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Macroeconomic Effects of Information and Communication Technologies in Turkey and Other OECD Member Countries

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Abstract

This paper investigates the effects of ICT on economic growth in Turkey and other OECD member countries. After discussing the theoretical relationships between ICT usage and economic growth, we test the positive impact of ICT revolution on economic growth econometrically. In the empirical part of the study, we perform panel data analyses by employing data sets that belong to 30 OECD member countries for 1999-2008 period as well as carrying out time series analyses for only Turkey by using data between 1980 and 2009. We find out that ICT usage and production have a positive significant effect on economic growth in OECD case. However, due to some methodological difficulties and insufficiency of critical mass regarding ICT area and complementary physical and social infrastructures in Turkey, we cannot find any significant relationship between ICT and economic growth for Turkish case.

Keywords: ICT, economic growth, Turkey, OECD

1. Introduction

With the great improvements within itself during recent decades, information and communication technologies (ICT) came to the fore as one of the most vigorous areas in terms of technological progress. As a result of high R&D and innovation potential of the sector and booming demand to its products, ICT sector has emerged as a major and rapidly growing one in modern economies. Over and above, ICT is accepted as a general purpose technology. General purpose technologies, like steam engine and electricity in the past, are used by most of the other sectors for different purposes and trigger technical improvements and innovational activities in economy wide level (Bresnahan and Trajtenberg, 1995). In fact, ICT diffuses to the all segments of the economy and the society and, thus, leads to usage of knowledge and other physical and human capital more efficiently which eventually creates productivity gains. As a result of ICT diffusion, new jobs, professions and fields of business activity emerge, some of the old ones disappear, structure of labor market, characteristics of jobs and organizational forms change. Furthermore, important alterations in public administration as well as social and daily lives of individuals occur.

The term ICT revolution is used to express this widespread ICT diffusion and concomitant radical and influential changes in different aspects of social and economic lives. Analyzing the repercussions of this revolution provides a suitable workspace for those who basically want to investigate the relationship between technological progress and economic growth. In this manner, the current study examines the macroeconomic impacts of ICT revolution by focusing on the simultaneous evolutions of economic growth and ICT usage and production.

This study aims to analyze macroeconomic influences of ICT revolution both theoretically and econometrically. In the theoretical part, we evaluate the economics of ICT with a broad perspective by touching various segments of social and economic spheres. In order to test the findings of the theoretical analyses, in the empirical part, we are trying to find out whether ICT had a positive effect on economic growth in OECD member countries between 1999 and 2008 and in Turkey between 1980 and 2009. Thus, this paper presents an up to date investigation of ICT-economic growth relation in terms of involved time span and sample of countries.

In OECD countries results of ICT revolution generally occur in a more advanced level compared to other parts of the globe. Because, this group commonly constitutes of developed countries which possess necessary and complementary social, technical and economic elements for ICT revolution. Moreover, post-2000 period is usually treated as the time span in which results of that revolution would be observed substantially due to generation of a critical mass in terms of ICT diffusion in that interval yet. In the light of these two facts we think that investigating OECD member countries for the post-2000 period will be very useful to see macroeconomic impacts of ICT revolution clearly. In addition, performing separate econometric analyses for only Turkey allows us to make comparisons between two cases and helps us to draw worthwhile conclusions.

Vast majority of similar studies that go after macroeconomic effects of ICT revolution are limited with only results of ICT usage. As distinct from them, we are also interested in the production side of the ICT area. Since, we believe that ICT revolution promises more than the benefits that can be reaped by just importing ICT products and services and utilizing them. According to us, ICT production volumes and capabilities of individual countries have a significant meaning in terms of economic potential of them for both present and the future.

Combining the theoretical and empirical results that we obtain at the end, we sketch some lessons peculiarly for Turkey. Because ultimate objective of this study is offering suggestions for policymakers in Turkey. We think that if the associated benefits can be anticipated properly, decisions regarding the total amount and distribution of ICT investments may be taken more appropriately. Besides ICT investments, if it can be proven that there exists a positive and significant relationship between ICT production competences and economic development of a country, policymakers can be further encouraged to fulfill necessary actions that will improve the ICT production capabilities and volume of the country more proactively.

The organization of the paper is as follows. After this introduction in the first section, section 2 includes theoretical discussion regarding economics of ICT and a representative and rich sample of similar studies. Third section browses the ICT sector in OECD area in general and specifically in Turkey by investigating policy frameworks, priorities and implementations as well as developments in ICT area from the point of ICT diffusion, ICT production and ICT employment. Section 4 is where we carry out empirical analyses in order to test the findings

of theoretical discussions in previous sections. Finally, section 5 concludes by summarizing and evaluating together the results of our theoretical discussions and empirical analyses.

2. Theoretical Background

The term technology has been so popular due to a general acceptance that technological progress has a positive impact on economic growth. Actually this acknowledgement is not fallacious. It is supported by findings and views of important economists like Solow, Schumpeter and Marx as well as main economic theories. (Solow, 1957; Taymaz, 2001; Foley and Marquetti, 1997). The common ground of all these views is that technology enables people to perform tasks with more quality and efficiency as well as with less effort and cost. All these advancements correspond to a number of benefits in terms of economic perspective. Furthermore, as technology improves the existing processes and products, it also helps intensively the creation of new things.

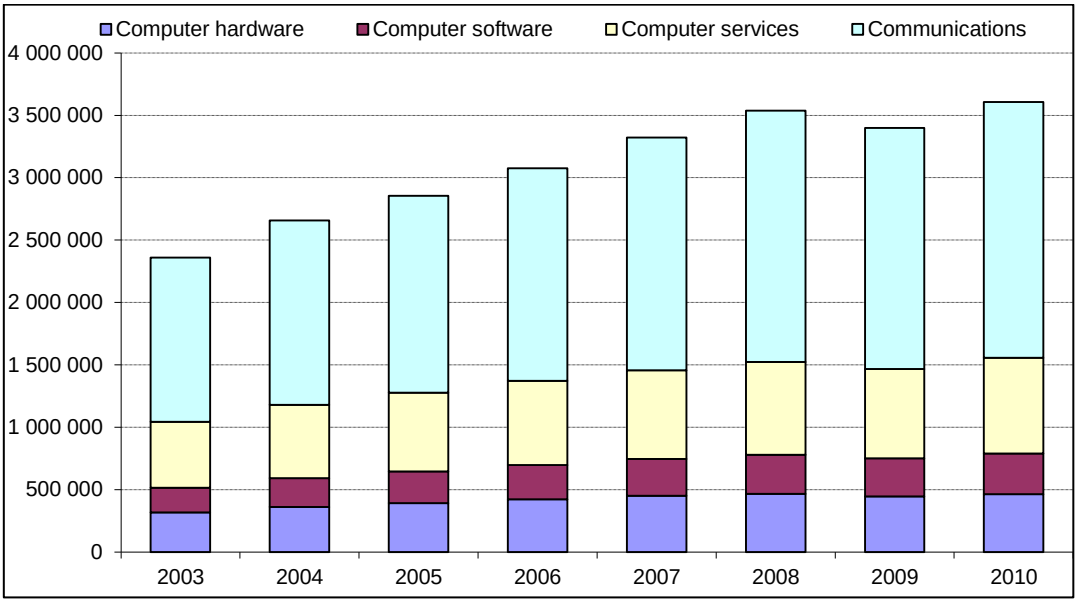
2.1 Economics of ICT

Recently, ICT sector has emerged as a major and rapidly growing one. Both economic volume and employment capacity of the sector expanded significantly. But more importantly because ICT is a general purpose technology and with the widespread usage of it in other sectors, those radical developments affected all segments of the economy and the society in general. Diffusion of ICT in other sectors leads to usage of knowledge and other physical and human capital more efficiently which consequently creates productivity gains. New jobs, professions and fields of business activity occurred, some of the old ones vanished, structure of labor market, characteristics of jobs and organizational forms changed. In addition, habits and way of entertaining and communicating of individuals as well as delivering of public services altered.

2.1.1. ICT Sector

ICT has become one of the major sectors of the modern economies. With high R&D and innovation capabilities of the sector and continuous and growing demand to its products by both individuals and other sectors of the economy, ICT sector has been expanding steadily. This demand is not only towards existing services and products but also occasion the new

ones to appear. In addition, it may require application of existing services and products in different areas with modifications.



Source: OECD IT Outlook 2010

Figure 2.1 Worldwide ICT spending by market segment, 2003-10
(USD millions, current prices)

As seen in Figure 2.1, worldwide ICT spending has increased more than fifty per cent from 2003 to 2010. Not only ICT spending but also value added in ICT sector is raising. When OECD area is considered, from 1995 to 2008 ICT sector value added had a compound annual growth rate of 4.7% which is higher than total business sector value added growth, 4.2%. In addition, ICT sector's employment growth was higher than total business employment growth for the same period. ICT sector has a high degree of globalization; global ICT trade had a 8.5% compound annual growth rate since 1996 and approached 4 trillion USD in 2008. Furthermore, ICT sector ranks number one in R&D investment and comes in second in terms of R&D intensity, which is measured as share of R&D expenditure in total sales. This paid attention to R&D by the sector bears its fruit and lead the technological progress and innovation activities (OECD, 2010).

2.1.2. Knowledge

By the widespread usage of ICT in all areas of economic and social life and Internet becoming a network that spreads the entire globe, dynamics of the knowledge creation

process has altered substantially. ICT provided great advancements in producing, processing, storing, sharing and easy access to information (SPO, 2006a). Developments in ICT area made knowledge-creating activities more efficient. Thus, knowledge became much more accessible and abundant. Faster and easier diffusion and absorption of newly developed knowledge supported further knowledge creation. These favorable impacts of ICT grow further as more people uses ICT thanks to network effects (Bartelsman and Hinloopen, 2005).

These positive effects of ICT regarding the knowledge result in various economic improvements. First of all, mankind equipped with much more knowledge finds better ways to use on hand resources to create economic value and achieve productivity growth. In addition, innovation and R&D activities which are highly dependent on the knowledge started to be carried out more effectively and efficiently. Researchers who reach better quality and more information and who are equipped with strong computing devices and skillful software become more creative and productive. Practitioners who also take advantage of ICT in similar manners can transform new technologies to economic value more efficiently. Moreover, decision makers can obtain better knowledge in terms of both quantity and quality more easily, thus can take more accurate decisions.

2.1.3. Work Environment

ICT becomes influential on nature, variety and the way of all sorts of activities of organizations. Within the firm; organizational structures, hierarchical relationships, types, numbers and methods of tasks may alter. Outside the firm, if advantages of ICT can be captured properly new business opportunities may become available to the firm or inversely firm may lose its previous advantages against other firms that achieve to reap the benefits of ICT revolution better.

Thanks to ICT, flow of information within the firm gets easier. This brings about more informed employees, reduces necessary coordination efforts, facilitates team work, increases flexibility and leads to creation of a more open and innovative culture in the firm. As well, more effective management becomes possible by taking advantage of more influential and diversified ways of accessing information from both inside and outside of the organization (David Skyrme Associates, 2012).

