

Boza-Núñez, Efraín; Vargas-Montoya, Luis; Robalino, Juan

**Conference Paper**

## More Internet for More Employment and Earnings: A Causal Estimation for Costa Rica

32nd European Conference of the International Telecommunications Society (ITS):  
"Realising the digital decade in the European Union – Easier said than done?", Madrid,  
Spain, 19th - 20th June 2023

**Provided in Cooperation with:**

International Telecommunications Society (ITS)

*Suggested Citation:* Boza-Núñez, Efraín; Vargas-Montoya, Luis; Robalino, Juan (2023) :  
More Internet for More Employment and Earnings: A Causal Estimation for Costa Rica, 32nd  
European Conference of the International Telecommunications Society (ITS): "Realising the  
digital decade in the European Union – Easier said than done?", Madrid, Spain, 19th - 20th  
June 2023, International Telecommunications Society (ITS), Calgary

This Version is available at:

<https://hdl.handle.net/10419/278020>

**Standard-Nutzungsbedingungen:**

Die Dokumente auf EconStor dürfen zu eigenen wissenschaftlichen Zwecken und zum Privatgebrauch gespeichert und kopiert werden.

Sie dürfen die Dokumente nicht für öffentliche oder kommerzielle Zwecke vervielfältigen, öffentlich ausstellen, öffentlich zugänglich machen, vertreiben oder anderweitig nutzen.

Sofern die Verfasser die Dokumente unter Open-Content-Lizenzen (insbesondere CC-Lizenzen) zur Verfügung gestellt haben sollten, gelten abweichend von diesen Nutzungsbedingungen die in der dort genannten Lizenz gewährten Nutzungsrechte.

**Terms of use:**

*Documents in EconStor may be saved and copied for your personal and scholarly purposes.*

*You are not to copy documents for public or commercial purposes, to exhibit the documents publicly, to make them publicly available on the internet, or to distribute or otherwise use the documents in public.*

*If the documents have been made available under an Open Content Licence (especially Creative Commons Licences), you may exercise further usage rights as specified in the indicated licence.*

**More Internet for More Employment and Earnings:  
A Causal Estimation for Costa Rica**

Efraín Boza-Núñez <sup>a</sup>, Luis Vargas-Montoya <sup>a, b</sup>, Juan Robalino <sup>a</sup>

<sup>a</sup> Research Institute of Economic Sciences, University of Costa Rica

<sup>b</sup> Corresponding author Luis Vargas-Montoya [luis.vargasmontoya@ucr.ac.cr](mailto:luis.vargasmontoya@ucr.ac.cr).

## **Abstract**

Information and communications Technologies (ICT) are crucial in people's daily activities, including the job-related ones. Previous literature has acknowledged the potential of ICT to enhance labor market outcomes. However, empirical evidence is scarce and concentrated in developed countries. By using a rich longitudinal dataset, we apply a novel Differences and Differences (DiD) method to estimate the effect of the access to computers and internet over the labor market participation, employment and earnings. We further test whether there are complementarity effects of having access to the internet and computers simultaneously on the labor market outcomes and the likely differential effect by having access to broadband instead of lower speed connections. We found that the access to computers and the internet positively affects labor market participation, employment and earning. We further found that the simultaneous access to the internet and computers enhances their effect on employment and earnings. Policy makers should be aware that, in the digital era, the access to ICT is crucial to enhance the labor market outcomes. Particularly for developing countries, which along with poorer labor markets outcomes face higher digital divides.

## **1. Introduction**

Over the last decades, Information and Communication Technologies (ICT) has consolidated its relevance in the world of work, even more with the Covid-19 pandemic (Stocker & Whalley, 2021; Wang et al., 2022). Despite policy makers and scholars broadly acknowledging the importance of digital life to be immersed in current society, digital divides among populations remain as a concern. The Covid-19 pandemic highlighted this reality. The sanitary restrictions to contain the pandemic led to millions of people without Internet connection being left out of a sort of daily activities, including job-related ones. Particularly, in developing countries, the Covid-19 effects on the labor market were even more severe. The lower share of the developing economies based on the service sector and remote work activities, along with its lower penetration and use of ICT, triggered sharper job losses with the pandemic crisis (Bundervoet et al., 2022; Khamis et al., 2021).

