REPUBLIC OF TURKEY
YILDIZ TECHNICAL UNIVERSITY
GRADUATE SCHOOL OF SOCIAL SCIENCES
DEPARTMENT OF ECONOMICS
PROGRAM OF ECONOMICS

MASTER THESIS

INFORMATION AND COMMUNICATION TECHNOLOGIES AND ECONOMIC INSTITUTIONS

ATAKAN AKINCI
13729004

THESIS SUPERVISOR
PROF. FERİDE GÖNEL (Ph.D.)

İSTANBUL
2016

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ÖZ

BİLGİ VE İLETİŞİM TEKNOLOJİLERİ VE EKONOMİK KURUMLAR

Atakan Akıncı
Ekim, 2016

18. yüzyılda yaşanan Sanayi Devrimi, bilim ve teknolojinin gelişmesinde ve yayılmasında etkili oldu. Dünya tarihininde kırılma noktalarından biri olan bu devrimden sonra, dünya daha önce görülmemiş bir tabloyla karşı karşıya kaldı. 20. yüzyılda ise bilim ve teknolojinin önemi çarpıcı bir biçimde arttı. Ekonomik kalkınma, ekonomik büyümenin sürdürülebilirliği ve rekabet gücü açısından bilim ve teknolojinin birbirine yakınlaşması önemli olmuştur. Ayrıca, son yıllarda Bilgi ve İletişim Teknolojileri (BİT) oldukça dikkat çekmektedir. Kişilerin ve kurumların hem kendi ilişkileri hem de birbirleri ile ilişkileri, üretim ve dağıtım süreçleri, yönetim yapıları, hükümetlerin inovasyon ve sanayideki rolleri, bilim, teknoloji ve sanayi politikaları üzerinde BİT'lerin etkisini reddetmek imkansızdır. Özellikle telekomünikasyon teknolojilerinde, yaşanan ilerlemeler ile birlikte dünyada Bilgi Toplumuna doğru büyük bir geçiş gözlemlenmektedir. 20. yüzyılın ikinci yarısında BİT'lerin kurumlar üzerindeki etkileri, dünyada ve Türkiye'de yaşanan dönüşüm açısından öne çıkan konulardan biri olmuştur.

Bu çalışmada, öncelikle BİT'lerin dünyadaki yerini görmek için BİT'lerin etkilerine değinerek BİT'lerin tarihi gözden geçirilmiştir. İkinci bölümde, teknoloji üzerine teorik perspektif ele alınmıştır. Üçüncü bölümde BİT ve ekonomik kurumlar ilişkisinden bahsedilmektedir. Sonraki bölümde, dünyada ve Türkiye'de BİT sektörü incelenerek, BİT'lerin kurumlar üzerindeki etkilerini göstermek üzere, Bankalar ve Borsa İstanbul gibi Türkiye'deki bazı ekonomik kurumlar ele alınmıştır. Sonuç bölümünde ise bazı politika önerileri yer almaktadır.

Anahtar Kelimeler: Bilgi ve İletişim Teknolojileri, Ekonomik Kurumlar, Büyüme ve Kalkınma, Teknoloji, İnovasyon.

ABSTRACT

INFORMATION AND COMMUNICATION TECHNOLOGIES AND ECONOMIC INSTITUTIONS
Atakan Akıncı
October, 2016

In the 18th century The Industrial Revolution has enabled to develop and deployment of science and technology (S & T). Then, the world has faced with an unprecedented picture after the Revolution which was one of the breaking points in the entire history of the world. In the 20th century, the importance of S & T has increased dramatically. Science-based technology, especially ICT, has been very significant within the framework of economic development, sustainability of economic growth, and competitiveness. It is not possible to reject the effects of ICT on relationships among individuals, institutions and between them, as well as on the processes of production and distribution, management structures, the role of governments in innovations and industry, determining the policies of science, technology, and innovation. The progresses in ICT, especially in telecommunications technologies, and transition to information society have been observed in the world. In the second half of the 20th century, the effects of ICT on institutions have been one of the prominent topics in terms of the transformation in the world and Turkey especially

In this study, the brief history of ICT is overviewed with its place in the world by referring to its effects in the extended introduction. In the second part, I explain the theoretical perspective on technology. Then in the third part, the relationship between ICT and economic institutions is viewed. In the next part, ICT sector situation in the world and Turkey, and some selected economic institutions in Turkey are observed to show ICT effects on. Last part is conclusion which includes some policy recommendations.

Keywords: Information and Communications Technology, Economic Institutions, Economic Growth and Development, Technology, Innovation.

PREFACE

In the 19th century, telephone was invented. In the 20th century, computer was invented. Then, they have been developed. In the 21th century, there are too much multifunctional machines and robots. Moreover, there are studies on smart things, internet of things, industry 4.0, artificial intelligence, artificial organs, tools which can be integrated with human body. Together with the meeting of internet and things, a data ball, in other words Big Data, has grown increasingly as a snow ball. Therefore, the world is changing in every moment of life. The future of the world is not easy predictable. It is a fact that it was not also easy to predict today's situation after telephone and computer was invented. Additionally, another fact is that ICT is a driving power of one of the breakings point in the world, transition to Information Society.

Today, I live during the period of electronic transformation and I am one of the witnesses in the world and in Turkey. Moreover, I am interested in with technology and its future. It is a fact that ICT has affected relationships between individuals, institutions and institutions-individuals, the processes of production and distribution, management structures, the role of governments in innovations and industry, determining the policies of science, technology, and innovation. The idea that 'How institutions have been affected by ICT' is one of the prominent topics. That is why I study on 'Information and Communication Technologies and Economic Institutions'. In this research, I tried to explain the effects of ICT on some economic institutions such as Banks and Borsa İstanbul in Turkey by referring to ICT market situation in the world and Turkey, by referring technological developments in ICT and information society.

It is a fact that technology-oriented topic did not come to my mind immediately. My interest on technology, especially ICT, has started when I was at

secondary school (the early 2000s). Next, during the period of undergraduate program (Political Science and Public Administration) at Faculty of Political Science, İstanbul University, the courses on Turkish Economy [by Asst. Prof. Ali Osman BALKANLI (Ph.D.)] caused that I realized myself and the importance of technology more. I would like to thank Asst. Prof. Ali Osman BALKANLI (Ph.D.). Then, during the period of graduate program (Economics) at Graduate School of Social Sciences, Yıldız Technical University, I reached to my dreams such as writing papers and a thesis. It is a fact that Prof. Feride GÖNEL (Ph.D.) my thesis supervisor, has inspired and motivated me to reach my targets every time.

I would like to thank Prof. Feride GÖNEL (Ph.D.) for her patience to read my thesis several times, and for her motivating and precious comments, suggestions, supports and her inspiring advices. I would like to thank Sırrı Emrah ÜÇER for his comments, advices and suggestions. Besides, I would like to thank my family for their patience during the period of thesis because I spent most of my time in the libraries in İstanbul.

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İstanbul, October, 2016 **Atakan Akıncı**

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LIST OF ABBREVIATIONS

ATM	:	Automated Teller Machine
BIST	:	Borsa İstanbul
BKM	:	Interbank Card Center
BPO	:	Business Process Outsourcing
BRSA	:	Banking Regulation and Supervision Agency
B2B	:	Business-to-Business
B2C	:	Business-to-Citizen
B2Cr	:	Business-to-Consumer
B2G	:	Business-to-Government
B2I	:	Business-to-Individuals
CBRT	:	The Central Bank of the Republic of Turkey
Cr2B	:	Consumer-to-Business
Cr2Cr	:	Consumer-to-Consumer
C2C	:	Citizen-to-Citizen
C2G	:	Citizen-to-Government
C2M	:	Citizen-to-Machine
Cr2M	:	Consumer-to-Machine
CT	:	Communication Technology
DPT	:	State Planning Organization
EITO	:	European Information Technology Observatory
GDP	:	Gross Domestic Product
GK	:	Geary-Khamis
GNP	:	Gross National Product
G2B	:	Government-to-Business
G2C	:	Government-to-Citizen
G2E	:	Government-to-Employee
G2G	:	Government-to-Government
G2N	:	Government-to-Nonprofit
G2E	:	Government-to-Employee
ICT	:	Information and Communications Technology
ICTA	:	Information and Communication Technologies Authority
IP	:	Internet Protocol
ISDN	:	Integrated Services for Digital Network
ISE	:	İstanbul Stock Exchange
IT	:	Information Technology
ITU	:	International Telecommunication Union
I2B	:	Individuals-to-Business
I2I	:	Individuals-to-Individuals
I2M	:	Individuals-to-Machine
KBPS	:	Kilobyte Per Second
LAN	:	Local Area Network
MODEM	:	Modulator-Demodulator

M2C	:	Machine-to-Citizen
M2Cr	:	Machine-to-Consumer
M2I	:	Machine-to-Individuals
M2M	:	Machine-to-Machine
N2G	:	Nonprofit-to-Government
NYSE	:	New York Stock Exchange
ODTU	:	Middle East Technical University
OECD	:	Organization for Economic Co-operation and Development
PBX	:	Private Branch Exchange
PC	:	Personal Computer
PCM	:	Pulse Code Modulation
POS	:	Point of Sale
PTT	:	Post, Telephone and Telegraph
R & D	:	Research and Development
S & T	:	Science and Technology
TCP	:	Transmission Control Protocol
TUBISAD	:	Turkey Informatics Industry Association
TUBITAK	:	The Scientific and Technological Research Council of Turkey
TUENA	:	Turkey National Information Infrastructure Master Plan
TUVAKA	:	Turkey University and Research Institutions Network
UNCTAD	:	United Nations Conference on Trade and Development
WTO	:	World Trade Organization
YOK	:	Council of Higher Education

1. INTRODUCTION

In the 20th century, the interest in information and communications technologies (ICT) has increased while increasing the importance of science and technology. It is undeniable that ICT is everywhere in our lives and around us. As ICT is having a strong influence on the society the relationships among institutions, communities and people, the process of production, distribution and management will also fall within the scope of this study. This thesis examines the place of ICT in the world and Turkey and attempts to bridge between ICT and economic institutions, particularly in the case of Turkey.

In this introduction, the development of ICT will be presented from the historical perspective by describing the concepts of information and communication, while talking about the generations of wireless telecommunication technologies (such as 1G, 2G, 3G, 4G, 5G) and the relationship between development and information society. As a starting point, the first part uses some concepts that enable us to understand the scope of information and communication by giving the table of ICT market structure. The market is split into two parts such as information market and telecommunications market while emphasizing the importance of the relationships of technology, research and development (R&D), and innovation.

Then, the historical evolution of ICT within the framework of ICT infrastructure will be explained by giving some examples such as steamship, railway, telegraph, telephone (including mobile and cellular), network systems, and etc., while specifying the relationship of development and information society.

In the second part of my thesis, theoretical framework for technological progress will be analyzed. Technological progress in terms of development and growth has been discussed increasingly in the 20th century within the theoretical discussions related to the use and adoption of technology exogenously or endogenously. Based on this information, we will mention in Solow Model that use technology exogenously, and

Schumpeterian approach in terms of neoclassical economics and Evolutionary economics.

In the third part, first I will connect ICT and economic institutions in terms of conceptual terms then the world and Turkey's ICT sectors will be examined by dealing with economic institutions.

After determining of the ICT sector situation, in the fourth part of the study, I will try to present the relationship between ICT and some financial institutions such as *Borsa İstanbul* and some other institutions such as Tax Authority under e-government process in Turkey.

Finally, I will summarize all of the study by generalizing in terms of ICT, growth, and development. Some policy recommendations will be given as well.

1.1. From Communication to ICT

Human beings used information every moment in life. Information has been strategic, mysterious and indispensable part of life from the time of hunter-gatherer society until today.

The concept of information is described in the Macmillan Contemporary Dictionary such as: "*knowledge or facts acquired or derived, as from study, instruction, or observation*" and "*act of informing; being informed*"[1].

Furthermore, the concept of communication is also described basically in the same dictionary as: "*transfer of information, wishes, or emotions, from a source to a receiver*" and "*act or process of communicating*"[2].

Carlson said that "*the concept of information is central to communication*"[3]. Additionally, information and communication are complementary concepts with each other; information cannot be attained without communication and communication cannot be occurred without information. Moreover, communication is mainly an essential way for transmission, spread, and accumulation of information.

[1] **Macmillan Contemporary Dictionary**, (İstanbul: ABC Publishing, 1988), 528.
[2] **Ibid**, 203.
[3] A. Bruce Carlson, **Communication Systems: An Introduction to Signals and Noise in Electrical Communication**, Third Edition (McGraw-Hill Series in Electrical & Electronic Engineering, 1986), 2.

Human beings have found ways to communicate each other thanks to developing technology and increasing accumulation of information in the world. There are various communication processes which have been seen in history such as painting; fire, smoke, lamp and voice signals; pigeon post, post rider, railway etc., shortly mail; telephone, electrical and wireless telegraph, radio, television, video phone, mobile telephone, cellular phone, and etc. Moreover, in the second half of the 20th century, the Research and Development (R&D) activities on space have been accelerated by a few countries such as USA, Russia, and some European countries, Japan, China and India which have developed their institutional transformation.

At the end of the 20th century, computer networking and satellite technologies have started to affect communication process. Therefore, as mentioned by Friend, Fike, Baker, and Bellamy, the concept of information is called as *data on the electronic systems*, in other words "*computer communications*" or "*data communications*". They specified the importance of the question that "why is data communications important?"[4]; such question would be important to understand today's world. Data communications are used several areas in the life such as financial operations in banking, downloading data in daily life, knowledge systems in institutions and so on.

The technological progresses have generated a new market in the world namely *ICT market*. It has also created a new type of economy, which we call as *Information Economy* or *Digital Economy*. Today the market using and/or adopted ICT is considered as a driving force in terms of economic development and wider social change. Huang et. al. specifies information technology (IT)[5] and communications technology (CT)[6] which these two have converged with each other increasingly in recent years. According to the study, it is understood clearly that this convergence caused new technological innovations in terms of "*cloud*[7]*, pipe*[8] *and device*[9]". They

[4] George E. Friend et. al., **Understanding Data Communications**, Second Edition, Third Printing (Indianapolis: Howard W. Sams & Company, 1989), 3.
[5] IT is described in the report as "hardware and software used to store, retrieve, and process data".
[6] CT is described in the report as "*it includes electronic systems used for communication between individuals or groups*".
[7] Cloud is described as "*internet services, broadcast services, telecommunication value-added services*".
[8] Pipe is described as "*traditional telecommunication network, internet data communication network, cable network*".
[9] Device is described as "*personal electronic devices, telecommunications premise, home entertainment boxes*".

also point out the cloud as it will accelerate the convergence between IT and CT, and the convergence among IT and telecommunications industries. Additionally, they specify that the needs of government, industries, and enterprises are provided by cloud services such as e-government, e-finance, e-education, and e-healthcare[10].

From Table 1 we can observe different sub-sectors of ICT and two main markets: *Telecommunications Market* and *Information Technology Market*[11]. All sub-sectors of these two are described in the report which is written by EITO.

Table 1 provides some technologies which represent the sub-segments of information technology market and telecommunications market. Both markets are categorized as: IT equipment, software and IT services in IT Market; and telecommunications equipment and telecommunications services in Telecommunications Market.

Table 1: The Markets of Telecommunications and Information Technology

TELECOMMUNICATIONS MARKET	SUB-SEGMENTS
Telecommunications Equipment	Mobile phones Smart phones Fixed IP phones Ethernet (LAN) switches IP PBX Voice Switching Equipment WAN Equipment (routers, ATM switches, etc.) WLAN Equipment Wireline Access Infrastructure Mobile Infrastructure Transmission Equipment Other Telco Equipment
Telecommunications Services	Fixed Voice Telephony Business Data Services Internet Access and Services Mobile Voice Telephony Mobile Data Services

[10] Ivan Huang et. al., "The Convergence of Information and Communication Technologies Gains Momentum", **The Global Information Technology Report 2012**, ed. Soumitra Dutta, Benat Bilbao Osorio (Geneva: SRO-Kundig, 2012): 35-45.

[11] European Information Technology Observatory (EITO), **ICT Market Report 2015/16: Definitions & Methodology** (2015), 5.

Table 1 - continue

IT MARKET	SUB-SEGMENTS
IT Equipment (Technological Hardware)	Servers Storage Workstations PCs Portable PCs Netbooks Consumer Portable PCs Business Portable PCs Desktop PCs Consumer Desktop PCs Business Desktop PCs Media Tablets Multifunction Printers Other IT Equipment
Software	System Infrastructure Software Application D&D Applications
IT services	Projects Outsourcing (Excl. BPO) Support & Deploy BPO Services (incl. Business consulting)

Source: European Information Technology Observatory (EITO), **ICT Market Report 2015/16: Definitions & Methodology** (2015), 5.

1.2. Technology, Research & Development and Innovation for ICT

Technology has irrefutable and significant role from first tools until today's tools within the framework of the history of the world. It has been a part of life of human beings, which has affected the civilization of the world in terms of economically, politically, socially, militarily, organizationally and administratively. For instance, as written by Chris Freeman and Luc Soete in the book namely The Economics of Industrial Revolution, there are a few processes in terms of the historical process about technical change and innovation. Industrial Revolution was the beginning of the processes of the world with the examples of "[…] *The Age of Electricity and Steel, Process Innovations in the Industry of Oil and Chemicals, Synthetic Materials, Mass Production and Automobile, Electronic Industry and Computers*"[12]. Moreover, they specified that technological change cycles[13] which were explained also by Schumpeter and Kondratieff.

[12] Chris Freeman, Luc Soete, **Yenilik İktisadı**, 5. Basım (Ankara: TÜBİTAK, 2004), XV.

Moreover, some studies have divided the industrial revolution into three periods as first, second, and third. *The Economist* has labeled these periods as "*appearance of the factory*", "*the mass production*" and "*the digitization*" respectively. That means the first period includes "*manufacturing, which started in Britain*", the second one includes "*the revolution with mass production, which was in the first quarter of the century*" and the last one is "*today's revolution*"[14].

The Industrial Revolution was a kind of transition process to new methods with scientific and technological improvements. It was like a main engine of inventions, innovations and processes in the world. During the period, the production system had rapidly transformed from hand production to machines-type production. There are some specifications on the process; firstly, this transformation has created faster production process than before and behind this transformation some new materials such as new machine tools and chemical improvements, iron, coal usage and steam power have affected the world enormously. Therefore, production, transportation, communication and welfare level have started to increase after the industrial revolution.

Actually in the 19th century, inventions generally had been done by individual scientist and workers. Research laboratories were not common usage, but the technology has become more complicated. The numbers of laboratories and its usage have been increased in the 20th century, especially after Second World War. Therefore, instead of individual scientist and workers, the professionalized R & D laboratories and human capital became important. When compared with previous period, new technologies need more scientific support. It helps S & T which has converged year by year. This development has created a knowledge-based or science-based technology which has gained quite an increased attention. Carey has summarized this situation in his essay: "[…] *from the telegraph forward,*

---

[13] Schumpeter's long cycles were showed with a table as: *The Industrial Revolution, The Age of Steam Power and Railways, The Age of Electricity and Steel, The Age of Mass Production in Automobile and Synthetic Materials (Fordism), The Age of Microelectronic and Computer Networks* respectively in the book namely *The Economics of Industrial Innovation* that written by Freeman and Soete.

[14] "The Third Industrial Revolution", **The Economist**, 21 April 2012, http://www.economist.com/node/21553017 [26.09.2015].

technological development came to be housed in professional engineering societies, universities, and research laboratories"[15].

Technological development in terms of communication will be explained under the next heading.

1.3. An Overview on Technological Development in ICT

As I mentioned before, the Industrial Revolution has caused inventions and innovations as one of the breaking points in the world. In terms of communication and transportation, steamship, railway, telegraph and others were very crucial devices. For instance, as written by Ronald Findlay and Kevin H. O'Rourke in the article namely *Commodity Market Integration 1500-2000*, there are two major developments in terms of transportation such as: *steamship* and *railway*[16]. Steamship which was invented by Robert Fulton was the most important innovation in shipping technology in the 19th century. The other one was the railway which was opened first between Stockton and Darlington in England[17]. Steamship and railway have pushed the world in an extremely different place which distances have shortened and transportation costs decreased. This technological development has also motivated the economic growth of world economy (Fig. 1). In Angus Maddison's study on the world GDP statistics, it is understood that there is an upward trend between 1-2008 (Fig. 1 and 2). As it is seen very obviously with the start of the 18th century, world GDP has increased dramatically.

Maddison has focused on some countries and regional totals[18] while analyzing the world GDP. It can be also said that the world GDP increased thanks to *transportation*, in other words *communication*. It is because of *steamship* and *railway* especially in the 19th century. For example, Pamuk has emphasized that the world

[15] James W. Carey, **Communication as A Culture: Essays on Media and Society**, Revised Edition (New York: Routledge, 2009), 7.
[16] Ronald Findlay, Kevin H. O'Rourke, "Commodity Market Integration 1500-2000", **National Bureau of Economic Research Conference Report**, Ed. by Michael D. Bordo, Alan M. Taylor, Jeffrey G. Williamson (Chicago: The University of Chicago Press, 2003): 13-64.
[17] It is specified in the article written by Findlay and O'Rourke that main railway was opened between Liverpool and Manchester in 1830 and it had played a significant role in the United States during the second half of the 19th century.
[18] He analyzed huge part of the world geography which involves almost all countries.

trade growth has been accelerated by the technological changes in marine transportation technology[19].

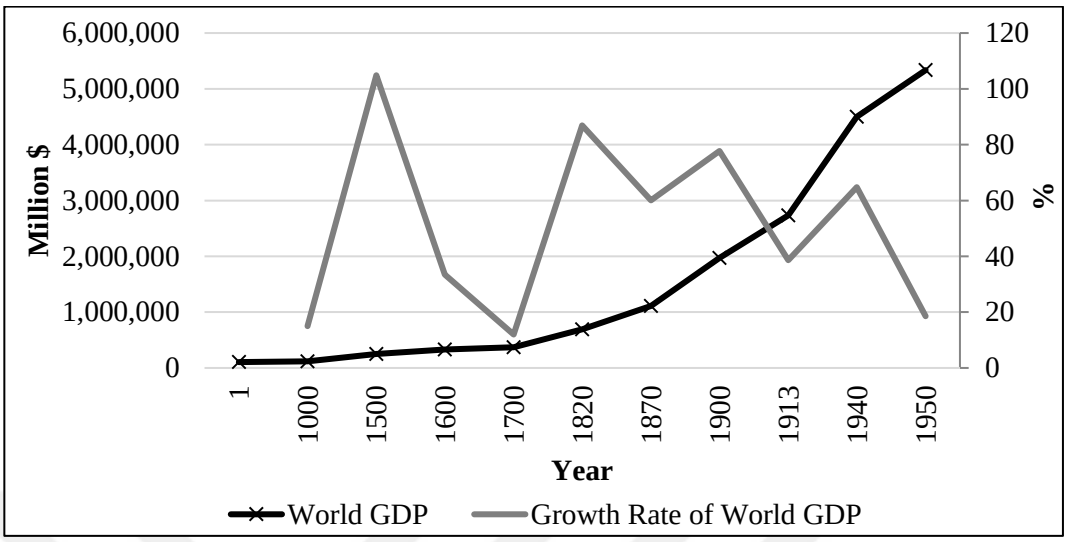


Figure 1: The World GDP, 1 - 1950 (1990 Int. GK $)

Source: Angus Maddison, "Statistics on World Population, GDP and Per Capita GDP, 1-2008 AD", http://www.ggdc.net/maddison/oriindex.htm [24.09.2015].

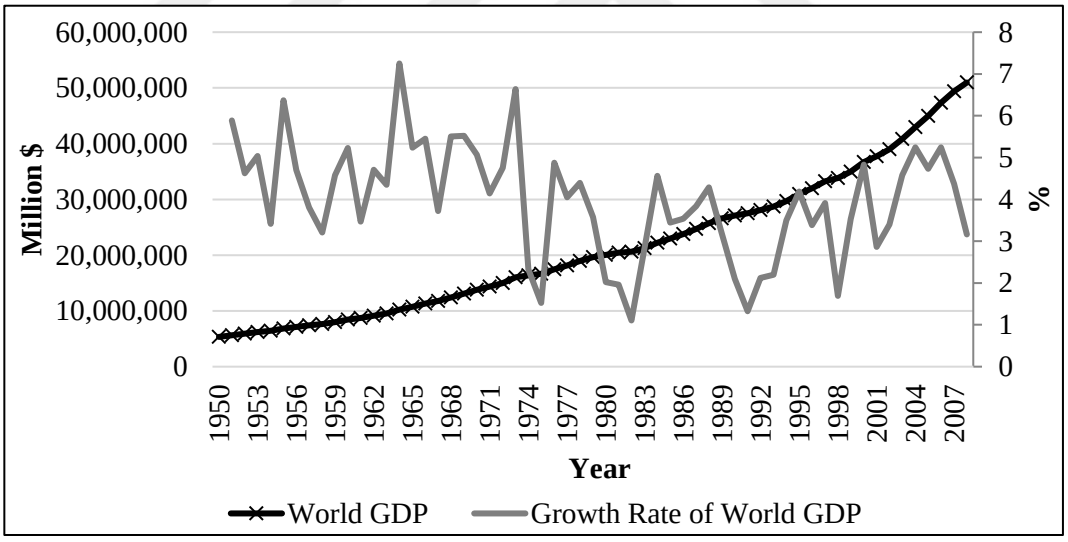


Figure 2: The World GDP, 1950 - 2008 (1990 Int. GK $)

Source: Angus Maddison, "Statistics on World Population, GDP and Per Capita GDP, 1-2008 AD", http://www.ggdc.net/maddison/oriindex.htm [24.09.2015].

Besides, there are generally high growth rates in the world GDP (22% in 1972) even though fluctuations. The world GDP has continued to increase together with the integration of the world after the 1980s. For example, there is an increasing growth

[19] Şevket Pamuk, **Türkiye'nin 200 Yıllık İktisadi Tarihi**, 6. Basım (İstanbul: Türkiye İş Bankası Kültür Yayınları, 2016), 7.

rate of world GDP between 1982 and 1986 (Fig. 2, 3). This period was the starting point of the rapid diffusion of ICTs.

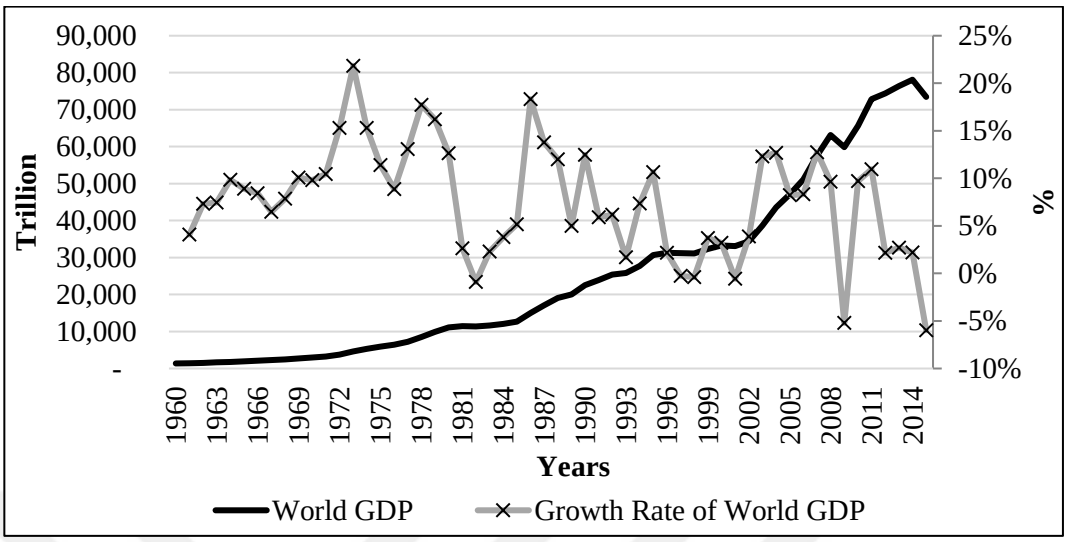


Figure 3: The World GDP, 1960 - 2015

Source: The World Bank.

In the 1800s, the studies on electricity have been increased. In 1837, another significant invention, *electrical telegraph,* was invented by William Cooke and Charles Wheatstone. It has an incontestable and a significant role in communication in terms of the changing world.

As mentioned by Carlson, the first telegraph message was that: "*Attention, the Universe! By Kingdoms, right wheel!*". The writer specified that the message was sent by using "*the electrical telegraph*" and "*16 km telegraph line*" by Samuel F. B. Morse in 1838. Therefore, Carlson called this development as the new way of communication in other words "*the electrical communication*"[20].

James Clerk Maxwell and Heinrich Rudolf Hertz who were the two researchers studied on electromagnetic waves[21] and they found *wireless communication*[22]. In the last decades of the 19th century, Guglielmo Marconi developed equipment called as

[20] Carlson, **opcit**, 1.
[21] In other words, radio waves were discovered by Heinrich Hertz in 1886. Radio waves were called as Hertzian waves until 1910.
[22] "A Short History of Radio: With an Inside Focus on Mobile Radio", Federal Communications Commission, https://transition.fcc.gov/omd/history/radio/documents/short_history.pdf [14.08.2015].

transmitters and *receivers* used for wireless telegraphy. He established his company: *The Wireless Telegraph and Signal Company*[23].

It is mentioned by Carey in the study namely *Technology and Ideology: The Case of Telegraph*[24] that the electronic telegraph as "*the first product of the electrical goods industry*" and "*a first electrical engineering technology and also as a milestone in communication*"[25]. According to Carey, the telegraph not only caused a "*messages to be separated from the physical movement of objects*" but also "*communication to control physical process actively*" and it was not only a tool in terms of commerce but also a tool that spread the information to all over the world. The spread of knowledge has started to change the ideas. It has also helped to manage the process of transportation by train[26].

Moreover, Carey writes that the telegraph has changed the meaning of the concept of communication, in other words the telegraph was another milestone. Before the telegraph, the meaning of communication was used together with the meaning of the transportation, but after the telegraph, these two concepts were separated with each other. However, transportation and communication have continued to affect each other inarguably[27].

All these inventions have given the concept of distance a new meaning; Distances have been closer and they have changed the world. Another device; *telephone* was invented by Alexander Graham Bell in 1876. News about this long distance talking was published on The New York Times:

> *"On October 9, 1876, Alexander Graham Bell and Thomas A. Watson talked by telephone to each other over a two-mile wire stretched between Cambridge and Boston. It was the first wire conversation ever held. Yesterday afternoon the same two men talked by telephone to each other over a 3,400-mile wire between New York and San Francisco. […]"*[28].

Meanwhile the studies on *the television* have started in the first quarter of the 20th century. After the Second World War, it has been improved and has become one

[23] "A Short History of Radio: With an Inside Focus on Mobile Radio", Federal Communications Commission, https://transition.fcc.gov/omd/history/radio/documents/short_history.pdf [14.08.2015].
[24] This essay is one of the essays in the book namely *Communication as A Culture: Essays on Media and Society*, which was written by James W. Carey.
[25] Carey, **opcit**, 156.
[26] **Ibid**, 157.
[27] **Ibid**, 157.
[28] "Phone to Pacific From The Atlantic", **The New York Times**, http://www.nytimes.com/learning/general/onthisday/big/0125.html [14.08.2015].

of the most prominent devices in the world. Improved cable[29] and satellite technologies have provided the transmission of voice and images. These technologies have motivated to increase information flow rapidly in the world. *The videophone* as another technological tool may be given as an example for this transmission.

In the second half of the 20th century, there was another significant and prominent invention in the world, *The Computer*. It had been seen as it is not so important to use personal in the 1950s, but its importance has been understood in the next decades (thanks to invention of transistor and developments in network technologies). New methods have been started to use with computers in terms of communication such as *packet-switching network*[30]. Networks in the world have started to use rapidly and this situation required *communication rules* to provide order and to control; it was called as *the Transmission Control Protocol (TCP)* and *the Internet Protocol (IP).*

During these years, *The Mobile Phone* has been invented. It has provided to transfer the data, voice, video and similar activities and applications to wherever people are. The invention of the mobile phone has required the communication network systems for data transferring process. In the early 1980s, the communication network systems have provided far more simultaneous calls than before. From the 1980s to 1990, first generation *(1G)* network system was used. In the early 1990s second generation *(2G)*, and in the early 2000s third generation *(3G)* systems were operated. In 2010 Fourth generation *(4G)* was started to use. Additionally, European Commission specified that fifth generation *(5G)* is planned for the years between 2020 and 2030[31]. As it is observed easily, ICT is developed extremely in a rapid way and each device of ICT creates the next generation of these technologies[32]. For

[29] Especially, after The Second World War, *Transatlantic Telecommunications Cables (TATs)* and some *private cables* have been used to provide communication. The cables have been improved from 1956 to today within the framework of the aim of increase communication speed in the world.

[30] It can be given as an example that ARPANET (The Advanced Research Projects Agency Network) is the first-packet switching network in the world.

[31] "From 1G to 5G Infographic", European Commission, 21 February 2014, https://ec.europa.eu/digital-agenda/en/news/1g-5g-infographic [26.09.2015].

[32] Technological development in terms of communication is important to understand today's technologies. Carlson's historical perspective shows the general view on the development of electrical communication chronologically. It is combined with the historical perspective by Anttalainen and Jaaskelainen (Appendix 1).

instance, "*a 10 percent increase in high-speed internet connections leverages a 1.4 percent increase in economic growth (on average) in developing countries*"[33].

Developments in the wireless telecommunications bring some additional studies. These studies are about the generations of wireless telecommunications technologies. A. Kumar, Liu, Sengupta and Divya refer to the generations as an overview in their study namely *Evolution of Mobile Wireless Communication Networks: 1G to 4G*. They tried to explain the network systems, its requirements as a graph, a table, and a schema. They specified that "*the 4G system will include other systems*", in other words it is *an encompassing system*[34].

R. Sharma and K. Kumar specify the main differences in terms of the generation network systems and also try to explain the generations by means of a table, a graph, and a schema. They emphasize that "*4G or 4.5G (LTE or LTE-advanced) will be the best*"[35]. In another study, P. Sharma, Shukla, Khare, and Garg mention to the wireless network technologies comparatively as a review in their study namely *Comparative Study of 1G, 2G, 3G and 4G*. They refer to also evolution of the generations as a review similar with A. Kumar, Liu, Sengupta and Divya. Additionally, they imply that "*the never used 5G technology has changed common perceptions about using cell phone in terms of very high bandwidth*"[36].

Vivek, Jain, Kurup and Gawade mention to the generations of network in their study and they refer about 3G as a gate that opens to the next one. They emphasize that 4G provided "*truly a mobile broadband*" and 5G will provide "*higher data transfer speeds and various high quality services*"[37].

There are many alterations such as a transition from analog to digital technology with 2G, changing standards in the generations, features of bandwidth since 2G, and data transmitting speed since 2G. The expected wireless

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[33] "Overview on Information & Communication Technologies", World Bank, http://www.worldbank.org/en/topic/ict/overview [26.09.2015].

[34] Amit Kumar et. al., "Evolution of Mobile Wireless Communication Networks: 1G to 4G", **The International Journal of Electronics & Communication Technology (IJEC)**, Vol. 1, Issue 1 (December 2010): 71.

[35] Rhythm Sharma, Kuldeep Kumar, "Comparisons in All Generations 1G, 2G, 3G, 4G, 4.5G", **The International Journal of Research (IJR)**, Vol. 2, Issue 08 (August 2015): 164.

[36] Sapna Shukla et. al., "Comparative Study of 1G, 2G, 3G and 4G", **The Journal of Engineering, Computers & Applied Sciences (JEC&AS)**, Vol. 2, No.4 (April 2013): 62.

[37] Vivek Sanghvi Jain et. al., "Overview on Generations of Network: 1G, 2G, 3G, 4G, 5G", **The International Journal of Computer Technology & Applications (IJCTA)**, Vol. 5 (Sept-Oct 2014): 1794.

telecommunications network technology in the future, 5G, is underlined strikingly by European Commission with differences from predecessors such as data transmitting time, bandwidth and relation with people & things. For instance, 5G technology will provide data transmitting speed to download "*a HD movie in 6 seconds*" and it is sixty times faster than data transmitting speed of 4G[38].

These generations of wireless telecommunications technologies bring more access to the range of telecommunications services. It means that these services have spread everywhere rapidly in the world towards the unpredictable future. Therefore, telecommunications services have gained more importance year by year. Together with increasing importance of ICT, network technologies, telecommunications services, and etc., they are combined with the concepts of development (*ICT for Development-ICT4D*) and information society in recent decades.

1.4. Emerging of Information Society

The human being has changed and shaped materials every time. There are differences when compared any two periods. For example, according to Balkanlı, the *Industrial Revolution* was an important point and the Revolution caused the transition from *physical strength* to *brain power* in terms of operation of changing and shaping materials. He implies that the transition has prepared *the background of Information Society* and the main examples have been seen in *electronics*[39].

The technological progress brings some transformations in terms of technology, society, and economy. As specified by Olszak and Ziemba, these changes have caused to emerge the new society and it is called as *the information society*[40]. All these technological, social and economic transformations contribute to the development of the information society[41].

