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Telecommunication Infrastructure Development and Economic Growth: A Panel Data Approach

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INTRODUCTION

World is going to be global village due to the introduction of new and advanced technology and new innovations in technology make it more possible day by day. The widely spread economic activities both in real as well as in credit market is possible when they use advance technology to communicate. This is a fact that the world is rapidly moving towards an economic system based on the continuous and ubiquitous availability of information. Developing countries try to maintain and develop their technology in such a way that they can become a part of this global village. Recent developments in telecommunication technology have been an important tool to exchange the information to develop a sharp and valuable commodity market. During 21st century to move into post-industrial, information based economic growth, countries and sector try to equip themselves with the necessary telecommunication system. A modern telecommunication infrastructure is not only important for economic growth but also to connect domestic market of commodities as well as credit with international commodity and financial markets. This would develop the smooth flow of foreign investment, positive value of net exports, increase the value addition in GDP of an economy etc.

Once the industrial and agriculture development was considered to be a best tool to enhance economic growth of a country, every country gave more importance to these sectors in its plans and policies, but now the trend has changed because the advancement and development of these two major sector of an economy sustain on the development of other factors, the role of service sector, advancement in technology, and the contribution of foreign sector in economic growth by different ways increases, and the major area of interest for foreign sector or investment was service sector and still it is, countries with the existence of GATS, started to privatise their set up, and after realising the importance of communications, the telecommunication sector is now on their main priorities. With the advancement of telecommunication services, a new market mechanism, low cost structure and expanded value chain of firms is possible [Kambil and Short (1994)], on other hand in developing countries, the average price of agricultural commodities is high in the area where there is telephone facilities available than the area where there is no facilities to communicate [Bayes, *et al.* (1999)].

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The telecommunication sector around the world has been undergoing dramatic reforms since 1980s. Developed countries started to developed or sustain their development in telecommunication in that era; on the other hand developing countries also started to develop their telecommunication infrastructure after realising its importance in economic development. They have privatised state-owned firms and slowly introducing telecommunication sector reforms. Not only a policy development in this sector started but researchers also tried to contribute to develop a theoretical base for policy implications, but on limited scale. Telecommunication sector succeeded to have an important focus as an essential component of the economic infrastructure. However with the strong existence of General Agreement of Trade in Services (GATS) under WTO brought a revolutionary reforms in telecommunications sector. Liberalisation and deregulation in telecom sector, developing countries were also in a position to increase the contribution of telecom sector in GDP ratio. With the emergence of liberalisation in this sector, the inflow of capital in the form of foreign direct investment increase. Thus, market converted into perfect competition and many service providers came in the market of developing countries. Mobile phone market went to its boom and the high quality of services at low tariff expanded market and thus makes economies of scale possible. High speed internet and broadband introduced in business development which contributed significantly in the development of the industry in the country. On the other hand some countries such as Korea, Japan, and China not only developed their telecom service industry but also developed their telecom equipments market and raised the value of net export with the help of import of telecom equipments. Before 1990s there was the availability of fixed line services at limited level, but the revolutionary steps changed the overall structure of telecommunication industry and not only mobile phone companies but also the wireless internet service, and pay phone card service provider expanded their business which, leads to financial transaction between different countries enhancing economic development.

Last decade saw a number of changes happening in telecommunications industry and most predominantly the emergence of Internet, innovations and inventions in electronic equipments and software applications. Globalisation and international trade on one end and ICT (Information Communication Technology) including telecommunications on the other end have created a new way of life to be lived. Numerous state-owned telecommunication operators were privatised. A wave of pro-competitive and deregulatory telecommunications policies swept the world.

With the advancement in telecommunication technology, the world has experienced a rapid growth in communications. The need for an efficient, modern telecommunication sector is now regarded as crucial to economic development in transition countries. The basic telecommunication industry comprises a vast portion of the world's economy. The development of new technologies has increased the need to communicate internationally, to spread new ideas and new technologies.

