Technological GINI: a study of the inequality in Ecuador

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***Abstract*—This paper introduces a Gini coefficient calculation for Ecuador in order to identify the inequality regarding the access to several ICTs and presents a new technological Gini for expenditure of ICT services by end users. A theoretical economic model is presented based on previous studies made by the International Telecommunications Union in order to understand the impact of technologies in a country´s economy, based on that model it is possible to identify the dual nature of ICTs. The present study interpret this model and make an analysis for the productive capacities of Ecuador based on its ICT infrastructure and ICT skills, but more importantly reviews the inequalities for the population to access and use ICTs as consumables. The technological Gini coefficient presented is an indicative of the consumption flow of ICT products and services taking into consideration socioeconomic levels, therefore new public policies can be design and implemented in Ecuador. These public policies aim to contribute to the affordability capacities of citizens to access information. Increasing access to information in a given society can foster the development of digital services and applications related to e-government.**

Keywords— ICT; GINI;access;inequality;public policies

I. INTRODUCTION

It has become evident over the last decade that Information and Communications Technologies have had a beneficial impact on the socio-economic levels worldwide, and that its use and diffusion explain largely the positive developments that have experienced the vast majority of first world countries since the mid-90s. ICT impacts are greater in developing countries and have positive effects on business and labor productivity [1] [2] [3].

In this sense to provide the proper access to technology to citizens and firms plays a crucial role in order to rapidly reduce the digital divide and increase the adoption of new technologies, improving productivity and competitiveness of the entire economy.

The study seeks to identify the distribution of Internet access, personal computers and cellphones between population groups and socioeconomic income and also analyze the expenditures distribution for the consumption of these products and services; being able to identify without difficulty that access to technology is concentrated in the minorities of higher income.

In order to obtain an indicative of inequality for technological access in Ecuador a calculation of the Gini coefficient for different kind of technologies is made. To obtain a comparison framework of ICT adoption in different countries an international measurements of several Gini coefficients are presented based on available literature and datasets.

Considering that increasing citizens' access to technology is an important aspect to foster the development of e-government services, it is imperative to reduce technological inequalities among the population with the accurate design of ICT public policies focusing on current affordability issues.

II. ICT FRAMEWORK

In order to understand the importance of technological access we can interpret the theoretical ICT economic model presented in [4].

An economy is measured by its total production capacity that involves two variables: capital and labor force. Thus the production of a country's GDP can be measured in terms of these two variables, namely the productive capacity of the nation depends on the amount of labor force and existing capital; where the only way to increase the production frontier and GDP is with the incorporation of the variable that involves the use of technology to increase productivity. Thus the use of technology becomes the productivity multiplier [5].

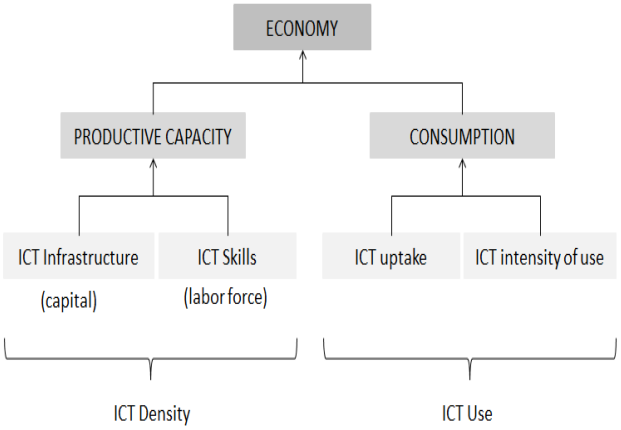

Fig.1 ICT Framework (authors elaboration based on ITU)

The model detailed in Figure 1 explains that ICTs have a binary nature; they can be both productive assets and consumables, inferring a country´s capacity in terms of its ICT density and ICT use. The level of development of a country´s *ICT density* determines its productive capacity observed by its amount of *ICT infrastructure* or capital (networks, equipment and devices) and labor force or human capital with *ICT skills*. The quality and quantity of these two variables are critical for growth and economic development. On the other hand, ICT use in an indicative of the consumption of products (*ICT uptake*) and services (*ICT intensity of use*) in an economy.

To understand more clearly what is contemplated within *ICT density* we can identify some indicators regarding *ICT infrastructure* such as mobile and fixed telephony subscriptions, cable TV subscriptions and international bandwidth. For *ICT skills* it can be understood by adult literacy rates and gross enrolment ratios by level of education. As for *ICT use* of products or *ICT uptake* we can stablished the amount of computers, amount of cellphones and the percentage of people who use internet, while for *ICT intensity of use* the expenditure made by the utilization of both infrastructure and products by end users.

