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Does it pay to have an internet connection?

Evidence from self-employees and employers in Costa Rica

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Abstract

Using propensity score matching it was possible to analyze the impact that access and use of internet had on the perceived income of self-employed and employers (also referred as microbusiness) in the first three quintiles of income during the period 2010-2018. This research was made with households and microbusinesses data from Costa Rica, country that in 2011 effectively opened the mobile telecommunications market to competition, resulting in a fast growth of people with access to the internet. The results show that for certain groups and years, having access to the internet represented a higher perceived income; ranging from 7% to 13% of the minimum salary, which in some cases represent almost a fifth of the average income of the group. Additionally, the effects were not constant over time and there was no evidence found of a difference according to the type of connection (fixed versus mobile). Furthermore, it is important to improve the data that is collected on access and use of technologies, in order to design and evaluate public policies towards a greater inclusion. Many of the questions and topics discussed gain more relevance in the context in which this paper was written: the outbreak of COVID-19 and its implications for the economy, especially micro and small business.

Key words

Digital divide, access to internet, developing countries, microbusiness, Costa Rica.

Table of Contents

1. Why should I read this research? 4
2. Introduction 5
3. Interdisciplinary state of knowledge 7
   3.1 Effects on productivity, employment and inequality 8
   3.2 Studying the relationship between access, use and income 10
   3.3 Policy perspective 12
   3.4 Specifics on Latin America 13
4. The Case of Costa Rica 15
   4.1 Gaps and actions 18
   4.2 Why does it matter? 20
   4.3 What has been like for self-employed and employers 21
5. Methodology, data and sources 23
   5.1 Data 23
   5.2 Hypotheses 27
   5.3 Empirical strategy 27
6. Analysis and findings 34
   6.1 Heterogeneity: are there differences by subgroups? 34
   6.2 Does the type of connection influence the income perceived? 37
   6.3 Does use have an impact on the income? 37
7. Conclusion and policy recommendations 39
8. Bibliography 41
9. Annex 45
   Annex I. The story of the telecommunications reform 45
   Annex II. 46
   Annex III. Variables used for the PSM ENAHO estimation 47
   Annex IV. Variables used for the PSM ENAHO + ENAMEH estimation 49
   Annex V 51

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1. Why should I read this research?

Almost 20 years ago, many claimed that ICTs, especially the internet, would be revolutionary and an instrumental tool to reduce inequality. Overtime, it became clear that it was not that simple. Not only access was a challenge, but education and training were key to take the most advantage of it, resulting in different kinds of digital divides. While access is less the issue in developed and many developing countries today, the use continues to be; access does not necessarily mean use, as many scholars have pointed out.

With the fast expansion of ICTs, many governments and business have felt the need to digitize. The process has been highly unequal among and within countries. Many of the studies are focused on the gains of the country as a whole on promoting access and use, however less have been done from the individual perspective, do people and business perceive the benefits of doing so?

Measuring the effects on an individual basis has many complications, the first one is related with the availability of data. Secondly, access and use are highly correlated with education and income level, where there could be a double causation, therefore it is extremely important to control by many factors in order to try to isolate the effects.

Costa Rica has lived a fast transformation towards higher connectivity in the last ten years, as a result of opening the telecommunications market to competition. There are different government programs to promote inclusion, however the programs are not evaluated and there is not enough public data to do it.

This thesis is an attempt to measure the perceived effect of having an internet connection at home (and using it) on low level income owned microbusinesses. There was a similar attempt ten years ago, however results were not conclusive. Today, with data from households and microbusinesses surveys and propensity score matching techniques, it was possible to calculate the effect on income of having an internet connection.

Results shows that self-employed and employers who had internet at home had higher income after the opening of the telecommunication market. In some cases, like for men in 2018 and individuals whose education level was primary school, their income was up to 18% of the average income compared to those who did not had an internet connection.

Why is it important to measure the perceived benefits? It allows to understand if individuals have the incentives or not to be connected, if there is an earning premium for microbusiness (many of them informal) to be connected to the internet. Understanding this allows for better policies towards inclusion. Specially in a time where there is pressure to digitize.

2. Introduction

The term digital divide was coined in the early 2000s, it "*refers to the gap between individuals, households, businesses and geographic areas at different socio-economic levels with regard to both their opportunities to access information and communication technologies (ICTs) and to their use of the Internet for a wide variety of activities*" (OECD, 2006). Furthermore, it usually reflects differences among and within countries.

For the last 20 years, there have been several studies and papers about the potential role of ICTs, specially the internet, in reducing inequality and enhancing development; as well as what the policies should be in order to reduce and eliminate the digital divide. First, many scholars studied the differences between countries at a macro level, further on, including differences within. However, until recently, it had been difficult to measure the impact of the digital divide on individuals. The data available, as with many other topics, is not comprehensive enough, but most importantly, technology keep changing and with it the related gaps. In addition, the models and theories that adjust to developed countries are not the same for developing ones, whose reality requires specific analysis.

As part of these developing countries, there is the case of Costa Rica. A country with high investments in education, who opened the telecommunication market in the late 2000s, much later than other countries in the region. However, in less than ten years, it became one of the countries with the highest penetration of mobile service worldwide. This jump in mobile adoption came as well with an increase in mobile internet connections, highly popular among the inhabitants as their main source of internet connection, especially in lower income groups.

Many claim that the opening of the market benefited the most lower income groups. That is why, the focus of this research are the first three quintiles of the population. Furthermore, as the literature suggest, some of the most powerful returns of internet connection are the impact on access to information and knowledge, the easiness to communicate with others, that can be translated into more education, as well as the easiness to find a job and productivity improvements. This work focuses on the latest, trying to measure how having access to the internet influences the perceived income of self-employed and employers in the lower quintiles. Literature suggests that perceived benefits (and the expected perceived benefits) as well as the price, are the main determinants when deciding whether or not to subscribe for an internet service, impacting the digital gap.

This topic gains considerably importance in this moment, in the middle of a world sanitary crisis, where technology, specially the internet, has been key to maintain some "normality" in different economic activities. Businesses have been forced to reinvent themselves, to go digital in a short notice, in order to survive. Understanding the impact microbusinesses perceived from having internet access, before this new reality, could be an important tool to develop public policy during and after the sanitary crisis. Also, it could be a starting point to measure the effects of the crisis on microbusinesses and their use of the internet.

There are four research questions in this paper. The first one is if there is a tangible economic impact of having internet access at home on the perceived income of the self-employed and employers. Because of the nature of microbusinesses, many of them do not have their own premises, therefore, home becomes the space where they run their business from. Secondly, if the impact of having internet connection has varied over time, it could be higher due to network

effects, having advantages for those who are connected, or it could be no longer a differentiating factor once a certain threshold is achieved.

The third one is related with the type of internet connection they have; some literature suggests that there are activities that are more productive with a fixed internet connection, while other authors advocate that the mobility component of mobile connections allows to communicate more fluidly and increase productivity. Therefore, a comparison between the impact of fixed and mobile connection is made. Finally, the fourth question has to do with the use of the internet by microbusinesses, to analyze and compare the results measuring access versus use. Unfortunately, this last one, was only possible for one of the years analyzed, for data availability reasons.

Regarding the data used, household surveys for the years 2010, 2012, 2014, 2016 and 2018 were used. The only data before the effective opening of the mobile telecommunication market is 2010. These surveys include data on type of internet connection, ICTs devices, perceived income, education, characteristics of the head of household and the house. As mentioned before, only the data for self-employed and employers within the first three quintiles of income was used. Another reason why the first three quintiles of income were selected is because many of the social programs of the government, including the ones related with ICTs, are for this population.

In addition, a recent survey on microbusiness was used, for this survey, people who claimed they had their own business in the household survey were interviewed again, been asked for specific information about their business. These businesses are characterized by being highly informal as well as not having their own premises in many cases. With data from the two surveys of year 2018, it was possible to merge them and have a more comprehensive analysis, including the use of the internet for business purposes.

The methodology used to analyze the impact of access to internet in the perceived income of the individuals was propensity score matching. This technique allows to create a control group similar in average to the treated group (people with internet connection) to calculate the effect of the treatment, then the average treatment on the treated is computed.

Regarding the results, it is important to point out that access do not necessarily mean use. Having that in mind, for the years 2012, 2014 and 2018, there was a positive impact of having access to the internet on the perceived income of the individuals studied. The effect varied by year, from 7% to 13% of the minimum salary of each year. However, it was not possible to find a difference by the type of connection. Finally, when analyzing the specific data on use, the impact was only significant when the estimations did not include the personal characteristics of the owner of the business, nor the network effects in the area.

From the policy recommendations, it stand out the need to improve the data collected regarding access and use of ICTs, both at household and business levels. Understanding how people use ICTs is fundamental to design public policies towards better and higher inclusion. Additionally, the government programs already in place which aim to close the digital divide, could be used to promote a "connected" self-employment and entrepreneurship, especially in times of high expected unemployment and informality, like the one we are living due to COVID-19.

The paper is structured as follows: first the interdisciplinary state of knowledge, which includes references to why people take the decision to "be connected" or not, the effects of reducing the digital gap on productivity, employment and inequality, as well as the relationship between access, use and income, and examples of similar studies conducted in Latin America. Next,

the case of Costa Rica is presented, the evolution of connection in the country, data on current gaps and why does it matter. Thirdly the information about the data used and the methodology. After that, the results and the main findings are presented; and finally, the conclusion and policy recommendations.

3. Interdisciplinary state of knowledge

There is vast literature about the impact of access to ICTs (Information and Communication Technologies) on economic growth and development, but less on the impact on households and individuals, as well as differences among the population. This has not been different in the specific case of the internet.

From a theoretic perspective, Bauer (2018) reviewed the link between access to internet and income inequalities. He highlighted that in conjunction with other factors, such as economic, technological, and political, access and use of ICT's can, both, increase or decrease income inequality. There is a known correlation between income inequality and digital divide, however causation is more difficult to prove: "*At the individual level, a mutually reinforcing dynamic links the level and quality of digital access of an individual or household with their income. Other things being equal, higher Internet access and use typically go hand in hand with higher income and vice versa*." (p.336). Furthermore, the role of economies of scale and network effects of ICTs and the internet should be considered.

Regarding the individual analysis behind getting access to the internet, Zhang (2013) examined the relationship between income, Gini index and the pattern of the internet diffusion curve (S-shaped), based on the Internet Consumption Model. He extended it applying concepts of the Diffusion Innovations Theory and the Technology Acceptance Model. He argued that since most of internet devices and services can be accessed through the market, then the logic behind market transactions should be used to study the access and consumption of internet: consumers make rational choices looking to maximize their utilities according to their budget restrictions, for each level of income, there is an equilibrium for the consumer. The perceived ease and usefulness of the internet play a role to determine the utility of acquiring the service or device, influenced by consumer's income and the internet's prices. *"there is a threshold in utility beyond which consumers will subscribe any kind of Internet Access*" (p.519). Furthermore: "*The Internet Consumption Model shows that even when people have different patterns of preference and face different prices, the individuals with high-income budgets will have higher possibilities to consume the Internet that those with low-income budgets" (p.525).*

Zhang (2013) recognizes that preferences influence internet consumption. In his model the perceived ease of use as well as the perceived usefulness of the internet are psychological determinants of preference; which can be influenced by the dissemination of information about the internet as well as accessibility and affordability, the last one being the fundamental influencing factor. Even if people can afford an internet connection, without accessibility their perceptions could be unclear.

Gruber and Koutroumpis (2011) also recognized the role the income of the users plays in the development and use of mobile telecommunication services. However they highlighted that from a demand perspective, not necessarily all the people with a mobile phone number are users of the service, especially in developing countries where pre-paid cards are common and might

remain unused for long periods of time, besides, some users might have more than one line. That is why they consider that mobile adoption is a proxy and not use itself.

Ono and Zavodny (2007) when studying digital inequalities in different countries made emphasis on distinguishing access from use, equal access does not necessary leads to equal use: "*creating access to computers does not guarantee that individuals have the necessary skills or desire to use them(…). Use presumes access, but not vice versa"* (p.1137). As factors that could inhibit people from using the internet, they mentioned misconceptions on what the internet and the applications have to offer, the complexity of use or master the applications, as well as the perceived benefits from using it. If a certain population considers that the benefits will be low, then they will be less likely to use the internet or the applications. Both, misconceptions as well as the expected benefits can be embedded in social constructions and related with economic inequalities; there was a strong correlation between digital and pre-existing inequalities. In the Asian countries that they studied, they found that even if the household had a computer, it did not ensure that women will use it. Regarding the internet, age, education and income were important factors that determined who used the internet; higher the age and lower the education and income levels, the less likely that individuals used the internet, in any of the countries studied. In the case of some Asian countries, there was also a gender divide, women were less likely to use the internet.

Other important factor that influence the digital divide is education. Cruz-Jesus et al. (2016) showed that more educated individuals are not only more likely to adopt new technologies and cope with technology complexities, but to be exposed to the use of them in their professional and personal environments; influencing level one and two of the digital divide. By analyzing differences among European Union countries as well as within the countries, they found that even in the best ranked countries in penetration and use, there are gaps between the high and low educated that should be addressed.

3.1 Effects on productivity, employment and inequality

ICTs have positive effects on productivity, influencing demand for capital and labor, which have an impact on remuneration and income distribution. These technologies promote higher division of labor but also more digital innovation; all of which results in the creation of jobs in both ends of the spectrum: high-paying jobs and low-paying jobs for low skilled people. Institutions and public policies mediate the interactions between ICTs, productivity changes, relocation of production and digital innovation. Overtime, the inequality produced by adoption of ICTs fluctuates, a technology will create less inequality once it reached a high level of adoption, with lower premiums in the labor market related with that specific technology (Bauer, 2018).

Various authors recognize the potential of fast broadband connection to households and business: it can enhance productivity and social and economic development (Gruber and Koutroumpis, 2011; Howell and Grimes, 2010; OECD, 2008; Prieger, 2013). For Madden and Savage (2000) this relationship can be illustrated by analyzing transaction costs and its impact on economic welfare: "*Modern telecommunications infrastructure reduces the costs of acquiring information, and improves the efficiency of product and factor markets. The direct productivity benefits that telecommunications infrastructure and traffic flows generate for*

information intensive sector such as the finance, wholesale trade, tourism, transportation, export and import sectors are well documented (…)" (P.3).

The latest has been illustrated by several authors in different contexts, for example, on the effects of broadband on productivity, Grimes et al., (2012) found in New Zealand that firms who adopted broadband connection had an increase in productivity of 7-10%, with no regards of the sector of activity or location of the firm within the country. More recently, Jung and López-Bazo (2020), studied the case of Brazil. They found that it is positive but not uniform across regions, dependent on quality of the connection as well as network effects, also the less developed regions have the higher productivity gains, which means that broadband could help regions converge.

In the case of Kenya, Mbogo (2010) applied the Theory of Technology Acceptance Model to predict success and growth in micro-business; she analyzed the case of mobile payments. She found that the convenience of this technology in addition to the accessibility, cost, support and security are related with the general feeling microenterprises have about mobile payment systems, wanting to use it to enhance their success and growth. This type of payment has revolutionized small business, allowing them to conduct more transactions more easily and without the need of leaving the business to go to the bank; furthermore it is affordable and it is not necessary to be a formal business to use it, neither to own a bank account. Shortly after the implementation of mobile payments, small business began to see benefits such as money and time savings as well as more access to new customers and services. A similar logic was used to promote mobile payments to support formal and informal microbusiness in Perú, looking to achieve not only financial inclusion but incentivizing formalization in the long-term (Marsili, 2013).

Regarding broadband expansion and employment, Kolko (2010) found a positive relationship in the United States, with a stronger relationship in technology-reliant industries. However, the growth in employment does not necessarily benefit local residents. In the areas and for the time frame analyzed, he did not find evidence that faster broadband expansion translated into higher employment rate or higher average pay per employee, relative to other areas.

In a similar line, Hjort and Poulsen (2019) studied the effect of the arrival of submarine internet cables in Africa in employment rates. In general, they found that there was an increase in employment, with bigger gains for higher-skill occupations. They used firm-level data to study the impact of fast Internet on employment. Their results contrasts with others, in this case, they concluded that fast internet "*decreases employment inequality in Africa*" (Hjort and Poulsen, 2019, p. 1035).