IMPORTANCE OF TELECOMMUNICATION DEVELOPMENT FOR ECONOMIC GROWTH

After 2000, the realisation the importance of telecom sector for economic growth has increased especially in developing countries. Countries struggled to advance their

telecommunication infrastructure in different ways. It is a fact that this sector increased the economic contribution of foreign sector within the countries. Telecom impact on economy can be decomposed into direct and indirect effect. The direct impact of telecommunication is very strong; it leads to attract the Foreign Direct Investment (FDI). The inflow of foreign capital in the country create different opportunities at sectoral level, With the establishment of the setup of these Foreign Service providers, create highly paid jobs opportunities and demand for technical labour increase. With the same token the liberalisation expanded the market and consumers had a greater choice to purchase. Not only service providers but the mobile phones and wireless companies also established a competitive equipment market and introduced advanced technology as well. On the other hand the indirect employment with the establishment of call centres, customer service centres and cellular phone franchises increased, and a highly competitive labour market also established. Secondly telecommunication development also generated the business activities as well, firms now connected to each other very easily and the international market is also on the finger tips of businessmen through internet. The existence of new companies increased the working capacity of financial market as well and the foreign investor could easily approach the stock market of any country in any part of the world.

Telecommunication sector development made the development of any sector possible, this sector contributed actively in fiscal and monetary policies. Thus become an easy and reliable source to attract FDI in a country.

This study focuses on the issues that how telecommunication development increases economic growth. A panel estimation is done here to learn the experience of other countries that how they developed their telecom industry, and how the increase in fixed line and mobile phone teledensity (users per 100 people) affect economic growth. What is the effect of telecommunication development on employment generation? What should be done to transform this increased teledensity into useful purpose and last but not least to see is telecommunication investment is increasing or decreasing returns to scale in the countries included in the panel. As Pakistan has an emerging telecom market so it is necessary to have an empirical solution to find out the rational of liberalisation and deregulation in telecom sector, this study tries to provide answers to all these problems.

LITERATURE SURVEY

Telecommunication infrastructure development got a great attention of researcher in many years. Zhu (1996) attempted to examine the causal relationship running from telecommunications investment to economic development only using a pooled time series analysis based on 17 years data from 23 countries, and found telecommunications investment countries, and found telecommunications investment countries, Madden and Savage (1998) analysed the relationship between telecommunications infrastructure investment and economic growth by taking a sample of transitional economies in Central and Eastern Europe. The study showed that overall, there appears to be two ways, or mutual causality between telecommunications investment and real economic growth at the aggregate level.

Boylaud and Nicoletti (2000) used factor analysis and panel data analysis to examine the effects of market entry, liberalisation and privatisation on productivity, prices and quality of service in long-distance fixed-line and in mobile telephony in

several OECD countries. In another study, Li and Xu (2001) examined the impact of privatisation and competition on fixed-line subscriptions, labour and factor productivity in the telecommunication industry worldwide..

A study of Yilmaz, *et al.* (2001) indicated that the accumulation of telecommunication infrastructure improves the overall productive capacity at the regional level by examining the impact of telecommunications infrastructure on economic output both at the aggregate and sectoral levels in the United States. Wallsten (2002) used data on telecommunication industry worldwide to analyse whether the sequence of reforms matters. Fink, *et al.* (2002) used data on 86 developing countries worldwide to analyse the impact of telecommunication policy reforms on industry performance.

Ding and Haynes (2004) empirically investigated the role of telecommunication infrastructure in long run regional economic growth in China for a sample of 29 regions for a 17 years' period, from 1986-2002. With a panel dataset, they used a dynamic fixed effects model for estimation, which allows to test the relationship between regional economic growth with initial economic condition, fixed investment, population growth, as well as telecommunications infrastructure. On the basis of the results, they showed that telecommunications is both statistically significant and positively correlated to regional economic growth in real GDP per capita in China. The results were strong even after controlling for investment, population growth, past levels of GDP per capita, and lagged growth. They further indicated that the telecommunication investment is subject to diminishing returns, suggesting in this manner that regions at an earlier stage of development are likely to gain the most from investing in telecom infrastructure.

The result has been confirmed by more recent analysis of economic growth in OECD by Datta and Agarwal (2004) which indicates that telecommunications infrastructure plays a positive and significant role in economic growth using a similar (but not identical) data set as Roller and Waverman, which includes 22 OECD countries. A dynamic panel data method is used for estimation, which corrects for omitted variables bias of single equation cross-section regression. Again, country-specific fixed effects are included. Their results showed a significant and positive correlation between telecommunications infrastructure and growth, after controlling for a number of other factors.

