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Impact of Covid-19 on Internet Usage: A Case Study of Pakistan

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Abstract: This study is related to the investigation of impact of COVID-19 on internet usage. An ordinary least square method is implied on data collected from Jan-21 to Oct-21. The assume effect variable is total number of subscribers of broadband. Total death cases are assumed cause variable whereas newly reported cases and economic growth are moderating variables. Test for unit root shows all variables are found to be stationary at first difference. All variables are normally distributed evidence from Jarque-Bera probability. The Kurtosis value explains that the variables are playkutric. A positive correlation is observed between death cases and total internet subscribers. The regression model is significant and the variables explain 96%. The total deaths have significant positive impact on internet subscribers. The estimation result shows coefficient value of 0.74884. Granger causal test shows that new deaths cases do cause total number of subscribers. The model satisfy all necessary assumption of ordinary least square. There no auto correlation, multi collinearity, and heteroskedasticity in the model. Whereas the variables are not cointegrated with each other. The cusum and cusum of squares shows that the model is stable.

Key Words: Broadband, Internet, COVID-19, ICT, Digital Divide, ICT Policy, Pakistan, Internet-of-things. **JEL Classification:** L86, I18

Introduction

As reported since 18th century till present this world have witness eight worldwide pandemics with at least 1 million deaths count. The first hit was in 1846, the cholera pandemic. The 21st century faced another pandemic, known as COVID-19. Covid-19 outbreak was declared as the sixth public health emergency of international concern by the World Health Organization (WHO) On January 30th, 2020.

The socio-economic norms foundations were challenged greatly by COVID-19 pandemic at the beginning of 2020. One after another, governments were taking measures and protocols for public safety. Initiating lockdowns and imposing social distancing procedures for controlling the spread of this deathly disease. These steps were the demand for controlling the spread but the economic cost was very high. The world was badly affected by COVID-19, everything was uncertain, no matter either economy is of developed country or under develop, every economy got shattered.

According to International monetary fund (IMF) (2020) world has been pushed into recession by COVID-19 pandemic and it may be worse than the financial crisis of 2008. The "work from home" mode was the solution for the consequences of lock down. After the help of nature, it is only the technology, especially internet that helped the economies to keep it moving. From the list of tools for earning, learning and entertaining, internet is one of empowering tool for them. Without any discrimination of the facility for significant access to everyone is its characteristic.

During the past decades a rapid diffusion of broadband (high-speed internet) across the world has been observed. The media used for delivering broadband services are multiple platform such as Fiber-optics, fixed wireless access, WiMax, DSL, powerline and cable. These are classified into two categories by Organization for economic Co-operation and Development (OECD) (2012): fixed broadband and mobile broadband. During past 15 years the steady growth in fixed broadband subscriptions with global penetration of 14.9% in 2019, as reported by international Telecommunication Union (ITU,2019). In the meantime, a rapid growth in mobile broadband has been observed with global penetration level of 83% in 2019. ITU (2003) reasoned broadband plays a vital role in an economy as it attracts foreign investment, escalates productivity and inspires innovations. Than ever before the influence of broadband on national economy is more profound.

COVID-19 in Pakistan

Pakistan was also affected by Covid-19 just like other countries. Thus the country has had to balance the consequences of pandemic on health and economic activities. However, Pakistan has escaped from the high death counts of covid-19 patients as compare to the countries across the border as shown in figure 1 below.

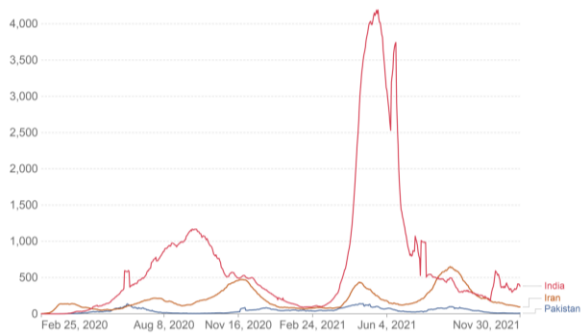
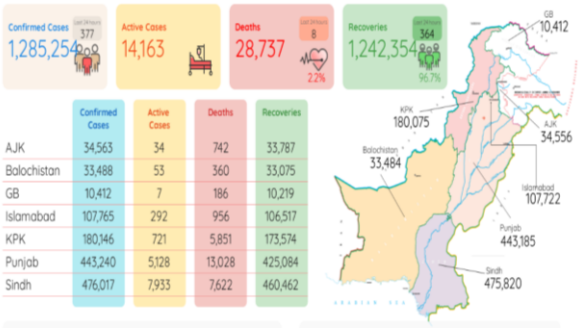


Figure 1: Death count of Pakistan India and Iran.

Source: our world data: 7-day rolling average of Death cases in India, Iran and Pakistan.

