THE IMPACT OF INFORMATION AND COMMUNICATION TECHNOLOGY ON ECONOMIC GROWTH: TURKISH CASE

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—Abstract —

In the modern economic perspective information and communication technology is seen as an important production factor by reason of knowledge-driven (new) economy. Many researches assess that knowledge, innovation and technological changes become important factor for economic growth. Furthermore modern growth theory highlights the importance of knowledge for economic growth. Depending on this, investing on information and communication technology becomes more important. Therefore, determining the impact of information and communication technology on economic growth arouse interest of researchers.

The main purpose of this paper is to put forth the impact of information and communication technology on economic growth for Turkey with the theoretical background. Characterization of information and communication technologies and a framework of impact of information and communication on economic growth will be presented. On the other hand, impact of information and communication technology on main sectors that effects growth is aimed to be examined. This will provide a better understanding of impacts of information and communication technology on economic growth and ICT-sensitive sectors that effect economic growth for Turkey. The hypothesis to be tested is whether information and communication technology boosts economic growth especially through ICT-sensitive sectors. In this context, the importance of results, which obtained from time-series analysis, in examination of the relationship between information and communication technology and economic growth is assessed. Thus, a contemporary analysis of the impact of information and communication technology on economic growth would contribute to discussions.

Key Words: *Economic Growth, ICT-sensitive sectors, Information and Communication, Knowledge*
JEL Classification: *O40, D80*

1. INTRODUCTION

In the modern economic perspective information and communication technology is seen as an important production factor by reason of knowledge-driven (new) economy. Many researches assess that knowledge, innovation and technological changes become important factor for economic growth. Furthermore modern growth theory highlights the importance of knowledge for economic growth. Depending on this, investing on information and communication technology becomes more important. Therefore, determining the impact of information and communication technology on economic growth arouse interest of researchers.

Since 1990's, numerous studies have shown the theoretical and empirical relationship between the development of information technology and economic growth, as it gains substantial research interest (Kim, 2007). The role of information technology in the growth of economy is now understood. The development and spread of information and communication technology is the key for the economic growth and development. Recently, OECD examined sources of and differences in growth patterns between OECD countries and concluded that one factor that has become increasingly important is information and communication technology (ICT) (Colecchia and Schreyer, 2002). Every year, developing and transitional economies spend in excess of US$800bn on information and communication technologies (ICT's) (Heeks, 2010).

Innovation in information and communication technologies has been substantial in recent years, with significant positive effects on productivity (Houben and Kakes, 2002). The rapid diffusion of information technology is a direct consequence of swift decline in the price of computer-related equipment, which has led to a vast and continuing substitution of IT equipment for other forms of capital and labor (Jorgenson and Stiroh, 1999). For many years, economics were skeptical regarding effects of computer technology on aggregate productivity and economic growth. The statement attributed to Nobel Prize winner Robert Solow "You can see computers everywhere, except in productivity figures" captures this perspective quite vividly (Edwards, 2002).
This main purpose of this paper is to examine the impact of information and communication technology to the main sectors of the Turkish economy. Our findings show that except financial services, expenditure on R&D and total public telecommunications operator investments have an impact on the main sectors.

The paper is organized as follows second section explains the role of information and communication technologies. At the third section literature is reviewed. Fourth section describes methodology and data. Fifth section presents the main results of time series analysis. Sixth section concludes the results.

2. THE ROLE OF INFORMATION AND COMMUNICATION TECHNOLOGIES

The ICT revolution had caused concrete and serious changes on the real economy. In particular, it created a huge goods and services economy with strong forward and backwards linkages (Erdil, Türkcan and Yetkiner, 2009). A mantra of the 'New Economy' –faster, better, cheaper- captures the speed of technological change and product improvement in semiconductors and precipitous and continuing fall in semiconductor prices. The price decline has been transmitted to the prices of products that rely heavily on semiconductor technology. This technology has also helped to reduce the cost of aircraft, automobiles, scientific instruments and a host of other products (Jorgenson, 2001).

Technological innovation in the ICT sector has important macro economic consequences that have launched the notion of a 'New Economy' (Houben and Kakes, 2002). Theoretically, the development in ICT may affect not only economic growth but employment as well, and economic growth and employment may affect ICT development. ICT development may positively affect productivity and growth, which will eventually lead to a higher employment, as such economic growth will positively affect labor market (Kim, 2007).

