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One goal, many paths: Policy proposals for universal access to broadband in Brazil

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One goal, many paths: Policy proposals for universal access to broadband in Brazil

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Abstract

The purpose is to introduce policy proposals for universal access to broadband, assessing the hypothetical implementation of instruments suggested by the sectoral literature to Brazil. The methodology is based on the analysis of the literature on policies for universal access and broadband plans in the context of Latin America and the Organization for Economic Cooperation and Development (OECD) and the discussion of its effects on related sectoral indicators. Then, the impact of the application of three approaches to universal access policies on indicators of broadband access is estimated: (i) incentive to service offers through allocation of funds for infrastructure deployment in underserved areas, (ii) demand-side stimulus using direct subsidies and (iii) service tax relief. Finally, the expected effects of each policy are compared and a hybrid model to maximize the social benefit of each approach is suggested.

*Keywords***:** Broadband, Policy, Universalization, Brazil.

Introduction

The purpose is to introduce policy proposals for universal access to broadband, assessing measures suggested by the sectoral literature and the impacts of their hypothetical application to Brazil. Although there are studies that address the relationship between development and telecommunications services since the 1980s (Hardy, 1980), studies measuring the impact of broadband access on Gross Domestic Product – GDP, or socioeconomic development in the broad sense, have recently gained prominence in literature (Qiang and Rossotto, 2009; Koutrompis, 2009; EUROPEAN COMMISSION, 2012).

In the meanwhile, governmental actions aimed at expanding high-capacity infrastructure and broadband access in general proliferate globally, and also in Latin America and Europe (Galperin et al., 2012; Calvo, A.G., 2012). Much of the governmental actions under the various plans is based on an analysis of the main bottlenecks found in each region and on globally-discussed public policy recommendations. This paper identifies major public policy recommendations found in the literature, and then we estimate the impact of applying three selected measures to the Brazilian case: (i) incentive to service offers through allocation of funds for infrastructure deployment in underserved areas, (ii) demand-side stimulus using direct subsidies and (iii) service tax relief. Through the evaluation of the impacts of their hypothetical application to Brazil, it posits the possibility of proposing a hybrid model that optimize the use of public resources, given the peculiarities of each approach.

The paper is organized as follows. In the first section, we briefly analyze the literature about universal access policies and broadband plans in Latin America and Organization for Economic Cooperation and Development (OECD) countries. Our interest is to identify policies more adherent to the socioeconomic context of emerging countries.

Secondly, the selected policies, their strengths and weaknesses, the parameters used in each economic model and the estimated impact of each policy to Brazil are described. On the one hand, allocating funds to stimulate infrastructure deployment and telecommunications services provision in underserved areas tend to lead to a restricted impact, considering the territorial limits of these measures. On the other hand, this might be recommended to deploy network infrastructure in isolated areas or to stimulate network deployment with a specific technology (when projects are not feasible in the mid-term). Apart from the expansion of accesses, the projected growth of data traffic in the forthcoming years and the demand for quality of service provision could justify encouraging the adoption of more robust technologies.

Nevertheless, there might be advantages in pushing policy efforts to stimulate service demand. Policies stimulating digital content and applications, video on demand, electronic games, e-government and capacity building for citizens and companies illustrate such policies (COMMERCE COMMISSION, 2012). In this paper, the instrument considered a reference for demand-side stimulus is direct subsidy to broadband service adoption, used in countries like Colombia for lower income families (Vive Digital, 2011). At first glance, this model might be recommended for non-feasible areas in the long-term (i.e. areas in which socioeconomic indicators lead the private sector to understand it may not reach the expected return over investment, even considering a timeline longer than the usually adopted).

Tax relief policies tend to generate a more homogeneous impact over the territory[1]. Apart from that, the following advantages may be highlighted: ease of implementation and impact especially beneficial to low-income population. For a given service package, the impact of a tax relief tend to be higher to low-income families because the price of the service corresponds to a bigger share of their income. The proportion between the price of the service and the average population income is one of the main indicators strongly related the high penetration of broadband service (CEPAL, 2012). However, this measure cannot ensure by itself that prices will be actually reduced to the end-user, or service provision will be expanded to underserved areas, although these effects are expected in markets with some level of competition.

Finally, the expected effects of each policy are compared and a hybrid model to maximize the social benefit of each approach is suggested.

Literature review

Development has been associated to the expansion of broadband by a number of papers and reports, especially since 2009. After analyzing more than 200 papers, a study from Analysys Mason e Tech4i2 (EUROPEAN COMMISSION, 2012) points out nine areas in which the impacts can be highlighted. It must be stressed that a variety of social benefits arise (apart from the economic impact), ranging from an increase in political and social engagement in local communities to benefits for public safety, education, environment and jobs.

[1] Excepting cases where a local authority grants an exemption or special conditions are created, a tax exemption applies to the whole country and all price ranges for a specific service.

The expected impact varies according to the methodology used and the specific subject under analysis. Anyway, it seems that for a given increase in broadband penetration, the impact in GDP gets higher as the level of broadband adoption grows (CEPAL, 2012). For a country with a low broadband penetration, the marginal benefit rises as the broadband adoption spreads throughout society.

In order to benefit from the information society more rapidly, a number of countries have been organizing their efforts to implement structured broadband policies, the so-called national broadband plans. There seems to be a positive correlation between the recent growth of broadband accesses (ITU, 2012) and the existence of a national broadband plan (Galperín et al., 2012; Calvo, A.G., 2012).

Among the policies usually adopted in national broadband plans, it is possible to highlight direct public investment (for instance, through the use of universalization funds), policies encouraging competition, tax reliefs, development of digital content, availability of radio frequency spectrum (on flexible use), sharing best practices with other countries, etc. (Jordán, V., H. Galperin and Peres, W., 2010). Generally, it is expected that each policy will have a severe impact in a specific indicator.

In the aggregate analysis of the sets of actions foreseen in the great variety of plans, it is possible to perceive a different focus as regards the plans of developed countries and those of emerging economies. National broadband plans in the OECD member countries are established in contexts of high levels of access and focus on universalization policies to rural or remote areas and on the increase of the average speed. In addition, they encompass a relatively greater emphasis on political investment in digital content and applications, considered an important factor in generating demand for high capacity network infrastructure.

On a different socioeconomic and political context, emerging countries (including those of Latin America) tend to concentrate efforts on infrastructure and basic broadband service access (with lower speeds). Besides the investment in infrastructure for isolated or underserved areas, tax relief (or tax exemption) policies for broadband services are also recommended, considering the high average tax burden of emerging countries. The low average per capita income of these countries have stimulated demand-side policies using direct subsidies for service adoption – for instance, in Colombia (Vive Digital, 2011), Guatemala and Kenya. Depending on the educational level, there are also capacity-building policies for basic technology use.

