi Arabia in this study is part of GCC characteristics, it would be interesting to repeat the models excluding Saudi Arabia to investigate the interaction of other GCC countries with models elements away from the biasing introduced by Saudi Arabia data.

5.3 Main Findings and Recommendations of UAE Models

Studying the demand of fixed line services in UAE revealed that price reduction was an element to increase expansions. On the other hand, introducing new technology into fixed line, manifested by internet access through Dial-up, was not an element to increase the demand over this service. This result is similar to what was found for GCC countries. Similarly, UAE telecommunication operators have to work on boosting demand over fixed line services. Another finding from this study is that demand over all telecommunication services is inelastic to subscribers' income; represented by GDP per capita. It is shown that demand in UAE is growing regardless of buyers' income. Specifically, the introduction of second generation mobile technology represented by GSM helped in increasing mobile market demand. Demand of all telecommunication services has a growing trend in UAE, indicating that there is room for new players in the market and there is a need to introduce more advanced mobile technologies.

The supply of telecommunication services in UAE was neither affected by the infrastructure growth nor the economical standing of the country. On the other hand, supply responded strongly to the introduction of new technology into the market. Moreover, supply of telecommunication is showing a growing trend with time. These findings are supported by the leading-edge telecommunication services offered in UAE reflecting a strong telecommunication infrastructure sustained by Etisalat, the incumbent operator.

On the level of economical growth of UAE, considering results from 1980 to 2003, labor production was an element that affects the growth. However; when GDP per capita data from 1980 to 1985 was excluded from the model because of the sharp decline in this period, results of the economical growth changed. Starting from 1986 to 2003, telecommunication sector has taken a positive effect on promoting further economical growth in UAE. Both, income generated from telecommunication services and investments in telecommunication sector were positively correlated with economical growth of UAE. This finding is aligned with the core idea of this research which is the important role that telecommunication sector development plays in the economical growth of every nation.

Finally, the UAE market is attractive for investors because of the high economical and political stability of the country. The result obtained from the study showed high growth potential of the local market in both supply and demand. This

proves that there is a room for competition and there is a need for new players in the market to push forward the economical growth of the country.

5.4 Significance of Results

This research provided three different models representing the following: demand of telecommunication sector, supply of telecommunication sector and economical growth model based on telecommunication sector development elements. The models have proven that they stand for GCC countries and hence can be implemented as well on different regions and countries of the world. As results may never be fully identical, however, it is of an interest to know that results agrees or differs from what were found in GCC. After all, obtained results described the story of the data that were entered into the models.

It would be also interesting to repeat the study after five years from 2003 to find out about the changed interactions between variables. For example, variables that showed significance in one of the models may not show contribution into the dependent variable after five years and vice versa. Keeping a study of changes in interaction between different elements in demand and in supply of telecommunication will help better understand the micro-economy of telecommunication market and ultimately will help telecommunication regulators and operators take more informed decisions in setting their policies or on lunching new technologies.

The model of Macro-economical growth will help in measuring the contribution of telecommunication market into the economical growth of GCC countries. Results of this model will help the government or the regulator of certain country, with low contribution rate from telecommunication sector, in issuing policies and regulations to increase the share of telecommunication sector into aggregate economy.

5.5 Research Limitations

The main research limitation was the lack of complete Economical, Socio-Economical and Telecommunication Indicators for GCC countries. Moreover, there is no developed database system of GCC statistics within the official entities to obtain datasets from. Consequently, this limitation resulted in the following:

1. Study period date was shifted from 1970 to 1980 as a way of maintaining reliable data series for the research.

2. Several missing indicators and proxies were changed to different indicators and some original hypotheses were excluded and replaced with new hypotheses based on the available datasets.

5.6 Future Work

Some suggested topics that can be conducted as future work based on this research are:

- Investigate the relationship between Demand and Supply of Telecommunication services using simultaneous modeling approach.
- Use the simultaneous approach again to find the interaction between the three models: Demand Model, Supply Model and Economical Growth Model.
- Enhance the demand model to investigate the effect of mobile on fixed-line services and vice versa.
- Include the effect of prices inflation according to inflation rate of each GCC country.
- Study the causation relationship between telecommunication market and economical growth.
- Investigate different indicators to represent the hypotheses of this research models, for instance, telecommunication price indicator can be replaced by service charges per minute instead of monthly subscription charges. Also demand can be represented by service revenue per capita.