The literature has identified two important channels by which ICT can have real effects on real economy: production of ICT and the use of ICT. Firstly, the ICT sector itself become an important industry at global level coincided with the growth of the service industries. Secondly, ICT revolution has contributed significantly to the whole economy by rising productivity (Erdil, Türkcan and Yetkiner, 2009).

3. LITERATURE REVIEW

In fact, early and detailed empirical studies of US business sector by Stephen Oliner and Daniel Sichel (1994), Erik Brynjolfsson (1993), and Dale Jorgenson and Kevin Stiroh (1995), among others, suggested that information technology

had made a very small contribution to US overall growth during the 1970s, 1980s and first part of 1990s (Edwards, 2002).

Oliner and Sichel (2000) and Jorgenson and Stiroh (2000) were the first authors who examined this resurgence of US growth. Oliner and Sichel (2000) concluded that ICT capital deepening and industry productivity of computer sector were responsible for two-thirds of the rise in ALP during late 1990s. Jorgenson and Stiroh (2000) used a slightly different methodology and found almost the same result (Antonopoulos, 2009).

Kim (2007) argued that there exist bi-directional Granger-causality relationships between ICT development and economic growth.

Erdil, Türkcan and Yetkiner (2009) find that ICT has positive and significant effect on economic growth.

Chew, Ilavarasan and Levy (2010) find that in urban microenterprises owned by women, business growthis a function of ICT access and is related to motivation to use ICTs for business purposes.

Schreyer (2000) argued that ICT capital goods have been important contributors to economic growth in his research.

4. METHODOLOGY AND DATA

In this study, using time-series methods of investigation in Turkey, the impact of ICT on sectors examined. The annual data is used in this study. The data ranging from 1980 to 2011 for Turkey obtained from OECD iLibrary system. The data's are as follows. Gross Domestic Expenditure on R&D as GERD and Total Public Telecommunications Operator Investments as TPTOI used as proxies for development in ICT. Nominal share of trade sector in GDP as TRA, nominal share of industrial sector in GDP as IND, nominal share of financial services in GDP as FIN, nominal share of constructing sector in GDP as CON and nominal share of manufacturing sectoring GDP as MAN deflated by consumer price index and used as proxies for GDP.

5. RESULTS

Results of the ADF tests for unit roots and check for the presence of cointegrating relations between GDP variable and ICT variables are shown below.

5.1 UNIT ROOT TEST

Before analyzing time series data, stationary test application as known the unit root test is required. According to the results of the unit root test count of time series are integrated of order is important. If the variables are integrated of the same order applying the cointegration test is possible. All of the variables tested by ADF unit root test for stationary. The lag length are chosen by the result of Akaike's Information Criterion and shown in the parenthesis. Table 1 illustrates that all variables have unit root and cointegrated of the same order, I (1).

Table 1: ADF Unit Root Test Results

Level	***Constant***	***Constant and Trend***
TPTOI	-1.137800 (0)	-2.182075(0)
GERD	-0.336073 (0)	-1.335354 (0)
TRA	-1.520491 (0)	-0.820224 (0)
IND	-1.550837 (0)	-0.931671 (0)
FIN	-1.514726 (0)	-0.992165 (0)
CON	-1.550892 (0)	-0.971829 (0)
MAN	-1.512336 (0)	-0.991344 (0)
1st Difference	***Constant***	***Constant and Trend***
TPTOI	-6.426937 (0)*	-6.327431 (0)*
GERD	-4.789869 (0)*	-4.714889 (0)*
TRA	-4.727914 (0)*	-4.607071 (0)*
IND	-4.844087 (0)*	-4.710207 (0)*
FIN	-4.976772 (0)*	-4.888455 (0)*
CON	-5.089368 (0)*	-5.020942 (0)*
MAN	-4.889019 (0)*	-4.753711 (0)*

* %1 level

5.2. JOHANSEN COINTEGRATION TEST

If all of the variables are integrated of same order, one has the opportunity to apply the cointegration test. Cointegration between the variables identifies the long-term relationship, if there is no cointegration states that there are no long-term relationships. In our study, we employ the Johansen cointegration test procedure. The results of the cointegration test applied to all time series are reported in each of the table.

