Digital inequalities in internet penetration in Mexican households

Keywords: Mexico Telecommunications Reform, public policy evaluation, fixed-line internet penetration, ICT4D, digital inclusion.

Abstract:

How do Mexican 2013 Telecommunications and broadcasting Reform helped mitigate or exacerbate the digital divide? In this paper, we assess if the Reform had an impact on fixed-line internet penetration in Mexico. For the assessment, the 2010 Census and 2015 Intercensal Survey data were used to create impact indexes through Poisson estimations. Results were confronted though a quintile analysis, with the intention of showing the average of internet penetration in each income group. The data obtained suggest that between 2010 and 2015, internet penetration had positive variations in all the quintiles indicating that recent regulatory changes in telecommunications matter had helped to reduce the digital divide. However, the impact was not homogeneous in all the quintiles, as internet penetration was more significant in high income households. Finally, it is concluded that the Reform had helped to reduce the digital divide, but the poorest remains at digital exclusion.

JEL Classification: L38, L96, L59, R58, O54

L38 (Public Policy), L96 (Telecommunications), L59 (Regulation and industrial Policy), R58 (Regional Development planning and Policy), O54 (Economywide Country Studies: Latin America; Caribbean).

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1. Introduction

It is well known that Information and Communications Technologies (ICT) are crucial for the economic growth (Roller and Waverman, 2001; Schreyer, 2000). Developing countries, where economic, social and cultural inequalities are usual,

face the challenge of broadband penetration. This problem is even bigger if the telecommunication market defies regulatory failures, combined with a challenging geography and extremely variable population densities. This is the case in Mexico, who despite being the second largest mobile market in Latin America in terms of subscribers, penetration levels remain lower than the regional averages.

On the subject of fixed-broadband penetration, there are only 12.7 subscription per 100 inhabitants, while the Americas mean value is 19.10 (ITU, 2017). In the last Global Competitiveness Index, Mexico's biggest problem regarding technological readiness was reported to be adoption and use of information technologies in the general population (World Economic Forum, 2016). The aforementioned report ranked Mexico 133, 137 and 122 in internet users, mobile broadband subscriptions and fixed broadband subscriptions categories.

The digital divide, here defined as the disparity in internet access (Lu, 2001), is a complex problem. On the one hand, market forces lead investment to highly populated and economically active areas, where the likelihood to recoup the deployment's cost is higher, leaving rural areas and some social groups at digital exclusion (Stern and Townsend, 2006). On the other hand, this before-mentioned ability to, at least, recoup the investment is highly related to internet adoption (Ovando et al., 2015).

The technology acceptance, alternatively, is related to the fulfillment of citizen's requirements and expectations (Davis, 1986, 1989). The literature suggest that the original digital divide of physical internet access has evolved into a divide that includes differences in skills to use the internet (Van Deursen and Van Dijk, 2011). For this reason, digital divide research applies multifaceted conceptualizations, spanning motivation, material access, skills, use, and outcomes (Van Deursenan and Mossberger, 2018). Therefore, digital inclusion solutions must consider both supply and demand side policies, in order to close the infrastructure access gap and to promote digital inclusion.

Digital exclusion is due to several factors such as differences in skills, culture and other demographics and social variables (Van Deursen and Van Dijk, 2014; Feasey, 2015; Flamm and Chaudhuri, 2007; Hilbert, 2011; Mossberger et al.,

2003), which must be assessed at the individual level (Davis, 1986, 1989; Mossberger et al., 2007).

From the socio-demographic factors, income and education are the strongest predictors of internet purchase (Chaudhuri et al., 2005; Mossberger et al., 2003; Norris, 2001; Quibria et al., 2003). Income is traditionally the most pervasive indicator of development and directly related with internet adoption (Hilbert, 2016; James, 2012). It is worth mentioning in this regard that income distribution in Mexican households is extremely unequal; the 10% richest households' income is almost 20 times bigger than the poorest 10% (CONEVAL, 2016; OCDE, 2016).

Mexican population presents several barriers to the internet adoption. According to data from the National Survey on the Availability and Use of Information Technologies in Households (INEGI, 2016a), the main reasons for not adopting the Internet are:

- The lack of economic resources (55.2%).
- Not knowing how to use it (10.8%).
- Insufficient equipment (2%).
- Lack of supplier or infrastructure in their locality (15.7%).
- Other not specified (16.3%).