With the purpose of optimizing the use of resources, the investment in infrastructure in isolated areas has been implemented through the use of a policy that might be called “reverse auction”. It is an open

call for proposals in which companies compete to comply with obligations established by the Government. This competitive procedure leaves to the private sector the responsibility to define what is the gap that needs to be fulfilled by the Government to make a given investment project feasible (from the private standpoint). Different versions of this policy were adopted in Chile (Proyecto Todo Chile Conectado, 2010) and in the United States (through the Connect America Fund – CAF). More details about this model to encourage infrastructure deployment and other policies to stimulate broadband adoption will be seen in the following section.

Four policy proposals and their estimated impacts to Brazil

As seen in the previous section, international experience and the specialized literature recommend a wide range of public policies to encourage broadband adoption worldwide. Among these instruments, the three types of public policies that seem more adequate to address the challenges of emerging countries were selected: high tax burden, lack of infrastructure, and extreme low propensity to pay, as found in poorest regions.

After the explanation on the methodology used for comparing the public policies proposals, the parameters and results of each one (reduction of taxes on service, direct subsidy to service consumption, and incentives to infrastructural investment) will be described. Subsequently, the combination of the models (hybrid model) will be presented.

Methodology

The result analysis of each proposal will be conducted with basis in two variables: the percentage penetration of fixed accesses (defined as the ratio between the total number of fixed accesses and the number of households) and the average speed of these accesses.

Each explored proposal offers a different result for these variables. Thus, it was necessary to define a valuation grade for each one of the indicators. This was done through a function designed to measure the general impact of each policy when we change each of the two parameters. Considering not only the necessity of prioritizing these two fronts in some way, but also the dependency among the two variables itself, the F function (or “objective function”) was defined in a concave format as:

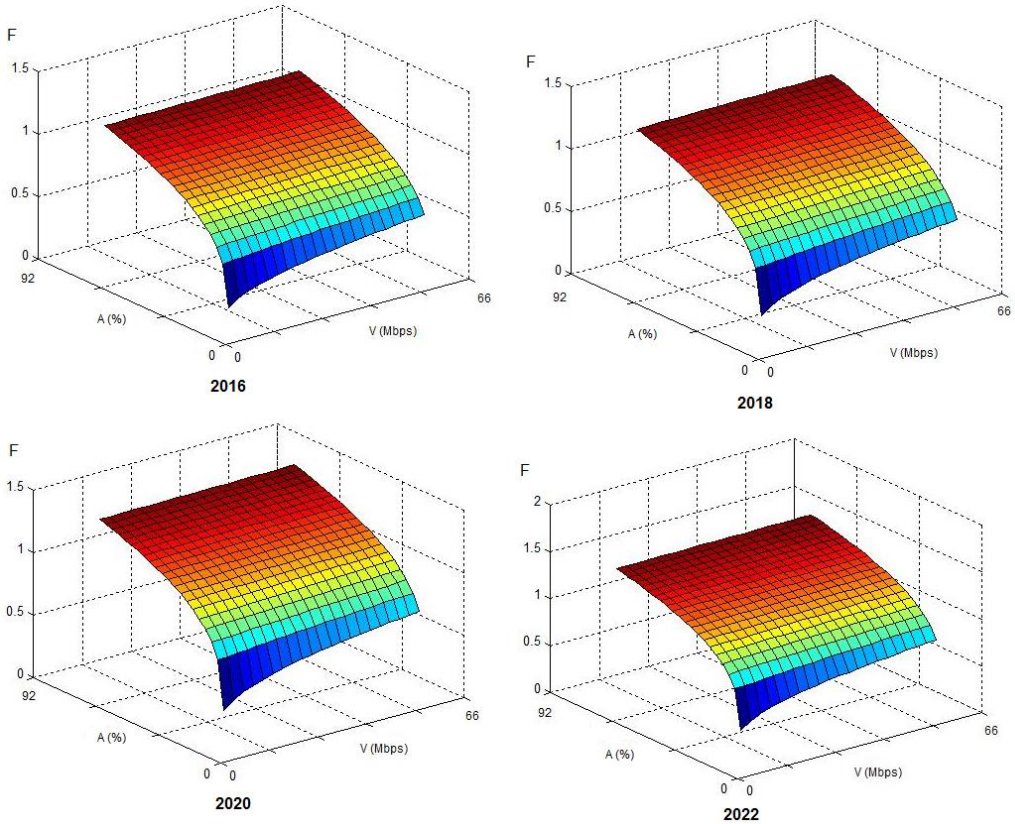
$$F(A,V) = A^{\alpha}V^{\nu}$$

Where A and V are the indicators of the levels of penetration and average speed, respectively. The coefficients α and ν were estimated according to the weight assumed by each one of these variables in the ICT Development Index – IDI – of the International Telecommunications Union (ITU, 2012).

It should be highlighted that, in recent years, indexes designed to measure the incorporation of communication and information technologies have been showing a relative increase in the weight of average speed in relation to the indicators of penetration and access. In index compositions, this fact is revealed in the evolution of reference values. In the calculation of the Network Readiness Index, of the World Economic Forum (WEF,2013), for example, the reference value for international bandwidth per user increased 147% from 2012 to 2013. In the same period, the reference value for indicators related to the penetration (such as the number of households with internet access and the number of households with access to fixed broadband) did not suffer significant alterations.

In the IDI case, the base value for international bandwidth increased from 100,000 bits/s to 408,813 bits/s between 2010 and 2012. These variations were projected to estimate the format of function F through time, as illustrated in Figure 1.

Figure 1. Objective function.



To make the comparison possible, the value of money by the government was defined as the same in all programs, arbitrarily established as US$ 20 billion (twenty billion dollars) in present value in the year 2013.

Besides this financial restriction, each studied model has inherent political limitations. Likewise, in this study, a proposal will be considered successful if it maximizes the function above, respecting financial and political restrictions.

Model 1 – Tax relief

In this section, we deal with the first option of public policy directed at the diffusion of home access to fixed broadband internet in Brazil, which consists in the tax relief of this service provision, with the objective of reducing the price charged from the final user. We begin by introducing the relief proposal and, subsequently, we present in detail the method used to evaluate its impact, based on the calculation of average prices from fiscal data and on the estimation of function of demand for fixed broadband internet through the application of regression techniques to the indicators derived from domestic surveys.

The taxes that are directly levied on the invoice of the fixed broadband internet access service are presented in Table 1.

