Paakat
Revista de tecnología y sociedad

Regionalization of the digital gap. Development of ICT infrastructure in Latin America and Uruguay

Regionalización de la brecha digital. Desarrollo de la infraestructura de las TIC en Latinoamérica y Uruguay

http://dx.doi.org/10.32870/Pk.a9n17.356

Santiago Escuder *
https://orcid.org/0000-0003-0041-5831
Universidad de la República - Facultad de Ciencias Sociales

Received: June 13, 2018
Accepted: April 4, 2019

ABSTRACT

The following research's purpose is to explore the "digital gap" of access to the Information and communication Technologies (ICT) for the development of the Information and Knowledge Society (SIC). Through the use of quantitative analysis techniques, the objective of this effort was to demonstrate digital segregation at three different levels of analysis. The first level sought to explore the situation in Uruguay regarding access to the SIC in the Latin American region. In the second level, it was proposed to see the differences in ICT access and other devices linked to the SIC (traditional media) in Uruguay according to the different departments. Finally, the third level sought to show these same differences in the country's capital according to the different neighborhoods. Among the main results are the existence of multiple spaces, where both countries and regions are "excluded" or "precarized" from ICT access according to territorial contingents. According to the ICT indicators, Uruguay's position in this scenario is one of the best. However, both within the country and in Montevideo, there are large differences in ICT access that reproduce digital segregation.

Keywords
ICT; digital gap; principal components analysis

RESUMEN

El siguiente trabajo tiene como finalidad explorar la brecha digital de acceso a las tecnologías de la información y el conocimiento (TIC) para el desarrollo de la sociedad de la información y el conocimiento (SIC). Mediante el uso de técnicas de análisis cuantitativas, el objetivo de este esfuerzo fue evidenciar la segregación digital en tres niveles diferentes de análisis. El primer nivel buscó explorar la situación de Uruguay en materia de acceso a la SIC en la región latinoamericana. En el segundo nivel se plantearon las diferencias de acceso a las TIC y otros dispositivos vinculados a la SIC (medios de comunicación tradicionales) en Uruguay, según los diferentes departamentos. Por último, el tercer nivel procuró mostrar estas mismas diferencias en la capital del país, según los distintos barrios. Entre los principales resultados se destaca la existencia de diversos espacios de acceso a las TIC, donde tanto países como regiones se encuentran "excluidos" o "precarizados" tecnológicamente debido a múltiples contingentes territoriales. De acuerdo con los indicadores TIC, la posición de Uruguay en este escenario es una de las mejores; sin embargo, tanto al interior del país, como en Montevideo, se constatan grandes diferencias en el acceso a las TIC que reproducen la segregación digital.

Palabras clave
TIC; brecha digital; análisis de componentes principales

* Researcher and professor. Sociology Department. School of Social Sciences of Universidad de la República, Uruguay. He is part of the research group ObervaTIC. Candidate for Doctorate in Sociology by the same institution. Email: santiago.escuder@cienciassociales.edu.uy.

Informational Development, Digital Divide and Access to ICT's

The access to information and communication technologies (ICTs) has been constructed as a necessary condition for the development of the society of information and knowledge (SIC, [Spanish acronym]). The capacity of economic growth of countries, as well as their social welfare, cultural inclusion, educational improvements, among other dimensions, is closely related to the access, use and creation of the ICTs infrastructure (Castells, 2000). Indeed, the lack of access to infrastructure and connectivity as well as its precarious use, is called "digital divide" and is constituted as a new social inequality (Kaztman, 2010; Rivoir, 2012; De la Selva, 2015; Jang *et al*. 2017).

This inequality suggests a technological "distance" in the development toward SIC between regions, countries, cities, as well as a segregation within these (Corona and Jasso, 2005). Likewise, the mode of production in SIC sets aside traditional relationships understood as "central-peripheral" in classical theories (Cardoso, 1971); Moreover, there is a new model "Mobile in Red" that crisscrosses different "islands" or "nodes" producers of knowledge and flows of information of high added value (Veltz, 2000; Castells, 2001).

It is also obvious that digitalization is related positively with economic growth, the creation of employments and the reduction of the unemployment rate (Katz, 2012; Biagia and Falk, 2017). However, this does not override the existence of ways of maximizing the accumulation and exploitation of sites or flows in the nodes network. On the contrary, many authors suggest new ways of economic appropriation and social inequalities as the outsourcing of innovation in less developed nodes such as "informational maquilas" (Friedman, 2007; Falero, 2011; Campos Martínez, 2015).

There can be multiple levels of digital divide. However, the first level is the access to ICTs in households, an obvious condition for the efficient use of ICTs (Rivoir, 2012; UIT, 2016).

From the objectives of the first world summits of the information society (The 2003 Geneva and the 2005 Tunis Summits), to the policies linked to the national and local sphere on the informational development, paramount importance has been given to the progress of the infrastructure and access to ICTs (Toudert, 2015).

On the one hand, the discussion on the access to ICTs refers to the context from which one can access and use technology and the normative, territorial and environmental contingencies that exist to develop infrastructure and get the best of them. The access to ICTs can depend on multiple factors such as places of connectivity (household, work, public and commercial spaces, for example, cyber cafes) or the speed of the network (broadband, optic fiber or mobile band). On the other hand, it is also important to point out the quality of the devices (speed, RAM memory and operative system), since many of the contents on the network require the installation of specific applications that facilitate downloading contents from the Internet (Harggitai, 2004; HyunJoo Lee *et al*. 2015).

Just as other goods and resources, the access to ICTs is stratified among individuals, household or enterprises according to their geographic location. Hence, the territory is made up as a central variable when it comes to measuring the access to technologies. The models of development of "dendritic" cities or "gentrification" of major metropolises are a clear example of these inequalities where everything converges in urban centers and capitals of the country, relegating digital exclusion to the remaining regions, whether among the regions of countries or to their interior (Johnson, 1970; Veiga, 2010).

Territorial polarization or "space tyranny" in SIC also includes new inequalities of use and creation of contents on the Internet; thus, knowledge becomes clearly biased in the development of urban regions. Speed and Internet appropriation will not be the same if ICTs are accessed from a household, work or educational center; from a rural rather than an urban region, from a peripheral region or a capital or metropolis, where the first have greater difficulty in connecting to the network (Robinson, 2006; Samaniego *et al*., 2012; Toudert, 2014).

ICTs Policies and Context

The expansion of the access to ICTs, just as other material commodities, acknowledges two paths with certain dissemination nuances. The first refers to the "market effects", i.e., the market is committed to reducing prices that facilitates the affordability of the access to ICTs (more specifically from broadband to Internet) to an excluded section of the population. The second path suggests the role played by the State through public initiative (or ICTs social policy), besides reducing and subsidizing prices or participating as part of the offer (Galperín *et al*., 2013). The countries that achieve a healthy balance between the role of intervention that the State can achieve in the area of ICTs and the different stakeholders that make up the productive apparatus, are those that achieve human development goals and digital inclusion that have an impact on their social welfare (Gascó *et al*., 2007; Peña López, 2009; Guerra *et al*., 2010).

The Uruguayan population has made significant progress in increasing its access to ICTs. In the last decade, the State has implemented several social policies about technologies to contribute in reducing the digital divide and in insisting on the digital inclusion in both households and enterprises.

