Original Research Article

A Comparative Study on the Impact of Telecommunication Investment on Economic Growth in EU vis-à-vis non-EU OECD countries: A Dynamic Panel Data Analysis

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ABSTRACT

This study aims to comparatively investigate the effects of telecommunication infrastructure on the economical growth in OECD countries. For this purpose, OECD countries were divided into two groups i.e. European Union (EU) and non-EU OECD countries for the period of 1993-2013. Findings of dynamic panel data model showed that investment on the telecommunication infrastructure has more positive effect on EU OECD countries than non-EU OECD countries. Since telecom appears as the key sector to fuel growth because it is associated with information technology and all ramifications of computer based applications and mobile communication, all countries at all development levels are proposed to focus on investing in these sectors the opposite of which hinders growth.

Keywords: Telecommunication; privatization; economic growth; dynamic panel data; European Union.

1. INTRODUCTION

Economic growth is defined as an increase in the level of goods and services produced, compared from one period of time to another. Growth models are used to identify inter-country income level difference. All countries, especially developing ones, intend to support economic growth for their citizens to enjoy higher living standards. Production gap between countries is widely explained by main factors of production and other determinants like technology, foreign direct investment and international trade. Although the effects of the factors differ from country to country, it is well-known that mentioned factors have significant impact on economic growth. For example, skilled labor force has a positive impact on production efficiency and labor force in developed countries is more qualified in comparison to developing countries. Similar to the labor force, capital is another factor that is categorized as physical, human, and financial capital.

In addition to labor force and capital, foreign direct investment (FDI) is also asserted as a vital determinant. FDI, defined as the flow of investment from one country to another, brings along technology and productivity. According to World Investment Report [1], global FDI declined in 2014 in comparison to 2013 due to fragility of world economy, political uncertainties and geopolitical risks. In spite of this decline in FDI, Gross Domestic Product (GDP), trade, and gross fixed capital have grown. Despite the fact that positive influence of FDI on economic growth has been widely verified, there are also number of papers revealing the contradictory outcomes. For example, Herzer [2] analysed the effect of FDI on economic growth in 44 developing countries. Adopting the general-to-specific methodology and reports a negative effect, but also large cross-country differences. Mencinger [3] likewise finds that

FDI has a negative impact on economic growth, with causality unidirectional from FDI to growth. In his study, Alfaro [4] emphasized that impact of FDI can drastically decouple between sectors. According to his findings, while FDI has a positive impact on growth in manufacturing sector, this impact is negative in primary business sector. Distinction of this impact is associated with the presence of bureaucracy in relevant sector, its cost and the economic structure of host country. Lyroudi et al. [5] find that FDI may raise investment and consumption but at the same time, it may lower growth rate due to impairment of prices or misallocation.

The reason why FDI is considered as an important determinant of economic growth is that it has a substantial role in fostering economic growth via transferring innovation, and capital in terms of financial and physical, and creating employment [6]. It is also asserted in other studies that telecommunication is a sector that benefits from FDI inflow [7, 8].

Compared to other infrastructure sectors, telecommunication itself has a more dynamic market structure. For instance, even during an economic crisis, consumers benefit from telecommunication services. Therefore, one of the crucial factors affecting economic growth is the development of telecommunication infrastructure. The crux of the telecommunication sector's impact on economic growth is also related to penetration, productivity and privatization of the sector. The position of telecommunication sector in economy has changed over time; new policies have been determined according to market structure. In 1960s, many developing countries nationalized their telecommunication tool providers. During 1980s, there was a trend towards privatization rather than nationalization. Although the reasons for this trend vary in each country, they can be summarized under three headings: (i) state-controlled telecommunication companies displaying poor performance. (ii) international organizations' pressure on countries for privatization, for example; World Bank was reserving fund for infrastructure investments in 1960s, for organization and management reforms in 1970s, for sectoral reforms including privatization in 1980s. (iii) tendency to remove institutions from state monopoly.

Moreover, during the rule of Thatcher (1979-1990), eliminating state monopoly many institutions in England were privatized [9]. Meanwhile, international organizations made agreements, and the most renowned of these was Agreement on Basic Telecommunications which was signed by 72 members of World Trade Organization (WTO) on February 5, 1998. The most important reason for this and other similar agreements was to provide room for foreign investors. The EU acquis place no limitation on foreign ownership in between the EU borders, albeit the OECD members out of the EU still have some substantial localizations on. These restrictions prevent the contributions to some sectors, especially telecommunication. However, ensuing privatization policies and infrastructural efforts boosted competitiveness. The restrictions in OECD member countries outside the EU are shown in Table 1. Until mid-1990s, integration in the telecommunication industry in Europe was vertical, productivity was low and state-controlled. The formation of a competitive environment in this field depended on privatization and infrastructure investments. To increase productivity, it was decided that an "externalization strategy" would be followed. This decision aimed at income growth and also it was a means of providing FDI flow [10]. The EU competitiveness policies had a significant role in the liberalization of telecommunication.

