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## Internet usage and economic development : Evidence from a Panel Data

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Dr.Chandrabhanu Das<sup>1,\*</sup>, Dr.Rooplatha Nanga<sup>2</sup>

<sup>1</sup>Assistant Professor, GITAM School of Business,GITAM University,cdas@gitam.edu

<sup>2</sup>Assistant Professor, GITAM School of Business,GITAM University, rirala@gitam.edu

\* [cdas@gitam.edu](mailto:cdas@gitam.edu)

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**Abstract.** The advent of internet and telecommunication technology has led to the emergence of digital footprint around the world. Subsequently there have been studies linked to internet usage and socioeconomic development. The difference in internet usage among different countries has also been identified as digital divide. Policy makers and government are concerned about internet and telecommunication usage as drivers of digital economy for sustainable development goals. However, not all countries are similar in their level of internet penetration and usage of advanced technologies. Socioeconomic barriers prevalent in different countries may prevent much of the population engagement in different information and communication technologies. Therefore it becomes imperative to study from a wider perspective whether the economic development of nations influence the usage of digital technologies.

This paper examines the impact of different economic development indicators on internet usage by applying different panel data analysis methods. The economic indicators evaluated here are GDP growth, proportion of salaried workers, unemployment levels, broad money, import of technology equipment, capital growth, mobile subscription, employment and income levels. All the factors except capital growth are having statistical significance with proportion of internet usage. Further, at different income levels the proportion of salaried workers has a significant influence on internet usage. The study reveals the importance of economic development in improving the digital footprint among different nations.

**Keywords.** Internet usage, economic development, digital economy, digital divide.

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### 1. Introduction

Technological advancements from late 1990s are signified by internet and wireless technology all over the world. Fundamental shift from industrial age to network age has been brought by information and communication technologies. Internet access is believed to promote productivity and innovation (Avgerou 2008; Paunov and Rollo, 2016).

Information management using modern technologies are being discussed in several studies as a progressive step towards sustainable development. However, information and communication technologies (ICT) benefits are being derived by rich countries compared to developing nations. This difference in benefits of ICT usage is also known as digital divide

(Bon, 2007). Further, internet and computers have become a necessity with global economies being increasingly dependent on internet technologies. Government of different nations has introduced policies on usage of ICT for social inclusion (Nel, 2004). ICT is a valuable tool for national development (Guimardes, 2004).

With globalization of markets and advancements in communication technologies, the internet has become a priority for economic sector. Timely and relevant information through internet usage will improve the decision making process for benefit of individuals and business. The use of internet varies from entertainment, social to business transactions (Anunobi and Mbagwu, 2009). The pertinent issue is that whether a digital divide is existent between different countries with developed nations having better internet access compared to emerging and undeveloped economies. Provision of basic needs, development of infrastructure and fiscal sectors are crucial for readiness towards digital technologies.

The present study will clarify which economic indicators are linked to internet use through their statistical significance with internet usage across different countries and different income levels to differentiate the extent of association. Section 2 discusses about different studies on determinants of internet usage and economic indicators employed by existing studies. Section 3 constructs the research hypotheses considering various economic determinants for the purpose of study. In section 4, the sample considered for the study is mentioned and explains the econometric method utilized for analysis. Section 5 interprets the outcome and discusses the results of the research constructs derived from this study. Finally, section 6 concludes the study with suggestions thereof and providing scope for future studies.

## **2. Literature review**

Numerous studies are reviewed to identify the economic factors which support the use of Internet. Chen, Boase and Wellman (2002) find a strong linkage between socio economic status and internet use. Guillen and Suarez (2005) argue that digital divide based on cross country analysis is the outcome of various economic and regulatory factors that have evolved over time. Taube and Joye (2002) argued about income per capita and communication infrastructure measured by telephone mainlines are crucial factors explaining the digital divide. Kshetri (2001) identifies level of income and supporting infrastructure are critical decisions for use of internet by individuals. Similarly Zhu and He (2002) have also explored income level as one criterion for internet adoption. Jiang (2009) mentions younger generations as drivers of internet usage. However, Godfarb and Prince (2008) explain that online hours per week are reduced when both income and education rise. Several studies find that Gross Domestic Product (GDP) has a positive influence on internet usage for European Union countries (Demoussis and Gianakopoulos, 2006; Vicente and Lopez, 2006).