FORMULATION OF HYPOTHESIS

This study will try to analyse the impact of telecommunication development on economic growth with a macro economic data structure, its focuse is on telecommunication development, i.e., there is positive impact of telecommunication infrastructure on economic growth, so we want to check the significant relationship of telecom and economic growth and make our hypothesis

H_1: There is a significant relationship between telecommunication infrastructure development and economic growth.

Against the null hypothesis of no relationship.

METHODOLOGY AND RESULTS OF FINDINGS

As this study will focus to investigate the causal impact of telecommunication infrastructure with the help of panel data. As discussed earlier, a lot of studies also

successfully tried to show a significant impact of telecommunications infrastructure development on economic growth in a cross section framework which involves the estimation of single cross country regression but they assume and use traditional identical production function for all countries.[1] To ignore the individual "country effect" leads to the possibility of biased results [Islam (1995); Datta and Agarwal (2004)] and it can modeled the change over time in dependent variable, when the change over time is part of the research problem [Johnson (1995)] while the time effect can be modeled as a variable in the common production function and other panel regression model is not possible with lagged dependent variable because each record contains all time points and the lagged effect measure change [Finkel (1995)], Roller and Waverman's study (2001), indicates that when "fixed effect" are ignored in their model, the importance of telecommunications in explaining productivity is too large to be true. However the primary use of the applying "random effect model" is its parsimony and it added only a single to the model. The important point to note by Allison (1994) that some researchers prefer to use fixed-effect models only when inferences are being made about the sample under consideration but prefer Random effect models when making inferences about larger population and if there is possibility to have some nuisance parameters, this decision rule is not relevant and this study focus on both random as well as fixed effect methods.

The present study focuses both on fixed and random effect to analyse the telecommunication development effect on economic growth. Then after analysing the fixed and random effect, this study will also focus to see the causal relationship of telecommunication infrastructure and economic growth. We can estimate a growth equation for each country by following the cross-sectional growth framework of Barro (1991), Levine and Renelt (1992)[2] and others is specified to examine the determinants of economic growth. To test the conditional convergence hypothesis[3] given by Solow and Swan (1956) and then endogenous growth theory, a Solow-type equation is used with a set of variables reflecting differences in the steady-state equilibrium. Beside to check the country specific effect, the lagged value of dependent variable also includes to check the short run autoregressive behaviour of dependent variable. On other hand countries dummy are used to countries according to their level of income. It is basically to check the optimum growth theory hypothesis.[4]

We try to account here for differences in initial economic conditions, population, lagged fixed investment, as well as in telecommunication infrastructure endowment. The growth equation is thus extended to include the effects of telecommunications infrastructure on growth, which has the following form.

$$GRTH_{it} = a_i + \eta_t + ß_1 GRTH_{i,t-1} + ß_2 (GDP)_{i,t-1} + ß_3 INV_{i,t-1} + ß_4 G^C/Y_{it} + ß_5 POP(1)_{it} + ß_6 POP(2)_{it} + ß_7 POP(3)_{it} + ß_8 TEL_{it} + \mu_{it} \quad \ldots \quad \ldots \quad \ldots \quad (1)$$

[1]This methodology is used by Barro (1991), Mankiw, *et al.* (1992) and Norton (1992).

[2]Some recent studies also used this framework like Datta and Agarwall (2004), Ding and Haynes (2004).

[3]According to neo classical growth theory, due to diminishing return to capital, the growth rate of a country is inversely proportional to its initial level of income. It leads to the concept that poorer countries are growing faster than rich ones (convergence hypothesis).

[4]To a specific growth limit of population, the contribution of population in economic development is positive otherwise it is negative beyond this limit.

$$GRTH_{it} = a_i + \eta_t + ß_1 GRTH_{i,t-1} + ß_2 (GDP)_{i,t-1} + ß_3 lNV_{i,t-1} + ß_4 G^C/Y_{it} + ß_5 POP(1)_{it} + ß_6 POP(2)_{it} + ß_7 POP(3)_{it} + ß_8 TEL\ SQ_{it} + \mu_{it} \quad \ldots \quad \ldots \quad \ldots \quad (2)$$