There have been different studies about the type and speed of connection, and the diverse impacts it can have. Gruber and Koutroumpis (2011) analyzed mobile telecommunications and the impact on economic development for 192 countries. Even though mobile penetration had a significant and positive effect on productivity in all countries, the impact was smaller for countries with low mobile penetration (usually low-income countries), which would suggest "*increasing returns from mobile adoption and use*" (p.391), with impacts on productivity growth. When mobile technologies become available, first it is possible to increase output as well as produce more quickly, due to the mobility benefits and information availability (there is an improvement in access to information, which reduces market failures). As a long run effect, the workforce is more productive. They identified the critical mass level at 30% of

mobile adoption. When this level has been achieved, economies earn more from the infrastructure already available, which is consistent with the theoretical implications of network externalities.

On the same line, Thompson and Garbacz (2011) focused their study on the direct effect (penetration) and the productive efficiency effect (network externality) of broadband technologies. They measured the impact of fixed and mobile wireless broadband usage on a per household basis on GDP per household for a developed country sample (2005-2009), which was positive for all the sample. However, they found that low income countries have more benefits from mobile broadband. Also, that mobile broadband is a significant driver of growth, reducing inefficiencies, especially in rural areas and developing countries where fixed broadband is scarce, helping to close the gap.

Similarly, Edquist et al., (2018) studied much later the impact of mobile broadband networks on global development. They did the analysis for 90 countries and found that mobile broadband had a statistically significant effect on GDP when it is first introduced (and adopted by a small percentage of the population), as well as through the process of diffusion in the economy. On average the increase of 10% in mobile broadband adoption results in 0.8% increase in GDP, in addition, there is evidence of a lagged effect. Controlling by the year of introduction, the effect over the economy gradually decreased over time, in average the economic effect had disappeared by year six. Furthermore, the effect of mobile broadband on GDP was much larger and significant in non-OECD countries, which on average had less broadband penetration before the introduction of mobile broadband. For the authors, mobile broadband can be a substitute for fixed broadband, but not the opposite, since mobile allows a faster distribution of information and ideas. This is why, many suggest that mobile broadband has allowed developing countries to leapfrog, reducing several transaction costs.

Regarding the gap between rural and urban areas Prieger (2013) studied case of the USA, where adoption in both areas have different rates, and in rural areas there are usually less providers and lower speed connection available. He found "*evidence that mobile broadband is helping to fill in gaps in fixed broadband coverage in rural areas*" (p.484); furthermore after controlling for demographics of households, rural ones are not in disadvantage in the use of mobile broadband. However, the rural/urban divide is more severe among low-income households, both for fixed and mobile broadband connections.

3.2 Studying the relationship between access, use and income

In recent years, more authors have addressed the impact of access to different technologies on the income level, with different levels of detail. For example, Rohman and Bohlin (2013) measured for a group of countries (some OECD, Brazil, India and China - BIC) the effect of broadband on household income. They did not only study the impact of access but if it was different according to the speed of connection, using Propensity Score Matching (PSM) techniques. They controlled by education, age, gender, type of education, type of housing, geographical area and marital status, as well as usability of ICT (internet and telephony for working purposes), and the access and speed of internet connection individuals have[1]. They

[1] They did two estimations, one in which they evaluated the impact of having broadband connection over not having one, and a second one, only with individuals who had broadband connections, but different speeds, to evaluate the impact of additional speed.

found that there is a minimum speed of connection necessary for the household to have a positive impact, which varied by country, with lower minimum speed in BIC countries; also the benefits from broadband are not linear nor continuous and households in more developed economies have more benefits result of upgrades in the speed of connection. They highlighted that fiber and cable connections have the greatest potential to deliver higher speed connections, while mobile broadband has been key to close the digital gap, especially in developing regions, it has limitations to provide high speed connections.

Another line of study was the one of Alam and Mamun (2017), who analyzed the impact of broadband internet in labor outcomes in rural Queensland, Australia; using as well PSM techniques. However, their results were not statistically significant, in contrast with what the literature suggest. The authors mentioned that there was a difference in the type of connection the rural households had, depending on copper, 3G and 4G mobile networks as well as satellite devices, along with a general dissatisfaction of the residents regarding the speed of the internet, which could had influenced the results. Furthermore, there might be benefits from broadband that were not fully captured by employment status or wage growth in the first stages of a network deployment. In addition, there is no evidence that the critical mass required to feel the impact of technology has been reached. Furthermore, due to the type of connections previously described, some of the economic benefits on employment from broadband technology, such as teleworking, e-business and video conference might not had been common yet in the area studied.

In the specific case of Latin America, Navarro (2010) studied the impact of internet use in different countries in the region, specifically Brazil, Costa Rica[2], Chile, Honduras, Mexico and Paraguay. He analyzed the effect only on men, differentiating between salaried full-time employees and self-employed[3] individuals. He used Propensity Score Matching techniques, controlling by education level, type of house, ownership of the house as well as ownership of PC at home, TV, telephone fixed line connection and satellite TV, occupation and sector of activity. He differentiated by rural and urban areas, in addition to where the individuals had access and used the internet (home versus office, for example). Costa Rica was the only country were the results for the self-employed were not significant; in the case of salaried full-time urban employees, the average treatment effect (ATT) of the use of internet in income was positive and significant in all countries but Paraguay. In the specific case of Costa Rica, the ATT for salaried men workers was a 24% increase in income. The author highlighted that the ATT obtained are higher that what the literature suggests for developed countries, which could be because internet had not reached a critical mass in Latin American countries and therefore the ATT could be reduced over time.

Fernández Machado and Medina Quispe (2011) measured the impact of access to ICTs (fixed and mobile phones and internet) at home in the income of households across Perú. They included variables regarding the composition of the household, characteristics of the house, region and of the head of the household. They found that internet was the technology that had the highest impact on the monthly income of households, however they recognized it was not

[2] The data used was from 2005.
[3] The analysis for Costa Rica includes both men and women.

as high as expected, mainly because there was a balance problem and not enough variation in the sample.

3.3 Policy perspective

As stated before, ICTs do not only promote the creative destruction process[4], these generate opportunities and new ways of value creation that promote economic growth and development, while forcing technological and economic changes. However, access to ICTs is not evenly distributed between nor within countries (even in the same region), therefore its benefits are not equally distributed among different populations. Furthermore, the benefits for those who have access are not automatic, there are many other factors involved that influence the way individuals interact with technology and get the potential benefits of it, both form a personal and economic perspective. That is why it is important to have suitable policies to not only guarantee access but benefits to all individuals; if it is not done, ICTs can be a tool to deepen social and economic inequalities (Balboni et al., 2011).

Due to increasing returns of scale, Gruber and Koutroumpis (2011) mentioned that there is strong evidence of welfare improving due to mobile telecommunications adoptions, benefiting not only individuals with direct access but those without it, since mobile telecommunications influence relationships across different sectors of the economy and improve the performance of those. This favorable impact has justified policies supporting diffusion, liberalization and private investments.

When revisiting what has happen in the telecommunication sector in the last two decades, Estache et al. (2002) highlighted the importance of effective competition and regulation in order for telecom reforms to allow everyone to benefit from the new economy. They found that an effective implementation of the regulatory agenda could accelerate the adoption of the internet, recognizing other important factors such as income level and access to primary infrastructure.

For example, looking at the process of liberalization and privatization in the telecom industry in OECD countries, Boylaud and Nicoletti (2000) studied the effects of the policies on productivity, prices, quality of services and mobile telephony services over a seven-year period (1991-1997). They found that prospective competition as well as effective competition result on productivity and quality improvements, as well as reduction in prices. In addition, the benefits of the reforms were usually large and quick.

In the case of developing countries, when analyzing telecommunications competition, privatization and regulation, Wallsten (2001) found an association between competition[5] and increases in per capita number of telephone lines, payphones, connectivity capacity, as well as lower prices of local calls[6]. One of his main conclusions was that "competition is the most effective agent of change" (P. 2). In addition, granting exclusivity periods to the incumbent telecom providers may delay the benefits of the reform to consumers. Later, Garbacz and Thompson (2007) highlighted the impact competition in mobile services have had in price and availability; identifying competition as one of the main three promoters of universal service, along with income growth and educational achievement.

[4] As explained by Schumpeter.
[5] Measured by the number of mobile operators that were not owned by the incumbent.
[6] His research was focused on Africa and Latin America.

According to Zhang (2013), countries, especially developing ones, should disseminate information about the usefulness and ease of use through economic channels, such as public education institutions and public broadcasting systems. Governments should also have policies in place to promote more accessibility and expansion of the telecommunication networks, such as stimulus or subsidizes to the infrastructure investments.

For Bauer (2018), the diffusion process should be accompanied by safety nets and public policies targeted to facilitate adaptation and retraining of workers[7], that in the medium and long run would help reduce the income inequalities associated with the increased use of ICTs. In high income countries digital innovations seem to create new high-skilled, high paying jobs, along with low-skilled, low paying jobs, which polarize the market, and at the same time shrinks middle paying jobs. The case of digital platforms, for example, could exclude a lot of people from the labor market, with winner takes all cases; but at the same time could create opportunities for new players and self-employ individuals to enter the market, that without the platform were excluded for several reasons.

3.4 Specifics on Latin America

As stated before, there are cultural and socioeconomic differences that can impact the use and access to technologies. This includes Latin America as a region, as well as within it. Regarding socio-economic determinants of ICTs in households in Latin America, Vergara and Grazzi (2011) found that income, family size[8], education, age, gender, area (rural versus urban) and cost of internet were key determinants of ICT diffusion. With income and education playing an important role in each country analyzed, being important drivers of adoption, especially in the earlier stages of the technologies.

About the area, there was a gap in urban versus rural households and evidence of geographical network effects and complementarities. In the case of geographical network effects, they found that "*households are more likely to own a computer and to have Internet access if a high percentage of people in their federative units have larger ICT penetration. Also, the magnitude of the network effects seems to be higher for Internet than for computer. This fact can be interpreted considering the nature of the Internet Technology itself, which is increasingly more useful as the Net is diffused in an area*" (Vergara and Grazzi, 2011: p.20). They believe there are positive local spillovers of existing users on potential ones, which could also play a role in reducing the costs associated with adoption, since individuals may have a friendly hand helping them to overcome faster the learning curve. However in the specific case of Costa Rica, they did not find that the use of internet at work affected the use of internet at home (Vergara and Grazzi, 2011).

Something different about Vergara and Grazzi (2011) research is that all the variables they used were from the household as a whole, they did not used household head characteristics. Claiming that in the case of developing countries household decisions are usually shared, since many of the members economically contribute to the household, therefore they can influence the

[7] According to the author, this scenario is more likely in low and middle-income countries and in rural areas.
[8] The size of the family was important since it is a proxy for potential users.

decisions[9]. Additionally, they highlighted the role having a computer at home plays; for example, it increases the probability of starting a new business, promoting entrepreneurship.

In the relationship between gender and internet use, Navarro and Sánchez (2011) found on average a gender divide against women in the use of internet in Latin America. The gap was higher in urban areas, in older women and at both extremes of the income distribution; however, these gaps do not seem to persist in the use of internet at work. Furthermore, women were more likely to use common access points as well as to use internet for education[10] and communication purposes, while men were more likely to use it for entertainment and e-commerce. They also found that women were less likely to use internet at home, for what they did not found any explanation. For them, the results are in line with the social constructions and characteristics of men and women. Nevertheless, in the case of Costa Rica, self-employed women used more the internet than self-employed men, which was not the case for salaried and employers.

Continuing on the topic of gender, Hilbert (2011) found that the reason fewer women had access and used ICTs was because of unfavorable conditions related with employment, education and income; by controlling for these variables, women were more active users of ICTs than men, especially with mobile technologies. ICTs represented concrete opportunities to reduce gender inequalities in the fields mentioned above and others, such as health services.

About patterns of use, Grazzi (2011) highlighted the fact that individuals who were online gained considerable economic benefits; specifically better access to information and knowledge, efficiency communication improvement as well as increasing technological skills, all of which are highly valued by the job market. It was not enough to have access to the internet, but the capability and interest to use it. In the specific case of Costa Rica, with 2005 data he found that income, education, being a student or employed and having internet access at home were positive determinants of internet use. The contrary was for being a woman, living in a rural area and being older.

There are different publications about the condition and accessibility of broadband connections in the region. In 2016 none of the countries in the region had more than 5% of its connections with speeds higher than 15Mbps; this contrasted highly with developed countries, who had almost half of its connections with speeds higher than 15 Mbps (CEPAL, 2016). Regarding use, the region in general has been well behind OECD countries, even though the gap has been closing, in 2015, it was still more than 25 percentage points, with a bigger dispersion within the region (CEPAL, 2016).

About affordability, Barrantes and Galperin (2008) studied how affordable mobile services were in Latin America. At the time, they found that the poor generally had pre-paid subscription, for which they paid a cost premium; nevertheless, it was in many cases lower than expected. Furthermore, even though low costs allowed low-income individuals to become mobile subscribers, the tariff structure limited and inhibited the services consumed by the poor.

[9] For the estimations of this paper, results were less biased when some characteristics of the head of the household were included.

[10] This is no surprise, since on average, women get more educated than men.

4. The Case of Costa Rica

Costa Rica is a small country in the middle of the Americas. With a population of five million people (INEC, 2018a), a high percentage of the expenditure[11] (as percentage of GDP) in education – 7% – (World Bank, 2018) and health – 7.3% – (World Bank, 2017); it is one of the countries in the region with the lowest poverty rates (World Bank, 2020), around 20%. However inequality has been rising in the last decades, with a Gini coefficient of 0.51 and an unemployment rate close to 12% (INEC, 2019).

During the last decades, the economy adopted a model that is highly dependent on exports and foreign direct investment. By the end of 2018, exports of services represented more than a third of the exports of the country (COMEX, 2019); exports of business service, telecom and IT overpassed tourism activity. Scholars mention that most of unemployed people are low-skilled, which makes it hard for them to find jobs in the service exports economy, as today one of the most dynamic ones. There is an increasing duality in the labor market: traditional sectors (domestic oriented and manufacturing) employ low-qualified workers, while the export oriented (higher value manufacturing, services and technological) employ high-skilled labor: there is a high-skills wage premium (González-Pandiella, 2016).

On the education part, less than one-third of young adults (25-34 years old) have attained tertiary education[12] and more than half of young adults had not graduated from secondary education in 2018. However, there is a higher percentage of women with higher education than men (31% versus 25%) and the earnings gender gap among tertiary -educated adults is smaller than the OECD average (OECD, 2019).

Regarding access to ICTs and adoption, according to Global Competitiveness Report of the World Economic Forum, Costa Rica is in the position number 7th in mobile-cellular telephone subscriptions[13] (169.9%), 33rd in mobile broadband subscriptions (97.2), 58th in fixed-broadband internet subscriptions (16.6%), 80th in fiber internet subscriptions (0.4%) and 57th in percentage of the adult population that are internet users (74%) (World Economic Forum, 2019).

The adoption of mobile and internet connections was propelled by the opening of the telecommunications market in 2007[14], which before was a national monopoly. It came with big changes, some of the biggest were in the mobile services, with the introduction of prepaid sim cards and plans, as well as a broader range of post-paid options. Part of the transformation included the creation of a technical institution named SUTEL, who is in charge of regulating the telecom market, and is financed by the different operators. Furthermore, a national telecommunication fund (FONATEL) was created, to be administrated by SUTEL and develop programs that would allow universal access to telecommunications (with special emphasis on internet), reinforcing the principles of universality, solidarity and transparency on which the reform was made (Monge Zeledón and Pérez Sáinz, 2013).

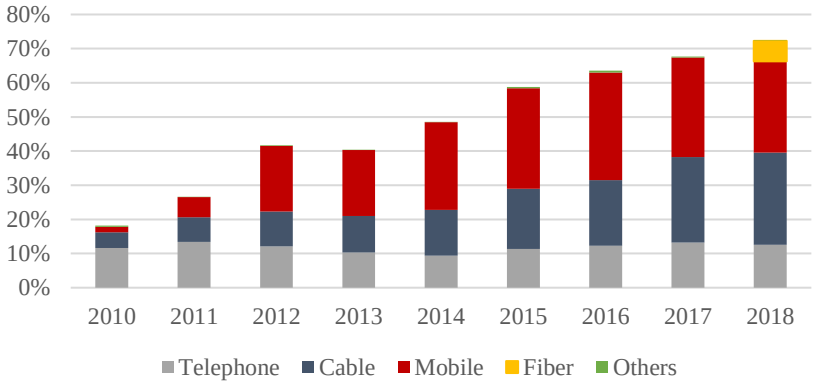
[11] This refers to government expenditure.