There have also been country specific studies on internet usage and economic development. Czernich (2014) finds a negative relationship between internet and unemployment for various municipalities of Germany. Al-Hammadany and Heshmati (2011) has observed that education level and government policies to support communications infrastructure have influenced the internet usage in Iraq. However, Robison and Crenshaw (2002) argue that internet capacity is not a simple linear function of economic development but an interaction between some factors which may be referred as post-industrialism. The authors suggest that interactions between different dimensions may provide clarity on modernization and sophistication of economy. This viewpoint is considered in our study by experimenting with likely interactions to arrive at a meaningful conclusion.

### **3. Determinants and Research hypotheses**

There is a possibility that certain economic indicators which are not mentioned in prior studies may influence the internet adoption. Our study attempts to examine the influence of some economic indicators along with those that share a common view in available studies to determine the extent of influence on internet usage.

#### **3.1. Internet Usage**

The internet use explained by internet penetration is considered as the dependent variable. Similar to study by Jakopin and Klein (2011) on broad band penetration, internet penetration is measured by ratio of total internet subscription to total population at end of each year.

#### **3.2. Prosperity growth**

Percentage growth of GDP per capita in a country is a proxy for prosperity growth (Jakopin and Klein, 2011). The hypothesis states that there is a positive association between prosperity of a country and internet use because prosperous nations are assumed to have greater internet penetration. Annual percentage growth rate of GDP per capita is used as the prosperity growth indicator here.

#### **3.3. Capital formation**

Most of the studies have considered gross domestic product but gross capital formation is not documented in the growing literature on internet usage. Capital formation implies an increase in investment which leads to increase in production and is an important indicator of economic development. Gross capital formation is linked to poverty reduction thereby increasing the standard of living (Akobeng, 2017). We introduce the annual growth rate of gross capital formation in this study. Our hypothesis states that growth in capital formation has a positive relationship with internet usage.

#### **3.4. Employment level**

Employment can be also be a factor for internet usage (Al-Hammadany and Heshmati, 2011). People in employment may have a tendency to depend on internet for getting the desired information. Our study considers both employment and unemployment as economic variables on the condition that there does not exist high correlation between the variables.

Employment to population ratio which explains the proportion of country population that is employed is considered as employment indicator. Unemployment variable in our study is the share of labor force that is without any job but is finding opportunities for employment. We hypothesize an increase in employment (unemployment) levels to a increase (decrease) in internet usage.

#### **3.5. Salary and Wages**

An increase in wages and salaries makes technology purchase easier and can have a positive effect on internet adoption (Roos and Jordan, 2006). However, Godfarb and Prince (2008) argue that increase in income level is associated with decrease in internet usage among US

households due to reduced leisure time. Wage and salaried workers as a proportion of employed workforce is considered for study. Our study will hypothesize a positive association between salary and wages with internet usage.

### **3.6. Imports of ICT equipment**

Imports of goods and services can be a proxy for exposure to foreign influences. However, Chinn and Fairlie(2006) find trade openness although positive yet insignificant factor for internet usage. We employ telecommunication equipment imports as a factor to have positive influence on internet usage (Mocnik and Sirec, 2010).The hypothesis states a positive correlation between telecommunication equipment imports and internet usage. Telecommunication equipment imports include computers, communication equipments and other information and technology goods as a percentage of total imports.

### **3.7. Broad Money**

To understand the role of banking sector development in internet usage, Chinn and Fairlie(2007) consider the ratio of private credit by banks and financial institutions to GDP. The authors find a statistically insignificant relationship with internet usage. Our study considers broad money as an economic indicator which may impact internet usage. Broad money consists of currency outside banks, time, savings and foreign currency deposits of residents. It also considers certificate of deposits and commercial papers. The purpose of considering this variable is to find whether the money supply in an economy has an impact on internet usage. Broad money as a percentage of GDP is considered for analysis. The hypothesis is broad money has a positive association with internet usage.

