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TELECOMMUNICATIONS AND ECONOMIC GROWTH IN INDIA: CAUSALITY ANALYSIS

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ABSTRACT

In the emerging global economy, telecommunication sector has made a significant impact on economic growth. It is one of the prime support services needed to promote growth and modernization of various sectors of an economy. Telecommunication is one of the sectors having high forward and backward linkages. The paper attempts to investigate the causal relationship between telecommunication development and GDP as well as various sectoral components of GDP in India. The results of the study reveal a long run relationship between growth of telecommunication and economic growth at aggregate level as well as at sectoral levels. The study indicates that there is causal relationship between telecommunication growth and growth of manufacturing sector as well as services sectors. Growth of FIRB services (Finance, Insurance, and Real estate and business services) is causing telecommunication growth in India while the causal relationship is other way round that is growth of SPC and TTHC is caused by telecommunication growth in India. The results show structural break in data in 1995 and 2005 which indicate strong impact of telecommunications on development of various sectors of the economy.

KEYWORDS: Telecommunication Sector, Information Technology (IT) and IT Enabled Services (ITES)

INTRODUCTION

Telecommunication has very significant role to play in development of various sectors of the economy. In the 21st century, telecommunication sector has become pivotal to a country's socio-economic development. It is one of the prime support services needed to promote growth and modernization of various sectors of an economy. Enormous growth of information and communication technology and its role in development of various sectors including services like finance, insurance, trade, hotel and business services as well as industry, agriculture and governance is commendable. Telecommunication infrastructure is somewhat different from other forms of infrastructure because of existence of network externalities, a phenomenon that increases the value of services with the increasing number of users. Thus the impact of telecommunication infrastructure on economic development is more pronounced as compared to other traditional infrastructure (Jha and kaleja; 2008).

Telecommunications help in dissemination of information to all the sectors and sections of the society, thereby helping in better performance of all the sectors including industry, agriculture, services, governance and social sector. Role of telecommunications in economic development has been acknowledged worldwide. According to a study by World Bank a 10 percent increase in teledensity will boost GDP by 6 percent point. Similarly, in India states with higher teledensity have experienced faster growth. (Earnest & Young and FICCI: 2011) Apart from that there is a significant relationship between industry and telecom sector in the era of market oriented strategies. Telecommunication affects productivity by lowering the costs of collecting information and thereby cost of doing business. There is scope for network externalities because with more users, the derived value of those users increases.(Isaksson:2010). Further, another aspect of India's recent telecom growth has been the dynamism of the service sector, particularly information technology (IT) and IT enabled services (ITES). Connectivity also fosters social development, including improved education, health and increased citizen participation in civil society. Telecommunication helps in providing access to health care and allied services. (Earnest &Young and FICCI: 2011)

Another beneficiary of the telecom revolution is the financial services industry, which has been on a growth trajectory. This is the next revolution that is expected to emerge through the use of mobile phones. Mobile phones provide consumers an opportunity to transact anytime and anywhere. M-commerce finds its applications across various end markets such as banking and financial institutions, paying bills for utilities such as power and gas, booking tickets for transportation services such as trains and taxis and online shopping. Mobile banking enables customers of banks and other financial institutions to access their account information, transfer funds, trade stocks and purchase financial products such as insurance. Financial inclusion is central to the overall task of inclusive growth. (TRAI: 2011).

REVIEW OF LITERATURE

Relationship between telecommunication development and economic growth has attracted the attention of researchers especially since 1980s. Many studies confirmed a clear and positive correlation between telecommunications and economic growth {eg. Hardy (1980), Saundesr.ed.al(1994), Lichtenberg(1995), Greenstein and Spillar (1996) and Norton (1992)}. Roller and Waverman (1996) investigated the impact of telecommunication infrastructure for 21 OECD countries over a period of 20 years and found a significant positive link between the two. Dutta (2001) applied Granger causality tests for a cross section of 30 developing and industrialized countries in three different years, and found a bi-directional causality for both developing and industrialized countries.

Beil et al. (2005) conducted Granger-Sims causality tests for a time series of 50 years in the U.S., and suggested a one-way causality from economic growth to telecommunications investment. Shiu and Lam (2007) studied the significance of telecommunications development to economic growth in 105 countries. The results indicated that there is bidirectional causality in case of European countries with high income level and relationship is unidirectional in general from economic growth to telecommunication for low income countries. Dvornik and Saboli (2007) investigated causal relationship between telecommunications investment and economic development in Eastern European countries in transition during 1998-2001 and the results showed causality in the direction from telecommunication investments toward GDP.

Kateja and Jha (2008) investigated causal relationship between rapidly developing telecommunication industry and economic growth in India, it was found that in short run growth of telecommunication is influenced by growth in GDP, while reverse is not true. Azim and Mahmood(2009) examined the casual relationship between telecommunication infrastructure and economic growth over a period of 8 years representing 24 countries and found unidirectional causality between the two from telecommunication to GDP per capita growth. Sadr.ed.al (2012) examined the causal relationship between information and communications technology (ICT) development and economic growth in the Iran over a period of 1980-2010.