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APPENDIX A

CHAPTER 2 RELATED TABLES AND REFERENCES

Table A.1
Economical and Socio-Economical Indicators [4]

Abbreviation		Indicator	Description	Unit
1.	GDPC	Gross Domestic Product per Capita *	Measure of country's economical standing	Current US$/inhabitant
2.	K	Gross Fixed Capital Formation (GFCF) **	Measure of country's real stock of capital stock	Current US$
3.	TLF	Total Labor Force	Proxy of stock of Human Capital	Number
4.	POP	Population		Number

*Note 1: "Gross Domestic Product at purchaser's prices 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 current U.S. dollars." [4] To obtain GDP per capita, GDP was divided by total reported population of a given year.

**Note2: "Gross Capital Formation 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." [4]

Table A.2
Telecommunication Indicators [9]

Abbreviation	Indicator	Description	Unit
5. PEN	Number of fixed-phone per 100 inhabitant	Fixed-line penetration rate part of telecommunication demand	Percentage
6. PENM	Number of mobile-phone per 100 inhabitant	Mobile penetration rate part of telecommunication demand	Percentage
7. PENT	Number of total-phone per 100 inhabitant	Total penetration rate part of telecommunication demand	Percentage
8. WL	Waiting List for fixed-line per 100 inhabitant	Waiting list for fixed line part of telecommunication demand	Percentage
9. TTI	Annual telecommunication investment	Measure of telecommunication supply.	Current US$
10. TP	Residential monthly telephone subscription	Measure of telecom fixed-line services price	Current US$
11. TPM	Cellular monthly subscription	Measure of telecom mobile services price	Current US$
12. TPT	Total cellular and residential monthly subscription	Measure of telecom services price	Current US$
13. Staf	Total full-time telecommunications staff	Measure of Telecom Quality of Service	Number
14. M	Dummy variable to represent the introduction of 2nd generation mobile services and Internet	Dummy variable as a measure the effect of introducing new technology starting from 1996 as average of peak-up starting year for all GCC countries as per statistical diagnostics.	0: Before introduction of new technology. 1: After introduction of new technology.

APPENDIX B

CHAPTER 3 RELATED TABLES AND REFERENCES

Table B.1

Test of Multicollinearity for Model 1 Case 3

Dependent Variable	Log (Total subscribers + Waiting List) per 100 inhabitant		Log (Total subscribers + Waiting List) per 100 inhabitant		Log (Total subscribers + Waiting List) per 100 inhabitant	
Model Adjusted Independent Variable	Original Case 3 Results		No Population		No Total Telecommunication Price	
Number Observations	132		132		132	
Mean Dependent Variable	3.020392		3.020392		3.020392	
Variable/Statistic	Coefficient Value	T-Statistics (Prob.)	Coefficient Value	T-Statistics (Prob.)	Coefficient Value	T-Statistics (Prob.)
Intercept	0.049907	0.185957 (0.8528)	0.098150	0.418583 (0.6762)	0.078702	0.308449 (0.7583)
Log Population	0.007349	0.373535 (0.7094)			0.008807	0.454904 (0.6500)
Log GDP per Capita	-0.001480	-0.067170 (0.9466)	-0.001316	-0.060975 (0.9515)	-0.004523	-0.214722 (0.8303)
Log Telecommunication Quality	-0.007369	-0.337172 (0.7366)	1.45E-05	0.001369 (0.9989)	-0.008217	-0.381274 (0.7036)
Telecommunication Price	0.004765	0.359717 (0.7197)	0.006068	0.463028 (0.6441)		
Dummy variable for new technology	0.085766	3.653835 (0.0004***)	0.090589	4.524419 (0.0000***)	0.083865	3.450012 (0.0008***)
Time trend	0.988349	40.77953 (0.0000***)	0.984358	46.54535 (0.0000***)	0.989038	41.06469 (0.0000***)
AR(1)	0.273073	2.287911 (0.0238***)	0.277048	2.328812 (0.0215***)	0.268968	2.265661 (0.0252***)
Adjusted R-squared	0.991488		0.991543		0.991547	
Sum squared residual	0.640040		0.640960		0.640729	
F-statistics	2180.741	(0.0000***)	2561.006	(0.0000***)	2561.935	(0.0000***)
Durbin-Watson statistics	2.050367		2.047411		2.049613	

Note. All results obtained using Least Minimum Squares. *, ** and *** indicates statistical significance at the 14%, 10% and 5%, respectively.