[12] Those with tertiary education earn at least twice as much than workers with secondary education (OECD, 2019)

[13] All subscriptions are per 100 population.

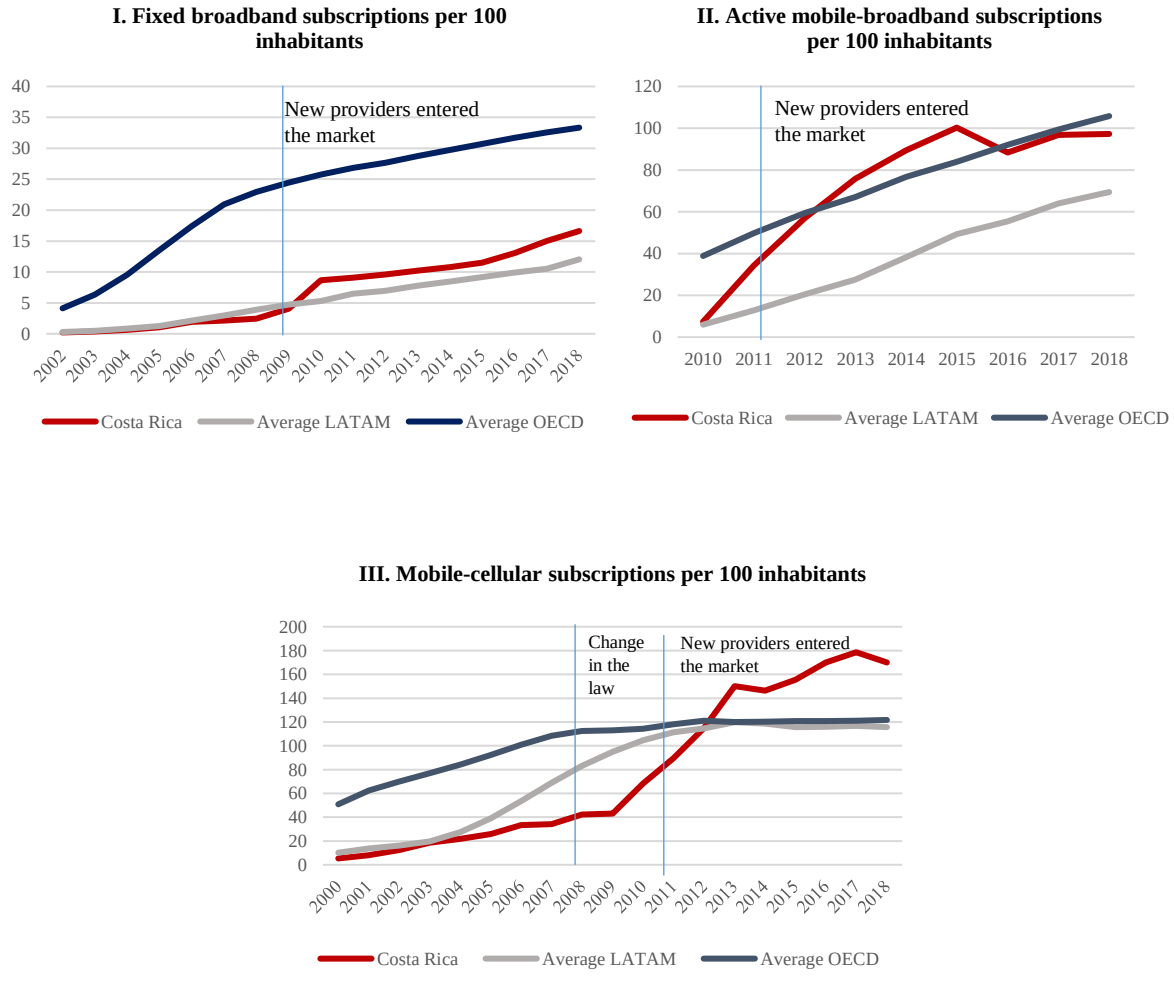
[14] The opening of the market was effectively for fixed services in 2009 and mobile services in 2011. A more in dept detail of the story of the reform is presented in Annex 1.

Figure 1. Costa Rica: Household access to the internet, by type of connection and year.



Source: INEC (2010, 2014a, 2014b, 2014c, 2016a, 2016b, 2017, 2018a)

Figure 2. Subscriptions per 100 inhabitants

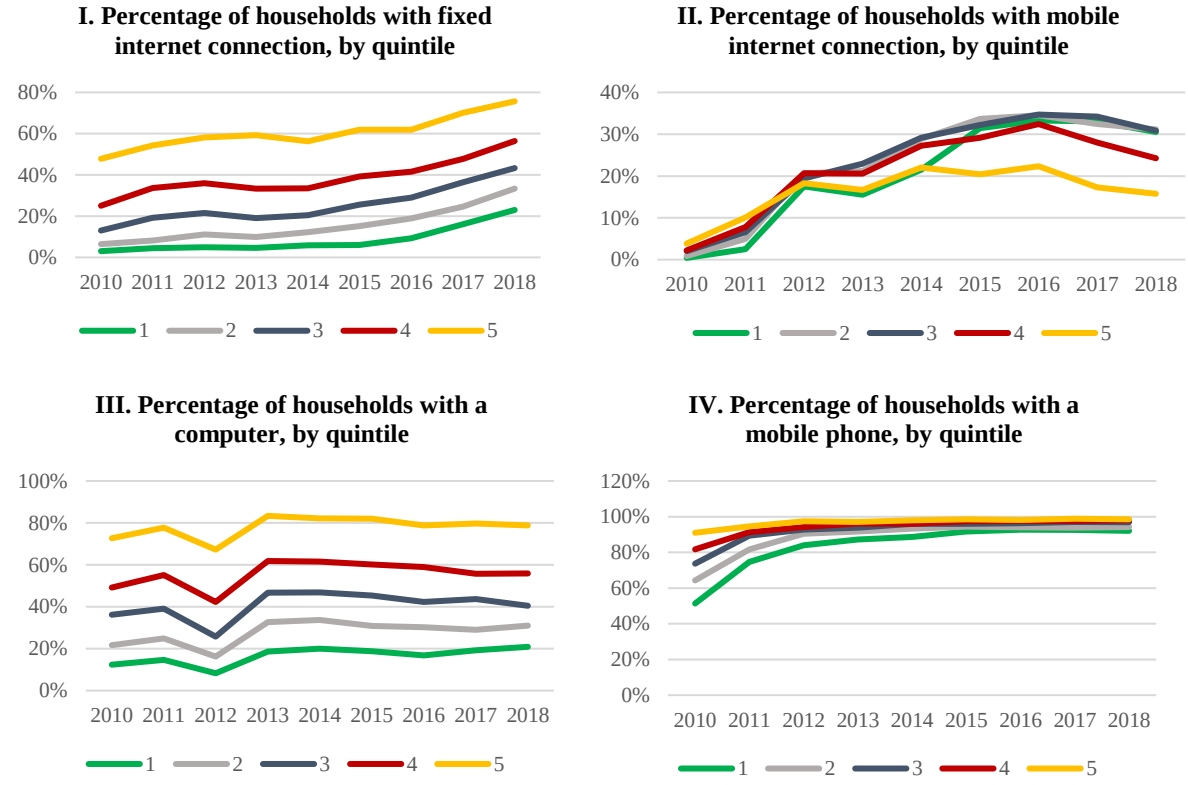


Note:
LATAM is the simple average of Argentina, Belize, Bolivia, Brazil, Chile, Colombia, Costa Rica, Ecuador, El Salvador, Guatemala, Honduras, Mexico, Nicaragua, Panama, Peru, Uruguay and Venezuela.
Source: ITU (2019).

Figure 1 presents the percentage of households with internet access and the type of connection they have; mobile access has been a strong component since the opening of the market. In addition, figure 2 shows the evolution in broadband and mobile subscriptions. Once the telecommunications law was approved a small increment in subscribers to fixed and broadband internet can be seen. In both cases the increment was bigger once new providers entered the market[15]. The case for mobile subscriptions is the most dramatic one, where in 10 years mobile subscriptions grew more than 4 times, not only closing the gap with other countries in the region, but OECD countries and surpassing it; becoming one of the countries with the highest mobile-cellular subscriptions per 100 inhabitants[16]. Nevertheless, not all mobile subscribers are connected to the internet, in 2018 the percentage was 57%, much lower than high-income countries and other Latin American, such as Uruguay, Bolivia, Mexico and Chile (ITU, 2018).

However, the distribution among quintiles of income has been unequal, with certain particularities, as it is shown in figure 3. As can be seen all quintiles have gained access, but, fixed internet connections continue to be dominated by higher income quintiles, while mobile internet connections[17] are more common in lower quintiles. The ownership of computer has remained stable over time, though, in the case of mobile phones, a conversion towards a 100% of the population can be seen in all quintiles[18].

Figure 3. Costa Rica. Percentage of households with different technologies, by quintile



Source: INEC (2010, 2014a, 2014b, 2014c, 2016a, 2016b, 2017, 2018a)

[15] It is important not to assume that all the growth was due to the opening of the market, as has been proven in other countries of the region (Ovando and Olivera, 2018).
[16] According to ITU (2018) data, in 2018 the country was the first one, followed by Lithuania and Uruguay.
[17] As the main source of connection.
[18] This number should be used with caution, there are more phone lines than people. Nevertheless, there is still a small percentage of the population without access to a mobile phone or line.

Within the region, Costa Rica was one of the countries with the highest percentage of households with internet access, during the period 2010-2015, all the quintiles gain access; being also in 2015 the country in the region with the highest percentage of people with access to mobile broadband. Regarding affordability, prepaid services play an important role, with minimum tariffs close to 2% of the minimum legal wage in Costa Rica, one of the lowest in the region by 2016. However, in terms of quality, and speed of connection, the country is well behind others (CEPAL, 2016).

There have been different reports and studies about the digital divide and gaps in diverse groups. For example, PROSIC[19] every year publishes a report about different aspects of ICTs in the country; analyzing the use by the government, households, productive sectors, banking, among others. They have highlighted that even though mobile broadband connection is more accessible after the opening of the market, the cost is still high and the quality low compared with international trends (Programa Sociedad de la Información y el Conocimiento PROSIC, 2014). Additionally, they recognize that even after opening the market to competition, there are still gaps in the democratization of the technology, with one in four households without access to the internet. For the researchers it has do to with illiteracy, costs and infrastructure (Programa Sociedad de la Información y el Conocimiento PROSIC, 2019).

4.1 Gaps and actions

In 2016, PROSIC began studying the multidimensional digital gap. They found that households in rural areas, of lower resources and lower education level did not have the same access and opportunities that the rest of the country. With data from the household surveys, they analyzed socioeconomic and demographic factors that impacted the digital gap, including in their research the disparity concerning ownership of mobile phones, computer and access to the internet. They found that the biggest difference is seen in the access to the internet, where the richest households (fifth quintile) have 5,67 times more chance to have internet access than the ones in the first quintile. Regarding the head of the household, those households with a female head had a 27% less chance of having a computer at home (Programa Sociedad de la Información y el Conocimiento PROSIC, 2016).

Continuing on the gender gap, there is a recent report that revealed details on it from the perspectives of access, use[20] and professionalization (Ministerio de Ciencia, Tecnología y Telecomunicaciones, 2017). By 2016, there was still a gap in access to computers that was positive in almost all the regions of the country. When studying it by income level, the two quintiles with the highest income had almost no gap, the gap was the biggest for the third

[19] Information and Knowledge Society Program

[20] In general, there is very limited information and data about the use of technologies by Costa Ricans. There is one survey conducted in 2016, that allows to make some national and stratum inferences. This survey confirms that pre-paid services are more common among people with 18 to 24 years old, as well as people older than 45 years, especially those less educated and within lower income groups. Around 82% of individuals who earned less than 250,000 colones (a little less than $500. Less than the minimum wage in 2016) had pre-paid services. People move to postpaid plans with higher income, the plans usually include mobile internet and do not necessarily use it as a substitute for fixed internet connections. Almost 80% use a mobile phone to access the internet, followed by 68% who use a computer. 92% of people use internet every day or almost every day; around 68% use it to get information about goods and service, 66% about health, 75% emails, and over 80% for social media and entertainment. Regarding the mobile apps more used, more than 90% use WhatsApp and 78% Facebook. Go to Annex II to see the evolution of type of subscription to mobile services over time.

quintile. Similar was the case controlling by education level, the higher the level of education of the head of the household, lower the gap. In case of age, for households with a head younger than 35 years old, the gap was negative, it increased considerably for households whose head was 45 and older. The trends were similar in the case of mobile phones. For fixed internet access, the gap grew after 2011 and decreased in 2015. It is interesting that by 2016 quintiles two, three and four had a negative gap. In addition, households' heads with no level of education had a negative gap. However, by quintile, the ones belonging to the first and fifth quintiles had a negative gap in the case of mobile internet.

Regarding use, women use more ICTs in activities related with care: such as medical appointments, search for medical and health information, while men use it more for work related activities (email, professional networking, applying for jobs, get information about goods and services) education (online courses, learning platforms, read, eBooks) content production (online storage, social media, manage personal web pages), political participation and entertainment. In the case of communication, social media is the only category where the difference is no significant. Even though in average, women are more educated than men, there are less women in STEM areas, as is the trend worldwide (Ministerio de Ciencia, Tecnología y Telecomunicaciones, 2017).

It is important to mention that in conjunction with opening the market, the government launched different programs and initiatives to reduce the digital gap. For example, the goal to develop a solidarity broadband[21], since broadband is more accessible in the metro area (Rectoría de Telecomunicaciones libro 2, in Monge Zeledón and Pérez Sáinz, 2013). All the initiatives in this area are conducted by FONATEL. Through FONATEL, the government aims to provide of free internet access to public health centers, "intelligent" community centers (CECIs), public schools and high schools, as well as subsidize access to broadband fixed connections for poor families (quintiles one, two and three)[22]. They do it by covering the infrastructure costs of "connecting" the different communities and centers, with special attention to promote connections in rural areas and prioritized districts defined by IMAS[23]. In the case of the subsidy to the families, they cover a percentage of the internet bill for up to 6 years (SUTEL, N.D.).

FONATEL performance has been highly criticized, since the development of the projects is very slow. Not only in the adjudication processes to bring connection to rural communities, but in monitoring for compliance and sub execution of the funds available (Lara, 2019). There has not been impact studies on the subsidy to poor families either, according to FONATEL's data more than 67 000 families were subsidized by the end of 2018 (SUTEL, N.D).

In addition, the government has different programs towards the reduction of poverty and unemployment. One of the most recently announced by INA[24], mentioned that more than 250 certification courses were going to be available online, free of charge and the only requirement was to have access to the internet (Cerdas, 2019). Even though, data shows that a higher

[21] This would be possible through three different programs: Cerrando Brechas (program by the Ministry of Education), CECIS 2.0 (by the Ministry of Science and Technology, aimed to transform community centers) and Connectivity to CEN CINAI (by the Ministry of Health, CEN CINAI are centers who support poor families, with nutrition and child care, and also support pregnant women and women in nursing period.).
[22] Families can also get a subsidized computer.
[23] Institution in charge of social assistance (in Spanish: Instituto Mixto de Ayuda Social).
[24] National institution in charge of education for adults, mostly technical certifications.

percentage of people have access to the internet each year, it is not universal yet; meaning that programs like this one could result in a bigger digital divide.

There are different government and academic reports on how the digital gap has evolved over time and a few surveys have been conducted on the different uses of technology. As well as anecdotical evidence, on how it is more difficult for lower income households and women to access technology and the benefits on better job opportunities it can represent (Ordoñez Laclé, 2011). However, there is no recent research on the economic impact access to technology can have and the limitations digital divide could impose for the excluded.