Table 1. Taxes levied on the invoice of the fixed broadband internet access service.

Tax	**Description**	**Basis of Assessment**	**Aliquot**
ICMS	Tax on the Operations related to the Circulation of Goods and the Provision of Interstate and Intercity Transport and of Communication Services	Invoice Value	25% to 35%
PIS	Tax that funds the Social Integration Program	Invoice Value	3%
Cofins	Contribution to Social Security Financing	Invoice Value	0.65%
Fust	Tax that constitutes the Fund for the Universal Access to Telecommunication Services – Invoice Value deducted of ICMS, PIS and Cofins	Invoice Value deducted of ICMS, PIS and Cofins	1%
Funttel	Tax that constitutes the Fund for Telecommunication Technological Development – Invoice Value deducted of ICMS, PIS and Cofins	Invoice Value deducted of ICMS, PIS and Cofins	0.5%

The relief proposal, which would enter in force in 2013, would mean the reduction to zero for the aliquots of PIS, Cofins, Fust, and the Funttel taxes, which are all taxes of the Union, and the standardization of the ICMS aliquots at 8.5%, which is a tax of competency of states and the Federal District, which, because of that, have autonomy to define their own aliquots.

In the case of Brazil, tax relief has great impact potential for two reasons. First, taxes represent an expressive share of the service price. Thus, in 2012, we calculate that the average monthly price for the service was US$40.00[2], that the average ICMS aliquot on broadband was 26.67%, and that taxes constitute 31.82% of the average price. Therefore, if the relief was implemented in 2012, and integrally relieved from the service invoice, the average price would be reduced to US$30.60, a decrease of 25%.

The average ICMS aliquot is calculated by weighting up the aliquots practiced by the 26 states and the Federal District with the participation of each one of these in the total number of fixed broadband subscriptions. To obtain the monthly average price of the fixed broadband internet service, we used information related to the tax revenues of states and the Federal District, which, because of its special attention from public administration, are considered more trustworthy and representatives than alternative data sources of this service price. The calculation is detailed in Table 2.

Table 2 – Calculation method of the monthly average price of the fixed broadband internet service – aggregated data of the 26 states and the Federal District

Variables and formulas	**Data**	**Sources**	**Time reference**
(a)	Collection of the ICMS on communication services	Confaz(1)	dec/12
(b)	Participation of the fixed broadband internet access service in the proceeds of the service and communication sectors	Telebrasil(2) and Anatel(3)	2012
(c)=(a)*(b)	Collection of the ICMS on fixed broadband internet access service	Authors' calculation	dec/12
(d)	Average ICMS aliquot on fixed broadband internet access service	Authors' calculation(4)	dec/12

[2] US$ 1,00 = R$ 2,00.

(e)	Number of subscriptions to the fixed broadband internet access service	Anatel(5)	dec/12
(f)=(c)/[(d)*(e)]	Monthly average price	Authors' calculation	dec/12

(1) Data obtained in 14/04/2013 from http://www.fazenda.gov.br/confaz/boletim/; (2) Page 62 of the document "O Desempenho do Setor de Telecom Séries Temporais 2012", published by the Brazilian Telecommunication Association (Telebrasil), in http://www.telebrasil.org.br/estatisticas/relatorio; (3) Document published by the National Telecommunication Agency (Anatel) on the brute operational revenue (ROB) and the net operational revenue (ROL) of Multimedia Communication Service (SCM) operators, which is the regulatory denomination of the fixed broadband internet access service, in http://www.anatel.gov.br/Portal/verificaDocumentos/documento.asp?numeroPublicacao=275709&pub=original&filtro=1&documentoPath=275709.pdf; (4) The average aliquot is calculated by weighting up the different ICMS aliquots, practiced by the 26 states and the Federal District, by their participation in the total number of fixed broadband subscriptions; (5) Data obtained in 14/04/2013 in http://sistemas.anatel.gov.br/SICI/Relatorios/IndicadorDesempenhoPresenteMunicipio/tela.asp.

The weight of taxes in the invoice value is evident in Table 3, below, which presents the monthly average prices (calculated according to the method detailed in Table 2) and the taxes levied on each subscription to the fixed broadband internet access service from 2010 to 2012. Moreover, the table presents projections of price and tax revenue for the years of 2014, 2018, 2020, and 2022 in two scenarios: with and without implementing the tax relief proposal. The projection considers that prices will fall until 2016, at the average annual rate observed in the last three years, and that, from 2017 onwards, they will remain constant. The underlying hypotheses is that the prices stop falling because the competition begins to focus on supplying access with greater speed and quality, with access network in majority based in fiber optics, usually more expensive than the accesses supported mainly by braided copper cables and coaxial cables.

Table 3. Monthly average and taxes levied on each subscription to the fixed broadband internet access service with and without implementing the tax relief proposal – 2010, 2011, 2012, 2014, 2018, 2020, and 2022.

Current Values (US$ 1.00)	**Analyzed years**				**Projected years**			
	2010	**2011**	**2012**	**Annual average variation**	**2014**	**2018**	**2020**	**2022**
	(a)	**(b)**	**(c)**	**(d)=[(c)/(a)]$^{1/2}$ -1**	**(e)=(c)*[1+(d)]^{2}**	**(f)=(c)*[1+(d)]^{6}**	**(g)=(c)*[1+(d)]^{8}**	**(h)=(c)*[1+(d)]^{10}**
Price **without** relief	48.37	46.86	40.80	-8.16%	34.41	29.03	29.03	29.03
PIS+Cofins(1)	1.77	1.71	1.49	n/a	1.26	1.06	1.06	1.06
Fust+Funttel(2)	0.51	0.49	0.43	n/a	0.36	0.30	0.30	0.30
ICMS(3)	12.86	12.47	10.88	n/a	9.18	7.74	7.74	7.74
Price with relief	n/a	n/a	n/a	n/a	25.81	21.77	21.77	21.77
PIS+Cofins(4)	n/a	n/a	n/a	n/a	0.00	0.00	0.00	0.00
Fust+Funttel(5)	n/a	n/a	n/a	n/a	0.00	0.00	0.00	0.00
ICMS(6)	n/a	n/a	n/a	n/a	2.19	1.85	1.85	1.85

(1) 3.65% Aliquot; (2) 1.5% Aliquot; (3) Average aliquot of 26.59% in 2010, 26.61% in 2011, and 26.67% in 2012 and the following years; (4) Zero aliquot; (5) Zero aliquot; (6) Uniform aliquot of 4%.