The results of this study found a one-way causal relationship from economic growth to ICT development for Iran. Extensive studies from the 1960s to the present have documented a strong correlation between GDP per capita and telephone density indicators. However, previous studies have accounted for only GDP as a development variable. Nowadays telecommunication has very significant role to play in the growth of various sectors like industry, hotel, tourism, finance, real estate, community, social and personal services etc. The causality analysis between telecommunication development and GDP as well as various sectoral components of GDP is very much relevant. Major components of GDP considered in the study include GDP component of Financial Sector, Insurance, Real Estate, Business Services, GDP Component of Trade, Hotel, Tourism, Communication Services, GDP Component of Industry, GDP Component of Manufacturing, GDP Component of Personal, Social and Community Services.

The study has three main objectives;

- To test the stationary and structural break for data in order to provide more conclusive evidence on structural breakpoint in India’s economic data.
- To measure the growth and performance of telecommunication and other sectors representing economic growth.
- To investigate the causal relationship between teledensity and economic
- Growth using various components of economic growth

DATABASE AND METHODOLOGY

In order to study the causal relationship between telecommunications and various sectoral components of economic growth, the study has used data over a period of 1976-2012. Data for the study has been collected from the Handbook of Statistics of Indian Economy, RBI, various issues and CMIE reports, Infrastructure.

Causality Analysis

One way of looking at relationship between teledensity on the one hand and various economic variables pair-wise on the other hand is to investigate causal relationship between the two. The causal behavior of the variables can be put into four different categories:

- **Unidirectional Causality:** When x causes y (x toy) or when x is caused by y(x to y) after some lag. In other words it indicates if the estimated coefficients on lagged x are statistically different from zero as a group and set of estimated coefficients on lagged y is not statistically different from zero and vice versa.
- **Bilateral Causality:** When both variables x and y are cause of one another with some lag(x to y) or when sets of x and y coefficients are statistically different from zero in both the regressions.
- **Instantaneous Causality:** When both the variables x and y are simultaneously the cause of one another without any lag.
- **No Causality:** When one of the variables, say x do not or is affected by the other, say y, (with or without any lag), i.e., there is no indication of causality.

Causality or causation indicates the direction of relationship between two or more variables. Mere presence of strong correlation between two variables is not sufficient to predict the direction of causality. Causal tests help in deciding the direction of relationship between two or more variables i.e., which variable is the cause and which is effect. Granger causality (1969) methodology has been used in this study. The relationship between growth of telecommunication sector and economic growth is examined using various variables including GDP component - Financial Sector, Insurance, Real Estate, Business Services, GDP Component- Trade, Hotel, Tourism, Communication Services, GDP Component - Industry, GDP Component-Manufacturing, GDP Component-Personal, Social and Community Services. The study has employed bi-variate causality framework using time –series data from 1976 to 2012.

We have studied the casual relationship in the following cases:

- Growth Rates of Teledensity and GDP per capita
- Growth Rates of Teledensity and GDP Component- FIRB services (Finance, Insurance, Real estate and business services)
- Growth Rates of Teledensity and GDP Component- TTHC services (Trade, Tourism, Hotel and Community services)
- Growth Rates of Teledensity and GDP Component- Industry
- Growth Rates of Teledensity and GDP Component- Manufacturing
- Growth Rates of Teledensity and GDP Component -Services
- Growth Rates of Teledensity and GDP Component- SPC (Personal, Social and Community services).

Eviews runs bivariate causality of the form:

$$X_t = \sum^{n}_{i=1}\alpha_i Y_{t-i} + \sum^{n}_{i=1}\beta_i X_{t-j} + \mu_{it}$$

$$Y_t = \sum^{n}_{i=1}\delta_i Y_{t-I} + \sum^{n}_{i=1}\gamma_j X_{t-j} + \mu_{2t}$$

For all possible pairs of X and Y series in the group. The null hypothesis is that X does not Granger-cause Y in the first regression and Y that does not Granger-cause X in the second regression. Here X represents various components of GDP defined above and Y represents the teledensity.

Tests for Unit Roots

Granger test for causality presupposes the stationarity. Most of the time series are likely to exhibit trend. If trended series are taken for analysis, the regression coefficients could be biased and relationship could be spurious. This is because in time series data, successive observations or values are likely to be correlated especially, if the time interval between two successive values is less. Therefore, the series has to be checked for stationary. A series is said to be stationary if its mean and variance are constant over time and value of covariance between the two periods depends upon the time gap between two time periods and not the actual time at which it is computed(Gujrati:2004). However if it does not meet these criteria, it is said to have unit root. If the series is non-stationary i.e. if the series possesses unit roots then, the relationship is likely to be spurious.

The theory behind Autoregressive Moving Average (ARMA) estimation is based on stationary time series. A series is said to be (weakly or covariance) stationary if the mean and auto covariances of the series do not depend on time. Any series that is not stationary is said to be non-stationary. A common example of a non-stationary series is the random walk:

$y_t = y_{t-1} + \epsilon_t$

Where ϵ is a stationary random disturbance term. The series y has a constant forecast

Value, conditional on t, and the variance is increasing over time. The random walk is a difference stationary series since the first difference of y is stationary:

$y_t - y_{t-1} = (1-L)y_t = \epsilon_t$

A differenced stationary series is said to be *integrated* and is denoted as I(d) where d is the order of integration. The order of integration is the number of unit roots contained in the series, or the number of differencing operations it takes to make the series stationary. For the random walk above, there is one unit root, so it is an I (1) series. Standard inference procedures do not apply to regressions which contain an integrated dependent variable or integrated regressors. Therefore, it is important to check whether a series is stationary or not before using it in a regression. The formal method to test the stationarity of a series is the unit root test.(Eviews5)

Augmented Dicky-Fuller Test (ADF Test)

In case of Dicky-Fuller test it is assumed that error term was uncorrelated. But in case the error term is correlated Dicky and Fuller has developed a test known as augmented Dicky-Fuller test which includes lagged terms of dependent variable in order to eliminate autocorrelation. The lag length on these extra terms is determined by Schwartz Bayesian Criterion (SBC).