Table B.2

Results of Telecommunication Sector Demand

Dependent Variable	Log (Fixed-line subscribers + Waiting List) per 100 inhabitant		Log (Mobile subscribers + Waiting List) per 100 inhabitant		Log (Total subscribers + Waiting List) per 100 inhabitant	
Model Specific Independent Variable	Fixed-Line Price		Mobile Price		Total Telecommunication Price	
Number Observations	138		108		132	
Mean Dependent Variable	2.755817		0.903153		3.020392	
Variable/Statistic	Coefficient Value	T-Statistics (Prob.)	Coefficient Value	T-Statistics (Prob.)	Coefficient Value	T-Statistics (Prob.)
Intercept	3.666783	2.950915 (0.0038***)	2.552249	2.730969 (0.0075**)	0.049907	0.185957 (0.8528)
Log Population	0.133113	1.911173 (0.0583**)	-0.078992	-1.602753 (0.1121)	0.007349	0.373535 (0.7094)
Log GDP per Capita	0.006919	0.142388 (0.8870)	-0.125771	-1.684211 (0.0953*)	-0.001480	-0.067170 (0.9466)
Log Telecommunication Quality	-0.263923	-8.803654 (0.0000***)	0.065932	0.903603 (0.3684)	-0.007369	-0.337172 (0.7366)
Telecommunication Price	-0.167628	-1.534843 (0.1274)	-0.203717	-3.186386 (0.0019***)	0.004765	0.359717 (0.7197)
Dummy variable for new technology	-0.012764	-0.643047 (0.5214)	0.453098	2.264141 (0.0257***)	0.085766	3.653835 (0.0004***)
Time trend	0.124208	1.265468 (0.2081)	0.886252	13.81552 (0.0000***)	0.988349	40.77953 (0.0000***)
AR(1)	0.956859	58.92226 (0.0000***)	0.039242	0.609642 (0.5435)	0.273073	2.287911 (0.0238***)
Adjusted R-squared	0.988732		0.983986		0.991488	
F-statistics	1643.176	(0.0000***)	940.2658	(0.0000***)	2180.741	(0.0000***)
Durbin-Watson statistics	2.008190		2.071853		2.050367	

Note. All results obtained using Least Minimum Squares. *, ** and *** indicates statistical significance at the 14%, 10% and 5%, respectively.

Table B.3

Results of Telecommunication Sector Supply

Dependent Variable	Annual Telecommunication Investment					
Model Specific Independent Variable	Log Fixed-Line Price		Log Mobile Price		Log Total Telecom Price	
Number Observations	138		120		138	
Mean Dependent Variable	18.31881		18.47000		18.31881	
Variable/Statistic	Coefficient Value	T-Statistics (Prob.)	Coefficient Value	T-Statistics (Prob.)	Coefficient Value	T-Statistics (Prob.)
Intercept	3.973918	2.078078 (0.0396***)	8.055163	2.852593 (0.0052***)	2.380974	1.038001 (0.3012)
Log gross fixed capital formation	0.420866	4.938956 (0.0000***)	0.435293	5.321283 (0.0000***)	0.404929	4.729028 (0.0000***)
Log GDP per Capita	-0.083850	-0.540510 (0.5898)	-0.388318	-1.653291 (0.1010)	0.024135	0.123643 (0.9018)
Telecommunication Price	-0.277579	-2.045533 (0.0428***)	-0.189635	-1.941819 (0.0546**)	0.078757	0.865619 (0.3883)
Dummy variable for new technology	0.513697	4.180662 (0.0001***)	0.419732	3.333951 (0.0012***)	0.546750	4.169383 (0.0001***)
Time trend	0.337551	2.813999 (0.0056***)	0.260883	2.086195 (0.0392***)	0.345233	2.742634 (0.0069***)
Adjusted R-squared	0.652898		0.630093		0.644286	
F-statistics	52.53937	(0.0000***)	41.54048	(0.0000***)	50.62807	(0.0000***)
Durbin-Watson statistics	2.190964		2.057470		2.191034	

Note. All results obtained using Least Minimum Squares. *, ** and *** indicates statistical significance at the 14%, 10% and 5%, respectively.