Many of these strategic actions are included in the goals of the Uruguay Digital Agenda – ADU 2020,[1] as is the case of the Basic Computer Educational Connectivity Plan for Online Learning[2] (Ceibal Plan, version of the "One Laptop per Child in

Uruguay) project, the Ibirapita Plan[3] of digital tablets for senior adults, the universalization of the Internet in poorer households (Universal Households) and the optic fiber cabling as initiative of the National Telecommunications Agency (ANTEL [Spanish acronym], Public telecommunication company), among other initiatives.

To provide context, according to the data of the International Telecommunication Union (ITU, 2017)[4] regarding the 2018 ICT Development Index (IDI), Uruguay reached a value of 7.16, which is considered a high IDI value, first and ahead of Latin American countries such as Argentina (6.79), Chile (6,57), Costa Rica (6.44), Brazil (6.12) and Colombia (5.36).

Nonetheless, inequalities remain in Montevideo as well as in the interior of the country; hence, not all households have access to technological devices equally. By 2006, according to the Continuous Household Survey (ECH, [Spanish acronym]), the number of households that had access to some type of personal computer (PC) was 19.1% for all of Uruguay and only 9.7% of households had Internet connection.

Ten years later, this number increased considerably. In 2017, 70% of households had access at least to one type of PC and 64.3% to Internet connection. But despite this, of all the households that had access to a PC, 18% had an XO laptop from the Ceibal Plan[5] as sole type of computer in the household.[6] 10% of the households also had a tablet from the Ibirapitá Plan. This suggests the importance of the social policy on ICTs, since no household would have access to a technological device if it were not through this initiative.

Regarding the informational development, more specifically in the business sector, despite the existence of multiple innovation and development policies of small and medium enterprises, based especially on the National Agency for Investigation and Innovation (ANII)[7], Uruguay Technological Laboratory (LATU)[8] and the Uruguay Chamber of Information Technology (CUTI)[9], Uruguay has not achieved transforming its productive matrix in an economy of knowledge (Rivoir, 2016). According to the World data, by 2016, 10% of the exported manufactured products were high technology, above countries such as Chile (7%) or Argentina (9%); however, less than 0.35% of the GDP was allocated to research and development (R&D).

Research Problem and Methodology

As mentioned above, this paper aims at showing the development of SIC in the Latin American region and, more particularly in Uruguay. It is most relevant to know how to configure the phenomena of digital inclusion and exclusion, the effects of territorial and contingent polarization for the development of technological infrastructure, as well as the incidence of ICTs social policies and the effects of the market in accessing these technologies.

We have used a quantitative (not experimental) methodological design which is divided into three levels: macro, meso and micro; i.e., it aims at illustrating the state-of-the-art of SIC crosswise in the territory, while going from general findings to specific results.

At the macro level, we seek to compare the different realities of Latin American countries in the light of the development of infrastructure and access to ICTs as central components in the development of the economy of knowledge or digital economy and the reduction of the digital divide. Nevertheless, there are multiple contingent realities regarding the territory and the incidence of ICTs social policies that allow going forward (or backward) in the development toward SIC.

In this sense, we are seeking to capture these differences in the region. To do so, a battery of indicators linked to the access and production of ICTs is taken into consideration, together with some territorial characteristics of the countries, which will then be compared with the existence of ICT access strategies and initiatives by the State.

On the other hand, it is relevant to know the positioning of Uruguay in the continent and its internal differences in accessing ICT devices according to the territory (meso level). At this level, we are seeking to distinguish the different degrees of inclusion to SIC in the different departments, whether through ICTs social policies or the market effect.

Lastly, and along these lines, at the micro level, we will take Montevideo as a case study of the inequalities that exist in different neighborhoods to access ICTs. Besides it being the city with the largest number of households (42% of the total of Uruguay) and inhabitants (1’319,108), Montevideo is the largest urban center of the country in matter of surface (77.61 mi2), which allows us to illustrate the incidence and contribution of ICT social policies within the territory and their relation with the reduction of the digital divide.

Techniques and Sources

The methodological design seeks to explore the phenomenon of the digital divide in accessing the continent, such as Uruguay different departments and Montevideo neighborhoods. With such a goal in mind, we used the principal component analysis (PCA) technique which can represent our data in a two-dimension (factors) plane easy to understand. This technique allows the construction of possible maps (scenarios) of the digital divide according to the production and access to information and communication technologies.

In order to group the cases and build the profiles of the countries, departments and neighborhoods of Montevideo, we resorted to the hierarchical grouping by using the Ward's method to determine the different clusters. The object of this technique allows to visualize and group those units that bear greater similarity.

The R-Studio computer program, based on the free software platform R[10] statistical engine, was used to process these data in PCA. The Factominer and Cluster libraries (extensions) were used to segment Latin American countries as well as the departments of Uruguay and the neighborhoods and localities of Montevideo.[11]

We used two data sources. First, we used the World Bank Open Data,[12] that gathers information from all the countries in the world, according to the recent data available. Regarding the choice of variables and the formation of our PCA model, we took the indicators that showed the countries that had at least one registry in the 2013-2016 period. Our selection included the following countries: Argentina, Brazil, Bolivia, Chile, Costa Rica, Colombia, Ecuador, El Salvador, Guatemala, Honduras, Jamaica, Mexico, Nicaragua, Panama, Peru, the Dominican Republic, Surinam, Trinidad and Tobago, Uruguay and Venezuela.

The variables, under the condition selected, were the possession of mobile phones for every 100 individuals, people subscribing to a broadband Internet connection and the number of Internet users for 100 individuals. These variables reflect the development in the consumption and Access to ICTs. The variable chosen to reflect the development and production of ICTs was the percentage of exportations of technological components according to the GDP.

The variables chosen to illustrate the territorial contingent were the percentages of the surface of the woodland area, of the inhabitants residing in the rural and in urban areas. None of these three variables were transformed or recoded for the analysis. The affordability of the Internet broadband process is above the income minimum market basket defined by the ITU (2016) was used but as exogenous to the PCA model in order to correlate and interpret the position of the countries regarding their access to ICTs.

The second source used to demonstrate the inequalities of access to ICTs in Uruguay and, more specifically in Montevideo, was the 2011 Household Census released by the National Institute of Statistics (INE, [Spanish acronym]).[13] While these data are outdated, they are the only ones that allow inferring statistically the phenomenon at national level. The variables used were the possession of a laptop or a common computer, the Ceibal Plan (OX) laptop and the connection to the Internet as variables to access ICTs.

Other variables included were traditional devices such as the radio, television and fixed telephone. The department and neighborhood (or locality) of residence; likewise, the number of unsatisfied basic needs were the variables that represented the territorial and the socio-economic contingent which may influence the development of the infrastructure and possession of ICT devices.

While there could be a discrepancy in the different methodological levels according to the years in which the information was produced (the 2016 World Bank databases and the 2011 Household Census), this paper seeks to represent the digital inequality and the access to ICTs structured over time, beyond concluding exact figures and updated data.

Lastly, it is necessary to outline that the size of the sample for the macro level (countries) and the meso level (departments of Uruguay) are not ideal. According to López Roldan and Fachelli (2015), the minimal size to conduct the PCA model of confirmatory level is of 50 cases and we only have 20 countries and 19 departments. Shaukat (*et al.*, 2016) argues that while the results improve in 30 or 40-case samples, this empirical limitation must not be an obstacle for conducting a first exploratory approximation. In the case of Montevideo neighborhoods, the sample for our study exceeds 50 cases.