Where *i* index is for the countries including in the low income, middle income and high income panels; *t* index stands for time; a*i* and η*t* are country-specific and time-specific parameters, respectively. GRTH represents the annual growth rate of real GDP per capita, it is basically the dependent variable of our study, which stands to measure economic growth of a country, $GRTH_{t-1}$ represents the lagged growth rate of real GDP per capita, it include to check the autoregressive behaviour of dependent variable, GDP_{t-1} represents lagged real GDP per capita measured in purchasing power parity (PPP). The lagged GDP variable is included to test for convergence in a panel data framework. A significant and negative coefficient of lagged GDP per capital is expected to support the convergence hypothesis: the higher level of past GDP, the lower the subsequent growth in GDP per capita. INV_{t-1} measures the share of fixed investment of previous year in current GDP. The correlation between lag investment and economic growth is expected to be positive. The G^C/Y representing the share of government consumption, in GDP measured as the ratio of government purchases to real GDP. In previous literature the share of government consumption is positive in somewhere as well as negative in other. So the sign of government purchases is not pre determined and it remained to be determined. POP represents population growth rate and in this variable we use panel dummy so that we check our optimal growth theory of population, POP(1) representing the growth rate of population of lower income countries, its sign is expected to be negative according to the optimal growth theory of population, POP(2) representing the population growth rate of the countries included in middle income panel, the second panel of our study, the sign of this variable is expected to be negative also, because the countries included in middle income panel is highly populated. POP (3) is introduced to see the effect of population growth rate of the countries included in the panel of high income countries and its sign is expected to be positive.

The TEL variable contains a measure of telecommunication infrastructure. The variable we are using here is the index of two basic infrastructure of telecom; one is teledensity, the number of telephones per 1000 inhabitants, including only fixed line and mobile phone subscribers and the number of internet users (per 1000 people), with the help of these two we made the index of telecom infrastructure and it stands for variable TEL. It is an output measure and therefore the current value is expected to have the strongest association with that year's growth rate. However previous studies have indicated a two-way causation between telecommunications investment and economic growth. In order to confirm that the results are not simply due to reverse causality this relationship is tested using current and lagged values of TEL (TEL, TELt-1, and TELt-2) for Equation (1). The expected signs for telecommunications variable and its lagged variables are positive.

Finally, TELSQ, the square of the telecom variable, is included in a separate model (Equation (2)) to study the nature of returns to scale to telecommunications investment. The intension of introducing a square term is to check whether the relationship between economic growth and telecommunications is linear or not. If the coefficient of TELSQ ($ß_8$) is negative and significant then we have support for a "diminishing returns" hypothesis. Positive signs for this coefficient, $ß_8$, will indicate

increasing returns. The impact of telecommunications infrastructure may be insignificant for low penetration rates. The explanations of the variables used in this model and their expected signs will be summarised later in this report.

THE GRANGER CAUSALITY TEST

The first attempt for testing the direction of causality was proposed by Granger (1969). Granger's test is an appropriate and very general approach for detecting the presence of a causal relationship between two variables. The granger causality test is a simple test to check causality between two 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.

$$GRTH_t = a\ Tel_{t-i} + ßGRTH_{t-j}$$
$$Tel_t = \lambda GRTH_{t-I} + \gamma Tel_{t-j}$$

Where

GRTH = growth in real GDP per capita
Tel = Telecommunication infrastructure

And t is time period, i and j stands for lag.

Regression Results

Regression results, presented in Table 1, perform with the specification of country in fixed effect model, The model is mainly used to see the effect of telecommunication infrastructure and economic growth in order to measuring individual effect after controlling of government consumption, population growth, investment etc. using fixed effect model as opposed to common intercept model, significantly improve the overall significance of the regressions. By running the data for fixed effect model, In Table 1, the coefficients of most of the variables are significant at 1 percent level of significance, the variable LGRTH is positive and highly significant to our dependent variable GRTH.

The coefficient of lagged GDP (GDP_{t-1}) which describe the effect of past GDP (PPP) on GDP per capita growth, has a negative and significant at 1 percent level of significance, which prove our convergence hypothesis which suggest the countries with high GDP per capita tends to grow at slower rate. With The negative coefficient—0.00012, the Convergence Hypothesis is proved by some previous studies of Ding and Haynes (2004) and Datta and Agerwall (2004). GC which was taken to see the impact of government expenditure on economic growth, has a negative and significant impact on economic growth, crowding out effect[5] occur in this situation. According to results, a negative and significant effect of government consumption expenditure is present in our case which explains the statement of Barro (1991), government consumption lowers savings and growth through the distorting that, 'effects of taxation or government-expenditure programmes'.