ICT alters the way jobs are performed within the firm dramatically. While some tasks are modified or automated, some of them are replaced by new ones. Interrelationships with customers and suppliers are also affected by the ICT revolution. Flow of information between firms and their stakeholders increases substantially. Firms are now more aware of customers' needs and desires so that they can direct their customization, production and advertising activities accordingly. More effective supply chain management becomes possible. Physical workplace environment is another point which is subject to the effects of the ICT revolution. Thanks to ICT, settlement of employees may become independent of some of the old limitations. This provides more flexibility while organizing the workplace in both office and building wide level (David Skyrme Associates, 2012).

2.1.4. E-Services

Transfer of many daily life applications to the virtual environment and dissemination of electronic services such as e-banking, e-health, e-learning, etc. provide easiness for people by removing some of the traditional constraints, especially geographical barriers, as well as making great time and money savings possible.

E-banking services enable customers to carry out almost all practices that are available in branch banks. Individuals can get detailed information on their accounts, conduct fund transfers, pay bills, exchange financial instruments like stocks, bonds and shares, create new accounts and apply for credits with no need to visit a bank branch (Cristina, 2008). This rescues them from lots of physical and time limitations in addition to providing opportunity to cut back their expenses. Likewise banks make advantage of e-banking by reducing their transaction costs and expenditures for branches.

E-health applications involve health information systems, electronic health records, telemedicine services, health portals and a number of other ICT-enabled tools that helps in disease prevention, diagnosis, treatment, health monitoring and lifestyle management. These tools contribute to provision of healthcare services in better and more efficient ways. E-health applications enable healthcare staff to obtain, exchange and track information about patients in more advanced ways. Patients can also reach more information about their own health status. Patients' condition can be monitored remotely and some health services can be presented with no need to patients leaving their inhabitations. E-health tools are useful in

relieving limits on resources in both budgetary and staffing terms and by this way affect productivity positively (European Commission, 2012).

Thanks to e-learning it becomes possible to capture, store and distribute enriched and more up-to-date information and resources in more diversified types and formats. In addition, e-learning provides great flexibility in terms of time, place and pace. Thus, people are freed from traditional constraints like attending at a classroom and using only printed resources. Educational institutions can reach markets that are beyond their periphery. People who live in disadvantageous regions both in country and international level are enabled to attain more qualified education opportunities. As well, e-learning promise important cost savings; especially corporate users show interest in it to be able train their personnel more effectively (Naidu, 2006).

2.1.5. E-Commerce

E-commerce transforms the marketplace by changing the way business is conducted, paving the way for new products and markets, string up new and closer relationships between firms and customers, changing the organization in work and introducing a work environment with more knowledge diffusion, human interactivity, openness and flexibility. E-commerce has an accelerating and facilitating effect on other contemporary reforms like globalization of economic activities and increasing demand for higher skilled workers. E-commerce also brings about enhanced interaction and transparency in the economic activities while decreasing the importance of time and physical limitations (OECD, 1999). E-commerce creates a new and more efficient marketplace where search, customization, exchange, distribution and consumption processes are improved (Coppel, 2000). E-commerce increase efficiency and effectiveness of economic activities and processes, decrease a number of costs and promote productivity in certain areas through several channels in different layers of the economy. These measurable and immeasurable positive impacts may also occur in economy-wide level.

2.1.6. Labor Market

Besides new employment opportunities created within the ICT sector, with the widespread usage of these technologies in other sectors, radical alterations take place in work patterns and

occupations. Demand for ICT experts and ICT literate staff grows. As new tasks and processes appear in work environment or complexity of existing ones increases due to involvement of ICT, some new job descriptions and professions emerge. These usually require higher skills and mean employment opportunity for individuals who have suitable qualifications. Moreover, some traditional jobs are ruled out while some of them are transformed. A great number of tasks that were performed based mainly on manpower previously started to be carried out automatically or with fewer but more qualified labor force. This shift towards a higher level in terms of employee qualifications generally increases labor productivity. On the other hand, this transformation process may job descriptions more ambiguous. Thus the value of expertise may depreciate in this transformation process. At least as importantly as this, while companies capture the benefits of possible raises in labor productivity and efficiency, life becomes much more difficult for those workers who have low level of qualifications and cannot adopt ICT revolution personally. They either lose their jobs or have to accept lower wages. This makes their relative economic position in the society, which is also not so good previously, even worse. This appears as an important issue that should be handled via different ways like retraining in order to spread advantages of ICT revolution throughout the whole society.

ICT has also indirect impacts on labor market and affects the general operation principles of it deeply, alters the dynamics and structure of the employment. ICT revolution leads the separation of work from physical environments completely or partly thanks to applications like tele-working. Providing service via telephone or internet also becomes a common practice and creates new working types. These help people who normally cannot participate to labor force due to several limitations like age, gender and geographical location to find a job and contribute to the economy. Furthermore, ICT give chance for job seekers and employers to meet in online platforms. This makes it possible for individuals to get a job that is compatible with their qualifications as well as enabling employers to find personnel who is vested with job requirements in a faster and more effective way.

2.1.7. Public Sector

E-government brings about improved efficiency, diminished costs, time savings and increased productivity in public services. Thanks to e-government applications public institutions can perform their tasks such as collecting, processing and sharing data as well as delivering

government services to the citizens in an automated way with a higher speed and more accurately and reliably. This improves their performance while reducing transaction costs. As well, general service quality of public sector rises significantly. E-government enhances availability and accessibility of government services. Citizens can perform government related operations without being bound to office hours or geographical constraints and this provides great flexibility and cost-saving opportunity for them (Almarabeh and AbuAli, 2010).

E-government triggers a transformation inside the government. Government reviews and restores its own organization, administration, rules, regulations, service delivery manner and principles and processes for coordination, communication and integration within itself (Almarabeh and AbuAli, 2010). Thanks to effective information sharing infrastructures and systems as well as interoperability and compatibility at technical, logical and processes levels among different public institutions, efficiency and quality of public services increase. Moreover, with e-government, administrative burdens are relieved, bureaucratic procedures diminish, repeated information acquires by the same or different public institutions and data losses are removed. Transparency, accountability and trustability of government bodies improve, necessities of citizens can be understood better and their satisfaction increases. It is also thought that citizens may be encouraged to fulfill their obligations towards the state due to fast and clear delivery of public services. Existence of such a motivation especially in doing payments straightly and on time contributes to the growth of public revenues (Almarabeh and AbuAli, 2010).

2.1.8. Social Transformation

Increasing usage of ICT in daily and working lives of people brings about a wide range of novelties for individuals such as those in habits, way of entertaining and networking, distribution of expenditures, education and training forms. These alterations affect a lot of complex interrelations and result in some economic consequences. Those new opportunities play an important role in achievement of easier sell-fulfillment, increased personal prosperity, advanced standards of living and grown social welfare. In addition, quality of services is improved and they are generalized throughout the country equally. Disadvantageous segments of the society, especially disabled people, who cannot or can only limitedly benefit from

services become more active and integrated to the society. These contribute the advancement of social development.

As seen above, ICT has various direct and indirect effects some of which can be measured easily whereas others cannot be quantified properly. In this study, we will look at the relationship between some ICT statistics and GDP growth because all those effects that are mentioned above are more or less contained by the GDP path in the long run. Next section summarizes the previous studies that discuss this relationship.

In the light of the facts that have been discussed above, it can be concluded that ICT revolution brings about a great number of alterations to the economic, social and daily lives. While some of the effects of that transformation can be observed easily by everybody, recognizing and evaluating some of those impacts require more exertion. Furthermore, it is not so easy to quantify the exact magnitude and scope of all of the direct and indirect consequences of ICT revolution. Instead, the current study tries to measure economic impacts of ICT revolution in aggregated terms. For this purpose, GDP growth path, which seems as a somewhat acceptable gauge for the overall direction of an economy and contains the results of all those effects that are mentioned above more or less in the long run, is related with ICT statistics in order to be able to analyze the impacts of ICT revolution on the overall economy. Next section summarizes a number of previous similar studies, which discuss and investigate the macroeconomic impacts of ICT.

2.2. Summary of Previous Work

Link between ICT and economic growth has been subject to a great number of empirical studies. These studies commonly share a curiosity about exact worth of ICT and try to quantify it with different methods and different data sets belonging different countries and different periods of time. So they reach diverse results accordingly. But it should be stated beforehand that there is a general tendency in favor of ICT. A representative and rich sample of those studies is presented in this section with an ordering that generally prioritizes the studies that deal with earlier intervals. Because, we share the view which asserts that benefits of ICT can be received more as the share of these technologies in the overall economy increase and these technologies actually become widespread as time passes.

In addition to following production function framework and applying econometric analyses as the current study does, growth-accounting methodology is also widely utilized to determine the contribution of ICT to the economic growth. Growth-accounting emanates from the seminal work of Robert Solow in 1957 and explains the output growth with the growth in inputs plus growth in the efficiency. In this method, different types of capital inputs are weighted according to their income shares. Efficiency, which is defined as multifactor productivity (MFP) and actually a residual term, is used to capture the portion of output growth that cannot be related with the growth in any of the inputs. MFP growth may occur due to advancements such as introduction of new technologies, organizational improvements, resource reallocation and scale economies (Parham et al., 2001). Another critical contribution by Solow to the literature is so called "Solow Productivity Paradox" which originates from his famous 1987 quip as "you can see the computer age everywhere but in the productivity statistics" (Solow, 1987). This term refers the contradiction between intensive ICT investment after 1970s and nonappearance of expected positive effects of ICT diffusion on productivity and economic growth in the US. This situation was mainly due to lag effects; diffusion of ICT takes a longer period than expected. There are lots of studies dedicated to deal with this paradox including some of the below mentioned ones.

Norton (1992) questions the sources of differences in economic growth rates of nations and tries to investigate if telecommunications is one of those sources. He claims that there is a link between transaction costs, telecommunications, and economic growth and telecommunications foster economic growth by decreasing transaction costs in information, product and factor markets. According to Norton (1992), telecommunications makes it easier and cheaper to access relevant information and, thus, increase the efficiency of decision making processes. To test his hypothesis about positive effects of telecommunications on economic growth, Norton (1992) carries out regression analyses for 47 countries and time span between 1957 and 1977. Depending on the results of those analyses which show that telecommunications variables are positive and generally significant, Norton (1992) concludes that telecommunications support economic growth by lowering transaction costs.

Being aware of substitution of IT equipment and technical change are not the same thing, Jorgenson and Stiroh (1999) examine technical and economic effects of IT diffusion in the US during 1948-1996. They explain substitution as the introduction of computer-intensive technology that produces benefits for only those who use that technology whereas arguing

that technical change occurs only if some benefits spillover to the overall economy and it becomes possible to produce more output from the same inputs. By employing growth-accounting methodology, they find out that average output growths for different sub-periods show a declining trend and this signals that diffusion of computers did not go hand in hand with a raise in economic growth.