### **3.8. Mobile phone subscription**

Infrastructure development also reflects government policy for planned economic progress of a nation. Cellular phone subscription will ensure internet availability in remote areas. Moreover, mobile phone use is rising in many developing countries compared to fixed line subscription (Mwesige, 2004). Hence, this will give a clear picture on internet usage irrespective of fixed line subscription or personal computer users in remote areas. Cellular phone subscriptions are measured as subscriptions to mobile services per hundred people. Logarithm of this value is considered to reduce skewness and to achieve a near normal data. The hypothesis states that with rise in cellular phone subscriptions there is an increase in internet usage.

### **3.9. Interaction variable**

Per capita income is one of the main determinant for level of internet penetration (Balioune-Lutz, 2003). Developed, emerging and underdeveloped countries are categorized on the basis of their income level. The study identifies per capita income as a dummy variable ranked in order of 1,2,3 and 4. The interaction variable is the product of per capita income with salary which differentiates salary structure between different nations. The hypothesis states that higher income nations with better salary and wage structure have a greater influence on internet usage compared to other nations.

#### 4. Data and methodology

Data source is World Bank's World Development Indicators database. The database access is free and can be downloaded from the website. Internet usage data and economic indicators required for study are retrieved for different countries. The period of study is considered from 2000 to 2017 based on availability of data. For a particular country with missing values in any one year, all the observations for that country is dropped from analysis. This is to done to have a balanced panel data-set for study. Final data-set consists of 87 countries with 1566 country year observations.

The methodology applied is fixed effect regression model for panel data analysis. The objective of using fixed effect regression model is to assess the relationship between internet usage and economic indicators within a country. However the model must fulfill specific criteria and has to be robust enough for study. These criteria are listed below.

- a) From the two types of panel data regression models, the research construct must be suitable for fixed effect regression. Hausman Test will identify the preference for fixed effect over random effects.
- b) There should not be any multicollinearity between the variables. Multicollinearity followed by variance inflation factor (VIF) is tested by following the approach of Gujarati (2004).
- c) Heteroskedasticity and serial correlation must be absent between the observations. The Woolridge serial correlation test will confirm serial correlation and heteroskedasticity is known by Wald test. If such problems persist, the outcome is estimated by panel corrected standard error.

Based on the research hypothesis two equations are constructed for our study. The first equation is our base case equation written as follows:

$$INT_{i,t} = \beta_1 PG_{i,t} + \beta_2 CF_{i,t} + \beta_3 EMP_{i,t} + \beta_4 UEMP_{i,t} + \beta_5 SW_{i,t} + \beta_6 IMP_{i,t} + \beta_7 BM_{i,t} + \beta_8 MP_{i,t} + \alpha_i + \mu_{it}$$

(1)

Where  $INT_{i,t}$  = Internet usage of country i during time t

$PG_{i,t}$  = Prosperity growth of country i during time t

$CF_{i,t}$  = Gross capital formation of country i during time t

$EMP_{i,t}$  = Employment level of country i during time t

$UEMP_{i,t}$  = Unemployment level of country i during time t

$SW_{i,t}$  = Salary and wages of country i during time t

$IMP_{i,t}$  = Import of telecommunication equipment of country i during time t

$BM_{i,t}$  = Broad money of country i during time t

$MP_{i,t}$  = Cellular phone subscriptions of country i during time t

$\alpha_i$  = Constant for time invariant country effect

$\mu_{it}$  = Error term

The next equation incorporate the interaction and is expressed as follows:

$$INT_{i,t} = \beta_1 PG_{i,t} + \beta_2 CF_{i,t} + \beta_3 EMP_{i,t} + \beta_4 UEMP_{i,t} + \beta_5 IN_{i,t} * SW_{i,t} + \beta_6 IMP_{i,t} + \beta_7 BM_{i,t} + \beta_8 MP_{i,t} + \alpha_i + \mu_{it}$$