These results are consistent with previous assessments in México, where poverty is identified as the main reason for technological exclusion (Casanueva-Reguart and Pita, 2010; Cave and Flores-Roux, 2017; Mariscal et al., 2016).

In the recent past, Mexico has been heavily criticized for the need of regulatory changes that permit a new dynamic in the telecommunications sector (OECD, 2012). Among the most important challenges for the Mexican government are the high concentration, which results in low levels of competition as well as the lack of facilities and low broadband penetration rates.

During the current presidential term, Mexico has been engaged in strategic changes. One of the most emblematic was the 2013 Telecommunications Reform. The Reform was intended to promote competition and access in the telecommunication sector. The Reform consisted in a constitutional amendment in

which the access to ICTs, as well as, the rights of audiences and users of telecommunications, were recognized as fundamental rights (Álvarez, 2017).

Conversely, on the supply side, government measures had been quite modest. It consisted in the deployment of digital community centers in remotely isolated areas (Casanueva-Reguart, 2018); providing free internet access in government buildings and public schools, through the *"Mexico Conectado"* program (Quintanilla, 2016); and giving computers to fifth and sixth graders (Mecinas, 2016). There is no evidence of the existence of a digital literacy programs. As most of the digital inclusion policies had been centered on closing the (infrastructure) access gap, it is not clear if the Reform by itself would have a direct impact on broadband penetration or if additional measures should be required.

The question addressed in this paper is how do Mexican 2013 Telecommunications and broadcasting Reform helped mitigate or exacerbate the digital divide. In particular, we evaluate if the Reform had an impact on fixed-line internet penetration in Mexico For the assessment, the 2010 Census and 2015 Intercensal Survey data were used to create impact indexes through Poisson estimations. Results were confronted though a quintile analysis, with the intention of showing the average of internet penetration in each income group.

The paper is structured as follows. Section 2 describes the telecommunication industry in Mexico. Section 3 exposes methodology, beginning with a conceptual framework. In section 4 the results are explained and the discussion is set. This section is subdivided in two sections: 4.1 where income inequalities in the five wealth groups are explained and 4.2, where impact index per household results are explained. Finally, in section 5 main conclusions, limitations and future works are exposed.

2. The Telecommunications industry in Mexico

On June 11, 2013, the Official Journal of the Federation (DOF for its acronym in Spanish), the institution responsible in Mexico for publishing provisions in various areas of competence issued by the Federation's powers to be observed and

applied, announces the Reforms (additions) to The Magna Charta in the field of telecommunications.

The decree establishes that the State will guarantee or promote that services are provided under conditions of competition, quality, plurality, universal coverage, interconnection, convergence, continuity, and without arbitrary interference. The Reform included the following (Álvarez, 2017).

- The recognition at the constitutional level of several fundamental rights (right of access to Information and Communication Technologies, rights of audiences and users of telecommunications).
- The establishment of the Federal Telecommunications Institute (IFT for its acronym in Spanish) as the regulatory body for telecommunications.
- The establishment of telecommunications and broadcasting services as public services of general interest.
- The creation of specialized courts in telecommunications, broadcasting and economic competition.
- The establishment that against IFT's rules, acts and omissions only an indirect protection writ of appeal could proceed and the suspension of the act claimed will not be granted.
- The figure of preponderance (Significant Market Power), and the imposition of asymmetric regulation, such as price intervention.
- The obligation to retransmit broadcast signals (must carry, must offer).
- The growth of foreign investment limits.
- The construction of a shared public wholesale network.
- The mandate for the creation of a public broadcasting body.

In 2013 the IFT was established as the regulatory body for telecommunications responsible to implement the Reform (Álvarez, 2017). The creation of specialized courts in telecommunications, broadcasting and economic competition and the figure of preponderance (significant market power operator) were also included in the Reform. Overall, the 2013 Telecommunications Reform was a game changer in

the Telecommunications market, where the state adopted an anti-monopolistic regulatory vision.

Nowadays after the Reform market concentration in telecommunications industry have not changed much. Before the Reform, ICT sector was dominated by two operators in the telecommunications sector by America Movil, and in the broadcast sector by Grupo Televisa.