In short, the conceptual framework of ICTs is used to appreciate the relationships between the productive capacity of a country with its ICT capital and labor force, which are a function of the existing infrastructure and ICT skills, while consumption is defined by the use of ICT products and services.

Based on the Network Readiness Index [6] we can observe that in the case of Ecuador the indicators for ICT infrastructure and ICT skills (each pillar has a maximum score of 7) have been improving since 2011 as shown in the Table below, reflecting that the productive capacity is increasing conservatively.

TABLE I. NETWORKED READINESS INDEX FOR PILLAR 3 AND 5.

Networked Readiness Index: Pillars	***2011***	***2012***	***2013***	***2014***
3. Infraestructure and Digital Content	2,81	3,4	3,7	3,9
5. Skills	4,7	4,4	4,5	4,9

Under this framework, with the objective to increment the ICT uptake and technological use in Ecuador and, therefore improving the flow of consumption of products and services in it is necessary to observe the distribution of the variables mentioned before related to ICT use within different groups of population defined by its income. These aspects are crucial especially considering that Internet use can increase the productivity between 0.2% and 0.4% [7].

III. CALCULATING TECHNOLOGICAL GINI COEFFICIENTS

Typically the Gini coefficient is used to measure inequality income in the range between 0 and 1 (being 0 perfect equality), but this calculation technique can be applied to calculate cumulative shares of ICTs and utilization.

Several international studies employ these calculation techniques to measure technological Gini coefficients, the results presented by the United Nations in [8] are used to explain the reduction of the world´s inequality in terms to ICT access around the globe, and determined Gini coefficients of Internet access as a measure of the Digital Divide. This is a simple way to illustrate the unequal distribution of ICT, and provides a visual representation of the Digital Divide in order to identify the gaps between groups under analysis regarding access to technology as it shown in [9], [10] and [11].These calculation techniques and graphical representation of technology inequality serve to justify the design and implementation of new ICT public policies.

A. International Benchmark

A complete set of indicators of the global distribution of information and communication technologies is presented in [12]. The data includes gini coefficients for the distribution of internet access within countries and a technology diffusion index that weights the distribution of broadband subscribers, personal computers, mobile phones, internet users, and international internet bandwidth by economic output. The data is secondary source data, based on analysis of primary data from 204 surveys fielded in 47 countries.

The figures presented below correspond to the graphical representation of the gini coefficients based on the dataset availble until the year 2008 of the WIA project. Three gini coefficients are presented: GINISES, GINIAGE and GINIEDU, which shows the calculation of the gini coeffcient for Interent acces by socieconomic levels, age and by level of education respectivley. Only available data for these coefficientes are computed.

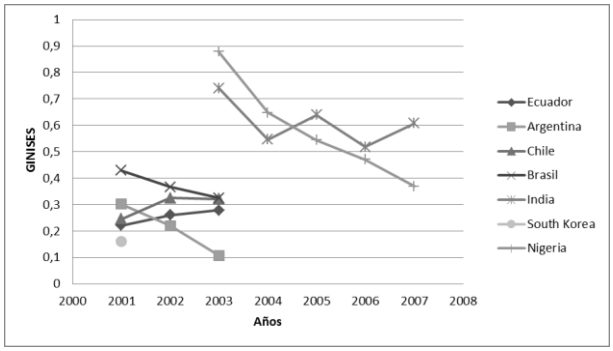

Fig.2 Gini coefficient for Internet access by socioeconomic levels (GINISES)

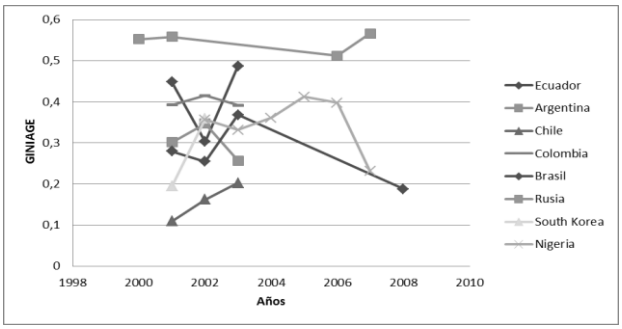

Fig.3 Gini coefficient for Internet access by age (GINIAGE)

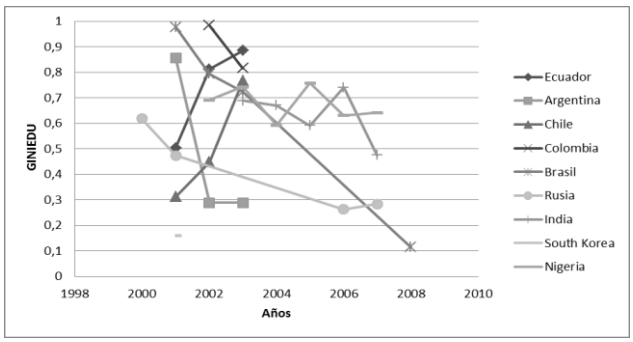

Fig.4 Gini coefficient for Internet access by level of education (GINIEDU)

Clearly the Digital Divide in the countries listed in the figures has been reducing throughout the years. But a more current measurement is needed.

