

# Impact of ICT on GDP in Developed, Emerging and Developing Countries

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## Abstract

This paper analyzes the impact of Information and Communication Technology (ICT) on economic growth in developed, developing and emerging markets. The central question of the study is whether the gains from investments in ICT are different between the developed, developing and emerging markets. It is based on a sample of 58 countries for the period 1995 to 2010. From the initial descriptive statistic we observe that investment in ICT is higher in emerging economies as compared to developed and developing economies.

## Introduction

In a rapidly changing world, societies have experienced a paradigm shift of how things used to be done to new ways, which have been enabled by the use of Information and Communication Technology (ICT). ICT has made world to a small village with better living standards. Improved standards of living usually correlate with productivity growth(Timmer et al. 2010)

As a matter of fact, some of the developing and emerging markets have become major engines of global growth however there is little evidence on the effective contribution that ICT investments have on economic performance for these sub- categories. On the other hand, this relationship has been extensively studied in the firm, industry and country level for developed countries with a majority of studies and panel regressions confirming the positive relationship between ICT capital and GDP growth(Cardona, Kretschmer, and Strobel 2013)

Different methodologies can be applied for the study of the impact of ICT on GDP percentage growth, however it might be important to distinguish why the impact differs between developed, developing and emerging countries. Lacking micro and macro level data sets in developing and emerging nations could be a reason explanation the little evidence. Lacking absorptive capacities such as appropriate levels of human capital or insufficient funding for conducting research and development are all valid factors to consider when studying the effect of ICT in these different country classifications. On the other hand, it is often the case that ICT is referred to as a catalyst for innovation and modernization, lowering transaction costs, blurring boundaries and spreading information that will make societies better off. The World Bank for instance, states highly ambitious expectations for the development of ICT infrastructure in developing and emerging nations, associating ICT investments with reduced poverty rates, increased productivity rates, improve accountability and governance and overall boosting economic growth(Group 2012).The International Institute for Sustainable Development defines ICT as an enabler for sustainable development across many sectors, ranging from farming, foresting to energy efficiency and education. United Nations ICT Taskforce has identified ICT as key tool to enable economic growth in developing countries offering these the unique opportunity to leapfrog certain stages of development by the use of technologies that undergo the traditional stages of progress to the information society(Force 2003)

In the following section we define the variables used in the study, data source, methodology and timeline

# Definition of key variables

## Country Categorization

The country groups are based on GDP per capita in purchasing power parity (PPP) adjusted US Dollars of 2013. So countries with less than 6,500 2013 US dollar GDP per capita are classified as developing countries and all countries above 23,000 2013 dollar are developed countries. The countries between 6,500 and 23,000 are defined as emerging countries. ## GDP growth ## The sum of the final uses of goods and services are measured in Purchasing Power Parity (PPP) expressed in 2013 U.S dollars. ## ICT ## The acronym ICT stands for Information Communication Technology. We define ICT as the acquisition of equipment and computer software that provide access to information through telecommunication. For the purpose of this study we will only look at 2 communication technologies, the Internet and cell phones as we assume these to be key drivers in the boosting economic growth. ## ICT Capital service growth ## Defined as the change in the flow of productive services provided by ICT assets. We focus on three types of ICT assets namely computer hardware and equipment, telecommunication equipment, and computer software and services. The underlying capital stock series are calculated from the investment data using the perpetual inventory method. The aggregation of the growth in capital services over the different asset types is calculated using the user cost approach. ## Non ICT Capital Service growth ## Refers to the change in the flow of productive services provided by non-ICT assets. Three types of non-ICT assets are included—transport equipment; plant, machinery, and other non-ICT equipment; and construction, building and other structures. The underlying capital stock series are calculated from the investment data using the perpetual inventory method. The aggregation of the growth in capital services over the different asset types is calculated using the user cost approach.

## Contribution Labor Quality ## The quality of labor captures the heterogeneity among the labour force. ## Contribution Labor Quantity ## Different definition based on the country location. In advanced economies it is the growth rate of total hours worked. In developing and emerging countries it is the employment growth rate. These methodologies do not differ as long as the average hours worked per person stay consistent over time # Capital and Labor Input variables ## For the purpose of our study we focus on capital services rather than capital stocks. As emphasized by Inklaar and Timmer (Timmer et al. 2010). “A capital services measure would reflect that shorter lived assets have a larger return in production, as indicated by the user cost of capital of each asset”. For the calculation of ICT capital services as well as non-ICT capital services we use the growth rates of the stocks of the single assets (information technology equipment, communication technology equipment and software for ICT) weighted by their factor shares in total ICT (non-ICT) capital compensation. The labor input variable is the growth rate of labor services calculated as the sum of the growth rate of the labor composition index and the growth rate of labor quantity. Labor composition includes the growth rate of the share of different skill-level groupings in the labor force weighted by their share in total labor compensation. A significant limitation for our study is the inexistence of data for labor compensation which might affect the comparison between the output elasticity of ICS and the growth accounting base ICT compensation share. Moreover the definition of labor compensation itself is not unanimous between countries: in advanced economies it is the growth rate of the total hours worked whereas in developing countries it reflects the employment growth rate.