Till November 2021 total confirmed cases are 1.2 million, having 96.7% recovery ratio, 2.2% death ratio and 1.1% active cases ratio. Sindh has the largest number of confirmed cases whereas Punjab being more populated than Sindh has reported less confirmed cases. But death ratio is higher than Sindh. Overall the highest death ratio is of Khyber Phaktun Khaw (KPK) 3.25%. Only 7 active cases are remaining in Gilgit Balbistan (GB) that is been the most smallest in active cases ratio (0.07%) amongst all province. While Islamabad the capital respondent comparatively best in recovering from the covid-19 having recovery ratio of 98.84%.



	Confirmed Cases	Active Cases	Deaths	Recoveries
AJK	34,563	34	742	33,787
Balochistan	33,488	53	360	33,075
GB	10,412	7	186	10,219
Islamabad	107,765	292	956	106,517
KPK	180,946	721	5,851	173,574
Punjab	443,240	5,128	13,028	425,084
Sindh	476,017	7,933	7,622	460,462

Figure 2: Overview of COVID-19 in Pakistan

Source: Ministry of National Health Services Regulations & Coordination.

Pakistan health care system was not ready to handle this pandemic. Therefore the main encounter for Pakistan has been to be able to handle the pressure on its health capacity. The burden has raised in the first wave (April-July 2020) resulting 141010 new confirmed cases and 2852 deaths were reported for the month of Jun-20. These numbers are the second most numbers for Pakistan. After to some extent puzzling phase of relief and a short second wave (October 20-Jan-21) Pakistan experienced the third wave. The month of april-21 is the month of highest confirmed cases to be recorded in Pakistan (Figure3) and is same for death counts too (figure 4).

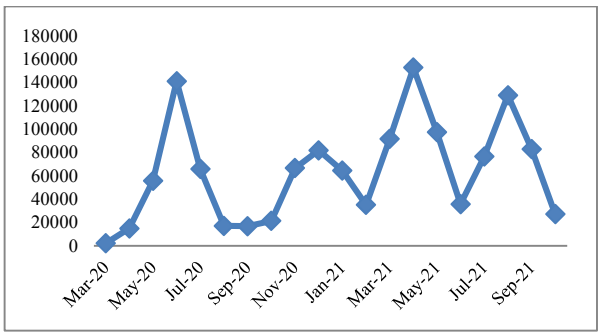


Figure 3 New COVID-19 Cases (Monthly)

Source: Ministry of National Health Services Regulations & Coordination.

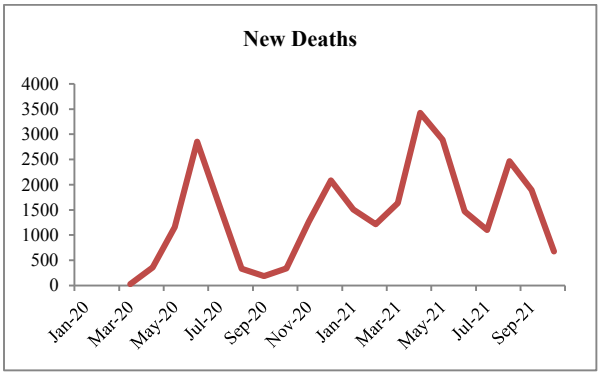


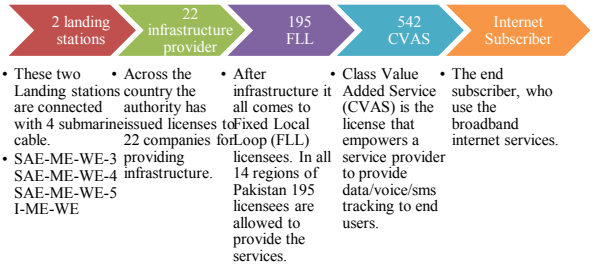
Figure 4: New Deaths of Covid-19 Patients (Monthly)

Source: Ministry of National Health Services Regulations & Coordination.

Landscape of internet for Pakistan

Pakistan Telecommunication Authority works under the watch of government of Pakistan. Its main purpose is to regulate the Pakistan's telecommunication systems from establishment to maintenance, including operations of telecommunication systems and provision of telecommunication services in Pakistan.

There are only two companies in Pakistan that are the mother source of internet as they are entitled with landing station rights. PTA has divided its telecom structure in to 14 regions. The rein of infrastructure for providing internet is in the hands of 22 licensees across all Pakistan. Moreover there are 195 licensees for fixed local loop and 542 Class Value Added Service licensees across Pakistan to provide internet services and related services to the end subscribers.