Table B.4

Results of Macro Economical Growth of GCC Countries

Dependent Variable	GDP per Capita					
Model Specific Independent Variable	Fixed-line subscribers per 100 inhabitant		Mobile subscribers per 100 inhabitant		Total subscribers per 100 inhabitant	
Number Observations	138		108		132	
Mean Dependent Variable	9.335977		9.329036		9.319955	
Variable/Statistic	Coefficient Value	T-Statistics (Prob.)	Coefficient Value	T-Statistics (Prob.)	Coefficient Value	T-Statistics (Prob.)
Intercept	6.714660	8.522691 (0.0000***)	10.55857	10.58481 (0.0000***)	8.690706	9.435397 (0.0000***)
Log gross fixed capital formation per labor	0.095656	1.709132 (0.0898*)	0.104102	1.295634 (0.1981)	0.136573	1.574412 (0.1179)
Log Telecommunication demand	0.866719	4.944912 (0.0000***)	0.095998	2.264138 (0.0257**)	0.272836	2.973528 (0.0035***)
Log Telecommunication Supply	-0.046238	-1.813225 (0.0721*)	-0.135023	-2.656109 (0.0092***)	-0.090298	-2.012801 (0.0463**)
Dummy variable for new technology	0.125689	2.386710 (0.0184**)	0.141144	2.361545 (0.0201**)	0.156854	2.762505 (0.0066***)
AR(1)	0.852563	30.72066 (0.0000***)	0.533977	4.167549 (0.0001***)	0.525175	3.713424 (0.0003***)
AR(2)			0.335002	2.845490 (0.0054***)	0.302574	2.310579 (0.0225**)
Adjusted R-squared	0.915862		0.879221		0.880056	
F-statistics	299.2573	(0.0000***)	130.8189	(0.0000***)	161.1958	(0.0000***)
Durbin-Watson statistics	2.127622		1.908226		2.049957	

Note. All results obtained using Least Minimum Squares. *, ** and *** indicates statistical significance at the 14%, 10% and 5%, respectively.

APPENDIX C

CHAPTER 4 RELATED TABLES AND REFERENCES

Table C.1

Results of UAE Telecommunication Sector Demand

Dependent Variable	(Fixed-line subscribers + Waiting List) per 100 inhabitant		(Mobile subscribers + Waiting List) per 100 inhabitant		(Total subscribers + Waiting List) per 100 inhabitant	
Model Specific Independent Variable	Fixed-Line Price		Mobile Price		Total Telecommunication Price	
Number Observations	22		21		22	
Mean Dependent Variable	3.145022		1.468272		3.461937	
Variable/Statistic	Coefficient Value	T-Statistics (Prob.)	Coefficient Value	T-Statistics (Prob.)	Coefficient Value	T-Statistics (Prob.)
Intercept	4.606704	3.434759 (0.0040***)	-55.46869	-0.151599 (0.8817)	1.682041	0.212827 (0.8345)
Log Population	0.021784	0.165874 (0.8706)	1.498046	1.362418 (0.1946)	0.345365	1.241969 (0.2347)
Log GDP per Capita	-0.145840	-2.145050 (0.0500**)	0.161620	0.519060 (0.6118)	0.031839	0.294269 (0.7729)
Telecommunication Quality of Service	-0.228863	-2.068602 (0.0576**)	0.425355	0.998210 (0.3351)	0.161344	0.937005 (0.3646)
Telecommunication Price	-0.996125	-3.920292 (0.0015***)	13.85404	0.080979 (0.9366)	-2.896346	-1.998955 (0.0654**)
Dummy variable for new technology	-0.035937	-1.372198 (0.1916)	0.095023	0.648152 (0.5274)	-0.075185	-1.505223 (0.1545)
Time trend	0.999740	11.88583 (0.0000***)	0.588539	2.484985 (0.0262**)	0.716977	3.651153 (0.0026***)
AR(1)	0.516219	2.519010 (0.0245**)			-0.015124	-0.805311 (0.4341)
AR(2)						
Adjusted R-squared	0.994082		0.993994		0.996246	
F-statistics	504.9411	(0.0000***)	552.6337	0.000000***	797.0432	(0.0000***)
Durbin-Watson statistics	1.990703		1.795101		1.281200	

Note. All results obtained using Least Minimum Squares. *, ** and *** indicates statistical significance at the 10%, 5%, and 1% respectively.