System of Hypothesis

It is relevant to know whether the ICT social policies, as well as the market effects have reached all households equally or, on the contrary, the access to ICTs is also part of these socio-economic inequalities that, in the long run, form a "dendritic" or "gentrification" reproduction model (Johnson, 1970; Veiga, 2010), where everything converges to the urban centers and capitals of the country, which increases urban fragmentation and homogeneity (Veiga, 2010).

While the research is embedded in an exploratory study at different reference levels, we propose four rival hypotheses that can orient our work. Regarding the Latin American situation, the first hypothesis sustains that those countries with digital strategies and strong participation of the State in the regulation of prices through public enterprises and maker of social policies for ICTs should be better positioned in their inclusion to SIC, regardless of their territorial contingencies. Uruguay, by having an eloquent strategy to develop SIC, should be one of the countries better positioned in this sense.

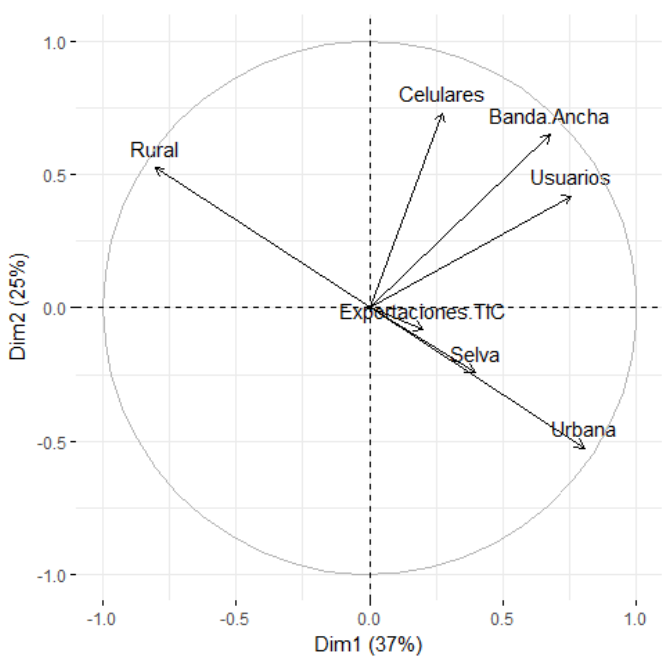
The second hypothesis argues otherwise, the non-existence of policies linked to SIC would withdraw its access for the purposes of the private market which would restrict the access to ICTs to countries with greater territorial contingents and low affordability in accessing ICTs.

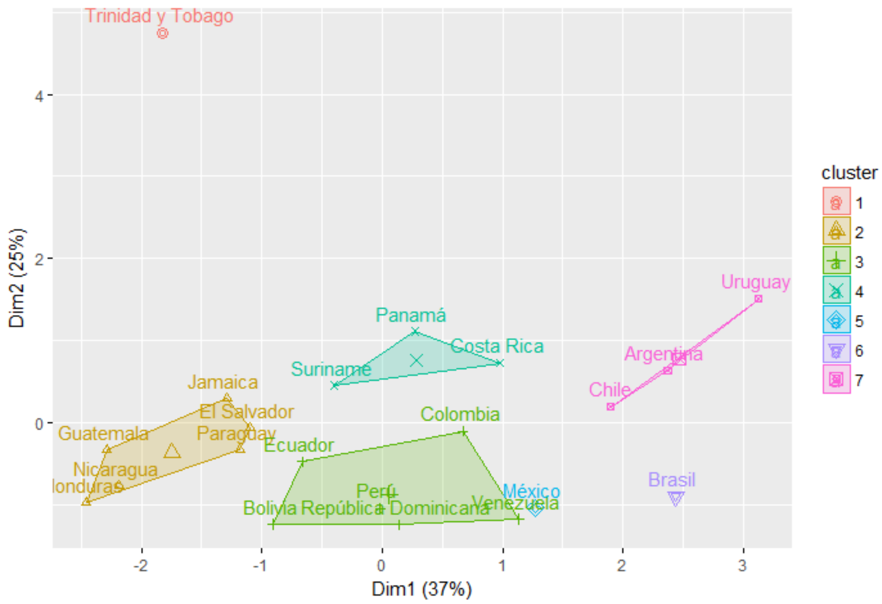
In Uruguay, the reproduction pattern would be similar; hence, the access to SIC would be strongly segregated according to the specific characteristics of the departments. The effect of the social policy of ICTs would have greater penetration in the poorer regions, while the effects of the market would have greater coverage in more central and socially and economically developed zones. In the case of Montevideo, the model of access to ICTs will reproduce the "gentrification" or "dendritic" model of urban development. The neighborhoods more integrated to SIC would be those located in the center, relegating the effects of the social policy of ICTs to the urban outskirts.

Main Findings

Uruguay in Latin America – macro level

On the other hand, the development of SIC receives State support for the implementation of a long-term digital plan[14], which supposes a positive impact on digital inclusion. Moreover, it also has a publicly and privately-owned telecommunication enterprise. As a consequence, in 2015, Trinidad and Tobago had the most affordable broadband Internet prices in the region, since it represents only 1.30% of the expense minimum market basket of a household[15] (ITU, 2016), which determines that this profile is in an advantageous position on the PCA map.





Figures 1-2. Incidence of the variables studied and the classification according to Latin American countries.

The second group is made up of Central America (El Salvador, Guatemala, Honduras, Jamaica and Nicaragua), together with Paraguay. These are countries with a double territorial contingent; they have much of their population scattered in rural areas, besides a high percentage of woodland surface which has an impact on lesser percentages of users and subscribers to broadband Internet in comparison with the rest of the groups.

While these countries all have digital strategies[16], some of these are more updated (Paraguay and Honduras), not all of them have efficient state market operators that guarantee an equitable access. Many of these enterprises have even merged or became privatized; hence, relegating the State to a marginal role as technological provider. The high costs of ICT price affordability are proof that these prices are the highest of the region and the world (between 5 and 10% of the minimum market basket of a household).

Group three is made up of geographically and politically Andean states (Bolivia, Colombia, Ecuador, Peru and Venezuela), together with the Dominican Republic. They have an intermediate level of access to ICTs. Several of these countries such as Peru, Colombia and Bolivia, have innovative ICT access strategies and initiatives (more specifically Colombia), just like state enterprises that participate in the regulation of ICT prices.

However, these countries have not achieved increasing the access to ICTs in households given the territorial obstacles. They have a considerable number of inhabitants that live in rural zones or woodland areas. Just as group two countries, the market effect does not guarantee the best access in these regions; they are at an intermediate level regarding the affordability according to the cost of access to ICTs (between 3 and 6% of the minimum market basket of income per household).

Group four is made up of Costa Rica, Panama and Suriname. These countries have similar characteristics to the previous group regarding the territoriality indicators; however, they have better indicators in ICT infrastructure (60%, 51% and 43% of Internet users respectively). Moreover, they have a certain participation in the exportation of this line of product. In these countries, the ICT policy has been central in defining a development strategy, whether in operators and enterprises of State telecommunications, as well as competing private providers.