Table1. Restrictions in the Telecommunication Sector in non-EU OECD Countries

Countries	Restriction, Explanations
Australia	After the privatization of Telstra, the largest operator of Australia, aggregate foreign ownership was limited to 35%, individual foreign ownership was limited to

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	5%.
Brazil	In Brazil, foreign ownership in public telecommunication companies is limited to a maximum of 49%.
Canada	Foreigners cannot own more than 46% of voting shares in telecommunication carrier. Moreover, a certain part of administrative body must consist of Canadian citizens.
Chile	There are no foreign ownership restrictions with one exception: only up to 10% of radio broadcasting companies can be owned by foreign companies.
Iceland	There are no restrictions.
Israel	There are rules such as the nationality of the members of administrative body, residence clauses, more than 75% of administrators must be of Israeli nationality or consist of those residing in Israel.
Japan	There are no restrictions for individuals or institutions to invest in public telecommunication operator (operators) in Japan. Nevertheless, share of foreign capital for Nippon Telegraph and Telephone (NTT) is limited to less than one third (directly and/or indirectly).
Korea	Foreign ownership cannot be more than 49% of securities issued.
Mexico	Concessions are for Mexican nationals only. Foreign investment cannot exceed 49% except for cellular telephone service.
New Zealand	There are no restrictions for other operators but no company can own more than 49, 9% of New Zealand Telecom Company.
Norway	The state holds majority of the shares.
South Africa	Even though there are no direct foreign investment restrictions, foreign ownership in radio or television is limited to 20%.
Switzerland	The federal state must hold majority of the shares in Swisscom, the telecommunication company of Switzerland.
Turkey	There are no restrictions.

Source: OECD [61]; ICT Regulation Toolkit [62]; Pretorius [63.]

The internet and its technologies are massively used for their trade agreements, trade, and market researches in today's companies. Not only companies but also customers get in touch with companies by means of the internet, and they do online shopping. The revenues provided by this expanding market are thought as telecommunication revenues [11]. Telecommunication revenues declined by 4% between 2014 and 2015 in the world. However, developing countries experienced a compound annual growth rate in telecommunication revenue of 6.6% in the period 2007-2015 [12].

According to the estimated data of the International Telecommunication Union (ITU), the number of individuals using internet will be 3.5 billion, and of which 2.5 billion will be from developing countries in 2017 [12]. Technically speaking, number of internet users in developing countries has widely outscored internet users in developed countries by experiencing average growth rate of 16.7% between 2006 and 2017, whereas this rate is 4.3% for developed countries.

Global growth rate for telecommunication between 2001 and 2017 is given in Figure 1. Accordingly, the highest increase has been in the number of mobile phone subscribers (15.5 % in 2001, 103.5 % in 2017), and the highest decline has been in the number of fixed line subscribers. Mobile broadband segment which stands out with its dynamic structure has grown more than 20% annually in the last five years. Compared to 2007, it has increased fourteen times and it is expected to reach 4.3 billion globally by end 2017 [12].

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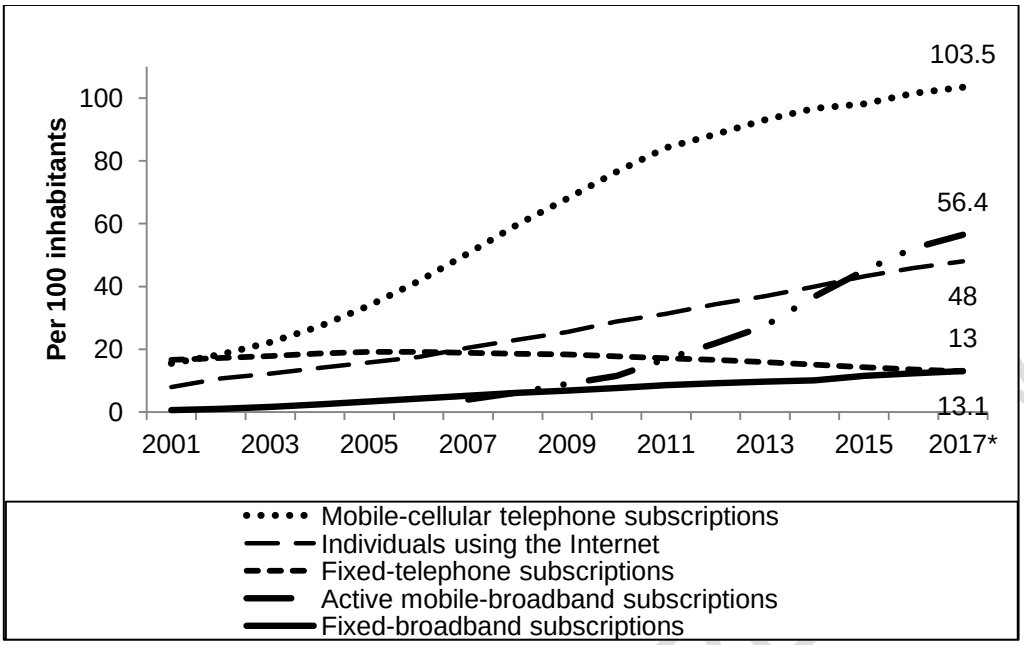

Figure 1. Global ICT Developments, 2001-2017.