It is emphasized by Nick Moore that the effects of the information technology are "*enabling technology*", "*the capacity of the technology*", and decreasing "*cost of*

[38] European Commission, **opcit**.
[39] Ali Osman Balkanlı, **Makroekonomik Denge ve Küresel Krizler**, (İstanbul: Filiz Kitabevi, 2011), Önsöz.
[40] Celina M. Olszak, Ewa Ziemba, "The Information Society Development Strategy on a Regional Level", **Issues in Informing Science and Information Technology**, Vol. 6 (2009): 213.
[41] As mentioned by Celina and Olszak in their study (2009), the concept of the information society was used firstly in 1960s by Tadao Umesao who is Japanese economist and interested in the importance of information and technology in terms of the development of civilization.

the technology" rapidly. He explains the effects of being influenced from economists (like Freeman) in terms of the idea that ICT will cause the new long wave of economic growth by accelerating the development of the information society[42].

We agree with Moore in terms of the idea that it is hard to explain all the characteristics of the information society by generalizing. According to Moore, there are "three main characteristics of the information society". These are "*the use of information as economic resource*", "*the use of information among the general public*" and "*the development of an information sector in within the economy*"[43].

- The use of information as an economic resource: shortly-EIEC.
  - "*to increase the Efficiency of organizations*",
  - "*to stimulate Innovation*",
  - "*to increase the Effectiveness of organizations*",
  - "*to increase Competitive positions of organizations*".
- The use of information among the general public: "People use information in their activities as consumers and as citizens".
  - "*to inform their choices between different products*",
  - "*to explore their entitlements to public services*",
  - "*to take greater control over their own lives*",
  - "*to exercise their civil rights and responsibilities*".
- The development of an information sector within the economy:
  - "*the function of the sector is to satisfy the general demand for the information facilities and services*",
  - the effects of technological infrastructure on the sector: "*the networks of telecommunications and computers*", and "*the generating of the information by information-content providers*".

ICT is seen as one of the necessary factors for economic and social development targets. There are crucial effects of spreading of mobile telephony and communication systems, spreading internet networks, expanding the use of a broadband infrastructure and similar techniques on economic growth and development and social development. These systems, networks and infrastructures

[42] Nick Moore, "Issues and Trends: The Information Society", **World Information Report, 1997/1998**, (UNESCO, 1997): 273.
[43] **Ibid**, 271-272.

are imperative in terms of transition to the information society. European Commission emphasizes the importance of getting digital technologies in the Digital Agenda for Europe. They believe that this agenda will help to the EU's economy in terms of the economic growth, competitiveness and getting benefits from the digital era for their society[44].

In the last quarter of the 20th century, improvements about communication systems, networks and infrastructures have supported the birth of internet. Since the 1990s, internet usage and mobile phone usage in the world have dramatically increased and their effects have been seen economically, politically, socially, militarily, organizationally and administratively. For instance, "*e-Europe Action Plan 2002*" in Europe and "*e-Transformation Turkey Project 2002*" in Turkey can be given as examples in terms of relationship among ICT, information society and knowledge-based economy within the framework of transition to the information society. Additionally, *Information Society Strategy (2006-2010)* and *2015-2018 Information Society Strategy and Action Plan* in Turkey, *Horizon 2020* in Europe can be also added to examples. Importance of these kind of strategies and plans that have some features such as actualizing effective public service, providing cheap internet access, and etc. has increased together with the process of transition to information society.

The society has been affected by technological developments such as improving network technologies and increasing the usage of mobile phone and internet. These developments have transformed our lifestyle as a virtual one; for example, it causes the change in relationships from face-to-face to virtual platforms. For instance, some services such as finance, governmental facilities or commerce have been started to present on virtual platforms. As specified by Anttalainen and Jaaskelainen, the importance of telecommunications and its services has increased in many areas and they give examples of services that depend on telecommunications such as:

- Banking, automated teller machines (ATMs), telebanking;
- Aviation, booking of tickets;
- Sales, wholesale and order handling;

[44] European Commission, **Digital Agenda for Europe**, (Luxembourg, 2014), 3.

- Credit card payments at gasoline stations;
- Buying or selling things on the Internet;
- Social networks;
- Government operations such as taxation;

Regarding to telecommunications and its services, these technologies have joined strikingly in the center of the life[45]. The examples represent the main areas in life that we cannot stay away from them.

Zhiyuan Fang explained the characteristics of e-government types or models such as:

- *Government-to-Citizen (G2C),*
- *Citizen-to-Government (C2G),*
- *Government-to-Business (G2B),*
- *Business-to-Government (B2G),*
- *Government-to-Government (G2G),*
- *Government-to-Nonprofit (G2N),*
- *Nonprofit-to-Government (N2G),*
- *Government-to-Employee (G2E),*

He summed up also them that the types or models in an e-government as C2G, B2G, G2N, G2G, G2E in the context of changing of relationships[46].

Fang's triangle relationship model (Fig. 4) shows that "*the relationship among E-Government, E-Business, and E-Citizens in the context of knowledge society, globalization and sovereignty*"[47]. He explains different characteristics of e-government types. Some relationships are not seen in this format.

[45] Anttalainen and Jaaskelainen, **opcit**, 3.
[46] Zhiyuan Fang, "E-Government in Digital Era: Concept, Practice, and Development", **International Journal of the Computer, the Internet Management**, Vol. 10, No.2 (2002): 1-22.
[47] **Ibid**, 6.

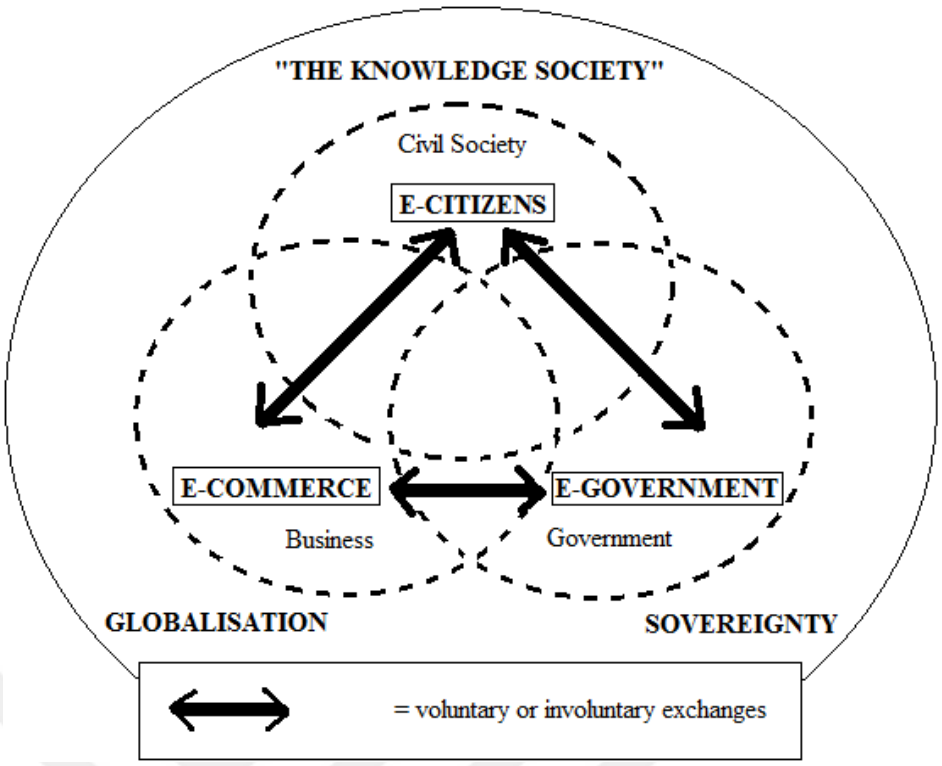


Figure 4: A Triangle Relationship Model among E-Government, E-Business and E-Citizens

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Source: Zhiyuan Fang, "E-Government in Digital Era: Concept, Practice, and Development", **International Journal of the Computer, the Internet Management**, Vol. 10, No.2 (2002): 6.

Moreover, types of relationship can change with respect to people who they are. Main question is that "*are they individuals (I), citizens (C), clients (Ct) or consumers (Cr)?*". Actually, more types of relationship[48] can be added to Fang's format.

These relationships in the society have caused to start the processes of transition from *face-to-face* to *virtual platforms* in terms of commerce, finance, government, and so on. They are called as e-commerce, e-finance or e-government, in other words m-commerce, m-finance or m-government respectively[49].

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[48] For Example: B2B (E-commerce among firms. Meetings between companies via camera on internet), B2Ct (Advertisement on bill board) become popular. Outbound calls in call center), Ct2B (Inbound calls in call center), B2C (Providing electricity by private electricity distribution companies), B2Cr (Advertisement on bill board or via technology), Cr2Cr (Discussions and chat on forum websites), I2I (Social media applications such as Whatsapp), M2I and I2M (Personal mobile phone), M2Cr and Cr2M (Vending machine for getting a bottle of water. Jet Cash), M2Ct (Password SMS by bank while shopping on the internet), Ct2M (ATMs), M2C (Electronic traffic sign, Electronic Detection System-EDS), C2M (Charge money via machines for Electronic City Card), M2M (Internet of Things, Smart weight and smart watch for controlling health by doctor).

[49] The letter "e" in front of the words refers the concept of "electronic". In some studies, it can be seen as "m". The letter "m" refers the concept of "mobile".

Technology which has gained a strategic role in the economy of countries in terms of competitiveness, growth and development is accepted by everybody. In the second half of the 20th century, it may be said that ICT has become a prominent factor to increase competitiveness, growth and development. For instance, it is seen that the world GDP has increased shiningly in the 20th century (Figure 1, 2 and 3). It is not possible to deny that the increasing in the world GDP has been affected by ICT.

2. THEORETICAL FRAMEWORK ON TECHNOLOGICAL PROGRESS AND THE ROLE OF ICT

In the above extended introduction, I've explained that the technology is a kind of strong wave that has affected all over the world. The importance and usage of technology have increased so rapidly therefore it is necessary not only to understand and explain the technological progress but also to manage the process of technology and related innovation.

In this second part, we will try to analyze the theoretical framework on technological progress. As the importance and usage of technology have increased, technological progress and process have been discussed academically in social and natural sciences.

Technological progress and process have been discussed in economics within the framework of using technology as a parameter in models exogenously or endogenously. In addition, production function with technological change has been discussed from the first quarter of the 20th century to today as well. Especially, the concept of productivity has played an important role in economics from Adam Smith to today, who referred to the concept of "the division of labor" in his study (An Inquiry into the Nature and Causes of the Wealth of Nations-1776). As specified by Daniele Besomi, some economists such as Pigou, Hicks, Harrod, Robinson have attended to the discussion on "*the classification of technological progress into neutral, labour- or capital-saving inventions*"[50].

Mulder, De Groot and Hofkes have specified that "*dissatisfaction with the 'old' neo-classical theories of economic growth [...] resulted in two classes of models of*

[50] Daniele Besomi, "Harrod on The Classification of Technological Progress: The Origin of a Wild-Goose Chase", **BNL Quarterly Review**, No. 208 (March 1999): 1.

economic growth and technological change: neo-classical endogenous growth models and evolutionary growth models"[51].

In economics, two main approaches have risen to prominence within the framework of technological progress and process: The Neoclassical Approach and The Evolutionary Approach. As specified by Taymaz, these approaches are significant in terms of the economics of technology and innovation[52].

The main neo-classical growth model is a well-known model in terms of the economic growth in the academic world, which is called as the Solow-Swan model. This model is based on Robert M. Solow's study (1956 and 1957) and Trevor Swan's study (1956), namely "A Contribution to The Theory of Economic Growth", "Technical Change and The Aggregate Production Function" and "Economic Growth and Capital Accumulation" respectively. Then, as mentioned by Boianovsky and Hoover, with the help of these two economists' studies, the Growth Economics became "*a main area of research in macroeconomics and economic theory*"[53].

The Neoclassical growth theory uses technology as an exogenous parameter in the models and it was not enough to explain the technological progress and innovation. So, the Neoclassical Economics has criticized by the Evolutionary Economics.

The Evolutionary Economics uses technology as an endogenous parameter and it is an alternative to explain the technological progress and innovation. According to Hanusch and Pyka, "*there has been a significant increase in the impact and role of Schumpeter's intellectual heritage*", which is called as "*the Age of Schumpeter* or *Schumpeterian Renaissance*" from the 1980s to today[54]. In other words, the Evolutionary Economics has become prominent approach after the 1980s in terms of the economics of technology and innovation.

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[51] Peter Mulder, Henri L. F. De Groot, Marjan W. Hofkes, "Economic Growth and Technological Change: A Comparison of Insights from A Neo-classical and an Evolutionary Perspective", **Technological Forecasting & Social Change**, Vol. 68, Issue 2 (2001): 151.

[52] Erol Taymaz, **Ulusal Yenilik Sistemi: Türkiye İmalat Sanayiinde Teknolojik Değişim ve Yenilik Süreçleri**, (Ankara: TÜBİTAK, TTGV, DİE, 2001), 5.

[53] Mauro Boianovsky, Kevin D. Hoover, "The Neoclassical Growth Model and Twentieth-Century Economics", **History of Political Economy**, Vol. 41 (2009): 1.

[54] Horst Hanusch, Andreas Pyka, "Schumpeter, Joseph Alois (1883-1950)", **Elgar Companion to Neo-Schumpeterian Economics**, ed. by Horst Hanusch, Andreas Pyka (Cornwall: Edward Elgar Publishing, 2007): 19-26.

2.1. The Neoclassical Growth Theory and Solow-Swan Model

The main neo-classical model (the Solow-Swan model) comes from Solow's (1956) and Swan's (1956) studies, which is known generally as the Solow model.

Robert M. Solow analyzed the theory of economic growth mathematically and diagrammatically in his studies. Solow tried to explain the long run growth with a new model that technological progress was used as an exogenous parameter. The aims of the Solow-Swan model are to create a theoretical framework in terms of "understanding world-wide growth of output and the geographical differences in per capita output"[55].

Solow referred Harrod-Domar Model in the inception of his study in 1956, which "*the model consistently studies long-run problems with the usual short run tools*". According to the writer, "*the characteristic and powerful conclusion of the Harrod-Domar line of thought is that even for the long run the economic system is at best balanced on a knife-edge of equilibrium growth*"[56]. Additionally, according to Boianovsky and Hoover, Solow saw in the Harrod-Domar Model that "knife-edge property as a result of an inconsistency between Harrod's warranted rate of growth and Solow's natural rate of growth"[57]. Solow also specified that "*where the warranted rate of growth which depends on saving and investing habits of households and firms and the natural rate of growth which depends on the increase of the labor force*"[58].

The neo-classical production function is known as "$Y(t) = F[K(t), L(T), t]$" where (Y) is output, (K) is capital, (L) is labor, and t is time, which is a continuous function and a concave function with respect to origin[59]. The Solow-Swan growth model is derived from the neo-classical production function.

Boianovsky and Hoover refer to how Solow started to build a model and the writers specified that Solow growth model is:

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[55] Mulder, De Groot, Hofkes, **opcit**, 152.
[56] Robert M. Solow, "A Contribution to the Theory of Economic Growth", **The Quarterly Journal of Economics**, Vol. 70, No. 1 (1956): 66.
[57] Boianovsky and Hoover, **opcit**, 5.
[58] Robert M. Solow, "Technical Change and The Aggregate Production Function", **The Review of Economics and Statistics**, Vol. 39, No. 3 (1956): 312.
[59] Türkan Turan, **İktisadi Büyüme Teorisine Giriş**, (İstanbul: Yalın Yayıncılık, 2008), 46.

"[…] around three equations:
(a) a constant-returns-to-scale production function with smooth substitution and diminishing returns to capital and labor,
(b) an equation describing capital accumulation on the assumption of a constant rate of savings (investments) as a fraction of output,
(c) a labor-supply function in which labor (population) grows at an exogenously given rate"[60].

Solow model is worked on four variables such as "output (Y), capital (K), labor (L) and 'knowledge' or the 'effectiveness of labor'(A), as mentioned by Romer. The writer specified that the production function with these variables is like

$$Y(t) = F[K(t), A(t), L(T)]$$"[61].

As mentioned by Turan, the main dynamic equation (the condition of Solow-Swan Equilibrium) is "$\dot{k}(t) = s.f\big(k(t)\big) - (n + \delta).k(t)$" on the assumption that the technology (A) is constant because of exogenous parameter (A)[62]. The condition of Solow-Swan Equilibrium is shown as geometrically in Figure 5.

Romer also analyzes the dynamic of the Solow-Swan Model. He specifies that the key equation of the Solow Model is "$\dot{k}(t) = s.f\big(k(t)\big) - (n + g + \delta).k(t)$" where g is (A)'s growth rate and n is population growth rate. As described by Romer, the equation shows that "*the rate of change of the capital stock per unit of effective labor is the difference between two terms*" such as "$s.f(k)$" and "$(n + g + \delta).k$", in other words "*actual investment per unit of effective labor"* and *"break-even investment*" respectively[63]. As it is mentioned by many studies, technological progress and population growth rate are assumed as exogenous parameters in the Solow-Swan model[64].

As described by Turan, there are three processes such as "*capital deepening*", "*capital widening*" and "*non-accumulation of capital*". If we summarize the processes by means of Turan's study[65]:

- *Capital deepening*: If k is between zero and k^*, actual investment per unit of effective labor is more than break-even investment. Then, the rate of change of the capital stock per unit of effective labor is more than zero. Therefore, "*capital grows faster than labor*".

[60] Boianovsky and Hoover, **opcit**, 4.
[61] David Romer, **Advanced Macroeconomics**, Third Edition, (Berkeley: McGraw-Hill, 2006), 9.
[62] Turan, **opcit**, 54.
[63] Romer, **opcit**, 14-15.
[64] Mulder, De Groot, Hofkes, **opcit**, 153.
[65] Turan, **opcit**, 55-56.

($0 < k < k^*$, $k = k_0$, $s.f(k_0) > (n + \delta).k_0$, therefore $\dot{k} > 0$).

- *Capital widening*: If k is equal to k^*, actual investment per unit of effective labor is equal to break-even investment. Then, the rate of change of the capital stock per unit of effective labor is equal to zero. Therefore, "*capital and labor have same growth rate*".

($= k^*$, $s.f(k^*) = (n + \delta).k^*$, therefore $\dot{k} = 0$).

- *Non-accumulation of capital*: If k is more than k^*, actual investment per unit of effective labor is less than break-even investment. Then, the rate of change of the capital stock per unit of effective labor is less than zero. Therefore, "*capital grows smaller than labor*".

($> k^*$, $k = k_1$, $s.f(k_1) < (n + \delta).k_1$, therefore $\dot{k} < 0$).

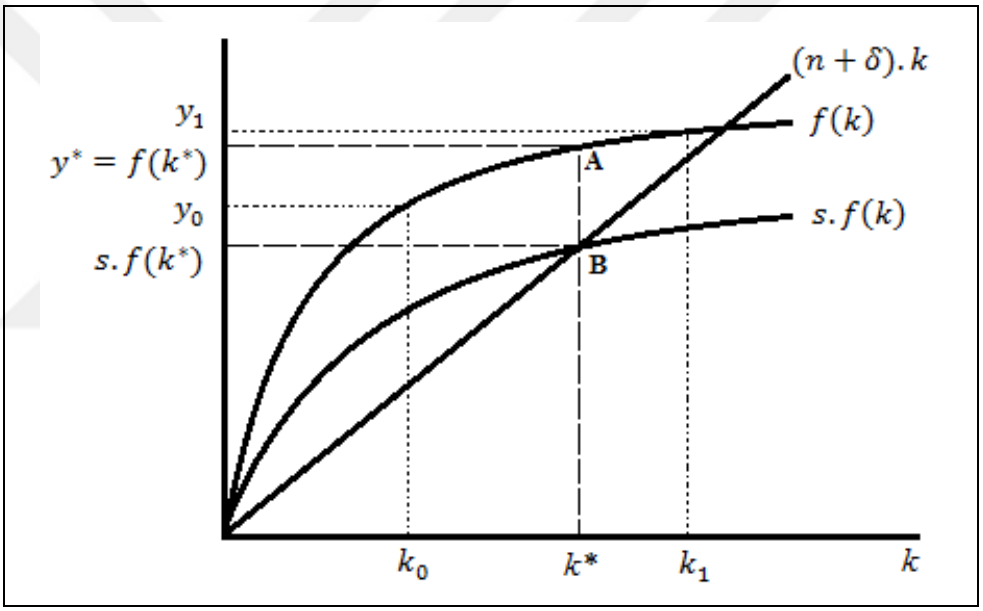


Figure 5: Solow Chart

Source: Türkan Turan, **İktisadi Büyüme Teorisine Giriş**, (İstanbul: Yalın Yayıncılık, 2008), 55.

Turan says that there are two results of the Solow-Swan Model and these results do not change in different versions of the model such as "*included technological progress and not included technological progress*". One of the results is that "*every economic system has long run growth path called as the steady state*" and "*every economy converges to its steady state path (absolute convergence)*". Other one is that "*every economy moves towards same long run equilibrium path*"[66].

[66] **Ibid**, 77-78.

As mentioned by Turan, according to Solow, real income per capita will not grow in the steady state in the long run; it is constant. It is seen that real income per capita has increased in the last centuries thanks to technological progress. Together with technological progress parameter, the model explains that "*real income per capita growth rate is equal to technological progress growth rate in the long run*". Moreover, countries have different indicators in terms of the growth rate and living standard, in other words countries do not have same long run equilibrium path. It is seen that some countries converge each other[67].

Solow-Swan model has been discussed and criticized by not only Evolutionary Economics but also Neoclassical Economics in terms of internalization of technological change. Arrow model and Romer model are well-known models in terms of endogenous growth theory.

The Arrow model is one of the models that internalized technological change. Kenneth J. Arrow tried to explain in his growth theory in terms of innovation and technical change. According to Arrow, "*learning is the product of experience*"[68]. Arrow assumed that "*the growth rate of the effectiveness of labor is the result of learning-by-doing*", and Mulder, De Groot, Hofkes specify that the assumption is about internalization of the labor productivity. As mentioned by the writers, learning is assumed as a public good in Arrow model, and the effects of investment are seen as external to each individual firm[69].

The Romer model is another one that internalized technological change. According to Paul M. Romer, technological change actualizes with conscious investments which are decided by profit-maximizing agents and technology is excludable good[70]. Romer built his model upon the ideas of Frankel and Arrow, as mentioned by Mulder, De Groot, Hofkes. The idea of Romer was specified in their study as "*technology grows in proportion to the macroeconomic capital stock, potentially offsetting the effects of diminishing returns*"[71]. They refer that when the Romer model compared with the Solow-Swan model, "*a positive growth rate of*

[67] **Ibid**. 77-78.
[68] Kenneth J. Arrow, "The Economic Implications of Learning by Doing", **The Review of Economic Studies**, Vol. 29, No. 3 (1962): 155.
[69] Mulder, De Groot, Hofkes, **opcit**, 154.
[70] Paul M. Romer, "Endogenous Technological Change", **The Journal of Political Economy**, Vol. 98, No. 5 (1990): 71.
[71] Mulder, De Groot, Hofkes, **opcit**, 154.

output can be sustained without population growth and exogenous growth of technological progress"[72]. According to Aghion and Howitt, Romer has introduced the product-variety model which use R & D sector and he has completed it in 1990[73].

The above growth theory was considered from the perspective of the neo-classical economics, and now it will be explained from the perspective of the evolutionary economics.

2.2. The Evolutionary Economics and Schumpeter

To understand Evolutionary Economics and its development, we should deal with Darwin's evolutionary theory and how it spread to other sciences, particularly social sciences. It is significant to understand how the relationship between economics and evolutionary theory has been started.

Evolutionary approach has started to be discussed in biology through Charles Darwin's book namely '*The Origin of Species*' (1859). The evolutionary approach has started to be discussed not only in biology but also in other sciences. The convergence of social and natural sciences has caused that the evolutionary approach spread into economics.

Darwin mentioned Malthus's thoughts on population in the Introduction part of his study. Dinç Alada emphasizes that Darwin had been affected by some social scientists. For example, according to Alada, "*Darwin had been affected from Malthus but this effect is metaphoric*". Alada refers also that "*Darwin had been inspired by the moral philosophy of Hume, Smith and Kant*". Additionally, he remarks that instead of political economy, Darwin was interested in modern social sciences philosophy[74].

Bahar Araz discusses the relationship between Darwin's and Evolutionary Economics in her study. She specifies that Darwin had been affected by Matlhus. According to Araz, Darwin's evolutionary thought and Marx's evolutionary thought cannot be tackled separately because Darwin's evolutionary thought is seen in

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[72] **Ibid**, 155.
[73] Philippe Aghion, Peter Howitt, **The Economics of Growth**, (Massachusetts: The MIT Press, 2009), 81.
[74] A. Dinç Alada, "Darwin ve İktisat Düşüncesi Üzerine Çok Kısa Bir Not", **Darwin ve Evrimsel İktisat Sempozyumu 19-20 Kasım 2009**, ed. Muammer Kaymak, Ahmet Şahinöz (Ankara: Hacettepe Üniversitesi Yayınları, 2011): 9-10.

Marx's social and technological change theories. Morover, she refers that as Marx had been inspired by Darwin, Schumpeter had been inspired by Marx that means Schumpeter indirectly had been inspired by Darwin[75].

Metin Sarfati mentions the relationship between Darwin and classical political economy while referring the relationship between physical science and social science in his study namely "Have Smith affected to Darwin?". According to Sarfati, Darwin had been affected by Smith's political economy, instead of Malthus' political economy[76].

The evolutionary economics has been drawn more intensive attention by academicians in the past three decades. Actually Thorstein Veblen has invented the term of "evolutionary economics" in the literature. In the second half of the 20th century, the studies have referred to Schumpeter's studies and his revolutionary ideas. The Evolutionary Economics has criticized the Neoclassical Economics and gained importance in terms of economic growth and development.

As specified by many academicians such as Araz, Mulder, De Groot, Hofkes, Fagerberg, Nelson and Winter, Schumpeter has become the pioneer of evolutionary economics.

Fagerberg writes that Schumpeter took some ideas from Marx, the historical school and Neoclassicals "*dynamic outlook* (from Marx), *the emphasis on historical specificity (with respect to technology, industry/sector, institutions and so on)* (from historical school), *the need for a micro-based approach* (neoclassical)"[77]. Schumpeter had been affected by Marx in terms of the idea that technological competition among firms has affected capitalist evolution. As specified by Fagerberg, Schumpeter adopted the argument that the basic way in terms of sustaining competitiveness of the capitalist firms was to enhance productivity via new and more productive machine (that idea mentioned by Karl Marx), in other

[75] Bahar Araz Takay, "Evrimsel İktisat ve Gelişimi", **Darwin ve Evrimsel İktisat Sempozyumu 19-20 Kasım 2009**, ed. Muammer Kaymak, Ahmet Şahinöz (Ankara: Hacettepe Üniversitesi Yayınları, 2011): 11-24.
[76] Metin Sarfati, "Adam Smith'in Ekonomi Politiği Darwin'i Etkilemiş midir?", **Darwin ve Evrimsel İktisat Sempozyumu 19-20 Kasım 2009**, ed. Muammer Kaymak, Ahmet Şahinöz (Ankara: Hacettepe Üniversitesi Yayınları, 2011): 33-40.
[77] Jan Fagerberg, "Schumpeter and The Revival of Evolutionary Economics: An Appraisal of Literature", **The Journal of Evolutionary Economics**, Vol. 13, Issue 2, (2003): 4.

words technological competition (the centerpiece of the evolutionary dynamics) has been used by Schumpeter as "*the nature of capitalist competition*"[78].

Fagerberg shows the difference between Marx and Schumpeter in terms of the contribution to the argument in his study. He has quoted the difference as follows:

> "Schumpeter extended the Marxian argument by introducing a broader notion of innovation. While Marx had limited the analysis to mechanization (i.e., process innovation), Schumpeter also included a number of other elements such as the development of new products (or new variants of such), the introduction of new types or qualities of raw materials or intermediary products, the creation or exploitation of new markets and new ways to organize business"[79].

Schumpeter has not only extended the notion innovation, but also separated some notions such as invention and innovation as conceptual so that is why Schumpeter is important. As referred in the study of Freeman and Soete, according to Schumpeter, real innovation in economy occurs when the first commercial success actualized as related with new product, production process, or tool[80]. Dosi and Nelson refer that *incentives for potential innovators/adopters* and *changes in the characteristics of them* are related with Schumpeter's distinction (invention, innovation and diffusion)[81].

According to Schumpeter, "*economy is qualitatively transformed by innovations*"[82]. As Taymaz underlined, technological innovation and learning processes are prominent concepts in the process of economic progress within the framework of Schumpeterian approach. That means technological innovation process has a central role in Schumpeterian approach compared with Neoclassical approach[83].

Schumpeter has specified some theories in terms of entrepreneurship. As mentioned by Fontana, Nuvolari, Shimitzu and Vezzulli, these theories describe "*the characterization of industries*", and the theories are called as "Schumpeter Mark I and Schumpeter Mark II*"*. Schumpeter has discussed these characterizations in his

[78] **Ibid**, 6.
[79] **Ibid**, 6.
[80] Freeman and Soete, **opcit**, 7.
[81] Giovanni Dosi, Richard R. Nelson, "The Evolution of Technologies: An Assessment of the State of the Art", **Euroasian Business Review**, Vol. 3, Issue 1, (2013): 30.
[82] Joseph A. Schumpeter, **Business Cycles: A Theoretical, Historical and Statistical Analysis of the Capitalist Process**, Abridged with an introduction by Rendigs Fels, (New York, Toronto, London: McGraw-Hill Book Company, 1939).
[83] Taymaz, **opcit**.

books: "*The Theory of Economic Development* (1911)" and "*Capitalism, Socialism and Democracy* (1947)"[84].

According to Fontana et al., Schumpeter has made this separation in terms of environment, barriers, size of firms and effects of technological competition.

> "[…] Schumpeter Mark I industries are characterized by turbulent environments with relatively low entry barriers where innovations are (mostly) generated and developed by new 'entrepreneurial' firms. Accordingly, technological competition among firms in Schumpeter Mark I industries assumes the form of 'creative destruction' with successful innovating entrants replacing the incumbents. Vice versa, Schumpeter Mark II industries are characterized by stable environments with relatively high entry barriers in which innovations are generated and developed by large established firms. In Schumpeter Mark II industries technological competition assumes the form of 'creative accumulation' with incumbent firms introducing innovations by means of a process of progressive consolidation of their technological capabilities along well establish technological trajectories. […]"[85].

Freeman and Soete have underlined the difference between Schumpeter's "Mark I and Mark II"[86]. According to them, large firms have started to become main tool in economy together with Mark II, therefore R & D activities towards industry have grown rapidly[87].

Aghion and Howitt have implied that the Schumpeterian growth model emphasizes the importance of quality-improving innovations which has been called as "*creative destruction*" by Schumpeter[88]. According to them, the Schumpeterian paradigm was that "*faster growth is generally implies a higher rate of firm turnover, because this process of creative destruction generates entry of new innovators and exit of former innovators*"[89]. They have also emphasized that the problem of the neoclassical model is that technical progress cannot be explained[90]. They believe that some internal forces in economic system affect the rate of technological progress. They specified the importance of the process of innovation and the incentive to innovate in terms of technological progress[91].

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[84] Roberto Fontana et. al., "Schumpeterian Patterns of Innovation and The Sources of Breakthrough Inventions: Evidence from A Data-Set of R & D Awards", **Lisbon Technical University School of Economics and Management**, (2012): 2.
[85] **Ibid**, 2.
[86] Mark I and Mar II are called as "early period of Schumpeter" and "late period of Schumpeter" respectively in the book namely "The Economics of Industrial Innovation" that written by Freeman and Soete.
[87] Freeman and Soete, **opcit**, 10.
[88] Aghion and Howitt, **opcit**, 15.
[89] **Ibid**, 16.
[90] **Ibid**, 13.
[91] **Ibid**, 21.

In another work, Nelson refers that early evolutionary analyses did not notice "*the complex institutional structures that characterize modern economies*"[92]. According to Nelson, the reasons of the economic growth are the co-evolution of technologies, firm and industry structures, and supporting and governing institutions in terms of the new evolutionary growth theory[93]. Nelson says that "*successful development involves the co-evolution of technologies employed, firm and industry structure, and broader economic institutions*" but it is not possible without "*government policies and programs*"[94]. In this point, evolutionary economics has emphasized the importance of endogenous technology and its internalization which has been provided by institutions such as R & D centers, universities, banks, firms, tax offices.

In the 20th century, as a result of expansion of technology, it has become mostly spoken topic in the world. Especially, the progresses in ICT are one of the conspicuous topics in terms of economic development and growth, and Hughes and Moore think that technology is *a motivational power*. As a result of diffusion of technology, particularly ICT, it has started to enter the policies, strategies and programs, and it has started to implement in the processes of work in institutions, because of the effects of ICT on institutions such as low costs. Hughes and Moore call it as a *"new Industrial Revolution"* and specify manual emerging social and economic institutions that support the new revolution and "*require active policy measures*". They also refer to "*the effects of social and economic institutions and behaviours in determining the role and development of the technology"*[95].

[92] Richard R. Nelson, "Economic Development from the Perspective of Evolutionary Economic Theory", **University of Oxford Department of International Development**, (2004): 10.
[93] **Ibid**, 10.
[94] **Ibid**, 14.
[95] Kirsty Hughes, Nick Moore, "The Role of Information in the Economy and Society: An Overview", **Proceedings of A Workshop**, **3-4 November 1992**, (Luxembourg: European Commission, 1992): 1-51.

3. RELATIONSHIP BETWEEN ICT AND ECONOMIC INSTITUTIONS

In the second part, we tried to analyze the theoretical framework on technological progress. In this part, I will focus on relationship between ICT and economic institutions in the world and Turkey while referring to the reflections of ICT on the information society.

3.1 The Reflections of ICT on the Information Society

The New Industrial Revolution, in other words *Technology/ICT Revolution*, has caused to rise unprecedented society in the world. That society is called as *a new society* by Olszak and Ziemba[96], it can be called as *the Information Society* or *rising society*. Transformations under the effects of ICT, have been seen in every part of the society, it means in culture in politics and in economics. Common ICT usage has accelerated transition to the information society which has caused evolutions globally, and this world has been called as *a small village*. Therefore, some developments such as recent ICT usage in every field of life and high connectivity level, high speed travelling have been seen in this small village.

As global change has spread throughout the world, the meaning of place and time has evolved. The progress of ICT has hastened evolving of the perception of place and time therefore distant locations have become close. For example, countries had sent post each other via a man who riding horse in the medieval age and thus the post had reached in several weeks, but today a message goes from someone to another person within seconds. In this mechanism, institutions have been affected because communication process has caused impacts on the process of works such as faster connection among institutions so the people. Hughes and Moore mention by referring to Freeman's perspective that ICT causes *the reduction in the costs* and *widening the area of the information activities* within the framework of economy[97].

[96] Olszak and Ziemba, **opcit**, 213.
[97] **Ibid**, 1-51.

Quicker communication has brought competitive market structure. It is seen from Schumpeter's separation (Mark I and Mark II) that technology brings competition among firms[98]. It means that ICT brings a new dimension to competitiveness of institutions. For instance, increasing uncertainty and rapid changes in the perception of place and time has required quick decision making, sustainability of resilience etc. in institutions. In order to make such decision, people need quick analysis and getting information that they use quickly.

As a result of these, institutions have required new structure and technology to maintain their activities. Majority of goods and services are connected with ICT such as robotics, computers, financial operations and almost whole commercial activities via e-mail. Therefore, it is possible to say that the way of providing goods and services has been transformed from physical environment to virtual (electronic) status[99].

As a result of diffusion of ICT, virtual effect on market brings various relationships among institutions, individuals, and institutions-individuals such as *Fang's types* (see page 16) (see footnote 48). It means that relationship types change thanks to ICT revolution with respect to what your position is.

Common use of electronic mailing among institutions/branches/individuals is one of the prominent examples in almost all types. It has caused change in the speed and cost of communication thanks to ICT.

Communication among institutions/branches/individuals is not only via e-mail, but also telephone, mobile phone, camera, videoconference. For example, meetings between them is making via videoconference among different places. Therefore, they get some advantages such as rapid decision making process, low travelling costs, less greenhouse gas emissions, low personal pay. For example:

> "Darryl Draper, the national manager of customer service training for Subaru of America, used to travel 9 months in a year, now travel rarely. According to her estimates, she would reach in six months about 220 people at a cost of $300 a person, now she reaches 2500 people at a cost of 75 cents a person"[100].

[98] Fontana et. al., **opcit**, 2.
[99] Today, as a result of spread of mobile technologies, they also called as m-finance (m-banking, m-borsa, m-taxation), m-commerce. "m" refers to "mobile".
[100] Lohr Steve, "As Travel Costs Rise, More Meetings Go Virtual", **The New York Times**, 22 July 2008, http://www.nytimes.com/2008/07/22/technology/22meet.html?_r=0 [2.10.2016].

Commercial activities on the internet among firms and people are enabled to reach to more consumer, client, goods and services easier thanks to electronic market. Thus, e-commerce is one of the new rising topics. For instance, some websites such as *amazon.com*, *ebay.com*, *hepsiburada.com*, *sahibinden.com* are active for electronic commercial activities in the world and in Turkey. Today amazon.com has "*over 70,000 entrepreneurs*", and in 2015 the company reached "*$100 billion in annual sales*"[101].