This group has several digital agendas with the long-term vision that does not only poses the access issue, but also of the production and development of the technological industry. The cost of access to ICTs in Costa Rica and in Panama does not exceed 1.7% of the income of the minimum market basket. Suriname seems to be the exception since it is relegated to the queue of these countries with a 4% expenditure.

Groups five and six are made up of Mexico and Brazil respectively. Mexico has the highest participation of ICT exportations, probably due to the existence of "informational maquilas" in the north of its territory. It is the country with lesser number of subscribers to mobile telephony (86%). On the other hand, Brazil has the largest woodland area in the region, but at the same time, it has one of the highest percentages of urban population, which can cancel out the territorial contingent effect.

The number of Internet users and access to a broadband subscription in Brazil is also positioned in an intermediate level in the region. These countries, although they have government ICT strategies and ICT social policies, it is the market effect that has an impact on their ICT access indicators beyond their territorial contingencies, especially in Mexico, where most of its telecommunication sector is private. The affordability of ICTs is different for every country. In Brazil, the cost of Internet broadband, does not exceed 1.5% of the minimum market basket per income, while in Mexico, it represents 4%.

Group number seven consists of Uruguay, Chile and Argentina. These are countries with lesser territorial contingents; they are urbanized, and they show the highest percentages of users of Internet and mobile phones: i.e., they are major ICT consumers but with low technological production. The reduced number of individuals that live in considerably rural areas would allow reaching good ICT access indicators.

It is also worth highlighting that these countries since the beginning of the decade have extensive experience in specific strategies to reduce the digital divide, as well as lengthy documents that articulate ICT social policies with the use of digital literacy and the

Internet universalization where the ICT social policy is part of the country's development strategy.

Within this vanguard group, Uruguay is the best positioned (top, right). It has a state-owned telecommunication company, with a near-monopoly in providing broadband Internet. The cost to access this broadband represents 1.32% of the minimum market basket per household income; hence, ranking only below Trinidad and Tobago. Therefore, we can infer that within this elite group, Uruguay is one of the best countries within the region regarding the access to ICTs and the reduction of the digital divide.[17]

Regionalization of the Digital Divide in Uruguay – Meso Level

Despite Uruguay's good position within the Latin American region, it is necessary to surmise what is happening within the country in terms of the access to ICTs. The question here is to know whether the regional dynamics only reproduces the digital divide at the departmental level or, on the contrary, achieves an equitable distribution of the technological commodities. The PCA map below shows the results (Figure 3).

The PCA assessment and adjustment for Uruguay's departments aimed at a primary exploration of data to define the regions with a digital divide. Hence, the core mission of this technique application was to corroborate different department profiles regarding the access to ICTs and find "movement" patterns in the PCA map rather than making a definite assessment.

Nevertheless, the model was statistically valid, and it explains the intersection of two factors, more than 78% of the data inertia (variance). In short, our variables were able to expand our sample cases sufficiently as to find significant differences between the different departments.

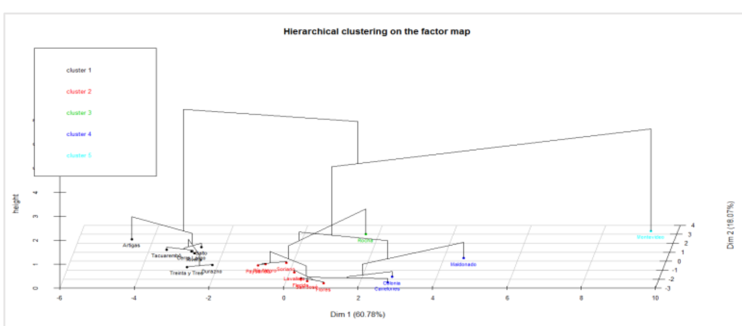


Figure 3. PCA Classification Map of ICT Access in Households per Department.

Through the factorial analysis, we could identify three large spaces that vary according to the first factor which explains almost 61% of the data variance. This dimension reflects the territorial polarization. It represents the increase or decrease of ICT access together with the dependence of ICT social policy or access through the market effect. When further to the left of the map, the lesser is the access to ICTs and the greater is the dependence of social policy on ICTs. When further to the right, greater will be the access and greater is the market effect.

On the other hand, factor two (above-below) explains less than 19% of the total data inertia. This is the indicator "approximation". The higher is a department, more equalized will be the access to a common PC and the connection to the Internet (every household that possesses a common personal computer will have a connection to the Internet available). The lower is a department, the connection to the Internet will not have correspondence or will be below the possession of a common PC.

The departments that depended more on the ICT social policy, i.e., the Ceibal Plan, are on the left side of the map. It is a homogeneous space where the distance between the departments is reduced. The access through the market effect is lesser, and the regions where the possession of a common PC is barely 1-2 percentual points above the access to the XO laptop of the Ceibal Plan.

In these departments, the access to the Internet is also restricted. Its coverage is one of the lowest in the country; it does not exceed 30% of the households. The rest of the traditional technological goods such as fixed telephony do not exceed 40% of the households. Therefore, this space is the one with greater "ICT precarity" in Uruguay, and, to a greater extent, it depends on the ICT social policies.

Space number two is located in the center of the PCA map. This is where the departments with the lower Ceibal effect are located and where the possession of traditional goods such as common PC and the connection to the Internet greatly improves; i.e., the possession of devices through the ICT social policies as well as the market effects are not at a lesser distance (between 8-10% difference in average). Nevertheless, the Ceibal effect is not marginal. This space could be called the "transition" or "co-existence" space, where both ICT social policy and the market effect coexist.

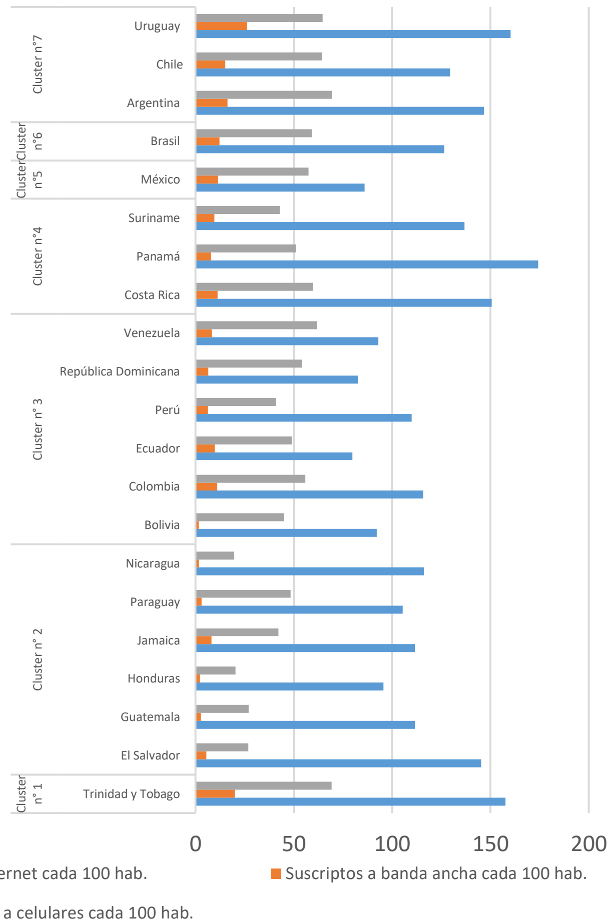
Space three (to the right) shows the lowest impact of ICT social policies. This is where the departments with low Ceibal effect are located. However, this is also where the possession of the Internet connection for both common PC and traditional devices is the greatest and practically equated. Every household that has at least one common PC also has access to the Internet. To illustrate this phenomenon in figures, Graph 1 describes the classification by group of department conglomerates according to their access to ICTs.