Both operators held market shares above 60% in every telecommunication product. On the one hand, America Movil's Telmex dominated the 71% of the total subscribers in fixed telephony and 60.2% of the fixed data share. In the mobile segment, America Movil's Telcel held 69% of subscribers in telephony and 68.6% in mobile data. On the other hand, Grupo Televisa held 60.1% in Pay TV and 70% in Free-to-air TV (Álvarez, 2015) .

In 2016 the telecommunication sector impacted 3.6% of the Mexican Gross Domestic Product (IFT, 2016). In the same year, the total fixed telephone lines were 20.03 million, representing penetration of 60 lines per 100 persons. The data show two moments: an increase until 2013 and a decrease after this year. This effect may be due to the fixed-mobile substitution as suggested by the literature (Srinuan et al., 2012; Suárez and García-Mariñoso, 2013; Vogelsang, 2010; Ward and Zheng, 2012).

Regarding fixed-line broadband segment, the market also remains concentrated after de Reform. Despite being a big telecommunications market, only 58 of 100 households are telephone fixed line subscribers and only 47 of 100 households are fixed-line broadband subscribers.

Figure 1 shows that America Movil, maintains by far, market's preponderance and that the second operator only holds 15% of the market. New entrants market's participation is almost despicable.

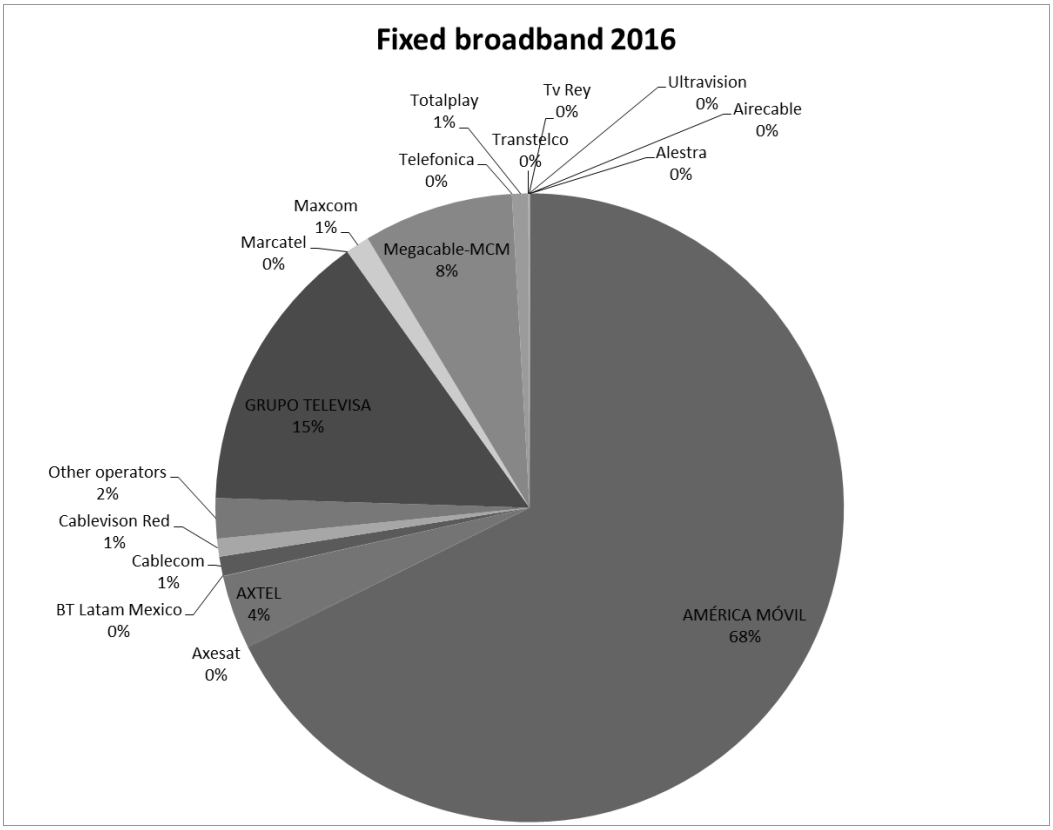

Fig. 1. Distribution of fixed broadband lines by operator. IFT (2016), statistical projects.