The figure 5 shows that there are 187 million cellular subscribers having teledensity of 85.33 representing demand, need and usage of mobile phones. Out of these subscribers 106 million are using Next Generation Mobile Services (NGMS) that is 3G/4G services having penetration of 48.19%. whereas the basic telephony subscribers are very few just 2 million. This shows that the Pakistan is moving towards the adoption of technology. On the other hand 109 million are broadband (high speed internet) subscribers, penetrating 49.53%. This figure shows that almost 50% population is using fixed broadband connections and 3G/4G services.

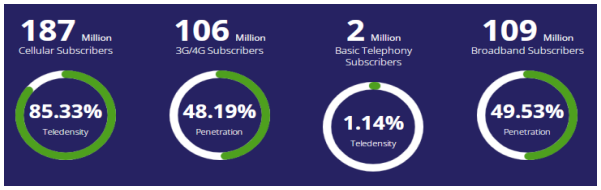


Figure 5: **Overview of Telecom in Pakistan**

Source**: Pakistan telecommunication Authority (PTA)**

The Figure 6 below is a graphical representation of NGMS subscribers for Jan 2021 to Oct 2021 showing company-wise share of subscribers. Over the time approx. 11% growth is observed. Out of this the major share is of PMC (jazz) and CMPAK (zong).

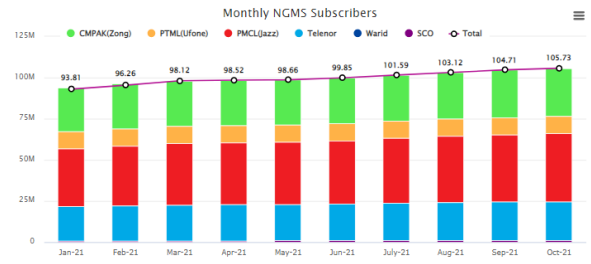


Figure 6: **Monthly NGMS Subscribers**

Source**: Pakistan Telecommunication Authority (PTA)**

Figure 6 shows that NGMS usgaes has been incearsing. At the start of the year it was 41.9% while just in 10 months it has accelerated to 48.19%. the increase is penetratio is almost steady but in the month of Apr-2021 it is steeper than the last months. This is the time span of second wave of pandemic.

Figure 7 shows the upward straight line represents the increasing trend. In early phase a massive change of approx. 89% whereas later the trend of increasing till 2021. The overall change is on average of 35%. The subscribers have been increasing with decreasing trend till 2019-20 lowering to 15% on an average. But in 2021 it has jumped to 18.37%.

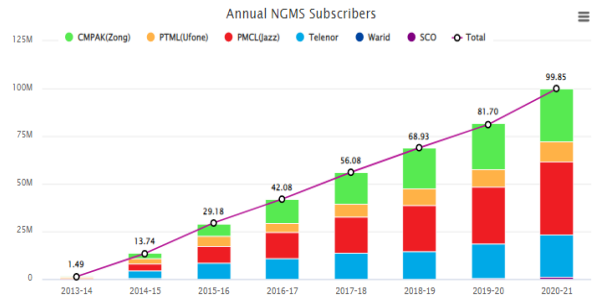


Figure 7: **Annual NGMS subscribers.**

Source**: Pakistan Telecommunication Authority (PTA)**

While the figure 8 illustrates that the NGMS penetration has increased over the time. There is a sharp change in the year 2020. This implies the to the year of pandemic. The demand has increased for the usage of mobile broadband.

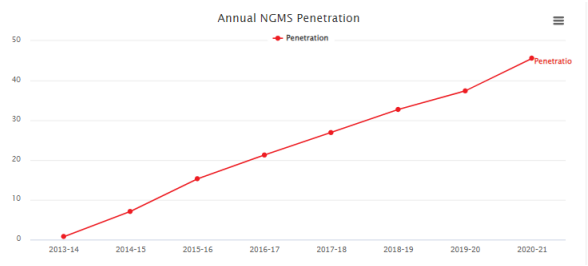


Figure 8: Annual NGMS Penetration.

Source: Pakistan Telecommunication Authority (PTA).

The figure 9 shows that in the third month the subcribers have crossed 100 million benchmark. however this is still alraming that still 50% people doesn't have internet usage. The usages of internet has been increasing in this pandemic period as the individuals are now closely related to it. In terms of socio-economic activities.

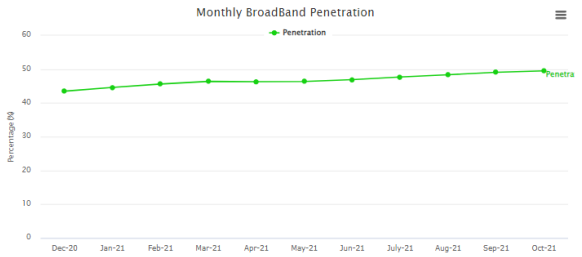


Figure 9: Monthly Braodband Penetration.