$\Delta y = a_0 + \gamma y_{t-1} + a_2 t + \sum \beta_i \Delta y_{t-I} + u_t$

$\Delta y_{t-1} = (y_{t-1} - y_{t-2})$

U_t is pure white-noise error term

Phillips-Perron Test (PP Test)

Phillips-perron test use nonparametric statistical methods to take care of serial correlation in the error terms without adding lagged difference terms. Phillips and Perron (1988) developed a generalization of the ADF test procedure that allows for fairly mild assumptions concerning the distribution of errors. The test regression for the PP test is Autoregressive of order one {AR (1)} process;

$\Delta y_{t-1} = a_0 + \gamma y_{t-1} + e_t$

While ADF test corrects for higher order serial correlation by adding lagged differenced terms on the right hand side, the PP test makes a correction in the statistic of the coefficient γ from the AR(1) regression to account for the serial correlation in e_t. So, the PP statistics is just the modification of the ADF t-statistics that takes into account the less restrictive nature of the error process.(Gujrati:2004)

Results of both ADF and PP tests for stationary are reported in Table 1 and 2. The results unanimously confirm that most of the variables including GDP per capita, teledensity, Industry, manufacturing, FIRB services, TTHC services, overall services and SPC services are integrated of order zero I(0). The optimal lag in the ADF test is automatically selected based on the Schwarz Info Criterion (SIC) by Eveiws.

Table 1: Results of Augmented Dicky-Fuller Test

Variables	Level	First Difference	Second Difference	Order of Integration
GDP percapita	-6.84(0.000*)	_	_	I(0)
Teledensity	-7.73(0.000*)	_	_	I(0)
FIRB services	-7.17(0.000*)	_	_	I(0)
TTHC services	-4.27(0.009*)	_	_	I(0)
Industry	-4.22(0.010*)	_	_	I(0)
Manufacturing	-4.04(0.016*)	_	_	I(0)
Services	-4.21(0.010*)	_	_	I(0)
PSC services	-5.57(0.003*)	_	_	I(0)

*Indicates significant at 1%

Table 2: Results of Phillips-Perron Test

Variables	Level	First Difference	Second Difference	Order of Integration
GDP per capita	-7.38(0.000*)	_	_	I(0)
Teledensity	-7.71(0.000*)	_	_	I(0)
FIRB services	-14.00(0.00*)	_	_	I(0)
TTHC services	-4.20(0.011*)	_	_	I(0)
Industry	-3.98(0.018*)	_	_	I(0)
Manufacturing	-4.08(0.014*)	_	_	I(0)
Services	-4.196(0.011*)	_	_	I(0)
PSC services	-10.16(0.000*)	_	_	I(0)

*Indicates significant at 1%

Chow Test for Structural Break

When we use a regression model involving time series data, it may happen that there exist a structural break in the relationship between the regressed y and the regressors. By structural change we mean the values of the parameters of the model do not remain same through the entire time period. Sometimes structural change may be due to external forces or due to policy changes. The Chow breakpoint test compares the sum of squared residuals obtained by fitting a single equation to the entire sample with the sum of squared residuals obtained when separate equations are fit to each subsample of the data. The F-statistic is based on the comparison of the restricted and unrestricted sum of squared residuals and in the simplest case involving a single breakpoint, is computed as; (Gujrati: 2007). To carry out the test, we partition the data into three subsamples 1976 to 1994, 1995 to 2004, 2005 to 2012. So, we have estimated two structural breakpoints at two point's i.e, 1995 and 2005. The graphical representation of data shows an upward trend at these two points, especially in the year 2005.

Based on three subsamples we have three possible regression equations

$Y_t = \alpha_1 + \alpha_2 x_t + \mu_{1t}$ $n_1 = 19$

$Y_t = \beta_1 + \beta_2 x_t + \mu_{1t}$ $n_2 = 10$

$Y_t = \gamma_1 + \gamma_2 x_t + \mu_{1t}$ $n_3 = 6$

Y_t= Teledensity

X_t=FIRB services, TTHC services, Industry, Manufacturing, Services, SPC services

$$F = \frac{(RSS_n - RSS_{UR})/k}{(RSS_{UR})/(n_1 + n_2 + n_3 - 3k)} \sim F_{[k,(n1+n2+n3-3k)]}$$

K is the number of parameters estimated in the equation, k=3 in our case

RSS_{ur} is the unrestricted sum of squares, $RSS_{ur}=RSS_1+RSS_2+RSS_3$

n=is the whole sample

n_1=period before liberalization of telecom sector i.e., 1976-1994

n_2=period after liberalization and policy change and before unusual increase in teledensity (1995-2004)

n_3= period of unusual increase in teledensity (2005-2012)

Results of Chow's Breakpoint Test

We have checked structural break for all the variables at two points of time-series data i.e., 1995 and 2005. The results of Chow's Breakpoint test revealed that there exists structural break in the series in case of relationships including GDP per capita and teledensity, manufacturing and teledensity, industry and telednsity in 1995 which depicts the lagged impact of policy change in 1991.