Second, the relief may be relevant because there are evidences that the broadband service demand is sensitive to price variations. There are several empirical studies that estimate high values for the price elasticity of demand for fixed broadband internet in Brazil. Ávila (2008) finds values between -1.00 and -3.36; Guedes, Pasqual, Pitoli e Oliva (2008) found -2.00; and Macedo e Carvalho (2010) estimate values between -1.92 and -2.15. Thus, an eventual reduction in the average price caused by tax relief would result in a significant increase in the numbers of subscriptions of fixed broadband service.

Hence, in this section, to evaluate the potential impact of the relief proposed, we estimate functions of demand for fixed broadband internet in Brazil. These functions make it possible to quantify the demand in two scenarios with different prices: with and without the relief proposal. For this reason, inspired by the research of Macedo e Carvalho (2010), we use exponential regression equations:

$$D = Se^{\alpha P},$$

Where P is the monthly price for the fixed broadband internet access service, D is the demand for the service, S is the level of saturation of the demand (i.e., the demand that would be found if the price of the service P was equal to zero) and α is the damping coefficient and one of the components of the price elasticity of demand[3], defined as $\varepsilon = \alpha P$.

The saturation S and the damping coefficient α are parameters estimated by the Ordinary Least Squares (OLS) method from data of price P and demand D. The latter is obtained by the researches of CGI.br (2011,2012)[4], which indicate the proportion of people willing to acquire internet access for different levels of service price, in 2010 and 2011, respectively. The data is presented in Table 4.

Table 4. Proportion of people that declare to be willing to acquire internet access service for different levels of service monthly prices –

Price	**2010**	**2011**	**Absolute Variation**
More than US$ 125	1%	1%	0%
Not more than US$ 125	2%	2%	0%
Not more than US$ 100	3%	3%	0%
Not more than US$ 75	5%	6%	1%
Not more than US$ 50	12%	13%	1%
Not more than US$ 40	17%	20%	3%
Not more than US$ 35	23%	26%	3%
Not more than US$ 25	36%	41%	5%
Not more than US$ 20	45%	50%	5%
Not more than US$ 15	56%	62%	6%

[3] Therefore, for a larger α, more sensitive the demand will be to price variations.

[4] K2 indicator: the maximum value declared for acquisition of internet access (percentage of the total population aged 16 or above). See http://cetic.br/usuarios/tic/2010-total-brasil/rel-aquisicao-02.htm and http://cetic.br/usuarios/tic/2011-total-brasil/rel-aquisicao-02.htm

Not more than US$ 10	64%	68%	4%
Not more than US$ 5	69%	73%	4%
Would not pay	31%	27%	-4%

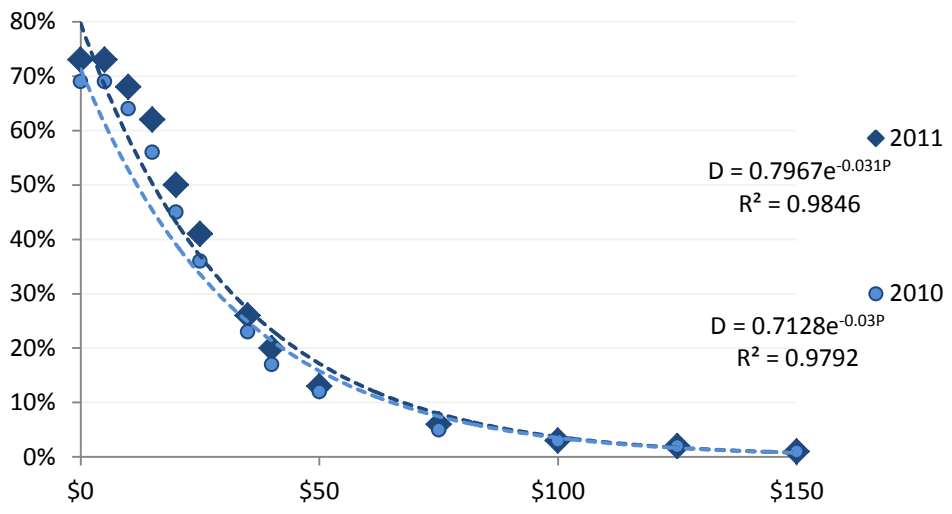
In this study, *we defined the demand D for broadband internet as the domestic penetration of this service (i.e., the proportion of households that have this service)* and we assumed that this value is the same as the proportion of people that would be willing to acquire the internet access service. Besides of having unavailable data on the disposition to pay for fixed broadband internet, this equality is justified by three reasons:

i. The studies from Cetic.br have a domestic characteristic and their surveys are submitted to only one resident of each household;
ii. Generally speaking, a household is served by only one subscription of the fixed broadband service, which is share by all its residents
iii. According to this research, the great majority of internet accesses are fixed broadband. In fact, in 2010 and in 2011, more than 70% of domestic accesses to the internet were fixed broadband.

Below, Figure 2 presents the combinations of price and demand (the same exposed in Table 4), in dispersion graphs, the regression equations estimates by OLS, the determination coefficient of these equations, and the drawing of the resulting curves for the years 2010 and 2011[5]. Both the curve outline and the determination coefficients reveal that the exponential regression model is adjusted to the data observed in 2010 and 2011, and, therefore, adequate to explain the variations of the demand for the fixed broadband internet service.

Figure 2. Price-demand coordinates, exponential curve, regression equation, and determination coefficient – 2010 and 2011.

[5] To estimate the regression model, the disposition to pay more than US$ 125.00 was arbitrarily redefined as the disposition to pay not more than US$ 150.00. Moreover, since the saturation *S* levels do not go over 1 (i.e., 100%), we chose to maintain the regression model estimate without restriction *S* values, even considering that the data shows that only 69% and 73% of households would have broadband internet even if the service was free, in 2010 and 2011, respectively. In reality, the determination coefficient values in the models where *S*=0.69 and *S*=0.73, i.e., the level of adjustment of the models to the data, were below those obtained by the unrestricted models.



The function estimation makes quantifying the demand for any given price possible, and not only to those considered by the Cetic.br (2011,2012) studies. Particularly, it enables the demand to be measured before and after the reduction resulting from implementing the tax relief proposal.

To estimate the demand curves from 2013 to 2022 by the method adopted here, it is necessary to project the price-demand coordinates for each year included in this timeframe. This is done through the following:

i. We take as a basis the price-demand coordinates of 2011 (last year with available data) and add an appropriate multiple of the absolute annual variation of demand, registered between 2010 and 2011, to the correspondent price level. These data is available from previous years, but we decided to use the most recent annual variation for considering that the demand will continue to significantly increase in the next decade, since only recently the Brazilian population began to prioritize the purchase of a computer and acquisition of a fixed broadband internet service.

ii. We introduced three logic restrictions:
   a. A value of 100% is attributed to demand projections projected higher than 100%;
   b. A value of 0% is attributed to demand projections projected lower than 0%;
   c. The demand at a given price level must be at least the same as the demand on the immediate previous price level.