3. Methodology

Figure 2 shows the research framework, which includes data from two statistical reports published by INEGI[1]. The 2010 Census and the 2015 Intercensal Survey are statistical reports intended to ensure municipality level statistical representativeness (INEGI, 2010, 2015). Census data provide sociodemographic information described in Table 1 for the 2010 census and in Table 2 for the 2015 Intercensal Survey. For the assessment variables of conditions related to household conditions: type of dwelling (e.g. detached house, mobile house, apartment; etc.), services availability (electricity, drinking water, sewer system, computer, telephone, cell phone and internet) and household income; were used.

[1] The Instituto Nacional de Estadística y Geografía (INEGI for its acronym in Spanish) is the National Agency who regulates and coordinates the National System of Statistical and Geographical Information in Mexico. The INEGI is the Agency who performs: national census and prepare national indexes and others statistical projects.

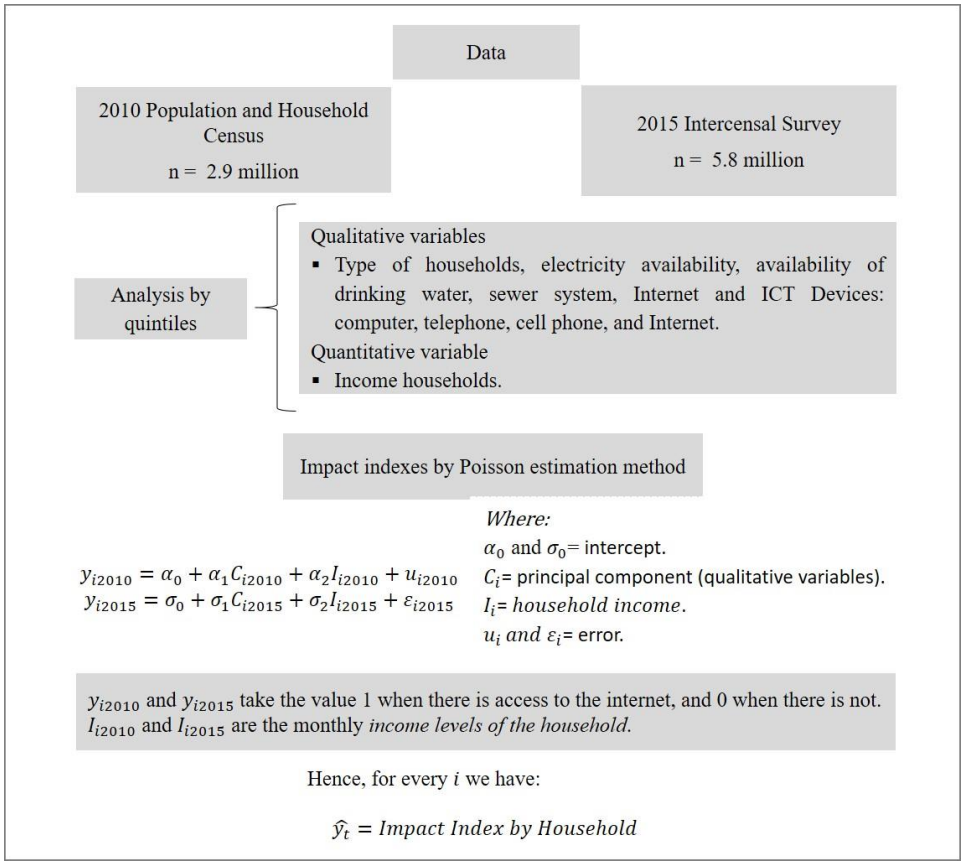

Fig. 2. Conceptual framework.

Variable	Obs	Mean	Std. Dev.	Min	Max
State	2,903,640	17.95129	7.86225	1	32
Municipal levels	2,903,640	81.89604	107.5908	1	570
Type of dwelling	2,903,640	1.09896	0.70309	1	9
Electricity availability	2,885,227	0.954559	0.20827	0	1
Availability of drinking water	2,626,692	0.498773	0.499999	0	1
Sewer system	2,874,519	0.505125	0.499974	0	1
Internet and ICT Device: computer	2,882,847	0.172374	0.377705	0	1
Internet and ICT Device: telephone	2,882,380	0.289679	0.453614	0	1
Internet and ICT Device: cell phone	2,883,058	0.467046	0.498913	0	1
Internet and ICT Device: internet	2,882,004	0.112451	0.315921	0	1
Household income	2,310,550	6380.41	12947.82	0	999998

Table 1. 2010 Descriptive statistics.