According to Graph 2, the first group is made up of bordering departments and those of the northern coast (Artigas, Durazno, Rivera, Salto, Tacuarembo, Cerro Largo and Treinta y Tres). These are departments with restricted economies; some of these departments depend on the production of primary goods with a greater number of households reporting some type of unsatisfied basic necessity NBI (Spanish acronym); i.e., with a greater amount of shortages. On the other hand, the Ceibal effect was the greatest and, in some departments, it exceeded more than 30% of households. Therefore, the dependence on the ICT social policy is considerable in this region.

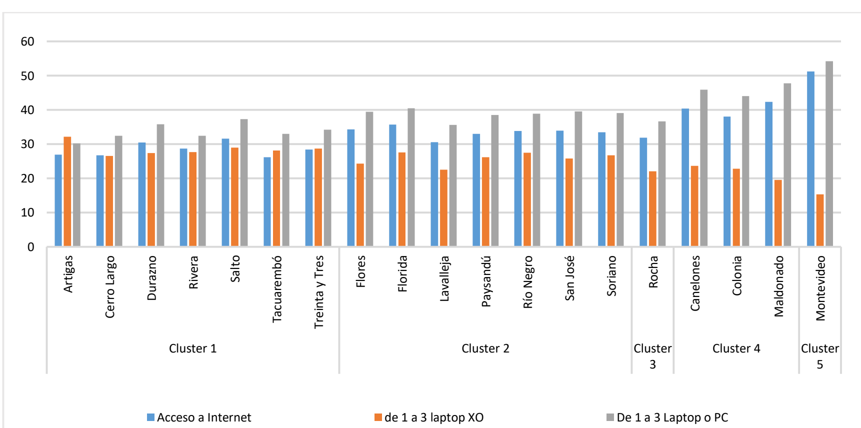
Group 2 is made up of the departments of the center and the southern part of the country (Flores, Florida, Lavalleja, Paysandu, Rio Negro, Rocha, San Jose and Soriano). Although their economy also depends to a greater extent of the primary sector, they use intensive manpower (e.g., the development of the dairy basin and of the horticultural production). They have intermediate Internet connectivity (30-35%), although its penetration in PC or laptop such as the XO, was similar to that of group 1.

Something similar occurs in group 3 which consists of the Rocha department only. It is a region with a low Ceibal effect and an intermediate common PC or XO laptop possession effect. However, the market effect is relatively equated. This is a department where the market and the ICT social policy coexist.

Group 4 consists in the coastal departments (Maldonado, Canelones and Colonia). This is the most populated region of the country with diversified economies in the primary, secondary and service (tourism) sectors. Their households report the least NBI shortages and the greater ICT market effect. They have good indicators of infrastructure and Internet penetration which exceed 40% of the households of the region, the same as for the possession of a laptop of PC. The Ceibal effect does not reach more than 24% of the possession. These are departments that depend less on the ICT social policies.



Graph 1. Subscriptions to mobile phones, broadband and Internet users per 100 inhabitants according to the profiles of the countries. According to the World Bank Open Data, 2013-2016.



Graph 2. Access to ICTs in households las TIC in households according to the departments (in percentage of households).

Lastly, group 5 consisted only of the capital of the country which had the best indicators of access to ICTs, product of the market effect and of an economy developed in three sectors. 54.1% of the households had access to some type of connection to the Internet and 57.6% at least had a laptop or a desktop PC. The Ceibal Plan effect was the lowest here (only 16.2% had access at least to one XO laptop). On the other hand, the distance on the PCA map regarding the rest of the departments was the greatest; which can sustain the importance of a specific study within the capital to escape the dichotomy of the Montevideo-interior of the country analysis.

Informational Segregation in Montevideo –Micro Level

In 2011, the department of Montevideo was the region that showed the best indicators of access to ICTs. Nevertheless, its 62 neighborhoods did not escape the technological segregation model that was seen in the previous PCA models, taking the shape if an inverted "U".

From this PCA model, two factors can explain more than 90% of our data inertia; hence, the application of the technique accurately reflects the situation that we want to illustrate according to the variables chosen that reflect the digital divide, the phenomenon of our study.

The reproduction pattern is equivalent to the model of departments seen previously: low ICT penetration to the right, high ICT penetration to the left. However, the effects of the ICT policy are not marked in the left-right axis, but they come into play in the second factor (above-below).

In the PCA map (Figure 4), eight types of neighborhoods are identified in three big spaces within the map. The first space is the area below and to the left of the X axis which consisted of peripheral neighborhoods and rural locality of the capital city; many of these areas have an important number of households with some type of NBI (more than 38%). The neighborhoods with low ICT penetration are also represented here.

This space is new in the development of SIC, since both the efforts of the ICT social policy and the market effect do not come into play in these households. This can be due to factors associated to the absence of a public objective of the ICT social policy; e.g., the lack of children beneficiaries of the Ceibal Plan in the rural outskirts, or the lack of development of infrastructure by the agents both public and private. This new phenomenon can be named "ICT exclusion", which seriously exceeds the "ICT precarity" where at least the ICT social policy has an effect.