Regarding the case of Costa Rica. On the one hand, this developing country, in the midst of the digital era, still accounts for a high percentage of people without Internet connection. In 2022, 13% of households did not have an Internet connection and only around 23% of the connections were broadband. On the other hand, Costa Rica faces the challenge to create more and better employment and, with no doubt, Internet access and use are crucial to leverage the new employment opportunities that are increasingly focused on the service sector and mediated by technology. In 2022, 21% of employment was generated by the service sector. It is also important to highlight that in 2022 only 11% of the employed people were fully or partially working remotely.

Despite literature has acknowledged the positive relationship between Internet connectivity and employment and earnings, empirical research is scarce (Zuo, 2021). It is even scarcer when analyzing a cause-and-effect relationship and based on data from developing countries

(Hjort & Poulsen, 2019; Leng et al., 2020). We exploit the availability of a longitudinal dataset with a vast set of sociodemographic, ICT access and use, and job-related predictors to estimate the effect of Internet access and use on individuals' employment and earnings. The dataset from 2014 to 2022 has a sample of 165,237 observations with both regional and national representativeness. We apply novel differences-in-differences techniques to leverage the availability of several ICT access and use categorical and continuous variables considered as treatment, as well as different periods in which the individuals were exposed to treatment (Callaway & Sant'Anna, 2021; Goodman-Bacon, 2021). The dataset provides information on the speed of the Internet connections, which previous literature found that, along with access, affects employment and earnings (Hjort & Poulsen, 2019). The dataset also provides information which allows to conduct heterogeneity analyses. This panel further includes observations before and after the starting point of the Covid-19 pandemic, which allows us to assess whether there were differential effects in both time periods.

The contribution of this research is three-folds. First, it provides empirical evidence on the causal relationship between Internet access and employment and earnings. Second, it is one of the few researches based on longitudinal data from a developing country. Third, to the best of our knowledge, it applies for the first time a sort of novel differences-in-differences estimation methods, leveraging the availability of a rich longitudinal dataset. These methods also allow us to deal with endogeneity issues (Sun & Abraham, 2021).

We found that the access and use of the Internet positively affects employment and earning. Our results also show that there were no complementarities between computers and the internet simultaneously. Another result was that the higher the speed of the Internet connection (particularly, broadband connections), the stronger the effect of Internet access on employment and earnings. From a policy making perspective, this research provides causal

evidence on the positive effect of Internet access and use on employment and earnings. Thus, it motivates and supports public policies intended to close digital divides. It also warns policy makers on the importance of digital technologies investment and digital divides bridging in the era of the digital economy, as a determinant of employment and earnings and, consequently, of well-being.

## **2. Data sources and research designs**

This study was carried out using a rich administrative database at the household and individual level. The National Institute of Statistics and Census of Costa Rica (INEC) conducts a national cross-section household survey every year, with a representative sample for the population. The survey asks for socioeconomic and demographic questions. The sample varies by 25% each year in order to capture socioeconomic changes between each year. In this way, the progressive variation of the random sample makes it possible to generate an unbalanced panel base that follows the individuals for at least two years. Hence, the provided panel consists of 165.280 observations over a sample interval from 2014 to 2022. The previous interval was selected in order to ensure sufficient time for testing the time trend from before.

### **2.1 Dependent variables**

In this work, there are three core dependent variables, first, we study the impact of internet and computer access over the earnings. The income variable has been resized to a logarithm scale in order to capture the percentage effects produced by the treatment. Second, we study the impact of the technologies mentioned above over the probability of being employed. The employment variable was constructed dichotomously by analyzing the changes in the employment situation of each individual. Finally, we are interested in studying the impact over a related variable, being the probability of being in the labor force. The main difference between the probability of employment and the probability of being in the labor force, is that

the last accounts only for those individuals that are working or looking for a job at the time of reference.

