Telecommunications Impact on Economic Growth: A Case of 11 European Countries

Golnoush Soroush

Department of Management and Production Engineering, Polytechnic University of Turin, Turin, Italy.

Abstract
This study is related to the potential relationship between telecommunications and the economic growth and how this industry can impact the growth. The main purpose of this investigation is to examine the primary hypothesis that telecommunications has a positive impact on the economic growth. For this aim the previous existing literature has been used to understand the possible trends and finally it has been decided to use two tests: the simple regression analysis and the Granger causality. During this research the results will be discussed and possible policy implications will be debated. At the end a conclusion of all findings and discussions will be presented which includes debating the existence of a positive relationship between telecommunications and the economic growth and the possible trends which can be used to improve this positive connection.

Introduction
Although usage of spectrum goes back to more than 120 years ago, but the past three decades is a special period for the telecommunications industry since it has been growing with an increasing pace during this time. The truth is that it is still growing as new technologies, which need to have access to spectrum which is the main infrastructure for telecommunications, are being developed rapidly. Mobile devices are a proper example of such technologies. The subscriptions to mobile services has been increasing rapidly and started to exceed the fixed line subscriptions since 2002. This growth is a global trend and this technology is particularly relevant in developing countries, where there were more than twice as many subscriptions (3.2 billion) as in developed countries (1.4 billion) in 2009 [1].

The fact is that new technologies make it possible to move towards a global village which is going to be unavoidable since the economic activities are spreading globally rapidly. Therefore an efficient communications system which can provide information continuously and widely is needed. It is one the reasons why it is important to pay more attention to the telecommunications technology and its impact on the economy.

By comparing the average share of revenues of the telecommunication industry in total GDP of European countries between 2011 and 2012, we can see the growing importance of this sector and the fact that it will play a quite important role economically in the future. In OECD (Organizational Economic Cooperative Developing) countries the spread of telecommunication networks alone considered to be responsible for one 3rd of growth between 1970 and 1990, [2].This is the reason why this role and the impact it may have should be studied carefully. The impact of the industry is not only economical but also social, since it is used in almost all of the important aspects of modern life. As the sector will change and improve the way people connect to each other, it will also have impact on the economic activities and interactions between them. The researchers discuss the point that as the ICT infrastructure improves, transaction costs reduce, and output increases for firms in various sectors of the economy [3].

As revenues from mobile telecommunications account nowadays for a significant percentage of GDP especially in developing countries, mobile telecommunications have also become an important and efficient means for tax collection [1].

Another point of view says that, as the application of the industry grows, the amount of investment will grow too. For instance, developing countries which generally have lower penetration benefit from ICT
developments will have lower growth impact and thus the investment will be lower. Countries with low initial capital, in this case the stock of telecommunications, will grow at a slower rate than countries with a high stock of telecommunications, [4]. Therefore as investment in ICT infrastructure and derived services provide significant benefits to the economy [5], this aspect becomes important in long term for any country.

The relation between the telecommunication sector and economic growth is a two-way one. Although telecommunications industry is one of the determinants of growth and GDP but growth itself has an important impact on the sector’s development. Therefore it is important to understand the nature of this connection and how they can affect each other.

This research focuses on how the telecommunication industry and spectrum usage will affect the economic growth by considering it as one of the determinants of GDP alongside other factors such as population growth rate. The two-way causal relationship between these two will also be examined to understand the direction of this relationship. This will be done by investigating a panel dataset consisting of 11 European countries, all members of OECD, for the time period between years 1997 and 2008. Tab.1 shows the countries in the sample and their average annual growth rate for the studied period.