Röller and Waverman (2001) investigate how telecommunication infrastructure affects the economic growth by using evidence from 21 OECD countries for 1970-1990. According to authors, increase in the production of telecommunication equipment is the first channel through which benefits of investment in telecommunication infrastructure occur. But more importantly, those benefits are reaped throughout the whole economy via decrease in transaction costs and increase in information intensity of production processes. At the end of their econometric analyses, they find out that telecommunications has positive and significant effects on aggregate output growth. Moreover, Röller and Waverman (2001) rightly test if there exists any network externalities for telecommunication infrastructure differently from other types of infrastructures. They reach evidence of increasing returns to telecommunication investment and conclude that advancement of telecommunication infrastructure create higher growth effects for more developed countries which already have a higher penetration rate.

Oliner and Sichel (1994), in their comprehensive study, examine the contribution of ICT to economic growth in the US over 1970-1992 period by using growth-accounting framework and also touch on discussions regarding Solow Paradox. Performing various analyses for different sub-periods and for different ICT categories, Oliner and Sichel (1994) conclude that ICT do not have a significant positive effect on economic growth of the US for 1970-1992 interval as well as it does not suggest good signs for the future. They attribute this fact to tiny share of ICT in economy by arguing that "computers were not everywhere".

Parham, et al. (2001) analyze the role of IT in Australia's economic growth between years 1964 and 2000 and compare it with the experience of the US. Average annual output growth in Australian market sector between 1964 and 2000 is 3.4 per cent and according to Parham, et al. (2001)'s calculations, a portion of 0.4 per cent of that growth is due to IT. But when only 1990s is considered share of IT in average annual output growth raise to 1.1 per cent. Besides, second half of the 1990s is prominently better than the first half in terms of IT contribution. When they compare their results for Australia and results of some other

researchers for the US, Parham, et al. (2001) find a similar or slightly higher contribution from IT in Australia. Combining this and the fact that the US is a major IT producing country, they conclude that production of IT equipment is not necessary to benefit from ICT revolution.

In another country specific study, Ramlan, et al. (2007) seek to determine whether there is significant impact of ICT on economic growth of Malaysia. They follow growth-accounting methodology and measure ICT contribution to growth in aggregate output in Malaysia between 1966 and 2005. Ramlan, et al. (2007) find out that investments in telecommunications affect the economic growth in Malaysia significantly. They also prove that approximately one tenth of the growth in human capital productivity is due to ICT during the investigated years and decide that ICT played a major role in human capital development of Malaysia.

Yoo (2003) investigates the relationship between investment in information technologies and economic growth by using data from 56 developing countries for the time interval between 1970 and 1998. He uses an extended version of the augmented Solow model that is initially suggested by MRW (1992) and then modified by Nonneman and Vanhoudt (1996). According to results, impact of IT investment on economic growth is found to be statistically meaningful. Therefore, Yoo (2003) argues that IT investment is beneficial for the developing countries in order to raise per capita income.

Regarding the ICT revolution as one of the leading forces behind the economic and social change throughout the world, Kim (2002) is curious about the sources of economic growth and productivity in Korea which is one of the first countries come to mind when IT is referred. Kim (2002) argue that IT and knowledge capital are the main sources of economic performance of Korea and tries to prove this hypothesis by using growth-accounting methodology and data for 1971-2000 interval. Depending on both the significant contribution of IT to economic growth in the past and the upward trend in magnitude of that contribution according to results of his empirical work, Kim (2002) suggests to Korea to place special emphasis on information technology area.

In their comparative study, Jorgenson and Motohashi (2005) analyze the sources of economic growth in Japan and the US from 1975 to 2003 with a particular interest towards the role of

information technology and by employing growth-accounting analyses. At the end, they find out that contribution of IT investment to GDP growth in Japan has been increasing since 1975 and reached to two thirds of total output growth for 1995-2003 period. This contribution is close to that in the Unites States and is actually much better in proportional terms. Therefore, this constitutes another piece of evidence that is in favor of the ICT revolution.

Whelan (2000) focuses on economic effects of computers in the US between 1974 and 1998. What Whelan (2000) distinctively says is that effects of computer usage throughout the economy are underestimated so far because technological obsolescence, which occurs when the capital is retired while it still has productive capacity, is not taken into account. On the basis of this argument Whelan (2000) calculates computer capital stock afresh and finds that it constitutes a larger fraction of total capital stock than the conventionally used measurement methods indicate. Whelan (2000) uses these estimates in his empirical implementation and calculates that computers contributed to annual economic growth of the US on average 0.50 per cent for 1974-1995 and 1.23 per cent for 1996-1998. Thus, he responds those who explain the Solow Paradox with the fact that computers were not everywhere by noting that computers might not be everywhere but they are more common than thought thus far.

Oliner and Sichel (2000) update their previous study with some modifications and more recent data that belongs to 1974-1999 period and this time they reach more favorable result regarding economic effects of ICT. They keep Whelan (2000)'s word and following him they base their empirical work on productive capital stocks instead of wealth stocks as it is the case in their 1994 study. Authors show that ICT contributed significantly to output and labor productivity growth in the US, especially during the second half of the 1990s. Moreover, Oliner and Sichel (2000) state that there exist some efficiency gains associated with the production of computers and semiconductors. In order to detect those gains they decompose the contributions of computer sector, semiconductor sector and other nonfarm business sector to multifactor productivity growth. They see that approximately one half of the growth in MFP in the US over 1974 to 1999 stems from computer and computer-related semiconductor sectors.

Breitenbach, et al. (2005) complain that even though there are lots of efforts to evaluate the role of ICT in economic growth and development throughout the world there is no such a study for South Africa. As a toe-hold, they analyze the impact of ICT on South African

economy by utilizing a time series regression analysis with the data that belongs to the period of 1975 to 2002. However, their empirical analyses seem a bit weak due to both several oversimplifications as well as limited number of data points. According to the results, a statistically significant relationship between ICT and GDP is proved. Thus, authors conclude that ICT is an important factor for economic growth of South Africa but they do not refrain from suggesting testing the magnitude of that relationship with a broader set of data.

In order to make a contribution to efforts in this area, Pohjola (2000) investigates the effects of information technology investment on economic growth in 39 developed and developing countries for the period 1980-1995 by using the augmented version of the Solow growth model as Yoo (2003). Regression results show that ICT investment has a strong impact on economic growth of the developed nations whereas when the broader sample, which involves both developed and developing countries, is taken into consideration, it is seen that ICT is not so influential on economic growth. This situation is explained by the author with the existence of a well-established physical infrastructure and a mature stock of human capital which enhance the effects of ICT revolution in developed countries.

Oulton (2001) uses a growth-accounting approach to estimate the contribution of ICT to the growth of both aggregate output and aggregate input in England over the period of 1979-1998. According to empirical results, ICT accounted for the 13 and 21 per cents of GDP growth in 1979-1989 and 1989-1998 intervals respectively. Share of ICT in total output is also small in England but that rising trend in ICT contribution is observed for this country too. Moreover, Oulton (2001) looks at the contribution of ICT capital to the growth rate of aggregate capital stock. He finds out that approximately one half of the growth of capital services in England between 1979 and 1998 is due to the growth of ICT capital.

With the motivation of learning about international experiences regarding returns to ICT investment, Dewan and Kraemer (2000) estimate an aggregate production function that relates GDP to ICT and non-ICT inputs using panel data from 36 developed and developing countries between 1985 and 1993. They aim to understand whether there exist any meaningful differences between returns from ICT investment and investment in other capital as well as comprehending differences between developed and developing countries in terms of returns from capital investments. Their findings indicate that there are important differences between developed and developing countries with regards to returns from capital investments. It is

estimated that ICT investment provides 53 per cent of annual GDP growth in developed countries whereas it has no statistically significant contribution in developing countries in the sample. Dewan and Kraemer (2000) explain this situation with the lack of complementary investments in infrastructure, human capital and information-oriented business processes in developing countries whereas developed countries have already built up a mature stock of ordinary capital to support economic activity.

Schreyer (2000) looks to the contribution of ICT to economic growth in G7 countries which are namely Canada, France, Germany, Italy, Japan, England and the US between 1980 and 1996. He questions the fact that although investment in and use of ICT are not confined to the US, other developed countries could not experience growth rates as high as the US. Schreyer utilize a conceptual growth-accounting framework in order to quantify impacts of ICT on economic growth. According to his results also, ICT contributes to output growth significantly in the general sense. But this contribution varies across countries. While the US reaps the benefits of ICT mostly, European economies and Japan have to settle with more modest returns. Schreyer (2000) explains this situation with the relatively smaller share of service industries, which tend to invest in ICT much more, in those countries.

In a similar vein to Schreyer (2000), Colecchia and Schreyer (2001) investigate the relationship between ICT and economic growth in nine different OECD countries, especially during the 1990s in their comparative study which uses a growth-accounting. According to empirical results, contribution of ICT to output growth of the business sector in those nine countries over the twenty years from 1980 to 2000 is between 0.2 and 0.5 percentage points per year. Not surprisingly this contribution is higher for the more recent years. The US is the leader in reaping the benefits of ICT and followed by Australia, Finland and Canada. Over and above, Colecchia and Schreyer (2001) examine the role of ICT-producing industries in the economy and argue that existence of a strong ICT-producing industry is not a necessary condition for taking advantages of ICT as well as not being a sufficient condition for it. They prove this view with the experiences of Australia and Japan. Their empirical work indicates that growth contribution from ICT is higher in Australia, which has a very small ICT-producing sector, compared to Japan, which is one of the largest ICT producers in the world. On the other hand, authors do not abstain from mentioning the positive impacts of ICT producing industries on economy-wide MFP growth although they do not quantify those impacts.

Armstrong, et al. (2002) examine and compare the sources of economic growth for the 1981-1995 and 1995-2000 periods in Canada. Authors analyze the growth of investment, capital stock and capital services in Canada by decomposing these into three components as arising from investments in ICT, other machinery and equipment and structures for 1981-1988, 1988-1995 and 1995-2000 sub periods. They show that ICT contributed significantly to advancements in all those three types of growths for the whole sub periods. They also implement a growth-accounting exercise in order to determine the contribution made by ICT investment to the GDP growth. According to empirical results, average annual growth of Canadian business sector between 1981 and 2000 is 3 per cent and 0.5 percentage point of this growth is due to ICT investment. Moreover, post 1995 period gives more favorable signs for the economic impacts of ICT.

Van Ark (2001) analyzes the contribution of ICT to output growth during the 1990s for ten OECD countries. As distinct from the growth-accounting methodology that finds the ICT contribution by treating it as a separate input, Van Ark (2001) follows an alternative approach and distinguishes the total output into three sectors as ICT-producing, ICT-using and non-ICT sectors. Van Ark (2001)'s computations indicate that both ICT-producing and ICT-using sectors have a positive impact on GDP growth in all countries. As it is expected, the US is the leader in the growth contribution of the ICT-producing and ICT-using sectors combined in absolute terms. Besides the US, Finland and Japan come to the forefront in ICT-producing side whereas differences among countries are not so big for the contribution of ICT-using industries. Moreover, as most of the other studies in this field, Van Ark (2001) also detects the higher contribution of ICT in the second half of the 1990s compared to the first half.