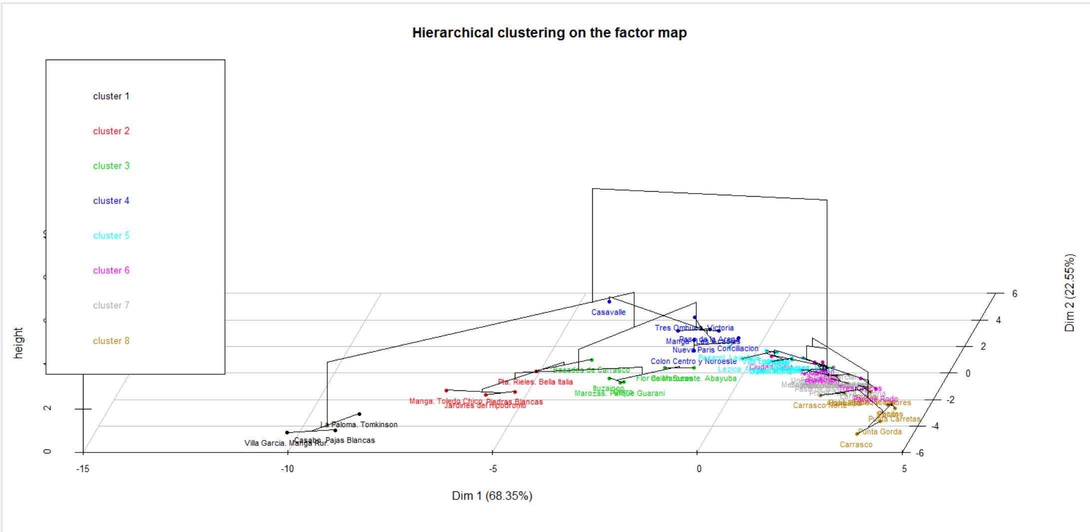


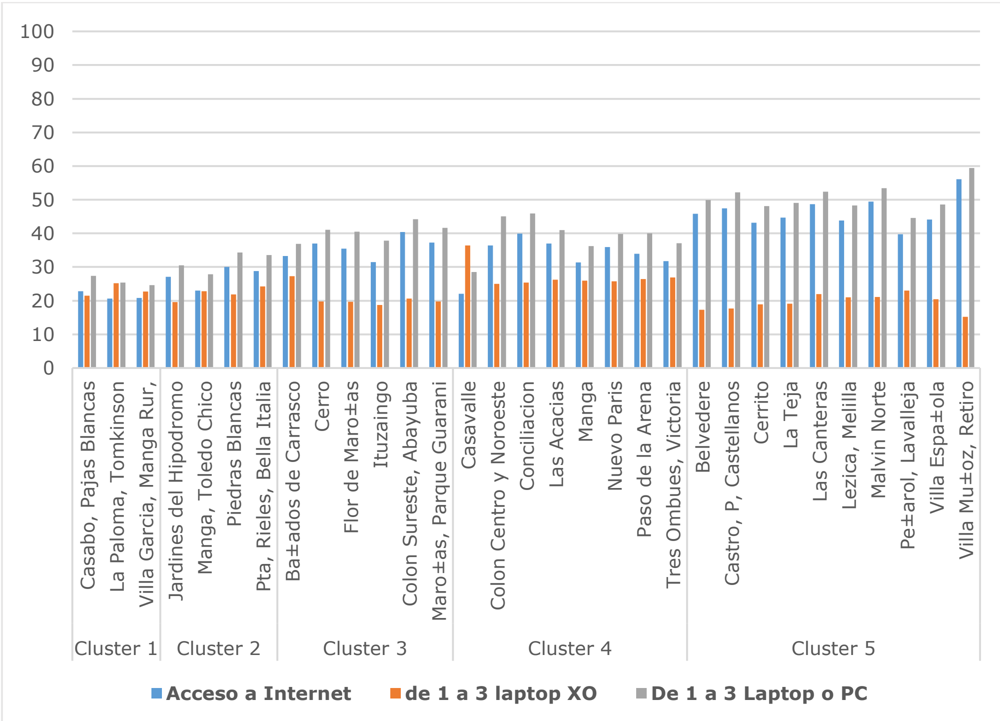
Figure 4. PCA Map ICT Access classification in households according to localities, department of Montevideo.

In the second space (above left), the Ceibal penetration slightly improves. Although the availability of a PC or common laptop in the household and the connection to the Internet is of low penetration, it is greater regarding the first space, going from exclusion to "ICT precarity". These neighborhoods, just as the previous ones, are part of the northern periphery of the capital. Many of these households report an NBI percentage higher than 15%; however, these are in an urban cone of the city. These are neighborhoods where the number of children should be higher per household; hence part of the Ceibal effect can be explain.

The third space consists of the urban center and the residential zone of the Montevideo coastline. This is the greatest "ICT inclusion" space in infrastructure with less than 10% of the households with some type of NBI and with high ICT penetration indexes.

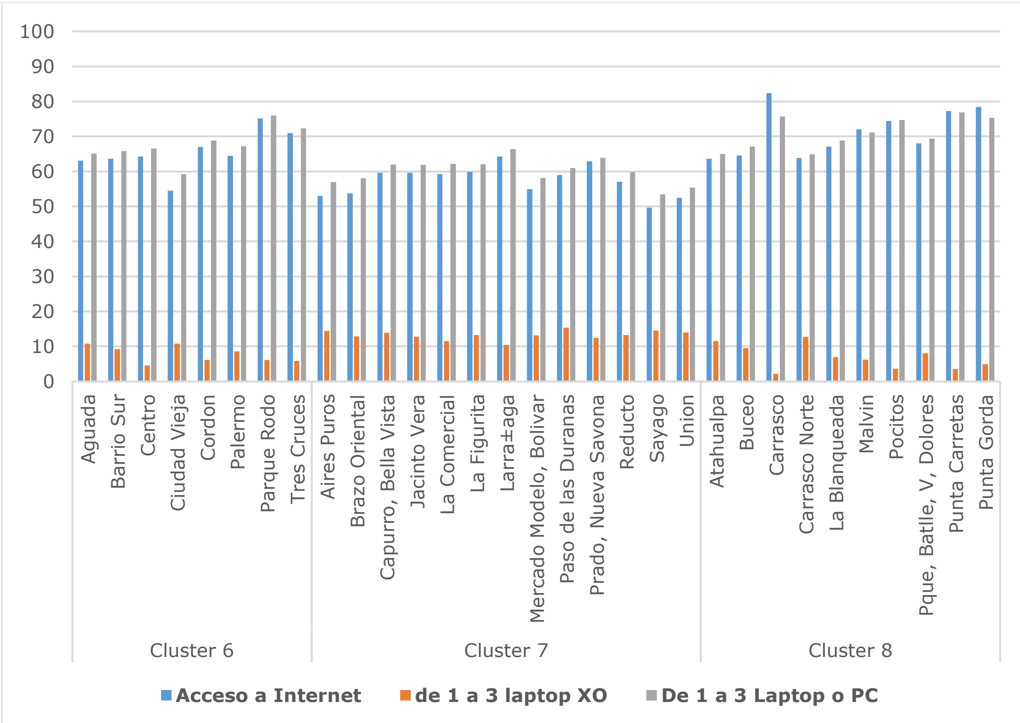
Paradoxically, this third space shares the neighborhood space with the first group low effect of the ICT social policy. In those neighborhoods, the Ceibal effect is residual and the market effect is greater.

To illustrate this phenomenon, we considered the data grouped by neighborhood conglomerates. As shown in Graphs 3 and 4, the penetration of Ceibal as well as common PC is marginal and does not exceed 35% of the households that make up the neighborhoods of groups 1, 2 and 3. The connection to the Internet (to the exception of the Piedras Blancas neighborhood) does not reach 30% of the households; i.e., both the Ceibal effect and the market effect in these zones are less.



Graph 3. Acces to ICTs in households according to localities in the Department of Montevideo (1), in household percentage.

In group 4 neighborhoods, the Ceibal penetration slightly improves, especially in the Casavalle zone (La Cuenca), one of the poorest neighborhoods of the capital and of Uruguay. However, the market effect is detaching from the ICT social policy, reaching in some cases 40% of the connected households. In group 5, the Ceibal effect is less and the market effects reach 50% of the households. These are neighborhoods, although they are in majority in the Montevideo outskirts, have made up their own urban centers with the arrival of multiple decentralized services, among which the infrastructure for ICTs.



Graph 4. Access to ICTs in households according to localities, Department of Montevideo (2), in household percentage.

Groups 6 and 7 make up the epicenter of the city (Tres cruces, Centro and Cordón). These neighborhoods have high indexes of connection and low Ceibal effect. Close to 60% of the households of these sections had access to a common PC and connection to the Internet, which gave rise to the hypothesis of the "gentrification" or "dendritic" model of urban convergence.