<table>
<thead>
<tr>
<th>Country</th>
<th>Average Annual Growth Rate (1997-2008)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Denmark</td>
<td>1.83%</td>
</tr>
<tr>
<td>France</td>
<td>2.10%</td>
</tr>
<tr>
<td>Germany</td>
<td>1.64%</td>
</tr>
<tr>
<td>Hungary</td>
<td>3.37%</td>
</tr>
<tr>
<td>Italy</td>
<td>1.35%</td>
</tr>
<tr>
<td>Norway</td>
<td>1.63%</td>
</tr>
<tr>
<td>Poland</td>
<td>4.53%</td>
</tr>
<tr>
<td>Portugal</td>
<td>2.13%</td>
</tr>
<tr>
<td>Spain</td>
<td>3.58%</td>
</tr>
<tr>
<td>Sweden</td>
<td>1.60%</td>
</tr>
<tr>
<td>Turkey</td>
<td>3.53%</td>
</tr>
</tbody>
</table>

**Literature:**

Several researches have been done which examine the way that telecommunication infrastructure can affect GDP and economic growth. The general findings of these studies can be pointed out as for instance the communications sector has a positive impact on the economic growth or broadband has a more significant impact on the growth than other forms of telecommunications.

Some of these researches and their results will be discussed in this section. For instance Roller and Waverman did an investigation on the impact of telecommunications infrastructure on the economic growth in specifically developing countries [3].

The relation between these two is in fact a two-way causal relation and the investigations should answer the questions about the dynamics of this connection. They have to clear it whether it is telecommunication services that accelerates economic growth or overall economic growth that creates the demand for more telecommunication services for their growth to occur? [5]. In this case the literature focuses on the telecommunication sector as one of the determinants of GDP.

In general, investment on infrastructure can improve the economic growth. This improvement can be related to reducing the production cost, increasing revenue and increasing the employment. Each of these effects will have a positive impact on the GDP by itself.

The same as other infrastructure investments, investing in telecommunication will increase the demand for the goods and services used in their production and increase total national output, [5]. However, investment on telecommunication is, to some degree, different from other investments, since it will be affected by network externalities (by increasing the number of users, the value will increase too). This will make the telecommunication, and its effect on the GDP, more important than other infrastructures. In one research done by Kim et al. (1997), it has been shown that in presence of congestion which is a negative externality, the value of telecommunication will decrease, but in long run, it will be an incentive for the owners to increase the investment [6].

Andrew Hardy (1980), who investigated 45 developing and 15 developed countries between 1960 and 1973, was the first one who showed the impact of telecommunication on economic growth. The result of his research was that the telecommunication investment has a larger impact on GDP, in the less developed countries than the most developed ones. He also found that the number of phones per capita has a positive impact on growth [7].

Roller and Waverman studied 21 OECD countries during 1970s and 80s and found that when a critical mass is reached, there is positive causal relationship between growth and fixed communications, [3]. Waverman himself, in 2005 performed an investigation on both developed and developing countries during 1980 and 2003
and concluded that the mobile telephony has a significant and positive impact on economic growth, however, this impact is twice larger in developing countries than in developed ones [8].

Koutroumpis in 2009 studied 15 European countries and reached this result that with a critical mass of 20 percent subscriber and 50 percent household penetration, broadband investment will face a positive and increasing return [9]. Koutroumpis in 2009, utilizes the framework developed by Roller and Waverman in 2001, and estimates that broadband deployment has had a strong and statistically significant effect on growth in the European Union, although the data covers only the years 2003-2006, [9]. He finds that the growth effect of broadband is more pronounced in countries with high existing levels of broadband penetration — that is, the marginal impact of adding broadband lines is higher in countries where there is a “critical mass” of broadband lines already in place, [10]. Later on, in 2010, Koutroumpis and Gruber, by studying a large sample of 192 countries, found that there are also increasing returns to mobile communications [1].

On various aspects, researchers have tried to demonstrate the social and economic effects of telecommunication too. For instance, Bayes et. al., found that about 50 percent of telephone calls are related to economic activities and the average prices of goods are higher in a place where the number of telephones are larger, [11]. On another study, Leff notes that companies which have better interior telecommunication services, can experience economy of scale and scope [12].

In a research done by Cronin et. al. (1991 and 1993), a significant causal relationship between productivity growth and telecommunications is demonstrated. He uses Granger causality, Sims and modified Sims tests to investigate this causality at the state and sub-state levels, [13].