Simon and Wardrop (2002) wonder whether Australia could benefit from ICT revolution thoroughly as she does not have a strong ICT production sector but is one of the countries that invest in ICT heavily. They look at the gains from the use of IT in Australia during the 1990s by employing a growth-accounting methodology. Results of their empirical work reveal that IT capital played an important role in the economic growth of Australian economy during the investigated period. Authors conclude that IT usage provides advantages for countries even if they cannot produce much of it as it is the case for Australia. In addition to aggregate analyses, Simon and Wardrop (2002) examine the role of IT investment for growth of individual sectors. They see that traditional industries like agriculture, mining, construction

and manufacturing were not the outstanding beneficiaries of ICT revolution. Instead, service sectors, especially communications and finance, principally took advantage of IT investment.

Daveri (2002) tries to understand differences in economic growth experiences of Europe and the US during the 1990s from the perspective of ICT revolution. In order to examine the relationship between ICT diffusion and economic growth in Europe between 1992 and 2001, Daveri (2002) employs a growth-accounting methodology by using data for 14 European countries. His empirical analyses indicate that, along with differences from country to country, ICT did not have a significant growth effect in Europe as a whole during the 1990s despite most European countries experienced a high level of ICT diffusion. This situation is interpreted as migration of Solow Paradox from the US to Europe and is linked with several factors. First of all, notwithstanding the recent improvement in GDP portions allocated to ICT spending and investment, the value added share of ICT capital remains too small in Europe because of low levels of investment in the 1990s. Furthermore, wide-ranging organizational changes in the mode of production as well as a certain length of time to learn how to use these technologies effectively are also necessary for Europe to be able to reap the benefits of ICT revolution greatly.

A skeptical study towards the economic impacts of ICT, Gordon (2000), analyzes and compares ICT revolution with other revolutionary developments in the history. In the empirical part of the study, Gordon (2000) finds out that 1995-1999 period, which is characterized by the rapid diffusion of ICT, is better than previous periods that coincide with the great inventions of the past in terms of macroeconomic indicators of the US. Despite the statistics are outstanding in the economy wide level, when a closer look is taken it is seen that favorable economic impacts of the ICT is limited with the production of computer hardware, peripherals and telecommunication equipment. Therefore, Gordon (2000) argues that ICT does not affect the economy and daily lives as deeply as the great inventions of the late nineteenth and early twentieth century.

Complaining about the lack of studies that try to estimate the economic impacts of ICT revolution in post-communist economies, Piatkowski (2003) delineates the contribution of ICT to economic growth in Poland. In order to quantify results of those impacts, he employs an extended growth-accounting methodology by using data covering the period of 1995-2000. Piatkowski (2003)'s empirical analyses reveal that the average contribution of ICT capital to

Polish economic growth in the period of 1995-2000 was 0.47 percentage points which correspond to 8.9 percentage of average output growth. Piatkowski (2003) shows that this ICT contribution to economic growth in Poland is much smaller compared to experiences of the EU and the US.

Jalava and Pohjola (2005) investigate the influences of ICT on economic growth of Finland. In order to determine the exact impact of ICT on Finnish development between 1995 and 2002, Jalava and Pohjola (2005) utilize the growth-accounting framework. In the production side, it is found that approximately one third of the output growth in Finland over 1995-2002 stemmed from ICT production. Besides this, according to results of growth-accounting on the input side, ICT capital contributed 0.66 percentage points to GDP growth on average which implies that 16 per cent of output growth was due to ICT investments. Therefore, it can be concluded that ICT was helpful for the economic growth of Finland at least between 1995 and 2002.

Nasab and Aghaei (2009) test the relationship between economic growth and ICT investment for a sample of oil-reach countries by following the production function approach and working with panel data. Their study includes 7 of 11 OPEC member countries and covers the time span of 1990-2007. According to their estimations, ICT investment induces the economic growth significantly in the OPEC member countries. Accordingly, Nasab and Aghaei (2009) advice those countries to allocate more resources to ICT investment as well as reminding them the importance of the social and cultural infrastructures and skills, that are necessary to benefit from ICT revolution fully.

A very recent study, Erdil, et al. (2010) question whether ICT revolution has a significant meaning in terms of strengthening the economic growth in the underdeveloped and developing countries. To be able to achieve this, Erdil, et al. (2010) apply an empirical analysis by using a panel dataset for 131 underdeveloped and developing countries belonging the period of 1995-2006. At the end, Erdil, et al. (2010) find out that 1 per cent increase in ICT stock bring about approximately 0.1 percentage increase in GDP growth. Authors consequently conclude that ICT usage has a significant positive effect on economic growth for underdeveloped and developing countries and, therefore, they should keep investing in ICT.

2.2.1. Stylized Facts

As a result of above literature survey some common facts come into prominence and these can be stated as follows:

* ICT is a general purpose technology.
* ICT influences the economy through two main channels as ICT production and ICT usage.
* There are some different views and findings about whether ICT production capacity is a necessity for ICT revolution to show its economic impact properly.
* ICT revolution has significant effects on economic growth of developed countries.
* There are some doubts about whether underdeveloped and developing countries can benefit from ICT investments greatly.
* Extent and scope of the growth effects of ICT revolution are highly dependent on the share of ICT in total economy.
* Other elements such as complementary physical infrastructure and human capital as well as social and cultural factors have also critical importance for reaping the benefits of ICT revolution fully.
* There are strong signals about existence of externalities and spillover effects associated with ICT investment.
* The impacts of ICT investments on economic growth take time.

3. Information and Communication Technologies in OECD

As the previous section reveals, there seems to be a positive relationship between ICT and economic growth, especially for developed countries. Among OECD countries, which are overwhelmingly developed ones, ICT has been treated as an important issue and paid special attention in order to foster economic growth. This section analyzes adopted ICT policies, their implementation and outcomes in OECD countries during post 2000 period. In addition, Turkey is dealt with separately in this context in line with the main aim of the current study. Our ultimate goal is reaching ICT policy suggestions for Turkey by showing regard to experience of OECD member countries as well as developments in Turkey in ICT field from past to present.

3. 1. ICT in OECD Member Countries

3.1.1. ICT Policies in OECD Area

Being aware of the economic and social importance and impacts of ICT, most OECD member countries have been designing and implementing ICT strategy and policies as well as embedding those to the broader policy visions. It is generally seen that ICT policies have become gradually more integrated to the general economic and other policies. OECD IT Outlook publications overview the ICT policy priorities in the member countries and may be a helpful reference guide in order to analyze the evolution of ICT policies in OECD area during the post 2000 period.

Before the ICT revolution becomes so widespread around the world in twenty first century, during the 1990s, governments newly faced with a transformation similar to that from agricultural societies to industrial ones. This was the transformation to information societies and started to affect all elements of the economy and society deeply in many aspects. In this early stage, governments tend to approach to the issue in a broader sense. OECD's prioritized main policy areas regarding this subject were competition, private investment, regulatory framework and infrastructures. As time progresses and top level policy frameworks settle, different topics started to become prominent depending on the developments in technology, economy and social structure (OECD, 1997).

In the beginning of the twenty first century, OECD IT Outlook 2000 mainly focuses on electronic commerce and related issues. Readiness for e-commerce, which has technical, social and economic aspects, was a prominent issue. In this context, development of network infrastructure, diversification of access channels including mobile technologies and improvement of service quality and user friendliness were seen as the top technical priorities for e-commerce readiness. Existence of IT workers with sufficient skills and taking effective precautions for closing the digital divide within and between countries were the important issues in the social side. Ensuring security, trust, liability, privacy and consumer protection in electronic financial transactions was the main subject regarding economic aspect of e-commerce readiness. In addition to e-commerce, intelligent agent technologies, global navigation satellite systems and flat panel displays were other topics addressed by OECD (OECD, 2000).

OECD IT Outlook 2002 states that the effect of ICT on competitiveness of businesses; the possible improvements thanks to ICT regarding output, employment and productivity; the digital divide and utilizing ICT in delivery of government services as well as improving government efficiency were the policy areas that gain particular attention from the OECD member countries generally. In addition, technology development, R&D, government procurement, ICT for government use and venture finance came to the forefront as the major policy areas. Diffusion of ICT to the both households and businesses; reliability and trustworthy of electronic transactions and exchange mechanisms; security, privacy and consumer protection in the digital environment were also among top ICT policy priorities. Moreover, ICT skills which were started to be perceived as a general skill throughout the all industries as well as being an essential requirement for the ICT sector gained remarkable attention from OECD countries (OECD, 2002).

In 2004, OECD IT Outlook indicates that ICT R&D and innovation, technology diffusion, ICT skills, broadband and digital content and delivery are at the focal point of ICT policies of OECD member countries. It became more important to coordinate and evaluate economic impacts of ICT policies for countries in OECD area. E-government activities and projects were seen as a tool to improve public administration and digital networking of various parts of that. Building and extending high-speed networks like broadband infrastructure were a priority for almost all OECD member countries. Furthermore, policy makers continue to pay great attention to security, privacy and data and consumer protection (OECD, 2004).

ICT policy priorities in OECD IT Outlook 2006 were somewhat similar to the previously mentioned ones. ICT policies in OECD member countries mostly focus on fostering innovation in ICT area, especially thanks to R&D activities and innovation networks and clusters; increasing ICT usage; extending e-government services; promoting ICT skills and employment, especially via ICT education; fostering digital content; improving ICT business environment; guaranteeing intellectual property rights and advancing infrastructure, especially broadband infrastructure. In addition to these, coordination and prioritization of ICT policies remained among most important concerns of policy makers (OECD, 2006).

Towards 2008, ICT was seen as a driving force behind innovation, economic growth and job creation increasingly. According to OECD IT Outlook 2008, ICT policy areas with top priority in OECD member countries were promoting innovation and R&D in ICT as well as

utilizing ICT as an effective tool for those activities in other areas; fostering e-government application and services; extending the coverage of broadband networks; advancing ICT diffusion to all segments of the society and economy; promoting ICT skills and education; increasing ICT employment and encouraging digital content creation. Besides these, public sector information and content was also mentioned among highly prioritized policy areas (OECD, 2008).

When it comes to 2010, ICT policies in OECD member countries have become mainstream policies and intended to serve for the general social and economic objectives. ICT policies are now designed to foster economic growth and employment, raise productivity, improve delivery of public and private services and enhance the welfare and living standards of the citizens. In this respect, ICT policies are more integrated into other policy areas like health, education, environment, transportation, etc. According to the results of a questionnaire conducted by OECD on member countries, top ten policy priorities in 2010 for governments were as such: security of information systems and networks; broadband; R&D programmes; government on line, government as model user; innovation networks and clusters; ICT skills and employment; digital content; consumer protection; technology diffusion to business and technology diffusion to individuals and households. This prioritized policy areas are very similar to those of the last ten years. But, importance attributed to the certain policy areas like broadband development, technology diffusion to individuals and households and e-government activities has increased considerably in recent years (OECD, 2010).