4.2 Why does it matter?

As stated before, inequality is growing in the country. Even though there are trainings and social programs to help address income gaps, if the digital gap is not reduced, it is unlikely that inequality will do as well with the digitalization of the global economy, and Costa Rica following that trend. Moreover, the access to the internet was declared a basic human right by the constitutional court of the country in 2010, arguing that internet is an indispensable and necessary vehicle to "transit in the information society" (Soley Gutiérrez, 2010). Additionally, in 2011, United Nations highlighted the role governments should have in developing effective policies to attain universal access to the internet (United Nations, 2011). Without adequate policies, gaps will continue and grow, perpetrating disadvantage situations. Furthermore, having no access impacts economic development and "enjoyment of a range of human rights" (United Nations, 2011: p.17) like access to knowledge, education and freedom of speech.

Today we are living a global health pandemic, with many social and economic implications. Due to the pandemic, many businesses were forced to close the attention to the public, to prevent the spread of the disease, raising unemployment. Since the health and economic panorama are uncertain, demand for many goods and services has reduced. In addition, many of the ones who keep offering goods and services have had to reinvent, in order to work with the movement restrictions imposed. This has showed the gaps in connectivity, in all sectors, and stratums, with specific attention on lower quintiles.

As reported by The Economist (2020), worldwide and Costa Rica is not the exception, COVID-19 is having a similar effect to the one SARS outbreak of 2003 had in China, helping accelerate and embrace e-commerce. However, it is more difficult for those without similar practices in place earlier.

As stated by the Interamerican Development Bank (Nuguer and Powell, 2020), the objective of the public policy in this circumstance should be to complement the partial closure. Among others, it should incentivize and support companies to remain open and keep their employees.

According to CEPAL (2020), the unemployment rate in Latin America will increase 3.5 percentage points, reaching to 11.5%; with 37.7 million people unemployed. The Interamerican Development Bank also estimated how the pandemic will impact employment in Latin America. The high informality which characterizes the region will increase, furthermore, sector activities[25] will he highly impacted. The more service oriented and open an economy, higher will be the impact in the labor market, which is precisely the case of Costa Rica. The estimates suggest that there will be a fall of formal jobs between 8% and 22%, depending on the length of the crisis. This will significantly increase the informality in the labor market. The

[25] Including commerce, restaurants, hotels and transportation.

organization recognizes that there is a gap in the region regarding the capabilities of companies and households to adopt a higher rate of work from home and digitization of services. Therefore, part of the measures after the sanitary crisis should be focused on enhancing structural policies that promote and develop new markets; digitization and work from home in all the sectors where this is possible (Azuara Herrera et al., 2020).

Furthermore, an online survey conducted during the month of April along the region, found that 57% households with small business closed their business because of the pandemic. This percentage is much higher than the one in other regions, which is a representation of the vulnerability of small business in Latin America. Lower income households are overrepresented in employment lost rates and closure of microbusiness, which will increase inequality in the near future. Some of the reasons for this overrepresentation is the impossibility to work from home, because of the nature of the job, as well as the gap in access and knowledge on different technologies. Additionally, many of these small business are informal and concentrated in sectors such as services and commerce, which, as stated earlier, are more vulnerable in this crisis (Bottan et al., 2020).

As an illustration of the stated above, 36% of the people in Costa Rica who applied for the government's funds[26] to help the ones who lost their job because of the pandemic, are independent workers, and 22% informal workers (Mora, 2020). On the other side, the national mail company reports that micro and small business have tripled their package shipments in the first three months of the pandemic. The institution has a platform specific for small business who use their service, with lower rates and national coverage. (Lizano-Jiménez, 2020).

There is evidence that even micro and small business who use online banking do not take the most of it, and many of them do not accept online payments (Gudiño, 2019). The government has launched several initiatives in the last years to promote e-commerce in micro, small and medium companies, one of them is to provide free of charge access to a platform (Kolau) that allows them to create a webpage and sell their products and services online. This service is available for formal and informal business (El Economista, 2020). According to INEC (2018b), less than 5% of all surveyed companies had a web page, and in the first three quintiles it was even lower: around 1%.

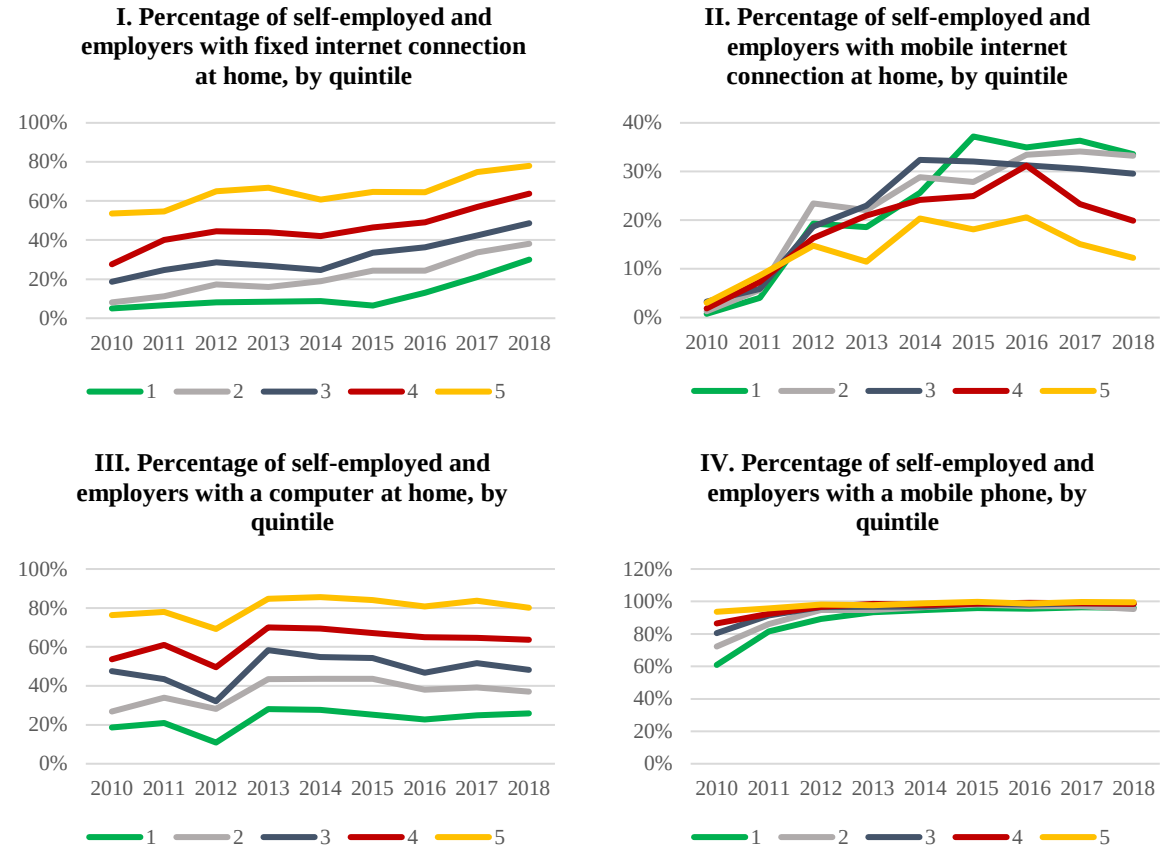
More than 15 years ago, Lee (2004) analyzed the effect free computer classes had on a group of women, many of them entrepreneurs. All of them reported feeling empowered and thankful for the opportunity, many of them applying their new knowledge not only to their business but to their personal life. However, a major obstacle back then was access to the devices and internet connection, as well as further training for them and other women in this and other areas. This was an isolated program, that covered 100 women that did not really addressed social change.

4.3 What has been like for self-employed and employers

Figure 4 shows that the trends in type of connection, as well as devices, are similar to the ones of the whole population (figure 3) in the case of individuals who are self-employed and employers.

[26] The funds were specifically put in place to help people who lost their job or a high percentage of their income due to the pandemic. It is called "Bono Proteger", and it is a subsidy for up to three months. In order to receive the subsidy, people should prove that their income was affected by the pandemic and comply with the prerequisites to be part of social programs, such as belonging to the first 3 quintiles of income.

Figure 4. Costa Rica: Percentage of self-employed and employers with different technologies, by quintile.



Source: INEC (2010, 2014a, 2014b, 2014c, 2016a, 2016b, 2017, 2018a)

Going further, with data of self-employed and employers from 2018, it can be seen in figure 5 that more than 80% of business have at least one mobile phone they use for working. Computers and fixed internet connection are more common in microbusiness with higher income owners. The use of tablets is lower than 10%.

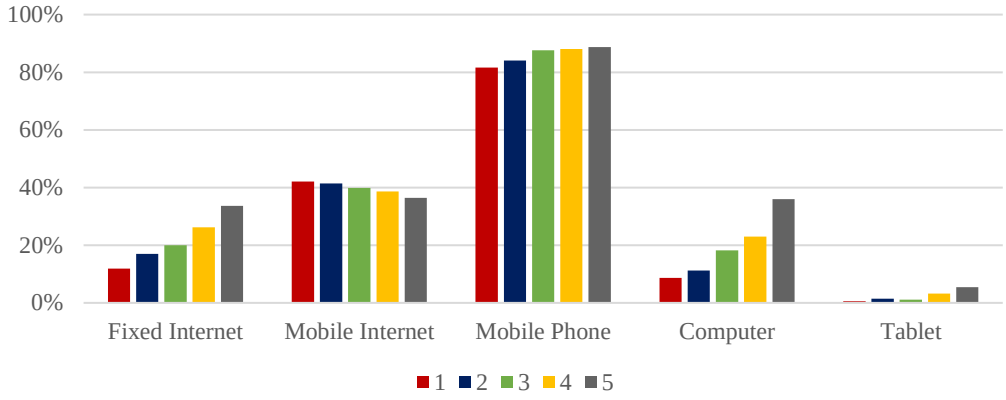
Regarding the type of use, figure 6 shows the more common uses are customer service and email and messages. The percentage of business who use of internet to buy goods and services from their providers (sourcing) is lower than those who receive orders from their customers. The government procedures percentage is very low, in all quintiles lower than 10%.[27]

Additionally, is important to have in mind that more than half of the microbusiness included in the microbusiness survey by INEC (2018b), who belong to individuals from the first three quintiles of income, do not have any condition of formality[28].

[27] This would be expected to change in the following years, especially for formal microbusiness, since the government is transitioning to digital procedures in many areas. For example, over the past years the Government has launched e-Government programs and initiatives, some of the latest include as requirement to have a digital signature and submit some of the paperwork online only.

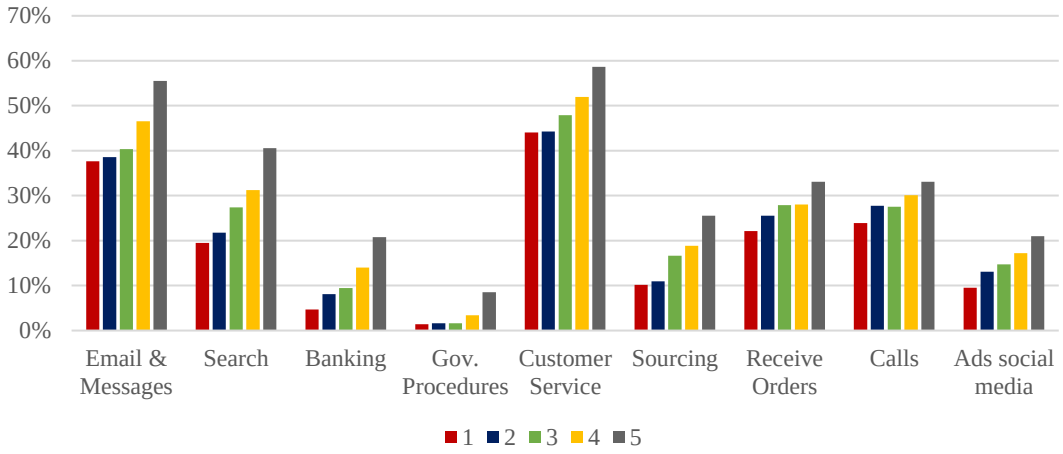
[28] This means these microbusinesses are not registered at least before social security nor the fiscal institutions. Depending on the activity other registrations are mandatory, for example before the Ministry of Health, the local government or a professional board.

Figure 5. Costa Rica: Microbusinesses' type of access to the internet, by quintile of the owner.



Source: INEC (2018a, 2018b)

Figure 6. Costa Rica: Microbusinesses' use of the internet, by quintile of the owner.



Source: INEC (2018a, 2018b)

5. Methodology, data and sources

5.1 Data

In order to analyze the impact of access to the internet on individual earnings, data from Household Surveys (ENAHO) was used, for years 2010-2018 (INEC, 2018c, 2016b, 2014a, 2014b, 2010). The National Institute of Statistics and Census (INEC, by its initials in Spanish) conducts these surveys every year. An additional survey was used, whose population of analysis are the individuals who reported in ENAHO that they have their own business, the survey is called National Survey on Microbusiness (ENAMEH for its initials in Spanish), for the year 2018[29](INEC, 2018b). The units of observation are individuals who claimed to be employers or self-employed and whose household are in the first three quintiles of income, for the period of study. The dependent variable is the total gross income per month per individual.

[29] The first edition of the survey was on 2017, there was a previous one in 2014 but it is not entirely comparable.

ENAHO

The total number of observations are shown in table 1. As can be seen in the period analyzed the percentage of self-employed and employers from the quintiles 1 to 3 with access to an internet connection at home grew, especially with mobile ones. This can be explained because of the opening of the telecommunication market to competition; mobile subscriptions grew nationwide since the end of 2011.

Table 1. Number of observations in the sample of ENAHO (2010-2018), per year

	2010	2012	2014	2016	2018
Total Sample	41,116	39,349	38,353	36,922	35,022
Quintiles 1-3	29,850	28,651	24,811	23,083	23,306
Economic Active	11,150	11,288	10,661	9,860	8,853
Self Employed & Employers	2,713	2,666	2,511	2,159	2,105
%	24.3%	23.6%	23.6%	21.9%	23.8%
Self-employed & Employers Quintiles 1-3					
Internet connection at home	325	1,004	1,149	1,245	1,488
	12.0%	37.7%	45.8%	57.7%	70.7%
Fixed connection[1]	275	456	426	518	809
	10.1%	17.1%	17.0%	24.0%	38.4%
Mobile connection[2]	46	544	722	719	678
	1.7%	20.4%	28.8%	33.3%	32.2%
Electronics at home[3]	813	601	1,035	880	854
	30.0%	22.5%	41.2%	40.8%	40.6%
Mobile phone at home	1,910	2,484	2,410	2,091	2,036
	70.4%	93.2%	96.0%	96.9%	96.7%
Fixed phone at home	1,597	1,338	1,021	743	507
	58.9%	50.2%	40.7%	34.4%	24.1%

Notes:
[1]It includes connections by fixed phone, coaxial cable and fiber. Fiber is only included for year 2018.
[2] It includes connection by SIM cards.
[3] It includes computers (laptops and desktops) and tablets. Tablets are included from 2014 onwards.
Source: INEC (2018b, 2016b, 2014a, 2014b, 2010)

Table 2 shows the growth in internet access for self-employed and employers during the period of study by different subgroups. By area for example, the gap has been reduced mainly by mobile networks. It can also be seen how the differences by gender are not high; connection appears to be slightly higher in the case of women. Regarding age groups, the sample was divided based on the different generations identified in the country, this classification is the result of a research about behaviors, opinions, interests and lifestyle of the population according to their year of birth (Sanabria et al., 2017). The authors recognize that the classification is more than a segmentation of ages, it is defined by economic, social, cultural and political structures, which is particularly useful in the context of adoption of technology; the explanation of the generations is shared in table 3. Finally, it can be observed a clear correlation between education level and access to internet, the higher the level of education, higher will be the percentage of individuals with an internet connection, prioritizing a fixed connection.