## 2.2 Independent variables

The main objective of this article is to estimate the quantitative impact of the adoption of new information technologies on income and employment decisions. Hence, our main treatment variables are the access to a computer and the access to the internet in a reference period at an individual level. Therefore, we treat  $treat_{it}$  as the individual dummy variable. The variable  $treat_{it}$  is set to 1 if the person  $i$  had access to the technology at the time  $t$ . Otherwise, it equals 0. There are also other control and fixed effects variables at individual and household level such as sex, geographic zone and age. In addition to the treatment variables, there exists an interaction between treatments, this variable is included in order to analyze the complementary role of the two technologies, therefore the variable  $interac_{it}$  takes the value of 1 if the person has access to the internet and computer at the subsequent time. Finally, a broadband variable has been included into the study to measure if the high-speed internet has a significant and positive impact over the dependent variables. Table 1 shows the descriptive statistics of the main variables.

**Table 1.** Descriptive statistics of the variables.

	N	Median	Mean	SD	min	max
Earnings	32297	12.48	854.920	1035.979	0	57397.471
Employment (%)	36692	na	0.893	na	na	na
Participation (%)	70689	na	0.519	na	na	na
Broadband (%)	90611	na	0.212	na	na	na
Access to internet (%)	90611	na	0.633	na	na	na
Access to computer (%)	90611	na	0.177	na	na	na

*Notes.* In dichotomous variables, the mean represents the percentage of observations with a value of one.

### 2.3 Model

We analyze the relationship between information technologies and the changes in employment and earnings in a given time period for given individuals, therefore leveraging the structure of the data, we chose to implement a time-varying difference-in-differences (DiD) model containing year, household and individual fixed effects. The specific model is described as follows:

$$y_{it} = a_0 + a_1 treatment_{it} + a_2 interac_{it} + \sum \gamma_{it} X_{it} + u_i + w_j + v_t + \varepsilon_{it}$$

where  $it$  represents the individual  $i$  status at the year  $t$ , the dependent variable  $y$  accounts for the logarithm of earnings and the dichotomous variables labor market participation (from now on participation) and employment status (employed or unemployed). The variables  $X$ ,  $u$ ,  $w$  and  $v$  represent control variables; respectively, the individual level fixed effects, the household level fixed effects and the year fixed effects. Finally, the variable  $\varepsilon_{it}$  accounts for the error term. The household-time period fixed effects control for any invariant changes within-households-location changes in employment outcomes that may be correlated with having access to computer and internet. The standard errors are robust and clustered at household level.

The coefficient of the treatment  $a_1$ , is the main concern of this study, indicating the average effect of telecommunications over the dependent variables. In the case of the earnings, it represents an average semi elasticity. This is the percentage change in income regarding a discrete change in the treatment condition. For the other dependent variables, the coefficient can be interpreted as an average effect over a discrete linear probability model. A statistically significant and positive  $a_1$  suggest that the access to this information technologies positively



affect labor earnings, being part of the economically active population and being employed on an average basis.

### **3. Empirical results and analysis**

In the following section we present the main results concerning the causal effect of having access to telecommunication technologies over our main dependent variables. The empirical testing was developed following two models. The first model analyzes the impact with the inclusion of a broadband variable. The broadband variable measures the difference in the average treatment when the data transmission used by the individual supports a wide range of frequencies and internet traffic types. Thus, the variable related to the internet quality receives a value of 1 when the connection is being held using coaxial cable, optical fiber, wireless internet or satellite communication, otherwise it has a value of zero. The second model tests the causal effect of having access to computers with the inclusion of an interaction term. In this case, the relevant factor in the second model is to measure the existence of a technological complementarity on the dependent variables.

#### **3.1 Regression results**

Table 2 shows that having access to computers increased the probability of being part of the labor market by 2.1%. It also increased the probability of being employed by 1.2%. The earnings were also increased by 8.9% when an individual had access to computers. Further, the internet access was positively related to being part of the labor market by 1.9% and earning by 4.5%. Internet access was not related to being employed. Having access to a broadband connection was barely related to earning and was not related to being part of the labor market or being employed.

**Table 2.** Baseline regression results for the treatments.

	Computer			Internet		
	(1)	(2)	(3)	(4)	(5)	(6)
	Earnings	Employment	Participation	Earnings	Employment	Participation
Constant	12.132*** (0.033)	0.898*** (0.011)	0.508*** (0.009)	12.061*** (0.035)	0.898*** (0.011)	0.473*** (0.009)
Treatment	0.089*** (0.015)	0.012** (0.006)	0.021*** (0.005)	0.045** (0.019)	0.001 (0.006)	0.019*** (0.005)
Broadband				0.036* (0.035)	0.012 (0.011)	0.007 (0.009)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Individual FE	Yes	Yes	Yes	Yes	Yes	Yes
Household FE	Yes	Yes	Yes	Yes	Yes	Yes
F	24975	24224	16605	7845	6773	9982
N	32297	36692	70689	20159	22740	46732

Note. Standard errors in parentheses are robust clustered at household level \*  $p < 0.1$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ .

### 3.2 Interacting terms

Table 3 shows the estimation results when considering the externality of having access to the Internet on the effect of computers access on the labor market variables analyzed. The access to computers positively increases the labor participation probability by 1.4%. It also positively affected labor earning by 7.3%. The access to computers did not affect being employed. There were no externalities of being connected to the internet on the positive effect of access to computers on the labor market variables analyzed.

**Table 3.** Baseline regression results for computer with an interaction term

	<b>Computer</b>		
	(1)	(2)	(3)
	Earnings	Employment	Participation
Constant	12.129*** (0.033)	0.897*** (0.011)	0.507*** (0.009)
Treatment	0.073*** (0.022)	0.006 (0.008)	0.014** (0.007)
Interaction	0,020 (0.019)	0.008 (0.007)	0.01 (0.006)
Year FE	Yes	Yes	Yes
Individual			
FE	Yes	Yes	Yes
Household			
FE	Yes	Yes	Yes
F	22377	21588	15021
N	32297	36692	70689

*Note.* Standard errors in parentheses are robust clustered at household level \*  $p < 0.1$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ .

### 3.3 Robustness check and heterogeneity analysis

*Table 4. Heterogeneity analysis with subsamples.*

Variables	Earnings		Employment		Participation	
	Computer	Internet	Computer	Internet	Computer	Internet
High Educational Level	***	<i>null</i>	***	***	***	***
Low Educational Level	***	<i>null</i>	<i>null</i>	<i>null</i>	<i>null</i>	<i>null</i>
Rural area	***	<i>null</i>	<i>null</i>	<i>null</i>	***	<i>null</i>
Urban area	***	<i>null</i>	***	<i>null</i>	***	<i>null</i>

*Note.* \*\*\* means that the estimation keeps its significance at 1%.

Table 4 shows the effect of access to computers and internet on the labor market variables analyzed by educational level and area. These two variables of group are the ones in which there is a broader gap in the access to ICT in Costa Rica. The effect of the access to computers on being in the labor market, being employed and earnings remains positively significant for people with higher education (secondary or more). The only exception is the effect of internet access on earnings. Regarding the group of people with lower education, only the effect of access to computers on earnings remains significant.

#### 4. Limitations and extensions

The present study is not without limitations. First, despite it considers a rich longitudinal dataset, there are some shortcomings to be acknowledged. It is not possible to identify whether an individual has access to Internet before the year we considered the treatment time. To mitigate that, we propose to apply other robustness checks, for example, considering only individuals with more than one year without treatment prior to the treatment year. There are also other control variables relevant to incorporate as control variables (e.g., the sector in which a person is employed and the level of qualification of its employment). It is relevant to highlight that the likely bias due to omitted variables are partially by considering

fixed effects by individual and year. Second, as previous literature highlights, the relationship between ICT variables and employment is intrinsically endogenous. Thus, despite that we worked with longitudinal data and applied different procedures to mitigate this shortcoming (e.g., estimating standard errors robust and clustered at household level). Third, we focus our analysis on access to ICT and not on ICT use in terms of likely uses and their extent of use, which is relevant when analyzing the transmission mechanism between the effect of access to ICT on the labor market.

Future empirical works should be based on administrative dataset to certainly identify the first period in which a person has access to internet. A broader access to reliable data should also encourage more precise analyses by socioeconomic groups. It is also suitable to apply other estimation methods and robustness checks to validate the estimation results results of the effects of ICT use on the labor market. One option is to apply non-parametrical methods which are increasing its relevance in empirical literature. Posterior works should be focus on the transmission mechanisms of the access to ICT on the labor market results. There also will be empirical research analyzing the effect of different intensities and types of ICT uses on the labor market. The availability of a variable that measures the frequency of use in the above technologies can allow us to perform robustness checks over our estimates. To do this, we should perform a placebo test to ensure the weak presence of endogeneity by comparing the average effect between the control group and the treated individuals with a low extent of use. In future versions of this work, we expect to test the difference in the effect between the Covid-19 pandemic period and before it, due to during this period remote work reinforced the role of ICT in the world of work. Thus, we expect a stronger effect of ICT access on the labor market outcomes during the pandemic.