3.1.2. ICT Usage in OECD Area

As ICT diffuse all areas of economic and social life, usage of and demand for ICT products and services increase significantly. OECD countries are among those which spend on ICT heavily. Despite a declining trend, OECD area is the largest ICT market in the world. Total worldwide ICT spending in 1992 was estimated to be USD 1.28 trillion and 92 per cent of this, which is USD 1.18 trillion, belongs to OECD member countries (OECD, 2000). When it comes to year 2009, total worldwide ICT spending increased to USD 3.4 trillion but OECD countries' share decreased to 76 per cent, which corresponds to USD 2.57 trillion. This fact is mostly due to the rapid increases in ICT expenditures of emerging non-OECD economies (OECD, 2010). The US is the largest national ICT market by far and followed by the Japan.

Above mentioned huge ICT budgets brought about important improvements in ICT diffusion throughout the OECD member countries. From 2001 to 2007, total mobile subscribers in 30 OECD countries increased to 1.14 billion people from 604 million people and internet subscribers increased to 382 million people from 189 million people. Total communication access channels (analogue lines, ISDN lines, DSL, cable modem and mobile subscribers) per 100 inhabitants across the OECD area rose to 157 in 2007 from a value of 104 in 2001. When individual countries are investigated in terms of this statistics, it is seen that backmost countries (Mexico, Turkey and Poland) and the headmost one (Luxembourg), due to its low population, remain same. Sweden is another leading country in total communication access channels together with Italy and Greece which achieved great improvements in recent years. Broadband is the dominant way of internet access recently and broadband penetration rates may give an idea about the level of ICT diffusion in OECD countries. Total broadband subscription per 100 inhabitants for the whole OECD area was 4.8 in 2002 while this value is increased to 23.3 in 2009. Together with being in different magnitudes, all OECD member countries proceeded significantly in this area since 2002. By 2009, Netherlands is at the best position in terms of broadband subscription while Turkey is the country that has the longest way to make (OECD, 2011).

3.1.3. ICT Production in OECD Area

In addition to using ICT in a widespread manner, OECD countries are also strong at ICT production. 197 of top 250 ICT firms in the world belong to OECD countries and US is by far the best country with 75 ICT firms. As it is the case in ICT usage, ICT production in OECD area becomes more and more important. Between 1995 and 2008 ICT sector value added in OECD area grew 4.7 per cent annually and outpaced the growth in total business sector value added. By 2008, share of ICT value added in business sector value added in whole OECD area is about 8.2 per cent; Finland, Ireland and Korea are the leading countries in this respect. ICT services constitute an important part of ICT sector value added for OECD area and it is the most rapidly growing segment. On the other hand, ICT manufacturing in OECD area grew least rapidly because of shift of ICT manufacturing to non-OECD countries, especially in Asia (OECD, 2010).

In terms of ICT exports there is a slightly upwards trend in total amount but share of OECD countries' total ICT goods exports in worldwide is decreasing. While in 2000 67 per cent of

world's total ICT goods exports were from OECD countries, in 2009 this ratio decreased to 43 per cent. That simultaneity of increasing ICT spending and production and decreasing share in worldwide ICT spending and exports of OECD member countries indicates that emerging non-OECD economies started to become serious rivals of OECD economies in ICT area. When we look at individual countries in terms of ICT good exports, US, followed by Korea, Japan and Germany, is the leader country. On the other hand, Slovenia, Greece, Luxembourg, New Zealand, Chile and Iceland are the most lagging countries with ICT goods export less than USD 1 billion. Another meaningful point to investigate in order to gain insights about ICT production capacities of OECD member countries is R&D capabilities of them. Actually, OECD countries are quite active in this area. OECD member countries have about 52,000 patents in the ICT sector in 2007. Ordering among OECD countries in this respect is very similar to that about ICT goods exports. US, Japan, Germany and Korea are the leading and Luxembourg, Slovak Republic, Iceland and Chile are the lagging countries (OECD, 2011).

3.1.4. ICT Employment in OECD Area

By 2008, approximately 16 million people were employed in the ICT sector in OECD countries and this value corresponds to 5.8 per cent of total business sector employment in OECD area. Finland and Sweden are the countries where shares of ICT sector employment in total business employment are the largest with values more than 8 per cent. On the other side, almost half of the ICT sector employment of OECD area is in the US (30 per cent) and Japan (19 per cent) (OECD, 2010).

11 million of those 16 million people employed in ICT sector in OECD countries are employed in ICT services while remaining 5 million are in manufacturing. Employment in ICT services grew on average 2.7 per cent annually and this growth rate is significantly higher than growth in employment of business services as a whole which is equal to 1.6 per cent. On the other hand, during the same period, employment in ICT manufacturing in OECD countries declined 1.3 per cent annually and this is a more rapid decrease than that in total manufacturing employment which is 1.0 per cent annually. Employment in ICT sector as a whole in OECD area grew on average 1.3 per cent annually between 1995 and 2008 and this is higher than growth in employment of total business sector which is 0.9 per cent annually (OECD, 2011).

It is possible to categorize ICT employment as ICT specialists and ICT-using professions. By 2009, in most OECD countries approximately 3-4 per cent of total employment was ICT specialists, employers who deal with ICT systems directly as a fundamental part of their jobs. Besides, ICT-using professions (including ICT specialist) constitute about 20 per cent of total employment in most OECD countries. These two rates are generally lower in Eastern European countries (OECD, 2010).

3.2. ICT in Turkey

3.2.1. ICT Policies in Turkey

Turkey, as other OECD member countries, has been attributing great importance to ICT and paying considerable attention to this area, at least by writing down so in a great number of policy documents. As it is the case in other policy areas in Turkey, the general frame for ICT policy is drawn in development plans. In addition, there are several important policy and strategy documents prepared by The Scientific and Technological Research Council of Turkey (TÜBİTAK). Besides, there are various legislative arrangements which intend to put into practice the policies that are determined in those documents. A number of policy documents that belong to 1990s such as Sixth Five Year Development Plan (1990-1994), Turkish Science and Technology Policy 1993-2003, Seventh Five Year Development Plan (1996-2000) and Science and Technology Policy of Turkey prove the paid attention to the ICT area, at least to a certain extent. Transformation to an information society, raising computer literacy, extending the usage of computers and supporting R&D activities were primary ICT policy objectives in these documents.

In a similar vein to previous development plans and other relevant policy documents, Eighth Five Year Development Plan (2001-2005) of Turkey treats ICT as a strategic sector and prioritize the boosting the competitiveness of the Turkish ICT sector. Major policy concerns regarding ICT was stated as facilitating the competition in telecommunication sector, promoting electronic commerce, supporting R&D activities in ICT area, improving the Internet and mobile communication infrastructure, ensuring information security and giving weight to e-transformation of government (SPO, 2000). In 2001 with an intention about accelerating the technological progress in Turkey, Technology Development Zones Law was introduced. This law purposed conglomerating the advanced technology oriented firms by

offering them financial support for land, infrastructure and construction costs and various tax exemptions (Official Gazette, 2001).

In 2003 "e-Transformation Turkey Project" was initiated under the coordination of State Planning Organization (SPO). This project aimed at rearranging policy and legislations about ICT within the framework of EU legal acquis, rendering public services more efficient, transparent and accountable by availing from ICT as much as possible, extending the usage of ICT, coordinating, monitoring and evaluating public investment projects in ICT area and guiding private actors in ICT sector (Prime Ministry Memorandum, 2003). After a while later a short term action plan, which proposed actions about information society strategy, technical and judicial infrastructure, information security, education, human resources, standards, e-government, e-health and e-commerce, was put into effect (SPO, 2003a). In 2004 Turkey's Information Society Transformation Policy document was accepted by e-Transformation Turkey Executive Board. According to this document Turkey's vision in this transformation was being a country that has become a focal point in the production of science and technology, that uses information and technology as an effective tool, that produces more value with information based decision making processes, that is successful in global competition and that has a high level of welfare (e-Transformation Turkey Executive Board, 2004). In 2005 a new action plan, which includes updated actions in the same areas with previous short term plan, was brought into force.

In 2004 National Science and Technology Policies 2003-2023 Strategy Document was published by TÜBİTAK. This document included a technology foresight study which attached gaining competence in science, technology and innovation to the 2023 vision of Turkish Republic. Grounding on this foresight study, national science and technology strategy was determined as dominating in strategic technology areas and transforming this dominance to economic and social benefits. Being one of those strategic areas, ICT sector was expected to contribute to sustainable economic development by creating new products and technologies as well as putting more effective communication opportunities and richer information sources into service of other sectors (TÜBİTAK, 2004a). Moreover, Science and Technology Policies Application Plan 2005-2010 was accepted by The Supreme Council for Science and Technology (BTYK) in 2004. In this plan seven major action areas were stated as developing science and technology awareness and culture, educating scientists, supporting result oriented and qualified researches, activating national science and technology management,

strengthening the performance of the private sector in science and technology, improving research environment and infrastructure and enabling national and international networks. Moreover, with this document Turkish Research Area (TARAL), which was a conceptual unity aiming to bring synergy among all actors in IT and R&D fields, was defined (TÜBİTAK, 2004b).

In the Ninth Development Plan (2007-2013) of Turkey, disseminating ICT was determined as one of the main strategic economic and social priorities in order to raise competitiveness of the country. Within this framework, improving ICT infrastructure by encouraging competition in the electronic communication sector, introducing alternative infrastructure and services, ensuring efficient, fast, secure, and widespread access to information at affordable costs; extending broadband coverage; increasing the usage of ICT by enterprises, citizens and institutions and using public procurement as an effective tool to foster development of ICT within the country were the major policy priorities in this document (SPO, 2006c).

In addition to previous efforts within the scope of e-Transformation Turkey Project, Information Society Strategy (2006-2010) and its annexed Information Society Strategy Action Plan were prepared by SPO with the contributions of other stakeholders in order to enable Turkey to benefit from ICT effectively and identifying the middle and long term strategies and targets for the realization of that transformation. Strategic priorities in the Strategy were social transformation, ICT adoption by businesses, citizen-focused service transformation, modernization in public administration, a globally competitive IT sector, competitive, widespread and affordable telecommunications infrastructure and services and improvement of R&D and innovation (SPO, 2006a). The Action Plan covers the activities and projects that would be implemented to achieve the identified strategic objectives (SPO, 2006b).

In its fifteenth meeting in 2007 BTYK adopted National Innovation Strategy 2008-2010 to achieve desired progress by coordination and strategic management of all innovation elements and instruments within the country. Action areas proposed by this document can be summed up as encouraging entrepreneurship, innovativeness and productivity, using science and technology capacity of the country most efficiently, supporting existence of sustainable, strong and competitive markets, facilitating appropriate environment and infrastructure, enhancing international cooperation and improving management and coordination of the

innovation system (TÜBİTAK, 2007b). Also another document named as International Science, Technology and Innovation Strategy Application Plan (2007-2010) was accepted in the same meeting. This document aims increasing science, technology and innovation competencies of Turkey in international arena by taking advantage of international cooperation with countries that were advanced in these areas (TÜBİTAK, 2007a).