Table 2. Number of observations with and without Internet by area, gender age group and level of education (ENAHO 2010-2018)

	Number of Observations[1]		With Fixed Internet Connection		With Mobile Internet Connection	
	2010	**2018**	**2010**	**2018**	**2010**	**2018**
Total Observations	2,713	2,105	10.1%	38.4%	1.7%	32.2%
By Area						
Urban	941	1,319	16.9%	48.3%	1.6%	28.3%
Rural	1,772	786	6.5%	21.9%	1.7%	38.8%
By Sex						
Male	1,968	1,400	9.8%	37.5%	1.4%	30.3%
Female	745	705	11.0%	40.3%	2.6%	36.0%
By Age Group (Generation)						
AM	96	21	4.2%	4.8%	0.0%	4.8%
Pregonera	812	492	7.9%	27.8%	1.2%	24.6%
Satelital	1,423	1,026	12.2%	43.3%	1.8%	32.3%
Digital	382	551	8.6%	40.5%	2.6%	39.2%
Virtual[2]	n.a	15		26.7%		60.0%
By Level of Education[3]						
Less than Primary School	1,290	882	6.1%	33.2%	1.0%	32.1%
Primary Education	1,003	787	9.5%	34.7%	1.7%	34.1%
Secondary Education	305	295	19.0%	47.1%	3.9%	33.9%
Tertiary Education	114	141	37.7%	73.8%	3.5%	19.1%

Notes:

[1] Observations are restricted to self-employed and employers in quintiles 1 to 3.

[2] There are no self-employed or employees of this generation in 2010. In 2010 Virtual Generation was less than 10 years old.

[3] Some observations are missing, because the education information is missing from the database.

Source: INEC (2018b, 2016b, 2014a, 2014b, 2010)

Table 3. Generations

Generation	Year of birth	Age range in 2010	Age range in 2018	Technology and communication characteristics
AM	1924-1939	**71+**	**79+**	The radio is their main source of communication and information. In general, have low access to internet and advanced technological devices.
Pregonera	1940-1960	**50-70**	**58-78**	The printed press is key for them. They have more access to advanced technological devices than AM, but their relationship with social media and apps is weak.
Satelital	1961-1981	**29-49**	**37-57**	Transition generation. Relies on printed press but is also "connected". They have adopted new technologies, use social media and apps.
Digital	1982-1999	**11-28**	**19-36**	Social media and internet are their main tool of communication. Surrounded by technology. Heavy use of social media and apps.
Virtual	2000 onward	**-11**	**-19**	Connotation: reality in transformation. Surrounded by technology. Heavy use of social media and apps, and early adopters of new media and functionalities.

Source: Sanabria et al. (2017)

ENAMEH

As mentioned before, the survey ENAMEH 2018 was conducted as well by INEC (National Statistics Institution), based on the answers provided in ENAHO 2018. Less than 6 months later, they re-interviewed all the households who mentioned in ENAHO that any of its members were self-employed or employers. The objective is to have more information about these types of business, where informality is usually high. Is important to keep in mind that not all the respondents of ENAHO who are self-employed, or employers are also respondents of ENAMEH for a variety of reasons, some are not available at the time of the interview, while others are not included to maintain the balance of the sample. Furthermore, to be included in ENAMEH, the microbusiness must comply with at least one of the following characteristics: 1. not registered as a business at the National Registry nor having a legal name; 2. do not have formal accounting books to quantify the income and expenses of the company; and 3. the owner of the business do not have a fixed income assigned for his job (INEC, 2018b).

Since ENAMEH is based on ENAHO, it was possible to identify the respondents of ENAMEH based on different variables present in both surveys, such as the primary sampling unit number and double checking by age and education level. Of the 1,142 individuals who reported to be

self-employed or employers in 2018 and whose households' income classified them in the first three quintiles of income, 94 had more than one economic activity (most of them two and fewer three). In those cases, the data used was the one from the activity that generated higher earnings, the other was discarded.

Is important to mention that the data on earnings and income (ENAMEH) and personal income (ENAHO) is not necessarily the same. In the first case it refers to the income and earnings of the business, while in the second one is the one the person perceives. These could differ due to various reasons, for example the number of employees, how much they invest in their business, as well as one of the characteristics of these type of business mentioned above: they do not have a fixed salary assigned for their job. Both are measured on a monthly basis (monthly average). That is why, the income that is used to calculate this impact is the one reported in ENAHO 2018 for the activity included in ENAMEH.

One of the main advantages of the data from ENAMEH is that the individuals are not only asked if they have internet access, but if they use it for the business, and the types of use. Therefore, this allows to measure the impact of using the internet on the earnings of the person. In this case is important to mention that all the people who claimed that have internet access for their business, alleged as well to use it for at least one task related with the business (presented in figures 5 and 6).

5.2 Hypotheses

According to the literature review previously presented, the following hypotheses will be studied:

1. Having access to the internet at home, results in higher income for self-employed and employers.
2. The impact of having access to the internet has varied overtime. It could be higher due to higher network effects, or lower, in case that the percentage of microbusinesses adopting it is higher than the gains in network effect.
3. The impact on income is higher for those homes with fixed internet connection than those who rely on mobile connections.
4. When measuring the impact of use of the internet in microbusinesses related activities (ENAMEH data), the gains from the use of the internet will be higher.

5.3 Empirical strategy

Previous data presented showed that there has been a sustained increased in adoption on internet connections at home in general, as well as in homes of self-employed and employers. As the literature suggest, there are many factors that can influence the internet access by households, one of the main ones is the income. The relationship between income and access to technologies (in this case internet access) can be both ways.

Table 4 shows that households with access to internet have on average higher income. There is a difference among households with and without internet access, as well as the type of internet access they have. However, the differences shown in the table might also be explained by other variables. It is not correct to assume that the differences between the groups are because of the access to the internet, they are many other factors that not only affect the gross income but the

decision on whether or not have an internet connection, and these should be taken into consideration.

For example, as the literature suggests, there is a strong relationship between income and education, as well as income with wealth (represented in this case, by the ownership of the house among others). Furthermore, it is important to control by the factors that influence the decision of having access to the internet.

Table 4. Average gross income per month, for self-employees and employers, quintiles 1 to 3, (ENAHO, 2010-2018)

In Costa Rican colon[30]

	2010	2012	2014	2016	2018
No internet connection	143,596.2	140,416.7	138,647.2	140,167.2	135,082.4
Internet connection[1]	217,151.3	204,146.2	206,071.1	190,972.7	190,756.4
Fixed connection	220,898.9	240,502.5	247,562.2	223,189.6	213,811.2
Mobile connection	194,442.6	173,211.9	181,393.4	168,497.0	163,159.4
Minimum salary[2]	206,045.0	235,287.0	266,942.7	288,386.7	300,255.8

Notes:
[1] Type of internet connection (fixed or mobile) refers to the main source of internet connection in the household.
[2] The minimum salaries data correspond to the salary established for the private sector in the first semester of each year. The salary shown is the one generic per month for non-qualified workers.
Source: INEC (2018b, 2016b, 2014a, 2014b, 2010); MTSS (2017, 2015, 2013, 2011, 2009)

The variables used to match the observations and control include personal aspects, work-related, characteristics of the house, as well as ones of the head of the household[31] and others that might be related[32]. In the case of personal aspects were included: years of education[33], gender, age (by generation, as explained in table 3), if he or she speaks a second language and the role of the individual in the economic support of the household. The literature emphasizes the role education and age can play in the use of technologies, as well as the proficiency in a second language, especially English. The work-related variables analyzed are the sector of activity, the occupation, if he or she works from home or not, as well as if he/she is self-employed or an employer.

Then the other variables are related with the household environment, for example area, the percentage of households with internet in the same region (to control for network effects[34]), the type of housing, as well as quality issues regarding it, ownership of the house and connection to electricity. The characteristics of the head of the household that were included are years of

[30] Later on it will be referred as "colones".
[31] There are mixed opinions about the role of the head of the households in the decision of acquiring technology in Latin America, since in most cases, all the people who live in the same house and has a job contributes with the expenses (Vergara and Grazzi, 2011). However, estimations were made with and without the characteristics of the head of the household and bias was reduced when these were included.
[32] The list of variables used is in Annex III.
[33] Bias was lower using the number of years instead of classifications by track completed.
[34] Vergara and Grazzi (2011) found that network effects, particularly in internet connection in the area are strong in Latin America, including Costa Rica. Reinforcing the idea that there are local positive spill overs of technology adoption.

education, age (by generation) and employment status. Also related with other members of the household, the presence of specific age groups was included, like school and high school aged kids who can influence positive the probability of having access (Vergara and Grazzi, 2011 & Fernández Machado and Medina Quispe, 2011). There are also dummies for ownership of electronics (laptops, desktops or tablets), mobile phones and subscription to cable or satellite TV. Finally, information about the primary sample unit as well as the expansion factor were included, this is recommended to be able to generalize the results to the rest of the population (DuGoff et al., 2014).

In order to compare the groups with and without internet connection, the method Propensity Score Matching (PSM) was used. This method allows to create a control group based on observed characteristics. Each treated individual (with internet access) is compared with one not treated (without internet access) whose characteristics are similar in average, therefore the only difference between the individuals is the treatment, and this is what allows to isolate the effect (Dehejia and Wahba, 2002). Which is helpful to reduce the bias. It can be represented as follows:

$$E\ (Y_i^1 - Y_i^1 \big| t_1 = 1) = E\ (Y_i^1 | t_i = 1) - E(\ Y_i^0 \big| t_i = 1) \quad \textit{equation 1}$$

Where:
Y_i^1 = is the outcome of individual *i* as a result of the treatment
Y_i^0 = is the outcome of individual *i* in case the treatment was equal to 0
t_i = treatment for individual *i* (dummy variable), it is equal to 1 if the individual has the treatment (access to internet).

The effect of the treatment can be calculated by $Y_i^1 - Y_i^0$, however Y_i^0 is not observable. Therefore, $E(\ Y_i^0 |\ t_i = 1)$ can be rewritten as:
$E(\ Y_i^0 |\ t_i = 1) = \ (E(\ Y_i^0\ P(x)|\ t_i = 1) = (E(\ Y_i^0\ P(x)|\ t_i = 0)$

P(x) is the probability of the treatment (internet access) based on a set of observable characteristics. It is important to consider a range of observations that allows the comparison of expected values between the treated and control groups, which is known as common support. As long as there are all the necessary control variables, the reason why one observation is treated and the others not, given the same likelihood of being treated, can be assumed random (Rosenbaum and Rubin, 1983). Therefore, the difference between the outcomes can be attributed to treatment.

PSM can be estimated through a Probit or Logit, being the default the first one[35], in this case Probit, which is the most common[36] (Albright, 2015) , was used . Additionally, one of the main advantages of using PSM is that it is not necessary to assume a specific functional form (Dehejia

[35] For this paper, results with both methods were very similar.
[36] Both methods produce similar results. However, Logit is more commonly used in health sciences (like epidemiology), since the coefficients can be interpreted as odd rations. Probit is more popular in economics and political science, because it is possible to generalize for non-constant error variances.

and Wahba, 2002). This is specifically useful in the case of the relationship between ICT's and income (Fernández Machado and Medina Quispe, 2011).

The specific technique of matching used was the Kernel Method. With this method, each treated individual is given a weight of one. A weighted composite of comparison observations is used to create a match for each treated individual, where comparison individuals are weighted by their distance in propensity score from treated individuals within a range, or bandwidth, of the propensity score. Only observations outside the range of common support are discarded (Garrido et al., 2014). According to the authors, "*Kernel matching maximizes precision* (by retaining sample size) *without worsening bias* (by giving greater weight to better matches)" (p. 1710).

Applying PSM, observations with discrete variables that in all cases perfectly predicted whether the person had internet connection were removed. This implies that those observations were one only when the treatment variable is either one or zero, so there wouldn´t be good control observations for those treated observations and that observation wouldn´t be a good control observation for any treated observation. This was useful because for the next stage there were not considered observations that were not comparable with those treated, of which the effect wants to be isolated. Therefore, for the match making, bad controls had been eliminated from the sample.

After matching, most of the explanatory variables the differences in means between the control group (without internet connection) and the treated group (with internet connection) decreased. In figure 7, it is shown the total number of variables for which the difference decreased or increased. As a result of the matching strategy implemented, the sample is more balanced, it considerably reduced the differences between those with the technology and those without.

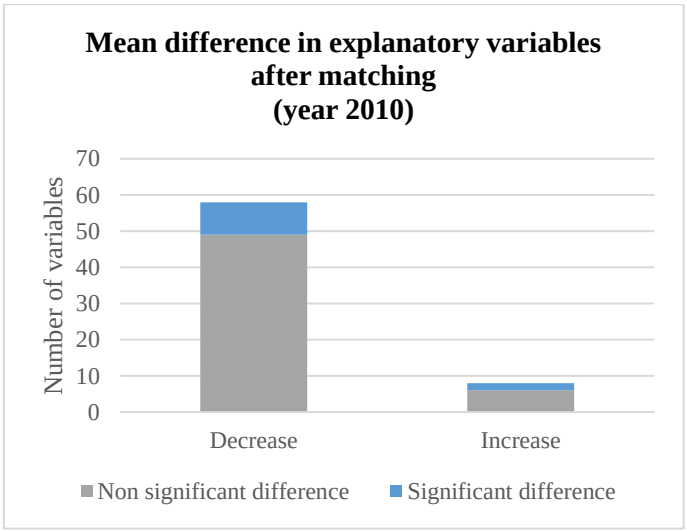
Finally, in order to calculate the effect of having access to the internet, the Average Treatment on the Treated (ATT) is computed. This is the mean difference between the treated observations and the control group created through the matching.

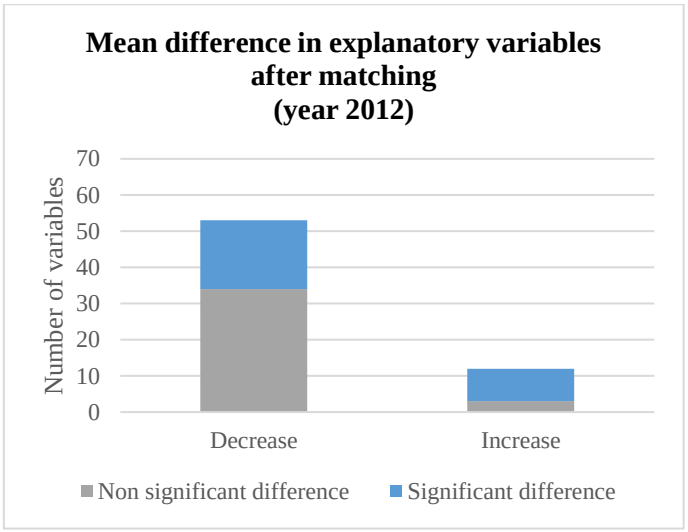
However, is important to keep in mind that one of the main limitations of the data available through ENAHO, is that it is about access but not use, and as the literature suggests, access do not necessarily imply use (Ono and Zavodny, 2007); therefore the positive effects that use could provide are not necessarily represented. This is why, the ENAMEH survey was used as well to measure the effect. However, this survey began in 2017, so, there is not enough data to compare the evolution overtime. Nevertheless, the results with 2018 will be presented in the next section, showing how use could differ from access.

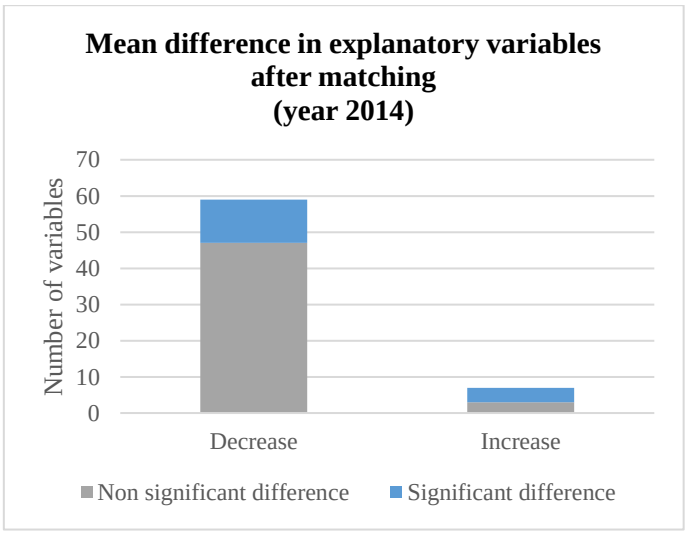
Additionally, in order to reduce the bias of the estimations, different transformations of the variables were made. Presented in this paper are the specifications that resulted less biased without excluding variables that were theoretically important. More attention was put on important covariates and the balance of those, since they are more likely to impact the outcome. It is expected to have more imbalance at the tails of the distribution, were usually are the observations outside common support (Garrido et al., 2014).