## Method

Our study is centered on the use of two key datasets: the Total Economy Database (TED) as a primary data source and the World Bank Development Indicators (WDI) for the study of the control variables. The TED dataset contains annual data for GDP, ICT and non ICT Capital Service and labor services for 123 countries with a timeframe ranging from 1990 to 2013.

## Outlier Detection

The total economy database is the primary data base used in our study. During the visual observation we dropped 75 countries from the data set as there were missing data with regards to ICT capital investment. Maximum countries dropped were from the developing countries category as getting quality with regards to ICT is still challenge in middle and low income countries.

## Methodolgy

The data gathered was arranged into a pannel format for descriptive statistic and understand the pattern of ICT investing in all the categories-

```
#Uploading the data set
d<-read.csv(file = "/Users/Nitij singh/Documents/gdpcoun.csv")
#Creating separate table for developed countries
d1<-subset(d,d$D.E.De == 1)
#View the new table
View(d1)
# Dropping the variable country name
d1$X<-NULL
# Dropping the variable years
d1$X.1<-NULL
#Summary Statisitc of Developed Countries
summary(d1)
```

```
##      D.E.De      GDP.Growth      Lab.Qual      Lab.Quant
## Min.      :1      Min.      :-8.631      Min.      :-1.2487      Min.      :-9.9211
## 1st Qu.:1      1st Qu.: 1.528      1st Qu.: 0.1684      1st Qu.: -0.1009
## Median :1      Median : 2.582      Median : 0.3080      Median : 0.9513
## Mean      :1      Mean      : 2.307      Mean      : 0.3683      Mean      : 0.8325
## 3rd Qu.:1      3rd Qu.: 3.700      3rd Qu.: 0.5316      3rd Qu.: 1.9577
## Max.      :1      Max.      :10.234      Max.      : 1.6147      Max.      : 5.6898
##
##      ICT.Capital      NICT.Capital      Cl.Quality      Cl.Quant
## Min.      : 0.5678      Min.      :-2.459      Min.      :-0.8349      -0.005051575: 1
## 1st Qu.: 7.9922      1st Qu.: 1.482      1st Qu.: 0.1181      -0.011881914: 1
## Median :11.3690      Median : 2.182      Median : 0.1900      -0.020699907: 1
## Mean      :11.1155      Mean      : 2.324      Mean      : 0.2296      -0.036002317: 1
## 3rd Qu.:14.0709      3rd Qu.: 2.880      3rd Qu.: 0.3420      -0.039768842: 1
## Max.      :24.4539      Max.      : 7.957      Max.      : 1.0359      -0.051124505: 1
##                                     (Other)      :298
##      ContriICT      ContriNICT
## Min.      :0.02453      Min.      :-0.7256
## 1st Qu.:0.33692      1st Qu.: 0.4360
## Median :0.52180      Median : 0.6500
## Mean      :0.54836      Mean      : 0.7778
## 3rd Qu.:0.73754      3rd Qu.: 0.9742
## Max.      :1.32499      Max.      : 3.0919
##
```

```
#Creating separate table for emerging countries
d2<-subset(d,d$D.E.De == 2)
```

```

#Viewing the new table
View(d2)
#Dropping the variable country name
d2$X<-NULL
#Dropping the variable years
d2$X.1<-NULL
##Summary statistc of Emerging Countries
summary(d2)

```

```

##      D.E.De      GDP.Growth      Lab.Qual      Lab.Quant
##  Min.   :2      Min.   :-11.426      Min.   :-2.7864      Min.   :-11.9105
##  1st Qu.:2      1st Qu.:  1.610      1st Qu.:  0.2345      1st Qu.:  -0.4425
##  Median :2      Median :  3.878      Median :  0.4328      Median :   1.4046
##  Mean   :2      Mean    :  3.346      Mean    :  0.4657      Mean    :   1.2821
##  3rd Qu.:2      3rd Qu.:  5.612      3rd Qu.:  0.6217      3rd Qu.:   3.0000
##  Max.   :2      Max.    : 16.794      Max.    :  4.4470      Max.    : 16.5887
##
##      ICT.Capital      NICT.Capital      Cl.Quality      Cl.Quant
##  Min.   : 0.09741      Min.   :-1.945      Min.   :-2.0512      #N/A          : 16
##  1st Qu.:10.60355      1st Qu.: 1.995      1st Qu.: 0.1071      -0.026004581: 1
##  Median :16.42471      Median : 3.500      Median : 0.2090      -0.051332603: 1
##  Mean   :16.60128      Mean    : 3.768      Mean    : 0.2469      -0.054426707: 1
##  3rd Qu.:22.20121      3rd Qu.: 5.123      3rd Qu.: 0.3232      -0.055708771: 1
##  Max.   :40.35037      Max.    :13.969      Max.    : 3.2197      -0.0559251   : 1
##                                     (Other)      :331
##      ContriICT      ContriNICT
##  Min.   :-0.003895      Min.   :-1.1190
##  1st Qu.: 0.354109      1st Qu.: 0.7937
##  Median : 0.575092      Median : 1.4061
##  Mean   : 0.696091      Mean    : 1.6367
##  3rd Qu.: 0.887822      3rd Qu.: 2.2452
##  Max.   : 4.388306      Max.    : 6.4375
##