In addition, various topics have discussed in several websites among individuals. This virtual discussion area leads to solve many problems or at least sharing knowledge etc. For example, a consumer can share news about any goods immediately in a goods-oriented forum website when its price diminished, or they can share their opinions and experiences on any goods and services. A consumer can reach to other consumers immediately wherever they live in, therefore a consumer can affect with each other via ICT.

Furthermore, people have meet different machines several time in their daily life. For examples:

- (as a consumer) you can buy a water, a chocolate or a sandwich from vending machine when you feel thirsty or hungry, or you can pay all goods that you bought via Jet Cash after shopping in the supermarket;
- (as a client) you can deposit and withdraw money, and make several financial operations such as transferring money from one account to another account immediately via ATMs;
- (as a citizen) you can charge money on your electronic city cards such as *İstanbulCard* via charging machines, or you can encounter with electronic traffic signs and electronic detection system in daily life while driving a vehicle, or you provide electricity from private electricity distribution companies.

Together with common usage of mobile-phone, almost all relationships became mobile via these technologies and various kinds of applications. Social media

[101] Amazon.com, **2015 Annual Report** (2016), http://phx.corporate-ir.net/External.File?item=UGFyZW50SUQ9NjI4NTg0fENoaWxkSUQ9MzI5NTMwfFR5cGU9MQ==&t=1 [2.10.2016].

applications, such as *Whatsapp* and other applications such as e-banking, e-government, cause the relationships moved from face-to-face communications to virtual one. For example, when you buy something on the internet, you have to fill information of your payment card and then you will get a password SMS by bank on your mobile phone to complete payment process securely. You can make also several financial operations via bank applications such as electronic funds transfer, getting new deposit account or virtual card, invest your savings into different securities, controlling situation of accounts etc. Additionally, advertisements can reach to individuals/institutions over the internet by bill board or via technologies such as digital screen, computer, mobile phones etc.

In recent years, new notion has been called in everywhere, *the Internet of Things*, shortly most of goods and services which connected with internet. For example, smart home system includes variety of goods and services to protect home and to provide efficiency of sources such as electricity, water, gas. Their connection with mobile phone, most of goods and services have been provided mobile way.

All these examples show that people has used technology in the various areas of life with their related institutions. At this point, it is important to emphasize that institutions should be flexible and innovative to keep pace with technological developments, and should be equipped with latest technologies to compete more strongly in this ever-changing environment. It can be given as an example for Schumpeter's creative destruction, as I mentioned in the second part in this study (p. 28), if firms cannot keep pace with technological developments, their infrastructure may not provide innovative goods or services and therefore they may lose their competitive power against other firms. Therefore, it reminds us evolutionary economics, which introduce technological developments as a necessary component for internalization by institutions.

On the one hand, the capability of institutions to keep pace with technological developments is important. On the other hand, as I mentioned in the second part, according to Schumpeter, the meaning of innovation includes new products, new markets, new work processes, and new services. These innovations are similar with the effects of ICT. This is all to say that ICT is a driving power of real innovation.

3.2. The Role of Economic Institutions

During the 20th century internalization of technologies has been discussed in Economics.

Internalization process of technology cannot realize automatically; it requires supporting of regulator institutions to internalize the environment. It means that the institutions qualify economies with regulations so they provide necessary environment in order to internalize technology.

In this way, Richard R. Nelson has highlighted the necessity of government's policies and programs[102]. Similarly, Hughes and Moore have emphasized the behaviors of social and economic institutions to determine the role and development of technology[103]. For instance, as a result of rising ICT sector, especially telecommunications sector in the second half of the 20th century, on the one hand, governments and institutions have regulated their policies and programs. On the other hand, they have regulated also the sector by upgrading infrastructure and providing necessary legal framework. It is important to emphasize the prominent role of public institutions in terms of the internalization process of technology and ICT. For example, there are some institutions in the world which have prominent roles to internalize technology such as universities, technoparks, R & D centers, Ministry of Technology, and ICT Authorities.

During the last two decades, ICT sector has been one of the prominent sectors in the world. Additionally, regarding its economic benefits, most of the reports, written by World Bank, OECD, ITU, include the development ICT which emphasizing its importance and shaping the sector itself and the future.

The World Bank points out the importance of ICT for development. In this sense, according to the World Bank, connectivity (via the internet or mobile phones) affects business and production processes, services in terms of how they will be done. The World Bank underlines that "*with 10 percent increase in high-speed internet connections, economic growth increases by 1.3 percent*"[104].

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[102] Nelson, **opcit**, 14.
[103] Hughes and Moore, **opcit**, 1-51.
[104] "Information Communications Technology for Development", World Bank, http://live.worldbank.org/information-communications-technology-development [02.04.2016].

ITU specifies the effects of growth in ICT on economy in both developed and developing economies. Growth of ICT sectors (both services and manufacturing) brings benefits for economies such as new jobs and revenue. According to ITU, the size of these kinds of benefits depends on the large of ICT sector and its growth rate. Moreover, telecommunications users, privatized and competitive telecommunications services sector causes increase in the benefits of growth[105]. OECD refers to ICT "*as drivers of growth in OECD economies*" in its 2003 report namely "*ICT and Economic Growth: Evidence from OECD Countries, Industries and Firms*". The report mentions ICT investment is analyzed between 0.3 and 0.8 percentage points of growth in GDP per capita over the 1995-2001 period. It can be seen in this report, some countries had the largest boost such as USA, Australia, the Netherlands and Canada.

TUBISAD mentions the role of ICT in economy in terms of growth rapidly in its 2012 report namely "*ICT for Development: ICT Market Development Strategy 2023 for Turkish Economy*". According to TUBISAD, in the second half of the 20th century, there are different growth performances among countries which have been seen. Some of them have converged to developed countries such as South Korea and Singapore and the main reason for this convergence was ICT sector. For example, GDP per person of Singapore and GDP per person of South Korea are equal to 80% of the same figure of USA and 40% of USA respectively. It seems ICT plays an important role in terms of growth and development. However, some countries have not converged such as Turkey and Brazil.

Information flow is related with ICT and its market, growth and development implicitly. Calhoun refers to Fritz Machlup in his book namely "*Wireless Access and the Local Telephone Network*". Calhoun specified that Machlup is the first economist in terms of analyzing quantitative measurement of the importance of information flows within the economy. Machlup estimates "*29% of the USA GDP was derived from the production and management of information*"[106]. Moreover, Calhoun also implies by quoting from Daniell Bell that "t*he USA GNP that increased from 3% in the 1930-1950 period to 7,5% by 1969*"[107].

[105] ITU, **World Telecommunication/ICT Development Report** (2003), 10.
[106] George Calhoun, **Wireless Access and the Local Telephone Network**, First Edition (Artech House, 1992), 9.
[107] **Ibid**, 9.

Moreover, telecommunications networks have been developed shiningly so it has affected the cost of network operations. Additionally, technologies associated with the context of communication have become more strategic factor. It can be say that increasing communication in the world has affected the ICT sector due to developing network equipment. Developing network equipment has caused the reduction in telecommunications costs. It can be also given as an example in OECD papers:

> "*Fiber-optic cables made international telecommunications less expensive and in 1992, the introduction of the TAT-9 cable between Europe and the United States halved the costs of telephony per minute from estimated USD 0.04 per minute to USD 0.02 per minute*"[108].

The World Bank Group has a strategy to help developing countries in terms of "*increasing use of mobile phones and the internet*", "*reduction in prices of computing and mobile internet devices*", and "*increasing penetration of social media*" in order to "*transform delivery of basic services*", "*drive innovations and productivity gains*", and "*improve competitiveness*" respectively[109].

DIGITALEUROPE implies the digital technologies as a *transformational power* in its Vision 2020. The Vision emphasizes the importance of ICT sector in terms of network, software, and internet. Additionally, there are more topics that highlighted in its vision such as digital infrastructure and networks, future internet and services, ICT R & D, e-skills, and etc. These are seen as essential conditions for economic growth and development[110].

Luis Enriquez et. al. refer also ICT within the framework of economic growth and development in *The Global Information Technology Report 2015*. They specify the impact of internet on economy and the importance of its contributions. It is mentioned through the World Bank research that "*for every 10 percentage-point increase in the number of high-speed internet connections in developing countries, there was an increase of 1.3 percentage points in economic growth*"[111]. Luis Alvarez

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[108] OECD, **International Traffic Termination**, 2014, 7.

[109] John Hogg, "Transform, Innovate, and Connect: A New Strategy for Information and Communication Technology", http://www.worldbank.org/en/news/feature/2012/07/25/transform-innovate-connect-strategy-ict [07.10.2015].

[110] DIGITALEUROPE, **DIGITALEUROPE's Vision 2020 Executive Summary**, http://www.digitaleurope.org/DesktopModules/Bring2mind/DMX/Download.aspx?Command=Core_Download&EntryId=157&language=en-US&PortalId=0&TabId=353 [1.10.2016].

[111] Luis Enriquez et. al., "Creating the Next Wave of Economic Growth with Inclusive Internet", **The Global Information Technology Report 2015: ICTs for Inclusive Growth**, ed. by Soumitra Dutta, Thierry Geiger, Bruno Lanvin (Geneva, 2015): 57-65.

says "*there is a correlation between network uptake and national economic performance, measured by annual GDP*"[112]. Moreover, Juan Jung refers broadband potently by emphasizing the importance of ICT within the framework of economic growth[113].

The diffusion and developments of ICT and technology have brought prominent needs for financial institutions such as "*upgrading of ICT infrastructures, providing of speed, safe, nonstop electronical communication with low cost*"[114].

As it is understood from the above reports, the institutions have emphasized generally the impacts of ICT on economy. Therefore, on the one hand, they have started to create suitable environment for ICT, in other words shaping ICT sector by institutions. On the other hand, it is also important to highlight here that ICT has forced to change the structure of institutions, and their work processes, policies and strategies and their programs. In order to see the effects on financial sector (for example banks, stock markets, tax and revenue institutions, etc.), it is important to analyze the role of ICT. In the 20th century, these economic institutions have realized its role and they have improved their technological infrastructures to get more productive work processes and to be connected with other financial institutions in the world. Particularly, in the 1990s we have observed some changes in the structure of stock markets such as stock market mergers[115] and their transition to joint-stock company. For example, in Turkey the structure of İstanbul Stock Exchange (ISE) has been changed as joint-stock company in 2013 and its name became *BorsaİstanbuI* (BIST)[116]. The mergers and structural changes have provided that the stock markets have gotten a way to reach global markets.

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[112] Luis Alvarez, "Developing the Network for Growth and Equality of Opportunity", **The Global Information Technology Report 2015: ICTs for Inclusive Growth**, ed. by Soumitra Dutta, Thierry Geiger, Bruno Lanvin (Geneva, 2015): 67-72.

[113] Juan Jung, "Digital Inclusion and Economic Development: A Regional Analysis from Brasil", **The Global Information Technology Report 2015: ICTs for Inclusive Growth**, ed. by Soumitra Dutta, Thierry Geiger, Bruno Lanvin (Geneva, 2015): 101-109.

[114] Devlet Planlama Teşkilatı, "İstanbul Uluslararası Finans Merkezi Stratejisi ve Eylem Planı" (Ekim 2009): 17.

[115] HKEx (Hong Kong Exchanges and Clearing Limited), CME Group, SGX (Singapore Exchange), TMX Group (Toronto Stock Exchange), ASX Group (Australian Securities Exchange), JPX Group (Japan Exchange Group), Deutsche Börse Group, LSE Group (London Stock Exchange), NASDAQ OMX Group (National Association of Securities Dealers Automated Quotations), HELEX Group (ATHEX Group - Athens Exchange Group), NYSE Euronext.

[116] "27 Yıllık IMKB gitti, BIST geldi", NTV, 5 Nisan 2013, http://www.ntv.com.tr/ekonomi/27-yillik-imkb-gitti-bist-geldi,swVYbpp15Eak3wosI4kDug?_ref=infinite [23.09.2016].

In the next topic, ICT sector situation will be analyzed in terms of the world, and some examples will be viewed in Turkey, and some economic institutions such as banks, stock market, and tax offices will be viewed to see the impacts of ICT on them. It is necessary to say that this sector will be examined sometimes from the perspective of the World, Developing and Developed Economies in terms of general overview. Besides, it will be analyzed from the perspective of OECD Economies which they have more detailed data in several specific topics.

4. ICT SECTOR AND ITS EFFECTS ON ECONOMIC INSTITUTIONS IN THE WORLD AND IN TURKEY

4.1. ICT Sector in the World

One of the breaking points in the history of the world has seen in the second half of the 20th century together with rising ICT sector and transition to information society.

Cowhey and Aronson view historically the development of ICT sector by separating into three parts such as 1950s-1983, 1984-2000, and the post-2000 period[117] (Table 2). Computing, software, and communication have converged each other in these periods. The convergence of computing, software and communication has showed us that new highly influential sector has rising.

From Table 2, it can be said that the rise of ICT sector has affected communication and transportation costs, network structures, and competition in most of the sectors, policies and commercial activities in the world. World Trade Report mentions that major service industries such as transportation and telecommunications were deregulated in the early 1970s. Additionally, costs of calls and telecommunications services have decreased[118].

Table 2: The Development of World ICT Sector Historically

1950s - 1983	− The characterizing of the telecom market. − The separating of software industry from hardware vendors. − Changes in network performance. − The rising of computer and corporate networking. − The price for services has decreased.

[117] Peter F. Cowhey, Jonathan D. Aronson, **Transforming Global Information and Communication Markets: The Political Economy of Innovation**, (Massachusetts: The MIT Press, 2009), 19.
[118] World Trade Organization, **World Trade Report 2008 Trade in a Globalizing World** (2008), 21.

Table 2 - continue

1984 - 2000	− Neo-liberal policies have spread gradually (transition to open economy) and increasing privatization in terms of Telecommunications Sector. − The breakup of AT&T in 1984, and the Rising New Companies (Regional Bell Operating Companies, shortly Baby Bells). − Government interventions. − The development of network architecture (1980s semiconductor industry-ICT). − Increase in telecommunications switching, data traffic and transmission capacity. − Decrease in costs. − The growth of mobile wireless. − Tim Berners-Lee "The World Wide Web" HTML code that enabled the Web. − Commercial use of internet (1991- US Policy). − Commercial email services (1994).
Post - 2000	− Competition in the sector has increased. − Broadband usage. − Great decrease in costs per subscriber in terms of networks. − Increase in data traffic enormously.

Source: Peter F. Cowhey, Jonathan D. Aronson, **Transforming Global Information and Communication Markets: The Political Economy of Innovation**, (Massachusetts: The MIT Press, 2009).

According to OECD and WTO, telecommunications sector should be liberalized in order to provide the sound competitive environment. Therefore, following to this advice, privatizations in telecommunications sector have accelerated such as British Telecom, Mexican Telecom, Magyar Telecom (MATAV), Czech Telecom, Belgium Telecom, Danish Telecom, South African Telecom, Telecom Serbia, Armenian Telecom and Telecom Romania.

In the second half of the 20th century, total trade in the world has increased strikingly. Balkanlı pays attention to the 1970s because of increasing unprecedented world trade and change in dominant economics ideology[119]. Total world trade has started to increase relatively since the 1970s, except 2009, because of *2008 Global Crisis* that is called as the biggest crisis after The Great Depression. According to World Trade Report, total exports increased 8.2% per year between 1950 and 1973. It is seen in the report; the reason of the rise of total trade in the 1990s is *the innovations in IT sector*. Additionally, the reason of slightly shrinkage in 2001 is

[119] Balkanlı, **Makroekonomik Denge ve Küresel Krizler**, 40.

specified as *the dotcom crisis* by the report, in other words *the crash of NASDAQ stock market in 2000*[120].

OECD specifies that ICT goods and services have an importance in terms of international trade and world trade in ICT goods is $3.7 trillion in 2007. According to OECD, China is world's largest ICT goods exporter since 2004, USA was the largest importer of ICT goods[121].

After 2000, the share of world ICT goods trade (export and import) in world total trade almost decreased approximately 5% in thirteen years (Fig. 6 and 7). The share of ICT goods exports and imports in 2002 in developing economies, and the share of ICT goods imports in 2009 in both developed and developing economies increased. Moreover, there is an upward trend between 2011 and 2013 in the world. According to UNCTAD, the reason of these increases in world ICT goods trade is that *increasing demand for communication equipment*, particularly in developing economies[122].

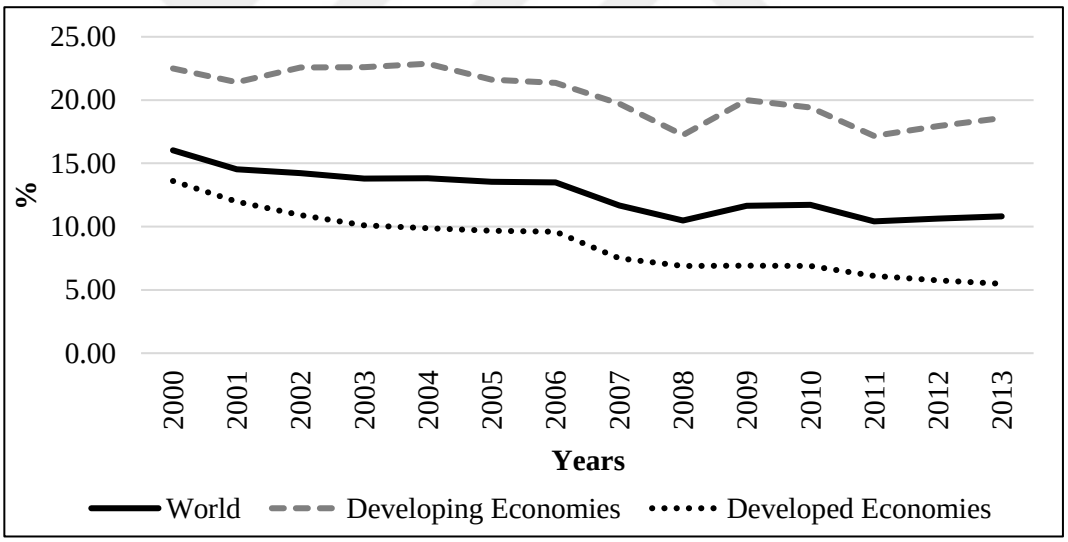


Figure 6: The Share of World ICT Goods Exports in World Total Trade, Annual, 2000 - 2013

Source: UNCTAD.

[120] World Trade Organization (2008), **opcit**, 15.
[121]OECD, **OECD Science, Technology and Industry Scoreboard** (2009), 90.
[122] "Global Imports of Information Technology Goods Approach $2 trillion, UNCTAD Figures Show", UNCTAD, http://unctad.org/fr/pages/newsdetails.aspx?OriginalVersionID=692&Sitemap_x0020_Taxonomy=Technology%20and%20Logistics; [04.03.2016].

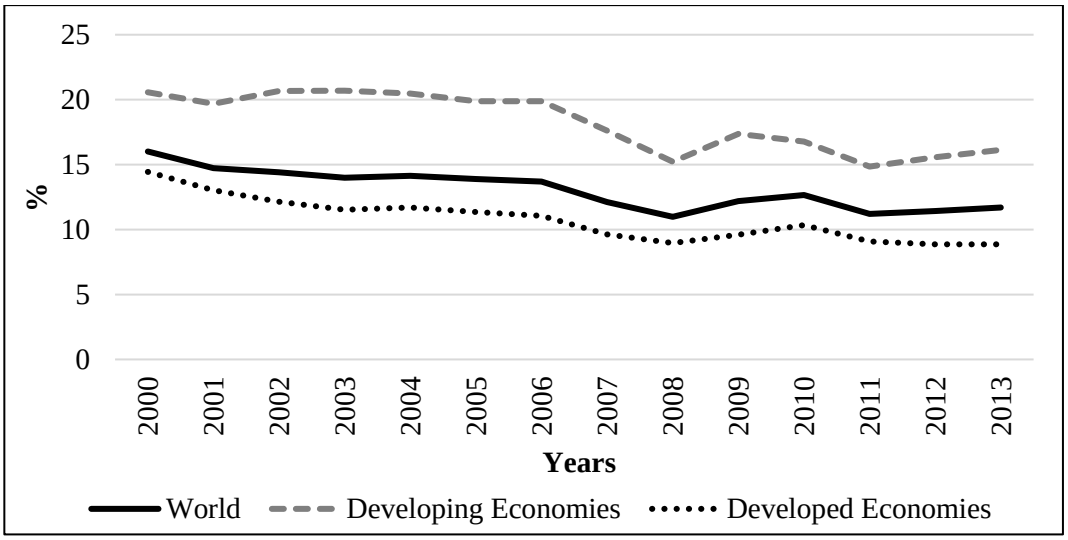


Figure 7: The Share of World ICT Goods Imports in World Total Trade, Annual, 2000 - 2013

Source: UNCTAD.

Though the share of world ICT goods trade in world total trade almost decreases after 2000, telecommunications equipment & parts trade in the world has increased except 2001, 2002 and 2009 thanks to increasing demand for communication equipment, particularly in developing economies (Fig. 8 and 9). For instance, world ICT Goods Exports of China grew from 4.4% to over %30 between 2000 and 2012[123] and world ICT goods import is nearly $2 trillion in 2012. According to Information Economy Report, NASDAQ crash caused decrease in ICT goods trade in 2001. As it is started to recover in 2002, the trade has increased again in 2003 (more than $1.1 trillion exports) due to some regulations on international trade[124]. Also, the Global Crisis in 2008 caused the recession in 2009 in terms of the trade.

Another Information Economy Report mentions that "*the global market in ICT goods trade has witnessed a general shift from developed economies to emerging economies in the developing world*"[125]. It is seen that there is a decrease in telecommunications equipment & parts exports of developed economies in 2001, 2002, 2003, 2007 and 2009 (Fig. 8). The reason of the downward trend in the early 2000s is that decrease in the share of global telecommunications exports from 74 to

[123] OECD, **Measuring the Digital Economy: A New Perspective**, (2014), 144.
[124] United Nations, **Information Economy Report 2005: E-commerce and Development** (New York and Geneva, 2005), 24.
[125] United Nations, **Information Economy Report 2007-2008: Science and Technology for Development: The New Paradigm of ICT** (New York and Geneva, 2007), 116.

60 in Europe[126]. Though there is an upward trend in telecommunications equipment & parts trade in the world, it decreased again in developed economies in 2007 and 2009, respectively, because of decreasing demand in telecommunications sector and 2008 global crisis.

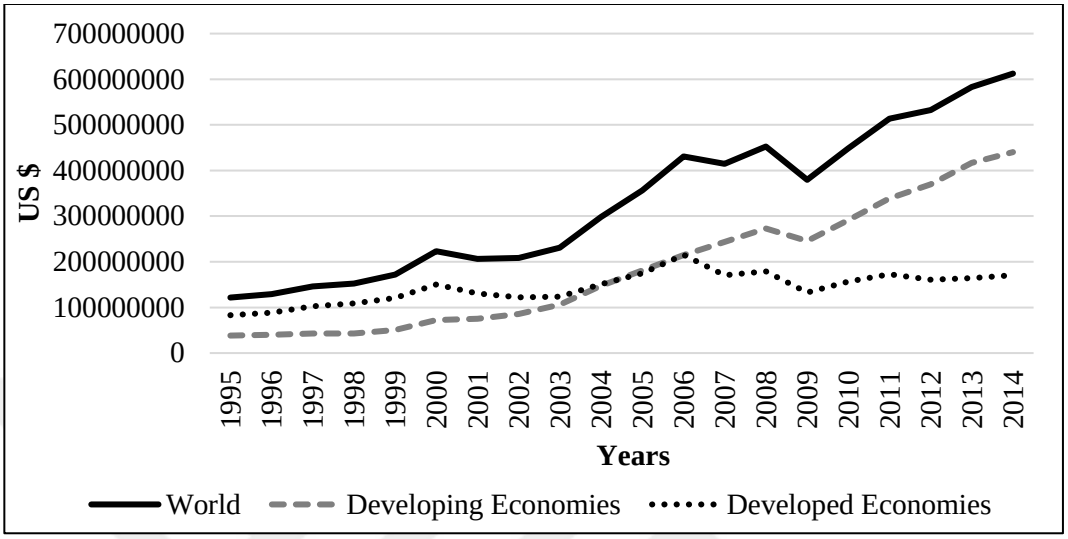


Figure 8: Exports of Telecommunications Equipment & Parts in the World (Thousands of US Dollars), Annual, 1995 - 2014

Source: UNCTAD.

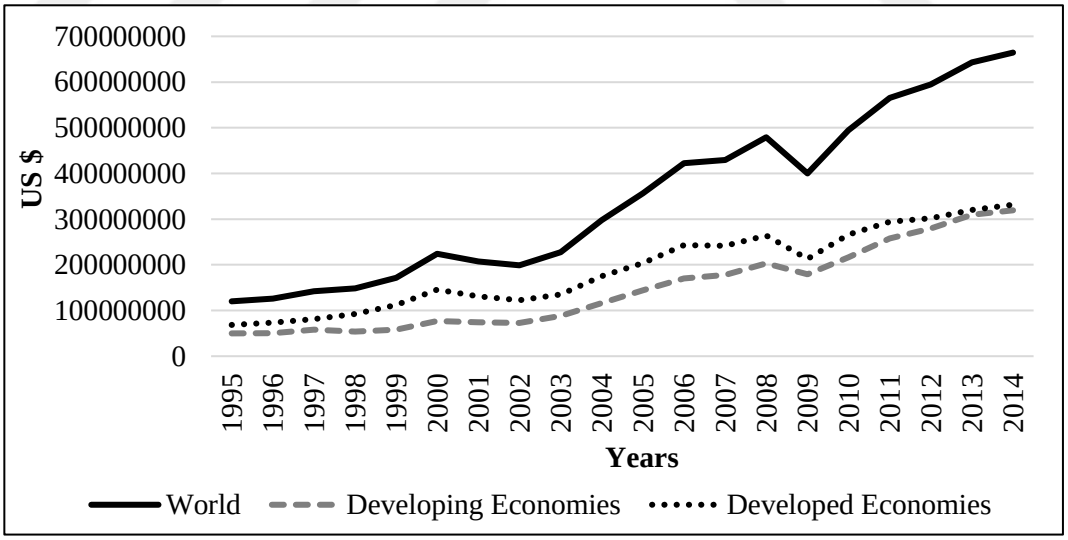


Figure 9: Imports in Telecommunications Equipment & Parts in the World (Thousands of US Dollars), Annual, 1995 - 2014

Source: UNCTAD.

[126] United Nations, **Information Economy Report 2005**, 32.

After the recession in 2009, the export indicators of world and developing economies are almost parallel while it is decreasing in developed economies (Fig. 8). In other words, export of telecommunications equipment & parts in the world has increased thanks to developing economies. Their exports and imports have sharply increased when compared with developed economies due to increasing demand in telecommunications sector in developing economies.

World exports of communication services and information and computer services have increased after 2000 (Fig. 10). According to OECD, ICT services trade in the world grew much faster than ICT goods trade and the share of computer and information services changed from 3% to 6% in world services export between 2000 and 2013[127].

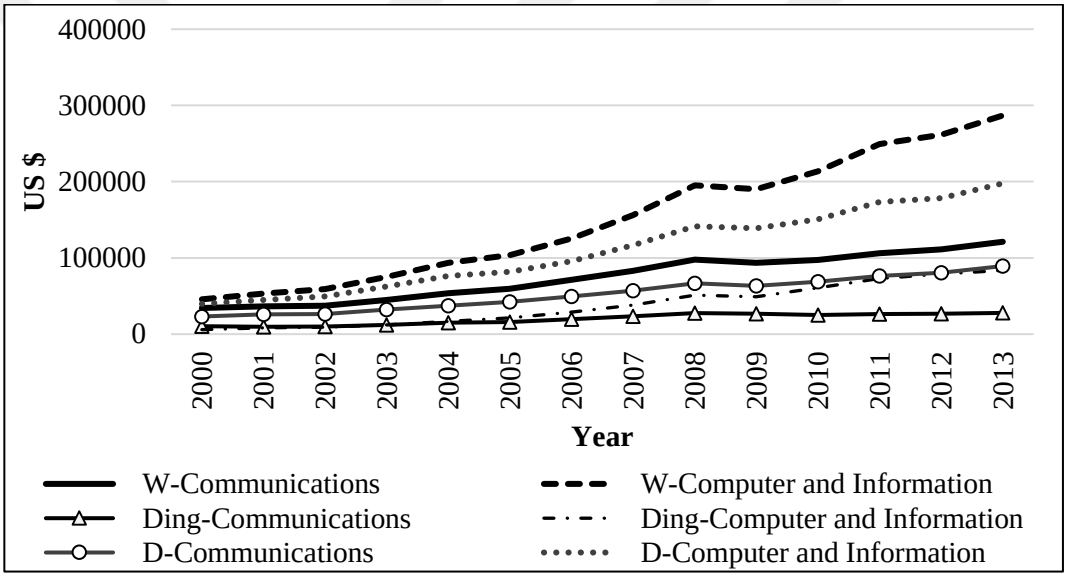


Figure 10: World Exports by service-category (US Dollars at current prices and current exchange rates in millions), Annual, 2000 - 2013

Source: UNCTAD.

According to International Trade Statistics, a world export of communications services is US$ 115 billion in 2014. In the report, it is pointed out that the growth rate of communications services is 9% per year on average since 2000, and this growth has not been affected too much thanks to continuous demand for mobile phone services[128]. Moreover, world internet penetration has incrementally increased

[127] OECD 2014, **opcit**, 144.
[128] World Trade Organization, **International Trade Statistics** (Geneva, 2015), 21.

since 1990, particularly since 2000 in the period of diffusion of ICT and its services (Fig. 11).

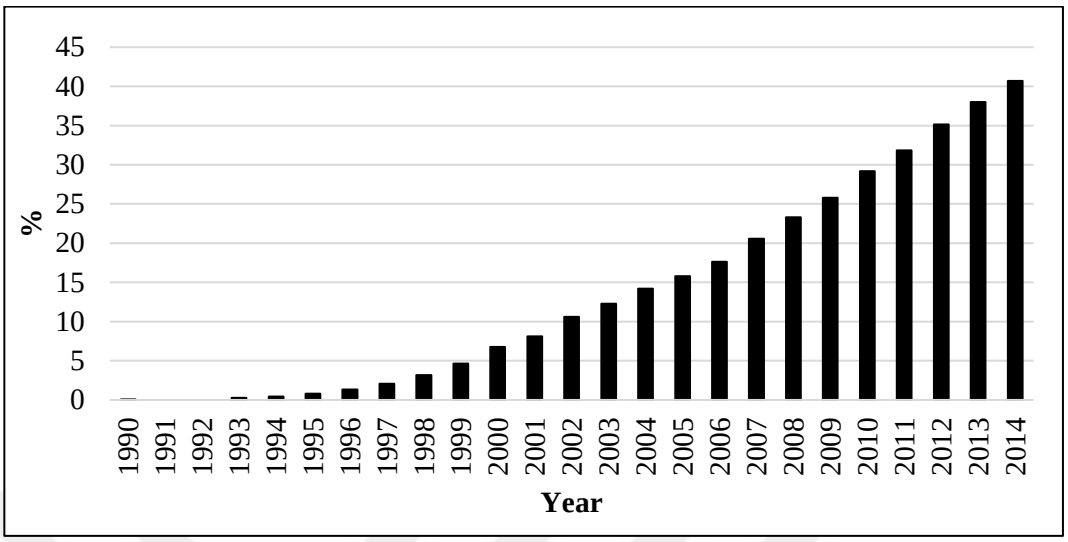


Figure 11: World Internet Penetration, Annual, 1990 - 2014

Source: UNCTAD. 1991 and 1992 are not available.

ITU specifies also that telecommunications services sector is growing in terms of access to the services. It is mentioned that "*the number of telephone subscribers (fixed + mobile) kept growing at a minimum annual rate of 12 percent even during the dotcom crash*"[129].

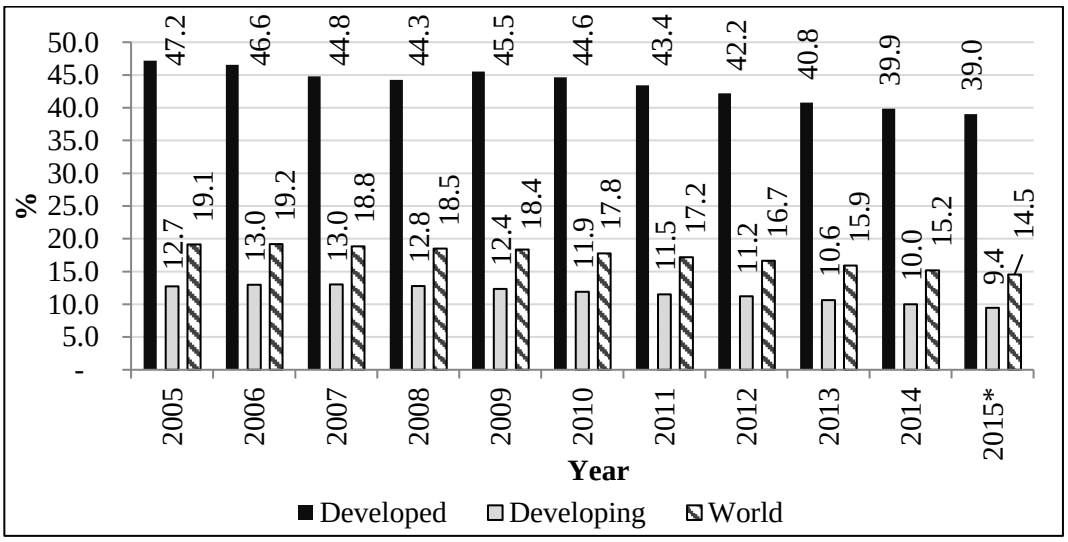


Figure 12: Fixed Telephone Penetration in the World

Source: ITU World Telecommunication/ICT Indicators database. *Expected.

[129] ITU 2003, **opcit**, 10.

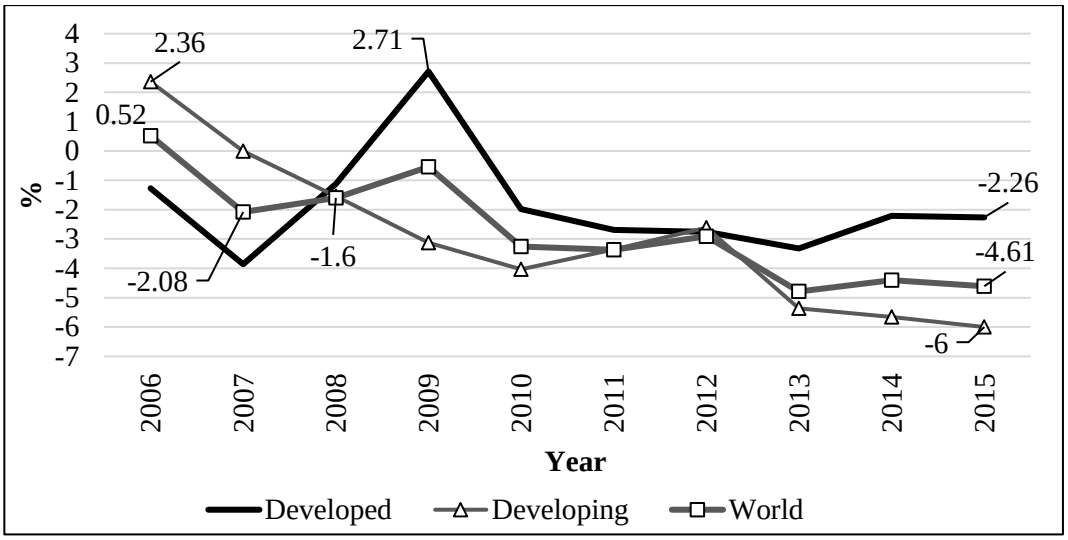


Figure 13: Growth Rate of Fixed Telephone Penetration in the World

Source: ITU World Telecommunication/ICT Indicators database.

Diffusion of ICT and its services in the world, telephone subscriptions (fixed + mobile) are increasing year by year. As telecommunications services and tools develop, particularly in mobile, it is seen that there is a downward trend in fixed telephone subscriptions because of diffusion of mobile network and change in perception of space and time (Fig. 12). For example, there is negative growth since 2006 in fixed telephone subscriptions in the world (it is more in developing economies than developed) because of increasing demand in telecommunications sector, particularly in developing economies (Fig. 13).

However, according to the Information Economy Report, fixed telephone penetration has decreased since 2003. The report mentions that there are two reasons of slow or negative growth in fixed telephone penetration. One of the reasons is significant developments in both voice over Internet Protocol (VoIP). Other one is the rise of mobile telephony[130].

Contrary to decreasing fixed telephone penetration, fixed broadband penetration in the world has increased since 2005 (Fig. 14 and 15). According to Information Economy Report, its reason is that there is a transition from traditional voice services to public switched telephone network with VoIP (PSTN) or voice over broadband (VoB). The report specifies that VoB services are driven by telephone, internet and television "*triple play bundles*". For instance, "*France had the world's*

[130] United Nations, **Information Economy Report 2009: Trends and Outlook in Turbulent Times** (New York and Geneva, 2009), 2.

biggest IPTV market in 2007 with over 2 million subscribers". It is also specified that the spread of triple play services supported the transformation to Next Generation Networks (NGNs[131]) that provide significant progress in developed economy markets[132].