(2)

Where IN = Income level of a country

$IN_{i,t} * SW_{i,t}$  = Product of salary of a country i with income type during time t

## 5. Analysis and discussion

**Table 1: Correlation matrix.**

	INT	PG	SW	UNEMP	BM	IMP	CF	MP	EMP
INT	1.000								
PG	-0.187	1.000							
SW	0.632	-0.102	1.000						
UNEMP	-0.06	-0.035	0.293	1.000					
BM	0.457	-0.026	0.374	-0.106	1.000				
IMP	0.258	0.077	0.239	-0.163	0.489	1.000			
CF	-0.067	0.215	-0.011	-0.002	-0.026	0.001	1.000		
MP	0.614	-0.085	0.5105	0.029	0.331	0.199	0.017	1.000	
EMP	-0.076	0.027	-0.450	-0.655	-0.106	0.037	-0.023	-0.202	1.000

Table 1 presents the correlation matrix which demonstrates the correlation between different variables. From the table, it is seen that the correlation coefficient is well within the acceptance range for all the variables (Ray, 2017, Gujarati, 2004). This allows us to consider all the predictors for our study. However, before any model estimation technique we evaluate the tolerance and variance inflation factor to detect any problem of multicollinearity .

**Table 2: Results of equation(1).**

Variables	Ordinary least squares regression		Fixed Effect regression		Panel corrected standard error	
	Coefficient	p-value	Coefficient	p-value	Coefficient	p-value
PG	-0.787	0.000	-0.742	0.000	-0.742	0.040
SW	0.535	0.000	1.346	0.000	1.346	0.000
UNEMP	-0.413	0.000	0.422	0.048	0.422	0.089
BM	0.1029	0.000	0.313	0.000	0.313	0.000
IMP	-0.111	0.125	-1.005	0.000	-1.005	0.000
CF	-0.042	0.021	-0.015	0.245	-0.015	0.194
MP	7.030	0.000	4.319	0.000	4.319	0.001
EMP	0.456	0.000	2.123	0.000	2.123	0.000
<b>Hausman Test</b>	Preference for Fixed effects					
<b>Autocorrelation</b>	Presence of serial correlation					
<b>Heteroskedasticity</b>	Presence of heteroskedasticity					
<b>VIF</b>	Within the threshold range					



Table 2 displays the results of equation(1) by applying linear regression, fixed effects and panel corrected standard errors estimation for fixed effects model. The variance inflation factor is within the threshold value and therefore there is no problem of multicollinearity. Hausman Test indicated the preference for fixed effect model over random effect. The model has encountered serial correlation and presence of heteroskedasticity. Since the number of observations exceed the number of years, panel corrected standard errors estimation is feasible for analyzing the outcome.

From the table we can see that all variables are statistically significant except growth in capital formation. Therefore investments by different nations is not linked to increase in internet usage. This probably suggests that asset addition in an economy may not increase the digital footprint. Similarly, contrary to other studies it is observed that prosperity growth is negatively linked to internet usage at 1% level of significance. As nations increase their productivity, individuals dependence on internet decreases. There is a possibility that mostly internet use is for leisure and entertainment purposes. An increase in productivity may make the workforce busier with lesser time availability for relaxation. This can be reiterated by evidence of unemployment having a positive relationship with internet usage at 10% level of significance. However, it is observed that salaries of workforce coefficient(1.346) and employment coefficient(2.123) are having a positive association with internet usage at 1 % level of significance. This suggests that better job prospects and incentives allow people to purchase ICT equipment. Therefore money supply also has a positive relationship (0.313) with internet usage at 1% level of significance. Imports of ICT equipment is negatively associated with internet usage(-1.005) at 1% significance level suggesting that costlier imported equipment discourages internet usage even if money is in circulation in the economy. Mobile phone usage has the highest coefficient(4.319) which indicates that most of internet users prefer to access internet through their mobile handsets.