The results from the cointegration analysis in Table 2 indicate that there exists a long-run relationship between the Industrial Sector and ICT variables. A close relationship between industrial sector and ICT variables implies that an increase on GERD or TPTOI enhances the industrial sector.

Table 2: Johansen Cointegration Test Results (Industrial Sector)

	λ_{trace}	
	Trace Statistic	*%5 Critical Value*
None*	34.24509	24.27596
At most 1	11.44596	12.32090
At most 2	1.173987	4.129906
	λ_{max}	
	Max-Eigen Statistic	*%5 Critical Value*
None*	22.79913	17.79730
At most 1	10.27197	11.22480
At most 2	1.173987	4.129906

Trace test indicates 1 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
Max-eigenvalue test indicates 1 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level

The estimated equation can be written as:
IND = 0.629030 TPTOI + 0.089839 GERD
Investment on communication and expenditures on R&D affect the industrial sector. TPTOI has much more impact than GERD.

Table 3: Johansen Cointegration Test Results (Manufacturing Sector)

	λ_{trace}	
	Trace Statistic	*%5 Critical Value*
None*	33.31210	24.27596
At most 1	11.68509	12.32090
At most 2	1.276690	4.129906
	λ_{max}	
	Max-Eigen Statistic	*%5 Critical Value*
None*	21.62701	17.79730
At most 1	10.40840	12.32090
At most 2	1.276690	4.129906

Trace test indicates 1 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
Max-eigenvalue test indicates 1 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level

Next, we test for the presence of cointegrating relations between share of manufacturing sector in GDP and ICT variables. The results from the cointegration analysis at Table 3 indicate that there exists a long-run relationship between share of manufacturing sector and ICT variables.

The estimated equation can be written as:
MAN = 0.664582 TPTOI + 0.026 GERD
Also TPTOI affects manufacturing sector more than GERD. This result with the above result became more important.

The results from the cointegration analysis in Table 4 indicate that there exists a long-run relationship between the Constructing Sector and ICT variables. Only trace statistics indicates a cointegration relationship. Trace tests is more reliable for cointegration relations. There exists a relationship between construction sector and ICT variables.

Table 4: Johansen Cointegration Test Results (Construction Sector)

	λ_{trace}	
	Trace Statistic	*%5 Critical Value*
None*	26.89748	24.27596
At most 1	12.12220	12.32090
At most 2	0.790183	4.129906
	λ_{max}	
	Max-Eigen Statistic	%5 Critical Value
None	14.77529	17.79730
At most 1**	11.33201	11.22480
At most 2	0.790183	4.129906

Trace test indicates 1 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
Max-eigenvalue test indicates no cointegration at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level

The estimated equation can be written as:
CON= 0.560813 TPTOI + 0.173013 GERD
As expected, two of the ICT variables affect the construction sector. Like the other results TPTOI affects construction sector more than GERD. But unlike the other results GERD has an important effect on construction sector.

The results from the cointegration analysis in Table 5 indicate that there exists a long-run relationship between the trade sector and ICT variables. A clear

relationship between trade sector and ICT variables implies that an increase on GERD or TPTOI enhances the trade sector.

Table 5: Johansen Cointegration Test Results (Trade Sector)

	λ_{trace}	
	Trace Statistic	*%5 Critical Value*
None*	31.38073	24.27596
At most 1	10.72423	12.32090
At most 2	0.945529	4.129906
	λmax	
	Max-Eigen Statistic	%5 Critical Value
None*	20.65650	17.79730
At most 1	9.778701	11.22480
At most 2	0.945529	4.129906

Trace test indicates 1 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
Max-eigenvalue test indicates 1 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level

The estimated equation can be written as:
TRA= 0.527203 TPTOI + 0.229796 GERD
Two of the ICT variables affect the trade sector. Like the other results TPTOI affects the Trade sector more than GERD. Also like the results of the trade sector GERD has an important effect on Trade Sector.