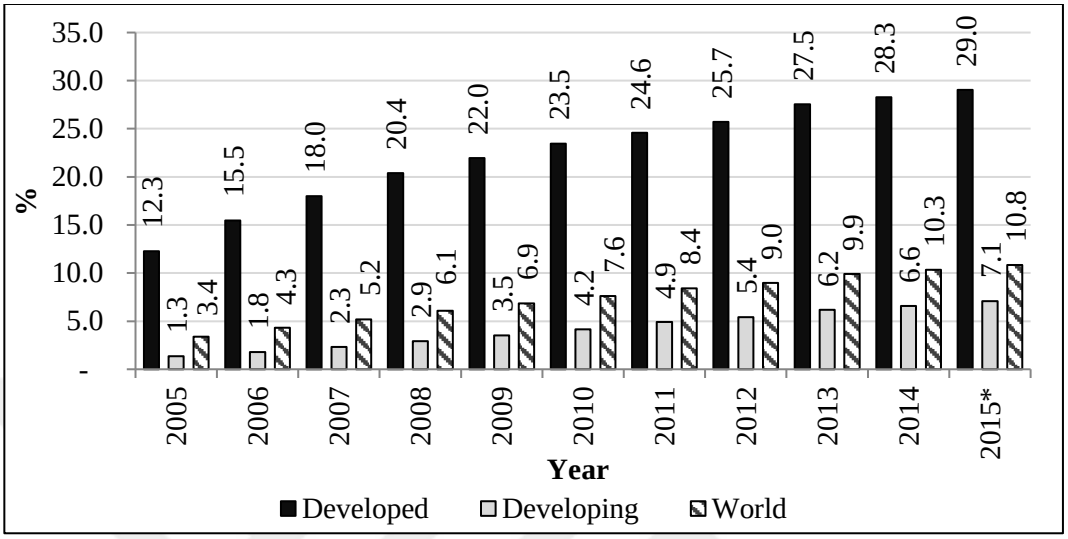


Figure 14: Fixed Broadband Penetration in the World

Source: ITU World Telecommunication/ICT Indicators database. *Expected.

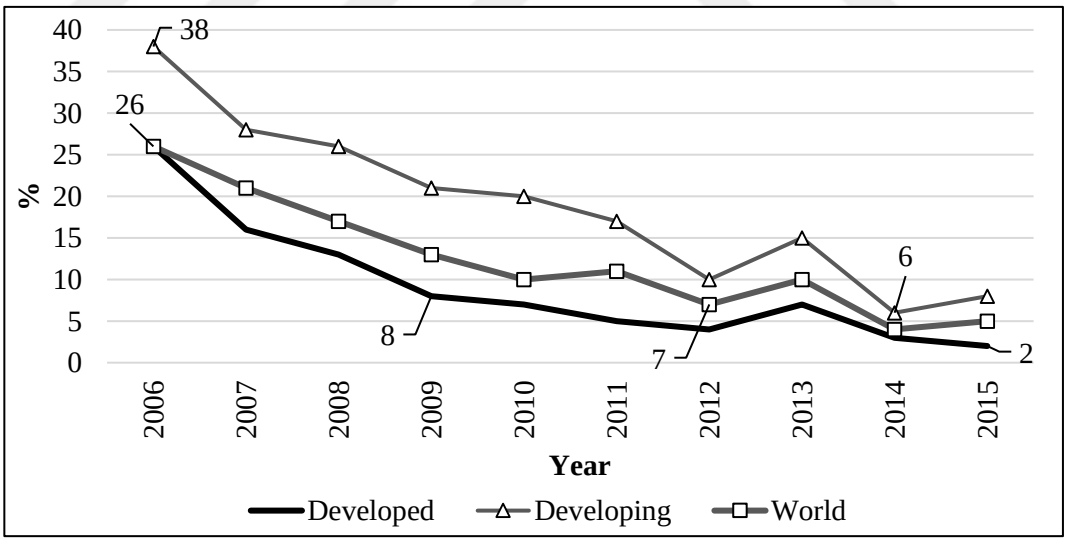


Figure 15: Growth Rate of Fixed Broadband Penetration in the World

Source: ITU World Telecommunication/ICT Indicators database.

Even growth rate in fixed broadband penetration are more in developing economies than developed, the penetration is more in developed economies than

[131] In the Information Economy Report 2009, Next Generation Networks (NGNs) are described as "where all services are provided over an Internet Protocol-based platform".
[132] **Ibid**, 3.

developing. Because fixed telephone investments in developed economies have started earlier than developing, and it was high volume investments. Telephone has diffused in developing economies mainly as mobile.

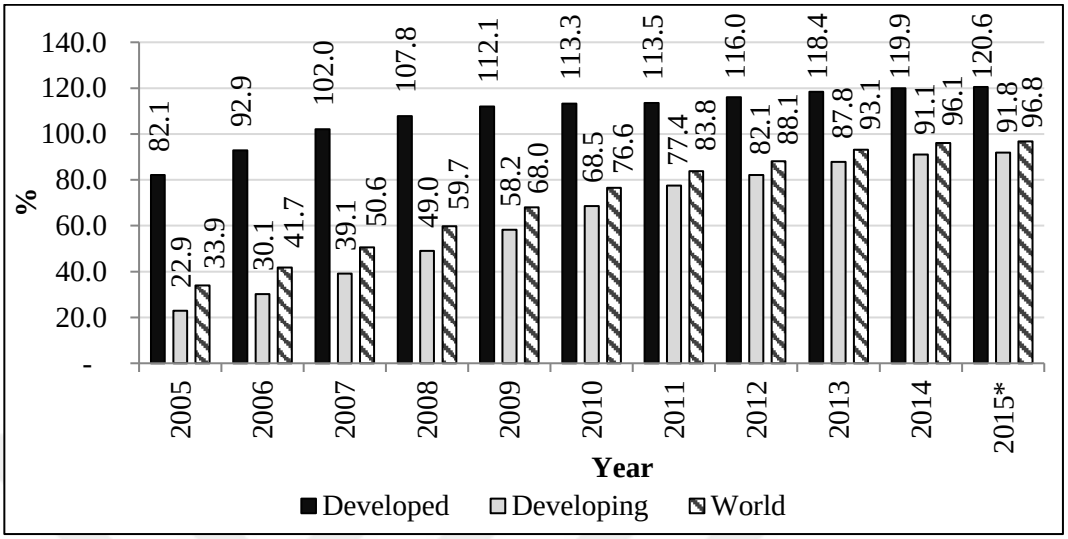


Figure 16: Mobile-Cellular Telephone Penetration in the World

Source: ITU World Telecommunication/ICT Indicators database. *Expected.

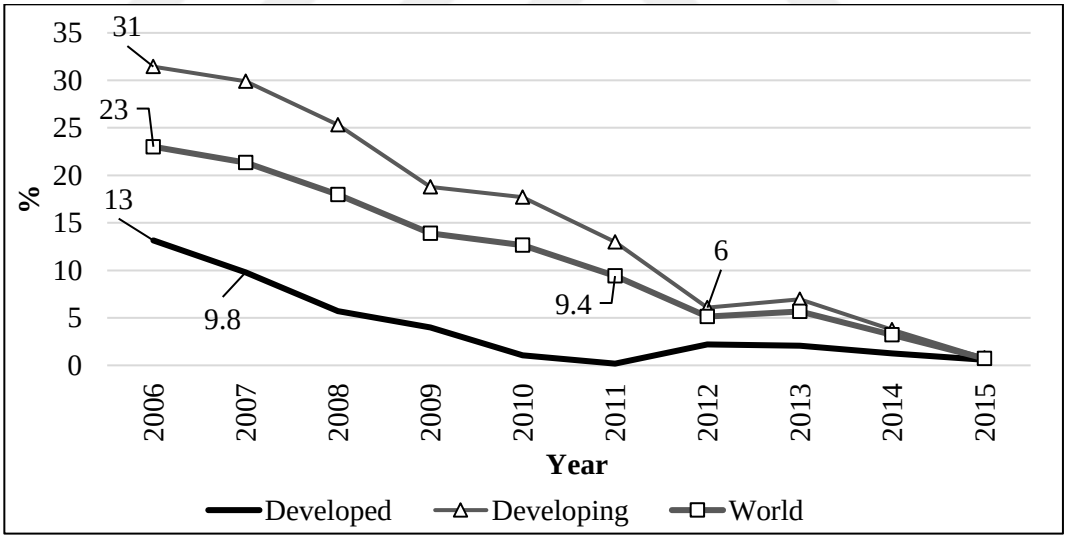


Figure 17: Growth Rate of Mobile-Cellular Telephone Penetration in the World

Source: ITU World Telecommunication/ICT Indicators database.

As ICT trade and its services, internet users, change in perception of space and time increase in the world, mobile life has started to become more intensive and powerful in almost every field of life. Naturally, world mobile-cellular telephone penetration has increased in the world. Its growth rate in developing economies is more than developed (Fig. 16 and 17). Its reason is that the diffusion of telephone in

developing economies has actualized mainly as mobile, and of course increasing demand in telecommunications sector.

Mobile-cellular telephone penetration when compared with fixed telephone penetration between 2005 and 2015, it is seen obviously that mobile-cellular telephone penetration is substantially more than fixed in the world. Contrary to negative growth in fixed telephone penetration in the world (Fig. 13), mobile-cellular telephone penetration has positive growth between 2006 and 2015 (Fig. 17).

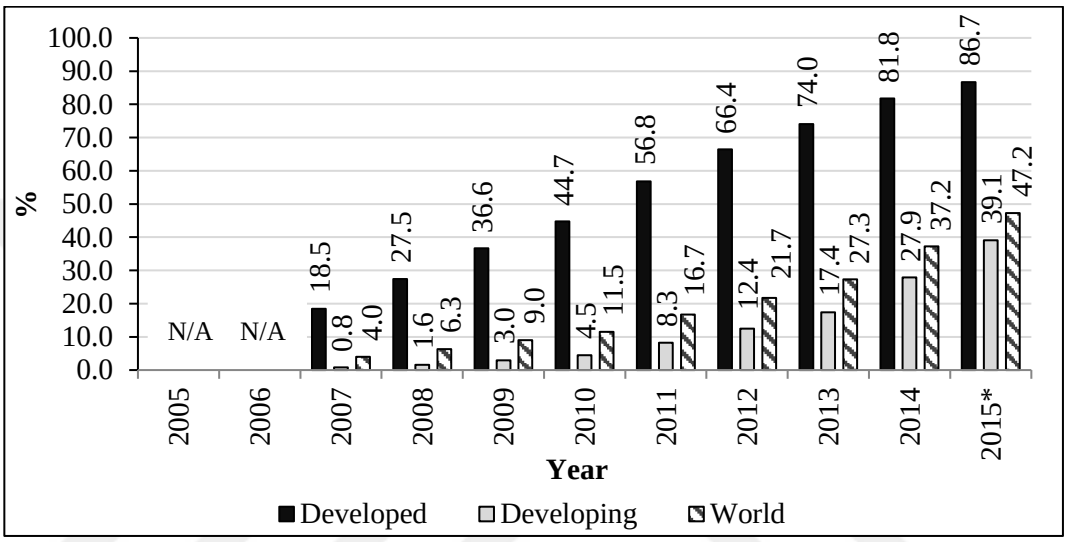


Figure 18: Active Mobile Broadband Penetration in the World

Source: ITU World Telecommunication/ICT Indicators database. *Expected. Not available for 2005 and 2006.

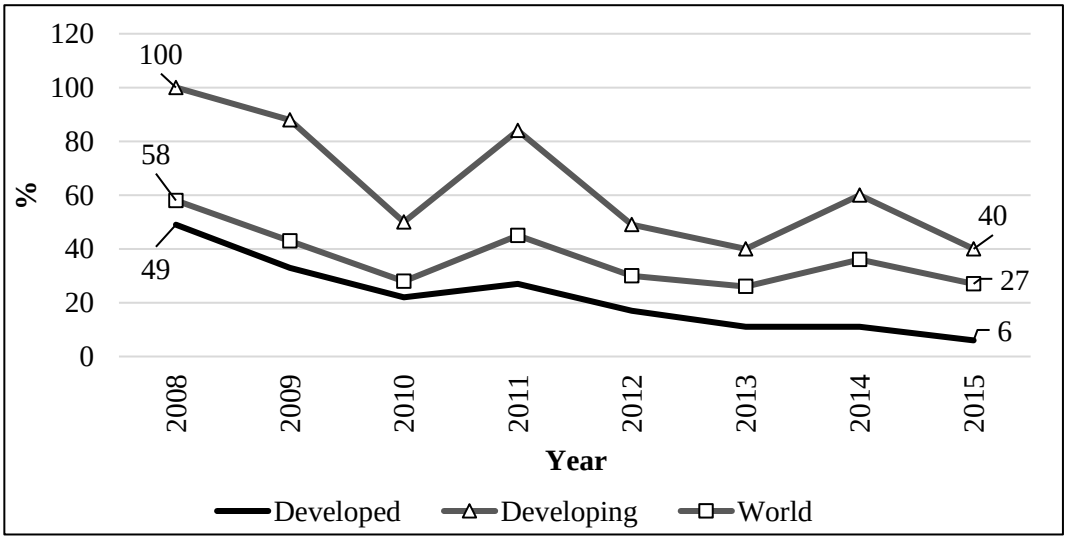


Figure 19: Growth Rate of Active Mobile Broadband Penetration in the World

Source: ITU World Telecommunication/ICT Indicators database.

In the light of diffusion of ICT and its services, as mobile-cellular telephone penetration increases, active mobile broadband penetration has increased. Active mobile broadband penetration when compared with fixed broadband penetration between 2005 and 2015, it is seen obviously that mobile broadband penetration is substantially more than fixed broadband in the world. It is seen that there is an upward trend in terms of mobile-use.

As specified by Brahima Sanou, Director of the ITU Telecommunication Development Bureau, "*technological progress, infrastructure deployment, and falling prices have brought unexpected growth in ICT, access and connectivity to billions of people around the World*". For instance, there are 400 million online internet users in 2000 (300 million from Developed Countries, 100 million from Developing Countries), and also 3.2 billion online internet users in 2015[133] (1 billion from Developed Countries, 2.1 billion from Developing Countries) in the world. ICT growth from 2000 to 2015[134] has increased such as: "*mobile cellular subscriptions increased from 738 million to 7 billion*", "*individuals using the internet penetration from 6.5% to 43%*", "*population covered by 2G mobile-cellular phone network grew from 58% in 2001 to 95%*", "*mobile broadband penetration 47% in 2015 that increased 12 times since 2007*", "*fixed broadband subscriptions increased to 11% in 2015*", and "*households with internet access at home increased from 18% in 2005 to 46%*"[135].

To view more deeply in terms of revenue, investment etc. of telecommunications sector, OECD countries can be analyzed.

As it is explained before, ICT-use and its services have boomed in the world generally in the 2000s. This boom is based on the investments in telecommunications infrastructure between 1980 and 2000 (Fig. 20). In that period, telecommunications investments increased from $50,9 billion to $280,4 billion ($203 billion in 2013). These investments have decreased after 2000 and there are two main points: 2001 and 2009. During 2000s there were two crises in the world, *the dotcom crisis* and *the global crisis* respectively. But, the investments have continued in spite of the crises.

[133] Estimates.
[134] Estimates.
[135] "**ICT Facts & Figures 2015**", International Telecommunication Union, 2015, p. 1.

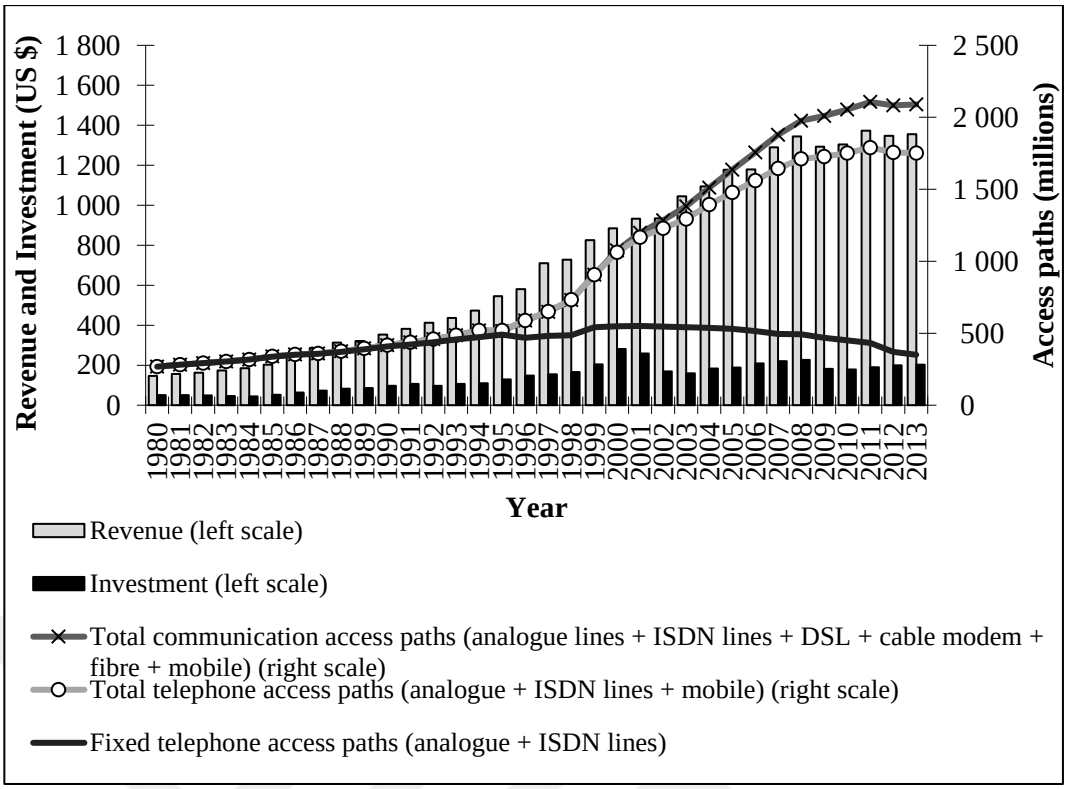


Figure 20: World Trends in Telecommunications Revenue, Investment and Access Paths, 1980 - 2013

Source: OECD Digital Economy Outlook 2015, http://www.oecd.org/sti/oecd-digital-economy-outlook-2015-9789264232440-en.htm [20.07.2015].

Telecommunications access paths are another way in terms of diffusion of communication. Total communication access paths have strikingly upward trend between 1980 and 2013, particularly after 1995. In other words, that paths have increased approximately 2 million in 33 years, 1.7 million of it after 1995. The reason of that is diffusion of new technologies and investments on mobile, digital subscriber line (DSL), cable modem (cable modulator-demodulator) and fiber line. Contrary to these developments, fixed telephone access paths such as analogue line and integrated services for digital network line (ISDN line) have decreased after 1999 because of increasing demand for new telecommunications access paths such as mobile, fiber line and DSL. Moreover, difference between total telephone access paths and fixed telephone access paths represents the mobile, which difference has increased year by year (Fig. 20).

Telecommunications revenue is another issue to understand the telecommunications sector in the world. The revenue has increased almost every year

between 1980 and 2013, from $146,8 billion to $1.355,5 billion, except 2002 and 2009 because of the dotcom crisis and global crisis respectively.

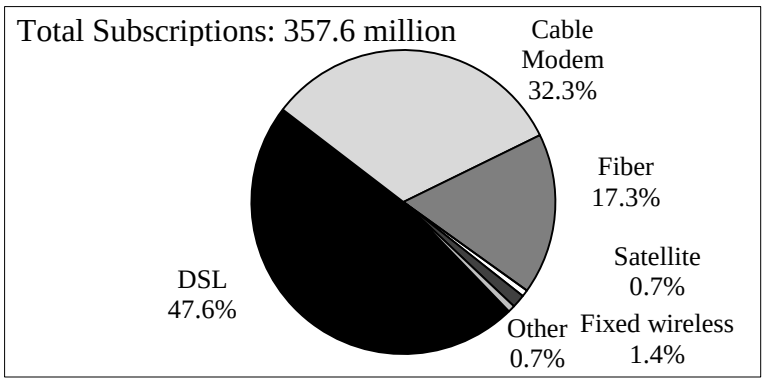


Figure 21: OECD Total Fixed Broadband Subscriptions, by Technology, Dec. 2014

Source: OECD, Broadband Portal, www.oecd.org/sti/broadband/oecdbroadbandportal.htm [20.07.2015].

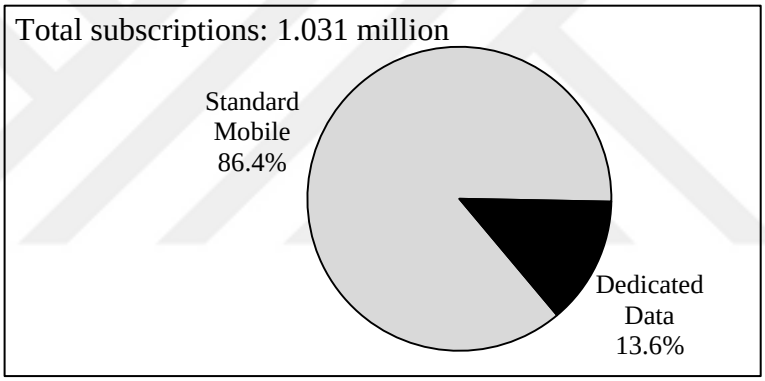


Figure 22: OECD Total Mobile Broadband Subscriptions, by Technology, Dec. 2014

Source: OECD, Broadband Portal, www.oecd.org/sti/broadband/oecdbroadbandportal.htm [20.07.2015].

Almost in every topic, the effects of mobile have been seen. It is given before that mobile broadband penetration is substantially more than fixed broadband in the world. In OECD countries, it is similar that total subscriptions of mobile broadband are 1.031 million, in other words approximately three times more than the subscriptions of fixed broadband (357.6 million) (Fig. 21 and 22). In more detail, when it is examined by technology, fixed broadband subscriptions in OECD countries include 47,6% digital subscriber line (DSL), 32,3% cable modem (cable modulator-demodulator), 17,1% fiber, 1,4% fixed wireless, 0,7% satellite, 0,7%

other. Mobile broadband subscriptions in OECD countries include 86,4% standard mobile, 13,6% dedicated data.

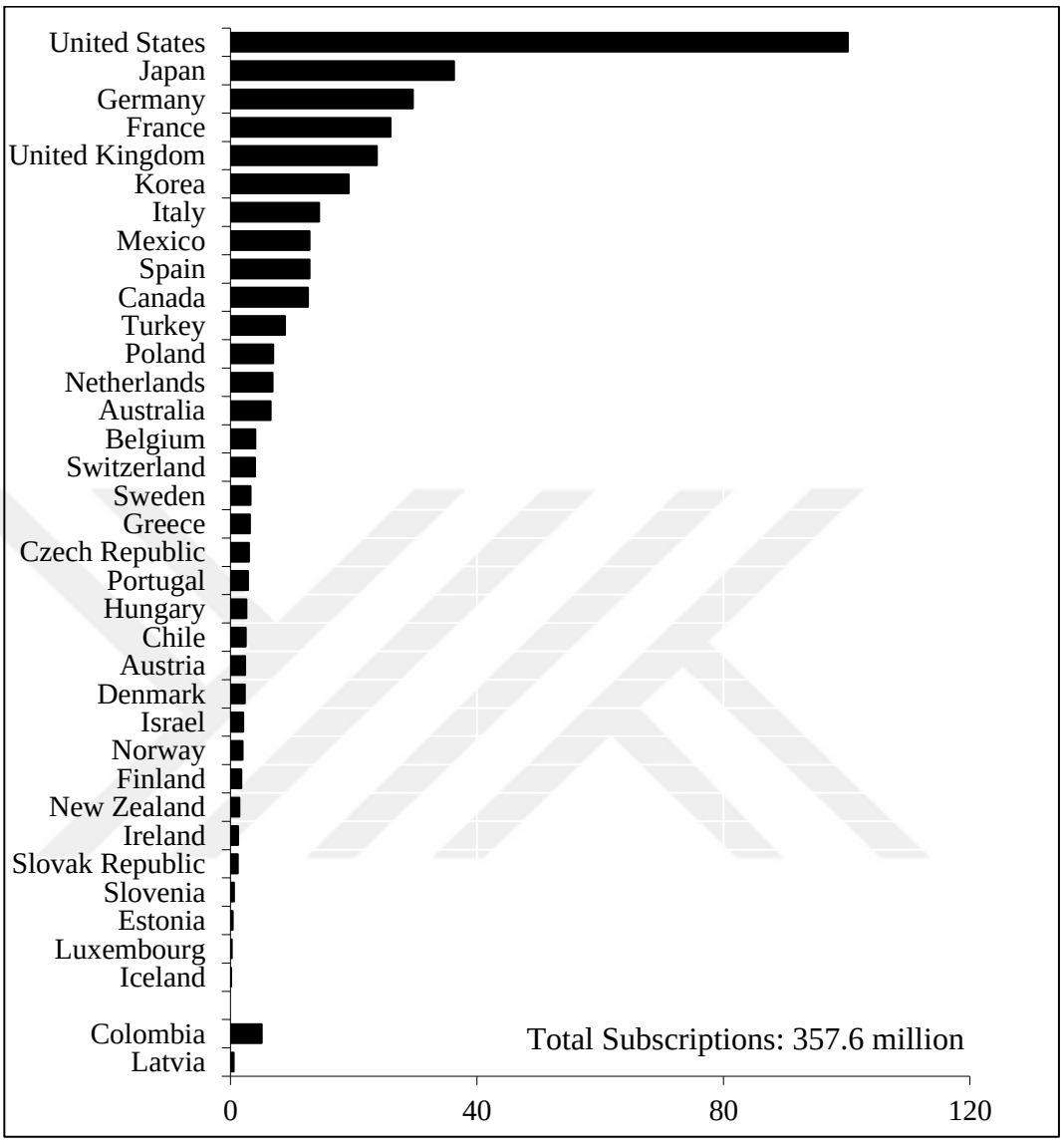


Figure 23: OECD Fixed Broadband Subscriptions, by Country, Millions, Dec. 2014

Source: OECD, Broadband Portal, www.oecd.org/sti/broadband/oecdbroadbandportal.htm [20.07.2015].

Fixed broadband subscriptions are 357.6 million in OECD countries, as given before. When it is viewed by countries, United States has the largest part in fixed broadband subscriptions (approximately 100 million), in other words, lion's share (Fig. 23). Other countries are respectively Japan, Germany, France, United Kingdom, Korea, Italy, Mexico, Canada and Turkey.

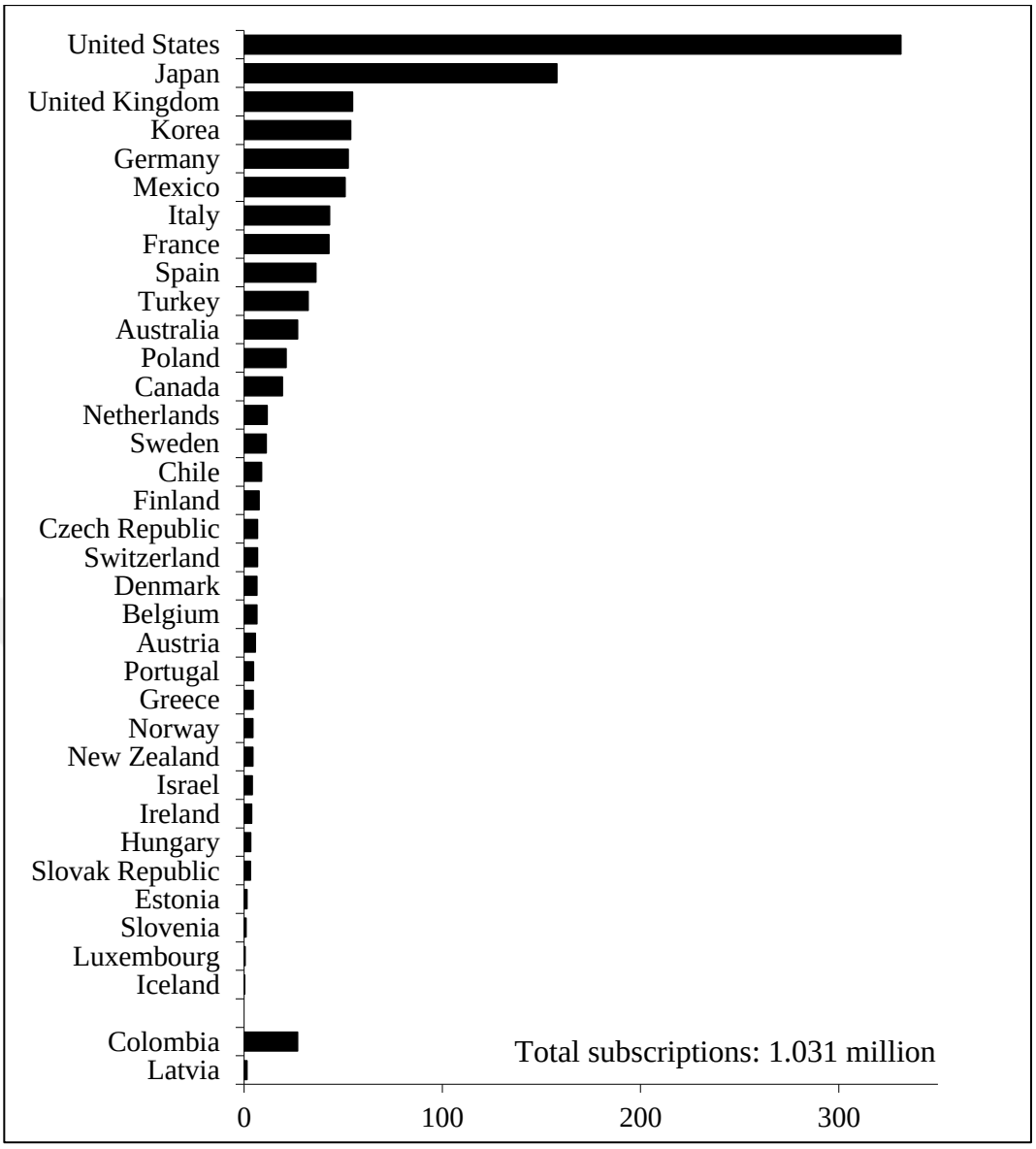


Figure 24: OECD Mobile Broadband Subscriptions, by Country, Millions, Dec. 2014

Source: OECD, Broadband Portal, www.oecd.org/sti/broadband/oecdbroadbandportal.htm [20.07.2015].

Additionally, mobile broadband subscriptions are approximately three times more than the subscriptions of fixed broadband in OECD countries. United States has also lion's share here, approximately 331 million (Fig. 24). Other countries are respectively Japan, United Kingdom, Korea, Germany, Mexico, Italy, France, Spain and Turkey.

Table 3: OECD Fixed Broadband Penetration, by Technology and Country, Dec. 2014

Rank		DSL	Cable	Fiber	Satellite	Fixed Wireless	Other	Total	Total Subs.
1	Switzerland	27,7	14,8	5,7	0,0	0,0	0,7	48,9	3.990.200
2	Denmark	20,5	11,6	8,9	0,0	0,2	0,1	41,3	2.331.830
3	Netherlands	17,3	19,3	4,0	0,0	0,0	0,0	40,6	6.851.000
4	France	33,8	3,6	1,4	0,0	0,4	0,0	39,2	25.969.000
5	Norway	14,6	11,9	11,3	0,1	0,7	0,0	38,7	1.985.997
6	Korea	3,2	8,9	25,9	0,0	0,0	0,0	38,0	19.198.934
7	Iceland	27,3	0,0	9,2	0,0	0,3	0,0	36,8	119.917
8	UK	29,7	7,0	0,0	0,0	0,0	0,0	36,8	23.729.800
9	Belgium	17,4	18,4	0,1	0,0	0,0	0,1	36,0	4.011.201
10	Germany	28,2	7,2	0,4	0,0	0,0	0,0	35,9	29.572.818
11	Canada	13,4	18,9	1,7	0,0	1,4	0,0	35,4	12.569.087
12	Sweden	12,7	6,2	14,8	0,0	0,1	0,1	33,8	3.281.000
13	Luxembourg	26,3	3,6	3,7	0,0	0,0	0,1	33,7	187.600
14	Finland	17,6	7,2	1,1	0,0	0,1	6,2	32,2	1.758.500
15	N. Zealand	28,1	1,4	1,6	0,2	0,3	0,0	31,6	1.421.621
16	US	9,6	17,7	2,8	0,8	0,3	0,2	31,4	100.192.000
17	Greece	28,6	0,0	0,0	0,0	0,0	0,0	28,7	3.156.071
18	Japan	3,1	4,7	20,7	0,0	0,0	0,0	28,5	36.261.653
19	Czech R.	9,1	5,0	3,9	0,0	10,3	0,0	28,34	2.979.400
	OECD	13,4	9,1	4,8	0,2	0,4	0,2	28,2	357.641.000
20	Estonia	10,7	6,3	9,3	0,0	1,5	0,4	28,2	371.009
21	Australia	21,6	4,1	1,4	0,3	0,3	0,0	27,7	6.536.000
22	Spain	19,3	4,7	3,4	0,0	0,2	0,0	27,6	12.834.049
23	Austria	18,2	8,7	0,4	0,0	0,2	0,0	27,5	2.351.905
24	Ireland	18,0	7,9	0,1	0,1	1,1	0,0	27,3	1.258.758
25	Portugal	10,5	9,7	6,0	0,0	1,1	0,0	27,2	2.830.930
26	Slovenia	12,0	8,4	5,9	0,0	0,3	0,1	26,7	551.062
27	Hungary	8,3	12,5	4,0	0,0	1,4	0,0	26,2	2.580.537
28	Israel	16,6	8,7	0,0	0,0	0,0	0,0	25,3	2.077.000
29	Italy	21,4	0,0	0,9	0,0	0,9	0,4	23,6	14.373.844
30	Slovak R.	8,5	2,8	5,7	0,0	5,0	0,0	22,0	1.191.216
31	Poland	7,4	6,0	0,8	0,0	2,1	1,6	18,0	6.922.890
32	Chile	5,6	7,0	0,6	0,0	0,1	0,6	14,0	2.489.717
33	Turkey	8,9	0,7	1,9	0,0	0,0	0,1	11,6	8.866.361
34	Mexico	3,0	6,7	0,7	0,0	0,0	0,3	10,7	12.838.093
	Latvia	7,2	1,1	14,5	0,0	0,7	1,8	25,3	504.841
	Colombia	5,2	4,9	0,1	0,0	0,3	0,1	10,6	5.051.552

Source: OECD, Broadband Portal, www.oecd.org/sti/broadband/oecdbroadbandportal.htm [20.07.2015].

Even United States has the largest share of fixed broadband subscriptions in OECD countries; it is not the first country in fixed broadband penetration. Switzerland is the first country with approximately 50% penetration, that penetration is two times more than OECD average of fixed broadband penetration (Table 3).

Other countries are respectively Denmark, Netherlands, France, Norway, Korea, Iceland and United Kingdom by the penetrations.

Table 4: OECD Mobile Broadband Penetration, by Technology and Country, Dec. 2014

Rank		Standard Mobile Broadband Subscriptions	Dedicated Mobile Data Subscriptions	Total (breakdown not available)	Total	Total Subscriptions
1	Finland	9,0	129,0		138,0	7.537.800
2	Japan	96,0	28,1		124,1	157.812.151
3	Sweden	27,7	87,8		115,6	11.204.000
4	Denmark	73,4	42,1		115,5	6.518.062
5	Australia	89,0	25,4		114,4	27.028.000
6	Estonia	64,8	49,4		114,2	1.502.044
7	Korea	84,6	21,9		106,5	53.751.479
8	US			104,0	104,0	331.373.000
9	N. Zealand	65,6	33,2		98,8	4.440.948
10	Norway	62,8	25,2		88,0	4.520.385
11	Iceland	53,3	34,0		87,3	284.193
12	UK	76,8	8,1		84,8	54.718.423
13	Luxembourg	77,5	6,9		84,4	470.000
14	Switzerland	76,3	6,8		83,1	6.780.000
15	Ireland	72,3	9,8		82,1	3.787.863
	OECD			81,3	81,3	1.030.857.578
16	Spain	52,9	25,1		78,1	36.267.330
17	Italy	60,3	10,6		70,9	43.104.410
18	Netherlands	63,0	6,0		69,0	11.635.000
19	Austria	41,7	25,4		67,1	5.729.200
20	Czech R.	17,1	48,0		65,1	6.848.300
21	France			64,7	64,7	42.810.000
22	Germany	50,1	13,8		63,8	52.575.423
23	Slovak R.	50,2	9,7		59,9	3.246.305
24	Belgium	51,7	6,0		57,7	6.440.133
25	Poland	42,1	13,2		55,3	21.278.710
26	Canada	49,7	4,6		54,2	19.279.414
27	Israel			49,9	49,9	4.090.000
28	Chile	46,0	3,8		49,8	8.885.792
29	Slovenia	7,9	39,1		47,0	968.383
30	Portugal	26,9	18,9		45,8	4.755.599
31	Mexico	41,7	0,8		42,5	50.913.677
32	Turkey	40,4	1,8		42,2	32.360.661
33	Greece	14,9	26,6		41,5	4.559.958
34	Hungary	18,9	15,3		34,3	3.380.935
	Latvia	36,8	36,6		73,40	1.464.400
	Colombia	44,9	11,7		56,61	26.978.219

Source: OECD, Broadband Portal, www.oecd.org/sti/broadband/oecdbroadbandportal.htm [20.07.2015].