These three relationships have shown structural break in graphical representation also. Though India adopted liberalization in 1991, the impact of liberalization could have been realized after a gap of four years and therefore, the series have a structural break in the year 1995. Morover, the major policy change in telecom sector occurred in 1994 with the coming of national Telecom Policy 1994.

However, there also exist structural break in case of all the variables in 2005 as shown by the table 3 and the graphical representation. After 2005 the growth of teledensity is much faster in comparison to growth of other sectors. As $F_{calculated}$ is greater than $F_{tabulated,}$ which indicates that relationship between teledensity and other variables representing economic growth has undergone structural change over a period of time. This is because, the wider impact of policy changes in telecom sector occurred in 2005 and onwards due to following reasons:

- One India plan i.e., single tariff of Rs 1 per minute to anywhere in India was introduced in march 2005 by PSUs of department of Telecom, this tariff was emulated by most of the private operators also.
- Declining handset costs and lucrative costs launched by various operators to overcome competition have been instrumental in stimulating the exponential growth of wireless subscribers.
- The launch of tariff scheme of lifetime validity by various mobile service providers during Dec 2005 has proved to be an important initiative for luring the new customers.
- BSNL reduced tariff for international calls to Middle East countries and Sri Lanka by 20% and 40% respectively. All the points mentioned above led to structural breakpoint in 2005.(Government of India, DoT annual report; 2005-6)

The structural breakpoint follows the structural transformation of the Indian economy.

Table 3: Results of Chow's Breakpoint Test in the Years 1995 and 2005

Period	1995		2005	
Variables	**F-Statistics**	**P-Value**	**F-Statistics**	**P-Value**
GDP per capita and Teledensity	3.541	0.027**	25.63	0.0000*
FIRB services and Teledensity	2.203	0.109	19.41	0.00000*
TTHC services and Teledensity	2.12	0.119	20.85	0.0000*
Industry and Teledensity	4.784	0.018*	16.92	0.00002*
Manufacturing and Teledensity	3.11	0.042**	10.61	0.00007*
Services and Teledensity	1.69	0.190	25.63	0.00000*
SPC services and Teledensity	1.42	0.155	7.07	0.0014

***** Indicates significant at 1%
** Indicates significant at 5% and 10%
*** Indicates significant at 1%, 5%, 10%

Structural Break in Relationship between Teledensity and Growth Performance of Major Sectors: Graphical Analysis

Telecommunication is one of the sectors having high forward and backward linkages. In the era of globalization and liberalization services sector has become the largest economic sector worldwide, where development is heavily dependent on the telecommunication sector. It is really pertinent to statistically explore the relationship between the telecom development and growth of other major sectors of the economy.

All the other sectors are depicting almost same trend with teledensity, however, it can be seen from graphs that after 2004-05, there is sudden increase in teledensity but growth of other sectors has not shown much variations after that period. We may say that there is a structural break in data due to sharp increase in teledensity. The easy access to mobile services is the outcome of positive regulatory changes, intense competition among multiple operators, low-priced handsets, low tariffs and significant investments in telecom infrastructure and network (www.dnb.com).

Nowadays, Mobile phones have moved beyond their fundamental role of communications. Customers use their cellular phones to play games, read news headlines, surf the Internet, keep a tab on astrology, and listen to music, or check their bank balance. Thus, there exists a vast world beyond voice that needs to be explored and tapped and the entire cellular industry is heading towards it to provide innovative options to their customers.(VAS, Annual Report:2006)