**Table 3: Results of equation(2).**

Variables	Ordinary least squares regression		Fixed Effect regression		Panel corrected standard error	
	Coefficient	p-value	Coefficient	p-value	Coefficient	p-value
<b>PG</b>	-0.980	0.000	-0.766	0.000	-0.766	0.008
<b>UNEMP</b>		0.972	6.029	0.000	6.029	0.000
	0.003					
<b>BM</b>	0.150	0.000	-0.740	0.190	-0.740	0.012
<b>IMP</b>	0.123	0.136	0.259	0.001	0.259	0.000
<b>CF</b>	-0.044	0.035	-0.880	0.000	-0.880	0.000
<b>MP</b>	10.984	0.000	-0.014	0.090	-0.014	0.096
<b>EMP</b>	7.030	0.000	4.747	0.000	4.747	0.000
<b>IN*SW</b>	-0.068	0.000	-1.833	0.000	-1.833	0.000
<b>Hausman Test</b>	Preference for Fixed effects					
<b>Autocorrelation</b>	Presence of serial correlation					
<b>Heteroskedasticity</b>	Presence of heteroskedasticity					
<b>VIF</b>	Within the threshold range					

Table 3 exhibits the results of equation(2) utilizing linear regression, fixed effects and panel corrected standard errors estimation for fixed effects model. From the model test results it is seen that the outcome from panel corrected standard error estimation is most feasible for interpretation. The results are somewhat different from table 2 when we introduce the interaction variable. It is observed that an higher salary for developed countries significantly decreases the internet usage(-1.833). This indicates that individuals with higher salaries in developed nations spend fewer time in internet for recreation.

Prosperity growth coefficient(-0.766) and capital growth coefficient(-0.880) retain their negative association at 1% level of significance. This further supports our comment on internet spend towards leisure activities. Moreover, unemployment has the highest positive coefficient(6.029) with significance at 1% level thereby suggesting that higher internet consumption has been enjoyed by jobless people. The negative significance of money supply(-0.740) suggests that a decrease in money supply may interfere with productivity with more people engaged over internet due to available free time. Imports has a positive coefficient(0.259) which is significant at 1% level. Similarly, mobile phone usage has a negative significant influence(-0.014) on internet usage. However, imports of ICT equipment has a positive influence(0.259) at 1% level of significance on internet use. Thus in case of digital divide between nations in terms of salary, we can interpret that imported communication equipment are used for internet use due to which cellular device subscription for internet access decreases.

## 6. Conclusion

This paper presents the initial findings on economic determinants of internet usage across different countries. Thereafter the findings are assessed by considering the digital divide among nations on the basis of per capita income. Mobile phone subscription have a higher positive significance and imports have a higher negative significance with internet usage in our initial equation. The second equation findings reveal that cell phone subscription decrease is associated with increase in internet penetration and decrease in import of ICT equipment is associated with higher internet usage. Money supply is positively linked to internet usage in our initial equation but negatively linked to internet usage in the second equation. These outcomes can explain that in context of digital divide between nations, people purchase costly imported communication equipment to use internet use for their social outreach compared to cell phones. Money supply overall increases internet usage but in context of digital divide money circulation is diverted from internet connection to other sectors. Jobless people have a much greater contribution in internet usage in our assessment of digital divide. The outcome reveals that internet use has more in use probably for the purpose of entertainment or social outreach rather than for productive purpose. Our findings are further reinforced by the negative coefficient of interaction variable which indicates that higher salaries in developed nations is associated with reduced internet usage.

The current study identifies the digital divide across different income groups. Further study will determine the internet usage among different user groups to examine the purpose of internet use. Our study has policy implications for countries to identify different categories of internet users and their purpose of use in a digital economy. Internet usage has to be improved towards productivity and growth of economy instead of being a source of engagement for the unemployed population. The paper has a limitation wherein more country specific information is needed to get a more holistic approach in our study.



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