Though United States has the largest share of mobile broadband subscriptions in OECD countries, Finland is the first country with approximately 138% penetration, that penetration is one and a half times more than OECD average of mobile broadband penetration (Table 4). Other countries are respectively Japan, Sweden, Denmark, Australia, Estonia, Korea and United States by the penetrations.

4.2. ICT Sector in Turkey

In Turkey case, to understand how the situation of ICT sector is, we should view primarily institutional structure of ICT services. That institutional structure may be said as statist in the Ottoman Empire and then the statist perspective and structure have also continued in Turkey. Secondly, we have to understand the initial story of internet and its incredible rise in Turkey.

Institutions related with ICT services can be viewed by starting from the 19th century until today, in other words from the last century of Ottoman Empire until today. To examine the institutional processes of postal, telegraph and telephone services, I can separate the period into five parts such as 1840-1871, 1871-1909, 1909-1953, 1953-1995, 1995-2005, and after 2005.

The first period, 1840-1871, includes postal services and telegraph services that had been provided by two different institutions: *The Ministry of Post* and *The Directorate of Telegraph*. In the 19th century, during the period of Abdülmecit (1839-1861), first institution about communication was established in 23 October 1840, namely *the Ministry of Post*, and first post office had started to provide postal services in İstanbul with the name of "*Postahane-i Amire*" (*Department of Post Office*)[136]. According to State Planning Organization, the idea that establishing an institution that providing postal services (the Ministry of Post) by state is based on the thought of II. Mahmut (1808-1839)[137]. After testing telegraph in 1847[138], together with establishing the first telegraph institution in 1855, *the Directorate of Telegraph*. Therefore, telegraph services had been provided until 1871 as separate

[136] "History", Post, Telegraph and Telephone (PTT), http://en.ptt.gov.tr/ptten#ptt_tarihce_en [09.07.2016].
[137] Devlet Planlama Teşkilatı, **Dördüncü Beş Yıllık Kalkınma Planı Haberleşme Özel İhtisas Komisyonu Raporu** (No. DPT: 1568 – ÖİK: 255; Mart 1977), 1.
[138]According to State Planning Organization (4th Plan, Special Commission Report about Communication, 1977: p. 2), after testing telegraph, Abdülmecit had given a medal to Samuel F.B. Morse.

from the Ministry of Post. According to State Planning Organization, the first telegraph message was sent to Paris and London about news that "*Turkish Army had reached to Crimea*"[139].

After the union of Ministry of Post and Directorate of Telegraph in 1871, Communication services (*postal* and *telegraph* services) had been presented between 1871 and 1909 by *the Ministry of Post and Telegraph*[140].

In the 20th century, together with first using telephone in Ottoman Empire in 1908, the name of institution had been changed into *the Ministry of Post, Telegraph and Telephone* (*the Ministry of PTT*) in 1909 until 1911. It is understood from State Planning Organization Report that the period between 1909 and 1953, communication services (*postal*, *telegraph* and *telephone*) had been provided under the administration of various institutions such as *the Ministry of Finance* between 1909-1911, *the Ministry of PTT* between 1911-1912 and *the Ministry of Interior* between 1912-1913 during Ottoman Empire; *the Ministry of Public Works* between 1933-1939 and *the Ministry of Transport*[141] between 1939-1953 during Turkey[142].

After transition the status of PTT from the General Directorate to *the State-Owned Enterprise* in 17 October 1953[143], *postal* and *telecommunications* services have been separated from each other in 1995, and that separation caused that the services have been provided by two separate institutions such as *the General Directorate of Posts* and *Turk Telecom Corporation.* After all these processes, the changes did not stop in terms of postal services. The name of General Directorate of Posts was changed as *The General Directorate of Posts and Telegraph Organization* (PTT) in 2000, and then it has maintained its services after 2011 under the Ministry of Transport, Maritime Affairs and Communications. Finally, the name of the institution has become as *the Postal and Telegraph Corporation* with new duties and structure in 2013[144].

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[139] Devlet Planlama Teşkilatı, **Dördüncü Beş Yıllık Kalkınma Planı Haberleşme Özel İhtisas Komisyonu Raporu**, 2.
[140] **Ibid**, 2.
[141] The name of Ministry of Transport (1939) was changed as The Ministry of Transport, Maritime Affairs and Communications (2011), with the statutory decree no 655 which was published in the Official Newspaper no 28102(reiterated) in 1 November 2011. (for detailed information, http://www.udhb.gov.tr/k-1-tarihce.html).
[142] **Ibid**, 2.
[143] **Ibid**, 2.
[144] "Tarihçe", PTT, http://ptt.gov.tr/ptt/#!ptt_tarihce [27.09.2016].

The first call with mobile phone in Turkey has been seen in 24 February 1994 between Süleyman Demirel (The President of Republic of Turkey) and Tansu Çiller (The Prime Minister of Turkey)[145]. It is a fact that first mobile telecommunications services in Turkey have been provided in February 1994 by *Turkcell*[146]. Other company, *Telsim*, had started to provide telecommunications services to customers in May 1994. *Turk Telecom Corporation* was founded in 24 April 1995 by separating the telecommunications services from postal services each other.[147] Both Turkcell and Telsim had signed contract with Turk Telecom in July 1993 that based on income sharing (call fee, fixed monthly fee, facility fee: 67,1% of the revenue for Turk Telekom, 32,9% for Turkcell and Telsim) and until providing license conditions[148]. GSM licenses had not been given to the companies because of monopoly power of Turk Telekom in Turkey. Disadvantages of income sharing contract had been seen in a short time such as low level investment and (for instance, TurNET), and high prices that prevent development of telecommunications market (for instance, VSAT[149] and IBS[150]) [151].

According to Information and Communication Technologies Authority, together with signing a new contract ($500 million USD and GSM license concession contract for 25 years) in 27 April 1998 between *the Ministry of Transport* and the Companies (*Turkcell* and *Telsim*), it is the first time in real terms that new companies (*Turkcell* and *Telsim*, except Turk Telekom) have started to provide telecommunications services[152].

In the beginning of the 2000s, competition in telecommunications market in Turkey has begun to increase, and privatization in Turkey has started to spread into

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[145] Şükran Pakkan, "Cep'ten alo diyeli 10 sene oldu", **Milliyet Gazetesi**, 27 Şubat 2004, http://www.milliyet.com.tr/2004/02/27/pazar/paz05.html [09.07.2016].

[146] "Company Overview", Turkcell, http://www.turkcell.com.tr/en/aboutus/company-overview [09.07.2016].

[147] "Turk Telekom At A First Glance", Turk Telekom, https://www.turktelekom.com.tr/en/AboutUs/Pages/turk-telekom-at-a-first-glance.aspx [09.07.2016].

[148] Selçuk Arslan et. al., **Türkiye Telekomünikasyon Sektöründeki Gelişmeler ve Eğilimler 2007 Yılı Raporu**, Telekomünikasyon Kurumu Sektörel Araştırma ve Stratejiler Dairesi Başkanlığı (Ankara, Şubat 2008), 33-34.

[149] Very Small Aperture Terminal: A two-way and transportable satellite ground station with a dish antenna. It is used to transmit narrowband data or broadband data.

[150] In Building Solutions: A telecommunications solution which is used to extend and distribute the telecom signal of a given mobile telecom operators within a building. DAS (Distributed Antenna System), BTS (Base Transceiver Stations).

[151] Serbest Telekomünikasyon İşletmecileri Derneği, **TBS-İletişim Alt Yapısı Raporu**, http://www.telkoder.org.tr/core/uploads/page/document/abg_81.doc [04.10.2016].

[152] Arslan, **opcit**, 33-34.

some sectors such as telecommunications. As a result of more competitive environment in telecommunications market, another companies have joined the market such as *Aycell* (Turk Telecom's GSM Operator) and *Aria* (İş-TIM Telecommunications Services Inc.). After establishing Aycell and Aria in 2001, Aycell and Aria have merged each other in 2004 with the new brand "*Avea"* under the organization namely TT&TIM Communication Services Inc. In 2005, Vodafone bought Telsim and has joined to the market in Turkey.

Together with increasing privatization in telecommunications market in the World in the 1990s, emphasizing of privatization of Turk Telecom have been seen more in Special Commission Report on Communication[153]. Turk Telecom has been privatized in 2005[154], and the shares of Turk Telekom Group have been divided into three parts: Oger Telecom (55%), Turkish Treasury (30%) and Public Float Shares (15%)[155].

Even if postal services are provided by the Postal and Telegraph Corporation (PTT) in Turkey, it is still under control of the state and it is a fact that next privatization in Turkey may be PTT.

Until here, I tried to view the structure of communication institutions in Ottoman Empire and Turkey from the 19th century till today. Now, I focus on ICT sector in Turkey especially the last decades of Turkey by referring to Turkish political and economic history, and then how and when internet has started to use in Turkey. Then, indicators of fixed and mobile telephone penetrations in Turkey will be analyzed, and finally I will try to show the situation of market shares in Turkey.

[153] Devlet Planlama Teşkilatı, **Sekizinci Beş Yıllık Kalkınma Planı Haberleşme Özel İhtisas Komisyonu Telekomünikasyon Alt Komisyonu Raporu** (No. DPT: 2565 – ÖİK: 581; 2001), 6.
[154] 55% of Turk Telecom has been bought by Oger Telecom (6.55 billion US $).
[155] Turk Telekom, "Turk Telekom At A First Glance".

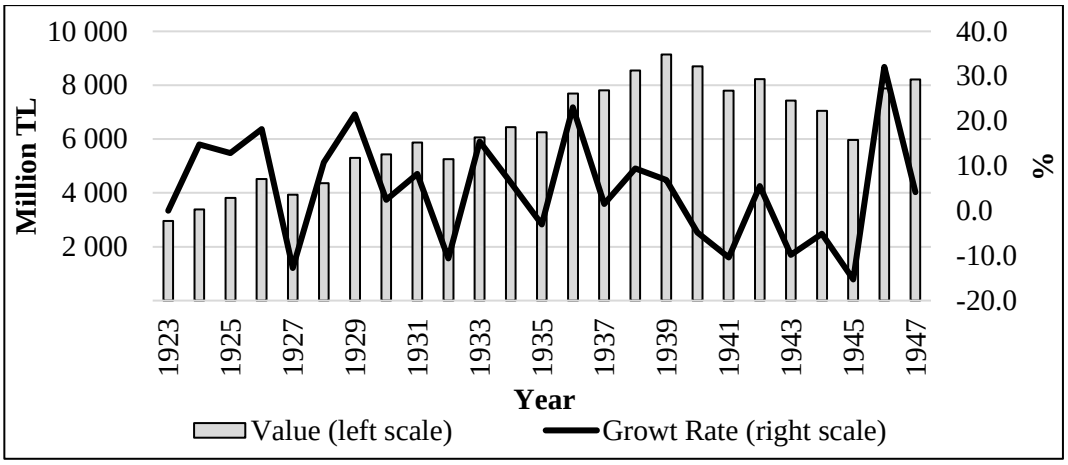


Figure 25: GDP of Turkey in Constant Prices, 1923 - 1947

Source: TURKSTAT. For the years between 1923-1947 base year is 1948=100.

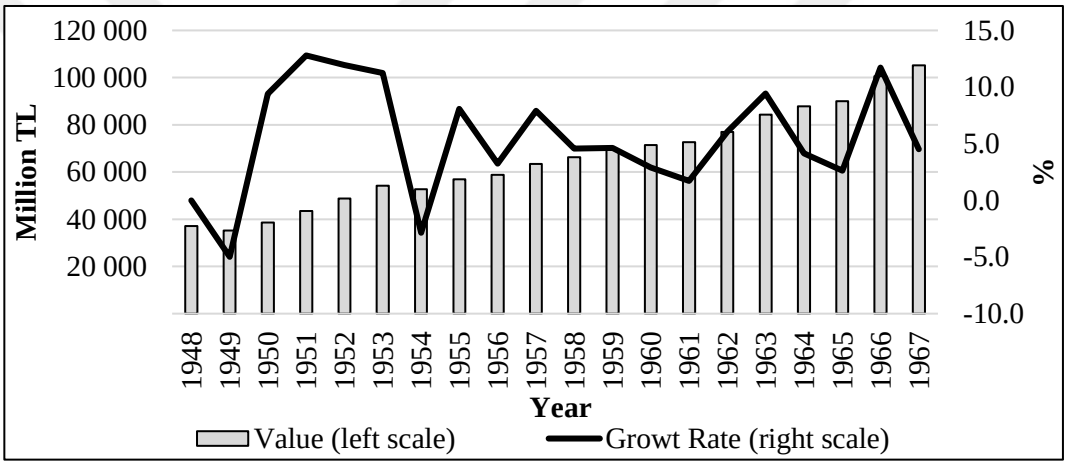


Figure 26: GDP of Turkey in Constant Prices, 1948 - 1967

Source: TURKSTAT. For the years between 1948-1967 base year is 1968=100.

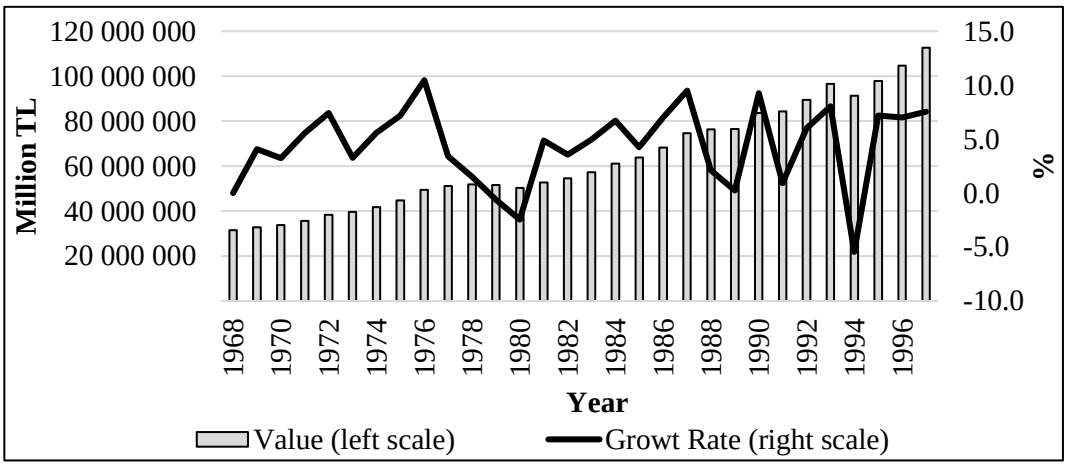


Figure 27: GDP of Turkey in Constant Prices, 1968 - 1997

Source: TURKSTAT. For the years between 1968-1997 base year is 1987=100.

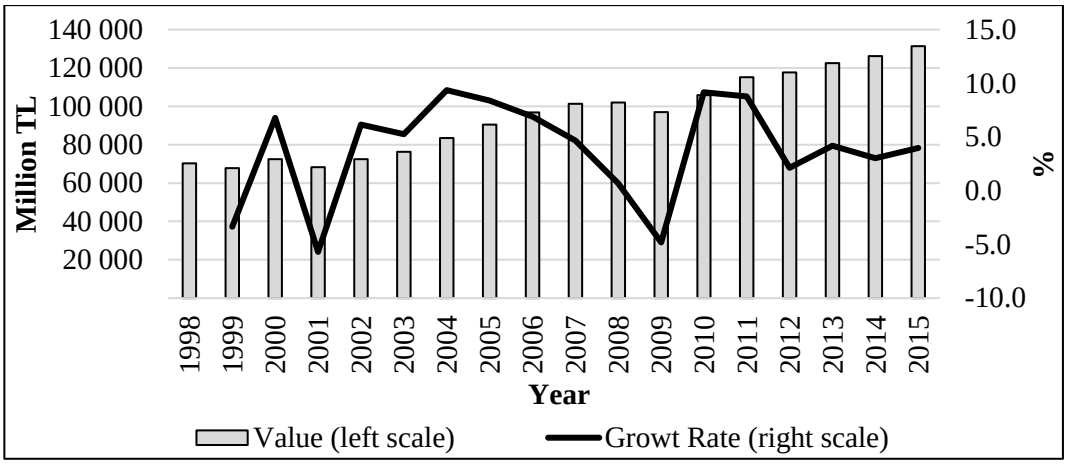


Figure 28: GDP of Turkey in Constant Prices, 1998 - 2015

Source: TURKSTAT. For the years between 1998-2015 base year is 1998=100.

After 1923, growth rate and GDP of Turkey fluctuated until end of the II World War (Fig. 25). On the one hand, Pamuk specifies that the period was distressed and difficult in terms of both political and economic history because of transition from empire to nation-state[156]. On the other hand, Balkanlı emphasizes that there is an agriculture-based economy[157] in Turkey[158]. It is the years that ICT usage was limited. For example, telephone services have been provided by private companies as city-oriented in the early 20th century, which based on manual and automatic switchboard technology[159].

During the period of Democrat Party and Adnan Menderes (The Prime Minister) in Turkey, the share of agriculture in the economy[160] was bigger than industry[161]. In this period, migration from rural to urban has started to increase. The migration has affected the telecommunications demand. According to Şişikoğlu, Taşkent and Güzeliş, the first telephone central of Turkey in Ankara reached more

[156] Pamuk, **opcit**, 214.
[157] For example, Balkanlı specified that: the years between 1923-1928 in Turkey, the share of agriculture in the economy was 45% as an average, the share of industry was 11%; in the period between 1929-1945, 40% and 17% respectively.
[158] Ali Osman Balkanlı, **Türkiye'de Ekonomik Gelişme ve Kriz, Gelişmekte olan Ekonomi Örneği Olarak Türkiye'de Ekonomik Gelişme Sorunu (1838-1979)**, (İstanbul: Filiz Kitabevi, 2004), 155.
[159] Hasan S. Şişikoğlu, Onur Taşkent, Alpaslan Güzeliş, "Türkiye'de ve İzmir'de Telekomünikasyon Tarihçesi-I", EMO İzmir Şubesi, Telefon Tarihi Araştırma Grubu, http://www.emo.org.tr/ekler/0d7a62d32071ec1_ek.pdf?dergi=4 [02.10.2016], 27-28.
[160] For example, Balkanlı specified that: the share of agriculture in the economy was 41.5% in 1946, 34.7% in 1947, 40.4% in 1948, 39.1% in 1958. The share of industry was 17 % in 1948 and 16% in 1951 and 16% in 1958. The share of services was 41.2% in 1946 and 46% in 1958.
[161] Balkanlı, **Türkiye'de Ekonomik Gelişme ve Kriz**, 155.

subscription capacity in the 1950s. For example, the capacity was 2000 in 1926, and 9547 in 1949, 15700 in 1952[162].

In 1960, the period with development plans in Turkey has started and import substitution industrialization policy had been implemented. The effect of policy was seen as increasing import of Turkey (Fig. 29). For example, the share of import in GNP was 2.6% in 1958, and 4.7% in 1960, 9.7% in 1962[163]. In 1965, new produced automatic telephone centrals (X-BAR) had been established in the most of cities in Turkey as a result of the migration, and then in the 1970s inter-city telephone connections have been completed[164].

In the 1970s, some developments in the world such as Bretton Woods System disintegration and increase in petrol price have caused doomy effects on Turkey (Fig. 27). As a result of Bretton Woods System disintegration, world financial system was liberalized and deregulated. That new transformations and technological developments enabled to increase the power of international financial markets. In the same period, digitization of networks in the world has been developed more. For example, as an average of the period between 1964 and 1973, the share of telecommunication investments in GNP for some countries is more than Turkey's, such as 11.15% in Switzerland, 10.57% in Japan, 9.84% in Greece, 9.05% in England, 8.9% in Spain, 7.57% in Germany, 6.68% Italy, 5.09% in France, and 1.69% in Turkey[165].

In 1980, transition to open economy has started in Turkey together with Turgut Özal (the Prime Minister) and 24 January Decisions. Liberalization has been seen in some sectors such as finance sector; however, infrastructure has been done by state. On the one hand, establishment of ISE (1985) and increasing number of commercial banks in Turkey are very typical examples. On the other hand, Turkey had used automatic telephone centrals until 1984 and then digitization of networks has been started[166]. In that period, 1G has already started to use in the world.

In the 1990s, political and economic instability have generally continued in Turkey. According to Pamuk, from end of the 1980s to the early 2000s, growth rate

[162] Şişikoğlu, Taşkent, Güzeliş, **opcit**, 28.
[163] Balkanlı, **Türkiye'de Ekonomik Gelişme ve Kriz**, 292.
[164] Şişikoğlu, Taşkent, Güzeliş, **opcit**, 28.
[165] Devlet Planlama Teşkilatı, **Dördüncü Beş Yıllık Kalkınma Planı Haberleşme Özel İhtisas Komisyonu Raporu**, 64.
[166] **Ibid**, 28.

and GDP of Turkey fluctuated more than before because of four big crises/recessions such as: *1990-1991 the Gulf War*, *1994 Crisis in Turkey*, *1997 East Asian Crisis*, *2001 Crisis in Turkey*[167] (Fig. 27 and 28). In that period, Turkey started to use 2G.

In 2002, with General Election in Turkey, new party has been elected: Justice and Development Party (Adalet ve Kalkınma Partisi) which has focused on financial discipline policy because of public sector debts. Since 2002, GDP of Turkey has increased, except 2009. It is a fact that 2008 Global Crisis has affected Turkey as other countries in the world (Fig. 28 and 29). Pamuk specifies that export and investments and consumption decreased in Turkey in the first months of *2008 Global Crisis*[168].

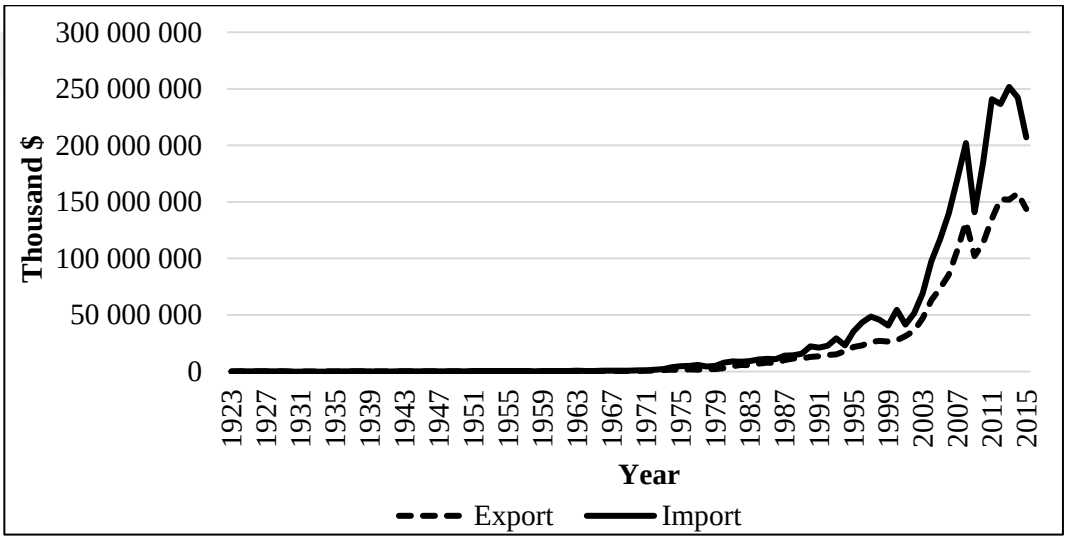


Figure 29: Foreign Trade of Turkey, 1923 - 2015 (Value, Thousand US $)

Source: TURKSTAT, Foreign Trade Statistics, June 2016.

As it is seen from the Figure 28, there is an upward trend in GDP of Turkey after 1998, except some years such as 1999, 2001 and 2009. Similarly, GDP of Turkey by ICT has upward trend, except 2001 and 2009 because of respectively *2001 Crisis* in Turkey and *2008 Global Crisis*. In other words, it is the years that there are negative growth rates of GDP by ICT in Turkey (1,2% in 2001, 1,3% in 2009). The share of GDP by ICT in total GDP of Turkey is generally around 2% even though value of GDP by ICT increase between 1998 and 2015 (Fig. 30).

[167] Pamuk, **opcit**, 281-283.
[168] **Ibid**, 290.

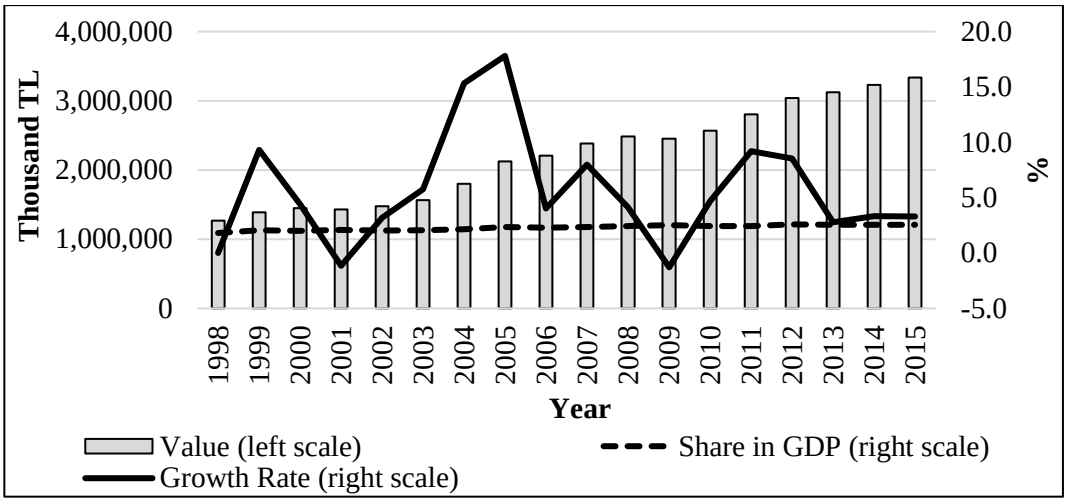


Figure 30: GDP of Turkey in Constant Prices by ICT (Value, Share in GDP, Growth Rate)

Source: TURKSTAT. For the years between 1998-2015 base year is 1998=100.

Furthermore, diffusion of internet is significant event. First internet usage in Turkey has started with Turkey University and Research Institutions Network (TUVAKA) under the leadership of Ege University in the end of 1980s. After first Wide Area Network connection to BITNET (network communications for research institutions) and EARN (European Academic and Research Network) over ODTU (Middle East Technical University) in 1991, according to TUBITAK (The Scientific and Technological Research Council of Turkey), the first internet connection in Turkey was via x.25 network between ODTU and Holland. In 1993, with TR-NET project, 64 Kbps internet connection has been provided between ODTU and NSFNET (Washington). According to Gönenç, TUVAKA was only for academic base, and the aim of TR-NET is not only academic but also all sectors. He specifies that internet connection and network in Turkey was too late and TR-NET project was aimed providing internet connection and spreading it in Turkey[169].

After the transition of mission that providing services about national and international computer connections of universities from YOK (Council of Higher Education) to TUBITAK in 16 May 1996, internet speed has been upgraded in 11 October 1996 and provided 512 Kbps internet connection between ULAKNET and NSFNET (USA). According to TUBITAK, 58 universities from 98 different places has been connected each other in the end of 1998, 80 universities and research

[169] E. Özgür Gönenç, "İnternet ve Türkiye'deki Gelişimi", **İÜ İletişim Fakültesi Dergisi**, s. 16 (2003): 95.

institutions from 114 different places in the end of 1999, 80 universities and research institutions from 160 different places in January 2002[170].

Even if Turkey has started to use internet in the 1980s, it was not widespread usage. Main developments about transition to knowledge society, the diffusion of ICT-use in Turkey have been seen in the 1990s, especially in the 2000s. For example, in 1993, *Turkey Informatics and Economic Modernization Report* was prepared in the collaboration with Turkey and World Bank, which report includes some topics such as *creating computer advantage, competing in software, human capital for an information society, the communications network, reducing uncertainty-the role of information*[171]. However, the report that gives action plan and suggestions could not be implemented because loan agreement could not be completed between Turkey and World Bank. Another study, *Turkey National Information Infrastructure Master Plan (TUENA),* was prepared with the aim of determination of information policies to understand the situation in the World and Turkey by Ministry of Transport and TUBITAK in 1999[172].

Developments in Turkey about transition to information society and diffusion of ICT-use have continued with another steps such as *e-Commerce Coordination Council* between 1998 and 2002, *KamuNET Councils* (Supreme Council and Technical Council) between 1998 - 2002, *e-Turkey* in 2001, *e-Transformation Turkey Project* since 2002, *2003 - 2004 Short Term Action Plan*, *2005 Action Plan*, *2006 - 2010 Information Society Strategy and Action Plan*, *2014 - 2018 Information Society Strategy and Action Plan*[173]. It is a fact that these developments have been continued together with the developments in Europe such as e-*Europe* in 1999[174], *e-Europe Action Plan* in 2002[175], *e-Europe+*[176], *e-Europe 2005 Action Plan (an update*

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170 "Dünden Bugüne ULAKNET", Turkish Academic Network and Information Center, http://ulakbim.tubitak.gov.tr/tr/kurumsal/ulaknet-tarihcesi [31.08.2016].

171 World Bank, **Turkey Informatics and Economic Modernization Report**, Country Study (Washington, D.C., 1993), viii - ix.

172 "Ülkemizde Bilgi Toplumuna Dönüşüm", Republic of Turkey Ministry of Development, http://www.bilgitoplumu.gov.tr/bilgi-toplumu/ulkemizde-bilgi-toplumuna-donusum/ [24.08.2016].

173 **Ibid**.

174 "e-Avrupa Girişimi", Republic of Turkey Ministry of Development, http://www.bilgitoplumu.gov.tr/uluslararasi-calismalar/avrupa-icin-sayisal-gundem/e-avrupa-girisimi/ [24.08.2016].

175 "e-Avrupa 2002", Republic of Turkey Ministry of Development, http://www.bilgitoplumu.gov.tr/uluslararasi-calismalar/avrupa-icin-sayisal-gundem/eavrupa-2002/ [24.08.2016].

in 2004)[177], *i2010: European Information Society for Growth and Employment* in 2005[178], *Europe 2020* in 2010[179], *Digital Agenda for Europe* in 2010[180].

As a result of diffusion of ICT, new policies and progress of technology in the world, other developments in Turkey have been seen such as: some institutions have started to use ICT (for example, universities and research institutions), some institutions have started to use systems to provide services over internet (for example, Ministry of Finance: VEDOP I in 1998, VEDOP II in 2004, VEDOP III in 2009). Especially, developments on the way of transition to information society such as e-Turkey and action plans have been accelerated together with increase in internet usage and implementations within the framework of *electronic transformation of Turkey*.

As a result of *electronic transformation movement* in the world, Europe and Turkey, some information society statistics can be analyzed as the footprints of movement such as computer and internet usage of households, individuals and enterprises. According to the survey made by TURKSTAT in Turkey, as computer usage has spread, internet usage and households with access to the internet have increased (Fig. 31).

Moreover, computer and internet usage have continued to spread in institutions such as enterprises. The figures of computer-usage and internet usage (generally over 80% in the 2000s) indicate that enterprises pay attention on ICTs. Enterprises having a website have also increased in the 2000s (Fig. 32).

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176 "e-Avrupa+", Republic of Turkey Ministry of Development, http://www.bilgitoplumu.gov.tr/uluslararasi-calismalar/avrupa-icin-sayisal-gundem/eavrupa/ [24.08.2016].

177 "e-Avrupa 2005", Republic of Turkey Ministry of Development, http://www.bilgitoplumu.gov.tr/uluslararasi-calismalar/avrupa-icin-sayisal-gundem/eavrupa-2005/ [24.08.2016].

178 "i2010: Büyüme, İstihdam ve Avrupa Birliği Toplumu", Republic of Turkey Ministry of Development, http://www.bilgitoplumu.gov.tr/uluslararasi-calismalar/avrupa-icin-sayisal-gundem/i2010-buyume-ve-istihdam-icin-avrupa-bilgi-toplumu/ [24.08.2016].

179 "Avrupa İçin Sayısal Gündem", Republic of Turkey Ministry of Development, http://www.bilgitoplumu.gov.tr/uluslararasi-calismalar/avrupa-icin-sayisal-gundem/ [24.08.2016].

180 **Ibid**.

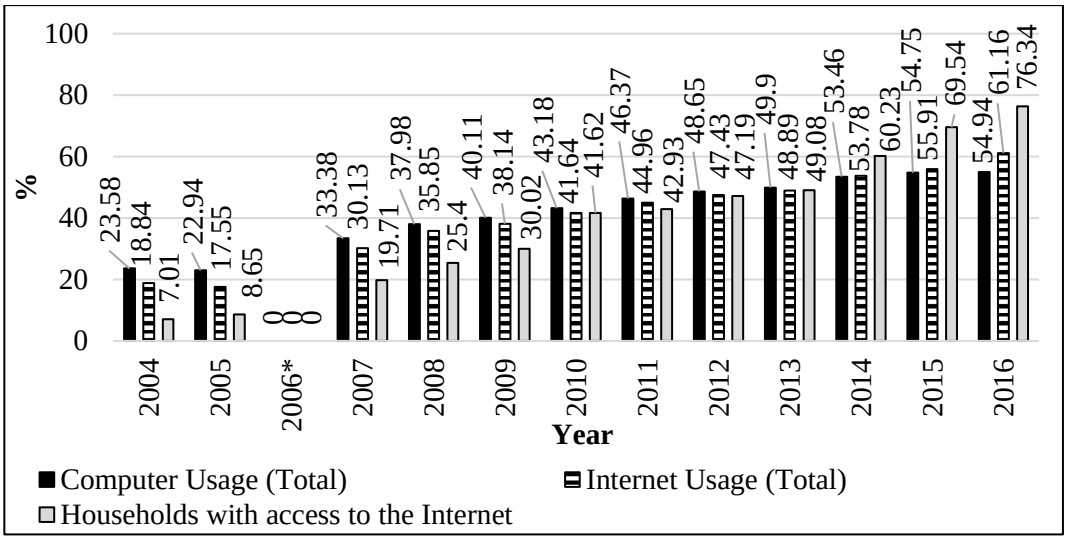


Figure 31: Computer and Internet Usage in Households and Individuals

Source: TURKSTAT. Survey on Information and Communication Technology (ICT) Usage Survey in Households and by Individuals. *The surveys were not conducted in 2006.

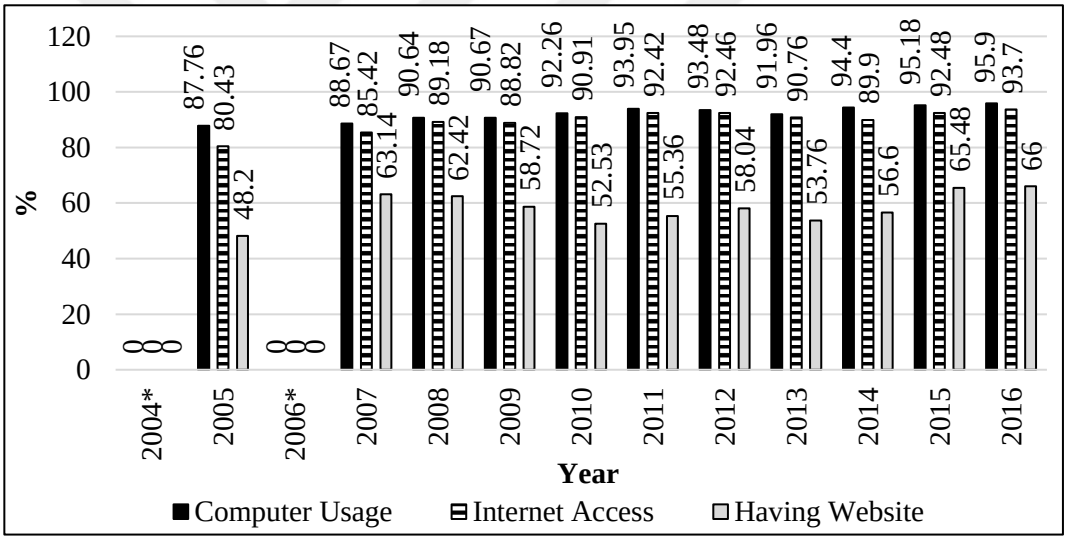


Figure 32: Computer and Internet Usage in Enterprises

Source: TURKSTAT. Survey on Use of Information and Communication Technology (ICT) in Enterprises. *The surveys were not conducted in 2004 and 2006.