[5]It refers to the situation when due to government consumption expenditure, saving become low and the result is the decrease in investment of a country.

Table 1

Fixed Cross Section
Dependent Variable: GRTH

Variable	Model 1	Model 2	Model 3	Model 4
Intercept	13.9202	13.941	13.885	13.8081
	(8.383)	(8.491)	(8.406)	(8.2498)
LGRTH	0.2721	0.2723	0.272	0.2691
	(6.5201)	(6.505)	(6.470)	(6.598)
GDP_{t-1}	–0.00012***	–0.00012***	–.000119***	–0.00011***
	(–3.7469)	(–3.803)	(–3.796)	(–3.471)
GC	–0.4794	0.4810	–0.483	–0.4786
	(–6.5886)	(–6.652)	(–6.66)	(–6.5233)
LAG FIXINV	–0.2036***	–0.2037***	–0.202***	–0.2002***
	(–3.1882)	(–3.172)	(–3.142)	(–3.807)
POP-1	0.2764***	0.2781***	0.2787***	0.279***
	(3.861)	(3.857)	(3.854)	(3.868)
POP-2	–0.1672*	–0.168*	–0.164*	–0.1562*
	(–1.813)	(–1.839)	(–1.771)	(–1.7008)
POP-3	–0.1021***	–0.102***	–01.102 ***	–0.1036***
	(–2.629)	(–2.603)	(–2.611)	(–2.626)
TEL	0.000319***	–	–	–
	(2.6358)			
TEL_{t-1}	–	0.00038***	–	–
		(2.558)		
TEL_{t-2}	–	–	0.000438***	–
			(2.395)	
TELSQ	–	–	–	0.0000000221***
				(2.911)
R-square	0.453	0.453	0.453	0.4519
F-statistic	19.77	19.16	19.12	19.07
Durbon-Wasten Stat	1.96	1.96	1.98	2.004

*** Significant at 1 percent, ** Significant at 5 percent, * Significant at 10 percent.

LAG FIXINV, the share of total investment in GDP, describes the effect of past fixed investment on the growth of GDP per capita, Its trend should be positive, but in our result it shows a negative but significant relationship with dependent variable GRTH by a coefficient of –0.2036 which shows its significance at 1 percent level. This trend shows that the fixed investment of last year has a negative impact on the growth of GDP per capita of current year. The basic reason of this negative impact is that due to telecommunication infrastructure development, most of the countries are interested to invest in this sector but the investment projects of this sector are of short term, which do not show their contribution in the next year GDP per capita.

On the other hand the population trend also shows significant results, POP1 shows the effect of population on lower income countries, its effect on GDP per capita on lower income panel is positive, and significant at 1 percent level, which describe the fact that

the growth in the rate of population is positively affect the growth of GDP per capita, the positive coefficient of this variable is due to the fact that this panel contains some countries like Sudan and Ghana which have slow growth rate of population in their countries. POP2, which describe the effect of population growth on GDP per capita of middle income panel, has a negative and significant coefficient which shows a negative relationship between independent and dependent variable but it is significant at 10 percent level, POP3 shows a negative but highly significant coefficient at 1 percent level which shows the negative impact of population growth on GDP per capita in high income countries. Datta and Agerwall (2004) also showed a negative relationship of population growth on GDP per capita in high income countries.

Finally the variable TEL in Model 1, which basically includes an index of Fixed line and mobile phone teledensity and internet users has a positive and highly significant at 1 percent level suggests a positive and strong relationship between telecommunication infrastructure, in previous study only supply side (teledensity) use to measure the effect of telecommunication on economic growth but we was used an important demand variable which is internet users, by using index, therefore expecting a strong association on current year growth, the telecom variable is significant at 1 percent level of significance . with having same magnitude when comparing with the current value, the variable TEL_{t-1} and TEL_{t-2} in Model 2 and 3, have a positive and strong relationship at 1 percent level of significance. This shows that telecommunication variable has a strong impact on economic growth not even with current condition but with past value as well.