In 2008, Law on Supporting R&D Activities and Electronic Communication Law were enacted. The former aimed to gain economic advantage through innovation and technology generation and brought various tax deductions, social security contribution aids, capital supports and grants for R&D activities of the private sector (Official Gazette, 2008b). Latter aspired to ensuring competition and efficiency in the electronic communication sector, extending electronic communication services throughout the country and encouraging technological development in this area (Official Gazette, 2008a).

Last but not the least, National Science, Technology and Innovation Strategy 2011-2016 was prepared by TÜBİTAK and adopted by BTYK in 2010. The vision drawn by this document for Turkey involved producing knowledge, developing new technologies and transforming these to innovative products, processes and services for the sake of the country and humanity. Also in this document, ICT was among prioritized sectors (TÜBİTAK, 2010).

3.2.2. Developments in ICT area in Turkey

ICT have been becoming widespread in all segments of the society in Turkey as it is the case in other OECD member countries. Main ICT indicators of Turkey that are represented in Table 3.1 show that usage of ICT has been increasing steadily. Apart from this increase in quantity, there are also significant improvements in terms of quality. Share of mobile communication which is obviously a higher level of technology application than public switched telephone network (PSTN) and share of broadband internet connection which provides much better service than dial-up network have risen significantly. In addition, share of information technology sector in ICT market has been enlarging though it is still much smaller compared to communications' share.

Table 0.1 Main ICT Indicators of Turkey

	2002	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**[1]

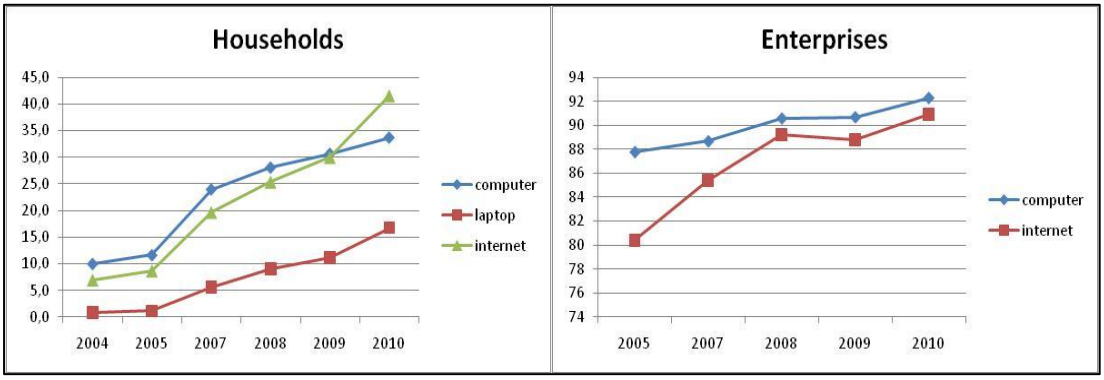
	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011[1]
PSTN Penetration (%)	27	26.8	26.7	26.3	25.8	24.9	24.5	22.8	22	20.7
Mobile Penetration (%)	33.3	39.7	48.5	60.5	72.2	84.9	92.1	86.6	83.9	87.8
Broadband Penetration (%)	-	-	-	2.2	3.8	6	8.4	9.4	11.6	16.9
Internet Penetration (%)[2]	-	8.5	13.5	13.9	18	26.7	35.8	38.1	41.6	45
ICT Market Size (billion $)	-	10.3	11.9	15.8	17.9	21.7	23.8	22.2	25.4	24.2
*Telecommunications	-	8.5	9.6	12.4	13.8	17	16.7	15.5	17.8	16
*Information Technology	-	1.8	2.3	3.4	4.1	4.7	7.1	6.7	7.6	8.2

Source: Annual Programmes between 2004 and 2012

(1) Ministry of Development estimation

(2) The ratios cover 16-74 age groups

As it is seen in Figure 3.1 computer and internet ownerships have been fairly increasing in both enterprises and households since 2005. Increasing competition in telecommunication sector as a result of privatization of Türk Telekom and entry into force of Electronic Communication Law, various discounts and tax deductions for computer purchases and decreasing prices due to advancements in technology played an important role in this progress. In parallel with the growing ICT diffusion in Turkey, there seems to be a positive trend also in terms of ICT employment. While the employment in ICT services sector was about 145,000 people in 2004, it increased to 232,000 by the September 2011 with a 60 per cent raise in seven years. If this fact is taken into consideration together with the rise in total employment in Turkey for the same period just being 26 per cent, enlargement and employment creation potential of ICT sector becomes more apparent (TURKSTAT, 2012).



Source: TURKSTAT Information Society Statistics

Figure 0.1 ICT ownership in households and enterprises

Public ICT investment has also been following a similar trend and its value for 2011 is more than 2 billion Turkish liras and about fourfold of the 2002 level in real terms. But it should be

noted that the upsurge in the last year is exceptional and due to initiation of a big project in the education sector (SPO, 2011). Thanks to these public funds allocated to ICT investments, usage of ICT in delivery of public services has increased as a result of several e-government projects in areas like judicial system, population and citizenship affairs, social security, tax collection and security issues. Likewise, computer and internet facilities in schools and curriculum have been developed in order to provide students with relevant ICT skills. Despite these positive developments, as the previous section reveal Turkey's position in ICT area by comparison with other OECD member countries is certainly not as favorable as desired.

3.3. Assessment

ICT has been treated as a strategic sector and among top priority policy areas in both OECD and Turkey for the last two decades. Depending on the present stage of the ICT revolution in terms of technical, economic and social aspects, a number of special fields arouse more interest. Turkey mostly follows those policy trends in OECD albeit usually with a certain time lag. Governments generally see ICT as an effective tool to achieve sustainable economic and social development ever-increasingly. As a result of the special attention paid to ICT area, recent statistics usually show upwards trends in demand, production, investment, exports and employment regarding ICT sector for OECD area. Also Turkey makes way in similar direction for most of the indicators; however she is among stragglers in most of the comparative statistics. On the other hand, the general problem for the whole OECD area, despite continual improvements in absolute terms, is decreasing shares in worldwide ICT pie, both in demand and supply sides, due to the rivalry of non-OECD economies. Before speculating on the possible suggestions, next section questions whether ICT deserves that great attention by investigating macroeconomic gains of ICT revolution via econometric analyses.

4. Empirical Analyses on Relationship between ICT and Economic Growth

4.1. Methodology

In this study, we carried out two different econometric estimations, one for sample of 30 OECD countries and one for only Turkey. For the sake of convenience, we will refer former as OECD case and for latter Turkey case through remainder of the text. For the OECD case,

we used a balanced panel data set which consists of 30 cross sections (countries) and 10 years time span and, thus, includes 300 observations. Panel data analysis is examining a specific subject by observing multiple experimental objects many times during a certain time span. For Turkish case, we performed a time series analysis with 30 years time span. For the OECD case, due to working with panel data we had to fix upon using fixed or random effects for cross sectional units in our model. Because, it is highly possible that there exist differences in country-specific characteristic among cross sectional units, we used fixed effects in the model's estimation procedures.

Especially for the OECD case, it is highly possible that error terms that are associated with different cross sectional units may have different variances and, thus, heteroskedasticity problem may occur. But unfortunately there is not any special tool to detect and fix heteroskedasticity problem beforehand in eViews. Instead, there are some special options which make eViews to run econometric models assuming the presence of heteroskedasticity and to make feasible estimations accordingly. In order to be in safe, for panel data we used "cross section weights" and for time series data we used "white heterokedasticity consistent covariance matrix estimator" options (Eviews, 2004).

To be able to clear the air regarding the autocorrelation problem, we used the "white period" option as coefficient covariance method in eViews. According to eViews Users Guide, "the white period robust coefficient variance estimator is designed to accommodate arbitrary serial correlation and time-varying variances in the disturbances". (Eviews, 2004, p. 866) Thus, we expect to obtain robust estimates against autocorrelation problem for the panel data analysis. For Turkish case, autocorrelation seems as a more serious problem because of comparative lengthiness of 30 years time span. Therefore, we carefully made autocorrelation test for all model alternatives that belong to Turkish case. Indeed, we encountered autocorrelation in some alternatives and fixed it by employing autoregressive model estimation technique.

For the OECD case, above mentioned possible problematic issues led us to use generalized least squares (GLS) method which is known to be robust against statistical problems like heteroskedasticity and autocorrelation (Gujarati, 2004). In addition, following Erdil, et al. (2010) we also made trials by employing generalized method of moments (GMM) estimation method. However, none of the estimates which are obtained by GMM is statistically meaningful. For Turkish case, we used ordinary least squares (OLS) method.

4.2. The Model

Our dependent variable in our econometric model is the aggregate output. We have two traditional factors of production, capital and labor, in the model as independent variables. Besides them, in parallel with our aim, there are two other explanatory variables as ICT usage and ICT production. Thus, we relate change in output (GDP) with the changes in capital, labor, ICT usage (ICTUSG) and ICT production (ICTPRD) as represented by equation (1) where the coefficients reveal the proportional change in output with the changes in independent variables. However, due to lack of data that goes back to 30 years for Turkey regarding ICT production variable, we could not include the ICTPRD to the econometric model that is used in Turkey case.

$$\text{GDP} = \text{C}(0) + \text{C}(1) \cdot \text{CAPITAL} + \text{C}(2) \cdot \text{LABOR} + \text{C}(3) \cdot \text{ICTUSG} + \text{C}(4) \cdot \text{ICTPRD} \quad (1)$$

We take the change in GDP in order to follow economic growth of countries by using two different proxies for this variable as total GDP and GDP per capita. Both GDP data are calculated according to expenditure approach and in US dollars, constant prices and constant exchange rates of the base year, 2005. For the capital variable, we use gross capital formation data that is calculated in US dollars, constant prices and constant PPPs of the base year, 2005. Considering that gross capital formation data is closely related to the investment, we use this proxy in a similar vein to a number of studies that use investment data for the capital variable such as Pohjola (2000), Yoo (2003) and Nasab and Aghaei (2009). As a matter of course we expect capital variable to have a positive coefficient in our econometric model. For the labor variable, we have two different proxies. First, similar to Röller and Waverman (2001) that use total labor force, we have total civilian labor force as a proxy for labor variable. Our second proxy is obtained by multiplying total civilian labor force data and labor productivity index. We also expect a positive sign for the coefficient of labor variable in either case.

In order to verify our hypothesis about positive relationship between ICT diffusion and economic growth, we add an explanatory variable as ICT usage in our econometric model anticipating a positive coefficient for it. As a proxy for ICT usage variable, similar to

Breitenbach, et al. (2005) and Erdil, et al. (2010), we employ communication access channels (total of analogue lines, ISDN lines, DSL, cable modem and mobile subscribers) and corresponding value of this statistics per 100 inhabitants.