*Source: ITU World Telecommunication / Global ICT Developments [64], *Estimated*

When it is looked at the perspective of global improvements, it can be seen easily that telecommunication sector keeps its dynamic structure even in time of economic crisis. By the marketization of this sector and some regulations made, countries have aimed at gearing up, addressing more people, reducing costs, increasing revenues, attracting foreign investors and reducing budget deficit. Another benefit is decreasing state incentives and that this paves the way for states to switch to areas where they can have a comparative advantage. Thus, states allocate all their energy to areas where they can use it more efficiently [13].

It is also mentioned that telecommunication sector can promote spread of market, also increase efficiency of both markets and administration of companies by reducing cost of information, variable cost of market participation and operation, and lowering uncertainty in Less Developed Countries (LCD) [14]. Not only does telecommunication involve fixed line but also many areas like mobile phones, internet, cable TV. Therefore, an investment made in telecommunication sector speed up integration and give rise to a more reliable information network. Especially with the increasing use of the internet, transaction costs have been reduced even more.

According to Thompson and Garbacz [15] who studied the impact of broadband penetration on economic growth, there are direct and indirect impacts of the internet on economic growth. Because along with the developments in communication, entrepreneurs in geographically far away countries gather in a market established in a larger network and they get into competition globally. Competition leads to the emergence of different products in similar sectors and appreciation of these products in the global market. This situation takes place not only in goods and services market but also in financial markets. Market integration also induces some positive effects on increasing export, technology flow and income. Regarding information and communication technologies (ICT's) Eggleston et al. [16] suggested that there is a means-end based reasoning from information technology to economic growth through disseminating information and creating effective markets as described in Figure 2 below.

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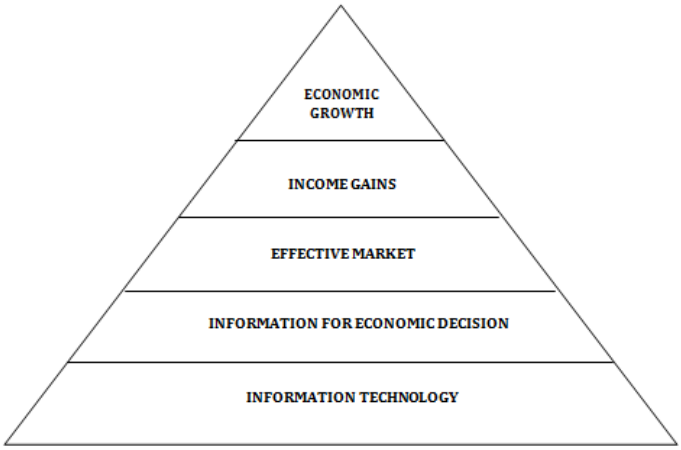

Figure 2. The Digital Provide
Source: Eggleston et al. (2002).

Jensen [17] also emphasizes the inevitable impact of telecommunication sector by indicating "information makes markets work" in his micro level survey. In their studies, Roller and Waverman [18] state that telecommunication infrastructure is pretty different from other infrastructures in terms of forming network externality. In other words, the higher the number of users is, the more benefit users get, and the more competitive market gets.

This study aims to comparatively investigate the effects of telecommunication infrastructure on the economical growth in OECD countries. Specific objectives of this research are to investigate whether the effects of telecommunication infrastructural investments vary in different country groups, and compare the impact of telecommunication on economic growth according to country groups in the OECD.

This paper investigates and analyses whether telecommunication infrastructure is a leading determinant of factors behind the economic growth within these country groups. It also seeks an answer to "Do the effects of telecommunication infrastructural investments vary in different groups?". For this purpose, OECD countries are categorized into two groups as the EU and non-EU countries. Some decisions are taken and goals set in the EU countries are legally obligatory in member countries. Therefore, member countries determine their national policies in accordance with these goals. After the removal of national border controls and impermeabilities where they share their sovereignty, basically to increase production efficiency and to minimize regional disparities. Nevertheless, this kind of novelty does not exist in non-OECD countries.

One of the main features of this study is that, a comparative analysis of telecommunication infrastructural investments in EU and non-EU OECD countries are assessed. Additionally, the answer to "*Is being a member of the EU OECD countries more advantageous*?" also searched in the sense of economic growth in telecommunication factor. This is important for both groups of countries in the OECD. As it is known, the EU has made a couple of regulations under competition policy in the telecommunication sector as in many other areas. These regulations have removed restrictions and eased investment in EU countries more flexibly. The main contribution of this research is to unveil whether developments in telecommunication sector lead to more economic growth in EU vis-à-vis non-EU OECD countries.

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As such, this study outlines the following hypothesis:

H_{01}: Telecommunication infrastructure has no significant impact on economic growth.
H_{02}: Compared to other OECD countries, telecommunication infrastructure in EU members has no significant impact on economic growth.

The rest of the paper is structured as follows: Section 2 discusses the previous literature. In this chapter, studies contributing to literature is analysed. Section 3 presents the dynamic panel data method. Section 4 comprises description of data, test results and adequacy of the model, and in the final section, conclusion is posed along with suggestions for future works.