Lastly, group 8 was composed of the coastal and residential neighborhoods with the highest purchase power of the country (Carrasco and Punta Gorda). There, the Ceibal effect was marginal and the access to ICTs was given exclusively through the market effect. Between 70 to 80% of households had at least one common PC and connection to the Internet.

Closing Remarks

The processing and application of the technique of principal components analysis (PCA) at different levels taken into account in this paper allowed us to understand in depth the digital divide at the regional level and, more specifically, in Uruguay. Especially in analyzing the infrastructure, production and access of the information technologies available in the countries and regions of Uruguay, particularly in the Montevideo neighborhoods through the World Bank Open Data and of those of the 2011 Household Census.

According to the analysis for Latin America, the PCA exploratory model demonstrated the link between the territorial contingents, the access indicators to the society of information and the existence of strategies to foster digital development. The countries where state strategies exist to develop ICT infrastructure, as well as the State participation through public enterprises that regulate the price of access, regardless of the territorial contingents (rural and woodland area), will have an advantageous position in the development toward SIC. Part of our theoretical model regarding the importance of ICT policies is sustained in this empirical analysis (Gascó *et al*., 2007; Peña López, 2009; Guerra *et al.*, 2010).

Conversely, territorial contingents had a greater impact on those countries with incipient strategies under the participation of the State in the ICT market and under the affordability of these goods. The PCA map also achieves to identify the ICT production countries (Brazil, Mexico, Costa Rica and Panama), as well as ICT consumer countries (Uruguay, Argentina, Chile and Trinidad and Tobago). Within these countries, at global level, Uruguay achieved the best position in Latin America thanks to the existence of State strategies, the State participation in the prices of ICTs and its low territorial contingency in regard to the rest of the country.

Some elements from the analysis and the relation with the socio-economic and geographic characteristics of the departments of Uruguay and the Montevideo neighborhoods allow us to characterize and elaborate profiles of the regions that show inequalities in the interior of the country.

Regarding the hypothesis of segregation and territorial polarization (Toudert, 2014; Veiga, 2010), we realized through the PCA that there are inequalities in the access to ICTs at national level as well as at the interior of Montevideo; i.e., ICT devices, more specifically those linked to the market effect (common PC or laptop and connection to the Internet) are not distributed equally among the different regions. Therefore, we note a persistent digital divide in the access as correlation of the spatial segregation.

Along these lines, the different PCA models recognize a constant dispersion pattern in virtually all the departments and regions, fundamentally along the abscissa axis, where the “left-right” dynamic indicates spaces of digital precarity and high effects of the ICT social policy against high market effects that entail an improvement of the digital inclusion.

Something similar occurs in the different models with the coordinate axis “above-below” and the confirmation of different effects of access to ICTs. The higher the effects of the market, the lower will the Ceibal effect be.

Despite finding central spaces where the policy on ICTs coexist with the market, a strong dichotomy is confirmed between the different departments regarding the access; those farthest from the capital are those that depend the most on the ICT social policy in terms of digital infrastructure. Likewise, we also found that the economic factor and the access to services (NBI) partly determine the possession of ICT devices; i.e., the access to ICTs and the digital divide are not more than another dimension of the reproduction of the social inequality and its correlation of the "gentrification" and "dendritic" development of the urban regions (Johnson, 1970).

In Montevideo, the PCA model corroborates also the hypothesis of the segregation of inter-neighborhood ICTs in a central-peripheral rationale with spaces where the policy on ICTs coexist with the market. However, the existence of a factor must be added to the phenomenon of dependence of this policy, i.e., the "ICT exclusion" factor, where neither the market effects not the effects of the initiatives of the State can include many households in the SIC.

Paradoxically, while Uruguay has the best indicators of access to ICTs of the region, and Montevideo has the best indicators of access to ICTs of the country, many households outside the outskirts are excluded. We would be dealing with a "periphery of the periphery" where household shortages are greater and the access to ICTs are not only precarious but exclusionary.

Lastly, the power of the model of the principal component analysis in measuring the phenomenon of the digital divide in neighborhoods is one of the most important points of this research. The power of the neighborhood as a construct-variable allows us to illustrate the digital inequality in the first level of the digital divide with more than 90% of the data variability explained.

As with other research studies (Kaztman, 2010; Veiga, 2010), this paper confirms the importance of the territory as a plausible reality when measuring inclusion or social segregation. Therefore, and in the face of the SIC construction social policies, the territory should be considered as a relevant scenario in the development of the access to ICTs.

As final reflection, it is important to mention that the phenomenon of the digital divide only provides feedback to the vicious circle of the social inequality dynamic. The most digitally excluded sectors correspond to the spatial and socio-economic exclusion of the households located in the most peripheral neighborhoods. The interaction between economic and digital inequality highlights even more the importance that the policies of access to the SIC be ICT social policies linked to the territory and its different contingencies.

REFERENCES

Biagia, F; Falk, M. (2017). Impact of ICT and e-commerce on employment in Europe. *Journal of Policy Modeling*, *39*. http://doi.org/10.1016/j.jpolmod.2016.12.004

Cardoso, F. E. (1971). ¿Teoría de la dependencia o análisis de situaciones concretas de dependencia? *Revista Latinoamericana de Ciencias Políticas*, *3*, 400-419. Recuperado de: http://revistas.ucm.es/index.php/POSO/article/view/POSO9494220107A/30231

Castells, M. (2000) *La era de la información. Economía, sociedad, cultura. Vol. I: La sociedad red*. Madrid: Alianza Editorial.

Castells, M. (2001) *La galaxia internet. Reflexiones sobre internet, empresa y sociedad*. Barcelona: Areté.

Campos Martínez, J. A. (2015). *El uso de las TIC, dispositivos móviles y redes sociales en un aula de la educación secundaria obligatoria* (tesis doctoral). España: Universidad de Granada. Recuperado de: https://hera.ugr.es/tesisugr/25642005.pdf.

Corona, L. y Jasso, J. (2005). Enfoques y características de la sociedad del conocimiento. Evolución y perspectivas para México. En G. Sánchez Daza (coord.), *Innovación en la sociedad del conocimiento*. México: Benemérita Universidad Autónoma de Puebla.

De la Selva, A. (2015). Los nuevos rostros de la desigualdad en el siglo XXI: la brecha digital. *Revista Mexicana de Ciencias Políticas y Sociales*, *60*(223), 265-285. Recuperado de: http://www.revistas.unam.mx/index.php/rmcpys/article/view/45387/40864

Falero, A. (2011). *Los enclaves informacionales de la periferia capitalista: el caso de Zonamérica en Uruguay. Un enfoque desde la Sociología*. Montevideo: Universidad de la República – CSIC. Recuperado de: https://www.colibri.udelar.edu.uy/jspui/handle/123456789/4148

Friedman, T. (2007). *La tierra es plana. Breve historia del mundo globalizado del siglo XXI*. Madrid: MR Ediciones.