Table 5 and 6 present the price-demand coordinates observed in 2010 and 2011 and those projected for the year selected between 2013 and 2022, with and without the imposition of the logic restrictions (highlighted in italic), respectively.

Table 5. Demand for observed and projected fixed broadband internet, without logic restrictions, for different levels of monthly service price – 2010, 2011, 2014, 2018, 2020, and 2022.

Monthly Price	**Analyzed Years**			**Projected Years**			
	2010	**2011**	**Absolute Variation**	**2014**	**2018**	**2020**	**2022**
	(a)	**(b)**	**(c)=(b)/(a)-1**	**(d)=(b)+(c)*3**	**(e)=(b)+(c)*7**	**(f)=(b)+(c)*9**	**(g)=(b)+(c)*11**
More than US$ 125	1%	1%	0%	1%	1%	1%	1%
Until US$ 125	2%	2%	0%	2%	2%	2%	2%
Until US$ 100	3%	3%	0%	3%	3%	3%	3%
Until US$ 75	5%	6%	1%	9%	13%	15%	17%
Until US$ 50	12%	13%	1%	16%	20%	22%	24%
Until US$ 40	17%	20%	3%	29%	41%	47%	53%
Until US$ 35	23%	26%	3%	35%	47%	53%	59%
Until US$ 25	36%	41%	5%	56%	76%	86%	96%
Until US$ 20	45%	50%	5%	65%	85%	95%	105%
Until US$ 15	56%	62%	6%	80%	104%	116%	128%
Until US$ 10	64%	68%	4%	80%	96%	104%	112%
Until US$ 5	69%	73%	4%	85%	101%	109%	117%
Would not pay	31%	27%	-4%	15%	-1%	-9%	-17%

Table 6. Demand for observed and projected fixed broadband internet, with logic restrictions highlighted in italic, for different levels of monthly service price – 2010, 2011, 2014, 2018, 2020, and 2022.

Monthly Price	Analyzed Years			Projected Years			
	2010	**2011**	**Absolute Variation**	**2010**	**2011**	**Absolute Variation**	**2010**	**2011**
	(a)	**(b)**	**(c)=(b)/(a)-1**	**(a)**	**(b)**	**(c)=(b)/(a)-1**	**(a)**	**(b)**
More than US$ 125	1%	1%	0%		1%	1%	1%	1%
Until US$ 125	2%	2%	0%		2%	2%	2%	2%
Until US$ 100	3%	3%	0%		3%	3%	3%	3%
Until US$ 75	5%	6%	1%		9%	13%	15%	17%
Until US$ 50	12%	13%	1%		16%	20%	22%	24%
Until US$ 40	17%	20%	3%		29%	41%	47%	53%
Until US$ 35	23%	26%	3%		35%	47%	53%	59%
Until US$ 25	36%	41%	5%		56%	76%	86%	96%
Until US$ 20	45%	50%	5%		65%	85%	95%	*100%*
Until US$ 15	56%	62%	6%		80%	*100%*	*100%*	*100%*
Until US$ 10	64%	68%	4%		80%	*100%*	*100%*	*100%*
Until US$ 5	69%	73%	4%		85%	*100%*	*100%*	*100%*
Would not pay	31%	27%	-4%		15%	*0%*	*0%*	*0%*

Based in the data from Table 6, we created the demand functions for each year of the period between 2013 and 2022, using the exponential regression model. In the majority of projected years, not to compromise the adjustment of the model, we chose not to fixate the level of saturation in 1, and we truncated the functions to guarantee that the demand would not surpass 100% at any given price[6].

The data projected to 2014, 2018, 2020, and 2022, the exponential regression curves, their determination coefficients, and the truncation of the demand functions in 100% are presented in Figure 3.

[6] The demand functions were truncated from the year 2016 onwards.

Figure 3. Price-demand coordinates, regression equation, determination coefficient, regression curve, and truncation in 100% - 2014, 2018, 2020, and 2022.