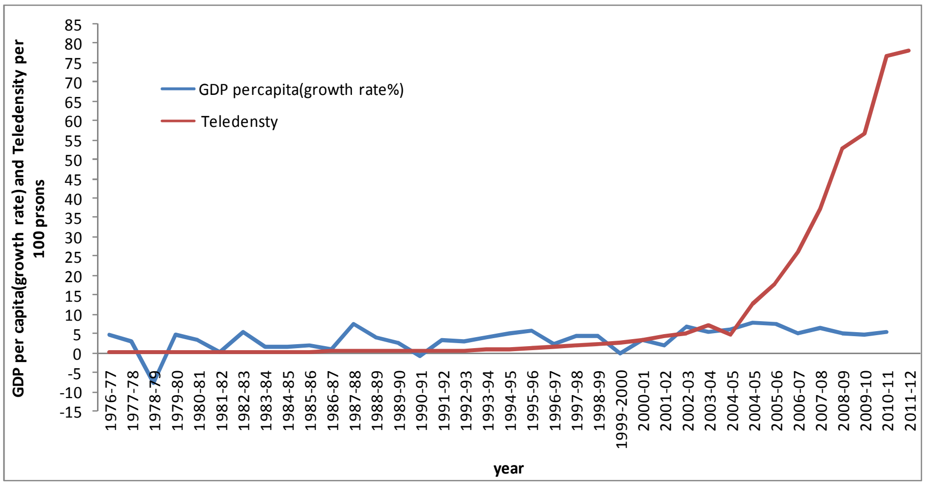

Figure 1: Teledensity and Growth Rate of GDP Per Capita over a Period 1976-2012

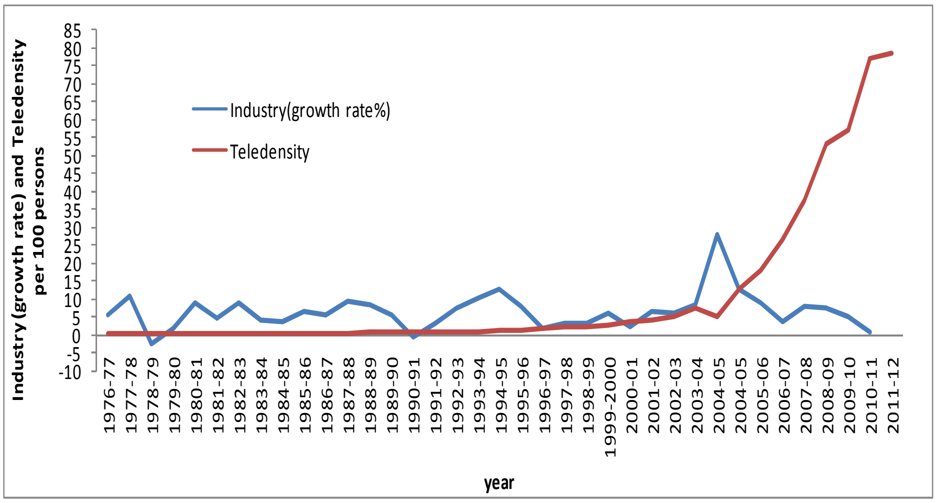

Figure 2: Teledensity and Growth Rate of Sectoral Component of GDP of Industry over a Period 1976-2012

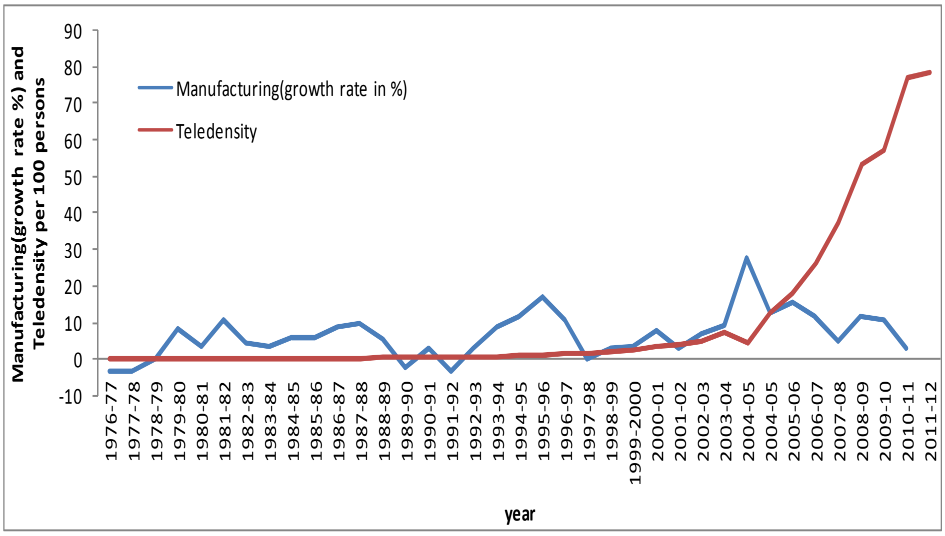

Figure 3: Teledensity and Growth Rate of Sectoral Component of GDP of Manufacturing over a Period 1976-2012

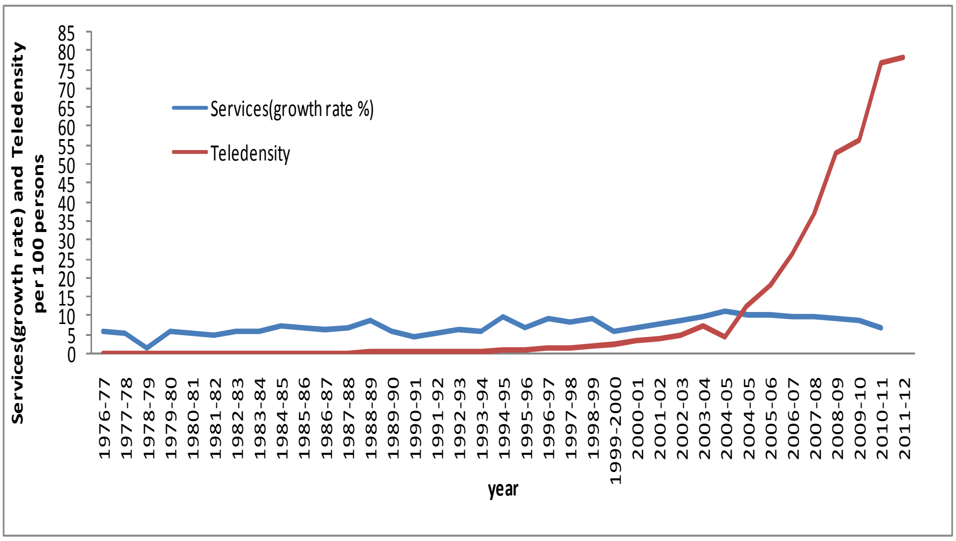

Figure 4: Teledensity and Growth Rate of Sectoral Component of GDP of Services over a Period 1976-2012