Our last value is TELSQ, which basically is to analyse the trend of rate of return of telecommunication investment, we assume that if it has a negative value then it has a diminishing rate of return trend otherwise it has increasing rate of return, our results strongly recommend the increasing rate of return condition. The TELSQ variable has a positive coefficient with 1 percent level of significance; on the other hand our original TEL variable has positive value, so we conclude that the increase in telecommunication infrastructure investment will lead to higher economic growth. These results show the evidence that most of the countries are in a process of developing telecommunication in our panel, and thus can not enjoy the full advantage of telecommunication development yet now.

Another variable OPEN is omitted from the analysis, because of the insignificant results, and most important is that its presence may affect the significance of other variables in the model. The OPEN variable is basically use to check the concept of global economy by the summation of its imports and exports thus we assume to have positive results from this variable.

However R square value is concerned, it is basically use to analyse the overall variation in growth rate due to our independent variable. In our all Models, it is rounded off 0.585, and it is considered significant in cross section data as well. The problem of multicollinearity is not found in our model and Durbon-Waston statistics shows satisfactory results in this context. In short our whole model is highly significant as our F statistic is round off till 19 in our all models.

Cross section fixed effect results show that most of countries in our panel have better result than average and the intercept term also proves the overall model that the model showing better results than average.

Table 2

Random Cross Section
Dependent Variable: GRTH

Variable	Model 1	Model 2	Model 3	Model 4
Intercept	6.5271***	6.542***	6.51***	6.753***
	(3.829)	(3.823)	(3.80)	(3.891)
LGRTH	0.420	0.4195	0.420	0.412
	(6.839)	(6.842)	(6.853)	(6.730)
GDP_{t-1}	–0.0000605*	–0.0000603*	0.0000583*	–0.0000548*
	(–2.733)	(–1.74)	(–1.680)	(–1.539)
GC	–0.219***	–0.220***	–0.220***	–0.231***
	(–2.734)	(–2.733)	(–2.716)	(–2.75)
POP-1	–0.153***	–0.153***	–0.152***	–0.152***
	(–2.357)	(02.352)	(–2.34)	(–2.33)
POP-2	–0.097**	–.0965**	–0.096	–0.092**
	(–2.27)	(–2.270)	(–2.264)	(–2.201)
POP-3	0.015	0.0156	0.138	0.0136
	(0.337)	(0.344)	(0.302)	(0.298)
TEL	0.00339	_	–	_
	(4.529)			
TEL_{t-1}	_	0.000384***	–	_
		(3.975)		
TEL_{t-2}	_	_	0.000456***	_
			(3.434)	
TELSQ	_	_	–	0.0000000242***
				(4.94)
R-square	0.3517	0.351	0.350	0.347
F-statistic	27.70	27.458	27.31	26.56
Durbon-Wasten Stat	2.245	2.244	2.243	2.23

*** Significant at 1 percent, ** Significant at 5 percent, * Significant at 10 percent.

In context of our results, the above Table 2 shows that the LGRTH which shows the lag growth rate of GDP per capita is positive and highly correlated to our GDP per capita growth. On other hand in random effect model we can also prove our conditional and convergence hypothesis because the GDP_{t-1} has a negative but significant coefficient at 10 percent level of significance. Therefore we can conclude that the countries of high GDP per capita rate have a slower trend to grow. In the same time the crowding out effect is again seen in this model in government consumption expenditure and it shows a negative relationship between economic development and GC by describing negative but highly significant value, It is significant at 1 percent level of significance. POP1 deal with the relationship of the population growth rate and economic development, in lower income countries and here it at high significance at 1 percent, shows a negative relationship by having negative coefficient value. POP2 also deal with the population growth variable but in middle income panel, its value is negative and significant at 5 percent level, in both of the population cases, the optimal theory of population seems to be true, where the population rate above the optimal rate has a negative impact on economic growth. In third case of POP3 results seem again to be inconsistent.

The TEL variable, which involves the index of both teledensity of fixed line and mobile phone users and internet users, has a strong and positive impact on our dependent variable which shows the increase in telecommunication infrastructure leads to economic growth. On the other hand TEL_{t-1} and TEL_{t-2} also proves to be beneficent with their highly significant and positive value

In random effect model, we find an increasing return to scale, which deals with the situation when the development of telecommunication infrastructure leads to high return in future. The positive and significant value of TELSQ with the help of TEL describes its strong impact on economic development

However R square is concerned, in Random effect model we bear the cross section impact here and the R square value in our model is round off till 30. On the other hand the value of Durbon-Waston assures us the absence of multicollinearity. On the whole this model is significant.