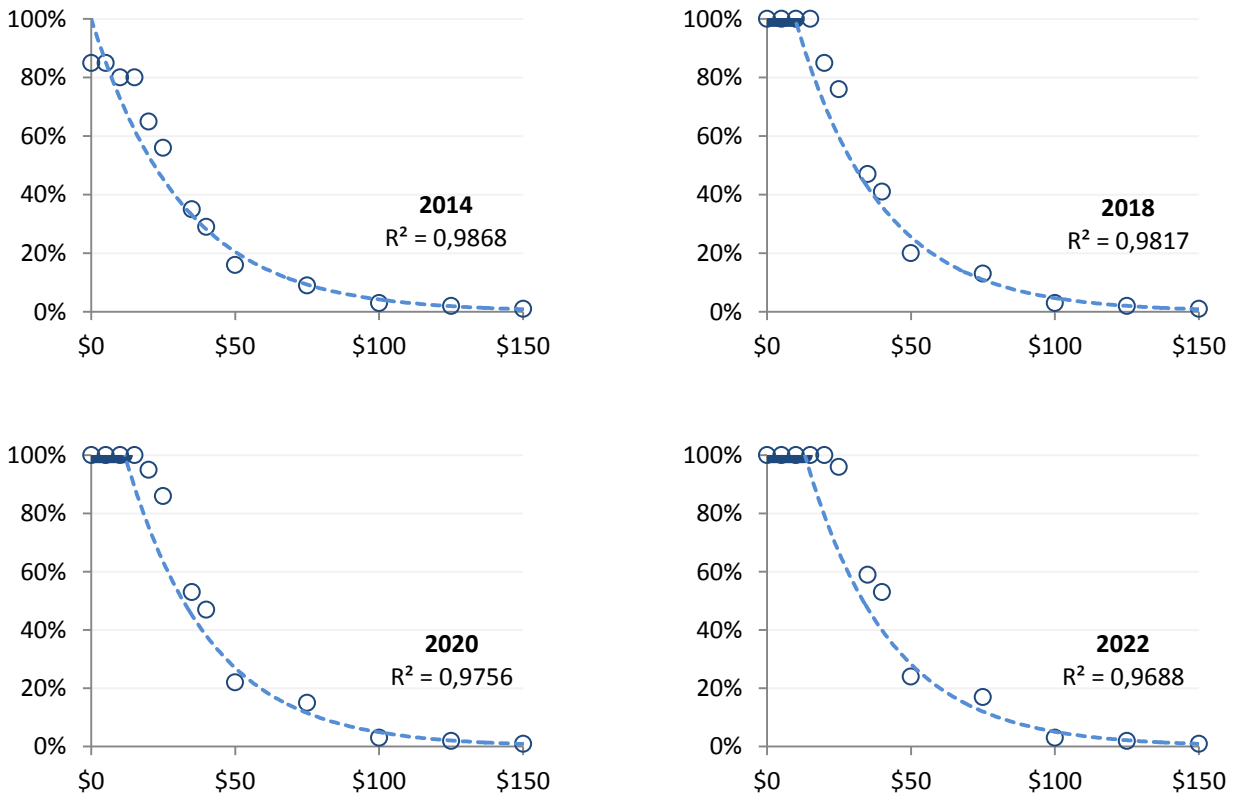


Table 7, below, presents the parameters of the demand functions for broadband internet access service, besides of showing the projected monthly average prices, with and without tax relief, and the correspondent demand.

Table 7. Parameters of the demand functions, monthly average prices and the estimated demand of the broadband internet access service, with and without tax relief – 2014, 2018, 2020, and 2022.

Current Values	**2014**	**2018**	**2020**	**2022**
Saturation level (*S*)	1.0000	1.3916	1.4879	1.5694
Damping coefficient (α)	-0.0317	-0.0339	-0.0341	-0.0343
Truncation price levels(1)(US$ 1.00)	n/a	9.74	11.64	13.15
Price **without** relief (US$ 1.00)	34.41	29.03	29.03	29.03
Demand **without** relief	33.6%	52.0%	55.2%	58.0%
Price **with** relief (US$ 1.00)	25.81	21.77	21.77	21.77
Demand **with** relief	44.1%	66.5%	70.7%	74.4%

(1) Lowest price for which the demand is forced to be equal to 1 (100%).

The tax relief, if relieved in its entirety from the value of the monthly service invoice, would reduce the price in all analysed years by 25%. Consequently, the domestic penetration of fixed broadband internet, in 2022, would pass from 58.0% to 74.4%, which would mean an increase of 28% in the demand for this service. Hence, the model developed in this section indicates that the price elasticity of demand for fixed broadband internet in Brazil[7] is equal to -1.13 in the medium-term[8].

What is left is to measure the absolute magnitude of the benefit generated by the relief. It means the quantity of households that would begin to have the fixed broadband internet access service as a result from the implementation of this public policy. Moreover, the cost, measured as the loss of tax revenue

[7] $(\Delta D/Q)*(\Delta P*P) = 0.28/-0.25 = -1,13$

[8] In the short-term, 2013, the calculated price elasticity is equal to -1.41.

(both from the Union and from the states and the Federal District) resulting from the relief process, needs to be assessed.

Table 8, below, shows the benefits and costs from the relief proposal in selected years in the period between 2013 and 2022. To calculate these magnitudes, we linearly projected the stock of Brazilian households for all the years in the period, considering the census survey undertaken in 2010[9] and the projections for 2017 and 2020, found in EPE (2012).

Table 8. Households stock and the impact of tax relief upon the households stock with fixed broadband internet access service and upon the tax revenue of this service – 2014, 2018, 2020, and 2022.

Current values	**2014**	**2018**	**2020**	**2022**	**Total[(1)] (2013-2020)**
Total stock of households (millions)	64.6	71.6	74.5	77.5	77.5
Scenario **without** tax relief					
Stock of households with fixed broadband (millions)	21.7	37.2	41.2	44.9	44.9
Tax revenues (US$ billions)	2.81	4.07	4.50	4.91	38.19
Scenario **with** tax relief					
Stock of households with fixed broadband (millions)	28.5	47.6	52.7	57.6	57.6
Tax revenues (US$ billions)	0.75	1.06	1.17	1.28	9.99
Benefit from tax relief – addition to the households stock with fixed broadband	6.8	10.4	11.6	12.7	12.7
Cost of tax relief – reduction in tax revenues	2.1	3.0	3.3	3.6	28.2

(1) The same as the value of 2022 in the case of stock variables (quantity of households); the same as the aggregate of values from 2013 to 2022 for the rest of the variables.

[9] Data published by the Brazilian Institute of Geography and Statistics (IBGE). They can be accessed at: http://www.sidra.ibge.gov.br/bda/tabela/listabl.asp?c=1134&z=cd&o=7

In 2014, in the absence of a tax relief policy, the households stock with access to fixed broadband internet would be equal to 21.7 million. With the relief, this number increases in 6.8 million and would arrive at 28.5 million. In addition, the tax revenue, which would be US$ 2.81 billion, would be reduced to US$ 750 million, a loss of US$ 2.1 billion.

Therefore, according to the method developed in this section, by the end of 2022, the tax relief policy would have added 12.7 million of households to the households stock with fixed broadband and would have cost US$ 28.2 billion, in current values, for the public funds. In constant values[10] of 2013, this would amount to US$ 19.9 billion or R$ 40 billion, approximately. Table 9 shows the results of function F for this approach.

Table 9. Model 1 – Service tax relief: Projected impact

	2016	**2018**	**2020**	**2022**
Accesses/household	62%	69%	74%	78%
Subscribed speed (average)	15.28	24.43	31.29	36.62
Objective function	0.8751	0.9826	1.0812	1.1839

Finally, considering the possibility that a tax relief measure is adopted together with other public policies to promote the diffusion of fixed broadband domestic access, we designed a proposal of tax relief that corresponds to waiver of R$ 20 billion in tax revenue, half of the total amount of public resources that would be available for application in public policies to promote the diffusion of fixed broadband internet domestic access. In this case, which will be detailed in Model 4, the aliquots for Union taxes would still be zeroed, but the aliquot for the ICMS would be fixated at 20%, resulting in an increase of 6.8 million to the stock of households with fixed broadband, by the end of 2022.

[10] Considering an annual discount rate of 7%.

Model 2 – Direct subsidy to service consumption

The direct subsidy to service consumption model consists in the monthly financial allowance to the user to sign a broadband service contract. This model seems to be the appropriate for pollutions with extremely low income.

A direct political restriction to this proposal is its scope, which necessarily needs to be defined on low income families. From the side of the penetration result, this restriction prevents an optimal allocation of resources, since there are households that would be willing to receive a lower subsidy to sign a service contract, but that would not be included in the program for being in upper classes.