2. LITERATURE REVIEW

Just after liberalization, majority of developed countries headed for privatization and reforms in infrastructure sectors like telecommunication. In order to engage in global competition, developing countries have recently started privatizing in these sectors. Prior to privatizations they harmonized their technologies and amended their laws/regulations accordingly. Telecommunication investments result in various consequences according to development level of countries. One of the pioneering studies in this field was penned by Jipp [19] who identifies the meaningful and positive correlation between number of telephones and GDP in underdeveloped and industrialized countries. Hardy [20] examines the impact of a number of telephone lines on economic growth in 60 countries for the years between 1960 and 1973. Considering his findings, there is a positive and meaningful effect of telecommunication with the number of telephone lines for developed and developing countries, but the impact is found to be greater in the latter group of countries, while there is no impact of radio investment.

Literature also involves studies employing causality and production function in order to identify the relationship between growth and telecommunication. For instance, Dvornic and Sabolic [21] attempt to find out whether telecommunication investments in Eastern European countries with transition economies affect growth or not; in other words, they try to answer the following two questions “Are telecommunication investments in these countries the cause or the result of economic growth?”, and “Are developments in telecommunication market the cause or the result of economic growth?”. In this respect, the association between telecommunication services and growth for the period 1991-2001 is examined with Granger causality test. Existence of causality from telecommunication investments to GDP is observed. That’s to say, telecommunication investments influence GDP. In case of a three-year delay, bilateral causality is identified between developments in telecommunication market and GDP. Wolde-Rufael [22] analyzes the correlation between telecommunication investments and economic growth for the period 1947-1996. According to Toda & Yamamoto test, bilateral causality is found out. Pradhan et al. [23] examine the correlation between developments in telecommunication infrastructure and economic growth in G-20 countries for the period 1991-2012. In the research which employed Panel VAR model and Granger causality test, estimations are made for developed countries, developing countries and G-20 countries on an individual basis. Considering their findings, there is a bilateral causality between telecommunication infrastructure and growth in developing and developed countries in the long run. In both of the groups, economic growth is the most significant determinant of FDI. However, developments in telecommunication infrastructure aren’t meaningful determinants of FDI. The meaningful correlation between growth and telecommunication has been revealed by the majority of the studies examining causality.

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In contrast to findings of bilateral causality, there are also a number of studies that championing the existence of one-way causality from telecommunication to GDP. For example, Dutta [24] emphasizes that there is a substantial causality pattern from telecommunications to economic activity for both 15 industrialized and 15 developing countries over the 1970-1993 period. He also indicates that evidence of causality is found to be weaker in the opposite direction. Chakraborty and Nandi [25] associate the existence of one way causality from tele-density to GDP with a low degree of privatization in 12 developing countries in Asia. Kumar et al. [26] analyse the effects of telecommunication on product output per person employed in Pacific Small Island Countries between 1979 and 2012. When it is viewed in terms of causality, one-way causality from telecommunication to production per person employed is identified. According to the findings of the research, telecommunication has contribution in per capita output both in short and long run. Existence of causality in opposite direction is also presented by some studies such as Shiu and Lam [27] who asserted the nexus from telecommunication to GDP in China and its regions for the period 1978-2004. According to the findings of the research, one-way causality from real GDP to developments in telecommunication is identified both at the national level and in the parts of the eastern region where welfare level is high.

In addition to the analyses of causality, some studies attempt to explain the impact of the sector on output. For example, Datta and Agarwal [28] explore the long-term relationship between growth and telecommunication infrastructure in 22 OECD countries over 1980-1992. In this regard, the dynamic stable panel model is employed as the estimation method. For telecom infrastructure, stock number reaching a hundred lines was employed. According to the findings, the relationship between telecom infrastructure and real GDP per capita is found to be positive and meaningful. Another result they propose is the presence of diminishing returns in telecommunication infrastructure. Considering this result, developing countries will make more profit from telecommunication infrastructure expenditures. In alignment with this finding, Yildiz [29] reveals that telecommunication investment has a positive impact on economic growth and there is a bilateral causality according to Granger test result for OECD countries over 1990-2009. It is also found with fixed effect model that telecommunication investment and income, foreign trade volume, public expenditures and fixed capital investment have a positive impact on economic growth. Furthermore, Roller and Waverman [18] examine whether effects of telecommunication distinguish between OECD countries and non-OECD countries by establishing four different models for the period 1970-1990. Accordingly, they identified that there is a strong and positive link between GDP and telecommunication; telecommunication infrastructure may not have a linear effect on growth and telecommunication may have more influence on growth in OECD countries in comparison to non-OECD countries.

Parallel to the findings by [27], there is a connection between real GDP and the development of telecommunication in countries where the welfare level is high, similar to the findings of this study concluding that the telecommunication infrastructure's effect on GDP is higher in EU countries than the other OECD countries. Yildiz [29] studied OECD countries by using the fixed effect model and found a positive relation between telecommunication investment and GDP. Akin to Yildiz (2012), in this study, despite having the same results, the dynamic panel model is used on EU and non-EU OECD countries.

The difference between our and Roller and Waverman [18] studies is that we used lagged GDP variables in dynamic panel data modeling compared EU and other non-EU OECD countries and the time period we have is more recent, while they did not use this method, compared OECD and OECD non-member countries, and did their research without including recent technological developments due to their time range. Our research findings are significant in that it examines the relationship between such important infrastructure as

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telecommunication and economic growth comparatively for European Union and non-European Union OECD countries.