Source: Pakistan Telecommunication Authority (PTA)

Over the time the internet data usage has increased. In the first quarter a jump can be observed as shown in figure 10. This is due the wave of covid-19 and increase in new reported cases and deaths of covid patients. This shows that once the consumption has increased it remains there because individuals are transforming the living style with this 'new normal' situation.

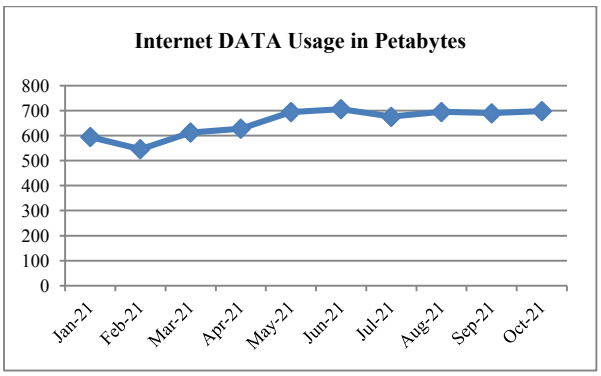


Figure 10: Total Data Usage in Petabytes (monthly)

Source Pakistan Telecommunication Authority(PTA)

The Covid-19 has had damaging effects on economies, resulting change in consumer behavior, their spending habits and lifestyles have changed from bricks to clicks. Therefore COVID-19 outbreak seems to be significant situational influence that affects individuals, societies, communities, organizations and governments towards internet usage.

Statement of Problem

In light of above mentioned complementary and potential effects of covid-19, internet usage in this pandemic has been center point among number of economists investigating the impacts of covid-19 on information communication and technology (ICT). According to the author of this paper, there has been no previous attempt to examine the influence of Covid-19 on internet usage in emerging economies like as Pakistan using secondary data. To handle this problem, this study will try to evaluate whether covid-19 has its impact on internet usage. This research will also focus on the relationship of internet usage in this pandemic period with newly reported cases along with economic indicators.

Research objective

The primary aim of this study is to determine whether Covid-19 has an influence on internet usage in Pakistan. This will be observed and analyzed using econometrics methods, namely the Granger causality test. Therefore, it will identify the factors that contribute to internet usage during the COVID-19 pandemic. Specifically, this study has the following research objectives:

- To analyze the overall impact of Covid-19 on internet usage.

Research Questions

This study has the following research question.

- Is there is any relationship between COVID-19 and internet usage for Pakistan?
- Does economic growth have positive impact on internet subscribers during covid-19 pandemic in Pakistan?

Significance of this Research

The main focus of the research is to contribute to the current body of knowledge regarding the impact of covid-19 on internet usage in Pakistan. The intention of this study is to address the absence of research on internet usage in Pakistan, specifically in relation to the Covid-19 pandemic and other socio-economic factors. The study will span a period of 10 months. (ii) There is insufficient empirical evidence to establish a causal relationship between internet usage and the number of active COVID-19 cases. This lack of evidence hinders the ability to formulate effective policies for the telecom business in Pakistan.

Delimitation of the study

To analyze the influence of Covid-19 from January 2021 to October 2021, a straightforward ordinary least squares model is used with time-series data to identify the key factors. The exogenous factors data is obtained from the Pakistan Telecommunication Authority, State Bank of Pakistan, and the Ministry of Health of Pakistan. Furthermore, this article is divided into four sections. Firstly, this discussion will focus on literature study to provide insight into the effects of the COVID-19 pandemic on various sectors, particularly in relation to internet usage. Furthermore, a thorough examination of the research technique will be conducted in order to accomplish the study objectives. Furthermore, the empirical findings will be provided together with their corresponding interpretation. Lastly, the concluding section will provide a summary and present policy recommendations for the telecom business.

Literature Review

It is crucial for economic policymakers and the health sector to make meaningful comparisons between previous widespread epidemics and freshly emerging outbreaks Rasheed et al., (2020). Comparative evaluation is crucial in managing biological risks by providing a baseline for evaluating the effectiveness of existing policy frameworks and gauging community response. Drawing from previous experiences, it is advisable to implement necessary and proactive changes in important sectors of the state in order to effectively control future outbreaks, as suggested by Lai et al. (2020). The previous viral epidemics were caused by closely related strains of the influenza virus, which were also responsible for cases of pneumonia (Baldo et al., 2016; Barro et al., 2020; Liu et al., 2020).

The telecom sector has performed well in the pandemic as compared to other sectors of economy, as it was exempted from the general restriction of pandemic such as social distancing, lock downs and work from home, The growth in traffic and usage has increased because these restrictions has pushed individuals to use more broadband than before for e-learning (online classes), earning (video confessing for meetings),press, e-commerce, and kept societies and individuals connected and informed with the access to commercials, financials, medical, social media and other essential services during social isolation. Dutta and Fischer (2021)

The surge in Internet Based Services (IBS) usage has been observed in restrictions of Covid-19 pandemic. Since there is usage of computers, laptops and smartphones has grown on wide range the infrastructure and technologies have been improved by organizations.