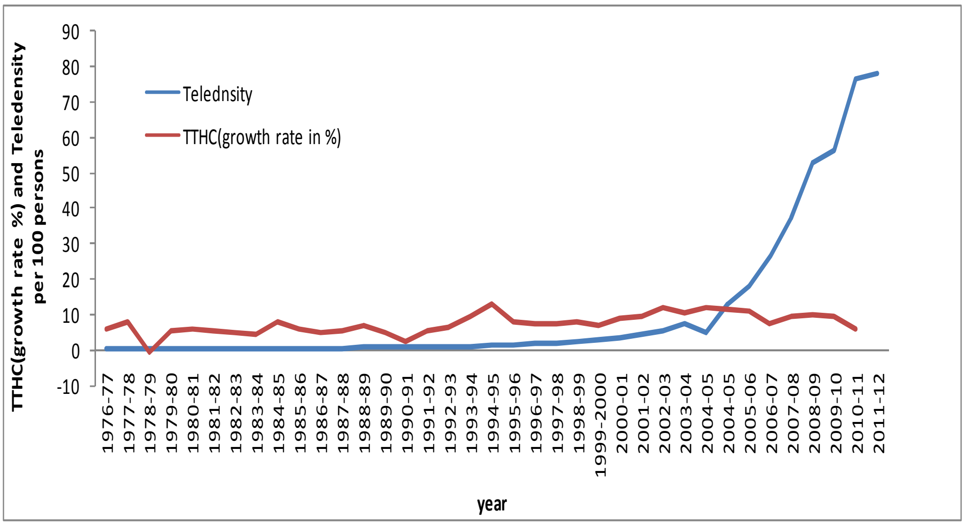

Figure 5: Teledensity and Growth Rate of Sectoral Component of GDP of TTHC over a Period 1976-2012

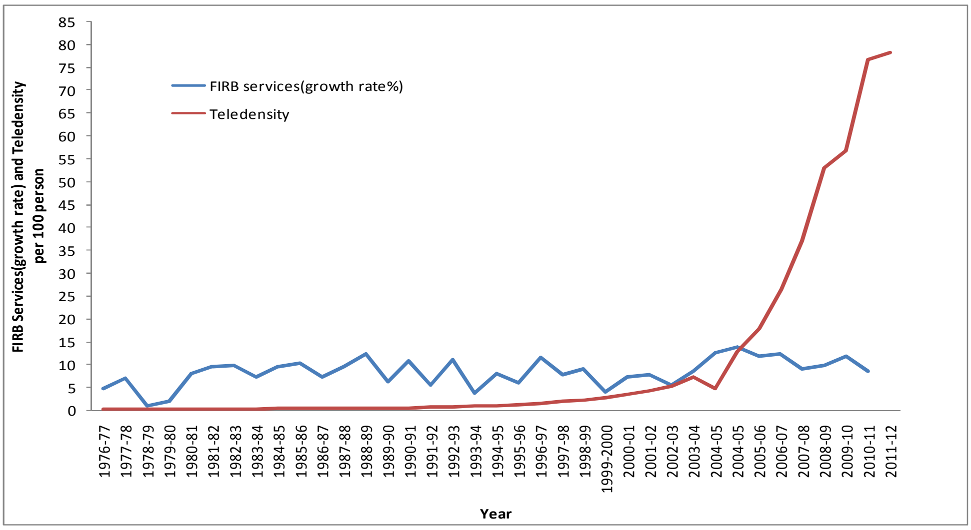

Figure 6: Teledensity and Growth Rate of Sectoral Component of GDP of FIRB Services over a Period 1976-2012

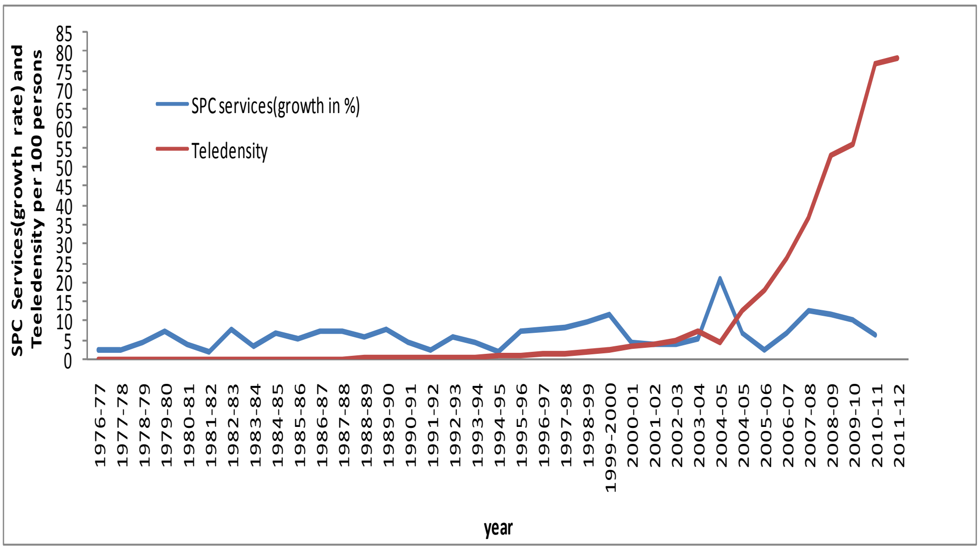

Figure 7: Teledensity and Growth Rate of Sectoral Component of GDP of SPC Services over a Period 1976-2012