To calculate the results, the same curves of willingness to pay detailed in Model 1 were used, but disaggregated by income class. Keeping the focus on low income classes (families with monthly income lower than 2 minimum wages), it was estimated how much would be spent by the government to subsidise the service for families that were willing to pay at least US$ 2.50 for the service between the years of 2013 and 2022. Additionally, for this proposal, the cost of access terminals for households that did not have computers was considered.

Table 10 evidences the result of the Objective function with the subsidy directed at different prices and speed plans. For the Basic, Intermediary and Advanced Plans, we adopted the monthly prices of US$ 17.5, US$ 30, and US$ 50, and the initial subscribed speeds of 1, 4, and 20 Mpbs. The price reduction of the signed Mpbs was considered by projecting an annual evolution of 20% for speeds, keeping prices constant.

Table 10. Model 2 – Subsidy to Service: Projected Impact

	2016	**2018**	**2020**	**2022**
Plan 1 – Subsidized Package = US$15.00				
Accesses/household	55%	61%	65%	69%
Subscribed speed (average)	13.09	20.77	26.86	31.31
Objective function	0.8438	0.9489	1.0477	1.1508
Plan 2 - Subsidized Package = US$ 25.00				
Accesses/household	50%	55%	59%	62%
Subscribed speed (average)	14.59	23.50	29.97	35.61

Objective function	0.8274	0.9320	1.0295	1.1325
Plan 3 - Subsidized Package = US$ 50.00				
Accesses/household	49%	55%	58%	61%
Subscribed speed (average)	15.55	25.28	31.75	36.50
Objective function	0.8276	0.9327	1.0297	1.1316

As it can be seen, the Basic Plan is the one that maximizes the function F, i.e., it is advised that the governmental subsidy be directed to cheaper plans, with lower speed.

One of the negative aspects of this model is that the subsidies to demand only create indirect structural investments. More than that, to reduce the cost per family and maximize the Objective function, this indirect stimulus should go the most basic technologies. Thus, the resources are not redirected to technologies that ensure a higher perpetuity and that contribute to the evolution of networks in the long-tem. Likewise, since it is a guaranteed amount of resources for a determined income class, the public funds can take on a continuity character.

One of the positive aspects of this implementation is the large impact in the short-term penetration. The issue of the perpetuity of the guaranteed resources can be mitigated by the gradual reduction of the subsidy, by family. This reduction was considered in the calculation through the projection of the increase in the willingness to pay, according to what was explained in model 1. However, the effect of the relative increase in the utility of the service in relation to other goods and services, in the family basket, can be even greater when catalyzed by the subsidy towards a first contact with the service.

Model 3 – Incentives for investment in infrastructure

The third model of public funding is the financing of network infrastructure for regions with low economic viability in the short and medium terms. As explained when describing the international experience, one way to make the transfer viable is through reverse auctions with a compromise of coverage and prices.

One restriction for this type of implementation is that the governmental investment must take place in technologies with some level of perpetuity (“future proof”). A second condition, and more intuitive, is that these investments could not be directed to areas with families with higher willingness to pay for the service.

Likewise, to simulate the result, we considered a governmental allowance to implementing the network infrastructure for FTTH access, with coverage and prices compromises for the entrance plan. The CapEx and OpEx costs were estimated based in the international experience and in business models for the Brazilian case. The curves described in Model 1 were used for the demand. Also, the financial restriction of US$ 20 billion to the Net Present Value (NPV) of the project, in the period between 2013 and 2030, was followed.

For the service price, an entrance plan was set, with speed of 40 Mpbs with a regulated price, and packages of higher speed without price regulation. For the calculation of the NPV of the cash flow of the business model, we considered the additional revenue from the exploration of TV and phone services. The internal return rate was fixated at 7% a year.

Table 10 evidences the result of the simulation. As it can be seen, the number of subscribed accesses increases when the determined price for the entrance plan is reduced. However, keeping the financial restriction in place, the average speed per access drops, since the required coverage is lower, causing the reduction of subscription to unregulated plans, which are those that can be offered at higher prices and speed. In relation to the two previous models, this proposal achieves higher average speed per access due to the investment focus on superior technologies.

Table 11. Model 3 – Incentives for investment in infrastructure: Projected Impact.

	2016	**2018**	**2020**	**2022**
Plan 1 – Subsidized Package = US$10.00				
Accesses/household	50%	55%	59%	63%
Subscribed speed (average)	18.36	28.47	35.82	41.95
Objective function	0.8348	0.9396	1.0363	1.1428
Plan 2 - Subsidized Package = US$ 20.00				
Accesses/household	47%	52%	55%	58%
Subscribed speed (average)	20.57	32.28	41.26	51.59
Objective function	0.8290	0.9320	1.0293	1.1346

Model 4 – Combining Models 1, 2, and 3

The fourth model is a combination of the previous three models, in an effort to extract the positive aspects of each one and to try to implement a better adjustment to the evolution of the Objective function (function F).

Table 12 illustrates the amount of resources directed for each model and the periods proposed for their implementation.

Table 12. Model 4 – Combined Solution: Implementation Proposal

	2016	**2018**	**2020**	**2022**	**NPV Government Cost (US$ bi)**
Model 1 - Service tax relief	✓	✓	✓	✓	10,00
Model 2 - Service subsidy	✓	✓			5,00
Model 3 - Incentives for Investment in infrastructure			✓	✓	5,00

The good response from F to the tax relief model justifies the greater focus of resources in this proposal and the maintenance of this model during the whole time. The subsidy model is interesting for the first years, because, in this period, the demand for the service, in the low income classes, is, still, significantly low. Thus, in this implementing model, there is a reduction of the resources wasted for the subsidy of families that would have subscribed to the service even without the program. Moreover, the fast, and with significant impact in penetration, result of the subsidy model creates more impacts in F during the first years, when relative weight of α is still greater than that of ν (Figure 1).

To implement Model 3 in the last five years and combined with the other proposals significantly optimizes the result of the program in relation to the isolated proposal of Model 3. First, the increase in average speed in the model creates more impact in the function F in the last years, due to the gradual increase of parameter ν of the Objective function as time progresses. Second, there is a significant reduction in public expenditure thanks to the evolution of the willingness to pay in the final years and to the reduction in CapEx to the construction of the FTTH access network. Finally, the use of the model, combined with the other two proposals, enables a more flexible political restriction to investment in all the regions of the country. Since there will be already in place proposals directed to lower income classes (subsidy to service) and for the population as a whole (tax relief), the investments in

infrastructure can begin in municipalities with higher population density, which would reduce the coverage cost, and in regions with greater willingness to pay for the service.

Table 13 shows the result of this proposal.