In Random effect model, countries again show good results at cross section specific and almost all countries showing better results than average. The intercept term is also showing a significant individual country effect as whole.

MODEL SELECTION CRITERIA

There are many of criteria which help to choose the best model in several alternative models. In general likelihood ratio test considered useful for choosing between two models where one model is a subset of other.

AIC Criterion

For alternative model selection, Akaike criterion introduced in 1974, which show a reasonable way to choose suitable model and known as Akaik Information Criterion. This equation can be write as

AIC = –2 * ln (maximised likelihood) + 2* (number of model parameters)

This methodology is used when we have many alternative model to compare. The model with a lower AIC is considered a better model.

Schwarz Information Criterion (SIC)

It is the second criterion which is also used with AIC. it also work in same way as AIC, the model which has low value of Schwarz Information Criterion (SIC) is considered a better model. It was used in order to compare the result of the model from the AIC.

Sum of Square Residual (RSS)

The sum of square residual is also recommended for choosing appropriate model. This study has used to this criteria. The model which have minimum sum of square residual is recommended the most appropriate and the best model for the study.

The Best Model for the Study

All of the above three criterions for the selection of the best model is reffering the dynamic fixed cross section model appropriate for this study. The AIC criterion shows the minimum value of 5.26 for this model; on the other hand SIC shows also a minimum value of 5.55 then other models applied in this study. For other models it has the value more than 5.63, and lastly the RSS criterion also giving a minimum value of 4662.169, for all of four semi-model applied in model 1, for other model it has the value 5384.936 for fixed period specific model, and for random effect, in both of models, it has shown the value 5529.519 and 5493.548 respectively. So it is concluded that the dynamic fixed effect model in country specific case consider the most appropriate and better model for concluding result and make policy implication.

The Result from Granger Causality Test

Granger causality test has been performed to check the causal relationship between telecommunication infrastructure and economic growth.

$GRTH_t = a\ Tel_{t-i} + ßGRTH_{t-j}$
$Tel_t = \lambda GRTH_{t-I} + \gamma Tel_{t-j}$

For this purpose one lag of both variables taken and got the result that GDP per capita growth has no causal effect on telecommunication infrastructure, where as telecommunication infrastructure has a strong causal relationship with GDP per capita, so the development of telecommunication infrastructure leads to the growth of economy. The relationship is significant at 1 percent level of significance.

Table 3

Granger Causality Test

Regression	Granger Causality Test
GDP on TEL INF	2.0531* (0.152)**
TEL INF on GDP	6.338* (0.012)**

* F-value. ** Probability value.

From the Granger Causality test, the causal relationship of telecommunication infrastructure development and economic growth has been proved. It indicates that the direction of causality is from Telecommunication to GDP per capita growth.

CONCLUSION

This study tries to show the role of development of telecommunication infrastructure and then show its effect on economic growth. For this purpose, 18 years data was taken, representing twenty four countries comprising low income, middle income and high income. Two tests have been used, first by applying a Solow type equation, fixed effect and random effect models have been performed to check the importance of macro level variables on economic growth, population, fixed investment, government expenditure etc, all of these variables showed a significant relationship with economic growth (either positive or negative). Secondly this study tries to prove the

causal relationship between telecommunication infrastructure and economic growth. After applying fixed and random effect models, it confirmed the convergence hypothesis, which suggests that the countries with higher GDP per capita tend to grow at slower rate, the lag fix investment showing a negative but significant result because the negative sign of lag investment shows the fact that, almost in all countries, investment contains a high share of telecom investment, which is of short term period, because of the short term influence, it shows a negative trend. Population however with the help of panel dummy, showing almost a negative but significant result.

The relationship between telecommunication development and per capita GDP growth was found to be highly positively correlated at 1 percent level of significance. The results are robust even after controlling for investment, population growth, past level of GDP per capita, government consumption, and lagged growth in GDP per capita. The result from both models also indicates that telecommunication investment is subject to increasing return to scale, this factor occurs because the study includes most of the developing countries which are in the process of telecommunication development. Secondly we use index of teledensity and internet users, most of the countries are struggling for two, but internet infrastructure is giving high returns, so countries gain more with the development of telecommunication infrastructure. From the perspective of public policy, the results of this analysis provides strong evidence that providing an efficient and appropriate telecommunications infrastructure is significant for fostering economic growth, as well as reducing regional disparity and shrinking digital divide.