Similar to Jorgenson and Stiroh (1999), Oliner and Sichel (2000), Colecchia and Schreyer (2001) and Jalava and Pohjola (2005) current study suspects optimistically about existence of significant positive impacts of ICT production capabilities and volumes of countries on their economic growths. In order to test this, we have an ICT production variable on the right hand side. Total ICT goods exports in constant US dollars and number of patents in the ICT sector are used as proxies for this variable.

Undoubtedly, there may exist more accurate proxies for all variables in our model. But we are not free from a common obstacle, data availability problem, for this kind of econometric studies, especially which need suitable data regarding ICT area. Therefore, we have to be contented with above described proxies. A summary of the variables and associated proxies is represented in Table 4.1.

Table 0.1 Description of Variables in the Model

Variable	Description
GDP	Total GDP or GDP per capita that are calculated according to expenditure approach and in US dollars, constant prices and constant exchange rates of the base year, 2005.
CAPITAL	Gross capital formation that is calculated in US dollars, constant prices and constant PPPs of the base year, 2005.
LABOR	Total civilian labor force or Total civilian labor force*Labor productivity index.
ICTUSG	Communication access channels or Communication access channels per 100 inhabitants.
ICTPRD	Total ICT goods exports or Number of patents in ICT sector

4.3. Data

For the OECD case, data sets that are employed in our econometric analyses belong to 30 OECD member countries that became so before 2010. Time span of our empirical study is the period between 1999 and 2008. This period actually coincides with the time span for which effects of ICT revolution are expected to be felt precisely. For Turkish case, our time series regression involves 30 observations between 1980 and 2009. We use a single data source,

OECD Statistics Database, for all proxies and hoping to benefit from this fact in terms of compatibility and consistency of our data sets.

To be able to stabilize the variation in the data sets we took logarithms for all of them. Further, suspecting about non-stationary nature of data sets, we performed unit root tests for all variables. Ultimately, it is seen that there is a unit root problem for all data series. We overcame this problem by taking first order difference of data sets for the OECD case. For Turkish case unit root problem in ICT usage data remained despite first order differencing. Therefore we had to take second order differences. Although these operations decreased the number of observations to 270 for the OECD case and to 28 for the Turkey case, they strengthen the reliability of econometric analyses. Furthermore, we were also cautious about the influence of GDP growth on growths in capital, labor, ICT usage and ICT production. For this reason, we carried out pairwise Granger causality tests for all data series and proved that there is not any reverse causal relationship between independent variables and dependent variable statistically.

4.4. Estimation and Results

We have two different proxies for each of GDP, LABOR, ICTUSG and ICTPRD variables and for the OECD case and we used both GLS and GMM methods separately for all proxy combinations. Besides, we made additional trials by including lagged value of dependent variable to the model. These facts result in 64 different estimation combinations for the OECD case. Here, we provide the outputs belonging to four best efficient estimations in terms of significance of variables. Table 4.2 displays the coefficients of each variable in each model as well as associated t-values in parentheses and adjusted R^2 statistics for the OECD case.

Table 0.2 Results of Selected Estimations for the OECD case

Variable	**Model-1**	**Model-2**	**Model-3**	**Model-4**
CAPITAL	**0.137**** (12.013)	**0.137**** (12.028)	**0.135**** (11.194)	**0.135**** (11.252)
LABOR	**0.397**** (10.037)	**0.397**** (10.035)	**0.411**** (9.508)	**0.410**** (9.526)
ICTUSG	**0.028**** (2.776)	**0.028**** (2.782)	**0.030**** (2.733)	**0.031**** (2.745)
ICTPRD	**0.008***	**0.008***	**0.008***	**0.008***

Variable	Model-1	Model-2	Model-3	Model-4
	(1.997)	(1.996)	(2.165)	(2.159)
CONSTANT	**0.009**** (6.844)	**0.009**** (7.209)	**0.001** (0.885)	**0.001** (1.019)
Adj. R2	0.806	0.806	0.798	0.798

* Significant at the 5 per cent level

** Significant at the 1 per cent level

In all of the above mentioned four models for the OECD case, gross capital formation, effective labor (total civilian labor force multiplied by labor productivity index) and number of patents in ICT sector are used as proxies for CAPITAL, LABOR and ICTPRD respectively. For GDP as the dependent variable, we use total GDP in models (1) and (2) and GDP per capita in models (3) and (4). Proxies for ICTUSG variable are total access channels in models (1) and (3) and total access channels per 100 inhabitants in models (2) and (4).

Concerning the significance of variables, all of them are significant at the 1% level in all four models except the intercept term which is not significant in models (3) and (4) as well as ICTPRD variable which is significant at the 5% level in all models. Moreover, coefficients of independent variables do not vary markedly among alternative models.

Apart from these, in order to be able to observe the marginal contribution ICT production variable to estimations, we performed additional trials for above mentioned 4 models by taking the ICTPRD variable out for the OECD case. As it is represented in Table 4.3, exclusion of ICTPRD variable resulted in a slight increase in the contribution of capital and ICT usage variables to GDP growth.

Table 0.3 Results of Selected Estimations for the OECD case without ICTPRD

Variable	Model-1	Model-2	Model-3	Model-4
CAPITAL	**0.143**** (11.941)	**0.143**** (11.957)	**0.142**** (11.164)	**0.142**** (11.205)
LABOR	**0.399**** (9.973)	**0.398**** (9.986)	**0.412**** (9.135)	**0.411**** (9.142)
ICTUSG	**0.030*** (2.541)	**0.030*** (2.546)	**0.032*** (2.467)	**0.033*** (2.482)
CONSTANT	**0.009**** (6.531)	**0.009**** (6.954)	**0.001** (0.920)	**0.002** (1.063)

Variable	Model-1	Model-2	Model-3	Model-4
Adj. R2	0.761	0.761	0.758	0.758

* Significant at the 5 per cent level

** Significant at the 1 per cent level

For Turkish case, using two different proxies for each of GDP, LABOR and ICTUSG variables and making additional trials by including lagged value of dependent variable to the model for each proxy combination we had 16 different estimations. Here, we provide the outputs belonging to four best efficient estimations in terms of significance of variables. Table 4.4 displays the coefficients of each variable in each model as well as associated t-values in parentheses and adjusted R^2 statistics for Turkish case.

Table 0.4 Results of Selected Estimations for Turkish case

Variable	Model-1	Model-2	Model-3	Model-4
CAPITAL	**0.101*** (6.288)	**0.101*** (6.282)	**0.101*** (6.391)	**0.100*** (6.389)
LABOR	**0.602*** (10.334)	**0.602*** (10.338)	**0.604*** (10.612)	**0.604*** (10.611)
ICTUSG	**-0.038** (-0.96)	**-0.038** (-0.973)	**-0.030** (-0.816)	**-0.030** (-0.826)
CONSTANT	**-0.001** (-0.552)	**-0.001** (-0.543)	**-0.001** (-0.305)	**-0.001** (-0.297)
Adj. R2	0.950	0.950	0.951	0.951

* Significant at the 1 per cent level

In all of the above mentioned four models for Turkish case, gross capital formation and effective labor (total civilian labor force multiplied by labor productivity index) are used as proxies for CAPITAL and LABOR respectively. For GDP as the dependent variable, we use total GDP in models (1) and (2) and GDP per capita in models (3) and (4). Proxies for ICTUSG variable are total access channels in models (1) and (3) and total access channels per 100 inhabitants in models (2) and (4).

Concerning the significance of variables, CAPITAL and LABOR are significant at the 1% level in all four models whereas the intercept term and ICTUSG are not significant in any models. Furthermore, coefficients of independent variables do not vary markedly among alternative models.

4.5. Assessment

As it is already clear to the reader, there are substantial differences regarding empirical analyses for the OECD and Turkish cases in terms of employed econometric method, time span of data sets and number of observations. Inherently, it is possible to reach findings that differ in terms of reliability and message for these two cases. Hence, we will evaluate the results of econometric analyses for the OECD and Turkish cases separately.

4.5.1. Assessment of the findings of the OECD case

According to results of our econometric analyses that belong to the OECD case, all of capital, labor, ICT usage and ICT production variables have a positive impact on the economic growth in compliance with our expectations. Even though all of those effects are significant in statistical terms, their magnitudes differ substantially.

We find out that ICTUSG variable has a coefficient about 0.03 which indicates that a 1% rise in ICT capital results in 0.03 percentage increase in GDP growth. This value is pretty lower than Erdil et al. (2010)'s estimate which is approximately 0.1. However, Röller and Waverman (2001), which investigates just OECD countries as we do, reached a value of 0.045 for the coefficient of independent variable associated with ICT diffusion. Yet more, Röller and Waverman (2001) comment that their estimate is a little bit large. Thus, our result regarding the effect of ICT usage on economic growth seems reasonable and can also be a supportive argument for the growth-friendly results of ICT revolution.

Coefficient of ICTPRD variable, 0.008, shows that a 1% rise in ICT production results in 0.008 percentage increase in GDP growth. Although this effect seems to be very small, it still provides some insights about the positive relationship between ICT production capabilities and GDP growth. In literature, favorable consequences of ICT revolution are mostly linked with the increase in ICT usage in economy and society wide levels instead of rise in ICT production volumes. When considered from this point of view, it is quite natural to obtain a smaller coefficient for the variable associated with ICT production than the ICT usage variable. Our findings about ICTPRD variable do not put away our affirmative opinion regarding the positive relationship between ICT production and economic growth; instead they encourage us to continue arguing so.

According to our results, coefficients of capital and labor variables are approximately 0.14 and 0.4, respectively. When well accepted economic growth theories are taken into consideration, these strong positive connections between capital and labor and output are no wonder. In fact, we can find some foot prints of ICT in shares of GDP growth attributed to capital and labor. Firstly, our proxy for CAPITAL, gross capital formation, includes the changes in ICT capital stocks. Moreover, as we previously explained, ICT diffusion improves labor productivity considerably. Therefore, our proxy for labor that is calculated by total civilian labor force multiplied by labor productivity index also involves indirect effects of ICT revolution. These facts constitute further support for the positive relationship between ICT revolution and economic growth.

4.5.2. Assessment of the findings for Turkish case

Before starting to evaluate the results of econometric analyses for Turkish case, we should state that these analyses are much weaker than those made for the OECD case. Because, number of observations in the former is approximately one tenth of the latter's and this fact reduces the power of analyses considerably. Therefore, it is better to be more attentive while drawing conclusions depending on the results of econometric analyses for the Turkey case, especially those contradict with the OECD case.

According to results of our econometric analyses that belong to Turkish case, capital and labor variables have a positive impact on the economic growth in compliance with our expectations. However, contrary to both our expectations and findings of the econometric analyses for the OECD case, ICT usage variable has not any significant positive effect on the economic growth in Turkey during the period between 1980 and 2009. As Table 4.3 indicates, ICTUSG is not a statistically significant variable in any models. This points out that there is not any remarkable linkage between ICT usage and economic growth. We think that, besides the methodological weakness due to fewness of data points, this result can be explained by the particular conditions of Turkey.