Table C.2

Results of UAE Telecommunication Sector Supply

Dependent Variable	Annual Telecommunication Investment					
Model Specific Independent Variable	Fixed-Line Price		Mobile Price		Total Telecommunication Price	
Number Observations	23		21		21	
Mean Dependent Variable	18.93159		19.01589		19.01589	
Variable/Statistic	Coefficient Value	T-Statistics (Prob.)	Coefficient Value	T-Statistics (Prob.)	Coefficient Value	T-Statistics (Prob.)
Intercept	25.60026	2.512893 (0.0223***)	540.5456	0.939184 (0.3636)	10.04596	1.054274 (0.3065)
Log gross fixed capital formation	0.014208	0.036520 (0.9713)	-0.262822	-0.668585 (0.5146)	0.207114	0.388944 (0.7021)
Log GDP per Capita	-0.385568	-1.024172 (0.3201)	-0.310190	-0.595524 (0.5610)	-0.715670	-1.310091 (0.2076)
Telecommunication Price	-6.851938	-2.251381 (0.0379***)	-250.4682	-0.915285 (0.3755)	-0.107897	-0.401572 (0.6930)
Dummy variable for new technology	0.118828	0.385806 (0.7044)	0.595186	2.401256 (0.0308**)	0.447723	1.068101 (0.3004)
Time trend	0.367993	2.082102 (0.0528**)	0.713532	5.263298 (0.0001***)	0.597398	4.323597 (0.0005***)
AR(1)			-0.445034	-1.648311 (0.1215)		
AR(2)						
Adjusted R-squared	0.886369		0.841155		0.853138	
F-statistics	35.32179	(0.0000***)	18.65149	(0.000011***)	26.56003	(0.0000***)
Durbin-Watson statistics	2.391449		2.054438		2.433139	

Note. All results obtained using Least Minimum Squares. *, ** and *** indicates statistical significance at the 10%, 5%, and 1% respectively.

Table C.3

Results of UAE Economical Growth Model

Dependent Variable	GDP per Capita					
Model Specific Independent Variable	Fixed-line subscribers per 100 inhabitant		Mobile subscribers per 100 inhabitant		Total subscribers per 100 inhabitant	
Number Observations	24		22		24	
Mean Dependent Variable	9.857470		9.817770		9.857470	
Variable/Statistic	Coefficient Value	T-Statistics (Prob.)	Coefficient Value	T-Statistics (Prob.)	Coefficient Value	T-Statistics (Prob.)
Intercept	2.922193	1.663255 (0.1127)	3.429795	1.955744 (0.0671**)	2.531350	1.483845 (0.1543)
Log gross fixed capital formation per labor	0.713481	5.369403 (0.0000*)	0.629851	4.740532 (0.0002***)	0.767160	6.980132 (0.0000*)
Log Telecommunication Income	-0.104847	-0.673493 (0.5087)	-0.010077	-0.312901 (0.7582)	-0.005915	-0.069298 (0.9455)
Log Telecommunication Investment	0.040674	0.588506 (0.5631)	0.036822	0.512620 (0.6148)	0.019713	0.265601 (0.7934)
Dummy variable for new technology	-0.138239	-1.328935 (0.1996)	-0.123004	-1.150388 (0.2659)	-0.161737	-1.534941 (0.1413)
AR(1)			0.511402			
Adjusted R-squared	0.720761		0.538152		0.714167	
F-statistics	15.84167	0.000007***	7.117382	(0.001476)	15.36662	(0.0000***)
Durbin-Watson statistics	1.362305		1.409999		1.341982	

Note. All results obtained using Least Minimum Squares. *, ** and *** indicates statistical significance at the 10%, 5%, and 1% respectively.

Table C.4

Auxiliary Regression Results of Model 2 - Case 1

Regressed Independent Variable	Adjusted R^2	F-Statistics	Prob.(F-statistics)
Gross Fixed Capital Formation	0.838	23.34	0.0000*
GPD per capita	0.123	1.77	0.1786
Telecommunication Price	0.884	43.08	0.0000*
New Technology	0.835	26.74	0.0000*
Time Trend	0.79	21.66	0.0000*

Note. * indicates statistical significance at the 5%.

Table C.5

Auxiliary Regression Results of Model 2 - Case 2

Regressed Independent Variable	Adjusted R^2	F-Statistics	Prob.(F-statistics)
Gross Fixed Capital Formation	0.802	22.31	0.0000*
GPD per capita	0.131	1.79	0.1769
Telecommunication Price	0.046	1.25	0.3264
New Technology	0.777	19.25	0.0000*
Time Trend	0.676	11.96	0.0000*

Note. * indicates statistical significance at the 5%.

Table C.6

Auxiliary Regression Results of Model 2 - Case 3

Regressed Independent Variable	Adjusted R^2	F-Statistics	Prob.(F-statistics)
Gross Fixed Capital Formation	0.796	22.42	0.0000*
GPD per capita	0.368	4.2	0.014*
Telecommunication Price	0.237	2.71	0.063*
New Technology	0.786	21.19	0.0000*
Time Trend	0.69	13.28	0.0000*

Note. * indicates statistical significance at the 5%.

Table C.7

Auxiliary Regression Results of Model 3 - Case 2

Regressed Independent Variable	Adjusted R^2	F-Statistics	Prob.(F-statistics)
Gross Fixed Capital Formation per Labor	0.337	3.05	0.0551*
Telecommunication Income	0.846	39.56	0.0000*
Telecommunication Investment	0.83	35.24	0.0000*
New Technology	0.816	31.99	0.0000*

Note. * indicates statistical significance at the 5%.