Covid-19 turned out to be global shock. It has limited the ability to be educated, attain services, earn for living and provide important government services.

This distance was bridged by internet in many cases, by allowing individuals to entertain themselves, communicating with each others, to do work from home, providing online tools and helped students in virtual learning. The internet has proven to be resilient as it has largely accommodated the increased demand of usage Michael (2020).

From the fear of transfer of virus individuals started avoiding physical stores (Andersen et al., 2020; Eichenbaum et al (2020), Watanabe & Omori, (2020); Yilmazkuday, (2020).

The pandemic outcomes were now 'new normal'. The stress was on the infrastructure of internet. The forecasted Global peak traffic was 28% but it escalated to 47% including social media such as facebook-video calling observed 100% increase and Netflix welcomed 16 million new subscribers. This have driven the changed and duration of patterns of peak traffic. Internet exchange point (IXP) traffic grew by in Asia Pacific ITU (2020)

Across the world has been affected by the spread of COVID-19. Shutting down the activities and complete lockdown are the ultimate results of COVID-19 pandemic . Paital et al. (2020); Bahadur et al. (2020).

The stringent limitations have transported the majority of individuals to an era where communication, contact, and work-from-home and home-based obligations rely heavily on the internet and information and communication technologies (ICTs) Singh et al. (2021).
Amidst the COVID-19 pandemic, individuals have observed a widespread and ongoing reliance on the internet and other information systems to connect, interact, and work remotely from home Kamal (2020).

Online education has brought about a significant change in the way classes are conducted, particularly in the field of education. Due to the widespread lockdown, people all around the world, including Pakistan, have been utilizing internet technologies including web-conferencing platforms such as Microsoft Teams, Google Meets, and Zoom, regardless of their level of knowledge. Some educational institutions provide both online classes and on-campus classes Tang et al (2020); Soni (2020).

A change in employment was observed during work online from home, labor has been hired on an informal basis like ad-hoc basis and subcontract by the organizations Roy et al. (2020). Whereas organizations have already shut down their business due to covid-19 crisis, millions of work force has lost their jobs because of the performance of the economy. Coibion et al. (2020).

Covid-19 has changed consumer behavior, the reason is the effect of worries for economic and health conditions. During pandemic interest in spending by consumers on traditional and online shopping has been declined, health conditions can make an impact on shopping Eger et al. (2021); Bhatti et al. 2019). Due to risk factor of banknotes and coins carrying virus, people well-being raised due to encouragement role of government in digital payments and currencies. (Allam 2020). With contrast to this through debit or credit cards delivery services are been paid online, which also results in surge of internet usage (Ali et al, 2020 De'et al 2020).

Thus the existing literature review reveals that there is lack of empirical studies that highlights the impact of covid-19 on internet usage. Therefore this manuscript will fill this gap. Based on the above literature review; following hypotheses are developed which will be tested by applying the appropriate research methodology:

- H_0: There is positive impact of COVID-19 on internet usage for Pakistan.

Data and Methodology

At this juncture, this study includes the situational influence (COVID-19) variable as a control to overcome the intention–behavior gap in the internet usage context. Furthermore, to the authors' knowledge, two more variables has been taken as moderate variable, new cases of covid-19 and economic growth. The present study contributes to these research gaps. Therefore, the research questions of the study are:

- Is there any relationship between deaths of covid-19 patients and internet subscribers?
- Does deaths of covid-19 patients has significant impact on internet subscribers?

We use time-series data from to investigate impact of Covid-19 on internet usage, in which the data is from first month of year 2021 to tenth month of 2021 due to limitation of data availability of variables.

Table-1: Types of variables and their proxies

Sr.	Type of Variable	Name of Variable	Proxy Measures
1	Dependent variable	Internet users	Total Number of Broadband Subscribers
2	Independent Variable	Total Death cases	Covid-19 patients death counts
3	Control Variable	Total new Cases	Covid-19 newly reported cases in a month.
4	Control Variable	Economic Growth	Selected Large Scale Manufactures (Quantum Index)

Total Broadband Subscribers (TS)

The total number broadband subscriber is in millions. This is the summation of total number of broadband subscriber by technology. Data **SOURCE** is Pakistan telecommunication Authority.

Total Death Cases (CTDC)

Total announced deaths of covid-19 virus infected patients in Pakistan. This is considered as assume effect variable. Data **SOURCE** is ministry of health of Pakistan.

COVID-19 New Cases (CNC)

Monthly new covid-19 cases reported in Pakistan is the exogenous variable and considered as assume effect variable. Data **SOURCE** is ministry of health of Pakistan.