Batuo [30] studies the impact of telecommunication investment on economic growth for 44 African countries between 1990 and 2010 employing panel data model with Least Squares and Generalized Method of Moments. According to the findings, telecommunication infrastructure has a positive effect on growth. As for the relationship between trade openness and growth, international trade is beneficial for economic growth.

There is also a number of studies examining the impact of the telecommunication investment by considering different services provided within the sector. For example, Garbade and Silber [31] explore the positive impact of technologic innovations i.e. telegraph and Trans-Atlantic cable on market integration in the USA between 1840 and 1975. They suggest that these innovations narrowed the inter-market price differentials by enriching the flow of price information and execution of the trade. Sridhar and Sridhar [32] analyse the relationship between telecommunication and growth in 63 developing countries for the period 1990-2001 by forming simultaneous equation model and applying three-stage least squares (3SLS) method. When the effects of capital and labor force are controlled, land line and mobile phone penetration have significant effects on economic growth. Levendis and Lee [33] unveil in their studies that an increase in the level of telephone penetration causes higher growth in 29 Asian economies between 1981 and 2006. Lee et al. [34] suggest that mobile phone is a substantial input for growth, and impact of the sector greater where landline phones are rare in their study for Sub-Saharan Africa over 1975-2006. Furthermore, OngoNkoa [35] explores the effects of FDI on economic growth on the Central African Economic and Monetary Community between 1980 and 2010. Unlike other studies, the writer adds interaction variables to the model as well in order to identify through which channels FDI affects growth. The findings of the research revealed that private investment, human capital and FDI are positive and significant, trade openness is negative-significant, and labor force is positive-insignificant. But the number of mobile phone subscription per a hundred people which is defined as infrastructure variable came out positive but insignificant. This finding is linked to low quality infrastructure and lack of adequate investment. Sahin et al. [36] contribute to the existing literature on tele-density and growth nexus in the EU area. They distinguished the impact of the number of telephone lines in EU 15, EU 12, and EU 27 countries over 1980-2010 period. According to the findings, landline service has a positive impact in all groups for three models with the exception of two models in EU 15.

Thompson and Garbacz [37] contribute to the previous literature on the direct and indirect impact of broadband services. They asserted that these impacts considerably differ for US state-level data over 2001-2006 period. According to the findings, direct impact is little or even negative, whereas indirect impact has a substantial role in catalysing market efficiency and productivity of other inputs. In their subsequent study Thompson and Garbacz [15] examine the impact of telecommunication broadband penetration on economic growth in 43 low and high-income countries. It is found out that mobile broadband has a direct influence on the GDP of all countries, but there is no impact of fixed bandwidth. When they are classified according to income groups, it is discovered that low-income countries benefit significantly more from mobile broadband.

Despite the substantial empirical evidence on positive impact of the sector, there are a few studies that assert the existence of negative impact. One such piece of research by Faridi et al*.* [38] unveil the negative effect of telecommunication investment analysed for Pakistan in the period 1972-2010. They find causality between capital and GDP as well as telecommunication and GDP. The writers employing the Solow Growth Model find capital and transportation positive and significant but telecommunication negative and significant. According to the writers, the misuse of telecommunication by young population could have a

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negative impact on society. Why labor force variable found positive but insignificant was linked to the fact that the majority of the labor force in Pakistan is unskilled or semiskilled. Cardoso and Dornbusch [59] summarize the traditional analysis of FDI in trade models. If capital is paid at its marginal product, a discrete inflow of capital increases national income, as the increase in output is larger than the returns to foreign capital. If some distortion implies that capital is paid more than its marginal product, foreign investment may imply a decrease in welfare. The intensity of the number of developing countries in the group lays the ground for trade openness to form meaningful impact on GDP. Lagged GDP impacts GDP positively in both European Union and other country group, a situation that indicates how economic growth is correlated with motivation. The series of the previous year shapes the growth of the present year. Ward and Zheng [39] compare the impact of mobile telephone and fixed service on growth in China between 1991 and 2010. They conclude that impact of fixed service in the later period deviates from the earlier period and turns out to be negative. In alignment with this finding, Seo et al. [40] establish a cumulative growth model to analyse the dynamic dependent relationship between telecommunication (ICT) and economic growth in 29 countries. They estimate four different equations showing that there is not any dependency between ICT investments and economic growth, whereas a causality exists between non-ICT investments and economic growth.

Possible nexus between regulation, privatization and growth is also examined in a number of studies. For example, Li and Xu [41] analyse the impact of reforms in the sectors pertaining to privatization and competition between 1990-2001 over 177 counties. They categorize these counties into two groups based on whether they implement more and less aggressive reforms. Results of the study indicate that countries that implement more aggressive reforms increase their production as a result of improving the allocation of labor and capital. It is also revealed that state-controlled sectors do not reveal any significant impact. Paleologos and Polemis [10] examine 30 OECD countries between 1988 and 2010. According to the findings, there is a strong and positive relationship between effective regulation and investment. A regulatory environment in telecommunication sector positively affects the economic growth. The better regulatory environment is, the better economy performs. Another finding is that privatization of telecommunication sector has a positive and significant effect on economic activities. But a comparative analysis of country groups we have in our study is not included in their research. Maiorana and Stern [42] analyse the nature of the relationship between regulations and the performance of mobile phone sector in thirty low-income and middle-income countries for the period 1990-2004. This is one of the pioneering studies employing a simultaneous equation model, and conclude that the existence of regulatory institutions in developing countries has a positive influence on mobile phone penetration. The better mobile phone infrastructure is, the more it will contribute to GDP per capita.