As the findings of many studies that investigate different group of countries for different time periods such as Jorgenson and Stiroh (1999), Röller and Waverman (2001), Oliner and Sichel (1994), Parham, et al. (2001), Ramlan, et al. (2007), Kim (2002), Jorgenson and Motohashi

(2005), Whelan (2000), Oliner and Sichel (2000), Oulton (2001), Armstrong, et al. (2002), Van Ark (2001) and Daveri (2002) suggest, positive impacts of ICT revolution occur with a certain time lag after widespread diffusion of ICT. Furthermore, those desirable impacts are felt increasingly with the passing of time thanks to spillover and network effects. Accordingly, lack of significant relationship between ICT usage and economic growth in Turkey for the 1980-2009 period can be explained by the fact that ICT diffusion in Turkey have not gone beyond the critical threshold yet or early enough. In addition to this, in a similar vein to Pohjola (2000) and Dewan and Kraemer (2000), we think that existence of complementary physical and social infrastructures in a country plays an important role in terms of exploitation of ICT revolution in that country and case in Turkey may be affected by also this circumstance. Moreover, weakness of proxies that were employed for ICTUSG variable might not be appropriate enough to reflect contribution of ICT usage to economic growth for Turkish case. Further research that works with better proxies as well as sectoral level data will be useful in terms of understanding the dynamics of ICT revolution in Turkey.

Lastly, our findings indicate that coefficients of capital and labor variables are approximately 0.1 and 0.6, respectively. Similar to the OECD case, these strong positive relationships between capital and labor and economic growth are quite expectable. It is seen that growth in effective labor is more influential on economic growth for Turkish case compared to the OECD case. May be, positive impact of ICT revolution that we could not be confirmed statistically with ICT usage variable is hidden in growth effect of labor to some extent for Turkish case.

5. Conclusion and Suggestions

ICT revolution has various direct and indirect positive impacts on the economy. However, it is not so easy to test and quantify the exact magnitude and scope of all consequences of that revolution. Even so, it is possible to achieve these in aggregated terms by investigating the macroeconomic effects of ICT. To that end, we looked at the relationships between GDP growth path, which seems as a somewhat acceptable gauge for the overall direction of an economy and contains the results of all those effects that are mentioned above more or less in the long run, and ICT usage and production variables econometrically. In the empirical part of the thesis, we performed two distinct sets of analyses. For the first one, the OECD case, we worked with data sets that belong to 30 OECD member countries and period between 1999

and 2008. For the second set of analyses, Turkish case, we utilized data only for Turkey and 30 years between 1980 and 2009. Naturally, due to fewness of number of observations in the latter, relevant results were weaker.

For the OECD case, results of our econometric analyses indicate that both ICT usage and production have a positive effect on the economic growth. We find out that ICT usage variable has a coefficient about 0.03 which indicates that a 1% rise in ICT capital results in 0.03 percentage increase in GDP growth. Besides, coefficient of ICT production variable, 0.008, shows that a 1% rise in ICT production results in 0.008 percentage increase in GDP growth. As a consequence, our empirical findings support that there exists a positive link between ICT revolution and economic growth, at least when 30 OECD member countries between 1999 and 2008 are considered within our empirical framework. This conclusion validates computationally our theoretical analyses regarding economics of ICT.

On the other hand, for Turkish case, we could not reach any significant positive effect of ICT usage on the economic growth. ICT usage variable in our econometric model was not statistically significant. This points out that there is not any remarkable linkage between ICT usage and economic growth in Turkey between 1980 and 2009. We think that, besides the methodological weakness due to fewness of data points, this result can be explained by the particular conditions of Turkey. As the findings of many similar studies suggest, positive impacts of ICT revolution occur with a certain time lag after widespread diffusion of ICT. Furthermore, those desirable impacts are felt increasingly with the passing of time thanks to spillover and network effects. Accordingly, lack of significant relationship between ICT usage and economic growth in Turkey for the 1980-2009 period can be explained by the fact that ICT diffusion in Turkey have not gone beyond the critical threshold yet or it is early to measure its impacts. In addition to this, we think that existence of complementary physical and social infrastructures has an influence on emergence of positive results of ICT revolution. Our findings for Turkish case may also root in insufficiency of those complementary infrastructures in Turkey.

5.1. Policy Suggestions

As our theoretical discussions and empirical findings reveal, there seems to be a positive relationship between ICT and economic growth, especially for developed countries. Although

our econometric findings for Turkish case fail to back up the optimism about ICT due to above explained reasons, growth friendly results of ICT revolution can still be championed quite easily and securely thanks to the general tendency of relevant literature as well as other empirical and theoretical findings of this thesis. Concordantly, OECD countries, including Turkey, have treated ICT as an important issue and paid special attention to it in order to foster economic growth. When the policy documents of last two decades are investigated, it is seen that ICT has been regarded as a strategic sector and among top priority policy areas in both OECD and Turkey. As a result of this particular attention towards ICT area, recent statistics usually show upwards trends in demand, production, investment, exports and employment regarding ICT sector for OECD area. Similar trends are also observed in Turkey; but she is among stragglers in most of the comparative statistics among OECD countries.

We think that Turkey should certainly get her share of ICT revolution. Because, as it is discussed throughout this study, ICT bring forth various economic and social advantages for those that can take necessary steps in an appropriate and timely manner. In this regard, the main aim of Turkish ICT policy should be "utilizing ICT as an effective tool to foster economic and social development".

To be able to reach this target, one of the priorities of ICT policy should be dealing with the ICT demand side. Turkey should not content itself with advancements in absolute terms regarding ICT diffusion. Instead, believing the growth friendly results of ICT usage, it should make some steps to improve its comparative position against other countries. In other words, following the general trends may not be enough to break through in economic progress, but proactive actions regarding ICT area may be more helpful to make a difference. On the other hand, just making more and more ICT investment and, thus, increasing ICT diffusion to whole economy and society cannot be the ultimate goal. Surely, qualitative improvements in ICT usage should accompany those developments. ICT spending should be directed to more productive aims; ICT investments should serve for increasing the efficiency, effectiveness and value added capacity of the economic activities. In addition to these, necessary precautions should be taken to channel individual users to benefit from ICT for more meaningful purposes.

In order to enhance ICT diffusion throughout the economy and society, various financial instruments in the hands of the government can be mobilized. In the simplest term, taxes on

ICT should be decreased by stretching the budgetary constraints. This reduction should be put into practice fractionally. Taxes on certain ICT products and services, which are determined as the most rewarding ones in terms of economic and social outcomes, should be cut more compared to others or even remove completely. Thus, both quantitative and qualitative improvements regarding ICT diffusion could be attained. Moreover, people that belong to disadvantageous segments of the society in terms of income, education, age, geographical location and physical or mental disabilities should be encouraged to own and effectively use ICT by the relevant tools. Tax reductions could be advanced specifically for these groups of people and also direct financial support for their ICT purchases can be provided. In addition to these, powerful precautions should be taken regarding the computer literacy and competencies of both citizens and businesses. Undergoing efforts to provide computer skills to students should continue increasingly. These efforts should also involve other civilians, especially employees. In this sense, firms may be encouraged financially to gain required computer competencies to their personnel. Further to that, economic and social opportunities and advantages that are brought by ICT, especially Internet, should be put across to relevant bodies effectively.

We strongly think that ICT revolution is not just an intensive usage of ICT in various segments of economic and social lives; it has also a supply side. Thanks to continuous and growing demand to its mostly value-added products, ICT sector matter a lot for modern economies. Therefore, Turkey should urge upon ICT production without loss of time. Thus, she can succeed more sustainable economic growth and proceed in solving the unemployment problem.

In accordance with this purpose, certain sub-fields in ICT area should be determined and all kinds of meaningful efforts in those fields should be encouraged and supported by the government by all available means. Designating the ICT as strategic sector as a whole is not sufficient and efficient enough. Instead, Turkey should focus on particular ICT products with the aim of constituting a worldwide perception as “that product can be produced best in Turkey”. For this assertive target, government should mobilize all financial, technical, legislative, administrative and regulatory possibilities. Although private sector mostly follows the new technological trends in the world better than the public sector, firms may suffer from lack of enough courage and scale. Government should bring together and lead forth actors from private sector and academia to develop new business in promising ICT fields. As the

most extreme possibility, government may become a partner of such enterprises. What is more, with its gradually increasing ICT spending budget, government is an important customer of ICT sector. This fact should be used to strengthen domestic ICT firms as far as they satisfy the quality requirements. Besides opting for the existing products and services of domestic ICT firms, government can make them to produce new ICT products and services that fulfill its necessities by giving guarantee of purchase.

As ICT diffuses and influence deeply to other sectors, ICT policy should also be highly integrated with policies in other topics like education, industry, foreign trade, labor, energy, transportation, environment, etc. As it is mentioned before, gaining sufficient computer skills to citizens and training qualified ICT professionals should be among priorities of education policy. Curriculums on computer related subjects in both vocational and higher education systems should be developed and transformed in line with technological trends and requirements of the real sector. Furthermore, while designing and implementing industry and foreign trade policies, high-value added ICT products should certainly be given primacy.

Moreover, opportunities and risks of ICT revolution should be kept in mind for labor policies. People, who do not have necessary skills required by the ICT revolution, face with threat of losing their jobs or retrogression in terms of income statue. Labor policy should ensure either updating competencies of this kind of people in order to help them to retain their current employment or retraining them to find new jobs in different areas. Besides, working forms like teleworking may be used as a tool for actualizing flexible employment policies. Labor policy instruments can be developed to make it possible for people, who cannot find an ordinary full time job, to earn money by accomplishing certain tasks via internet.

Eco-friendly or green ICT products and services offer tremendous opportunities for cutting energy costs and decreasing carbondioxide emissions by enabling energy efficiency improvements especially in manufacturing, buildings, transport systems and electric grids. Policies regarding energy, transportation, environment, construction and manufacturing sectors should pay attention to those innovative ICT solutions. Firms that operate in these sectors should be encouraged to adapt energy efficient ICT applications to their business and, thus, gain competitive advantage by cutting their costs.

Lastly, Turkey should strengthen its physical and social infrastructures in order to reap the benefits of ICT revolution fully. ICT makes factors of production more productive, but this positive impact is highly dependent on both quantity and quality of those factors. As well, because ICT diffuse in all aspects of economic and social lives, its effects occur in mutual interaction with economic and social conditions. Actually, measures to improve physical and social infrastructures comprise a very wide range of practices and this issue is a much more top level one compared to ICT policy. Generally speaking, Turkey should allocate proportionately more funds to long-termed physical and social infrastructure investments to benefit from ICT revolution properly as well as increasing living standards of its citizens.

Before concluding this study, we should state that our empirical analyses have some limitations. If the number of observations can be increased by working with data sets that cover more countries and longer time periods, strength of empirical analyses will also rise significantly. In addition, utilizing more accurate ICT proxies, especially for the ICT production variable, will undoubtedly lead more reliable conclusions. Further research should also focus on sectoral impacts of ICT revolution by employing micro data. By this way, eventual results of ICT revolution in different fields and on different aspects can be evaluated precisely.

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