Large Scale Manufacture (LSM_t):

For economic growth LSM is considered as proxy. Data has been extracted from state bank of Pakistan. Production of selected large scale manufactures using quantum index taking 2005-06 as base period. It is considered as control variable.

Methodology

As mentioned above, this study uses time-series data over a period of 10 months for determining the possible impact of Covid-19 on economic growth. The function for the model can be written as follow

TS = f (CTDC, CNC, LSM, other factors)

Using simple ordinary least regression we can formulate it as under

$$TS_t = \alpha + \beta_2(CTDC_{t-1}) + \beta_1(CNC_t) + \beta_3(LSM_t) + \mu_t$$

Where α is the constant, β is the coefficient of exogenous variables and $_t$is the time. TS, CTDC, CNC, LSM and μ is total number of broadband subscribers, total deaths cases of covid-19 patients, newly reported covid-19 cases, selected large scale manufacturers, and error term.

Result

This section of the study consists of in depth analysis of the variables and models as discussed earlier in this literature.

Descriptive Statistics

The table 1 shows descriptive statistics for the data for the period of 10 months of 2021 years starting from January to October.

Table-1: Descriptive Statistics

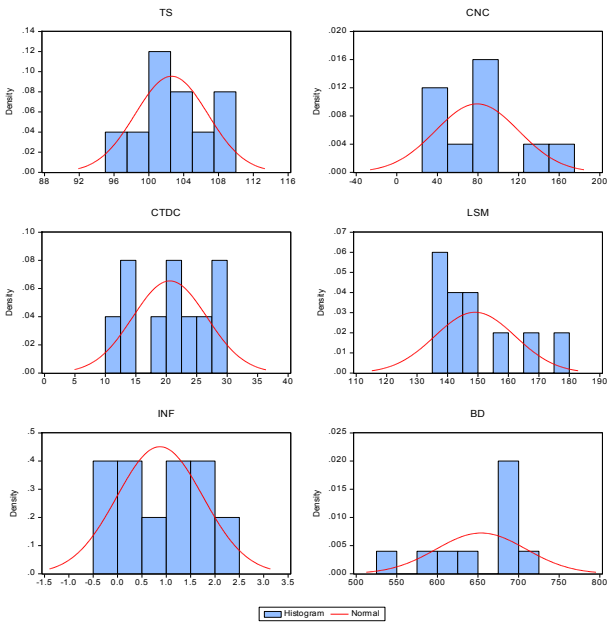
	TS	CTDC(-1)	CNC	LSM
Mean	102.6075	20.57890	79.13820	149.0717
Median	102.0724	21.58550	79.63950	143.9996
Maximum	108.6510	28.45600	152.5880	175.4589
Minimum	95.47610	11.68300	27.02200	137.9421
Std. Dev.	4.178556	6.100937	41.04240	13.18727
Skewness	-0.149678	-0.183539	0.361224	1.119288
Kurtosis	2.122866	1.652915	2.183621	2.729087
Jarque-Bera	0.357907	0.812243	0.495169	2.118589
Probability	0.836145	0.666229	0.780684	0.346700

The mean value doesn't deviate a lot from its median. The average of total subscribers in ten months is 102.6 million. The average of total deaths of covid-19 affected patients is 20,578, while the new active cases reported per month on an average is 79,138. On the other hand the LSM quantum index average for ten months report to be 134

The maximum number of newly reported cases for COVID-19 is 152,588 in the month of april-2021 and minimum number of newly reported cases for COVID-19 is 27,022 in the month of October 2021. On the other hand the death cases peak during this time was 3,427 with a lowest 671 deaths. This shows that in the start of second quarter covid-19 newly reported is at peak.

Two out of four variables are negatively skewed, total subscriber and total covid-19 death cases. But new cases and economic growth are positively skewed. The kurtosis values show that all variables are playkurtic. Jarque-bera probability lies in acceptance region therefore we accept its null hypothesis that the variables are normally distributed. The following figure shows that all are normally distributed.

Graph 1



Correlation

In order to check the relationship between regressand and regressors we have performed the following analysis:

Table-2: Correlation Matrix

Correlation	TS	CTDC(-1)	CNC	LSM
TS	1.000000			
CTDC	0.968375	1.000000		
CNC	0.025361	0.002589	1.000000	
LSM	-0.833151	-0.854272	-0.313570	1.000000

Total numbers of subscribers are strongly positively correlated with total numbers of deaths of covid-19 patients, but has weak correlation with covid-19 newly reported cases comparatively. TS is strongly negatively correlated with economic growth (selected large scale manufacturers). The newly reported cases have very weak correlation with total death cases. LSM is negatively correlated with all other variables.

Stationary Test:

Before moving forward towards regression analysis firstly variables must be checked for stationarity test. For this purpose, augmented dicky fuller test (ADF) is applied. The following table exhibits that all variables are stationary at the first difference I(1) including trend and intercept at a significance level of 0.05.