## **5. Conclusion and policy recommendations**

The present study analyzes the effect of access to ICT on labor market outcomes. To do this, we exploit the availability of longitudinal data for Costa Rica and apply novel DiD methods. Our results show that, overall, there is a positive effect of ICT access on the labor market participation, employability and earnings. Particularly, the access to computers positively affects the labor market variables analyzed. The empirical results also show that it seems that there are no complementarities between the simultaneous access to different ICT. The heterogeneity analysis conducting the estimations by sociodemographic groups, overall came to consistent results when analyzing the effect of access to computers on the labor market. Intuitively, this result may be explained by the stylized fact that, from the technologies analyzed, the computers are the ones we could more directly relate to employment uses.

The findings of this work provide empirical evidence to support the budgetary and institutional efforts to boost access to ICT as an enabler of employability and earnings. In a context of rapid technological change, it is a reality that access to ICT make the difference in terms of taking advantage of the current and potential labor market demand. Policy makers should increase efforts on ensuring ICT access regardless of the sociodemographic characteristics of the population, in other words, to bridge the first level digital divide. Along with it, they should bridge the remaining levels of the digital divide, particularly, to promote the acquisition of digital competences to leverage the opportunities ICT provides in terms of human capital formation, productivity gains and efficiency.

## References

- Bundervoet, T., Dávalos, M. E., & Garcia, N. (2022). The short-term impacts of COVID-19 on households in developing countries: An overview based on a harmonized dataset of high-frequency surveys. *World Development*, *153*, 105844.  
<https://doi.org/10.1016/j.worlddev.2022.105844>
- Callaway, B., & Sant'Anna, P. H. C. (2021). Difference-in-Differences with multiple time periods. *Journal of Econometrics*, *225*(2), 200–230. <https://doi.org/10.1016/j.jeconom.2020.12.001>
- Goodman-Bacon, A. (2021). Difference-in-differences with variation in treatment timing. *Journal of Econometrics*, *225*(2), 254–277. <https://doi.org/10.1016/j.jeconom.2021.03.014>
- Hjort, J., & Poulsen, J. (2019). The arrival of fast internet and employment in Africa †. *American Economic Review*, *109*(3), 1032–1079. <https://doi.org/10.1257/aer.20161385>
- Khamis, M., Prinz, D., Newhouse, D., Palacios-Lopez, A., Pape, U., & Weber, M. (2021). The Early Labor Market Impacts of COVID-19 in Developing Countries. In *Jobs Working Paper* (No. 58; Issue 58). <https://doi.org/10.1596/35044>
- Leng, C., Ma, W., Tang, J., & Zhu, Z. (2020). ICT adoption and income diversification among rural households in China. *Applied Economics*, *52*(33), 3614–3628.  
<https://doi.org/10.1080/00036846.2020.1715338>
- Stocker, V., & Whalley, J. (2021). *Committee exploring the impact of Covid-19 The Internet has coped well with Covid-19 , but problems remain* (No. 15; Weizenbaum Series).  
<https://doi.org/https://doi.org/10.34669/wi.ws/15>
- Sun, L., & Abraham, S. (2021). Estimating dynamic treatment effects in event studies with heterogeneous treatment effects. *Journal of Econometrics*, *225*(2), 175–199.  
<https://doi.org/10.1016/j.jeconom.2020.09.006>
- Wang, Q., Xu, W., Huang, Y., & Yang, J. (2022). The Effect of Fast Internet on Employment: Evidence from a Large Broadband Expansion Program in China. *China and World Economy*, *30*(3), 100–134. <https://doi.org/10.1111/cwe.12420>

Zuo, G. W. (2021). Wired and Hired: Employment Effects of Subsidized Broadband Internet for Low-Income Americans†. *American Economic Journal: Economic Policy*, 13(3), 447–482.  
<https://doi.org/10.1257/pol.20190648>