Souter provides a survey of the ways in which ICT can be employed for the social and economic development of remote or rural communities [14], [5]. Gupta concludes that one percent growth in telecommunication services will result in three percent growth in the economy [15].

Chatterjee et al., argues that income levels will affect the purchasing power for telecommunication services and eventually the growth of such services and economic growth as well, [16]. For instance if the purchasing power increases, the demand will also increase and the service providers should increase their investment and improve the services.

**Methodology:**

In order to examine the type and direction of the relationship between telecommunications sector and economic growth two hypotheses can be considered:

A) The main hypothesis that is the existence of a positive impact of telecommunications on growth;

B) The null hypothesis that there is no relationship between these two.

The goal is to prove the first one. Since there are multiple variables which affect the economic development in a country, it is only correct to consider all these variables together in order to understand their effects. Therefore it is both logical and appropriate to use regression instruments for this purpose. A simple regression analysis of these variables is the main model which is used in this research.

Several other studies have been performed before and they successfully proved that telecommunications infrastructure can have a positive impact on the economic growth. Some of these studies used a cross section framework.

In this research a panel data consisting of telecommunications and economic variable, through a time series, is used. In fact a panel regression model is used to analyze the coefficients and relationships.

To ignore the potential changes over time, specifically related to any of the countries, the time effect is considered as a dummy variable. Precisely, the time dummy is used for 1997 which is the first year of the testing period.

Here economic growth is considered as the dependent variable and the goal is to examine its changes, through time, according to the changes in independent variables which are each year’s population rate, GDP of last year, time dummy for the first year (1997) and the amount of spectrum authorized (the amount of spectrum licensed by the public authorities) in each year, which is a representative of the telecommunications infrastructure. The growth function can be as Eq.1:

\[ \text{Grate or } \Delta \text{GDP} = f(\text{GDP}_{t-1}, \text{POP}, \text{SPC}) \]  

(1)

The linear form of Eq.1 will be as Eq.2:

\[ \text{Grate or } \Delta \text{GDP} = \alpha_0 + \alpha_1 \text{GDP}_{t-1} + \alpha_2 \text{POP} + \alpha_3 \text{SPC} + \epsilon \]  

(2)

Where \( \alpha_0 \) is the intercept and \( \alpha_1, \alpha_2, \alpha_3 \), are the magnitude and \( \epsilon \) is the error term.

In both equations, ‘Grate’ is the annual growth rate of GDP or the country’s economic growth, which is the dependent variable; ‘\( t \)’ stands for time; ‘\( \text{GDP}_{t-1} \)’ is the lagged GDP and it is considered in order to be able to examine the convergence in the panel data.
The convergence hypothesis says that as much as the previous GDP is higher, the upcoming growth rate will be lower. This hypothesis is accepted when there is a negative and significant coefficient for GDP-1. ‘POP’ is the index for annual population growth rate. And finally, ‘SPC’ is the representative of the amount of spectrum authorized and it is considered as the telecommunications infrastructure. It is important for this variable to be an output measure, because then it will have a stronger association with each year’s growth rate.

Another variable which is considered in the regression analysis is ‘DUM1’ which is the time dummy for the first year of the study (1997). It is used basically to avoid the impact of potential major strikes which may have occurred during the time period of the study. The time dummies were used primarily for all the years from 1997 until 2008. But since using these variables for all the years did not change the results in a significant way, I decided to use the time dummy only for the first year.

In several studies, government expenditures and consumption is also used as an independent variable. In this research also, the primary model contained this variable but after analyzing the model and the results, I decided to eliminate it. The reason is basically because the government consumption has a large impact on the economic growth and its weight, comparing to other factors such as telecommunications infrastructure is too large. As in the analysis it affects significantly the way telecommunications would impact the economic growth, I performed the analysis without considering this variable.

Another variable which can be used is ‘Grate(t-1)’, which is the lagged growth rate of real GDP. It can be used in order to examine the short run autoregressive behavior of dependent variable [17]. But in current research this variable is not considered.