Galperin, H. y Katz, R. (2013). *La brecha de demanda: determinantes y políticas públicas*. En V. Jordán, H. Galperin y W. Peres (coord.). *Banda ancha en América Latina: más allá de la conectividad*. Santiago de Chile: CEPAL, DIRSI. Recuperado de: https://www.cepal.org/es/publicaciones/35399-banda-ancha-america-latina-mas-alla-la-conectividad

Gascó-Hernández, M.; Equiza-Lopez, F. & Acevedo-Ruiz, M. (2007). *Information Communication Technologies and Human Development: Opportunities and Challenges*. Idea Group Publishing. http://doi.org/10.4018/978-1-59904-057-8

Guerra, M. y Jordán, V. (2010). *Políticas públicas de la sociedad de la información en América Latina: ¿una misma visión?* Documento de Proyecto. Santiago de Chile: Comisión Económica para América Latina (CEPAL). Recuperado de: https://www.cepal.org/es/publicaciones/3757-politicas-publicas-la-sociedad-la-informacion-america-latina-misma-vision

Hargittai, E. (2004). Internet access and use in context. *New Media and Society*, *6*(1), 137-143. Londres: Publicaciones SAGE. https://doi.org/10.1177/1461444804042310

Jang, J.; Hessel, H. & Dworkin, J. (2017). *Parent ICT* use, social capital, and parenting efficacy. *Computers in Human Behavior*, 71, 395-401. http://doi.org/10.1016/j.chb.2017.02.025

Johnson, E. (1970). *The organization of space in developing countries*. Cambridge: Harvard University Press

Katz, R. (2012). *Banda ancha, digitalización y desarrollo en América Latina*. En Edwin Fernando Rojas (ed.), *Conectados a la banda ancha, tecnología, políticas e impacto en América Latina y España*. Naciones Unidas, Unión Europea: CEPAL - CIDOB. Recuperado de: https://www.cepal.org/es/publicaciones/4017-conectados-la-banda-ancha-tecnologia-politicas-impacto-america-latina-espana

Kaztman, R. (2010). *Impacto social de la incorporación de las nuevas tecnologías de información y comunicación en el sistema educativo*. Santiago de Chile: CEPAL. Recuperado de: https://www.cepal.org/es/publicaciones/6171-impacto-social-la-incorporacion-nuevas-tecnologias-informacion-comunicacion

Lee, H.; Park, N. & Hwang, Y. (2015). A new dimension of the digital divide: Exploring the relationship between broadband connection, smartphone use and communication competence. *Telematics and Informatics*, *32*(1), 45-56. https://doi.org/10.1016/j.tele.2014.02.001

López Roldan, P. y Fachelli, S. (2015). *Metodología de la investigación social cuantitativa*. Bellaterra: Universitat Autònoma de Barcelona. Recuperado de: http://ddd.uab.cat/record/129382

Peña López, I. (2009). *Midiendo el desarrollo digital para las políticas públicas: el papel del gobierno*. Ponencia presentada en la II Conferencia Internacional sobre Brecha Digital e Inclusión Social, Madrid, del 28 al 30 de octubre de 2009. Recuperado de: http://ictlogy.net/bibliography/reports/projects.php?idp=1432

Rivoir, A. (2012). *Estrategias nacionales para la sociedad de la información y el conocimiento en América Latina, 2000-2010. El caso de Uruguay* (tesis doctoral). España: Universidad Abierta de Catalunya. Recuperado de: http://openaccess.uoc.edu/webapps/o2/handle/10609/31281?mode=full

Rivoir, A. (2016). ¿Desarrollo humano informacional a la uruguaya? Constataciones y contradicciones del período 2005 al 2014. En A. Rivoir, *Tecnologías digitales en sociedad. Análisis empíricos y reflexiones teóricas*. Montevideo: Universidad de la República. Recuperado de: http://bibliotecadocomum.org/files/original/3c6cbd46b19a1735f0bce829fb7e973f.pdf

Robinson, S. (2006). Después de e-México: una propuesta. *Razón y Palabra*, *11*(51). Recuperado de: https://www.redalyc.org/pdf/1995/199520723018.pdf

Toudert, D. (2014). Evolución de la polarización territorial de la producción web: ¿para cuándo la esperada descentralización? *Economía, Sociedad y Territorio*, *14*(45), 549-580. Recuperado de: http://www.scielo.org.mx/scielo.php?script=sci_arttext&pid=S1405-84212014000200009

Toudert, D. (2015). Brecha digital y perfiles de uso de las TIC en México: un estudio exploratorio con microdatos. *Culturales*, *3*(1), 167-200. Recuperado de: http://www.scielo.org.mx/scielo.php?pid=S1870-11912015000100006&script=sci_abstract

Samaniego, P.; Laitamo, S.; Valerio, E. y Francisco, C. (2012). *Informe sobre el uso de las tecnologías de información y comunicación (TIC) en la educación para personas con discapacidad*. Quito, Ecuador: UNESCO. Recuperado de: http://riberdis.cedd.net/bitstream/handle/11181/3589/informe_sobre_uso_de_las_tic_en_educacion_personas_discapacidad.pdf?sequence=1&rd=0031392081826107

Shaukat, S. S.; Rao, T. A. & Khan, M. A. (2016). Impact of sample size on principal component analysis ordination of an environmental data set: effects on eigenstructure. *Ekologia (Bratislava)*, *35*(2), 173-190. Recuperado de: https://content.sciendo.com/view/journals/eko/35/2/article-p173.xml

Unión Internacional de Telecomunicaciones (ITU). (2016). *Measuring the Information Society Report 2016*. Informe anual. Suiza: ITU. Recuperado de: https://www.itu.int/en/ITU-D/Statistics/Documents/publications/misr2016/MISR2016-w4.pdf

Unión Internacional de Telecomunicaciones (ITU). (2017). *Measuring the Information Society Report 2017*. Informe anual. Suiza: ITU. Recuperado de: https://www.itu.int/en/ITU-D/Statistics/Documents/publications/misr2017/MISR2017_Volume1.pdf

Veiga, D. (2010). *Estructura social y ciudades en Uruguay: tendencias recientes*. Montevideo: Facultad de Ciencias Sociales Universidad de la República – Departamento de Sociología. Comisión Sectorial de Investigación Científica.

Veltz, P. (2000). *Le nouveau monde industriel*. París: Editions Gallimard.

[1] http://www.agesic.gub.uy/innovaportal/file/6122/1/agenda-uruguay-digital-enero-final.pdf

[2] http://www.ceibal.edu.uy/

[3] https://ibirapita.org.uy/

[4] https://www.itu.int/en/ITUD/Statistics/Documents/publications/misr2017/MISR2017_Volume1.pdf

[5] Subsection number 3 characterizes some of the ICTs social policies.

[6] Data of personal data according to the Household Continuous Survey, National Statistics Institute (INE, [Spanish acronym]).

[7] http://www.anii.org.uy/

[8] https://www.latu.org.uy/

[9] http://www.cuti.org.uy/portada

[10] https://cran.r-project.org/

[11] Factors and calculations taken from the Factorial Analysis Chapter in López Roldan and Fachelli.

[12] https://datos.bancomundial.org/indicador

[13] http://www.ine.gub.uy/censos-2011

[14] National Plan ICT – 2012-2016.

[15] This is the price sub-basket of ICTs calculated as percentage of GNI per capita.

[16] http://biblioguias.cepal.org/TIC/agendasdigitales

[17] Graph 1 shows the classification of countries in three key indicators that synthesize the inequality in accessing ICTs: Internet users, every 100 inhabitants: Internet broadband subscribers, every 100 inhabitants; and the number of subscribers to mobile phones, every 100 inhabitants.