Variable	Obs	Mean	Std. Dev.	Min	Max
State	5,854,392	17.84108	7.978077	0	32
Municipal levels	5,854,392	73.98461	96.97825	0	570
Type of dwelling	5,854,392	2.854398	12.24134	0	99
Electricity availability	5,826,321	0.976644	0.151031	0	1
Availability of drinking water	5,514,675	0.53137	0.499015	0	1
Sewer system	5,805,232	0.573734	0.494534	0	1
Internet and ICT Device: computer	5,813,807	0.200574	0.40043	0	1
Internet and ICT Device: telephone	5,812,499	0.242586	0.428647	0	1
Internet and ICT Device: cell phone	5,814,455	0.662042	0.473014	0	1
Internet and ICT Device: internet	5,811,062	0.185564	0.388755	0	1
Household income	4,284,584	7527.837	12833.16	0	999998

Table 2. 2015 Descriptive statistics.

The resultant variable, impact index per household, contains a large number of zeros, because of its categorical nature. Thus an analysis based on Poisson Distribution (Greene, 2008) is proposed because of the data distribution.

The Poisson estimation method is one of the most useful models in internet diffusion studies (Dinterman and Renkow, 2017; Stern et al., 2009; Yamin et al., 2011) and some related studies with the digital divide (Aker, 2008; Prieger, 2013; Yamin et al., 2011).

The Poisson method eliminates correlation between the error term and the explanatory variables, since it assumes a maximum likelihood function with E [X | U]= 1 is its multiplicative form. The Poisson Model is defined by:

$$Prob(Y = y_i|x) = \frac{e^{-\lambda}\lambda_i^{y_i}}{y_i!} \qquad y_1 = 0,1,2,\ldots \tag{1}$$

Where

$\lambda_i > 0$ is a parameter of the distribution.

$Y =$ is the dependent variable ($impact\ index\ per\ household$).

$X =$ is the vector of independent variables (initial conditions of the household – *type of dwelling, electricity availability, availability of drinking water, sewer system, Internet and ICT Device: computer, telephone, cell phone and Internet, and income levels of the household).*

Final equations for each impact index, ones for 2010 and another for 2015, are shown in Figure 2.

4. Results and Discussion

4.1 Income inequalities in the five wealth groups

After the creation of the five wealth groups by the aforementioned method, we confirmed that Mexico is characterized by a significantly unequal distribution of *household income,* as the Consejo Nacional de Evaluación de la Política de Desarrollo Social (CONEVAL for its acronym in Spanish) reported (CONEVAL, 2016). Table 3 shows the average *household income* distribution for 2010 and 2015 by quintile.

Average household income per quintile	2010	2015	Growth
1	$121.67	$1,001.56	$879.89
2	$2,129.59	$3,217.91	$1,088.32
3	$4,174.58	$5,250.57	$1,075.98
4	$7,032.87	$8,402.28	$1,369.41
5	$19,315.09	$20,272.24	$957.15

Table 3. *Household income* distribution.

Figure 3 and figure 4 show the evolution of household income (average), basic monthly basket of goods and welfare monthly threshold from 2010 to 2015 by quintile. It can observe that in all quintiles the variable household income had a

significant growth from year 2010 to year 2015. In 2010 the basic monthly basket of goods per person was 970 MXN and the welfare monthly threshold per person was 2,107 MXN. In 2015 the values were 1,271 MXN and 2,615 MXN respectively (CONEVAL, 2016). This information is important because there are several papers that confirm that internet adoption decreases under poverty conditions (Hampton, 2010; Hargittai, 2004; Norris, 2001).

In fact, income is the most influential factor of access exclusion (Hilbert, 2010). On the other hand, there are also numerous reports confirming the significant role of ICT's in poverty reduction (Cecchini and Scott, 2003; Slater and Kwami, 2005; West, 2015). However, poverty situation creates a vicious circle of digital exclusion as it come with lack of education, digital skills and other socio-demographic factors (Chaudhuri et al., 2005).

It can be observed that in 2010 and in 2015 the first quintile's average household income is below the basic basket of goods line. This information is consistent with the fact that in that 2010 13 million inhabitants (11.3% of the population) lived in extreme poverty and 46.1% (52.8 million inhabitants) lived in poverty (CONEVAL, 2017). As a consequence of this situation, it seems unlikely than a person of this quintile could afford 4.4% of its income on communications, which is the 2016 average spending (INEGI, 2016b).