From almost all of the discussion, both theoretical and empirical, the same conclusion has been found that telecommunication can actively participate in the growth of an economy. We also analyse some important issues on theoretical side which are drawn from facts and very important to discuss. In most of developing countries, the telecom sector is facing a number of challenges which need to be covered; some of them are given below.

- The first and foremost challenge which is faced by developing especially low income countries is the low teledensity especially in the rural areas of these countries, the steps to overcome this problem are insignificant.
- Low standard of services which are provided, this is due to the problem that these countries have a lack of network securities, strategies and awareness.
- In most of the countries, the facility of disaster recovery is not developed, not only this but they have lack of data warehouses and dearth of international call centres which lead to the problem of inadequate and expansive international connectivity and active provision of alternative networks.
- Shortage of quality human resource in IT and telecom sector.
- A main problem which is faced by these countries like Pakistan is that there is a lack of R&D activities in telecom sector, especially for indigenous production of telecom equipment; this factor leads to the problem that these countries become big importers of telecom equipments from other countries.
- The R&D coordination is not seen in these countries for the sharing of experience among the telecom R&D and manufacturing as well as service provider companies and universities.

- Low broadband penetration and high frequency charges within the country
- Because of state-owned monopoly in telecom sector, in most of the countries, there is restriction on the establishment of base-station for mobile cellular telephony.

These are some of the challenges which are faced by developing countries, there should be an open strategy to meet these challenges, and so that telecom sector can play an active role in the development of a country.

Regarding the impact of investment in telecommunication sector, it proves beneficial for most of the countries, especially the countries which want to develop their economy. The inflow of capital in the form of FDI in telecom investment is a major benefit for them, then the increase in tax revenues and job opportunities in this sector also give them an edge for growth, especially in developing countries. On the other hand, developed countries also take a great benefit in the form of service and telecom equipment provider countries. Most of the multinational service provider companies belong to high income countries. At the same time most of the developing countries are dependent on of these countries for telecom equipments. A comparative advantage situation arises here, but the situation after trade presents a different analysis here. Both countries are in trade, but both of commodities (telecom services, equipments) are provided by rich countries.

It is a clear and conducive fact arises from our study that telecommunication development has a very strong impact on the growth of an economy, but here sound planning is required to fulfil the requirement of an economy, so that telecom sector can play a role in industrial, agricultural, financial and manufacturing sector of the economy. On other hand the use of internet makes the fastest source of communication and generating more business activities.

This study tried its best to cover all of the aspects which may be important for analyses, all of the issues has been discussed which are related to the problem in this study. The results both from theoretical as well as empirical analysis confirm a positive correlation between telecommunications and economic growth.

But the lack of data is a major problem which is faced during research, most of the lower income countries have insignificant data, and the problem of missing values, especially in telecommunication data, which may affect the result of the telecommunication effect on economic growth, so that the panels are converted to the range of eight countries in each panel. Only teledensity (no of fixed line and mobile phone users per 1000 people) and internet users (per 1000 people) have been taken for the purpose to made the index. Some of the other variables related to telecommunication like import and export of computers and other telecom equipments, number of total mobile phones, telephone mainline, and telephone revenue per mainline etc. have insignificant data even for high income countries, so we just rely on the two variables discussed above.

Most of the former studies have been analysing the telecommunications with having only a panel of either developed or developing countries, this study tried to cover all of income group countries, so that we can broadly measure the impact of telecom on economic growth in perspective of all of income groups throughout the world.

Different Econometric test e-g co-integration test, unit root test and covariance analysis, have to be performed to analyse the impact of the development of telecommunication infrastructure development on economic growth. This study is just a contribution to see the importance of this factor, the research doors are open for further

investigation which may better find out the policies to make telecommunication sector more effective for economic development, especially in context of Pakistan telecom sector. The R&D issues should be the priority because it is the most growing sector of our economy which contributes 2 percent of its share in annual GDP and attracts more than 25 percent of FDI in Pakistan.

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