In the period of diffusion of internet and ICT, especially in the 2000s, as a result of implementations and developments (such as action plans, relations among Turkey, Europe and the World), mobile technologies have spread in the world and Turkey. For example, according to Information and Communication Technologies Authority (ICTA), mobile telephone subscriptions were approximately 16 million in 2000 in Turkey, and it is approximately 77 million in the first quarter of 2016. Moreover, providing 3G mobile broadband in Turkey in 2009 is one of the other

developments. Therefore, it may be said that as mobile telephone technologies and services have spread, subscriptions and penetration of fixed telephone have fallen (Fig. 33).

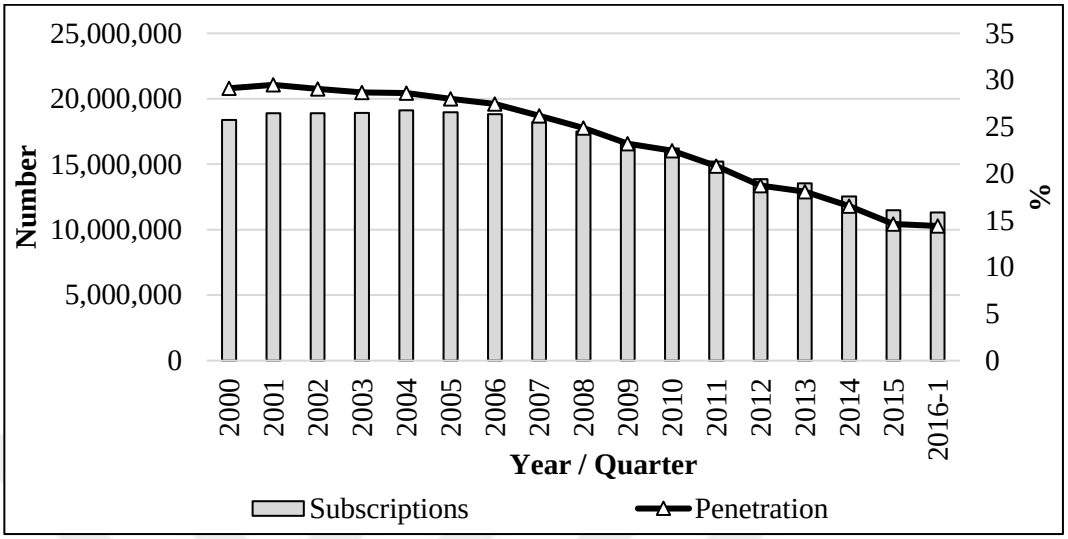


Figure 33: Fixed Telephone in Turkey, 2000 - 2016

Source: Türk Telekomünikasyon A.S., Information and Communication Technologies Authority (ICTA).

On the contrary of fixed telephone subscriptions and penetration in Turkey, fixed broadband subscriptions and penetration have increased in Turkey in the 2000s (Fig. 34). It is not a coincidence because investment on new communication technologies and its infrastructure have increased especially in the late 1990s and in the 2000s (Fig. 20). Therefore, fixed broadband subscriptions have increased from 10 thousand to 10 million in 15 years (from 2001 to 2016-1) as it seen from Figure 34.

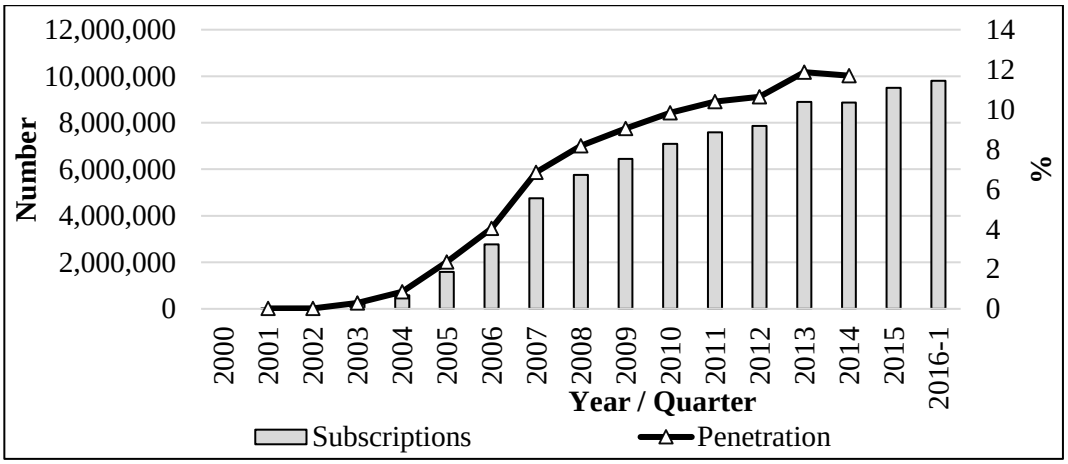


Figure 34: Fixed Broadband in Turkey, 2000 - 2016

Source: OECD, Türk Telekomünikasyon A.S., Information and Communication Technologies Authority (ICTA). The indicator of 2000 is not available.

Fixed broadband market has shaped in the 2000s with the help of rapid growth in fixed broadband subscriptions. As it is said before that the perspective of institutional structure in Turkey was mostly static, but it started to change in the 2000s because of privatizations, and implementations for creating competitive environment for the market. Turkey fixed broadband market structure shows that as other service and cable service providers have increased, the power of Turk Telecom in the market has started to fall (Fig. 35 and 36).

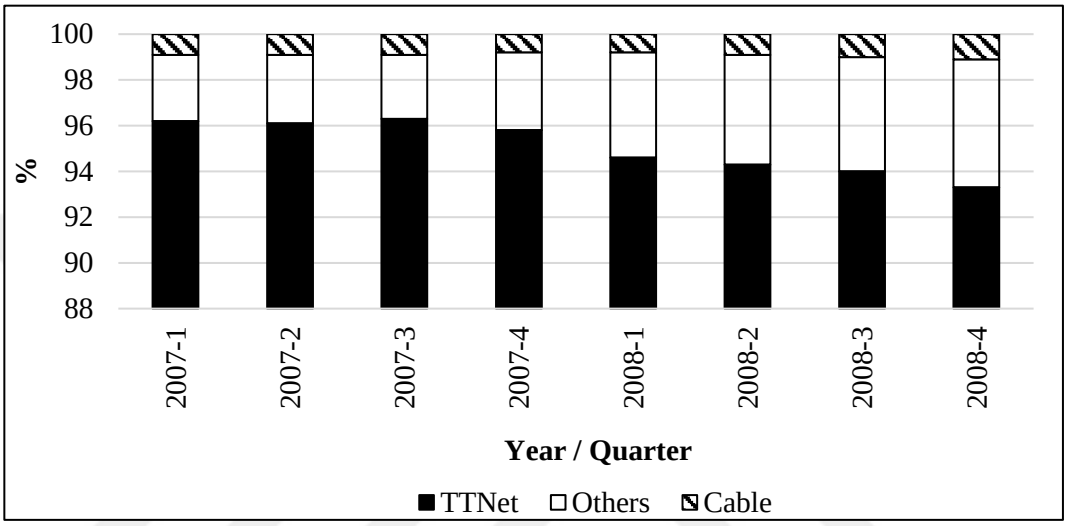


Figure 35: Market Share of Operators by Fixed Broadband Subscriptions in Turkey, 2007 - 2008

Source: Information and Communication Technologies Authority (ICTA).

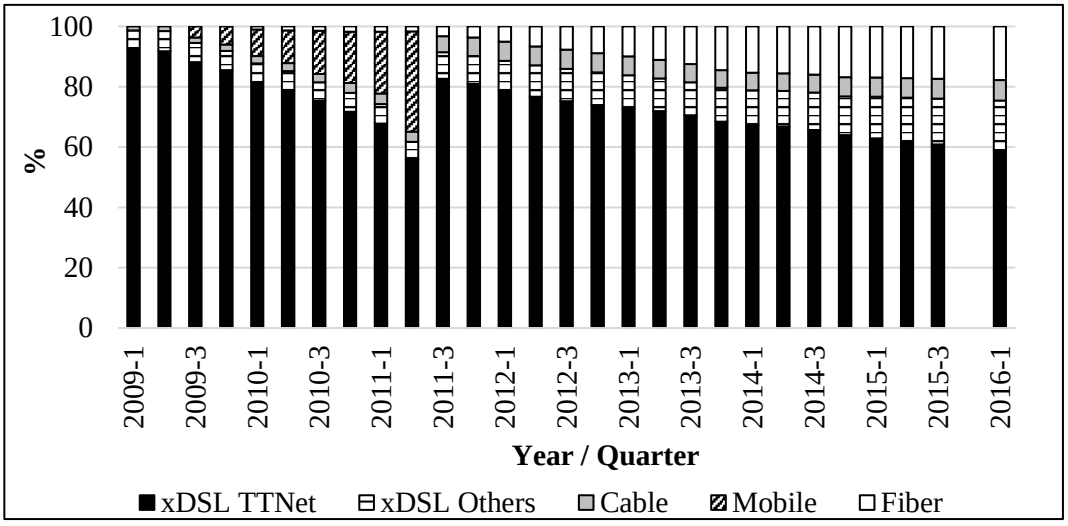


Figure 36: Market Share of Operators by Fixed Broadband Subscriptions in Turkey, 2009 - 2016

Source: Information and Communication Technologies Authority (ICTA). 2015-4 is not available.

Together with some categories such as Mobile and Fiber were added to data, the power of Turk Telecom in fixed broadband market has fallen more than previous year. After removing Mobile from the categories, the power of Turk Telecom has increased but it has continued to diminish (Fig. 36).

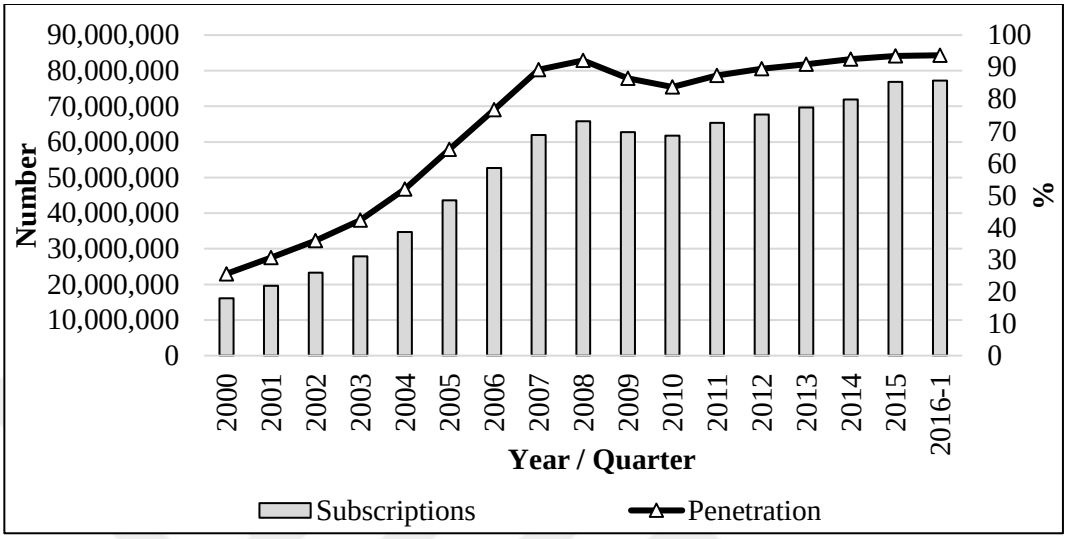


Figure 37: Mobile Cellular Telephone in Turkey, 2000 - 2016

Source: Information and Communication Technologies Authority (ICTA). 2016-1 represents the first quarter of 2016, in other words between January-March.

Expanding demand in mobile technologies and services has affected mobile market in Turkey, as in the world. There was 2G technology during the 1990s in Turkey and 3G technologies in 2009. But, 3G services have been started to provide in the early 2000s in the world. It means that transition from 2G to 3G in Turkey was late. After 7 years, in 1 April 2016, people have started to use 4.5G technology in Turkey.

Today, there are approximately 77 million mobile cellular subscriptions and 93,7% penetration in Turkey. Mobile cellular telephone subscriptions in Turkey has strikingly increased in the 2000s and mobile penetration was similar with it (Fig. 37).

Together with transition to 3G technologies mobile broadband internet subscriptions have started to increase dramatically, approximately from 2.5 million to 42 million in 7 years, in other words it has grown 1576% (Fig. 38).

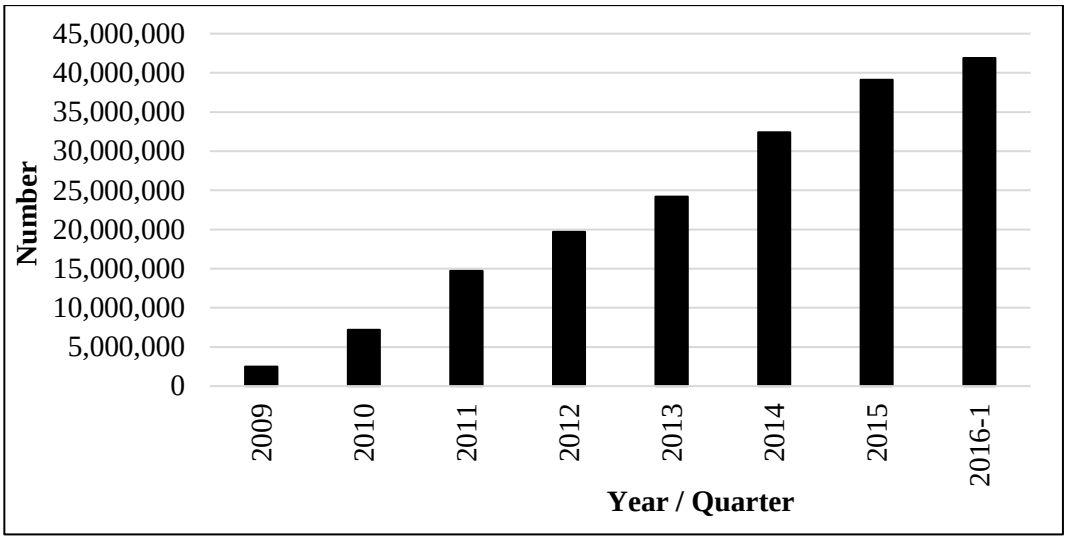


Figure 38: Mobile Broadband Internet Subscriptions in Turkey, 2009 - 2016

Source: Information and Communication Technologies Authority (ICTA). 2016-1 represents the first quarter of 2016, in other words between January-March.

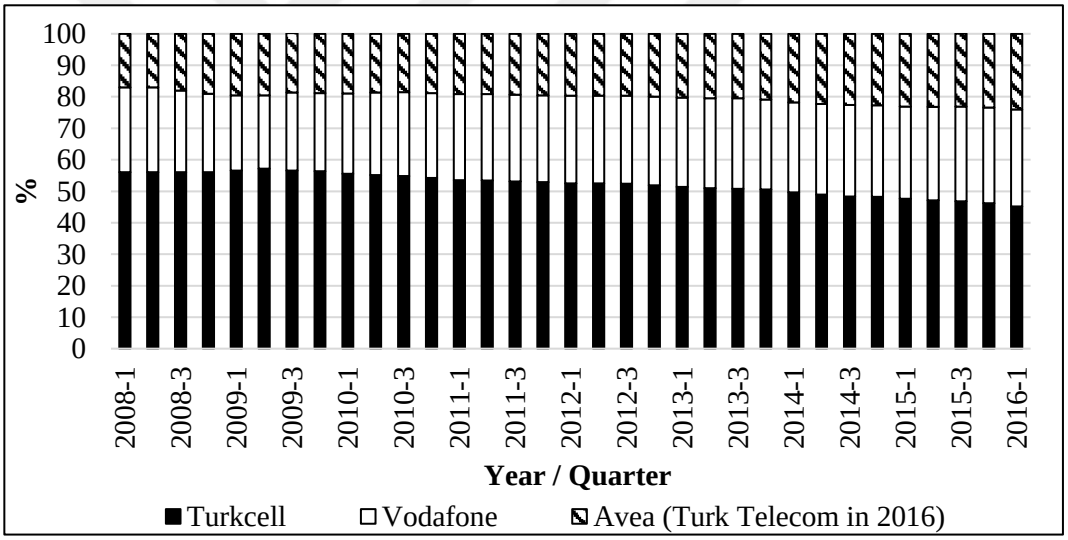


Figure 39: Market Share of GSM Brands by Subscriptions, 2008 - 2016

Source: Information and Communication Technologies Authority (ICTA).

As demand in mobile technologies and services has increased, and together with new service providers, the structure of mobile market in Turkey has started to change. It is a fact that mobile service market in Turkey has started to grow in the 2000s even though there are some mobile brands that provided mobile services in the second part of the 1990s such as Turkcell and Telsim. After 2000, other brands have joined the market such as Aycell, Aria, Turk Telecom (Aycell & Aria → Avea → Turk Telecom), Vodafone, and some *Mobile Virtual Network Operators* or *Satellite*

Operators (MVNOs or *SOs)*[181] such as PTTcell, Teknosa Mobil, BİMcell, POCELL. As a result of new brands in mobile market in Turkey, the market share has changed (Fig. 39). For example, on the one hand, Turkcell has lost its market share (approximately 10%) in last eight years. Therefore, the power of Turkcell has diminished. On the other hand, Avea and Vodafone have increased their market share. Moreover, Avea is mobile services provider in Turkey that has increased its share in last eight years more than Vodafone.

4.3. Some Examples from Economic Institutions in Turkey

4.3.1. E-Banking

ICT has diffused banking system over years together with increasing internet usage. As a result of this, banks have invested in their technological infrastructure to integrate with world financial system, and they have provided various services for corporate and personal clients via ICT and internet. Therefore, electronic banking has boomed in the world and Turkey.

The spread of ICT infrastructure and its usage have brought into more competition among banks. In that competitive environment, the meaning of sustainability has gained importance for banks. The sustainability of banks is based upon *providing services via technologic applications* and *customer satisfaction*. For example, widespread branch network and the number of personnel were prominent factors to struggle in the competitive banking sector in the 1990s, but *internet based services* in the 2000s[182]. According to Aytar, Yeğen and Erdemir, it doesn't mean that the importance of branches decreases in the 2000s[183].

Today, most of banking services have been provided via technology. Together with upgrading technological infrastructure, banks have acquired some advantages such as low costs in services and different service channels, lighter operational workload, decrease in error risks.

Different service channels in banking system such as ATM, POS, credit or debit cards, mobile and internet banking have provided to reach wider corporate and

[181] In Turkey, Turk Telecom has shared its base stations with *Mobile Virtual Network Operators (MVNOs) or Satellite Operators (SOs)* such as PTTcell, Teknosa Mobil, BİMcell, POCELL.
[182] Oğuzhan Aytar, İkbal Yeğen, Namık Kemal Erdemir, "Elektronik Şube ve Elektronik Bankacılık Hizmetleri", http://ab.org.tr/ab12/bildiri/102.pdf [21.9.2016].
[183] **Ibid**.

personal clients. For example, *BKM 3D Secure Platform* has been created to provide secure electronic commerce process over internet for credit or debit card users and e-commerce websites by Interbank Card Center (BKM) in Turkey[184]. Moreover, as a result of cooperation between BKM and Turkcell, it is the first time in the world that *mobile signature* has been started to use in credit card operations over internet in Turkey, and therefore all clients can do shopping over internet with their mobile signatures instead of using password[185]. These kinds of developments are significant to eliminate obstacles to e-commerce step by step. Additionally, institutions have started to do something to reduce the effects of climate change on the world in recent years, and Banks have started to send *credit card account statements via e-mail* as a result of their environment-friendly approaches.

Banking system in Turkey is one of the examples which can be viewed to show the effects of ICT on economic institutions. In this sense, some indicators have been chosen to analyze it such as the number of banks, branches and personnel, calls, clients, POS and ATM, financial operations, debit or credit cards.

Regarding to 24th January Decisions, the law no. 32 has accelerated the transition to open economy by enabling capital import. According to Balkanlı, it is the result of budget imbalances in Turkey, in other words decrease in the possibility of internal borrowing[186].

The number of banks in Turkey has increased until 2001 because of the transition processes and mistakes in legal infrastructure in financial system, and then it has decreased because of 2001 crisis in Turkey. CBRT specifies main reasons of the crisis as "*unsustainable internal debts*", "*temporary solutions for structural problems in finance system, mainly in public banks*" since 1990[187].

After the crisis, most of companies have started to implement new decisions with the aim of retrenching some of production costs such as severances. The effects

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[184] Feridun Kaya, "Türkiye'de Kredi Kartı Uygulaması", **Türkiye Bankalar Birliği,** No: 263 (2009), 20.

[185] "Turkcell-BKM'den mobil imza", İhlas Haber Ajansı, 11.02.2008, http://www.iha.com.tr/haber-turkcell-bkmden-mobil-imza-12466/ [21.09.2016].

[186] Ali Osman Balkanlı, **Küresel Ekonomi Koşullarında Türkiye'nin Dışa Açılması ve Gelişmesi Sorunu (1980 – 2002)**, (İstanbul: Filiz Kitabevi, 2012), 199.

[187] "Türkiye'nin Güçlü Ekonomiye Geçiş Programı", Türkiye Cumhuriyeti Merkez Bankası, http://www.tcmb.gov.tr/wps/wcm/connect/fc5a4a1a-63d9-4de3-bb8b-d56a61409df6/program+(1).pdf?MOD=AJPERES&CACHEID=ROOTWORKSPACEfc5a4a1a-63d9-4de3-bb8b-d56a61409df6 [24.09.2016].

of the crisis are seen in banking sector in Turkey as lowering the number of bank, branches and personnel in the early 2000s. For example; in 2001, the number of banks has decreased 23%; 12% decrease in the number of personnel, and 20% decrease in the number of branches[188] (Appendix 2). It is important to say that the reason of the downward trend is structural problems in finance system in contrast to ICT.

In the early 2000s, some programs such as *2000 Disinflation Reduction Program* and *2001 Transition Program for Strengthening Economy* have focused on structural problems in financial system and Turkish banking sector such as regulations in Banking Law in terms of providing solution, competitive environment and harmonization with international standards. These programs have implemented together with other programs such as *e-Turkey* in 2001 and *e-Transformation Turkey Project* since 2002 which emphasize electronic services such as e-commerce.

The impacts of ICT on Turkish banking sector have been seen especially in the 2000s as a result of developments in ICT infrastructure. Banks has increased their technological infrastructure and providing banking services have become easier. Therefore, new branches of bank have been opened in Turkey to communicate with more clients, in other words banks have coped with other banks more with the aim of having more market share because of developments in ICT infrastructure and rising competition in the sector. For example, the number of branches has grown 55% since 2000, and then the number of personnel in banking sector has grown 26% in Turkey[189].

Especially, internet usage and ICT have caused providing of commercial and financial activities and services over ICT and internet. As a result of rising of ICT usage, the process of communication has evolved as physical to virtual. For example, you can learn your bank account situation or can be called via fixed or mobile telephone by bank.

Together with the change in the process of communication, a new work types and institutions have joined the sector, *the Call Centers*. All institutions in the economy had their own telephone and section to provide connection with their

[188] They are calculated thanks to data from the Banks Association of Turkey and Banking Regulation and Supervision Agency.
[189] They are calculated thanks to data from the Banks Association of Turkey and Banking Regulation and Supervision Agency.

clients. The diffusion of ICT has caused a boom in their inbound and outbound calls. Therefore, the institutions have chosen one of any two choices such as: "*to buy call center services*" or "*to create or to enlarge their call section*". For example, in Turkey, it is seen that the number of call center personnel of banks has grown 77% (Fig. 40), and the number of inbound and outbound calls has grown 95% and 796% respectively in eight years (Fig. 41 and 42) (Appendix 3).

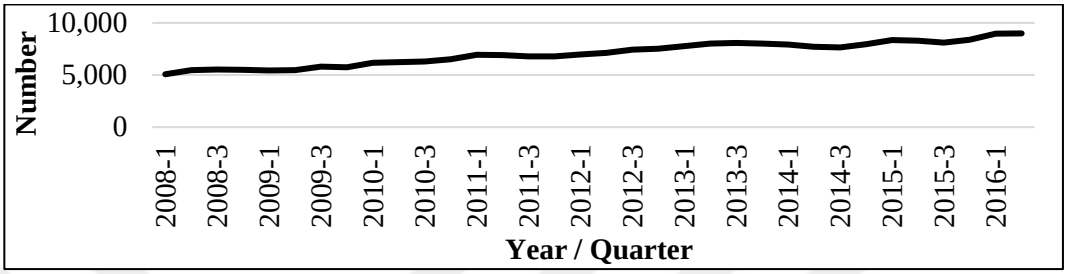


Figure 40: Total Number of Call Center Personnel of Banks in Turkey

Source: The Banks Association of Turkey.

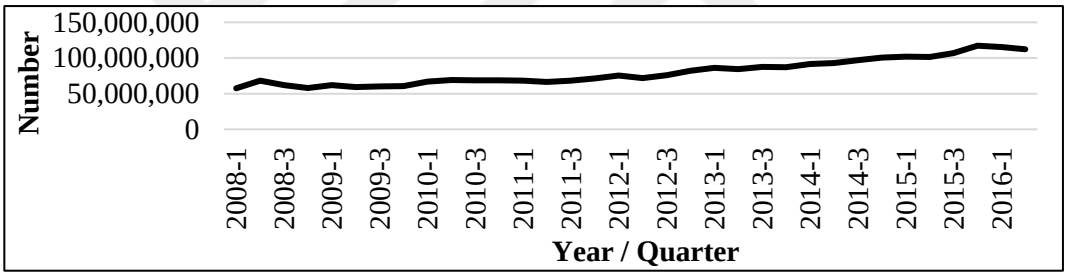


Figure 41: Total Number of Inbound Calls of Banks in Turkey

Source: The Banks Association of Turkey.

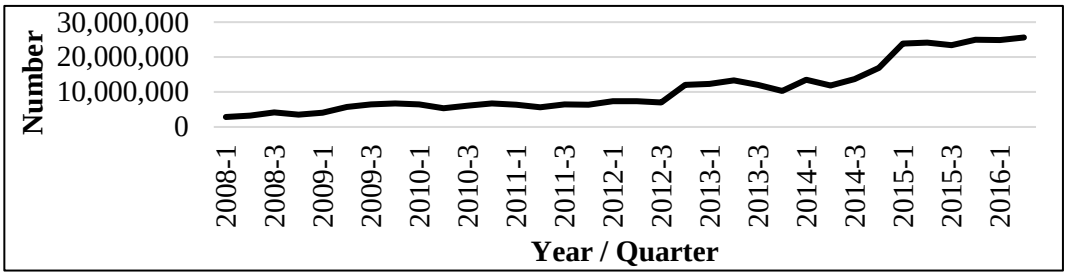


Figure 42: Total Number of Outbound Calls of Banks in Turkey

Source: The Banks Association of Turkey.

The banking services have not been provided via only telephone, but also over the internet by banks. Together with internet banking, clients save their times and do

financial operations wherever they are. It is important to say that *internet based services* are significant to struggle in the competitive banking sector in the 2000s.

The number of personal and corporate clients on internet banking in Turkey has been viewed in three segments such as "registered and login at least one time", "registered and login at least one time in the recent year" and "active". For example, the numbers of total clients who "registered and login at least one time" are approximately 53 million in 2016 (Fig. 45) (Appendix 4, 5, 6). But the number of total active clients (approximately 18 million in 2016) is better to analyze the internet banking usage. The number of personal active clients has grown 472% in last ten years, and the growth rate of the number of corporate active clients is 227% (Fig. 43 and 44). It is seen that ICT has gained importance in terms of financial services.

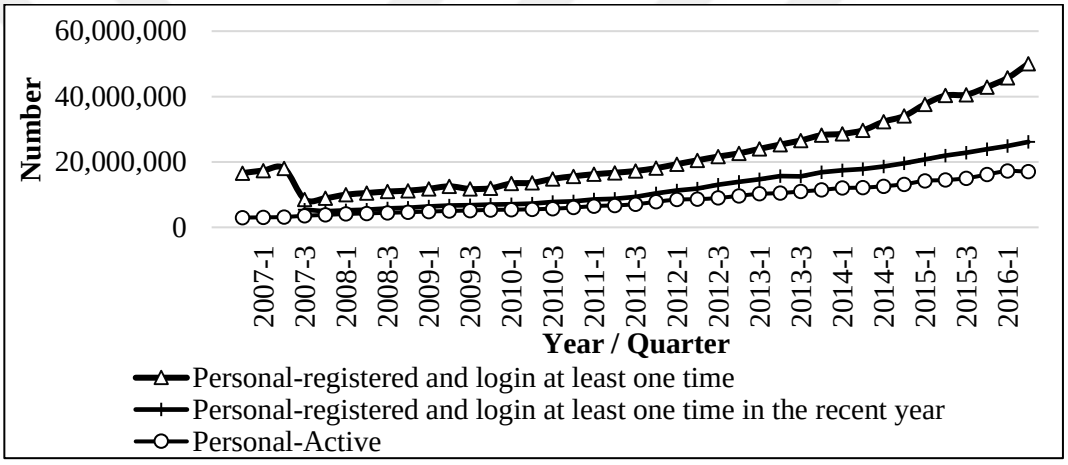


Figure 43: The Number of Personal Clients on Internet Banking in Turkey

Source: The Banks Association of Turkey.

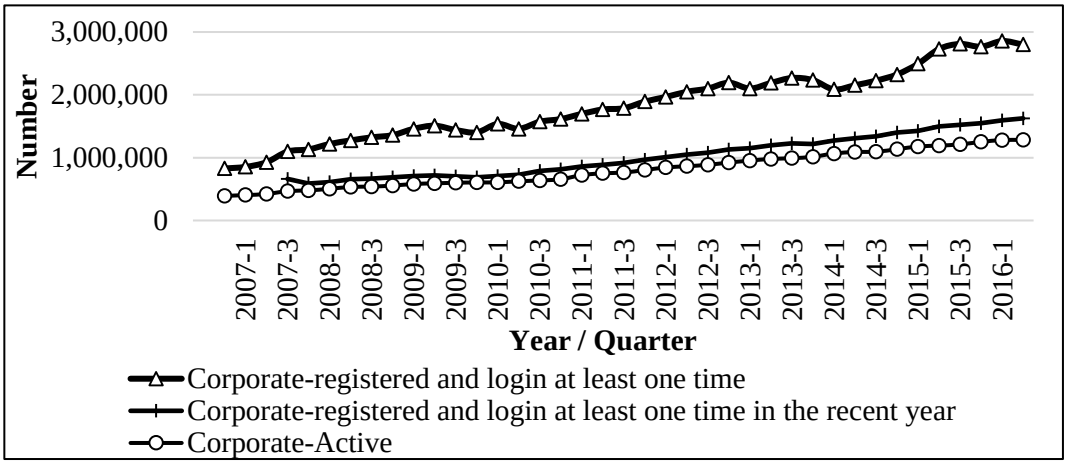


Figure 44: The Number of Corporate Clients on Internet Banking in Turkey

Source: The Banks Association of Turkey.

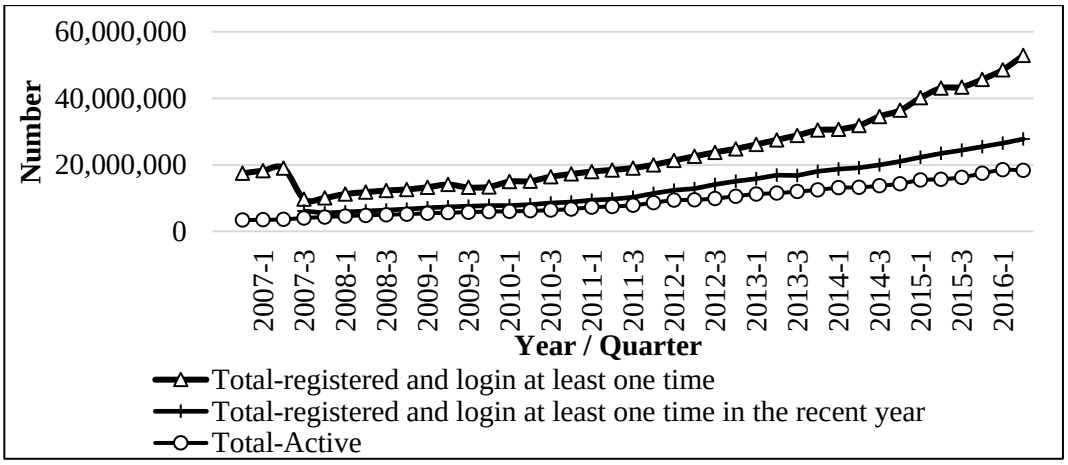


Figure 45: Total Clients on Internet Banking in Turkey

Source: The Banks Association of Turkey.

Internet banking clients do some financial[190] and non-financial[191] operations. The number of these operations may show the importance of ICT in financial sectors. For instance, the number of total non-financial operations on internet banking has grown 180% and the number of total financial operations 198% in last ten years (Fig. 46 and 47) (Appendix 8).

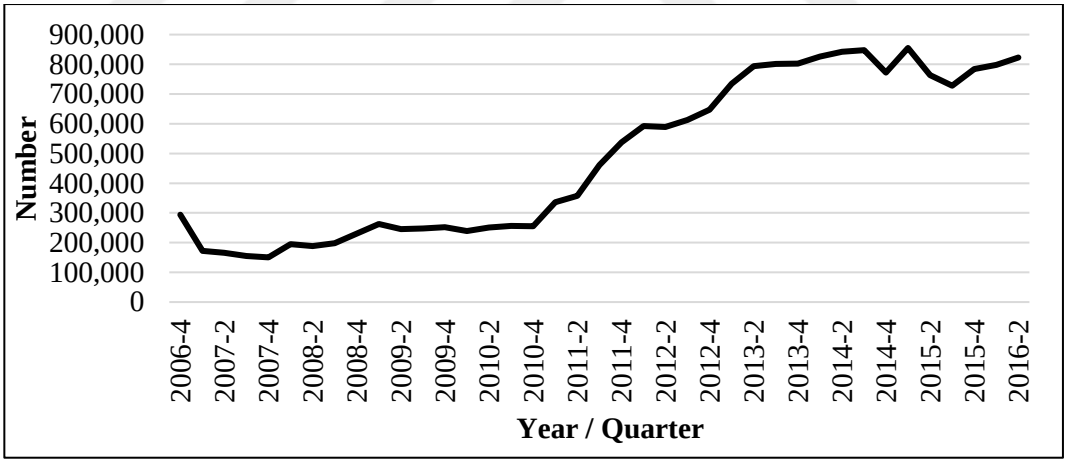


Figure 46: The Number of Non-Financial Operations on Internet Banking in Turkey

Source: The Banks Association of Turkey.

[190] Financial operations: money transfer (Electronic Fund Transfer 'EFT', money order, foreign exchange transfer), payments (utility bill, tax, insurance premium, loan), investment (time deposit account, foreign exchange, investment funds, equities, T-bills/government bonds, gold, derivatives exchange), credit cards (overdraft account, debt payment).

[191] Non-financial operations: application for credit or additional cards, loan application, automatic utility bill payments, standing payment orders.

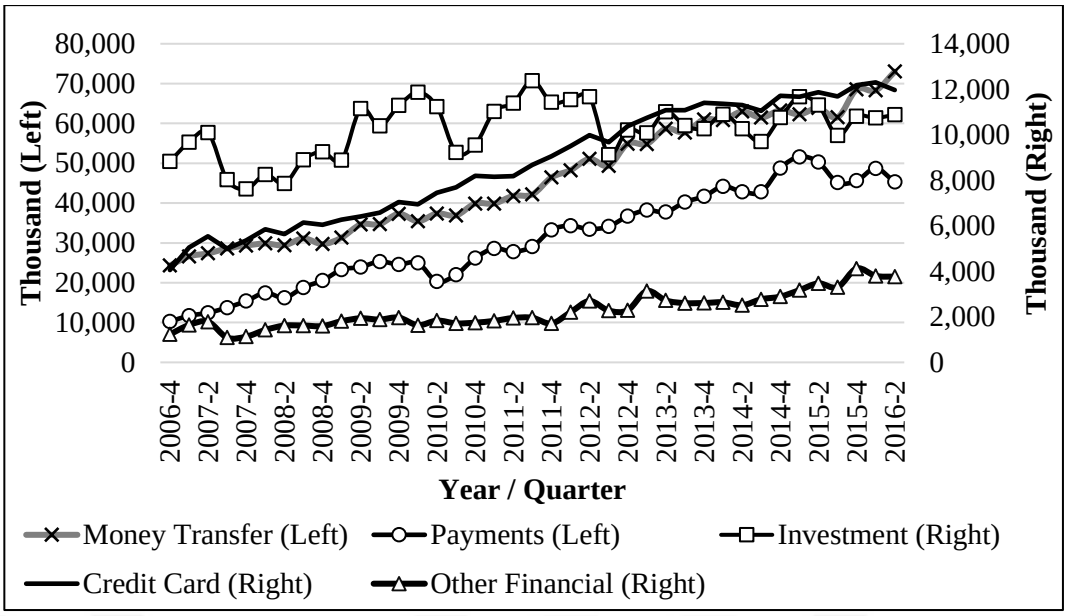


Figure 47: The Number of Financial Operations on Internet Banking in Turkey

Source: The Banks Association of Turkey.