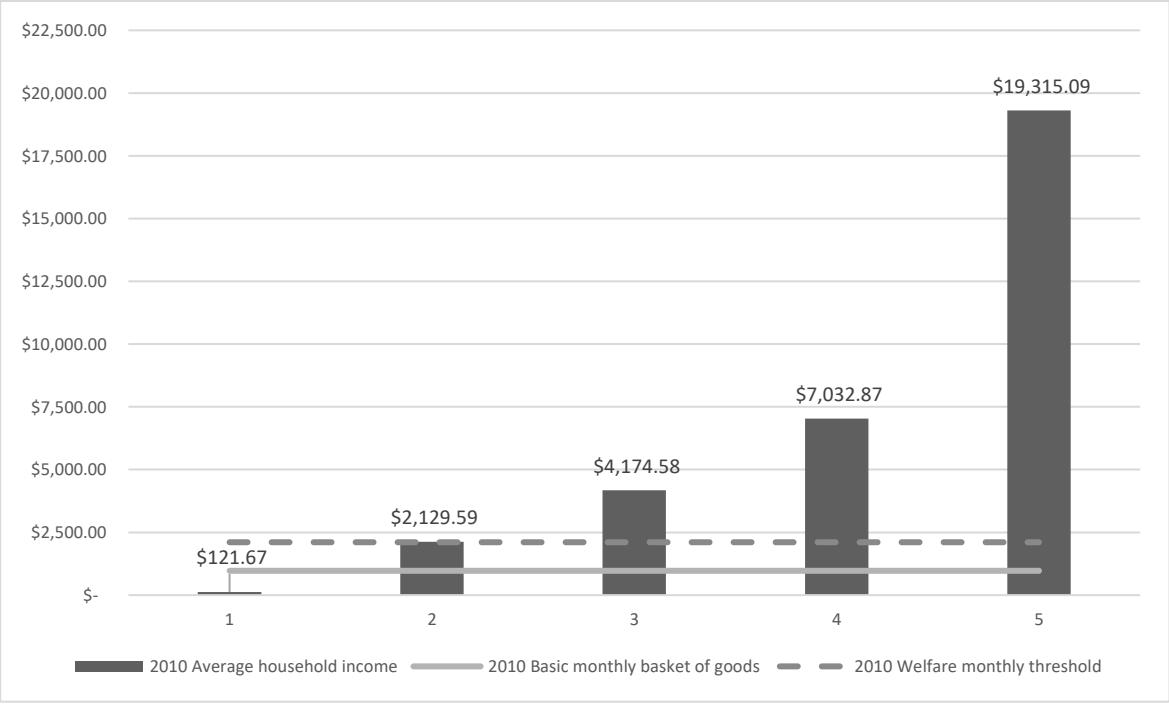

Fig. 3. 2010 average household income distribution.