B. Gini calculation for Ecuador

Although the calculation of the Gini coefficient is traditionally known to be a measure of income distribution, it can also be used as a measure of spending distribution [13]. In order to have a current diagnosis of inequality access to ICT products and expenditure for ICT services in Ecuador, two methods for computing the technological Gini coefficientes are used:

1) Calculation of the Gini coefficient from the distribution of average monthly spending on ICT in population by income decile (GINIEXPENSES).

2) Calculation of the Gini coefficient by the average number of ICT devices in each population decile (GINIACCESS).

The datasets used for both methods of calculating the Gini coefficient where extracted from the "Survey of Household Income and Expenditure" provide by the National Institute of Statistics of Ecuador, the survey information is collected annually.

For computing GINIEXPENSES datasets for 2012 and 2013 were used only, because previous sampling design lacked ICT spending as variables. In the case of GINIACCESS a computation for 2013 is made.

The Bootstrap technique was utilized that alllows the resampling of 100 iterations with the code “inegerr” for STATA.

```
. ineqerr gastotic2012

gastotic2012 ------------------------------------------------------------ (unlabeled)
8639 values = 0. Not used in calculations.
(obs=30978)

Bootstrap statistics

Variable |  Reps   Observed       Bias    Std. Err.   [95% Conf. Interval]
---------+--------------------------------------------------------------
    Gini |   100   .531583   .0000373    .001798    .5280153   .5351506  (N)
                                                    .5284288   .5354159  (P)
                                                    .5284288   .5354159  (BC)
```

Fig.5 Bootstrap technique

IV. RESULTS

The GINIEXPENSES was calculated considering mobile phones, Internet access and also for PCs. The computational results are shown in Figure 6.

The Gini coefficient for Desktops is at 0.29 in 2012 and 0.32 in 2013, beting the lowest coefficient among all expenses in the two years analysis. In spite of a good general behavior, an improvement from one period to another is observed. This increase could be interpreted as a slight decline in equity in household spending on desktops, but may also reflect a change in consumer behavior Ecuadorian abandoning desktops consumption, leaving the total consumption in a lower number of families.

Besides the above, the coefficients that show a strengthening in the concentration of the distribution of expenditure are the mobile phones and laptops. It is important to indicate that in Ecuador mobile subscribers represent 106% over the population according to the UN [14], meaning that despite the growth of the Gini coefficient in mobile phones, there are more cell phones than people. This apparent contradiction could be caussed by the aggreated value of the variables (market value of the phone and the monthly cost of postpaid mobile plans). This pair of items contains normal cellphones and smartphones, being the lattest more expensive in their equipment and services. That is, the coefficient evade the deception of people who own cellphones and differentiates between those with low-cost phones with basic services and smartphones. Corroborating the effectiveness of the methodology, according to INEC 86.4% of population own cellphones, but only 7.95% own a smartphone in 2013

Although 3 out of the 4 coefficients disaggregated grow, the internet is the coefficient showing a reduction in the concentration of spending , leading to a improvement of the national Gini coefficient. This is because such expenditure is not composed only of total spending on laptops , desktops , internet and mobile phones, but also has multimedia equipment spending and computer software.

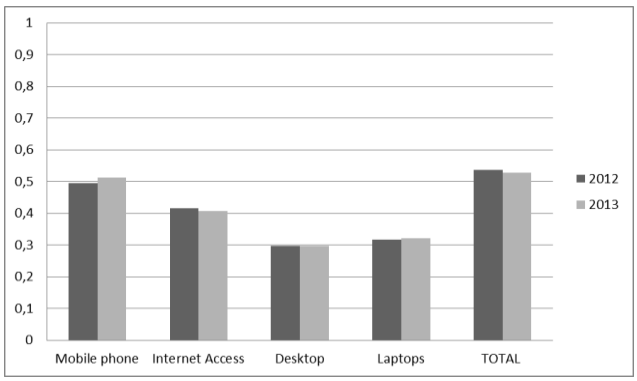

Fig.6 GINIEXPENSES: spending in several ICTs.