Table C.8

Auxiliary Regression Results of Model 3 - Case 3

Regressed Independent Variable	Adjusted R^2	F-Statistics	Prob.(F-statistics)
Gross Fixed Capital Formation per Labor	0.117	2.013	0.1445
Telecommunication Income	0.833	39. 35	0.0000*
Telecommunication Investment	0.844	42.39	0.0000*
New Technology	0.804	32.48	0.0000*

Note. * indicates statistical significance at the 5%.

Table C.9

Model 2 Variables Correlation

	log(GDPC)	***log(K)***	***log(TTI)***	***Log(TP)***	***Log(TPM)***	***Log(TPT)***
log(GDPC)	1					
log(K)	**0.999946**	1				
log (TTI)	-0.27179	-0.2676	1			
Log(TP)	0.232797	0.2283	**-0.9427**	1		
Log(TPM)	0.274827	0.27163	-0.375	0.3669117	1	
Log(TPT)	-0.69292	-0.6877	0.25027	-0.222331	0.376992	1
UAE_M	-0.16606	-0.1621	**0.87436**	**-0.912786**	-0.32515	0.169392

Note. Values in Bold, represent correlation level higher than 0.8 between variables of Model 2.

Table C.10

Model 3 Variables Correlation

	log(GDPC)	***log(K/TLF)***	***log(penm)***	***log(pen)***	***log(pent)***	***log (TTI)***
log(K/TLF)	0.799821	1				
log(penm)	-0.18115	0.15644	1			
log(pen)	-0.5235	-0.2574	0.9000	1		
log(pent)	-0.32967	-0.0326	0.98982	0.8842554	1	
log (TTI)	-0.27179	0.03252	**0.90877**	**0.8510313**	**0.909494**	1
UAE_M	-0.16606	0.22033	**0.86068**	0.7629715	**0.852426**	**0.874364**

Note. Values in Bold, represent correlation level higher than 0.8 between variables of Model 3.

Table C.11

Results of UAE Telecommunication Sector Demand

Dependent Variable	(Fixed-line subscribers + Waiting List) per 100 inhabitant		(Mobile subscribers + Waiting List) per 100 inhabitant		(Total subscribers + Waiting List) per 100 inhabitant	
Model Specific Independent Variable	Fixed-Line Price		Mobile Price		Total Telecommunication Price	
Number Observations	22		21		22	
Mean Dependent Variable	3.145022		1.468272		3.461937	
Variable/Statistic	Coefficient Value	T-Statistics (Prob.)	Coefficient Value	T-Statistics (Prob.)	Coefficient Value	T-Statistics (Prob.)
Intercept	4.606704	3.434759 (0.0040***)	106.4201	0.342542 (0.7364)	10.76637	3.505698 (0.0029***)
Log Population	0.021784	0.165874 (0.8706)				
Log GDP per Capita	-0.145840	-2.145050 (0.0500***)	0.275186	1.008116 (0.3284)	-0.056344	-0.796648 (0.4373)
Telecommunication Quality of Service	-0.228863	-2.068602 (0.0576**)				
Telecommunication Price	-0.996125	-3.920292 (0.0015***)	-51.81741	-0.349770 (0.7311)	-3.935543	-3.408124 (0.0036***)
Dummy variable for new technology	-0.035937	-1.372198 (0.1916)	0.226867	1.922009 (0.0726**)	-0.039956	-1.004104 (0.3303)
Time trend	0.999740	11.88583 (0.0000***)	0.941125	27.70813 (0.0000***)	-0.013135	29.69482 (0.0000***)
AR(1)	0.516219	2.519010 (0.0245**)			-0.013135	-0.978106 (0.3426)
Adjusted R-squared	0.994082			0.993839	0.996347	
F-statistics	504.9411	(0.0000***)	807.6143	(0.000000***)	1146.444	(0.0000***)

Note. All results obtained using Least Minimum Squares. *, ** and *** indicates statistical significance at the 14%, 10% and 5%, respectively.