RESULTS OF CAUSALITY ANALYSIS

Causality has been tested for various components of GDP including GDP component - Financial Sector, Insurance, Real Estate, Business Services, GDP Component- Trade, Hotel, Tourism, Communication Services, GDP Component of Industry, GDP Component-Manufacturing, GDP Component-Personal, Social and Community Services. Economic growth is the increasing ability of a nation to produce more goods and services. The use of Information and communication technologies can enable the production of goods in a short amount of time and services are also provided more efficiently and rapidly. Growth can occur in many different ways, for example, the increased use of land, labor, capital and business resources and increased productivity of existing resources use by using better communication services. Telecommunications diffusion increases GDP and total factor productivity by reducing transaction cost of communication, and also production processes become more information intensive. Telecommunication networks provide the framework for the delivery of different services, improves communications between firms, spreads to other industries and contributes to their profits affecting overall economic growth. (Sadr.et.dl:2012).

Industrial output is a significant component of economic growth. Better telecom infrastructure enhances firms' productivity, competitiveness and reduces the cost of capital and, more broadly, the cost of doing business. There are many advantages of well developed telecom infrastructure like orders can be better matched, delivery times can be shortened and made more timely, and costly inventory holdings can be reduced. Modern communication allows for outsourcing and production in smaller units, i.e., increased specialization. The telecommunication sector employs people and generates income in addition to act as an input to production. Indirectly, telecommunications can aid the delivery of government services such as education. Hence, its role is potentially crucial to the efficient functioning of the economy. (Isaksson: 2009). In India, small and medium enterprise contributes an estimated 39% of India's manufacturing output and provides employment to 31.2 million workers. A survey showed that mobile phones allowed the SME sector a more convenient and customized service for clients, improvement in quality of work through better monitoring, retention of better quality staff. Moreover, it also helps in saving time and cost from avoidance of travel to co-ordinate work or supplies (TRAI: 2011)

Apart from that there is a significant relationship between financial services and teledensity. The ability of the Indian telecom sector to reach the masses may help to achieve financial inclusion. Financial inclusion aims to bring the unbanked and under-banked population into the organized financial services framework and assist in growth of the electronic payments market in India. Financial services rely on good domestic as well as international network connectivity; therefore, there is a need for a sound telecommunication network. (www.mitsot.com) Communication technology plays a considerable role in travel and tourism. E-tourism reflects the digitization of all processes and value chains in the tourism, travel, hospitality and catering industries. At the tactical level, it includes e-commerce and applies ICTs for maximizing the efficiency and effectiveness of the tourism organization. At the strategic level, e-tourism revolutionizes all business processes, the entire value chain as well as the strategic relationships of tourism organizations with all their stakeholders. The e-tourism concept includes all business functions (i.e., e-commerce, e-marketing, e-finance and e-accounting, e HRM, e-procurement, e R &D, e-production) as well as e-strategy, e-planning and e-management for all sectors of the tourism industry, including tourism, travel, transport, leisure, hospitality, principals, intermediaries and public sector organizations. Hence, e-tourism bundles together three distinctive disciplines: business management, information systems and management, and tourism. (Buhalis and Jun: 2011)

The relationship between services sector and telecom sector has wide implications in the era of liberalization and globalization. One of the striking aspects of India's recent growth has been the dynamism of the service sector, particularly information technology (IT) and IT enabled services (ITES), while, in contrast, manufacturing has been less robust. It is useful to look at the composition of the services sector to see which services have contributed to the growth and dominance of the sector. It is estimated that four services, namely, Trade, Transport, Communication and Banking and Insurance have contributed more or less entire GDP growth in services sector during the last two decades. Within the services sector, the telecom sector has also been the major contributor to India's growth, accounting for nearly 3.6% of total GDP in 2010. (TRAI: 2011)

Connectivity fosters social development, including improved education, health and increased citizen participation in civil society. Social networking services are not just bringing Internet users into fast-flowing online conversations — social media are helping people to follow breaking news, keep up with friends or colleagues, contribute to online debates or learn from others. They are transforming online user behavior in terms of users' initial entry point, search, browsing and purchasing behavior. Many social network users access these services over their mobile phones (www.itu.com). Telecommunication helps to provide access to health care and allied services. It helps combat epidemics such as HIV/AIDS and malaria by supplying information on treatment and control, generating awareness, improving access to and connectivity with health centers, and establishing the mobile testing of diseases. With this theoretical background empirical results of causality analysis are presented below.

GDP Percapita and Teledensity – Causality Analysis

The results in the table 4 show that there is unidirectional causality from teledensity to GDP. But there is no reverse causation. The calculated p-value is significant at 5% level. Therefore, the null hypothesis is rejected.