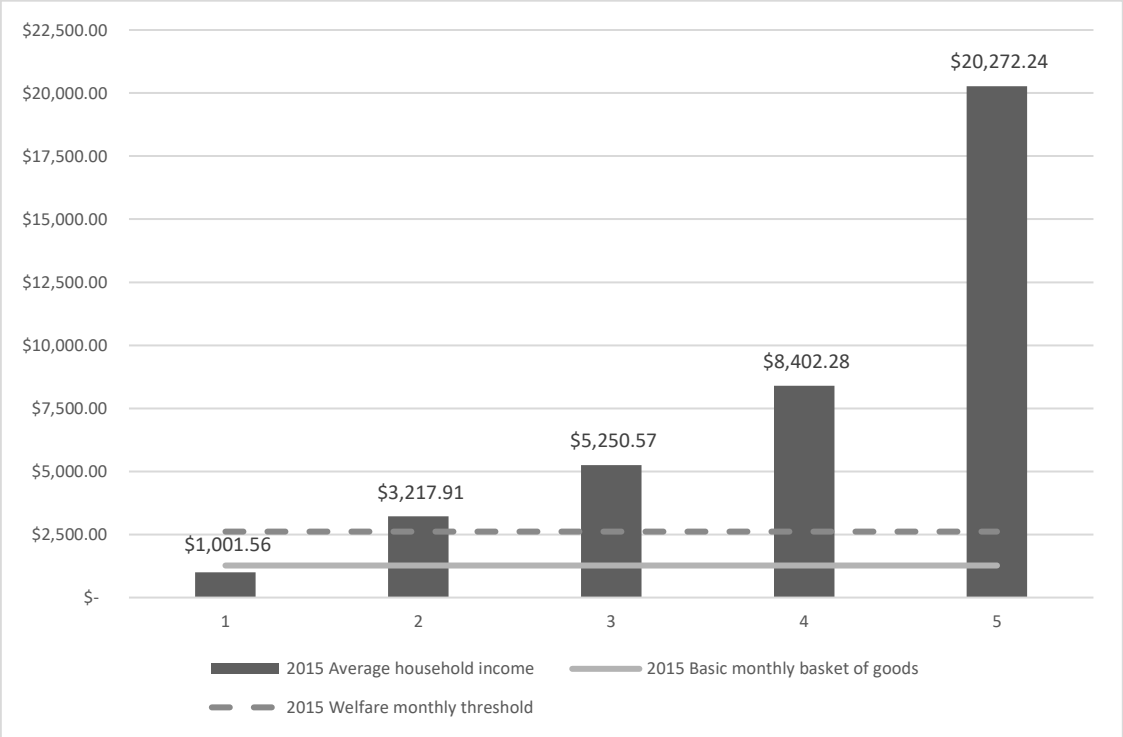

Fig. 4. 2015 average household income distribution.

4.2 Impact index per household results

Impact Index per household (IIpH)	N	Mean	Std. Dev.	Min	Max
IIpH 2010	2,088,838	0.1332629	0.2723592	0.0001439	5.396808
IIpH 2015	4,064,939	0.2210554	0.3138913	0.0025979	4.410047

Table 4. Impact index per household for year 2010 and 2015

Table 4 illustrates impart indexes created for the analysis here developed, and table 5 shows internet penetration per quintile. In the aforementioned table, percentage of households having or no internet in each wealth group is remarked in grey.

Despite the very unequal distribution on internet penetration, it can be observed a positive effect in all the quintiles. A positive overall impact of 66% increase in internet penetration is noted between year 2010 and year 2015.

It may be noted that despite a 66% increase in internet adoption between 2010 and 2015, internet penetration in quintile 1 only reached 1.14% of the population.

On the other hand, in quintile 5, internet penetration reached 76.34% of the population, implying most of the wealthiest households (those in the fifth quintile) have internet. In contrast, in quintile 1 to 3, the groups with the lowest incomes, the penetration level is below 7%. This outcome is not surprising, as internet adoption decreases as household income decreases.

Year	Internet Access	1		2		3		4		5		Total
2010	No	20.09%	99.90%	19.92%	99.70%	19.96%	99.01%	18.99%	96.20%	7.71%	38.55%	86.67%
	Yes	0.02%	0.10%	0.06%	0.30%	0.20%	0.99%	0.75%	3.80%	12.29%	61.45%	13.33%
	2010	**20.11%**	**100%**	**19.98%**	**100%**	**20.16%**	**100%**	**19.74%**	**100%**	**20.00%**	**100%**	**100%**
2015	No	19.98%	98.86%	19.30%	97.52%	18.62%	93.10%	15.25%	76.25%	4.73%	23.66%	77.89%
	Yes	0.23%	1.14%	0.49%	2.48%	1.38%	6.90%	4.75%	23.75%	15.26%	76.34%	22.11%
	2015	**20.21%**	**100%**	**19.79%**	**100%**	**20.00%**	**100%**	**20.00%**	**100%**	**19.99%**	**100%**	**100%**

Table 5. Impact index results by quintile.

Figure 5 illustrates Internet penetration per household's increment between years 2010 and 2015. It is important to note that, despite being below or near the basic basket line, quintile 1 and 2 showed a 1,050% and 717% internet penetration increase, respectively, from 2010 to 2015. This increase represents the most important changes with regard to the other quintiles. However this could be possible due to the extremely low penetration level in the year 2010.