Money transfer is the prominent financial operation on internet banking in Turkey. It is approximately 47% of the number of total financial operations (Fig. 47), and volume of money transfer is approximately 66% of total volume of financial operations in last ten years (average) (Fig. 48) (Appendix 9). Additionally, payments are 31% of the total number of operations and 3% of the total volume then investment is 11% and 23%, credit card 9% and 2%, other financial 2% and 6% respectively (Fig. 47 and 48).

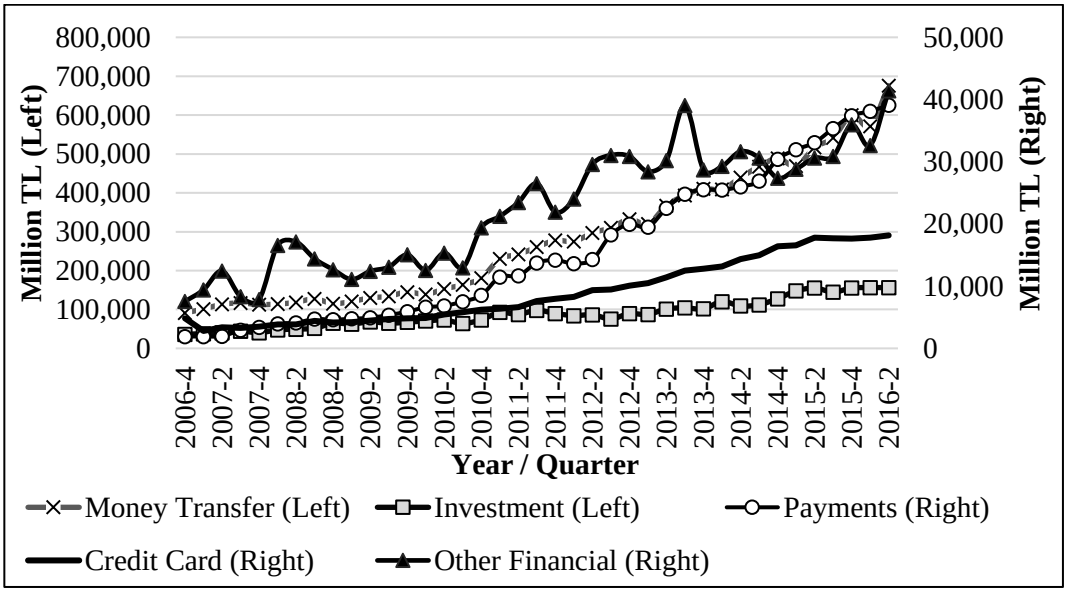


Figure 48: The Volume of Financial Operations on Internet Banking in Turkey

Source: The Banks Association of Turkey.

The banking services have been provided via applications on mobile phones thanks to mobile internet services. After transition to 3G services in 2009, the number of clients and financial operations on mobile banking has increased year by year in Turkey, and 4.5G services have been started to use by people in 1 April 2016. All these mobile broadband technologies provide rapid mobile internet services and therefore mobile applications usage has increased more. It has affected the number of clients and the number of non-financial and financial operations on mobile banking in Turkey.

Mobile banking has been viewed in three segments[192] as internet banking. The number of total active clients on mobile banking has grown 6500% since 2011 (Fig. 49) (Appendix 10, 11, 12). In 2016, there are approximately 15 million clients on mobile banking in Turkey.

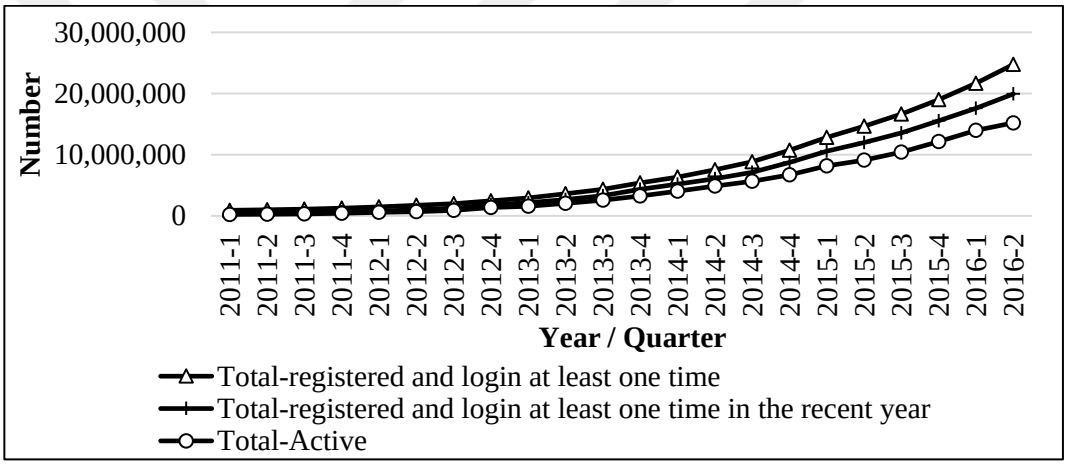


Figure 49: Total Clients on Mobile Banking in Turkey

Source: The Banks Association of Turkey.

Mobile banking clients can do financial and non-financial operations via not only internet banking but also mobile banking. It is important to say that together with increase in mobile banking usage, internet banking usage has decreased. It does not mean that internet banking is not important. In other words, it may be said that mobile technologies are significant for finance sector as much as internet banking especially in the future. For instance, the number of total non-financial operations on mobile banking has grown 170000%, and the number of total financial operations 9900% in last five years (Fig. 50 and 51) (Appendix 13).

[192] "registered and login at least one time", "registered and login at least one time in the recent year" and "active".

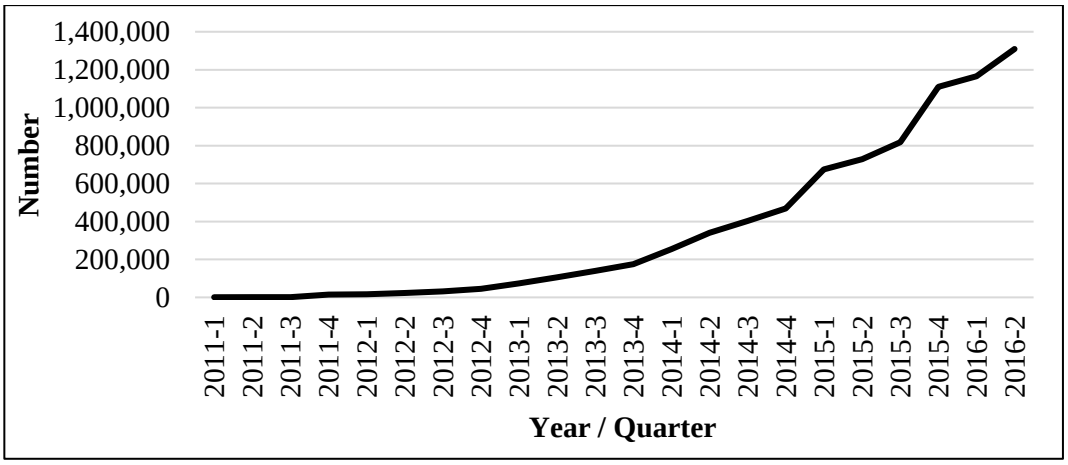


Figure 50: The Number of Non-Financial Operations on Mobile Banking in Turkey

Source: The Banks Association of Turkey.

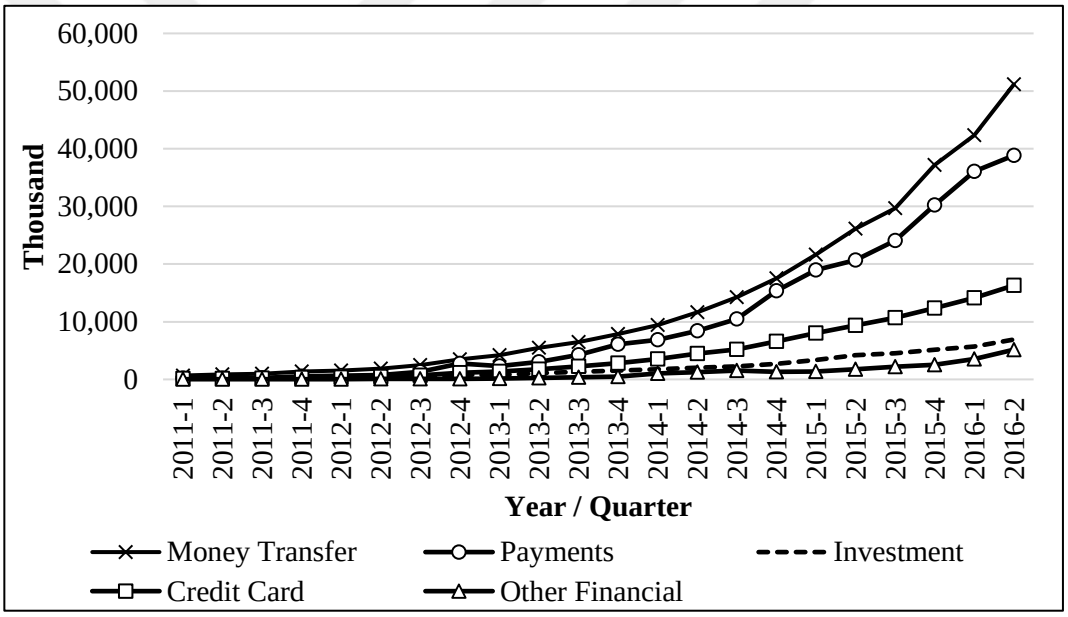


Figure 51: The Number of Financial Operations on Mobile Banking in Turkey

Source: The Banks Association of Turkey.

Money transfer is the prominent financial operation also on mobile banking in Turkey. It is approximately 46% of the number of total financial operations (Fig. 51), and volume of money transfer is approximately 56% of total volume of financial operations in last five years (average) (Fig. 52) (Appendix 14). Additionally, payments are 28% of the total number of operations and 2% of the total volume then credit card is 14% and 6%, investment 9% and 33%, other financial 3% and 3% respectively (Fig. 51 and 52).

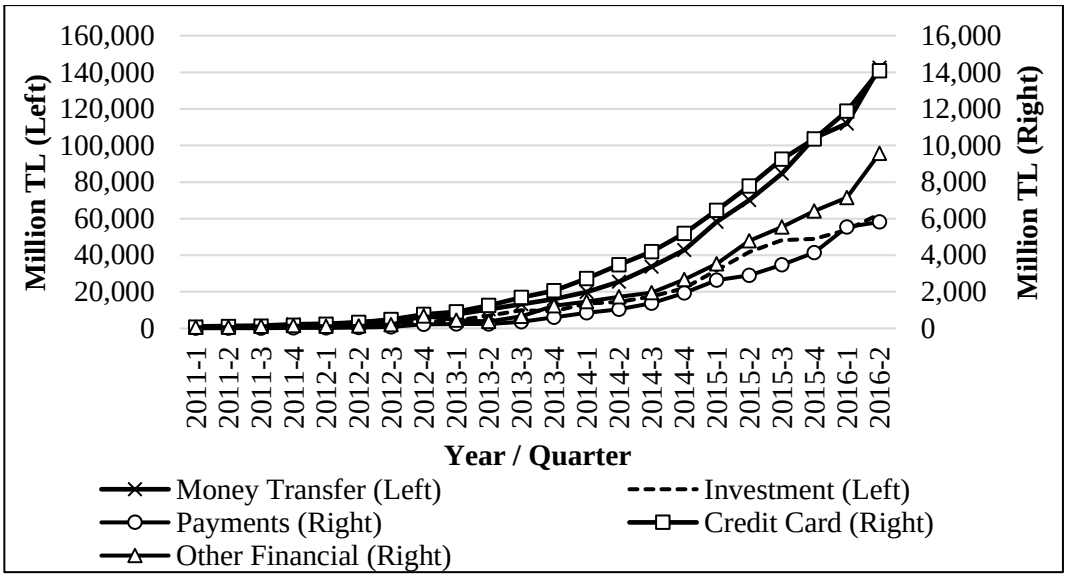


Figure 52: The Volume of Financial Operations on Mobile Banking in Turkey

Source: The Banks Association of Turkey.

Technological infrastructure in banking system has not seen as only internet or mobile banking, but also POS, ATM, and credit and debit cards. It is a fact that ICT has provided more ways to pay such as POS and ATM, and it is the result of ICT developments and widespread branch network. For example, the number of POS has grown 536% and the number of ATM 307% since 2000 in Turkey (Fig. 53). Therefore, credit and debit cards usage have boomed since the early 2000s. For example, the number of credit card has grown 340% and the number of debit card 291% since 2000 in Turkey, and total number of credit and debit cards is approximately 175 million in 2016 (Fig. 54). It means that the diffusion of ICT in banking sector has affected the number of credit and debit cards, the number of POS and ATM.

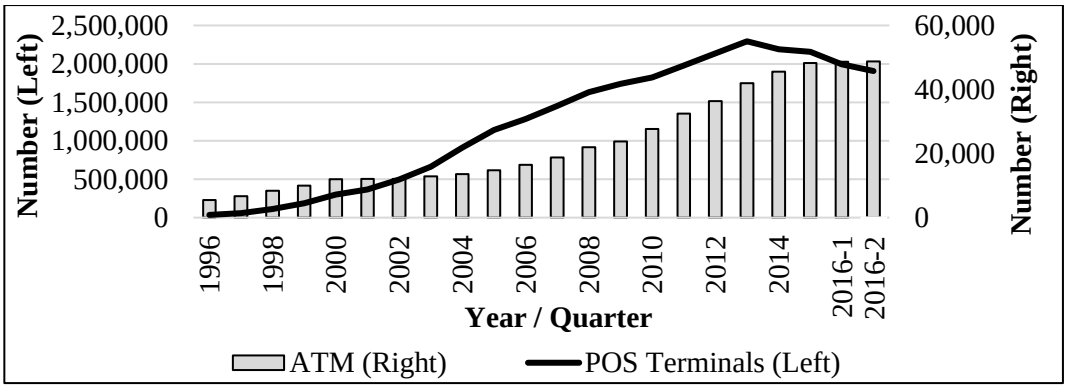


Figure 53: The Number of POS and ATM

Source: The Interbank Card Center (BKM) Annual Reports 2000-2015.

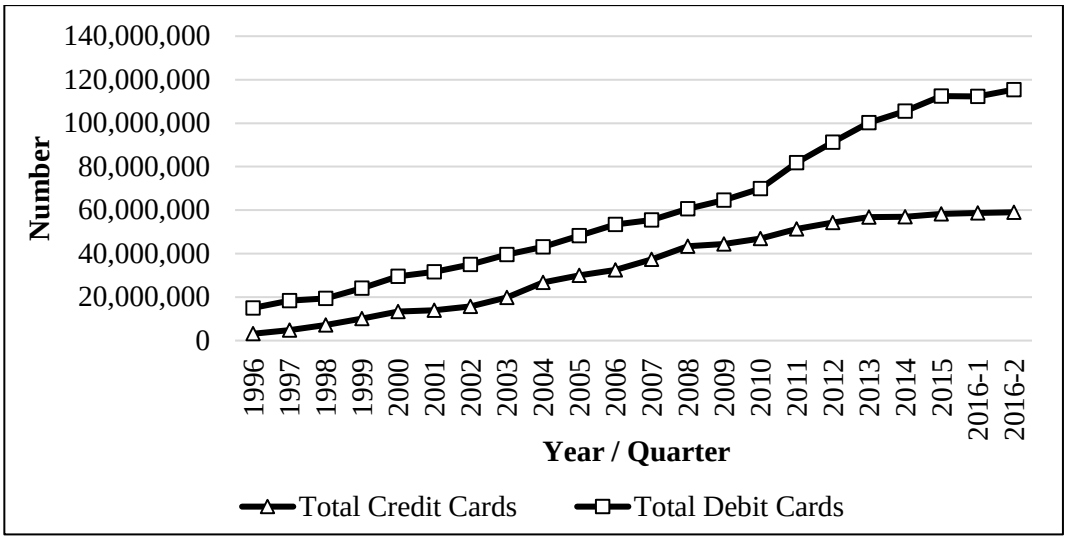


Figure 54: The Number of Credit Cards and Debit Cards

Source: The Interbank Card Center (BKM) Annual Reports 2000-2015.

Before the diffusion of ICT in banking system, branches were so important to provide services. People generally used these branches to do financial operations and the cost of operations was relatively high. Then, limited services have been started to provide via ATM, credit and debit cards. Today, people have used internet and mobile banking increasingly together with some technologies such as e-signature, virtual keyboard. And applications have caused providing various services for clients. Moreover, contactless cards have started to diffuse in the life and this may be pioneer of NFC (Near Field Communication). Additionally, there are some topics which have started to discuss and use step by step as future technological developments in financial system such as: NFC technologies will transform physical money to virtual money (*electronic wallet*) more than other ICT such as credit and debit cards; video call centers, virtual customer representative, and etc. For instance, today in Singapore, there are *VTMs (Virtual Teller Machines)* which provide human teller video chat option[193]. In Turkey, there are fingerprint and palm print-scanning ATMs.

It is important to emphasize that the diffusion of ICT in banking system has made easier some other operations in stock exchange or tax offices.

[193] "Singapore rolls out video-enabled ATMs so you can chat with a teller live", Mashable, 16 August 2016, http://mashable.com/2016/08/16/singapore-posb-vtm/#USDgQwo.Nuq8 [25.09.2016].

4.3.2. E-Borsa

Stock exchange is not a new actor in financial environment. Its history and its technological infrastructure have evolved since old times.

Stock exchanges have become active in the financial area since 301 BC. The oldest stock exchange was found in 1971 in Aizanoi Antique City where is near Çavdarhisar, Kütahya, Turkey. It is known as the oldest stock exchange in the world. In the city, some written tablets were found which is about wage determinations to cope with inflation[194]. In the period of Medieval Age, bill has started to use in commercial life and together with bazaars the bill has diffused. Therefore, stock exchanges have started to spread in the world. As a result of evolution of technological infrastructure, institutionalization of almost all stock exchanges has been seen generally in the 18th and the 19th century[195].

After the Industrial Revolution, the diffusion of ICT in finance sector has affected to stock exchanges work processes and their institutional structure in the world. For example, after the invention of telegraph and telephone, and transatlantic telecommunications cable, New York Stock Exchange (NYSE) has started to use telephone first time in 1878, and call system in 1881. Therefore, communication has boomed and the number of transactions has increased. Additionally, new services had been provided in 1889 by new companies such as ticker machine. In the 20th century, pneumatic tube system, upgraded ticker machines had been used. The first automation system to provide services has been launched in NYSE in 1972[196].

In Turkey case, BIST has been established as ISE in 1985. Transmission of commands has evolved until today thanks to developments in ICT infrastructure. Commands had been transmitted to stockbroker by a document or oral until 1988. Board methods had been used to do transactions until 1994. Then, BIST working hours were enhanced to 4 hours in a day with two sessions. Computer based systems had been launched in November 1994. New trading software for the Bonds and Bills Market has been activated in June 1999. Together with remote access system in July

[194] "Dünyanın İlk Borsası", Kütahya Ticaret Borsası, http://www.kutbo.org.tr/DünyanınİlkBorsası [29.9.2016].
[195] Some of them, for example: Paris (1724), Amsterdam (1608), Berlin (1739), Wien (1771), New York (1817), Brussels (1801), Milan (1808), Geneva (1857), Budapest (1864), Prague (1871), Stockholm (1876).
[196] "History of the New York Stock Exchange", Library of Congress, https://www.loc.gov/rr/business/hottopic/stock_market.html [29.09.2016].

2000, it has been enabled to send transactions commands from main centers of members to BIST. Moreover, some markets have been opened such as The Bonds and Bills Market in June 1991, Derivatives Market in December 2012[197].

As a result of the diffusion of ICT and technology, some institutions such as State Planning Organization (DPT) have started to made plans for upgrading technological infrastructures in institutions. DPT has specified some targets[198] about financial markets which will implement in Turkey such as:

- "*Powerful technological solutions will be created for firstly stock market, and financial institutions*",
- "*Technoparks will be established for financial markets*",
- "*Knowledge transfer and services export (such as applications and solutions) to other countries will provide more competitiveness power*".

BIST specified that technological infrastructures in institutions, especially in stock exchange, are significant for İstanbul to do it one of the prominent cities in the world in next 10 years. According to BIST, upgrading technological infrastructures of BIST brings new dimensions for İstanbul, therefore İstanbul will be one of the international finance centers which provides some advantages[199] for BIST such as:

- "M*ore liquidity and more depth in financial market*",
- "*The number of company which is traded at BIST will be increase*".

BIST has emphasized also the importance of some other aims[200] to make İstanbul as one of the international finance centers such as:

- "*To increase the shares of hardware, software, information technology solutions in ICT sector*".

To actualize these kinds of aims, BIST signed a landmark deal together with NASDAQ OMX Group in 31 December 2013, which agreement includes "*the*

[197] "Tarihsel Gelişmeler", Borsa İstanbul, http://www.borsaistanbul.com/kurumsal/borsa-istanbul-hakkinda/tarihsel-gelismeler [28.09.2016].
[198] Devlet Planlama Teşkilatı, **İstanbul Uluslararası Finans Merkezi Stratejisi ve Eylem Planı** (2009), 18.
[199] "Bilişim Teknolojileri", Borsa İstanbul, http://www.borsaistanbul.com/data/kilavuzlar/Bilisim_Teknolojileri.pdf [23.09.2016], 6.
[200] **Ibid**, 6.

delivery of market-leading technologies and advisory services to Borsa İstanbul"[201]. This agreement will provide upgrading of BIST technological infrastructure, and reliable advisory services. Therefore, as a result of using of more rapid and powerful "*technological infrastructure and software which are provided by NASDAQ*"[202], it is expected that BIST will get some advantages such as:

- "*A good position in the region to transfer NASDAQ's solutions (approximately 25 countries)*"[203],
- "*More powerful Brand Value*"[204],
- "*To be an international finance center for Euroasia*"[205],
- "*Increase in regional and international activities of BIST*"[206],
- "W*ider product range and more global interactions*"[207].

R & D of new financial products are significant to provide sustainability and progress. For example, *World Bank Global Islamic Finance Development Center* has been launched in 2013 at BIST[208]. Moreover, "*BIST Finance and Technology Zone*" has been started to build in 2014 which includes "*Borsa İstanbul*", "*Finance Technopark Technology Development Zone*", "*Central Securities Depository of Turkey*", and "*Settlement and Custody Bank – Takasbank*"[209]. For example, in 2014, Finance Technopark Project has been supported by the cooperation of Borsa İstanbul

[201] "NASDAQ OMX and Borsa Istanbul Sign Landmark Deal", Borsa İstanbul, 31 December 2013, http://www.borsaistanbul.com/en/news/2013/12/31/nasdaq-omx-and-borsa-istanbul-sign-landmark-deal [23.09.2016].
[202] "BIST, Nasdaq çözümlerini 25 ülkeye aktarabilecek", **Milliyet Gazetesi**, 21 Ocak 2014, http://www.milliyet.com.tr/bist-nasdaq-cozumlerini-25-ulkeye/ekonomi/detay/1824881/default.htm [23.09.2016].
[203] **Ibid**.
[204] "BIST-Nasdaq OMX anlaşması kabul edildi", 31 Aralık 2013, http://www.bloomberght.com/haberler/haber/1483627-bist-nasdaq-omx-anlasmasi-kabul-edildi [23.09.2016].
[205] "Borsa İstanbul ve NASDAQ OMX'ten çığır açacak anlaşma", 31 Aralık 2013, http://www.borsaistanbul.com/duyurular/2013/12/31/borsa-istanbul-ve-nasdaq-omx-ten-%C3%A7%C4%B1%C4%9F%C4%B1r-a%C3%A7acak-anla%C5%9Fma [23.09.2016].
[206] Borsa İstanbul, "Bilişim Teknolojileri", 3.
[207] **Ibid**, 6.
[208] "World Bank Global Islamic Finance Development Center, the Bank's first Representation Office on Islamic Finance, is Launched at Borsa İstanbul Premises", Borsa İstanbul, 31 October 2013, http://www.borsaistanbul.com/en/news/2013/10/31/world-bank-global-islamic-finance-development-center-the-bank-s-first-representation-office-on-islamic-finance-is-launched-at-borsa-istanbul-premises [25.09.2016].
[209] "Borsa İstanbul Finans ve Teknoloji Yerleşkesi'nin Temeli Atıldı", Borsa İstanbul, 26 September 2014, http://www.borsaistanbul.com/duyurular/2014/09/26/borsa-istanbul-finans-ve-teknoloji-yerleskesinin-temeli-atildi [25.09.2016].

and Boğaziçi University[210], and BISTECH R & D Center Project has been confirmed in 2016[211]. These institutional transformation means that Turkish ICT infrastructure has reached adequate level to establish the institutions which are significant to provide necessary environment for requirements of information age. Therefore, these institutions will support internalizing process of technology in institutions.

BIST Emergency Management Center has been moved to Ankara because of "*logistic and geographical advantages, operational and communication cost advantages*"[212]. Furthermore, order transmission infrastructure has been launched in Equity Market in 2013 within the framework of FIX Protocol (Financial Information Exchange)[213]. Furthermore, BIST has provided CoLocation services to intermediary institutions which get some advantages such as *Fastest Access to Exchange's System, Fairness, Risk Mitigation*[214]. Therefore, access time lag is "*less than 1 millisecond for equity market*" and "*less than 1,2 milliseconds for derivatives market*"[215]. In November 2015, BIST's new ICT infrastructure which is supported by Nasdaq has been activated for only equity market within the framework of first phase of BISTECH. It is seen obviously that experiences of countries on ICT can be effective in terms of development and growth of economy thanks to economic institutions.

All developments in stock exchange ICT infrastructure have affected the number of transactions. Since 1988, BIST market trade volume has increased generally. Remarkable growths in transactions have been seen in some years such as 1992, 1995, 2001 (Fig. 55).

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[210] "Borsa İstanbul and Boğaziçi University to jointly establish a 'Finance Technopark Technology Development Zone", Borsa İstanbul, 5 September 2014, http://www.borsaistanbul.com/en/news/2014/09/05/borsa-istanbul-and-bogazici-university-to-jointly-establish-a-finance-technopark-technology-development-zone [25.09.2016].

[211] "BISTECH Ar-Ge Merkezi başvurusu onaylandı", Borsa İstanbul, 9 Mayıs 2016, http://www.borsaistanbul.gov.tr/duyurular/2016/05/09/bistech-ar-ge-merkezi-basvurusu-onaylandi [26.09.2016].

[212] Borsa İstanbul, "Bilişim Teknolojileri", 5.

[213] "Bir Dönüşüm Hikayesi", Borsa İstanbul, http://www.borsaistanbul.com/data/kilavuzlar/Borsa_Istanbul_Bir_Donusum_Hikayesi.pdf [25.09.2016], 23.

[214] "Borsa İstanbul CoLocation Service", Borsa İstanbul, http://www.borsaistanbul.com/en/products-and-markets/technology-services/colocation [25.09.2016].

[215] **Ibid**.

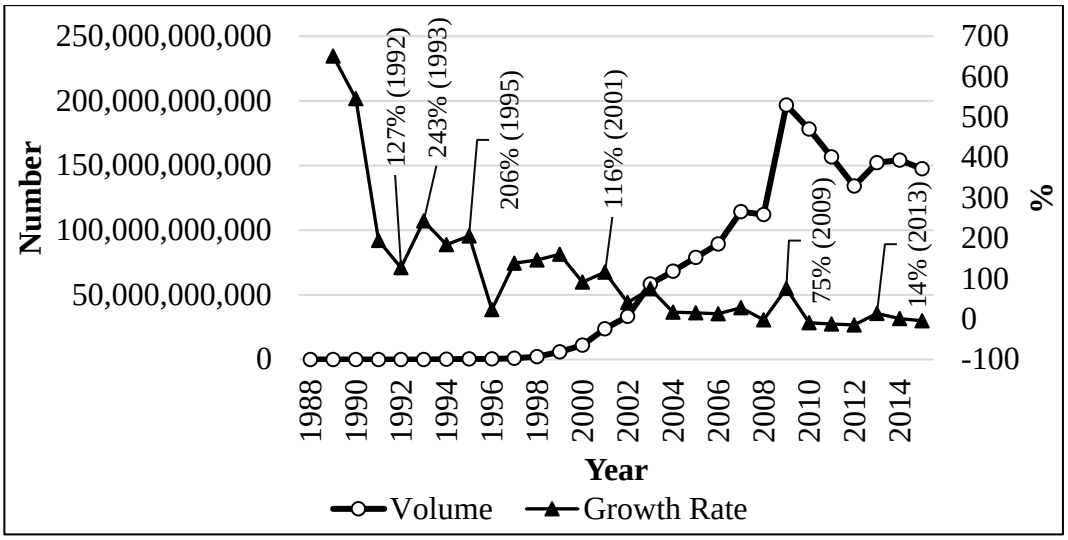


Figure 55: BIST National Market Trade Volume

Source: Borsa İstanbul. The data of the year of 2015 is until 27.11.2015.

The number of transactions has grown 127% in 1992 thanks to some reasons such as board methods and telephone usage, increase in the number of publicly traded companies[216] in 1990 and 1991. Then, computer based system in stock exchange has provided electronic work process in November 1994. We should view next year to see its effects better. In 1995, the number of transactions in stock exchanges has grown 206%. Together with transition to remote access system in stock exchange in July 2000, the growth is seen as 116% in 2001. Moreover, BISTECH has been activated in November 2015.

4.3.3. E-Taxation

Integration of financial market with ICT has continued rapidly not only in banks and stock exchange, but also in the Ministry of Finance which is one of prominent public institutions within the framework of e-Transformation Turkey in the 2000s. In those years, the financial policies have support e-transformation and financial integration such as sustainable financial discipline.

As a part of e-government project, e-taxation in Turkey has been started by Cybersoft as a project namely *Full-Automation of Tax Offices Project* (*VEDOP*), which continued between 1998 and 2009, and Cybersoft calls it as "*the Atatürk Dam*

[216] The number of publicly traded companies: 110 in 1990, 134 in 1991, 145 in 1992, 160 in 1993, 176 in 1994, 205 in 1995, 228 in 1996, 258 in 1997, 277 in 1998, 285 in 1999, 315 in 2000, 310 in 2001.

of Turkish IT Sector"[217]. It has been tried firstly as a pilot project in 1995. Main aims of the automation project are: "*providing equity distribution of tax incidence*", "*providing more productive tax collection*", and "*providing better services for citizens and institution*"[218].

VEDOP I (75 million $ budget) has been started in 1998 in Turkey. The diffusion of automation system in tax offices and revenue office has caused to increase in the number of registered taxpayers via VEDOP. For example, "*155 tax offices and 5 revenue offices in 22 cities have automation system*"[219], "*34 million taxpayers were registered*"[220]. VEDOP II (64 million $ budget) aimed to develop it and started in 2004. "*The automation system has been completed for 185 tax offices and 579 revenue offices in 81 cities*"[221]. VEDOP III (99 million $ budget) has provided greater opportunities since 2007. After the third one, "*448 tax offices and 585 revenue offices have been connected with web based automation system*"[222]. Today, there are totally *1019 tax and revenue offices* which have ICTs system in terms of providing services[223].

As a result of that national-level project, all tax and revenue offices have been connected to each other and new services have been provided such as *e-Decleration*, *Electronical Accounting Register System (EMKAS)*, *e-Signature*. Moreover, they have integrated with other public institutions and banks. Therefore, tax payments have become easier over banking system. In 2009, tax and revenue offices have integrated with other public institutions and banks. Therefore, taxes have been controlled easier, and tax payments services over internet via credit card have been provided, it is called as *e-Collection*[224]. In the same year, Data Warehouse Project (VERİA) and e-Bill have been launched in Turkey. There are also some other services such as Valuation Comission Automation Project (TAKKOM), Tax

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[217] "Full Automation of Tax Offices Project Phase-I (VEDOP-I)", Cybersoft, http://www.cybersoft.com.tr/ENG/?q=content/vedop-1 [20.9.2016].
[218] Devlet Planlama Teşkilatı, **OECD e-Devlet Çalışmaları TÜRKİYE**, 2007, 94.
[219] Cybersoft, **opcit**, http://www.cybersoft.com.tr/ENG/?q=content/vedop-1 [20.9.2016].
[220] **Ibid**, http://www.cybersoft.com.tr/ENG/?q=content/vedop-1 [20.9.2016].
[221] Ersan Öz, Doğan Bozdoğan, "Türk Vergi Sisteminde E-Maliye Uygulamaları", **Süleyman Demirel Üniversitesi İktisadi ve İdari Bilimler Fakültesi Dergisi**, c. 17, s. 2 (2012): 78.
[222] **Ibid**, 79.
[223] "İllerin Otomasyon Durumu", Gelir İdaresi Başkanlığı, http://www.gib.gov.tr/sites/default/files/fileadmin/user_upload/VI/IOD/TABLO_40.xls.htm [21.09.2016].
[224] "Faaliyet Raporu 2009", Türkiye Cumhuriyeti Maliye Bakanlığı Gelir İdaresi Başkanlığı, http://www.gib.gov.tr/fileadmin/faaliyetraporlari/2009/2009_faaliyet_raporu.pdf [28.09.2016], 13.

Communication Center (VİMER), SMS services (KMBS-1189), Debt Notification Services.

All these technological developments in finance have brought some advantages such as to cope with unrecorded economy and tax evasion, to provide rapid operations on internet tax offices for taxpayers, to provide saving, to increase efficiency and productivity, to collect taxes easier. For example, tax revenue has started to increase in the 1990s and then boomed in Turkey (45 million TL in 1990, 26 billion in 2000, 120 billion in 2005, 465 billion in 2015). In the same years, electronic transformation has been launched in finance sector and the Ministry of Finance. It may be said that the process of collection of taxes has been affected by ICT infrastructure.

5. CONCLUSION

In the 19th century, information has transformed into communications machines, and the machines have been developed continuously. In the 20th century, machines (ICT) can be thought as a game changer and we could also call them as General Purpose Technologies. Electronic communication is used in most of the institutions such as a bank, stock exchange, tax offices. Since there is a strong interaction between institutions and ICTs, we must understand properly to analyze their relationships. In this study, I try to analyze this relationship from the perspective of economic institutions and implementations in Turkey. In order to do this, firstly I overviewed historical evaluation of ICTs by focusing main inventions such as steamship, railway, telephone, telegraph, and computer. To do this, the relationship between economic growth and ICT is explained within the specific theoretical framework.

In the 20th century, associated with the considerable discussions on technology in economics, Schumpeterian approach has started to spread. On the one hand, I pointed out two notions: '*innovation*' and '*creative destruction*', on the other hand '*internalization process of technology by institutions*' from the perspective of evolutionary economics. These two notions and internalization process is related to each other. As technology is internalized by institutions, innovation may increase cumulatively. [→ innovation ←→ creative destruction ←→ internalization process of technology by institutions ←]

Schumpeter's innovation includes most of the new things such as products, markets, materials, management structure, work process, networks, and services Moreover, Schumpeter's creative destruction has been understood as shortly 'the n*ew wipes out the old*'. At this point, ICT is a perfect example. Contrary to the neoclassical economy which is accepted that every firm has the same technology, Schumpeter carries out the new role for technology in institutions.

In this new creative destruction atmosphere, technology has developed continuously therefore new ICTs create further ICTs. In other words, new ICT inventions bring new innovations in Schumpeterian term and new innovation affects old one. For example, as a result of improvement of mobile phone, the *application* sector destroys the fixed telephone system. Similarly, new services such as Call center, internet or mobile banking cause to destroy the traditional face-to-face communication.

If institutions cannot upgrade their technology and infrastructure with new innovations, their old structure may not produce innovative goods or services (new innovation) and therefore they may not compete against their rivals as before. When institutions gain momentum with the development of new technologies, internalization process of technology is accelerated by institutions. Therefore, there is two-sided relationship between them. For example, in Turkey, as the number of ATMs and POS has increased, the number of credit and debit cards usage has followed it. At the same time, improvement of debit card means increasing the financial deepening of the country. Additionally, as the number of mobile telephone usage has risen, mobile banking services and its usage have boomed. That means, on the one hand banking sector employs less employees and on the other hand banks are decreasing their costs. These examples provide evidences that people use technology in the various areas of life with related institutions.

Besides, Schumpeter's innovation is seen as a driven power to transform the economy. For example, in Turkey, upgraded ICT infrastructure in BIST provide some advantages such as a variety of products and services, financial deepening, productivity, work process and so on. Moreover, Taxing Authority has received benefits of upgrading from the establishments of ICT infrastructure such as increase in tax collection and decrease in unrecorded taxpayers. Turkish economy has been supported directly or indirectly by internalized technology and new innovations.

The behaviors of institutions play a key role to provide the necessary environment to internalize technology within the framework of economic growth and development. As mentioned by Nelson, successful economic growth and development driven by technological progress requires co-evolution of technologies, firm and industry structure, and economic institutions which must be supported with

government's policies and programs. They should support the internalization process of technology by regulating their own policies and sector. Therefore, internalization of technology by institutions may spread and innovation process may work effectively to achieve economic growth and development.

In this point, I want to give some policy recommendations within the framework of ICT, institutions and economic growth and development. Technology is a costly investment. Thus, incentives should be provided for economic institutions in order to establish/upgrade their ICT infrastructure. These institutions should be supported with lower cost ICT services which can be provided/expanded by cloud computing and by developing network infrastructure. In addition to this, economic institutions and their work processes should be strengthened in every sector by software and applications. Moreover, mobile technologies usage should be encouraged therefore economic institutions can provide their services everywhere.