Table 13. Model 4 – Combined Solution: Projected Impact

	2016	**2018**	**2020**	**2022**
Accesses/household	63%	70%	69%	70%
Subscribed speed (average)	15.20	24.35	44.28	65.52
Objective function	0.8775	0.9840	1.0808	1.1853

Conclusion

This study explored recent models that have been adopted to expand the broadband access service. Among the described models, three were analyzed from the point of view of its impacts in the penetration and average speed indexes: reduction of taxes on service; direct subsidy for the consumption of service; and incentive for investment in infrastructure. To estimate the impact of each proposal, an Objective function was constructed, and it had the ICT Development Index, from the ITU, as a basis. The tax reduction model created significant impacts in the service penetration, because the overall decrease of prices enables families with a higher propensity to pay to subscribe to the service. The subsidy model presented a good short-term impact in penetration, but it proved weak because of the focus of investment only in the most basic technologies, creating a growing waste by financing families that would already subscribe to the service, and because of the political restriction to subsidize families with a lower propensity to pay. The incentive to investment in infrastructure model resulted in a good response in the speed parameter, but low impact in the increase of number of new accesses. In the end, a fourth model was proposed, it tried to extract the positive aspects of each one of the initial models and those which better aligned with the variations of parameters α and ν of F. This model was the one that maximized the Objective function for a greater part of the studied period.

References

Ávila, F. (2008) Banda larga no Brasil: uma análise da elasticidade preço-demanda com base em microdados, Monografia de graduação do curso de Economia, Supervisor: Maria Eduarda Tannuri-Pianto, Universidade de Brasília (UnB).

Calvo, A. G. (2012) Universal Service Policies in the Context of National Broadband Plans, OECD Digital Economy Papers, No. 203, OECD Publishing. Available at: http://dx.doi.org/10.1787/5k94gz19flq4-en.

CEPAL. (2012) Estado de la Banda Ancha en América Latina y el Caribe, 2012: Informe del Observatorio Regional de Banda Ancha (ORBA). Disponível em: http://www.cepal.org/Socinfo.

EUROPEAN COMMISSION. (2012) The socio-economic impact of bandwidth. Final Report. Elaborado por Analysys Mason Ltd e Tech4i2 Ltd. SMART 2010/0033. Available at: http://ec.europa.eu/digital-agenda/en/news/study-socio-economic-impact-bandwidth-smart-20100033.

COMMERCE COMMISSION. (2012) High speed broadband services demand side study, New Zealand. Available at: http://www.comcom.govt.nz/high-speed-broadband-services-demand-side-study.

CGI.br. (2011) TIC Domicílios e Empresas 2010: Pesquisa sobre o Uso das Tecnologias de Informação e Comunicação no Brasil, Comitê Gestor da Internet no Brasil (CGI.br), São Paulo. Available at: http://op.ceptro.br/cgi-bin/cetic/tic-domicilios-e-empresas-2010.pdf.

_____. (2012) TIC Domicílios e Empresas 2011: Pesquisa sobre o Uso das Tecnologias de Informação e Comunicação no Brasil, Comitê Gestor da Internet no Brasil (CGI.br), São Paulo. Available at: http://op.ceptro.br/cgi-bin/cetic/tic-domicilios-e-empresas-2011.pdf.

EPE. (2012) Projeção da demanda de energia elétrica para os próximos 10 anos: 2013-2022, Série Estudos da Demanda, Empresa de Pesquisa Energética (EPE), Rio de Janeiro. Available at: http://www.epe.gov.br/mercado/Documents/S%C3%A9rie%20Estudos%20de%20Energia/20130117_1.pdf.

Galperín, H., Mariscal J. e Viecens, M. F. (2012) Análisis de los Planes Nacionales de Banda Ancha en América Latina. ACORN-REDECOM 2012. Valparaiso, Chile. Available at: http://www.acorn-redecom.org/papers/proceedings2012/013Galperin_Espanol.pdf.

Guedes, E. M., Pasqual, D. de, Pitoli, A. e Oliva, B. (2008) Avaliação dos impactos da cisão das operações de STFC e SCM em empresas distintas. Nota Técnica, Tendências Consultoria Integrada, São Paulo. Available at: http://www.anatel.gov.br/Portal/verificaDocumentos/documento.asp?numeroPublicacao=216576&assuntoPublicacao=Processo%20altera%E7%E3o%20do%20PGO&caminhoRel=null&filtro=1&documentoPath=216576.pdf (pages 16 to 32).

Hardy, A. (1980) The role of the telephone in economic development. Telecommunications Policy 4, 278-286.

Jordán, V., Galperin H. e Peres, W. (2010) Acelerando la revolución digital: banda ancha para América Latina y el Caribe, CEPAL-DIRSI, Santiago de Chile. Available at: http://www.eclac.cl/publicaciones/xml/7/41727/LCR.2167.pdf

Koutrompis, P. (2009) The economic impact of broadband on growth: a simultaneous approach, Telecommunications Policy, 33, 471-485.

ITU. (2012) Measuring the Information Society 2012, Geneva, Switzerland. Available at: http://www.itu.int/ITU-D/ict/publications/idi/material/2012/MIS2012_without_Annex_4.pdf

Macedo, H. R. e Carvalho, A. X. Y. (2010) Aumento da penetração do serviço de acesso à Internet em banda larga e seu possível impacto econômico: análise através de sistema de equações simultâneas de oferta e demanda, Série Textos para Discussão, Instituto de Pesquisa Econômica Aplicada (Ipea), Rio de Janeiro. Available at: http://www.ipea.gov.br/portal/images/stories/PDFs/TDs/td_1495.pdf.

Proyecto Todo Chile Conectado. (2010) Proyecto Bicentenario "Red de Internet Rural: Todo Chile Conectado". Ministerio de Transportes y Telecomunicaciones, Subsecretaría de Telecomunicaciones – DGFDT. Available at: http://www.subtel.gob.cl/images/stories/articles/subtel/asocfile/ppt_bicentenario_fdt_red_internet_rural.pdf

Qiang, C. e Rossotto, C. (2009) Economic impacts of broadband. Information and Communications for Development. Banco Mundial. Available at: http://siteresources.worldbank.org/EXTIC4D/Resources/IC4D_Broadband_35_50.pdf.

Vive Digital. (2011) Ministerio de Tecnologías de la Información y Comunicaciones, República de Colombia. Available at: http://www.vivedigital.gov.co/files/Vivo_Vive_Digital.pdf.

WEF. (2013) The Global Information Technology Report 2013, Geneva, Switzerland. Available at: http://www3.weforum.org/docs/WEF_GITR_Report_2013.pdf.