Table 6: Johansen Cointegration Test Results (Financial Services)

	λ_{trace}	
	Trace Statistic	*%5 Critical Value*
None	24.09520	42.91525
At most 1	11.98339	25.87211
At most 2	4.128261	12.51798
	λ_{max}	
	Max-Eigen Statistic	*%5 Critical Value*
None	12.11181	25.82321
At most 1	7.885130	19.38704
At most 2	4.128261	12.51798

Trace test indicates no cointegration at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
Max-eigenvalue test indicates no cointegration at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level

The results reported in Table 6 indicate that financial services is not cointegrated with any of the ICT variables, suggesting that share of the financial services in GDP is independent of ICT variables. Many researches assess other factors as laws, structure of the market and openness of the markets affects the share of the financial services in GDP.

6. CONCLUSION

Using multivariate Johansen tests to investigate the relationships between the GDP variables and ICT variables shows important results. This paper has two main findings. First, the results presented here provide clear evidence that the strength of the relationship between GDP sectors and proxies of ICT is clear except for the financial services. Gross Domestic Expenditure on R&D as GERD and Total Public Telecommunications Operator Investments as TPTOI has key roles in economic growth. Second, Total Public Telecommunications Operator Investments impact on economic growth is more than Gross Domestic Expenditure on R&D. This result is expected for Turkish economy. Investment for infrastructure of communication grows rapidly than innovation.

BIBLIOGRAPHY

Antonopulos, Christos and Plutarchos Sakerallis (2009), "The contribution of Information and Communication Technology Investments to Greek Economic Growth: An Analytical Growth Accounting Framework", *Information Economics and Policy*, Vol. 21, pp. 171-191

Brynjolsson, Erik (1993), "The Productivity Paradox of Information Technology", *Communications of ACM*, Vol. 12, pp. 67-77

Chew, Han Ei, P. Vigneswara Ilavasaran and Mark R. Levy (2010), "The Economic Impact of Information and Communication Technologies (ICTs) on Microenterprises in The Context of Development", *The Electronic Journal on Information Systems in Developing Countries*, Vol. 44, No. 4, pp. 1-19

Colecchia, Alessandra and Paul Schreyer (2002), "The Contribution of Information and Communication Technologies to Economic Growth In Nine OECD Countries", *OECD Economic Studies no.34 2001/1*, Paris:OECD

Edwards, Sebastian (2002), "Information Technology and Economic Growth in Developing Countries", *Challenge*, Vol. 45, No. 3, pp. 19-43

Erdil, Erkan, Burcu Türkcan and I. Haklan Yetkiner (2009), "Does Informnation and Communication Technologies Sustain Economic Growth? The Underdeveloped and Developing Countries Case", *Izmir University of Economics*

Department of Economics Working Paper in Economics 09/01, İzmir: Izmir University of Economics

Heeks, Richard (2010), "Do Information Technologies (ICTs) Contribute To Development", *Journal of International Development*, Vol. 22, pp. 625-640

Houben, Aerdt and Jan Kakes (2002), "ICT Innovation and Economic Performance: The Role of Financial Intermediation", Vol. 55, No4, pp. 543-562

Jorgenson, Dale W. (2001), "Information Technology and U.S. Economy", *The American Economic Review*", Vol. 91, No. 1, pp. 1-32

Jorgenson, Dale W. and Kevin J. Stiroh (1995), "Computers and Growth", Journal of Economics of Innovation and New Technology", Vol. 3, pp. 295-316

Jorgenson, Dale W. and Kevin J. Stiroh (1999), "Information Technology and Growth", *The American Economic Review*", Vol. 89, No. 2, pp. 109-115

Jorgenson, Dale W. and Kevin J. Stiroh (2000), "Raising the Speed Limit: US Economic Growth in the Information Age", *Brookings Papers on Economic Activity*, Vol. 1, pp. 125-211

Kim, Doh-Khul (2007), "Information Technology, Economic Growth, And Employment: Evidence From Time-Series Analyses", *Journal of Applied Business Research*, Vol. 23, No. 1, pp. 71-78

Oliner, Stephen D. and Daniel Sichel (1994), "Computers and Output Growth Revisited: How Big is the Puzzle?" *Brooking Papers on Economic Activity*, No. 2w, pp. 273-317

Oliner, Stephen D. and Daniel Sichel (2000), "The Resurgence of Growthnin Late 1990s:Is Information Technology the Story?", Journal of Economic Perspectives, Vol. 14, No. 4, pp. 3-22

Schreyer, Paul (2000), "The Contribution of Information and Communication Technology to output Growth*", OECD Science, Technology and Industry Working Papers 2000/2*, Paris:OECD