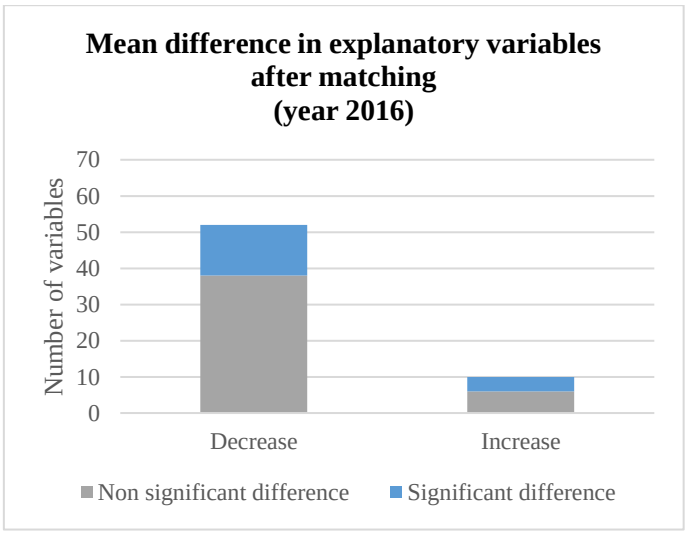
Figure 7. Differences in mean of the explanatory variables for the sample after matching.

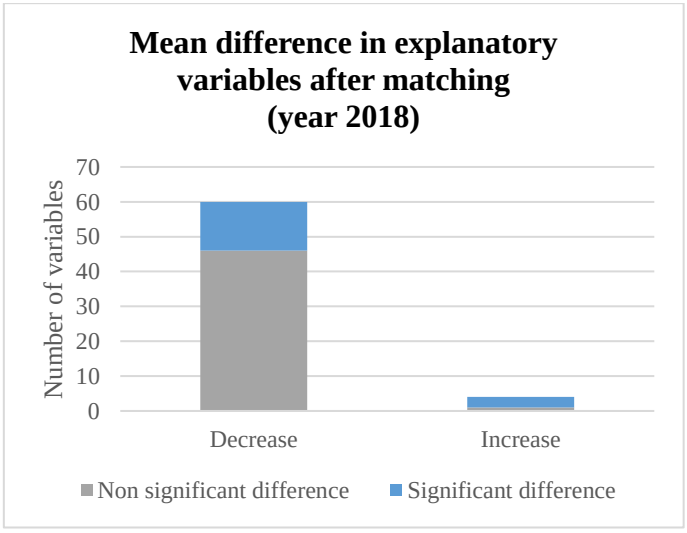
I. ENAHO





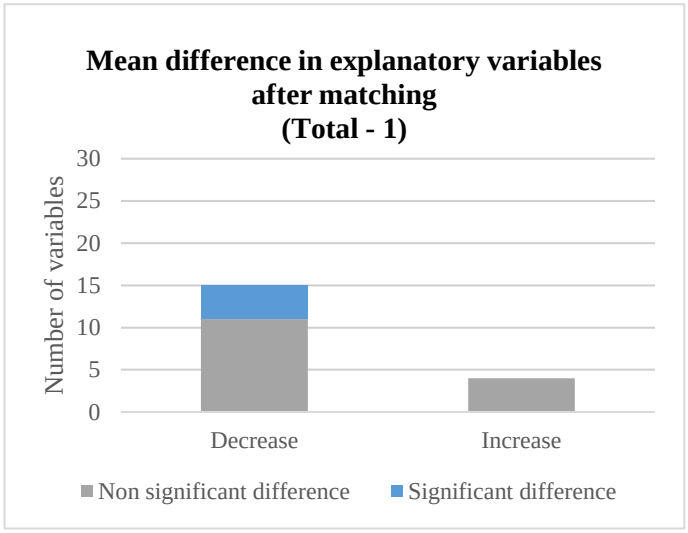




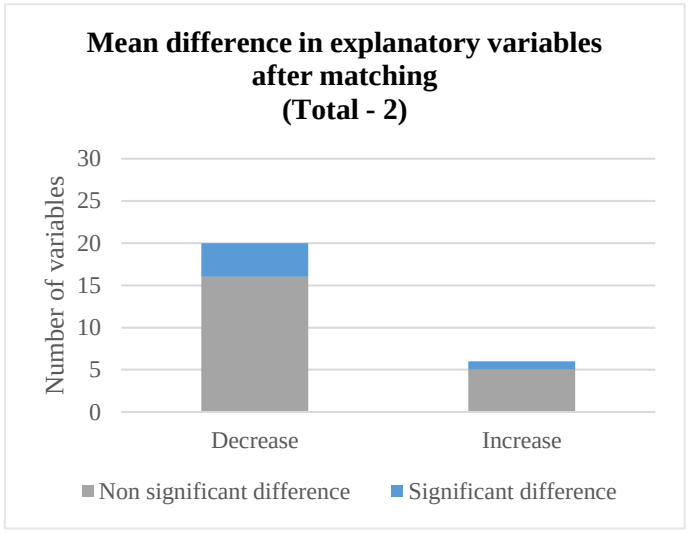


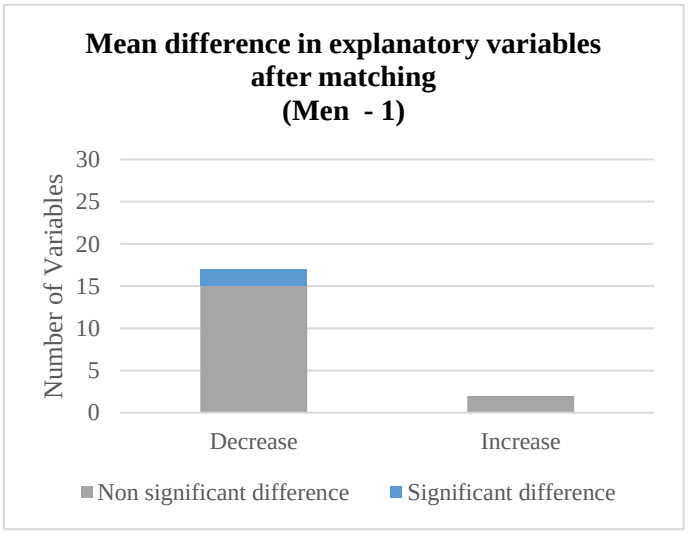
II. ENAMEH

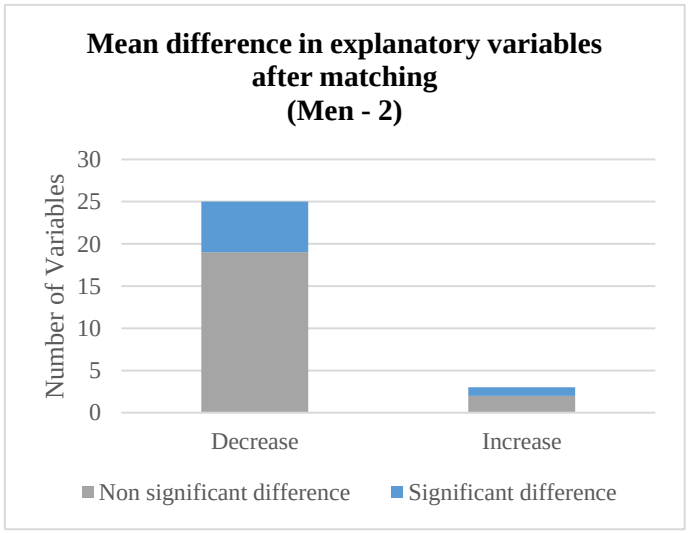
(1)

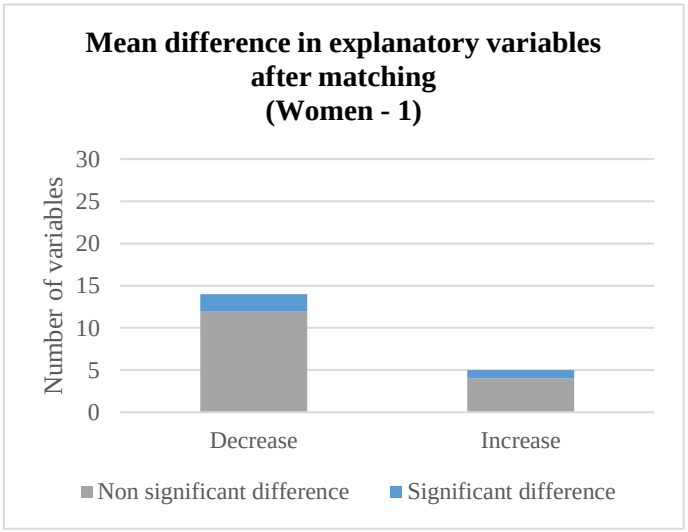

Mean difference in explanatory variables after matching (Total - 1)
Number of variables
30
25
20
15
10
5
0
Decrease
Increase
Non significant difference
Significant difference

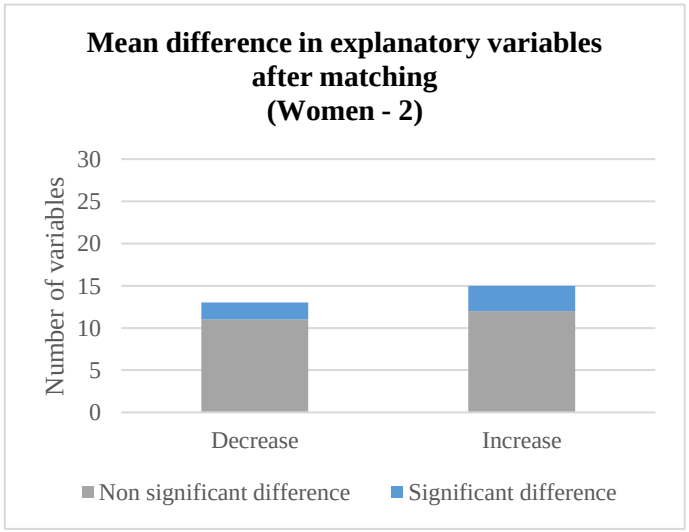
(2)

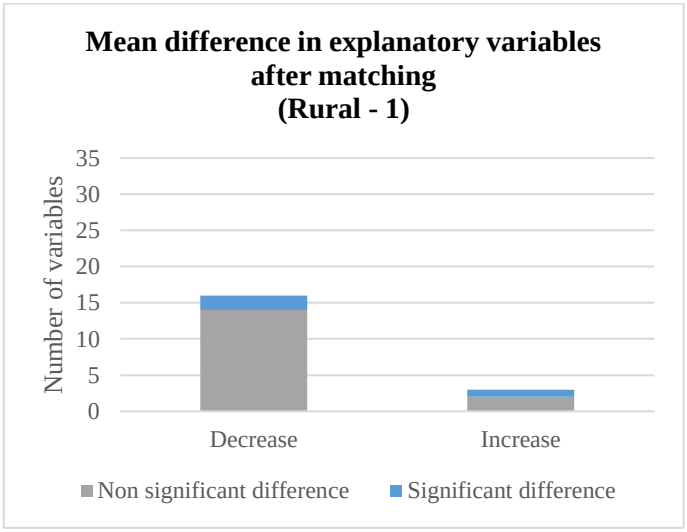

Mean difference in explanatory variables after matching (Total - 2)
Number of variables
30
25
20
15
10
5
0
Decrease
Increase
Non significant difference
Significant difference

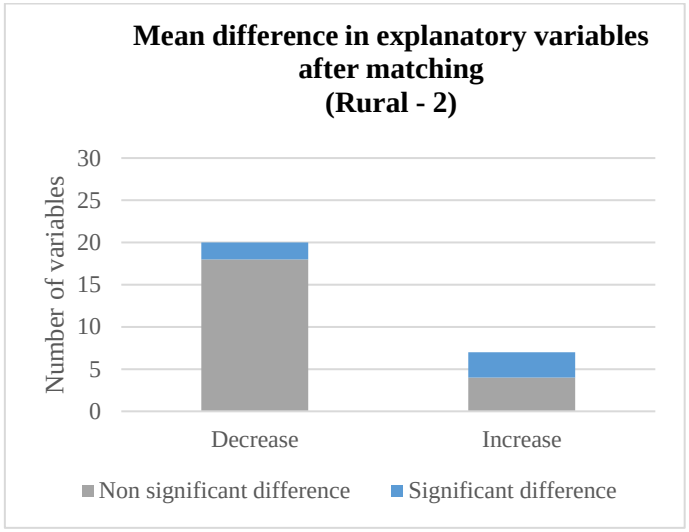

Mean difference in explanatory variables after matching (Men - 1)
Number of Variables
30
25
20
15
10
5
0
Decrease
Increase
Non significant difference
Significant difference

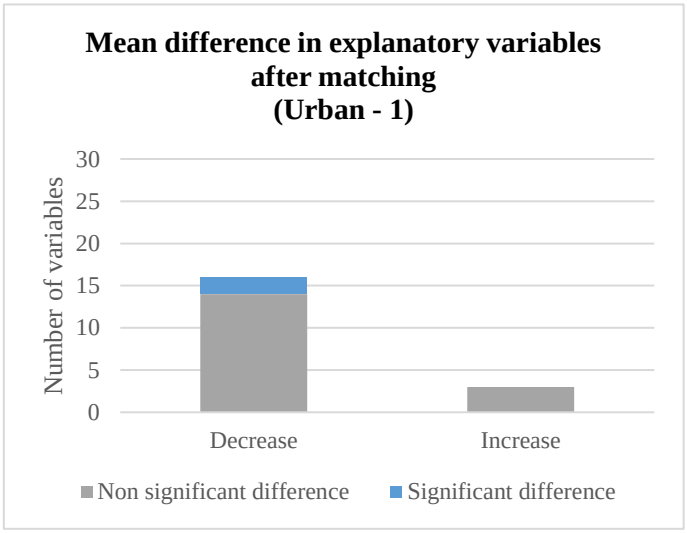

Mean difference in explanatory variables after matching (Men - 2)
Number of Variables
30
25
20
15
10
5
0
Decrease
Increase
Non significant difference
Significant difference

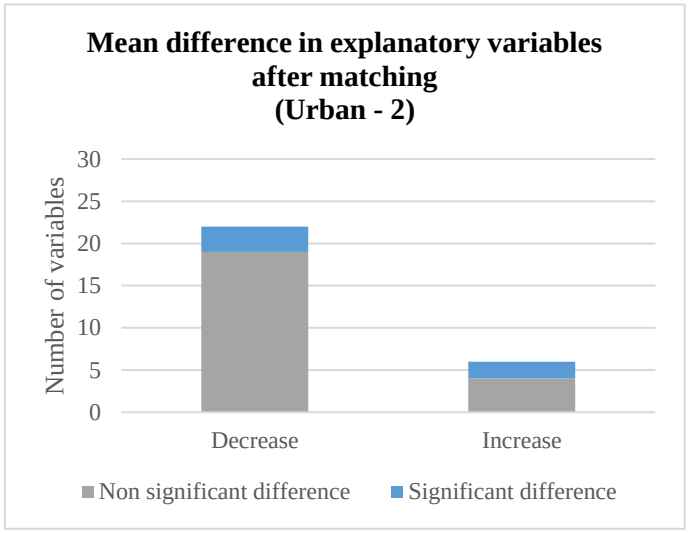

Mean difference in explanatory variables after matching (Women - 1)
Number of variables
30
25
20
15
10
5
0
Decrease
Increase
Non significant difference
Significant difference

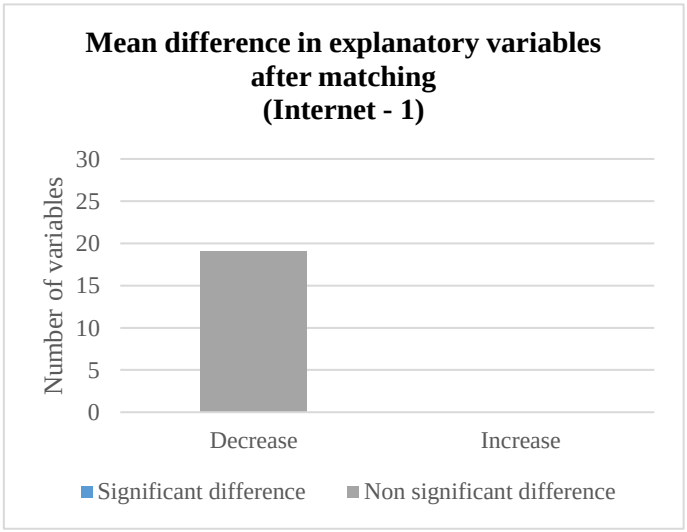

Mean difference in explanatory variables after matching (Women - 2)
Number of variables
30
25
20
15
10
5
0
Decrease
Increase
Non significant difference
Significant difference

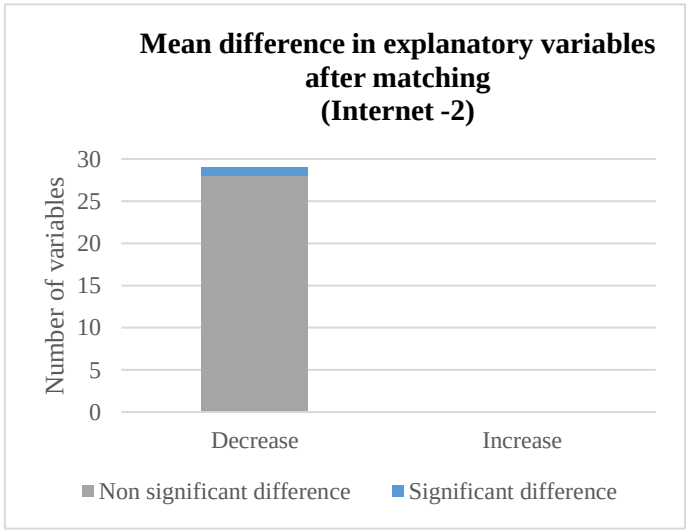












Source: Author's based on data from INEC (2018b, 2018a, 2016b, 2014a, 2014b, 2010)

6. Analysis and findings

First, the propensity score matching, and ATT were calculated for all the self-employed and employers in the first three quintiles, every two years. The treatment effect was having an internet connection (no matter the type) versus not having one at home. The results are presented in table 5. As can be seen, the results are significant for years 2012, 2014 and 2018, with a peak in the difference in 2014; therefore in 2014, having access to internet at home impacted the gross income in the equivalent of 12.5% of the minimum salary.