On the other hand, when working with regression analysis, one variable is the dependent variable and the others are explanatory ones. Therefore, since by explanatory variables we can explain the dependent variable, it is not unexpected to conclude that they cause it too. But not always it is possible to understand right away, which variable causes which ones. For investigating this matter, regression models can be used alongside the Granger Causality.

It was Granger himself who tried to investigate the causality direction, for the first time in 1969. It is a simple test which examines the causal relationship between two variables. This test is only reliable for time series variables. When a time series (X) is said to Granger cause another time series (Y), if the prediction error of current Y declines by using past value of X in addition to past value of Y [17].

As for the case of telecommunications and economic growth, many other researches have tried to understand this causal relationship before. We know that telecommunications infrastructure is a GDP determinant but the point is that when GDP, or in other words economic development, grows, it will affect the telecommunications infrastructure too. Therefore it is not always easy to understand the direction of the causal relationship between these two.

The Granger causality test will be used to demonstrate, if applicable, the direction of the causal relationship between telecommunications infrastructure and economic growth.

**RESULTS AND DISCUSSIONS**

In this section the results will be represented and discussed. Tab.2 contains the results of the regression test.

As it is mentioned before, regression analysis is used to understand the telecommunications infrastructure impact on the economic growth, alongside considering and controlling simultaneously, the effect of population growth and the lagged GDP.

<table>
<thead>
<tr>
<th>SUMMARY OUTPUT</th>
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<tbody>
<tr>
<td><strong>Regression Statistics</strong></td>
</tr>
<tr>
<td>Multiple R</td>
</tr>
<tr>
<td>R Square</td>
</tr>
<tr>
<td>Adjusted R Square</td>
</tr>
<tr>
<td>Standard Error</td>
</tr>
<tr>
<td>Observations</td>
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<tr>
<th>ANOVA</th>
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<tr>
<td>Df</td>
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<td>Regression</td>
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<tr>
<td>Residual</td>
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<tr>
<td>Total</td>
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</table>

<table>
<thead>
<tr>
<th>Coefficients</th>
<th>Standard Error</th>
<th>t Stat</th>
<th>P-Value</th>
<th>Lower 95%</th>
<th>Upper 95%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>0.024171009</td>
<td>0.004675805</td>
<td>5.169378842</td>
<td>8.87295E-07</td>
<td>0.014918434</td>
</tr>
<tr>
<td>POP</td>
<td>0.286385317</td>
<td>0.368351537</td>
<td>0.77554617</td>
<td>0.438277664</td>
<td>-0.442443535</td>
</tr>
<tr>
<td>DUM1</td>
<td>0.001299689</td>
<td>0.006999735</td>
<td>0.185676828</td>
<td>0.852994428</td>
<td>-0.01251524</td>
</tr>
<tr>
<td>SPC</td>
<td>1.53188E-05</td>
<td>1.6163E-05</td>
<td>0.947770515</td>
<td>0.345046223</td>
<td>-1.66649E-05</td>
</tr>
</tbody>
</table>
As it can be seen, the coefficient for the lagged GDP or GDPt-1 is negative and the P-value is quite small. The coefficient is equal to -4.49701959395647E-15. This means that if the past GDP is high, the economic growth will be lower. This is exactly the convergence hypothesis and this result proves it accurately Ding and Haynes and Datta and Agerwall have also proved this point in their studies [18], [19].

As for P-value, it is equal to 0.071 which is quite close to .05. It means that even though the impact of past GDP is not significant, but still it is highly important.

The coefficient for ‘POP’, which shows the population growth rate, is positive with the amount equal to 0.28638. This means that if the population increases, the economic development will also increase. The point is that the impact of POP variable is not significant. It is because the P-value for this variable equals to 0.438 which is quite more than .05.

And finally there is SPC, which is an indicator of the amount of spectrum authorized or in other words, it is an indicator of telecommunications infrastructure. The coefficient for SPC is 0.00001531 which is quite small but positive. This result proves the positive impact of telecommunications infrastructure on the economic growth. It means that if the investment in telecommunications increases, higher economic growth can be expected.