Table -3: Unit Root ADF Test

Variables	**TS**	**CTDC(-1)**	**CNC**	**LSM**
I(I)	0.0067	0.0018	0.0003	0.0078
C & Trend				

Estimation

The following table shows the estimation of the model using ordinary least square method.

Table-4: Estimation

Variable	Coefficient	Std. Error	t-Statistic	Prob.
CTDC(-1)	0.748844	0.106775	7.013267	0.0009
CNC	0.022337	0.010097	2.212246	0.0779
LSM	0.094492	0.063742	1.482399	0.1983
C	73.03592	11.79994	6.189516	0.0016

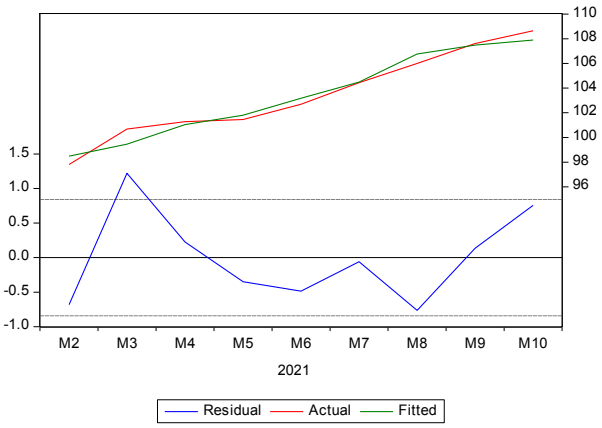
R-squared	0.964853	Mean dependent var	103.3998
Adjusted R-squared	0.943764	S.D. dependent var	3.546756
S.E. of regression	0.841082	Akaike info criterion	2.792848
Sum squared resid	3.537096	Schwarz criterion	2.880503
Log likelihood	-8.567814	Hannan-Quinn criter.	2.603688
F-statistic	45.75256	Durbin-Watson stat	1.927918
Prob(F-statistic)	0.000466		

The estimation result shows that there is significant impact of deaths of covid-19 patients and new cases reported of covid-19 affected patients. The R-squared is 0.96, this mean that the model explains 96% of the fitted data in the regression model. The f-statistics probability is 0.00046, the overall model is significant.

The total death cases coefficient is 0.74884 having t-statitics 7.013, it means that increases in total number of deaths leads to increase in total number of subscriber by 0.73884. Whereas the newly reported covid-19 cases increases total number of subscribers by 0.022337. The above estimation explains that 0.74 million internet subscribers increase due to additional of 1000 death cases.

ACTUAL Fitted residual Graph

Graph-1



Auto correlation

The value of Durbin-watson is very close to 2 as reported in the test result of regression shown in table. We can say that there no problem of auto correlation in the model. But as the model has lag of covid-19 total death cases therefore serial correlation LM test is used to check the auto correlation, i.e. there is no relationship between error term and lag error term (see table-5)

Table-5: Correlogram

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
. |***** |	. |***** |	1	0.643	0.643	5.5151	0.019
. |** . |	. *| . |	2	0.318	-0.162	7.0363	0.030
. |* . |	. | . |	3	0.127	-0.011	7.3136	0.063
. | . |	. *| . |	4	-0.035	-0.129	7.3380	0.119
. *| . |	. *| . |	5	-0.188	-0.150	8.1847	0.146
. **| . |	. *| . |	6	-0.299	-0.135	10.867	0.093
. ***| . |	. *| . |	7	-0.381	-0.167	16.669	0.020
. ***| . |	. *| . |	8	-0.412	-0.134	26.850	0.001
. **| . |	. |* . |	9	-0.274	0.103	35.876	0.000

The correlogram above and Breusch-Godfrey serial correlation LM test shows that there no problem of autocorrelation.

Table-6: Breusch-Godfrey Serial Correlation LM Test:

Breusch-Godfrey Serial Correlation LM Test:

F-statistic	0.423175	Prob. F(2,3)	0.6888
Obs*R-squared	1.980356	Prob. Chi-Square	0.3715

Furthermore co-integration test is conducted by using Engle-Garnger test. Both test shows that there is no autocorrelation

Cointegration

Table-7:

Engle-Granger Test for cointegration.

Null hypothesis: Series are not cointegrated

Cointegrating equation deterministics: C

Automatic lags specification based on Schwarz criterion (maxlag=1)

Dependent	tau-statistic	Prob.*	z-statistic	Prob.*
TS	-3.419968	0.5296	-28.41080	0.9999
CTDC(-1)	-3.245388	0.5918	-25.82820	0.9999
CNC	-5.512983	0.1022	-83.22324	0.9999
LSM	-2.990931	0.6808	-8.004626	0.8670

The Engle-Granger test is conducted to check cointegration among the variables. The result implies that there is no cointergration as the p-values is above 0.05 level therefore we fail to reject the null hypothesis that variables are not cointegrated

Multicollinearity

Table-8

	Coefficient	Uncentered	Centered
Variable	Variance	VIF	VIF
CTDC(-1)	0.011401	60.59990	4.287742
CNC	0.000102	10.61512	2.149231
LSM	0.004063	1107.792	4.564231

The above table-8 shows that there is no sever multicollinearity among the independent variables as all the centered VIF values are less 10. Thus this model follows the assumption best linear unbiased estimator.