3. METHODOLOGY

3.1. Dynamic Panel Data Models

Unlike static panel data models, dynamic panel data models contain lagged values of variables [43]. Cross-sectional data set alone cannot be used to estimate dynamic effects since dynamism literally asks for time dimension. As such, single time series data set is insufficient in the estimation of dynamic coefficients [44]. Both micro and macro dynamic effects are usually estimated in dynamic panel data framework. While forming the expectations, the policymakers are assumed to base their experiences on not only the past, although they make use of their existing information sets [45]. Expectations are adapted in a certain ratio of the difference between the value of the variable at that period and the previous one [46]. In this research model, the GDP expectations of policymakers are

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assumed to be on the ratio of the difference between the GDP at every period and its expectation formed in the previous period. Combining these principles to formulate the dynamic panel data models:

$$Y_{it} = \gamma_0 + \gamma_1 X_{it} + \gamma_2 Y_{i,t-1} + v_{it}\,, \mathrm{i} = 1, 2, \ldots \mathrm{N}, \mathrm{t} = 1, 2, \ldots \mathrm{T} \quad (1)$$

where v_{it} is the error term and since i is fixed for the unit during the entire time both Y_{it} and $Y_{i,t-1}$have impact on the error term.X_{it} is the independent variable. Since $Y_{i,t-1}$appears as a regressor on the right-hand side of the regression equation, it is correlated with v_{it} [47]. That is why the Least Squares is not the correct method of estimation since its variance is not unbiased [48]. In our research model, autoregressive dynamic panel structure is formed with the lagged values of the GDP as an independent variable. Arellano and Bover [49] and Blundell and Bond [50] made use of System Generalized Moments in Dynamic Panel Data analysis.

4. ANALYSES OF DATA

4.1. Description of the Data

Our data set includes observations from 31 countries 17 of which are members of the EU, and 14 are not. The EU members are Austria, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Holland, Poland, Portugal, Slovakia, Slovenia and England (though England is in process of exiting from the EU, data set we use covers the range where England is part of the EU) whereas the others are Australia, Brazil, Canada, Chile, Iceland, Israel, Japan, Korea, Mexico, New Zealand, Norway, South Africa, Switzerland and Turkey.

Data retrieved from World Bank Development Indicators were analyzed by STATA 13.2. The primary goal of our investigation is to figure out factors affecting growth in the stated countries over 1993-2013 with special emphasis on telecommunication investment.

We focus on the followings research hypotheses:

H_{01}: Telecommunication infrastructure has no significant impact on economic growth.
H_{02}: Compared to other OECD countries, telecommunication infrastructure in EU members has no significant impact on economic growth.

Dynamic panel data model we establish to estimate is:

$$Y_{it} = b_0 + b_1 X_{it} + dY_{i,t-1} + v_{it}, \mathrm{i} = 1, 2, \ldots \mathrm{N}, \mathrm{t} = 1, 2, \ldots \mathrm{T} \quad (2)$$

The dependent variable in the model is (GDP_{it}) with 2005 fixed prices. GDP is a proxy variable representing economic growth. In literature most studies show economic growth as the income per person; however, some studies used current income or real income. For instance, Faridi et al. [38] used GDP with current prices, OngoNkoa [35], Kumar et al. [26], and Shiua and Lam [27] use real GDP). Independent variables are collectively shown as X_{it}; gross capital formation with 2005 fixed prices (Capital), total labor force (Labor), share of foreign direct investment entry in GDP (FDI), share of foreign openness in GDP to account for how countries integrate with the foreign world (Trade Openness), and telecommunication infrastructure index (TII). In addition to them, we have a dummy variable (D1) and an interaction variable (D1*TII) in the analysis. D1 differentiates the country type: European Union or not. D1*TII is the interaction dummy to represent the telecommunication infrastructure index based on country type. The characteristics of the data series used in the

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448 analysis for EU Member Countries are presented in Table 2.
449
450 **Table 2. Descriptive Statistics of European Union Member Countries**

Variable		Mean	St. Dev.	Min.	Max.
Country	All	15.529	8.379	2	31
	Between		8.625	2	31
	In		0	15.529	15.529
Years	All	2003	6.064	1993	2013
	Between		0	2003	2003
	In		6.064	1993	2013
GDP	All	26.129	1.643	22	28.782
	Between		1.681	23.099	28.667
	In		0.182	25.030	26.567
Capital	All	24.630	1.581	20.931	27.169
	Between		1.606	21.772	27.079
	In		0.254	23.709	25.407
Labor force	All	15.415	1.419	11.909	17.564
	Between		1.460	12.046	17.528
	In		0.044	15.269	15.524
Trade Openness	All	4.376	0.388	3.586	5.201
	Between		0.355	3.879	4.899
	In		0.178	3.579	4.732
FDI	All	2.591	0.368	0	4.586
	Between		0.181	2.375	3.122
	In		0.323	-0.136	4.055
TII	All	1.130	0.720	-1.238	1.893
	Between		0.265	0.588	1.498
	In		0.672	-0.695	2.201