The P-value is equal to 0.345. According to this amount of P-value, the impact of telecommunications is not much significant. It in fact, has an average impact. This may be because of the size and type of the sample. The sample is consisted of 11 countries which are mostly developed ones. Several studies have investigated and proved that the impact of telecommunications infrastructure on economic growth is greater for developing countries than the developed ones. In fact, they have demonstrated that although the impact is positive in these countries and telecommunications can be used to develop the economy, it affects it only in a lower and slower trend than of those developing countries.

As for the causal relationship, although a positive impact has been demonstrated by the analysis, the causal relationship could not be proven. Tab.3 shows the results of the Granger causality tests. As it can be seen, the P-value is greater than .05 and it means that such a causal relationship does not exist from telecommunications infrastructure towards economic growth.

The causal relationship from economic growth towards telecommunications can also be examined. The result for this test was also negative, meaning that such a relationship does not exist.

Table 3: Results of the Granger Causality Tests.

<table>
<thead>
<tr>
<th>Null Hypothesis</th>
<th>Obs</th>
<th>F-Statistic</th>
<th>Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td>SPECTRUM_ISSUED does not Granger Cause GRATE</td>
<td>110</td>
<td>2.32144</td>
<td>0.1031</td>
</tr>
<tr>
<td>GRATE does not Granger Cause SPECTRUM_ISSUED</td>
<td>1.40378</td>
<td>0.2502</td>
<td></td>
</tr>
</tbody>
</table>

Policy Implications:

The results from the analysis can help us to develop the ways in which the telecommunications industry can contribute to the economic growth.

As the impact of the sector on the economic development is positive, it becomes an important component of the economy. Several previous studies have argued about various factors which can help the sector to be more effectively involved.

As it is obvious, infrastructure is the primary element needed to perform telecommunications services. Improving the infrastructure is one of the factors which could result in improving the economic growth.

Spectrum, which is the telecommunications’ infrastructure, is facing scarcity and interference issues, therefore regulators are trying to find more efficient ways to allocate the spectrum. For instance, regulated open access to some frequency bands is a way to provide an efficient access and a better quality for both owners and end users. It is clear that the competition for using the spectrum is going to increase as the technology and products related to telecommunications will develop.

Assuming all these facts, if the infrastructure (spectrum) is not allocated efficiently and therefore is not functioning in an efficient way, eventually it won’t be able to provide telecommunications services and its potential ability in impacting the economic growth in a positive manner will diminish.

Therefore the infrastructure is playing a central role in telecommunications industry. For this clear reason, it is important to pay more attention to the spectrum usage and allocation and to make it more accessible. The drive to roll out fiber networks closer to customers will increase the downlink and uplink speeds available to consumers in areas covered by those new investments, as well as ensuring that there is sufficient infrastructure is also available in areas where such investment may not be taking place [20].

As Bloom et al. argue, organizational factors are also important. Organizational factors are related to the way in which the organization uses the telecommunications services and how its structure can change according to this industry and its usage. These factors consist of management practices related to ICT section. They concluded that these managerial practices have a large impact on the productivity of organizations and ICT section and therefore they can facilitate the contribution of telecommunications sector to the economic growth [21].
There are also some other economic factors in both telecommunications industry and other sectors of the economy which are connected to each other and can have a considerable impact. Regulatory objectives and rules are an example of these types of factors. There may be some regulations which can affect the sector’s contribution in a negative way and reduce the sector’s positive impact.

Several investigations have been performed in order to identify these factors and their effects. For instance, Gust and Marquez found that the regulations, such as regulations applied to tax payments in case of firing an employee, which affect the labor markets, in some industrial countries, have caused the reduction of information technologies application and therefore the reduction of the economic growth.

In another study, Van Reenen et al. compared United States and Europe in order to investigate the connection between ICT and productivity and they found that the regulations related to labor and product markets can be the reasons of different effects of ICT observed in different countries. [21]. An example can be the regulations studied by Hausman (1997), which delayed the diffusion of mobile phones in US and therefore reduced the impact of telecommunications sector.