Table C.12

Results of UAE Telecommunication Sector Supply

Dependent Variable	Annual Telecommunication Investment			
Model Specific Independent Variable	Fixed-Line Price		Mobile Price	
Number Observations	23		23	
Mean Dependent Variable	18.93159		18.93159	
Variable/Statistic	Coefficient Value	T-Statistics (Prob.)	Coefficient Value	T-Statistics (Prob.)
Intercept	9.215227	1.116097 (0.2783)	12.38062	2.891839 (0.0093***)
Log gross fixed capital formation (K)	-0.108790	-0.278374 (0.7837)	-0.551468	-1.585333 (0.1294*)
Log GDP per Capita				
Dummy variable for new technology	0.621634	2.141898 (0.0454***)	0.546412	2.436483 (0.0248***)
Time trend	0.634999	3.842934 (0.0011***)	0.623934	4.314142 (0.0004***)
Adjusted R-squared	0.849392		0.866444	
F-statistics	42.35809	(0.0000***)	48.57495	(0.000000***)

Note. All results obtained using Least Minimum Squares. *, ** and *** indicates statistical significance at the 14%, 10% and 5%, respectively.

Table C.13

Results of UAE Telecommunication Sector Supply

Dependent Variable	Annual Telecommunication Investment			
Model Specific Independent Variable	Fixed-Line Price		Mobile Price	
Number Observations	21		22	
Mean Dependent Variable	18.97215		18.97215	
Variable/Statistic	Coefficient Value	T-Statistics (Prob.)	Coefficient Value	T-Statistics (Prob.)
Intercept	591.3697	0.876878 (0.3928)	368.2154	0.540204 (0.5961)
Log gross fixed capital formation (K)	-0.069954	-0.171879 (0.8656)		
Log GDP per Capita			-0.516901	-1.074374 (0.2977)
Telecommunication Price	-277.2547	-0.864668 (0.3993)	-169.4814	-0.521563 (0.6087)
Dummy variable for new technology	0.575549	1.925920 (0.0710**)	0.531268	2.243803 (0.0385***)
Time trend	0.607103	3.548843 (0.0025***)	0.618550	4.010763 (0.0009***)
Adjusted R-squared	0.840964		0.850817	
F-statistics	28.76134	(0.0000***)	30.94162	(0.0000***)

Note. All results obtained using Least Minimum Squares. *, ** and *** indicates statistical significance at the 14%, 10% and 5%, respectively.

Table C.14

Results of UAE Telecommunication Sector Supply

Dependent Variable	Annual Telecommunication Investment			
Model Specific Independent Variable	Fixed-Line Price		Mobile Price	
Number Observations	23		23	
Mean Dependent Variable	18.93159		18.93159	
Variable/Statistic	Coefficient Value	T-Statistics (Prob.)	Coefficient Value	T-Statistics (Prob.)
Intercept	7.750119	0.769098 (0.4518)	13.14284	2.702987 (0.0146***)
Log gross fixed capital formation	-0.054662	-0.118282 (0.9072)		
Log GDP per Capita			-0.613927	-1.421938 (0.1721)
Telecommunication Price	0.218698	1.507090 (0.1491)	-0.089122	-0.339865 (0.7379)
Dummy variable for new technology	0.601813	1.760808 (0.0953**)	0.541809	2.271600 (0.0356***)
Time trend	0.618284	4.368257 (0.0004***)	0.627970	4.362890 (0.0004***)
Adjusted R-squared	0.844848		0.859447	
F-statistics	30.94916	(0.0000***)	34.63103	(0.0000***)

Note. **All results obtained using Least Minimum Squares. *, ** and *** indicates statistical significance at the 14%, 10% and 5%, respectively.**

Table C.15

Results of UAE Economical Growth Model

Dependent Variable	GDP per Capita					
Model Specific Independent Variable	Fixed-line subscribers per 100 inhabitant		Mobile subscribers per 100 inhabitant		Total subscribers per 100 inhabitant	
Number Observations	23		22		23	
Mean Dependent Variable	9.840231		9.817770		9.840231	
Variable/Statistic	Coefficient Value	T-Statistics (Prob.)	Coefficient Value	T-Statistics (Prob.)	Coefficient Value	T-Statistics (Prob.)
Intercept	4.747319	2.103351 (0.0498***)	4.083155	3.461332 (0.0028***)	4.430757	2.084997 (0.0516**)
Log gross fixed capital formation per labor	0.591675	2.643507 (0.0165***)	0.632549	4.865250 (0.0001***)	0.602481	2.634603 (0.0168***)
Log Telecommunication Income	-0.097398	-0.538013 (0.5972)	-4.86E-05	-0.001941 (0.9985)	-0.023897	-0.267897 (0.7918)
Introduction of New Technology	-0.058550	-0.542509 (0.5941)	-0.105266	-1.062469 (0.3021)	-0.071548	-0.598337 (0.5571)
AR(1)	0.445296	1.756159 (0.0961**)			0.468838	1.822112 (0.0851**)
Adjusted R-squared	0.703284		0.557068		0.699742	
F-statistics	14.03622	(0.000023***)	9.80378	(0.0005***)	13.81759	(0.000025***)

Note. All results obtained using Least Minimum Squares. *, ** and *** indicates statistical significance at the 14%, 10% and 5%, respectively.