ICT as an internalized technology brings sustainability and productivity for the institutions. ICT has accelerated the internalization process of technology by economic institutions, and innovation process. Therefore, as a result, economic institutions which internalized technology, and innovations have driven the economic growth and development.

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APPENDIX

Appendix 1. A Chronology of the Developments of Electronic Communication

Year	Event
1800 - 1837	Preliminary developments: The primary battery by Volta; The mathematical treatises by Fourier, Cauchy, Laplace; Experiments on electricity and magnesium by Oersted, Ampere, Faraday, Henry; Ohm's law (1826); Early telegraph systems by Gauss, Weber, Wheatstone.
1838 - 1866	Telegraphy: Morse perfects his system; Steinheil finds that the earth can be used for a current path; commercial service initiated (1844); multiplexing techniques devised; William Thompson (Lord Kelvin) calculates the pulse response of a telegraph line (1855); transatlantic cables installed by Cyrus Field and associates.
1845	Kirchhoff's circuit laws enunciated.
1864	Maxwell's equations predict electromagnetic radiation.
1876 - 1899	Telephony: Acoustic transducer perfected by Alexander Graham Bell, after earlier attempts by Reis; first telephone exchange, in New Haven, with eight lines (1878); Edison's carbon-button transducer; cable circuits introduced; Automatic step-by-step switching (1887) by Strowger; the theory of cable loading by Heaviside, Pupin, Campbell.
1887 - 1907	Wireless telegraphy: Heinrich Hertz verifies Maxwell's theory; demonstrations by Marconi and Popov; Marconi patents a complete wireless telegraph system (1897); the theory of tuning circuits developed by Sir Oliver Lodge; commercial service begins, including ship-to-shore and transatlantic systems.

Appendix 1 - continue

1892 - 1899	Oliver Heaviside's publications on operational calculus, circuits, and electromagnetics.
1904 - 1920	Communication electronics: The audion (triode) based on Fleming's diode by Lee De Forest; basic filter types by G. A. Campbell and others; Experiments with AM radio broadcasting; transcontinental telephone-line with electronic repeaters completed by the Bell System (1915); The superheterodyne radio receiver (1918 by E. H. Armstrong; First commercial boradcasting station, KDKA, Pittsburgh.
1920 - 1928	Transmission theory: Landmark papers on the theory of signal transmission and noise by J. R. Carson, H. Nyquist, J. B. Johnson, R. V. L. Hartley.
1923 - 1938	Television: Mechanical image-formation system by Baird, Jenkins; Theoretical analysis of bandwidth requirements; Farnsworth and Zworykin propose electronic system; Vacuum cathode-ray tubes by DuMont and others; field tests and experimental broadcasting begin.
1927	Federal Communications Commission established.
1931	Teletypewriter service initiated.
1934	H. S. Black develops the negative-feedback amplifier.
1936	Armstrong's paper states the case for FM radio.
1937	Alec Reeves conceives pulse code modulation.
1938 - 1945	World War II: Radar and microwave systems developed; FM used extensively for military communications; improved electronics, hardware, and theory in all areas.
1944 - 1947	Statistical communication theory: Mathematical representation of noise by Rice; statistical metods to signal detection applied by Weiner, Kolmogoroff, Kotel'nikov.

Appendix 1 - continue

1948 - 1950	Information theory and coding: The founding papers of information theory by C. E. Shannon; Error-correcting codes by Hamming & Golay.
1948 - 1951	Transistor by Bardeen, Brattain, Shockley.
1950	Time-division multiplexing applied to telephony.
1953	Color TV standards established in the US.
1955	J. R. Pierce proposes satellite communication systems.
1956	First trans-oceanic telephone cable (36 voice channels).
1958	Long-distance data transmission system developed for military purposes.
1960	The first laser demonstrated by Maiman.
1961	Integrated circuits go into commercial production.
1962	Satellite communication begins with Telstar I.
1962 - 1966	High-speed digital communication: Data transmission service offered commercially; wideband channels designed for digital signaling; pulse code modulation proves feasible for voice and TV transmission; Major breakthroughs in the theory of implementation of digital transmission, including error-control coding methods by Viterbi and others; The development of adaptive equalization by Lucky and coworkers.
1963	Solid-state microwave oscillators perfected by Gunn.
1964	Fully electronic telephone switching system (No. 1 ESS) goes into service.
1965	Mariner IV transmits pictures from Mars to earth.

Appendix 1 - continue

1966 - 1975	Wideband communication systems: Cable TV systems; Commercial satellite relay services becomes available; Optical links using lasers and fiber optics; ARPANET created (1969) followed by other intercontinental computer networks. Digitization of transmission networks starts.
1968 - 1969	Digitization of telephone network begins.
1970 - 1975	Standards of PCM by CCITT are developed.
1976	Ethernet LAN invented by Metcalfe and Broggs.
1975 - 1985	High-capacity optical systems developed; The breakthrough of optical technology and fully integrated switching systems; Digital signal processing by microprocessors.
1980 - 1983	The start of global Internet based on TCP/IP protocol.
1980 - 1985	Modern cellular mobile networks are put into service, NMT in Northern Europe, AMPS in the United States, OSI reference model is defined by International Standards of Organization (ISO). Standardization for second-generation digital cellular systems is initialized.
1985 - 1990	Local area network (LAN) breakthrough; Integrated Services Digital Network (ISDN) standardization finalized; Public data communication services become widely available; Optical transmission systems replace copper systems in long-distance wideband transmission; SONET is developed; GSM and SDH standardization finalized.
1989	Initial proposal for a web-linked document (WWW) by Tim Berners-Lee.

Appendix 1 - continue

1990 - 1997	The first digital cellular system GSM is put into commercial use and its breakthrough is felt worldwide; deregulation of telecommunications in Europe proceeds and satellite-TV systems become popular; Internet usage and services expand rapidly because of the WWW.
1997 - 2001	Telecommunications community is deregulated and business grows rapidly; digital cellular networks, especially GSM, expand worldwide; Commercial applications of Internet expand and a share of conventional speech communications is transferred from PSTN to Internet; Performance of LANs improves with Gbps Ethernet technologies.
2001 - 2005	Digital TV starts to replace analog broadcast TV; Broadband access system make Internet multimedia services available to everybody; Telephony service turns to personal communication service as penetration of cellular systems increases; Second-generation cellular systems are upgraded to provide higher rate packet-switched data service.
2005 - 2010	Internet Protocol TV (IPTV) and high-definition TV becomes general; Third-generation cellular systems and wireless LAN (WLAN) technologies provide enhanced data services for mobile users; Location-based and other based mobile application expand; Cloud computing and social media spreads in the Internet; Global telecommunications network evolves towards common packet-switched network platform for all types of services.
2010 - 2014	Convergence of TV and Internet continues with smart TVs; Sales of tablet computers grow rapidly; more and more devices are connected to the Internet, and machine-to-machine (M2M) communication becomes an important business for telecommunications operators; Fourth generation mobile networks further enhance data rates and mobile broadband starts to compete with fixed broadband.

Appendix 1 - continue

2014 -	Ultra-high-definition displays applications enter into the market; mobile and other wireless networks start to support gigabit data rates; contactless and mobile payment technology becomes a commodity.

Source: A. Bruce Carlson, **Communication Systems: An Introduction to Signals and Noise in Electrical Communication**, Third Edition (McGraw-Hill Series in Electrical & Electronic Engineering, 1986), 11-12. Tarmo Anttalainen, Ville Jaaskelainen, **Introduction to Communication Networks**, (Artech House, 2015), 4-6.

Appendix 2. The Number of Banks, Branches and Personnel in Turkey

	1986	**1987**	**1988**	**1989**	**1990**	**1991**
Bank	56	57	61	63	67	66
Branch			6.552	6.617	6.584	6.477
Personnel	151.200	156.924	159.088	161.018	162.054	160.819
	1992	**1993**	**1994**	**1995**	**1996**	**1997**
Bank	70	71	68	68	69	72
Branch	6.206	6.228	6.104	6.240	6.442	6.819
Personnel	154.519	151.445	146.248	144.793	148.153	154.864
	1998	**1999**	**2000**	**2001**	**2002**	**2003**
Bank	75	81	79	61	54	50
Branch	7.370	7.691	7.837	6.908	6.106	5.966
Personnel	166.492	173.988	170.401	137.495	123.271	123.249
	2004	**2005**	**2006**	**2007**	**2008**	**2009**
Bank	48	47	46	46	45	45
Branch	6.106	6.247	6.849	7.618	8.790	9.581
Personnel	127.163	132.258	143.143	158.534	171.598	184.216
	2010	**2011**	**2012**	**2013**	**2014**	**2015**
Bank	45	44	49	49	51	52
Branch	10.066	10.518	11.066	11.986	12.210	12.269
Personnel	191.180	195.292	201.474	214.263	216.880	217.504

Source: The Banks Association of Turkey. BRSA.

Appendix 3. Total Number of Call Center Personnel, Inbound and Outbound Calls of Banks in Turkey

	Total Number of Call Center Personnel		Total Number of Inbound Call		Total Number of Outbound Call
2008-1	5,073	**2008-1**	57,519,482	**2008-1**	2,857,493
2008-2	5,481	**2008-2**	68,261,460	**2008-2**	3,239,059
2008-3	5,529	**2008-3**	61,752,609	**2008-3**	4,184,423
2008-4	5,506	**2008-4**	57,851,501	**2008-4**	3,565,017
2009-1	5,445	**2009-1**	61,931,541	**2009-1**	4,124,528
2009-2	5,464	**2009-2**	59,263,034	**2009-2**	5,695,432
2009-3	5,794	**2009-3**	60,149,761	**2009-3**	6,493,054
2009-4	5,745	**2009-4**	60,569,700	**2009-4**	6,747,432
2010-1	6,179	**2010-1**	66,908,009	**2010-1**	6,456,629
2010-2	6,229	**2010-2**	68,944,494	**2010-2**	5,355,801
2010-3	6,300	**2010-3**	68,497,684	**2010-3**	6,124,052
2010-4	6,508	**2010-4**	68,725,501	**2010-4**	6,692,093
2011-1	6,944	**2011-1**	68,221,452	**2011-1**	6,372,622
2011-2	6,895	**2011-2**	66,600,914	**2011-2**	5,633,583
2011-3	6,791	**2011-3**	68,149,212	**2011-3**	6,425,017
2011-4	6,775	**2011-4**	71,145,540	**2011-4**	6,369,687
2012-1	6,978	**2012-1**	75,277,498	**2012-1**	7,348,215
2012-2	7,131	**2012-2**	71,768,392	**2012-2**	7,375,812
2012-3	7,426	**2012-3**	75,630,326	**2012-3**	7,033,967
2012-4	7,520	**2012-4**	81,897,150	**2012-4**	12,054,164
2013-1	7,770	**2013-1**	86,370,464	**2013-1**	12,281,297
2013-2	8,007	**2013-2**	84,283,514	**2013-2**	13,349,749
2013-3	8,087	**2013-3**	87,602,420	**2013-3**	12,050,107
2013-4	8,007	**2013-4**	87,075,543	**2013-4**	10,287,514
2014-1	7,938	**2014-1**	91,632,452	**2014-1**	13,524,937
2014-2	7,714	**2014-2**	93,017,864	**2014-2**	11,830,471
2014-3	7,632	**2014-3**	96,851,816	**2014-3**	13,714,938
2014-4	7,961	**2014-4**	100,337,698	**2014-4**	16,926,768
2015-1	8,353	**2015-1**	101,752,865	**2015-1**	23,862,226
2015-2	8,297	**2015-2**	101,578,880	**2015-2**	24,128,244
2015-3	8,116	**2015-3**	106,923,496	**2015-3**	23,457,470
2015-4	8,398	**2015-4**	117,217,448	**2015-4**	24,959,873
2016-1	8,957	**2016-1**	115,224,814	**2016-1**	24,875,881
2016-2	8,991	**2016-2**	112,050,287	**2016-2**	25,614,111

Source: The Banks Association of Turkey.

Appendix 4. The Number of Personal Clients on Internet Banking in Turkey

Quarter	Personal-registered and login at least one time	Personal-registered and login at least one time in the recent year	Personal-Active
2006-4	16,603,617	-	2,976,292
2007-1	17,385,363	-	3,059,573
2007-2	18,066,542	-	3,156,279
2007-3	8,558,033	5,426,713	3,551,347
2007-4	8,908,956	4,920,907	3,795,627
2008-1	10,001,531	5,224,044	4,082,990
2008-2	10,494,772	5,436,926	4,262,930
2008-3	10,951,231	5,742,251	4,443,703
2008-4	11,222,126	5,946,652	4,613,670
2009-1	11,792,975	6,343,912	4,838,001
2009-2	12,540,061	6,676,472	5,001,219
2009-3	11,746,113	6,810,632	5,153,036
2009-4	11,959,640	7,012,289	5,343,098
2010-1	13,406,862	7,059,101	5,399,441
2010-2	13,621,487	7,248,242	5,524,461
2010-3	14,827,760	7,725,302	5,715,626
2010-4	15,608,554	7,974,788	6,038,342
2011-1	16,252,954	8,497,721	6,504,651
2011-2	16,696,199	8,764,170	6,720,661
2011-3	17,241,675	9,322,922	7,065,324
2011-4	18,105,703	10,389,383	7,802,990
2012-1	19,322,391	11,304,237	8,484,760
2012-2	20,508,749	11,828,470	8,604,566
2012-3	21,653,109	13,034,921	8,975,124
2012-4	22,610,971	13,883,544	9,629,597
2013-1	24,012,286	14,654,179	10,246,147
2013-2	25,313,204	15,706,945	10,468,199
2013-3	26,588,267	15,546,148	10,974,765
2013-4	28,190,102	16,824,193	11,422,331
2014-1	28,590,448	17,462,027	12,038,621
2014-2	29,669,291	17,806,595	12,134,311
2014-3	32,303,465	18,579,576	12,588,096
2014-4	34,047,501	19,614,641	13,181,279
2015-1	37,651,356	20,802,140	14,228,690
2015-2	40,319,927	21,976,588	14,466,370
2015-3	40,563,617	22,867,424	14,999,137

Appendix 4 - continue

Quarter	Personal-registered and login at least one time	Personal-registered and login at least one time in the recent year	Personal-Active
2015-4	42,916,743	23,899,879	16,169,883
2016-1	45,700,736	24,904,626	17,230,715
2016-2	50,063,824	26,112,844	17,019,055

Source: The Banks Association of Turkey.

Appendix 5. The Number of Corporate Clients on Internet Banking in Turkey

Quarter	Corporate-registered and login at least one time	Corporate-registered and login at least one time in the recent year	Corporate-Active
2006-4	828,053	-	391,565
2007-1	852,838	-	404,350
2007-2	926,945	-	421,734
2007-3	1,097,752	661,803	466,934
2007-4	1,131,302	588,211	478,737
2008-1	1,217,418	610,445	503,964
2008-2	1,274,368	654,069	534,007
2008-3	1,323,155	668,840	539,587
2008-4	1,358,545	687,737	555,459
2009-1	1,458,623	709,764	580,766
2009-2	1,508,642	719,878	591,336
2009-3	1,440,403	702,414	600,240
2009-4	1,402,286	684,906	605,623
2010-1	1,536,358	708,597	606,741
2010-2	1,459,006	729,266	624,371
2010-3	1,571,923	786,972	637,145
2010-4	1,614,365	813,721	655,490
2011-1	1,696,649	860,142	722,811
2011-2	1,767,095	887,371	751,120
2011-3	1,786,253	914,775	763,010
2011-4	1,892,315	968,458	803,155
2012-1	1,965,621	1,008,506	844,170
2012-2	2,048,629	1,049,752	863,263
2012-3	2,099,931	1,081,022	886,324
2012-4	2,192,771	1,131,488	922,167
2013-1	2,099,605	1,150,428	953,167
2013-2	2,189,484	1,197,426	979,619
2013-3	2,267,899	1,227,162	991,004
2013-4	2,234,533	1,217,169	1,013,621
2014-1	2,086,280	1,272,463	1,066,062
2014-2	2,152,471	1,310,916	1,089,624
2014-3	2,225,345	1,340,987	1,094,948
2014-4	2,323,690	1,399,384	1,133,777
2015-1	2,493,392	1,426,728	1,178,005
2015-2	2,728,836	1,495,298	1,191,329
2015-3	2,810,017	1,523,252	1,211,355

Appendix 5 - continue

Quarter	Corporate-registered and login at least one time	Corporate-registered and login at least one time in the recent year	Corporate-Active
2015-4	2,765,860	1,547,822	1,250,568
2016-1	2,856,102	1,593,579	1,280,420
2016-2	2,799,523	1,625,442	1,281,653

Source: The Banks Association of Turkey.

Appendix 6. Total Number of Internet Banking Clients in Turkey

Quarter	Total-registered and login at least one time	Total-registered and login at least one time in the recent year	Total-Active
2006-4	17,431,670	-	3,367,857
2007-1	18,238,201	-	3,463,923
2007-2	18,993,487	-	3,578,013
2007-3	9,655,785	6,088,516	4,018,281
2007-4	10,040,258	5,509,118	4,274,364
2008-1	11,218,949	5,834,489	4,586,954
2008-2	11,769,140	6,090,995	4,796,937
2008-3	12,274,386	6,411,091	4,983,290
2008-4	12,580,671	6,634,389	5,169,129
2009-1	13,251,598	7,053,676	5,418,767
2009-2	14,048,703	7,396,350	5,592,555
2009-3	13,186,516	7,513,046	5,753,276
2009-4	13,361,926	7,697,195	5,948,721
2010-1	14,943,220	7,767,698	6,006,182
2010-2	15,080,493	7,977,508	6,148,832
2010-3	16,399,683	8,512,274	6,352,771
2010-4	17,222,919	8,788,509	6,693,832
2011-1	17,949,603	9,357,863	7,227,462
2011-2	18,463,294	9,651,541	7,471,781
2011-3	19,027,928	10,237,697	7,828,334
2011-4	19,998,018	11,357,841	8,606,145
2012-1	21,288,012	12,312,743	9,328,930
2012-2	22,557,378	12,878,222	9,467,829
2012-3	23,753,040	14,115,943	9,861,448
2012-4	24,803,742	15,015,032	10,551,764
2013-1	26,111,891	15,804,607	11,199,314
2013-2	27,502,688	16,904,371	11,447,818
2013-3	28,856,166	16,773,310	11,965,769
2013-4	30,424,635	18,041,362	12,435,952
2014-1	30,676,728	18,734,490	13,104,683
2014-2	31,821,762	19,117,511	13,223,935
2014-3	34,528,810	19,920,563	13,683,044
2014-4	36,371,191	21,014,025	14,315,056
2015-1	40,144,748	22,228,868	15,406,695
2015-2	43,048,763	23,471,886	15,657,699
2015-3	43,373,634	24,390,676	16,210,492

Appendix 6 - continue

Quarter	Total-registered and login at least one time	Total-registered and login at least one time in the recent year	Total-Active
2015-4	45,682,603	25,447,701	17,420,451
2016-1	48,556,838	26,498,205	18,511,135
2016-2	52,863,347	27,738,286	18,300,708

Source: The Banks Association of Turkey.

Appendix 7. The distribution of Active Personal and Corporate Clients on Internet Banking by Regions and Cities in Turkey, 30.06.2016

Rank	Regions and Cities	The Number of Active Personal Clients	Rank	Regions and Cities	The Number of Active Corporate Clients
1	İstanbul	5,256,633	1	İstanbul	443,877
2	Ankara	1,696,217	2	Ankara	130,258
3	İzmir	1,096,180	3	İzmir	91,215
4	Bursa	621,170	4	Bursa	53,007
5	Antalya	584,764	5	Antalya	49,799
6	Kocaeli (İzmit)	457,028	6	Kocaeli (İzmit)	33,489
7	Adana	371,056	7	Adana	29,953
8	Konya	362,471	8	Konya	27,673
9	İçel (Mersin)	288,337	9	İçel (Mersin)	24,313
10	Gaziantep	261,360	10	Gaziantep	23,134
11	Muğla	255,800	11	Muğla	19,165
12	Eskişehir	231,772	12	Denizli	18,728
13	Balıkesir	219,125	13	Kayseri	17,986
14	Denizli	217,148	14	Hatay (Antakya)	15,160
15	Manisa	217,124	15	Samsun	14,576
16	Hatay (Antakya)	215,639	16	Sakarya	13,644
17	Samsun	205,387	17	Eskişehir	13,413
18	Kayseri	204,699	18	Balıkesir	13,063
19	Tekirdağ	202,460	19	Aydın	13,056
20	Aydın	187,157	20	Tekirdağ	13,051
21	Sakarya	184,693	21	Manisa	12,937
22	Diyarbakır	157,020	22	Diyarbakır	10,098
23	Bolu	133,939	23	Trabzon	8,774
24	Şanlıurfa	133,917	24	Şanlıurfa	8,323
25	Trabzon	127,674	25	Kahramanmaraş	7,758
26	Zonguldak	114,536	26	Zonguldak	7,058
27	Malatya	107,423	27	Afyonkarahisar	6,841
28	Kahramanmaraş	105,240	28	Çanakkale	6,541
29	Erzurum	104,637	29	Malatya	5,881
30	Çanakkale	102,983	30	Ordu	5,827
31	Kütahya	101,941	31	Kütahya	5,785
32	Afyonkarahisar	96,595	32	Çorum	5,536
33	Sivas	92,271	33	Kastamonu	4,934
34	Isparta	88,265	34	Düzce	4,853

Appendix 7 - continue

Rank	Regions and Cities	The Number of Active Personal Clients		Rank	Regions and Cities	The Number of Active Corporate Clients
35	Kastamonu	85,764		35	Elazığ	4,679
36	Çorum	84,627		36	Tokat	4,657
37	Ordu	78,571		37	Kilis	4,575
38	Tokat	76,827		38	Mardin	4,553
39	Edirne	76,517		39	Isparta	4,535
40	Van	66,973		40	Sivas	4,370
41	Kilis	66,675		41	Erzurum	4,350
42	Elazığ	66,261		42	Bolu	4,330
43	Düzce	66,260		43	Edirne	3,987
44	Mardin	65,838		44	Uşak	3,820
45	Burdur	65,602		45	Rize	3,653
46	Rize	60,520		46	Osmaniye	3,544
47	Aksaray	59,065		47	Aksaray	3,527
48	Şırnak	58,809		48	Giresun	3,483
49	Kırklareli	56,744		49	Nevşehir	3,415
50	Giresun	55,942		50	Burdur	3,391
51	Amasya	54,493		51	Batman	3,241
52	Batman	54,155		52	Kırklareli	3,236
53	Adıyaman	53,081		53	Van	3,118
54	Ağrı	51,315		54	Karabük	3,059
55	Uşak	51,301		55	Amasya	2,864
56	Karabük	48,949		56	Yalova	2,836
57	Osmaniye	48,856		57	Yozgat	2,814
58	Yozgat	47,433		58	Niğde	2,681
59	Kırıkkale	46,279		59	Şırnak	2,543
60	Nevşehir	46,269		60	Adıyaman	2,257
61	Niğde	44,042		61	Karaman	2,093
62	Yalova	41,626		62	Kırıkkale	1,901
63	Bilecik	38,168		63	Bilecik	1,842
64	Karaman	37,610		64	Bartın	1,769
65	Bartın	33,724		65	Artvin	1,733
66	Erzincan	32,243		66	Sinop	1,573
67	Kars	31,768		67	Erzincan	1,552
68	Artvin	31,354		68	Çankırı	1,492
69	Hakkari	30,851		69	Kırşehir	1,451
70	Bitlis	30,693		70	Ağrı	1,395
71	Siirt	30,438		71	Siirt	1,297

Appendix 7 - continue

Rank	Regions and Cities	The Number of Active Personal Clients	Rank	Regions and Cities	The Number of Active Corporate Clients
72	Muş	30,169	72	Bitlis	1,237
73	Kırşehir	29,925	73	Muş	1,077
74	Sinop	27,828	74	Kars	1,009
75	Bingöl	26,872	75	Bingöl	897
76	Çankırı	19,570	76	Iğdır	780
77	Tunceli	19,102	77	Tunceli	620
78	Gümüşhane	16,381	78	Gümüşhane	614
79	Iğdır	16,173	79	Hakkari	348
80	Ardahan	12,600	80	Ardahan	327
81	Bayburt	11,320	81	Bayburt	300
	Kıbrıs	30,513		Kıbrıs	3,091
	Foreign Countries	295		Foreign Countries	28
	Total	**17,019,055**		**Total**	**1,281,653**

Source: The Banks Association of Turkey.

Appendix 8. Total Number of Non-Financial and Financial Operations on Internet Banking, (Thousand)

Quarter	Non-FO	Financial Operations				
		Money Transfer	Payments	Investment	Credit Card	Other Financial
2006-4	293,441	24,300	10,232	8,832	4,058	1,231
2007-1	171,879	26,615	11,709	9,671	5,052	1,640
2007-2	165,542	27,376	12,443	10,101	5,537	1,784
2007-3	155,445	28,609	13,754	8,024	4,994	1,087
2007-4	150,371	29,335	15,393	7,615	5,352	1,131
2008-1	195,288	29,854	17,465	8,248	5,848	1,426
2008-2	188,051	29,406	16,236	7,861	5,634	1,615
2008-3	198,170	31,114	18,828	8,900	6,143	1,619
2008-4	230,428	29,718	20,578	9,248	6,050	1,596
2009-1	262,620	31,313	23,263	8,887	6,264	1,811
2009-2	245,623	34,632	23,952	11,145	6,411	1,937
2009-3	247,453	34,707	25,308	10,394	6,574	1,882
2009-4	252,319	37,309	24,581	11,287	7,048	1,968
2010-1	239,516	35,421	24,986	11,863	6,949	1,635
2010-2	251,162	37,383	20,295	11,235	7,457	1,836
2010-3	256,506	36,889	21,981	9,227	7,690	1,714
2010-4	254,864	39,868	26,186	9,551	8,203	1,745
2011-1	336,134	39,877	28,588	11,031	8,160	1,823
2011-2	357,054	41,811	27,810	11,398	8,184	1,951
2011-3	460,976	42,150	29,079	12,374	8,680	1,961
2011-4	537,224	46,424	33,258	11,432	9,057	1,709
2012-1	592,596	48,238	34,305	11,544	9,505	2,201
2012-2	588,640	51,095	33,448	11,666	9,987	2,695
2012-3	612,460	49,329	34,129	9,127	9,668	2,277
2012-4	647,442	54,914	36,708	10,216	10,374	2,291
2013-1	734,081	54,836	38,204	10,076	10,741	3,134
2013-2	793,991	58,684	37,769	11,013	11,084	2,721
2013-3	800,729	57,710	40,250	10,409	11,082	2,605
2013-4	802,662	61,025	41,695	10,269	11,405	2,610
2014-1	825,730	60,805	44,171	10,895	11,357	2,641
2014-2	842,107	62,995	42,836	10,271	11,307	2,511
2014-3	848,029	61,450	42,800	9,697	11,056	2,772
2014-4	771,780	63,281	48,748	10,759	11,711	2,890
2015-1	854,937	62,253	51,622	11,670	11,678	3,173
2015-2	763,732	63,860	50,263	11,305	11,862	3,471
2015-3	728,369	61,530	45,167	9,964	11,688	3,301

Appendix 8 - continue

Quarter	Non-FO	Financial Operations				
		Money Transfer	Payments	Investment	Credit Card	Other Financial
2015-4	784,267	68,534	45,612	10,812	12,176	4,124
2016-1	797,531	68,275	48,699	10,743	12,303	3,801
2016-2	822,529	73,011	45,304	10,879	11,965	3,766

Source: The Banks Association of Turkey.

Appendix 9. Total Volume of Financial Operations on Internet Banking, (Million TL)

Quarter	Financial Operations				
	Money Transfer	**Payments**	**Investment**	**Credit Card**	**Other Financial**
2006-4	90,935	1,921	36,004	4,819	7,559
2007-1	101,559	1,913	38,128	2,807	9,423
2007-2	113,260	1,976	40,516	3,396	12,453
2007-3	116,958	2,911	44,378	3,301	8,345
2007-4	112,693	3,400	40,344	3,486	7,851
2008-1	114,044	3,967	47,624	3,877	16,566
2008-2	118,679	4,137	49,449	3,847	17,121
2008-3	127,408	4,720	51,806	4,421	14,406
2008-4	115,218	4,626	64,660	4,165	12,671
2009-1	120,719	4,772	62,855	4,199	11,098
2009-2	129,948	4,933	68,121	4,451	12,416
2009-3	133,913	5,367	64,855	4,742	13,071
2009-4	145,164	5,901	67,441	4,859	15,050
2010-1	138,850	6,610	70,552	4,877	12,553
2010-2	152,928	6,838	73,185	5,427	15,353
2010-3	163,582	7,525	64,273	5,806	12,979
2010-4	181,110	8,535	73,504	6,199	19,401
2011-1	230,080	11,494	92,572	6,373	21,228
2011-2	241,664	11,669	87,474	6,630	23,468
2011-3	260,551	13,733	98,151	7,611	26,490
2011-4	277,861	14,203	89,922	7,978	21,908
2012-1	275,048	13,641	84,305	8,293	24,042
2012-2	297,076	14,284	86,488	9,383	29,602
2012-3	310,125	18,265	75,986	9,471	31,050
2012-4	332,320	19,970	89,311	10,095	30,886
2013-1	319,925	19,509	87,393	10,515	28,415
2013-2	367,380	22,547	101,605	11,419	30,209
2013-3	393,903	24,793	104,186	12,476	39,077
2013-4	410,797	25,531	101,730	12,797	28,714
2014-1	409,055	25,463	120,499	13,192	29,275
2014-2	439,562	26,002	109,059	14,346	31,655
2014-3	467,637	26,889	112,318	14,950	30,635
2014-4	488,705	30,390	127,800	16,393	27,374
2015-1	468,889	31,959	147,816	16,575	28,810
2015-2	516,836	33,092	155,299	17,792	30,610
2015-3	541,350	35,352	145,089	17,691	30,851

Appendix 9 - continue

Quarter	Financial Operations				
	Money Transfer	**Payments**	**Investment**	**Credit Card**	**Other Financial**
2015-4	600,081	37,421	155,279	17,634	35,961
2016-1	571,449	38,110	156,415	17,778	32,614
2016-2	675,769	39,107	156,304	18,167	41,426

Source: The Banks Association of Turkey.

Appendix 10. The Number of Personal Clients on Mobile Banking in Turkey

Quarter	Personal-registered and login at least one time	Personal-registered and login at least one time in the recent year	Personal-Active
2011-1	-	-	-
2011-2	-	-	-
2011-3	-	-	-
2011-4	-	-	-
2012-1	-	-	-
2012-2	-	-	-
2012-3	-	-	-
2012-4	-	-	-
2013-1	-	-	-
2013-2	-	-	-
2013-3	-	-	-
2013-4	-	-	-
2014-1	-	-	-
2014-2	-	-	-
2014-3	-	-	-
2014-4	-	-	-
2015-1	12,443,529	10,252,200	7,928,280
2015-2	14,203,372	11,565,383	8,831,163
2015-3	16,078,726	13,104,657	10,078,480
2015-4	18,383,240	15,001,699	11,778,445
2016-1	20,951,555	16,974,164	13,523,055
2016-2	23,932,804	19,271,079	14,721,615

Source: The Banks Association of Turkey.

Appendix 11. The Number of Corporate Clients on Mobile Banking in Turkey

Quarter	Corporate-registered and login at least one time	Corporate-registered and login at least one time in the recent year	Corporate-Active
2011-1	-	-	-
2011-2	-	-	-
2011-3	-	-	-
2011-4	-	-	-
2012-1	-	-	-
2012-2	-	-	-
2012-3	-	-	-
2012-4	-	-	-
2013-1	-	-	-
2013-2	-	-	-
2013-3	-	-	-
2013-4	-	-	-
2014-1	-	-	-
2014-2	-	-	-
2014-3	-	-	-
2014-4	-	-	-
2015-1	388,025	338,171	255,967
2015-2	464,610	404,307	294,854
2015-3	549,833	471,586	356,046
2015-4	628,780	529,650	385,923
2016-1	712,525	590,297	438,386
2016-2	821,816	658,062	483,869

Source: The Banks Association of Turkey.

Appendix 12. The Number of Total Clients on Mobile Banking in Turkey

Quarter	Total-registered and login at least one time	Total-registered and login at least one time in the recent year	Total-Active
2011-1	912,788	398,275	230,353
2011-2	992,017	430,563	247,910
2011-3	1,091,079	500,875	320,669
2011-4	1,274,296	642,649	445,723
2012-1	1,444,835	778,603	554,982
2012-2	1,717,298	998,857	693,262
2012-3	2,003,909	1,260,177	889,292
2012-4	2,466,798	1,835,728	1,375,634
2013-1	2,930,437	2,134,541	1,582,503
2013-2	3,594,972	2,685,511	2,018,650
2013-3	4,354,272	3,321,456	2,574,847
2013-4	5,371,567	4,321,194	3,227,096
2014-1	6,339,842	5,168,719	4,006,363
2014-2	7,513,963	6,093,607	4,851,233
2014-3	8,852,586	7,115,281	5,643,390
2014-4	10,752,733	8,743,309	6,711,360
2015-1	12,831,554	10,590,371	8,184,247
2015-2	14,667,982	11,969,690	9,126,017
2015-3	16,628,559	13,576,243	10,434,526
2015-4	19,012,020	15,531,349	12,164,368
2016-1	21,664,080	17,564,461	13,961,441
2016-2	24,754,620	19,929,141	15,205,484

Source: The Banks Association of Turkey.

Appendix 13. The Number of Non-Financial and Financial Operations on Mobile Banking in Turkey, (Thousand)

Quarter	Non-FO	Financial Operations				
		Money Transfer	Payments	Investment	Credit Card	Other Financial
2011-1	772	676	200	138	133	38
2011-2	1,682	845	224	143	166	39
2011-3	2,023	959	242	177	214	51
2011-4	14,002	1,360	526	376	295	55
2012-1	16,826	1,517	623	433	372	61
2012-2	22,568	1,889	749	501	509	68
2012-3	32,125	2,463	1,319	510	713	82
2012-4	45,704	3,503	2,783	796	1,126	112
2013-1	73,880	4,211	2,327	766	1,346	173
2013-2	105,886	5,454	3,037	1,075	1,751	268
2013-3	140,028	6,470	4,280	1,299	2,266	366
2013-4	174,427	7,842	6,092	1,546	2,822	465
2014-1	254,392	9,394	6,860	1,755	3,553	1,040
2014-2	340,225	11,646	8,405	2,023	4,485	1,249
2014-3	402,929	14,274	10,463	2,256	5,228	1,533
2014-4	467,976	17,528	15,361	2,687	6,565	1,335
2015-1	674,285	21,657	18,978	3,373	8,009	1,351
2015-2	728,488	26,141	20,670	4,217	9,361	1,737
2015-3	817,635	29,686	24,077	4,518	10,704	2,210
2015-4	1,110,324	37,162	30,258	5,124	12,354	2,564
2016-1	1,164,725	42,364	36,084	5,703	14,164	3,519
2016-2	1,309,154	51,138	38,839	6,915	16,299	5,153

Source: The Banks Association of Turkey.

Appendix 14. The Volume of Financial Operations on Mobile Banking in Turkey, (Million TL)

Quarter	Financial Operations				
	Money Transfer	**Payments**	**Investment**	**Credit Card**	**Other Financial**
2011-1	1,044	11	735	70	65
2011-2	1,343	13	841	91	69
2011-3	1,557	14	1,034	126	110
2011-4	2,232	27	1,494	175	150
2012-1	2,538	35	1,838	225	121
2012-2	3,313	50	2,442	328	129
2012-3	4,571	90	2,201	488	202
2012-4	6,464	217	3,501	763	670
2013-1	7,588	231	4,353	903	445
2013-2	10,498	243	6,927	1,248	377
2013-3	13,202	367	9,922	1,688	656
2013-4	15,985	605	9,430	2,057	1,230
2014-1	19,843	859	13,588	2,724	1,465
2014-2	25,549	1,050	14,552	3,476	1,724
2014-3	33,773	1,379	17,458	4,199	1,959
2014-4	42,851	1,933	21,963	5,186	2,671
2015-1	58,170	2,629	31,778	6,460	3,528
2015-2	70,182	2,905	41,728	7,784	4,785
2015-3	84,638	3,483	48,177	9,247	5,535
2015-4	104,032	4,133	48,855	10,351	6,422
2016-1	111,961	5,548	53,786	11,878	7,156
2016-2	142,556	5,817	62,454	14,087	9,558

Source: The Banks Association of Turkey.

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- Yıldız Technical University, Graduate School of Social Sciences, Economics (English), 2013 - 2016 (3,20/4)
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- Anadolu University, Open Education Faculty, Management Information System, 2016 - …
- Anadolu University, Faculty of Economics, Economics, 2009 - 2013 (2,90/4)
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Curriculum Vitae – continue

Publications : *PAPER*

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Work Experience :

- Project Manager, 88 Keys Institute, 12.2015 - 10.2016. (Turk Telecom Market Research Project).
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