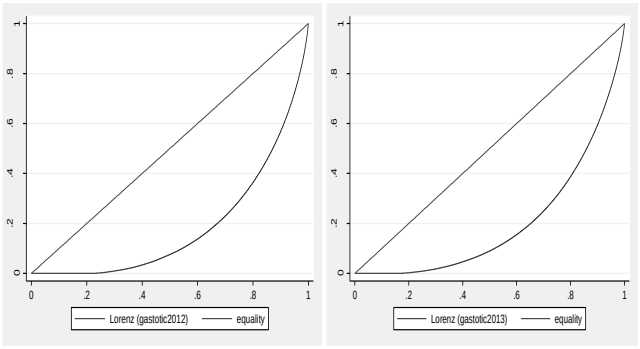

Fig.7 Lorentz Curve of expenditure for several ICTs.

According to the methodology proposed for calculation GINIEXPENSES Ecuador obtained 0.5375 in 2012 and 0.5284 in 2013. This slight improvement is reflected in the Lorenz curve, which divides the x-axis of population in 5 equal parts (quintiles), and with the per cent of expenditure on several ICT in the y-axis. We can observe that while in 2012 the first quintile (poorest 20%) and a quarter of the second quintile only takes 0% of national expenditures, that means that around 20% of the population does not spend in ICTs. For 2013 the fourth part of the second quintile starts spending in ICTs (we can observed in the curve), suggesting that this group of people started having computer and / or ICT services.

For the GINIACCESS it was computed the amount of cellphones, smartphones, desktops and laptops or ICT products for 2013. The Gini coefficients are shown in Figures 8 and 9.

Observing the coefficients for cellphones and smartphones we can notice a great difference in terms of inequality, it is shown that while the majority of Ecuadorian has cellphones, only a handful has smartphones. This situation is reflected in the Lorenz curve: while the Gini cellphones is very similar to perfect equality, the Smartphone is the most inequitable, where only 80% of the population accounts for 40% of total amount of smartphones, the remaining 20% of the population accounts for 60% of the amount of smartphones.

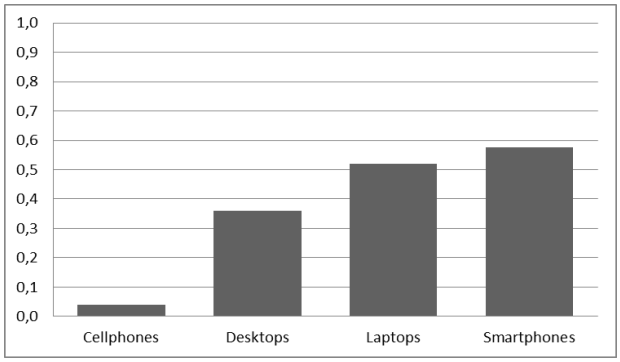

Fig.8 GINIACCESS: access to several ICTs for 2013.

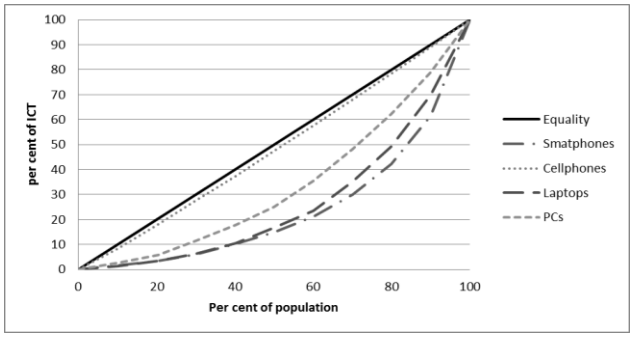

Fig.9 Lorentz Curve of access for several ICTs for 2013.

V. Recommendations and Conclusions

It is important to expand the present analysis using datasets from previous years with the intention to obtain a historical evolution of inequality regarding the consumption of ICT products and services in Ecuador.

The technological Gini could be used as an efficient mechanism to measure the impact of the implemention of ICT public policies; new national goals could be set in terms on diminishing technology inequality.

Two types of measurements for technological Gini coeficientes have been elaborated aiming to analyze the ICT use in Ecuador, divided by the consumption of productos or ICT uptake and the cosmpution of services or ICT itensity of use, this distinction is important in order to create the realtionship between ICT access and spending. Technology accesibility basically measures the amount of devices available for certain population group, in adittion ICT expenses deals with the spending capabilities of a population group to obtain an ICT service or good. Under this considerations is arguable that increasing the access to technology for citizens would reduce ICT expenses for the population or viceversa. In consequence it is imperative to desing public policies aimign to contribute on both aspects.

In order to increase access to ICTs for citizens and firms new policies have to focused on the regulation of prices and tax reduction for hardware and software. Considering policies for improving the purchasing power of citizens can contribute to ICT expenses aspects, allthough it is related to a country´s capacity to create new jobs.

The results have shown that technology inequality in Ecuador is a fact, and knowing that the impact of technology on the economy is greatly beneficial, it is important to continouly contribute with the development of an interconnected society.

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