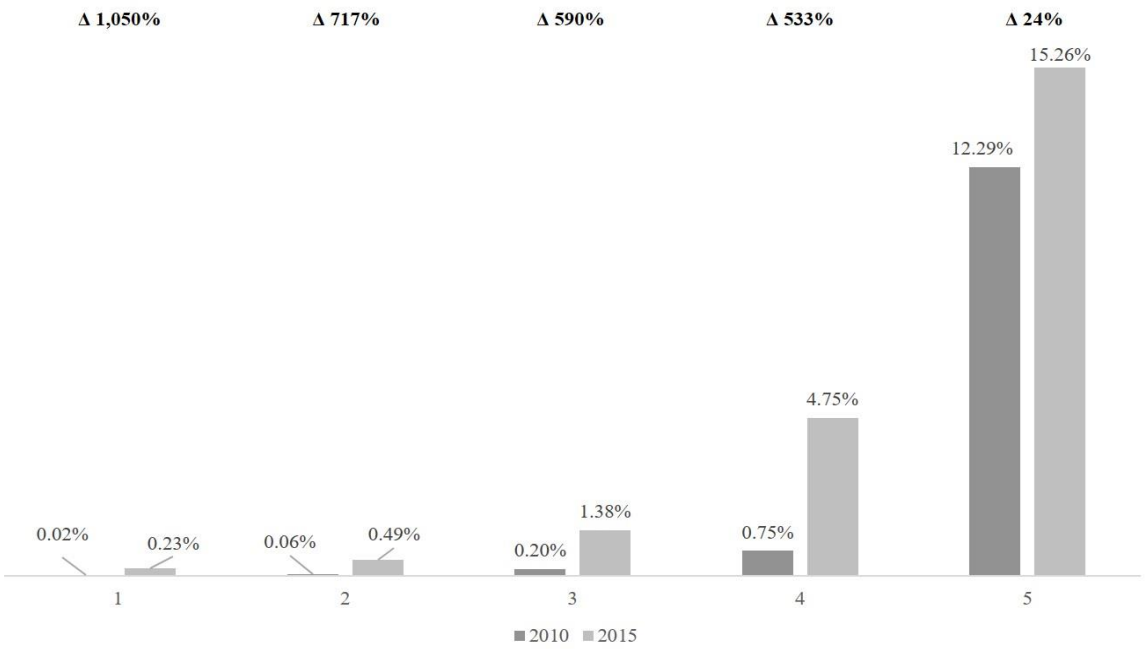

Fig. 5. Internet penetration per household's increment between years 2010 and 2015.

5. Conclusion

The question addressed in this paper is how do Mexican 2013 Telecommunications and broadcasting Reform helped mitigate or exacerbate the digital divide. In particular, we assess if the Reform had an impact on fixed-line internet penetration in Mexico. For the assessment, the 2010 Census and 2015 Intercensal Survey data were used to create impact indexes through Poisson estimations. Results were confronted though a quintile analysis, with the intention of showing the average of internet penetration in each income group.

The data obtained suggest that between 2010 and 2015, internet penetration had positive variations in all the quintiles indicating that recent regulatory changes in telecommunications matter had helped to reduce the digital divide. However, the impact was not homogeneous in all the quintiles; the less connected continue to

experience significant marginalization from society online as the literature reflects (Mossberger et al., 2012).

Internet penetration was more significant in the fourth and fifth quintile (those with higher income) and positive, but less important in the first, second and third quintile (those with lower income). In addition, it was found that the first quintile's average household income was below the basic basket of goods line. As a consequence of this situation, it seems unlikely than a person of this quintile could afford 4.4% of its income on communications, which is the 2016 average spending (INEGI, 2016b). For this reason, it can be concluded that the Reform had helped to reduce the digital divide, but the poorest remains at digital exclusion.

In this paper, we wish to draw attention to the fact that that digital exclusion is a very serious matter. Citizens from the lowest quintile are not taking advantage of the economic and social benefits of a connected society. For this reason expanding the IT budget, especially in digital literacy programs is highly recommended, as literature proves the effectiveness of this measure (Bakay et al., 2011; LaRose et al., 2007). In addition, a broadband universal service program, which includes cross subsidies to the digital excluded, is also recommended, as the lack of economic resources plays a fundamental role for broadband non-adopters.

The main limitation faced in this analysis was a lack of historic data that would enable to perform a more robust assessment. Future works will be centered on the evaluation of the Reform using other analysis methods. The long-term effect of the Reform on market competition, also, deserves a further study.

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