Table 4: GDP Per Capita and Teledensity – Granger Causality Test

Direction of Causality	No. of Lags	F-Value	P-Value	Decision
Tele ➔ GDP	2	3.979	0.029**	Reject
GDP ➔ Tele	2	2.209	0.127	Do not Reject

* Indicates significant at 1%

** Indicates significant at 5% and 10%

Teledensity and GDP Generated from Industry

The results in table 5 show that there is no causality in either case i.e., from Teledensity to industry or from industry to teledensity. Therefore, the null hypothesis is not rejected.

Table 5: Teledensity and Industry - Granger Causality Test

Direction of Causality	No. of Lags	F-Value	P-Value	Decision
Tele ➔ Industry	2	2.422	0.106	Do not Reject
Industry ➔ Tele	2	2.312	0.116	Do not Reject

*Indicates significant at 1%

** Indicates significant at 5% and 10%

Teledensity and GDP Generated from Manufacturing

The results in table 6 show that there is bi-directional causality from Teledensity to Manufacturing as well as from

Manufacturing to Teledensity with double lag. The calculated value of p-statistics is significant at 10% in case of causality from Teledensity to Manufacturing and at 1% level in case of causality from Manufacturing to Teledensity.

Table 6: Teledensity and Manufacturing - Granger Causality Test

Direction of Causality	No. of Lags	F-Value	P-Value	Decision
Tele → Manufacturing	2	2.85	0.074***	Reject
Manufacturing → Tele	2	7.87	0.001*	Reject

* Indicates significant at 1%
*** Indicates significant 10%

Teledensity and GDP Generated from Services

The result in table 7 shows that there is unidirectional causality from Services to Teledensity with double lag, but there is no reverse causation. The calculated value of p-statistics is significant at 5% level. So, null hypothesis is rejected.

Table 7: Teledensity and Services - Granger Causality Test

Direction of Causality	No. of Lags	F-Value	P-Value	Decision
Tele → Services	2	0.65	0.526	Do not reject
Services → Tele	2	4.02	0.028**	Reject

*Indicates significant at 1%
** indicates significant at 5% and 10%

Teledensity and GDP Generated from FIRB Services (Finance, Insurance, Real Estate and Business Services)

Now, if we see causality for FIRB services and teledensity, the results in the table 8 indicates that there is unidirectional causality from FIRB Services to Teledensity. The calculated p-value is significant at 5% level. Therefore, null hypothesis is rejected.

Table 8: Teledensity and FIRB Services - Granger Causality Test

Direction of Causality	No. of Lags	F-Value	P-Value	Decision
Tele → FIRB	2	0.145	0.865	Do not Reject
FIRB → Tele	2	3.160	0.051**	Reject

* Indicates significant at 1%
** Indicates significant at 5% and 10%

Teledensity and GDP Generated from TTHC Services (Trade, Tourism, Hotel and Community Services)

Furthermore, the results in table 9 show that there is unidirectional causality from TTHC Services to Teledensity with double lag. The calculated p-value is significant at 5% level. Therefore, null hypothesis is rejected.

Table 9: Teledensity and TTHC Services - Granger Causality Test

Direction of Causality	No. of Lags	F-Value	P-Value	Decision
Tele → TTHC	2	0.92	0.408	Do not Reject
TTHC → Tele	2	4.33	0.022**	Reject

* Indicates significant at 1%
** Indicates significant at 5% and 10%

Teledensity and GDP Generated from SPC Services (Social, Personal Community Services)

The results in table 10 show that there is unidirectional causality from Teledensity to SPC with double lag. The calculated value of p-statistics is significant at 5% level. Therefore, null hypothesis is rejected.

Table 10: Teledensity and SPC Services - Granger Causality Test

Direction of Causality	No. of Lags	F-Value	P-Value	Decision
Tele → SPC services	2	4.26	0.023**	Reject
SPC services → Tele	2	1.83	0.177	Do not rejected

** Indicates significant at 5% and 10%

CONCLUSIONS

The overall results of causality indicate a long run relationship between telecommunications and economic growth at aggregate level as well as at sectoral level. Teledensity has a significant role to play in the growth of various sectors of the economy. In today's era of globalization and privatization, Information and communication technologies are being used in services sector (including finance, business services, trade). The telecommunications infrastructure and its related services are a major source of economic development. The results of causality analysis in most of the cases strongly support the univariate causality. However, the direction of causality is different from case to case. In case of GDP per capita, direction of causality is from teledensity to GDP which reveals that telecommunications contribute to overall economic growth. In addition to it, in case of industry, there is no causality. In the case of manufacturing, there is bi-directional causality. Further the case of services indicates the direction of causality from services to teledensity i.e. all the services using telephone facilities in one-way or other are contributing to the growth of telecommunications. Next is the case of FIRB services, the results indicate causality from FIRB services to teledensity which reveals that finance, Insurance and business services contribute to the growth of teledensity. Further, the case of TTHC services shows causality from TTHC services to telecommunication indicating cause and effect relationship between the two sectors. Last is the Social, personal and community (SPC) services whereby direction of causality is from teledensity to SPC services.

The results of the Chow test indicate that there is structural break in the economic data of the country which has significant implications. The study found structural break in data in 1995 weakly and strongly after 2005 which indicates strong impact of telecommunications on development of various sectors of the economy.

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