```

```

#Creating separate table for developing countries
d3<-subset(d,d$D.E.De == 3)
#Dropping the variables country name
d3$X<-NULL
#Dropping the variable year
d3$X.1<-NULL
#Summary statistics of Developing countries
summary(d3)

```

```

##      D.E.De      GDP.Growth      Lab.Qual      Lab.Quant
##  Min.   :3      Min.   :-14.072      Min.   :-0.1247      Min.   :-17.487
##  1st Qu.:3      1st Qu.:  3.300      1st Qu.: 0.1505      1st Qu.:   1.522
##  Median :3      Median :  4.802      Median : 0.2866      Median :   2.715
##  Mean   :3      Mean    :  4.872      Mean    : 0.2603      Mean    :   2.788
##  3rd Qu.:3      3rd Qu.:  6.137      3rd Qu.: 0.3435      3rd Qu.:   3.907
##  Max.   :3      Max.    : 19.349      Max.    : 0.7314      Max.    : 20.593
##
##      ICT.Capital      NICT.Capital      Cl.Quality      Cl.Quant
##  Min.   :-0.4625      Min.   :-0.4561      Min.   :-0.06235      2.355307713 : 9

```

```

## 1st Qu.:11.2184 1st Qu.: 2.4931 1st Qu.: 0.06817 1.423988678 : 5
## Median :15.5674 Median : 3.4708 Median : 0.14361 -0.004049758: 1
## Mean :17.1562 Mean : 4.3258 Mean : 0.12141 -0.005843171: 1
## 3rd Qu.:22.1123 3rd Qu.: 5.8583 3rd Qu.: 0.16369 -0.115346734: 1
## Max. :43.7080 Max. :11.2052 Max. : 0.30076 -0.15710115 : 1
## (Other) :254
##
## ContrICT ContriNICT
## Min. :-0.01064 Min. :-0.2892
## 1st Qu.: 0.34028 1st Qu.: 1.1429
## Median : 0.58623 Median : 1.6457
## Mean : 0.77307 Mean : 2.0708
## 3rd Qu.: 0.89637 3rd Qu.: 2.8490
## Max. : 8.38740 Max. : 6.3529
##

```

## Explaining the results

1. The table above shows that investment in ICT capital service is higher in emerging countries as compared to developed and developing countries.
2. Non- ICT Capital is higher in emerging and developing countries.
3. Contribution of ICT to GDP is higher in developing and emerging countries
4. Contributiopn of ICT Non ICT in GDP is higher in developing economies
5. People tend to have higher working hours in developing countries as compared to developed and emerging countries

## Future Steps

In order to understand the effect of ICT capital on GDP growth among developed, developed and emerging countries we plan run two models- i) Logistic Regression Model ii) Fixed Effect Model. The following would the question used in our model

$$\Delta \ln Y_{c,t} = \beta_{ICT} \Delta \ln K_{c,t}^{ICT} + \beta_{NICT} \Delta \ln K_{c,t}^{NICT} + \beta_L \Delta \ln L_{c,t} + \beta_X \mathbf{X}_{c,t} + \lambda_t + \mu_c + \epsilon_{c,t}$$

Dependent variable - GDP Growth Independent variable - ICT Capital Services, Non ICT Capital Services, Labour services, ICT contributon into GDP, Non ICT contribution in GDP

Control Variable - Export percentage of GDP - Data will be gathered from World Bank indicator Dummy time will be used for year 2008-2009 in order to control for the effect of the recession

## Final Product

The website will have a dynamic graph displaying a timeline of ICT capital services in emerging and developing countries

Cardona, Melisande, Tobias Kretschmer, and Thomas Strobel. 2013. "ICT and Productivity: Conclusions from the Empirical Literature." *Information Economics and Policy* 25 (3). Elsevier: 109–25.

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Timmer, Marcel P, Robert Inklaar, Mary O'Mahony, and Bart Van Ark. 2010. *Economic Growth in Europe: A Comparative Industry Perspective*. Cambridge University Press.