The trend presented is consistent with the findings of Edquist et al., (2018) who claimed that the effect of broadband is not constant over time, there is usually a peak and then a gradual decrease over time. The difference is significant the year after the market opened to competition (2012), a year in which a great number of households gained access to internet at home. Moreover, it calls the attention of year 2016, not only there were less observations matched, but the results are not significant. This could be influenced by the fact that in 2016, FONATEL's program that granted subsidies for internet connections to households in the first three quintiles was launched, with this, households that were more likely to not have internet access due to their own characteristics were granted the resources. Unfortunately, there is no data in the surveys used that indicate if the household received the benefit, so it is not possible to measure it.

What the numbers suggest is that after the peak in 2014, having internet was not a differentiating factor that powerful anymore. Analyzing the percentage of individuals with internet access, from 2012 to 2018, there was an increase of 89% of the self-employed and employers who had internet connection at home. By being more common among the population of interest, the return in terms of income for having it decreases.

Table 5. Average Treatment Effect: having internet connection at home. Difference in total gross income per month (in colones). 2010-2018

	2010	2012		2014		2016	2018	
ATT	19,690.55	23,054.96	***	33,405.02	***	16,663.75	20,803.25	**
% Min. Salary[1]	9.6%	9.8%		12.5%		5.8%	6.9%	
On support observations	2,450	2,602		2,437		1,244	1,856	

***p<0.01, ** p<0.05, *<0.1

Notes:

[1]Minimum salaries data correspond to the salary established for the private sector in the first semester of each year. The salary shown is the one generic per month for non-qualified workers.

Source: INEC (2018b, 2016b, 2014a, 2014b, 2010); MTSS (2017, 2015, 2013, 2011, 2009)

6.1 Heterogeneity: are there differences by subgroups?

Next, different calculations were made, segregating the sample by various characteristics, such as gender, area, education level and age. These segments were selected according to what the literature suggest: influencing the decision regarding access. The estimations were made only for the years 2010 and 2018. The results for the estimation discriminating by gender are presented in table 6.

Table 6. Average Treatment Effect by gender: Having internet connection at home. Difference in total gross income per month (in colones). 2010 & 2018

	2010			2018		
	Men		Women	Men		Women
ATT	27,496.16	*	12,244.22	37,932.93	***	-9,513.16
% Min. Salary	13.3%		5.9%	12.6%		-3.2%
On support observations	1,747		647	1,194		557

***p<0.01, ** p<0.05, *<0.1

The results are only significant for male individuals. It is interesting that the additional income as percentage of the minimum wage is very similar in both years analyzed. In contrast with the results obtained for both genders at the same time (in terms of percentage of the minimum salary), there was a positive significant effect before the big jump in 2012. Back in 2010, only 11% of the individuals had internet connection at home, versus 68% in 2018. Probably the mechanism behind the impact of the internet in both cases was a little bit different, in 2010, it payed off as a result of a differentiating factor; while in 2018, it is more related with the network effects and productivity gains.

On the other hand, in the case of women, even though, a higher percentage of women had access to the internet than men (13% in 2010 and 76% in 2018), the number of observations is smaller. With fewer observations, especially heterogeneous ones, it is more difficult to find a proper match and the probability of having biased results is higher. In this case, it is important to point out that in Costa Rica, the female labor participation is low – less than 50% – one of the lowest in the region (Valverde, 2019). This is usually an issue when studying and trying to quantify some aspects of female labor participation; however there are qualitative studies that suggests that access to technology and related training have a positive influence in the use of computers by entrepreneur women, impacting positively their business and income (Lee, 2004).

Other of the heterogeneities analyzed was by area: rural versus urban. Some clarifications to put in context the results are important, first that Costa Rica is a country with a land area of 51,100 km^2 and the rural area has been reducing over the last years, with a higher percentage of households defined as urban overtime. Furthermore, more than 98% of households have access to electricity, which sets the path for other services such fixed telephony and later, mobile coverage. By dividing the households by area and analyzing separately urban and rural, the results were not significant for any of the years[37], even though the percentage of households with internet connection was at least 10 percentage points higher in urban areas for both years analyzed.

Thirdly, by dividing the sample by education level, it was not possible to find enough heterogeneity for both extremes: people with less than primary school and people with tertiary school (table 7). This was consistent with the theory and evidence that access and use of technologies is highly correlated with the level of education. However, in the case of primary school, the results are significant at 1% for year 2018, meaning that having access to the internet had an impact on more than 10% of the minimum wage in this population, which was not true in 2010. The mean salary of this group in year 2018 was 174,356 colones, approximately 58% of the minimum salary, therefore, the effect of having access to the internet represent on average

[37] Table 12. Annex V

an 18% higher income. In this specific group, the number of individuals with access grew almost 5 times during the period studied.

Table 7. Average Treatment Effect by education level: Having internet connection at home. Difference in total gross income per month (in colones). 2010 & 2018

2010

	Less than primary school	Primary school		Secondary education	Tertiary education
ATT	n.a	13,038.60		41,133.45	n.a.
% Min. Salary		6.3%		20.0%	
On support observations		1,464		107	

2018

	Less than primary school	Primary school		Secondary education	Tertiary education
ATT	n.a	31,551.13	***	41,022.98	n.a
% Min. Salary		10.5%		13.7%	
On support observations		1,106		209	

***p<0.01, ** p<0.05, *<0.1

Finally, the analysis by generation (table 8). As explained before, the approach by generations was selected since this grouping is the result of cultural and behavioral analysis, allowing controlling for unobservable characteristics. As well as in the case of the break down by education, there was not enough heterogeneity in the extremes of this grouping. This was expected, since the AM generation was over 71 years old in 2010 and 79 in 2018, and the Virtual generation was younger than 11 years old in 2010 and 19 in 2018. The only significant result is for the Pregonera generation in 2018, in that year, they had between 58 and 78 years old. This group is the one, after AM generation, with lower percentage of individuals with access to internet in 2018 (53%), the other three groups have more than 75% each. In Pregonera generation, it seems that having connection is a differentiator that impacts the income.

Table 8. Average Treatment Effect by generation: Having internet connection at home. Difference in total gross income per month (in colones). 2010 & 2018

2010

	AM	Pregonera		Satelital	Digital	Virtual
ATT	n.a	18,201.49		12,638.33	69,911.56	n.a
% Min. Salary		8.8%		6.1%	33.9%	
On support observations		713		450	283	

2018

	AM	Pregonera		Satelital	Digital	Virtual
ATT	n.a	34,001.08	*	10,671.66	12,638.98	n.a
% Min. Salary		11.3%		3.6%	4.2%	
On support observations		455		777	486	

***p<0.01, ** p<0.05, *<0.1

6.2 Does the type of connection influence the income perceived?

As the literature suggests, there could be differences in the benefits perceived of the internet depending of the type and speed of connection. Under the assumption that mobile connections are slower and less stable than fixed ones (especially in the first years of the analysis), a comparison was made. In this case, only the individuals with internet connection were considered, and the "treatment variable" was defined as having a fixed internet connection, versus a mobile one.

Results for this estimation for years 2010 to 2018 are presented in table 9. It is surprising that none of the estimations are significant. Neither in the aggregated version, nor the ones for different subgroups (gender, area and education level)[38]. One potential reason could be the uses of the internet, maybe the activities individuals mostly do through the internet are not highly dependent of the speed or quality of connection, for example sending emails versus uploading videos and photos, or storage and services on the cloud more recently. Unfortunately, with the data available at ENAHO it is not possible to know the type of uses neither the periodicity of it.

Another reason could be that the characteristics that define if a household has fixed connection or mobile are very different, therefore it will be difficult to build a good control group to measure the impact. Furthermore, some of the advantages of a fixed connection could be compensated by the ones of mobile, in specific: mobility. As stated by Edquist et al., 2018, mobile broadband can be a substitute for fixed broadband, but not the opposite, the former one allows a faster distribution of information and ideas, people can be connected "everywhere", reducing transaction costs, particularly important in the case of business without their own premises.

Table 9. Average Treatment Effect: Having fixed internet connection at home versus a mobile one. Difference in total gross income per month (in colones). 2010-2018

	2010	2012	2014	2016	2018
ATT	17,779.07	9,197.88	12,182.02	14,342.25	4,707.95
% Min. Salary	8.6%	3.9%	4.6%	5.0%	1.6%
On support observations	124	943	1,064	824	1,397

***p<0.01, ** p<0.05, *<0.1

6.3 Does use have an impact on the income?

As mentioned before, ENAMEH survey includes some data on use of internet for the microbusiness purposes. Therefore, an analysis with "use of internet" as treatment variable was possible for the year 2018. One of the key points of this measurement is that all the microbusinesses who claimed that had an internet connection that they used for their microbusiness, conducted at least one activity online. A 28% of the individuals responded that they had internet at home but did not have an internet connection they used for their business; this goes in line with what Ono and Zavodny (2007) alleged: access do not necessarily means use. In contrast, 5% did not have connection at home but they had one for their business.

In this case, two different type of estimations were made, one that only took into consideration the characteristics of the business (1) and a second one that included all the same variables that

[38] Tables 13, 14, and 15 in Annex V.

the first one, plus personal characteristics of the owner (2).[39] The results for the first pair of estimations are in table 10, these are for the entire sample of microbusiness from quintiles one to three in ENAMEH (2018). The average treatment effect is significant only in the first estimation, when comparing only by the characteristics of the business. In this case, the owners of business who use the internet, earn 6.8% of the minimum wage more than those who do not.

Table 10. Average Treatment Effect: Use the internet. Difference in total gross income per month (in colones). 2018.

	(1)		(2)
ATT	20,361.09	**	20,072.69
% Min. Salary	6.8%		6.7%
On support observations	1,138		1,125

***p<0.01, ** p<0.05, *<0.1

As with the estimations made only with ENAHO data, when calculating the effect by different subgroups, many of the results were not significant[40]. However, by area, when comparing only the microbusinesses from owners in urban areas, those who use the internet perceive higher income, which was not the case when comparing access and not use. Probably, in urban areas the productivity gains are higher (table 11).

Table 11. Average Treatment Effect by area: Use the internet. Difference in total gross income per month (in colones).2018.

	(1)			(2)	
	Urban		Rural	Urban	Rural
ATT	30,465.95	**	-3,413.63	18,797.38	-15,873.93
% Min. Salary	10.1%		-1.1%	6.3%	-5.3%
On support observations	690		433	642	415

***p<0.01, ** p<0.05, *<0.1

This exercise was also made comparing the type of internet connection, with the treatment being using a fixed internet connection. In none of the estimations results were significant [41]. The percentage of business with fixed internet is low, not enough heterogeneity could be affecting the estimation, but also, since the percentage is low, maybe they do not see the return of investment of having a fixed connection, or the advantages of a mobile one are more.

After doing the different estimations, some questions arise. For example, how important is informality[42] in the decision of not conducting processes online? In this case, 52% of the businesses who use the internet are informal, while those who do not use it, 63% are informal.

In addition, theory and practice suggest that there are some sectors more prone to conduct activities online. For example, more than a third of microbusinesses related with commerce, technical and professional services, accommodation, and transportation and storage use the internet; while only a few in agriculture, forestry and livestock (27%).

Furthermore, overtime more business, at least formal ones, have needed to conduct more procedures online. However, at the time of the survey, less than 10% of the microbusiness used the internet for government procedures. This percentage is expected to increase as more

[39] Variables used in each estimation are in Annex IV.
[40] Table 16 in Annex V includes the results for the estimation by gender.
[41] Results are presented in table 17 in Annex V.
[42] Informality defined as not paying at least social charges or taxes.

paperwork and administrative formalities are converted to be online; trend that is being triggered by the health pandemic caused by Covid-19.

The pandemic has not only pushed more procedures to be online, but many businesses have seen the need to be more present online to get to their customers. It will be very interesting to see the results of these surveys in a couple of years and if the returns of it change.

7. Conclusion and policy recommendations

Having access to the internet does have an impact on the perceived income by self-employed and employers, in the first three quintiles of income. The effect has not been constant over time, as the literature suggest, there is a maximum (peak) and later the effect decreases for the period analyzed.

In order to evaluate the impact of having access to the internet, the methodology used allowed to estimate the effect of having access controlling by socioeconomic and personal characteristics; creating a control group that in average is very similar to the group of interest. However there are limitations with this method, the first one is if there is not enough heterogeneity in the sample, it is very complicated to create a good control group, since there will not be observations diverse enough to create a similar control group; this is usually common at the extremes of the data. On the other hand, one of the main advantages is that it is not necessary to assume a specific functional form, which is particularly useful to work with variables such as income, education and access to technology, which are highly correlated, and also allow to control by these factors.

The technique selected, the Kernel method, allowed to maximize precision without worsening the bias. This was particularly useful since the size of the sample was not reduced, how it worked it that it prioritized better matches. Presented in this paper are the specifications that resulted less biased without excluding variables that were theoretically important. More attention was put on important covariates and the balance of those, since they are more likely to impact the outcome.

Of the hypotheses tested, two were not rejected. The first one: having access to the internet at home, results in higher income for the self-employed and employers. It was the case for the years 2012, 2014 and 2018. Also, for men in 2018 and for those whose highest education level was primary school in 2018. The effect on the later was particularly high, resulting in an increase of more than 18% of their average monthly income. The variation per year, is related with the second hypothesis.

Regarding the other two hypotheses, the results were not significant in any of the cases related with the difference per type of connection; suggesting that there is no advantage on having a fixed internet connection, which could be related with the type of uses people have. Similarly, that the differences in quality and speed are not that high, as has been reported in the past. Moreover, the differences in quality could be compensated by the advantage of having at their disposal internet connection everywhere, particularly if their business does not have a premise.

It is important to keep in mind that one of the main limitations of the data available through ENAHO (data used for the previous hypotheses) is that it is about access but not use, and as the literature suggests, access do not necessarily imply use; therefore the positive consequences that connectivity could provide are not necessarily represented. Hence, the ENAMEH survey

was used as well to measure the effect. However, this survey began in 2017, so, there is not enough data to compare the evolution overtime. Nevertheless, data from 2018 was used, in which an additional analysis specific on use was made.