451 *Source: Author's computation.*
452 *Note: Sampling size (N)= 357, Number of Countries (n) = 17 and Time (in year, T) = 21*
453
454 We made use of "telephone ground lines (user/1000 people), mobile phones
455 (subscriber/1000 people) and internet users (subscriber/1000 people)" to identify the TII. It is
456 derived with the help of the Principal Component Analysis (PCA) over the combination of
457 three series defined above following many panel data studies exemplified by researchers
458 [51, 52, 53, 54]. PCA consists of many steps since it is explanatory [55, 56]. Factor load is
459 computed using factor analysis. TII is computed with the factor loads of:

$$TII = \sum_{i=1}^{3} a_{ij} \frac{x_{ij}}{sd(x_{ij})} \quad (3)$$

460
461 where a_{ij} are the factor loads, and $sd(x_{ij})$ are the standard deviations of x_{ij}. We compute the
462 TII belonging to each country with this formulation. The characteristics of the data series
463 used in the analysis for Non-EU Member Countries are presented in Table 3.
464
465
466 **Table 3. Descriptive Statistics of Non-European Union Countries**

Variable		Mean	St. Dev.	Min.	Max.
Country	All	16.571	9.583	1	30

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	Between		9.928	1	30
	In		0	16.571	16.571
Years	All	2003	6.066	1993	2013
	Between		0	2003	2003
	In		6.066	1993	2013
GDP	All	26.568	1.322	23.058	29.196
	Between		1.352	23.419	29.117
	In		0.208	26.007	26.982
Capital	All	25.0380	1.401	21.258	27.801
	Between		1.411	21.772	27.656
	In		0.326	23.081	25.807
Labor force	All	15.956	1.575	11.901	18.403
	Between		1.588	12.046	18.018
	In		0.360	13.898	16.923
Trade Openness	All	4.034	0.449	2.746	5.101
	Between		0.360	3.164	4.586
	In		0.285	3.129	5.484
FDI	All	2.516	0.281	-0.225	3.842
	Between		0.112	2.316	2.797
	In		0.260	-0.290	3.777
TII	All	0.941	0.886	-1.715	1.914
	Between		0.540	0.017	1.498
	In		0.716	-1.022	2.452

Source: Author's computation
Note: Sampling size (N)= 294, Number of countries (n)= 14 and Time (for year, T) = 21.

In our Dynamic Panel data-modeling GDP_{it} is the dependent variable (Y_{it}); Capital, Labor, Trade Openness, FDI and TII are independent variables (X_{it}). We regress GDP_{it} on its lagged value, $GDP_{i,t-1}$, as if the lagged value is an independent variable in our Dynamic Panel Data Analysis. Apart from being an independent variable, another contribution of lagged GDP to the model is that it provides testing of autoregressive attitude of dependent variable for short term [28].

Descriptive statistics of EU and non-EU countries are illustrated in Tables 2 and 3, respectively. All results reported are in line with expectations. In order to obtain proper results in regression analysis, a series of variables used in models must be stationary, the lack of which may cause spurious regression. Hence, we report the results of the Levin, Lin&Chu test.

4.2 Unit Root test

Owing to the fact that only Labor has the p-value greater than 5% among the variables employed in the model formed for other Non-European Union OECD Countries as illustrated in Table 4, our model has all its variables stationary when Labor s differenced (The unit root test result for the first difference is displayed in brackets).

Table 4. Unit Root Test Results for Non-European Union OECD Countries

Variable	Levin, Lin &Chu t	p-value
GDP	-4.3248	0.0000

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Capital	-3.9743	0.0000
Labor	0.8172(-4.8162)	0.7931(0.0000)*
Trade Openness	-2.3229	0.0101
FDI	-5.2528	0.0000
TII	-8.4505	0.0000

Source: Author's computation

,Note: (*) First lagged value is in the brackets.

All series belonging to the EU countries are stationary at their levels, as portrayed by Table 5.

Table 5. Unit Root Test Results for European Union OECD Countries

Variable	Levin, Lin &Chu t	p-value
GDP	-7.7743	0.0000
Capital	-6.9780	0.0000
Labor	-7.0205	0.0000
Trade Openness	-7.7310	0.0000
FDI	-6.5476	0.0000
TII	-8.0872	0.0000

Source: Author's computation

4.3 Estimation Results

We present the estimation results of the model by Arellano and Bover/ Blundell and Bond's Method of System Generalized Moments in Table 6.

Table 6. Estimation Results for EU and non-EU Countries

European Union Countries and Non-European Union (other OECD) Countries				
Variables	**Coefficient**	**Std. Error**	**z**	**p**
GDP	0.2973	0.0962	3.09	0.002
Capital	0.1799	0.0372	4.84	0.000
Labor	0.3218	0.0250	12.87	0.000
Trade Openness	0.1675	0.0248	6.74	0.000
FDI	-0.0188	0.0080	-2.35	0.019
TII	0.0839	0.0207	4.05	0.000
D1	0.0614	0.0361	1.70	0.089
D1*TII	-0.0387	0.0223	1.73	0.083

Source: Author's computation

Note: Model was formed taking logarithms of all variables.