Table C.16

Results of UAE Economical Growth Model

Dependent Variable	GDP per Capita	
Model Specific Independent Variable	Fixed-line subscribers per 100 inhabitant	
Number Observations	23	
Mean Dependent Variable	9.840231	
Variable/Statistic	Coefficient Value	T-Statistics (Prob.)
Intercept	5.613242	2.260897 (0.0364***)
Log gross fixed capital formation per labor	0.555474	2.164151 (0.0441***)
Log Telecommunication Investment	-0.044987	-0.751417 (0.4621)
Introduction of New Technology	-0.033709	-0.327138 (0.7473)
AR(1)	0.530983	2.112693 (0.0489***)
Adjusted R-squared	0.707477	
F-statistics	14.30195	(0.000020***)

Note. All results obtained using Least Minimum Squares. *, ** and *** indicates statistical significance at the 14%, 10% and 5%, respectively.

Table C.17

Results of UAE Economical Growth Model (1986-2003)

Dependent Variable	GDP per Capita					
Model Specific Independent Variable	Fixed-line subscribers per 100 inhabitant		Mobile subscribers per 100 inhabitant		Total subscribers per 100 inhabitant	
Number Observations	18		18		18	
Mean Dependent Variable	9.769599		9.769599		9.769599	
Variable/Statistic	Coefficient Value	T-Statistics (Prob.)	Coefficient Value	T-Statistics (Prob.)	Coefficient Value	T-Statistics (Prob.)
Intercept	9.699559	4.752867 (0.0003***)	11.56695	5.581838 (0.0001***)	10.51929	5.224114 (0.0001***)
Log gross fixed capital formation per labor	-0.092899	-0.386104 (0.7052)	-0.210514	-0.905463 (0.3805)	-0.140141	-0.602632 (0.5564)
Log Telecommunication Income	0.278336	1.961856 (0.0700***)	0.067749	2.673935 (0.0182***)	0.144765	2.380124 (0.0321***)
Introduction of New Technology	0.026338	0.331488 (0.7452)	-0.021998	-0.281245 (0.7826)	-0.000742	-0.009436 (0.9926)
Adjusted R-squared	0.303181		0.411939		0.367534	
F-statistics	3.465524	(0.045348***)	4.969526	(0.014886***)	4.292969	(0.024075***)

Note. All results obtained using Least Minimum Squares. *, ** and *** indicates statistical significance at the 14%, 10% and 5%, respectively.

Table C.18

Results of UAE Economical Growth Model (1986-2003)

Dependent Variable	GDP per Capita	
Model Specific Independent Variable	Fixed-line subscribers per 100 inhabitant	
Number Observations	18	
Mean Dependent Variable	9.769599	
Variable/Statistic	Coefficient Value	T-Statistics (Prob.)
Intercept	8.014470	3.680676 (0.0025***)
Log gross fixed capital formation per labor	-0.000170	-0.000718 (0.9994)
Log Telecommunication Investment	0.092039	1.663504 (0.1184*)
Introduction of New Technology	-0.015293	-0.161469 (0.8740)
Adjusted R-squared	0.258230	
F-statistics	2.972718	(0.067882**)

Note. All results obtained using Least Minimum Squares. *, ** and *** indicates statistical significance at the 14%, 10% and 5%, respectivel.

VITA

Shaima Yousef Amiri was born in 1977 in UAE. She was educated in local public schools. She graduated from the American University of Sharjah in 2001 with a Bachelor degree of Science in Electrical and Electronics Engineering.

Ms. Amiri worked as a Telecommunication Engineer in ZADCO Oil Company in Abu Dhabi from 2001 - 2003. There she worked on the development of ZADCO telecommunication systems including microwave links, radio links, paging system and walki-talke system.

In 2003 she joined Emirates Telecommunication Corporation (Etisalat) and still working there as Wireless Packet Networks engineer. Her main responsibilities are the operation and maintenance tasks of third generation packet switched core network. During her presence in the switching and maintenance of GPRS section, she has worked occasionally on managing the operation and maintenance tasks of MMS system, WAP system and 2.5G GPRS system.

In 2003, Ms. Amiri joined Engineering Systems Management Master program at the American University of Sharjah and she was awarded the Master of Science degree in Engineering Systems Management in 2006.