As it can be seen, regulations related to other sectors of economy such as land-use regulations, barriers to entry, restricted shopping hours, trucking regulations and obstacles to cross-border trade [20], can affect also the telecommunications industry. If we want to improve the way this sector affects the economic growth, we have to take into consideration these other sectors and their regulations and if it is applicable, it is only appropriate to improve them in a way that we are able to increase the positive impact of telecommunications industry on the economic growth.

Conclusion:

In this research it has been tried to understand how the telecommunications sector and its infrastructure affects the economic growth and to answer this question, whether it can improve the growth or not.

As the sample 11 European countries which were all OECD countries, were chosen and the data of these countries were collected for a period of 11 years, between 1997 and 2008.

Two types of test were performed in this research. First of all a simple regression analysis has been done to understand the relationships between our dependent variable which is the economic growth and the independent variables which are the telecommunication infrastructure, population growth and the past GDP. A dummy variable was also considered for the first year of the research.

As it was expected the coefficient for the telecommunications variable is positive which means that telecommunications infrastructure has a positive impact on the economic growth.

By having a negative coefficient for the past GDP, the convergence hypothesis was also confirmed with these results, which suggests that when the past GDP is higher, the growth is slower. The population variable showed also a positive impact but a non-significant type.

The second test was the Granger causality test which was performed to examine the direction of the relationship between telecommunications and economic growth. In other words, to understand whether it can cause the economic development or it is the opposite. Unfortunately the test could not significantly specify the direction of this causal relationship.

The results can be interesting for the countries which would like to increase their growth, because then they can consider telecommunications sector to invest in and rely on it to achieve this goal. There are several ways and factors which can be considered to facilitate the telecommunications contribution to the economic growth. Factors such as improving the infrastructure and applying an efficient spectrum allocation, considering the organizational factors and management practices and considering the regulations in other sectors which may affect the telecommunications sector as well.

The telecommunications industry has both direct and indirect significant effects on economy and society. For instance it can be a resource to increase the tax revenues or it can help increasing the employment. It can also help to increase the exports and foreign trading of a country (a country can become a provider of professional telecommunications equipment).

There are some practices which can develop the telecommunications industry and therefore they can improve its positive effect on growth. Some of these practices are more or less as following:

a) Improving the teledensity volume (the number of telecom users which includes fixed line and cellular phones users) [17];

b) Improving the quality and standards of the services [17];

c) Developing disaster recovery facilities which will help to decrease the cost of international connectivity and to increase its quality [17];

d) Educating qualified human resources and IT professionals [17];

e) Encouraging R&D activities and developing innovative technologies [17];

Other practices which may be helpful are as following:

f) Decreasing the acquisition cost of frequency bands through an efficient spectrum allocation, in order to encourage the competition and to facilitate the entry to the market for smaller firms which may have more
innovative products and can deploy the spectrum in a more optimal way (such firms can add value to the telecommunication sector).

Encouraging the investment in the telecommunication industry (studies have proved that investment in telecommunications has a positive impact on growth, for instance for developing countries policy makers and regulators should promote a conducive and competitive climate for foreign investment so that the capital investment required for building telecom infrastructure can be met) [22].

Therefore, as it is clear from both empirical and theoretical analyses, the telecommunications sector has an important and positive impact on the economic growth and the necessary requirements should be fulfilled in order to maximize this positive effect.

Regarding the limitations through this study, the important one is lack of time-series data for the whole period of the study. For instance, one of the variables, which was primarily chosen to be considered as the independent variable, was the investment in telecommunications sector both by public and private sectors. But since the data was not sufficient for both of these sectors or it was not complete for the whole time period, it was decided to exclude this variable.

There were also some missing data related to the variables included in the study. For instance, the data related to the amount of spectrum authorized in different countries were not completely available in early years of the time period. The reason can be related to the fact that in these years new telecommunications technologies and products such as cellular phones and internet were in their diffusion stages and the spectrum acquisition was starting to get important for operators and other firms in telecommunications industry. Another issue can be the release of new frequencies and bands during these years by the general administrators and regulators which made the spectrum more available for more firms to acquire it.

REFERENCES