Heteroskedasticity

The Breusch-Pagan-Godfrey test is conducted to test the model for heteroskedasticity.

Table-9: Heteroskedasticity Test: Breusch-Pagan-Godfrey

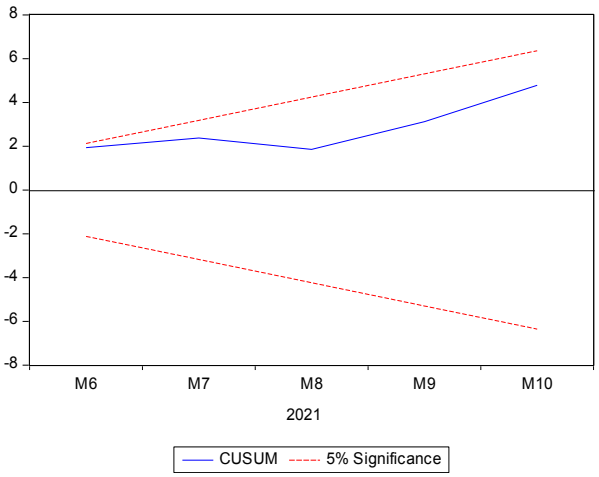
F-statistic	0.606622	Prob. F(3,5)	0.6388
Obs*R-squared	2.401631	Prob. Chi-Square(3)	0.4933
Scaled explained SS	0.474296	Prob. Chi-Square(3)	0.9245

The table-9 shows that probability is above 0.05 therefore the null hypothesis is fail to be rejected. This model is free from heteroskedasticity problem.

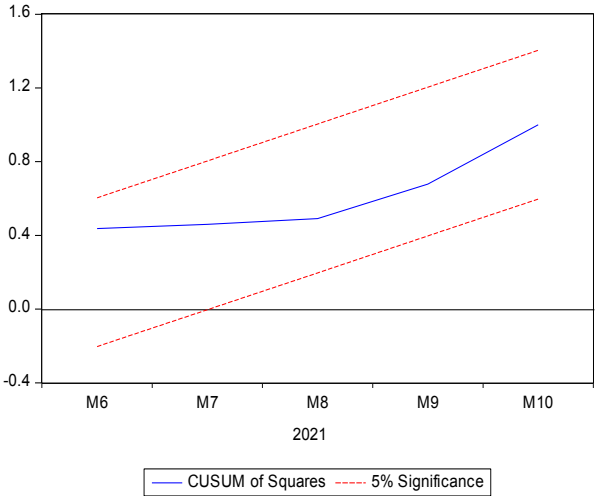
Stability Diagnostics

Graph-2

CUSUM



CUSUM of Squares



The CUSUM and CUSUM of Squares shows that there is stability in the model as it do not exceeds the 5% significance level.

Causality Test

Table-10: Granger Causality Test

Null Hypothesis:	Obs	F-Statistic	Prob.
CTDC(-1) does not Granger Cause TS	8	9.17380	0.0501

The null hypothesis is rejected; this implies that total deaths of covid-19 causes total subscribers of internet.

Conclusion

The on hand literature and results obtained from econometric tools has brought the findings that there is significant positive impact of COVID-19 on internet usage. The selected model satisfies all necessary conditions of regression such as; data is stationary, no multi-collinearity, no auto-correlation and no heteroskedasticity is found. The covid-19 death cases does cause increase in total subscribers.

Limitations:

The time span of covid-19 is to short. In case of Pakistan, the data collection is reported on annual basis. However the data collected is only for 10 months. The literature available is on survey based sample collection.

Policy recommendations

In order to meet any such pandemics, governments and societies should educate individuals and societies to tackle it. The pandemic not only effect health and economic affairs but also effects psychological too. Thus it is better to be prepared and educated for handling any such crisis in future.

The Government collects tax on the internet services, they should lower down them so that the cost of working from home, e-learning and other important activities may not get effected. From the collected amount some part should be invested in building better infrastructure for internet service providers.

Directions for further research

There is need to examine the impact of covid-19 on internet usage with complete data set of variables from the starting and to investigate pre and post behavior of internet usage. The impact of internet usage in covid-19 pandemic on different sectors of economy can be studied.

The economic growth proxy taken here is insignificant in the model, it is needed to be further investigation upon the reasons.

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