The fourth hypothesis was that with data on use of the internet, the gains from the use of the internet would be higher than those only relying on access. This was true, but solely when considering only the characteristics of the business and not the individual. One could argue that since most of these microbusinesses are unipersonal their characteristics are correlated with the socioeconomic ones of the owner; therefore, it would be enough for the comparison.

Policy recommendations

The first one is about data. It is imperative to improve the collection of data about use of different technologies, both at the household level, as well as business level. Understanding how people use ICTs is fundamental to design public policies towards a better and higher inclusion.

Currently, nearly half of the people who do not have an internet connection claim they do not have one because they consider it is not necessary (INEC, 2018c; (Programa Sociedad de la Información y el Conocimiento PROSIC, 2019). It would be useful to understand why some self-employees having internet connection at home do not use it for business purposes.

Government programs, such as the ones promoted by FONATEL, should not only be periodically evaluated, but could be a powerful tool to promote self-employment and entrepreneurship as well; prioritizing households who are not only part of the target but have microbusiness. Programs like this, could help individuals to perceive the benefits in the short term; unfortunately, there does not seem to be similar ones focused on entrepreneurs and microbusiness.

In a moment when access to technology has become crucial to continue day to day activities, such as education and contact with others, microbusinesses are not the exception. Anecdotical evidence suggests that it will promote a higher use of technologies, nevertheless, depending on the nature of the business this might be more difficult, especially in informal ones. The fact that government programs promoting transformation of business into e-businesses do not require them to be formal, at least during the first stages, looks like a good sign, especially in times with high unemployment rates.

Because of the current crisis, different organizations and private companies developed platforms where small businesses are encouraged to promote their goods and services for free. It would be of great value to follow up the evolution of these platforms and business. In dept interviews and qualitative analysis on how microbusiness used the internet before, during and after the pandemic would be a great tool to understand the right kind of policies towards a greater inclusion.

In order to promote a higher adoption rate and use, is important to understand why some people and microbusiness with similar socioeconomic characteristics use the internet and others do not. What is the perceived benefit they see of the internet?

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9. Annex

Annex I. The story of the telecommunications reform

The process to open to competition the telecommunication market in Costa Rica was long and full of public discussion. The national electricity company had the monopoly of telecommunications (both fixed and mobile). The first discussions about opening the market began in the 1980's but there was legal uncertainty and public pressure that prevented it from happening (Programa Sociedad de la Información y el Conocimiento PROSIC, 2012). Finally, in 2003, it was included in the negotiations of the Free Trade Agreement with the United States, requested by this country. Even though it was part of the agreement that Costa Rica signed a year later, public opposition persisted, and since the United States was not in favor of renegotiating the agreement, the country lived more than two years of strikes and public movements in favor and against the agreement, where opening the telecom market was a key topic of discussion. In 2007, the government decided to submit the application of the trade agreement to a national referendum. It took place in October of that year: 51% voted in favor of the agreement versus 48% against it. Shortly the president signed the trade agreement and it became law. In order to implement the treaty, different legislation had to change, including the one related with telecommunications (Programa Sociedad de la Información y el Conocimiento PROSIC, 2012).

Therefore, in 2008, the telecommunication general law (Law number 8642) was approved. It covers the regulation mechanisms of the use and exploitation of the networks, as well as the ones regarding the provision of the telecommunication services (*Law 8642. Ley General de Telecomunicaciones*, 2008). The same year, the government announced that a year later they would carry out the public contests for mobile and fixed internet lines. Nevertheless, it only happened for the fixed internet lines: the first private internet and IP telephony were allocated in June 2009 (Programa Sociedad de la Información y el Conocimiento PROSIC, 2012). One major issue at the time, that continues today, is the reallocation of frequencies; this did not only delay opening the mobile sector, but it is a burden on the modernization of the telecom market today.

In 2010, the government opened for the first time the public contest for providers of mobile connections. During 2011, all the arrangements were made[43], so that the two private companies who participated in the contest were able to provide the services. These companies were Movistar and Claro. Finally, in November of that year, they began operations (Programa Sociedad de la Información y el Conocimiento PROSIC, 2012).

Is important to mention that with the opening of the market and the new providers there were big changes. One of the major ones was the appearance of prepaid sim cards and plans; as well as a broader range of post-paid options. Prepaid was aggressively developed by the incumbent months before the new companies entered the market. Previously ICE (The Electricity and

[43] The process has not ended, since the beginning, providers have faced different challenges to expand and improve their services, for example with the installation of antennas, which face different red tape constraints.

Telecom Institution)[44] offered only one kind of mobile services. After 2011, there was a big jump in the number of people with access to mobile and internet services.

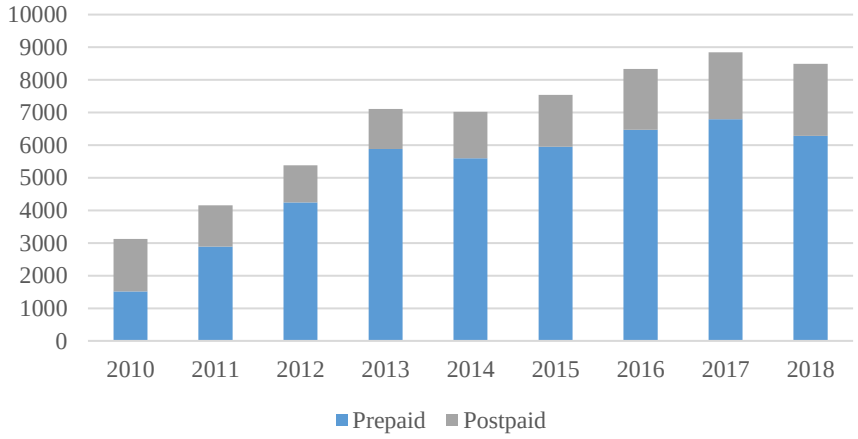
As part of the telecommunication general law, SUTEL was created. This is an independent administrative institution of ARESEP (the institution in charge of regulating public services). The main objective of this technical institution is to regulate the telecom market in Costa Rica, including establishing maximum rates, promote competition, authorize operating companies and enhance interconnection among them. It should oversee the quality of the services and protect the rights of the users. Operators pay a fee, based on their profits, to finance SUTEL (SUTEL, n.d.).

Other important competencies of SUTEL are that they are in charge of competition issues in the sector and of administrate FONATEL (National Telecom Fund). The telecom law created the last one as well, in order to develop programs that would allow universal access to rural areas and vulnerable populations (such as people with low resources, with disabilities and elderly adults) (SUTEL, N.D.). Over the last decade, there have been criticism over the role of FONATEL[45].

The general telecommunication law, put at the center of opening the market to competition three main principles: universality, solidarity and transparency. The first one is about making sure that telecom services should cover all the national territory, no one should be excluded because of their location. Solidarity is about the role of the state to guarantee that populations that would be excluded by the market or special needs are not, it is about reducing the digital gap. Finally, the third one is all about the consumers/users, they should be able to access and enjoy quality services at a reasonable price as well as to received detailed information regarding the service (Monge Zeledón and Pérez Sáinz, 2013)

Annex II.

Figure 8. Costa Rica. Total subscriptions to mobile services, by type of payment. (In thousands)



Source: Superintendencia de Telecomunicaciones (2019, 2015)

[44] ICE rebranded their telecom branch as Kolbi in 2009.
[45] FONATEL is financed by 1.5% of the revenues of the operators. Established by Law 8642

Annex III. Variables used for the PSM ENAHO estimation

	Variable	Details
Personal	Years of education	
	Gender	
	Age (by generation)	
	Speaks a second language	Dummy. It is 1 in case that the individual self-reported that he/she speaks / knows a second language (generally different than Spanish).
	His/Her role in the economic support of the household	If he/she is the head of the household, and if not, if his income contributes with the economic support of the household.
Work-related	Works from home	If the activities related with the economic activity are done from their home
	Employer or Self-Employed	
	Sector of activity: 18 types	The 22 different sectors present in the survey were included. These are: 1- farming, cattle, forestry and fishing, 2- mines and quarries, 3- manufacturing industries, 4- supply of electricity, gas, steam and air conditioning, 5- supply of water, water waste, waste management, 6- construction, 7- wholesale and retail trade, vehicle repair, 8- transport and storage, 9- accommodation and food services, 10- information and communications, 11- financial and insurance activities, 12- real estate activities, 13- professional, scientific and technical activities, 14- Administrative and support services, 15- public administration and defense; compulsory affiliation social security plans, 16 - teaching, 17- human health care and social assistance activities, 18- artistic, entertainment and recreational activities, 19- other services activities, 20- households as employers, 21- activities of extraterritorial organizations and bodies, 22- Others that cannot be classified.
	Occupation: 18 types	The 10 different occupation classifications present in the survey were included. These are: 1- directors and managers, 2- scientific and intellectual professionals, 3- technicians and mid-rank professionals, 4- administrative support staff, 5- sellers in stores and customer service, 6- farmers and qualified agro workers, 7- operators and craftsmen in mechanic activities, 8- machine and assembly workers, 9- elemental occupations, and 10 - others
Housing	Area	If it is a rural or urban household
	Network concentration internet fixed	The concentration of households with internet in the same region (there are 6 administrative regions). It's the percentage of households in the region with internet connection.

	Network concentration internet mobile	The concentration of households with mobile internet in the same region (there are 6 administrative regions). It's the percentage of households in the region with mobile internet connection as their primary mean of connection.
	Type of housing.	Five categories: independent, building, in line, condominium, room, slum.
	Physical state: good, regular, bad	It is a created variable in the survey, that summarizes the state of the house: is it good, regular or bad
	Quality of Housing	Created variable in the survey, it's the score of the house. Houses are classified in optimum, acceptable, deficient and unacceptable. For the purpose of this estimation, these were regrouped in 2: good (optimum and acceptable) and bad (deficient and unacceptable).
	Ownership of the housing.	If the people who live in the house owns it.
	Electricity	If the house has supply of electricity
Characteristics head of household	Age (by generation)	
	Years of education	
	Gender	
	Participation in the labor force	If he/she is working, unemployed or out of the labor market.
Other	Mobile phones	Ownership of mobile phones in the household
	Paid cable/ Satellite TV	
	Electronics	Ownership of electronics (laptops, Desktops and/or tablets) in the household
	Presence of children and young people in the house	Less than 5 years old, in school age (6-12 years old), in high school age (13-17 years old) and in university age (18-25 years old)
	Size of the household	
	Primary sample unit household Survey	
	Expansion factor household survey	

Annex IV. Variables used for the PSM ENAHO + ENAMEH estimation

	Variable	Details	Included in estimation (1)	Included in estimation (2)
Business related	Use of internet	Dummy. It is 1 if answered yes to any of the uses included in the survey (email and messages, search, banking, government procedures, customer service, sourcing, receive orders, calls and ads on social media)	x	x
	Does it have employees? Or regular help from a third person?	Dummy. If is 1 if the answer was positive.	x	x
	Number of permanent workers (including the owner)		x	x
	If the microbusiness has a separated physical space from the house or not	Dummy. If is 1 if the answer was positive.	x	x
	It doesn't have any type of formality	Dummy. If is 1 if the answer was positive.	x	x
	It the activity the main source of income of the household?	Dummy. If is 1 if the answer was positive.	x	x
	Business registered before the tax authority	Dummy. If is 1 if the answer was positive.	x	x
	Business registered before the social security authority		x	x
	Size of the business: 1 person	Dummy. If is 1 if the answer was positive.	x	x
	Size of the business: 2 people	Dummy. If is 1 if the answer was positive.	x	x
	Size of the business: 3 or more people	Dummy. If is 1 if the answer was positive.	x	x
	Sector of activity: 8 types	The 22 different sectors present in the survey were included. These are: 1- farming, cattle, forestry and fishing, 2- manufacturing industries and mines, 3- construction, electricity, gas and water, 4- wholesale and retail trade, 5- transport and storage, 6- accommodation and food services, 7- professional technical activities and other services to people, 8- other services activities.	x	x
Personal	Years of education			x
	Gender			x

	Age (by generation)			x
Other	Area	If it is a rural or urban household		x
	Network concentration internet fixed	The concentration of households with internet in the same region (there are 6 administrative regions). It's the percentage of households in the region with internet connection.		x
	Network concentration internet mobile	The concentration of households with mobile internet in the same region (there are 6 administrative regions). It's the percentage of households in the region with mobile internet connection as their primary mean of connection.		x
	Primary sample unit ENAMEH Survey		x	x
	Expansion factor ENAMEH survey		x	x

Annex V

Table 12. Average Treatment Effect by area: Having internet connection at home. Difference in total gross income per month (in colones).2010 & 2018

	2010		2018	
	Urban	Rural	Urban	Rural
ATT	15,646.51	5,319.85	12,078.33	18,895.07
% Min Wage	7.6%	2.6%	4.0%	6.3%
On support observations	820	1,542	1,073	714

***p<0.01, ** p<0.05, *<0.1

Table 13. Average Treatment Effect by gender: Having fixed internet connection at home versus a mobile one. Difference in total gross income per month (in colones).2010 & 2018

	2010		2018	
	Men	Women	Men	Women
ATT	15,630.66	n.a	-7,910.92	13,587.90
% Min Wage	7.6%		-2.6%	4.5%
On support observations	39		855	495

***p<0.01, ** p<0.05, *<0.1

Table 14. Average Treatment Effect by area: Having fixed internet connection at home versus a mobile one. Difference in total gross income per month (in colones).2010 & 2018

	2010		2018	
	Urban	Rural	Urban	Rural
ATT	n.a	-100,418.70	2,140.22	29,633.57
% Min Wage		-49%	0.7%	9.9%
On support observations		42	935	453

***p<0.01, ** p<0.05, *<0.1

Table 15. Average Treatment Effect by education level: Having fixed internet connection at home versus a mobile one. Difference in total gross income per month (in colones). 2010 & 2018

	2010			
	Less than primary school	Primary school	Secondary education	Tertiary education
ATT	n.a	n.a	n.a	n.a
% Min Wage				
On support observations				
	2018			
	Less than primary school	Primary school	Secondary education	Tertiary education
ATT	n.a	11,735.02	-26,136.99	n.a
% Min Wage		3.9%	-8.7%	
On support observations		838	190	

***p<0.01, ** p<0.05, *<0.1

Table 16. Average Treatment Effect by gender: Using the internet. Difference in total gross income per month (in colones). 2018.

	(1)		(2)	
	Men	Women	Men	Women
ATT	12,623.29	34,740.62	12216.48	39,475.24
% Min Wage	4.2%	11.6%	4.1%	13.1%
On support observations	793	330	760	299

***p<0.01, ** p<0.05, *<0.1

Table 17. Average Treatment Effect: Using fixed internet connection at the business versus a mobile one. Difference in total gross income per month (in colones). 2018.

	(1)	(2)
ATT	15,352.50	6,998.10
% Min Wage	5.1%	2.3%
On support observations	655	650

***p<0.01, ** p<0.05, *<0.1

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Does it pay to have an internet connection?

Evidence from self-employees and employers in Costa Rica

Gloriana Lang-Clachar

Abstract

Using propensity score matching it was possible to analyze the impact that access and use of internet had on the perceived income of self-employed and employers (also referred as microbusiness) in the first three quintiles of income during the period 2010-2018. This research was made with households and microbusinesses data from Costa Rica, country that in 2011 effectively opened the mobile telecommunications market to competition, resulting in a fast growth of people with access to the internet. The results show that for certain groups and years, having access to the internet represented a higher perceived income; ranging from 7% to 13% of the minimum salary, which in some cases represent almost a fifth of the average income of the group. Additionally, the effects were not constant over time and there was no evidence found of a difference according to the type of connection (fixed versus mobile). Furthermore, it is important to improve the data that is collected on access and use of technologies, in order to design and evaluate public policies towards a greater inclusion. Many of the questions and topics discussed gain more relevance in the context in which this paper was written: the outbreak of COVID-19 and its implications for the economy, especially micro and small business.

Key words

Digital divide, access to internet, developing countries, microbusiness, Costa Rica.