The variables that are employed in the models formed as a result of the controls of assumptions and models are in coherence with Dynamic Panel assumptions in Table 6. Based on our estimation results, there is a positive relation between Capital and GDP the coefficient of which reveals that one percent increases in capital causes approximately 0.18% increase in GDP. Similarly, Labor and Trade Openness are positively associated with GDP. One percent increase emerging at Trade Openness means 0.17% increase in GDP,

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and one percent increase in Labor leads to a 0.32% increase in GDP. In line with Capital, Labor and Trade Openness, the impact of Telecom Privatization on GDP is also positive; one percent increase in TII means 0.08% increase in GDP. The lagged GDP, as expected indicates an increase in GDP. In all countries, one percent increase in the GDP of the previous year increases the GDP of the present year by 0.3%. On the other hand, FDI is negatively oriented with GDP. One percent increase in FDI due to this inverse relationship reduces 0.019% from GDP. Negative impact of the FDI on GDP is set forth in other studies [57, 58]. We elaborate on this in the conclusion section more. Finally, D1 shows that there is a significant difference between European Union and non-European Union countries.

4.4 Adequacy of the Model

Three basic tests were applied in order to check the adequacy of Dynamic Panel Data assumptions before the model is estimated. Results of Wald, Hensen and Arellano-Bond (AB) tests are given in Table 7.

Table 7. Dynamic Panel Data Assumptions Check

European Union Countries and Non-European Union (other OECD) Countries		
Test	**Statistics**	**p**
Wald chi2(8)	1490.87	0.000
Hensen- chi2(203)	29.65	1.000
AR(1)	-1.18	0.240
AR(2)	1.37	0.170

Source: Author's computation

We made use of the Wald Test to check whether the set of independent variables is sufficient to account for explaining the dependent variable, growth. The null, $H_0$of insufficiency is rejected according to both model ($p<0.05$) results. We conclude that independent variables have the power of describing the dependent variable. In addition, we employ the Hensen test to check for whether the instrumental variables are external or not and conclude that independent variables and error term are not correlated. In addition, according to Table 7, auto correlation test is executed by Arellano-Bond (AB) test. Due to the fact that second degree correlation (AR(2)) has p-value>0.05in both the models, null hypothesis of "No Autocorrelation" is not rejected.

5. CONCLUSION AND SUGGESTIONS

It was observed that when European Union member countries and some OECD countries outside European Union were compared in terms of the factors affecting the gross domestic product, the same independent variables are effective at both country groups. While it was found out that the GDP for all countries in the study is affected by factors of capital, labor, trade openness and Telecom infrastructure in a positive way, the GDP of two country groups is affected by foreign direct investment in negative way. Furthermore, lagged GDP variables employed in dynamic panel data modeling contributed positively to the model in both country groups. Capital factor in all countries contributes to the GDP positively. Considering the fact that production efficiency is maintained by capital accumulation, the results are incoherent with theory.

Unlike many studies conducted in the literature, foreign direct investment's impact on growth is negative. This situation shows that European Union bears the effects of 2008 crisis. The

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fact that investment increases for countries contribute to economic growth negatively illustrates that the integrated structure of markets still tries to recover from the crisis.

In analyzing the impact of telecommunication on GDP, it is seen that it contributes to economic growth meaningfully for both country groups. This effect is more observed in European Union countries than other OECD countries. While there is no limitation on foreign investors in developing telecommunication in European Union countries, the condition is different in other country groups. In non-EU OECD countries, there are limitations on telecom depending on the country. For instance, one of the striking limitations is the maximum limit of 49 % foreign share in ownership. In other words, these countries do not wish to renounce their right to sovereignty. On the other hand, there are binding decisions that European Union countries have taken at market integration. Hence, European Union countries formed a common market structure in the sector of developing communication technologies. Formation of a common market in telecom reflects the prices of end-user and paves the way for users to approach Internet easily. Especially more widespread Internet lowers cost of operation considerably. As a consequence, the market that is limited to European Union turns into a market whose boundaries are designated by the access points of the internet.

The effects of progress in infrastructure on the economy are positive over the channels of employment creation, foreign capital inflow, and increase in productivity. Although positive results are focused on more, the results may be different due to the presence of bureaucracy, problems in administrations and economic or political crisis. In European Union, where obstacles in telecommunication sectors have almost been removed, improvements in telecommunication infrastructure have more impact on growth.

Since telecom appears as the key sector to fuel growth because it is associated with information technology and all ramifications of computer based applications and mobile communication, all countries at all development levels are proposed to focus on investing in these sectors the opposite of which hinders growth.

Studies to follow may comparatively examine different sectors, where limitations are removed or minimized, on growth. Furthermore, various studies could be conducted with simultaneous analysis of the related sector in terms of supplies and demand, indications of economic/political crisis, by the participation of foreign direct investment and labor to the model.

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