

## An overview of broadband connectivity: insights from Brazil

### Panorama sobre a conectividade de banda larga: insights para o Brasil

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#### **ABSTRACT**

The broadband market in Brazil is constantly evolving. We provide a legal basis and particularities of fixed and mobile broadband data, as well as a historical perspective of the beginning of the Internet in the country. We focus on the evolution of access density as the main metric of analysis, however we highlight other variables such as technology employed, payment modality and infrastructure by providers in the Brazilian telecom sector. According to Anatel (2021), responsible for regulating the market, in Brazil 56 in 100 households are connected to fixed broadband, while 101 in each 100 individuals have access to mobile broadband. We present incipient literature studying the effects of Internet expansion on the economy and social outcomes, highlighting important themes for future research.

**Keywords:** broadband, fixed, mobile, connectivity, density, technology.

#### **RESUMO**

O mercado da banda larga no Brasil está em constante evolução. Fornecemos uma base legal e particularidades de dados de banda larga fixa e móvel, bem como uma perspectiva histórica do início da Internet no país. Concentramo-nos na evolução da densidade de acesso como a principal métrica de análise, contudo destacamos outras variáveis como a tecnologia utilizada, a modalidade de pagamento e a infra-estrutura pelos fornecedores do sector de telecomunicações brasileiro. Segundo a Anatel (2021), responsável pela regulação do mercado, no Brasil 56 em cada 100 lares estão ligados à banda larga fixa, enquanto 101 em cada 100 indivíduos têm acesso à banda larga móvel. Apresentamos literatura incipiente que estuda os efeitos da expansão da Internet na economia e nos resultados sociais, destacando temas importantes para futuras pesquisas.

**Palavras-chave:** banda larga, fixa, móvel, conectividade, densidade, tecnologia .

## 1 INTRODUCTION

In the late 1980s, only Brazilian educational institutions was connected with the international community through the BITNET network. This network was initially offered as a narrowband (dial-up connection) with speeds between 2,400 and 9,600bps. Primarily, the use of the Internet was for communicability (e-mail) and training of network support technicians (Stanton, 1998; Vieira, 2003). On the other hand, the breakdown of state monopoly in 1995 and the creation of a regulatory framework with the General Telecommunications Law (LGT) and *Agência Nacional de Telecomunicações* (ANATEL) allowed competitiveness guidelines, with goals to expand and universalize use of the Internet. Initially, the commercialized internet was limited to a 64 Kbps connection, in which the structure was in the same frequency band of the telephone channel (narrow band), that is, the user only used the phone or the internet (Pena *et al.*, 2012).

This paper examines the expansion of the internet in Brazil and especially, the particularities of the sector, such as the required minimum structure, the laws, decrees and policies that guide the market, and the technological evolution. Katz e Callorda (2017) show that among Latin American countries, Brazil has an advanced digital ecosystem based in criteria such as infrastructure of digital services, competitive intensity, connectivity of digital services, household digitization, development of digital industries, and digitization of production. According to data<sup>1</sup> from Anatel, 55.7 in 100 Brazilians households have access to fixed broadband internet in 2021, while the density of mobile broadband is 101.4 subscriptions per 100 inhabitants. The xDSL was the most technology used due to already existing infrastructure fixed telephony in the country to provide a voice and data package for the user. Although over the years, the technology most implemented has been the optical fiber. Currently, mobile broadband has almost total national coverage in 3G and 4G signal supply, establishing mobile broadband as the main connection in 97.4% of households with internet (Teleco, 2020).

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<sup>1</sup> Besides Anatel as the original source of the sector's data, the BasedosDados (2021) also seeks to promote fast, easy and standardized access in order to serve research in a collaborative environment and connected to various other themes. Regarding the broadband theme, in addition to the data used in this article, other data such as the evolution of schools served by decree #8195/2008 and the installation of backhauls over the years in Brazilian municipalities are also publicly offered in the datalake.

Many studies have pointed out the correlation between penetration of the network with GDP growth, increase in the number of jobs and economic efficiency gain (Koutroumpis, 2009; Katz and Avila, 2010; Czernich *et al.*, 2011; Thompson and Garbacz, 2011; Grimes *et al.*, 2012; Kongaut and Bohlin, 2014; Castaldo *et al.*, 2017). Broadband produces not only economic but also social impacts - simplifying the connection between consumers, producers, and governments. Bessone *et al.* (2020) show evidence about political behavior after the entry of 3G in Brazilian municipalities, as online interaction through social media is more noticeable relative to offline efforts.

The production of specialized material in this area is still scarce, with lagged data and scarce information. The purpose of this paper is to contribute to the line of research that studies the evolution of telecommunications infrastructure in the country, understanding the current scenario of connectivity and intraregional and socioeconomic heterogeneities, and moreover providing a background to evaluate the impact of the broadband internet to important outcomes to Brazilian society. The work is organized beyond this introduction as follows. It deals with legal framework in section 2 analysing the guidelines of expansion. Section 4 and 5 shows the particularities of fixed broadband and mobile broadband. Section 6 concludes this study.

## 2 LEGAL FRAMEWORK

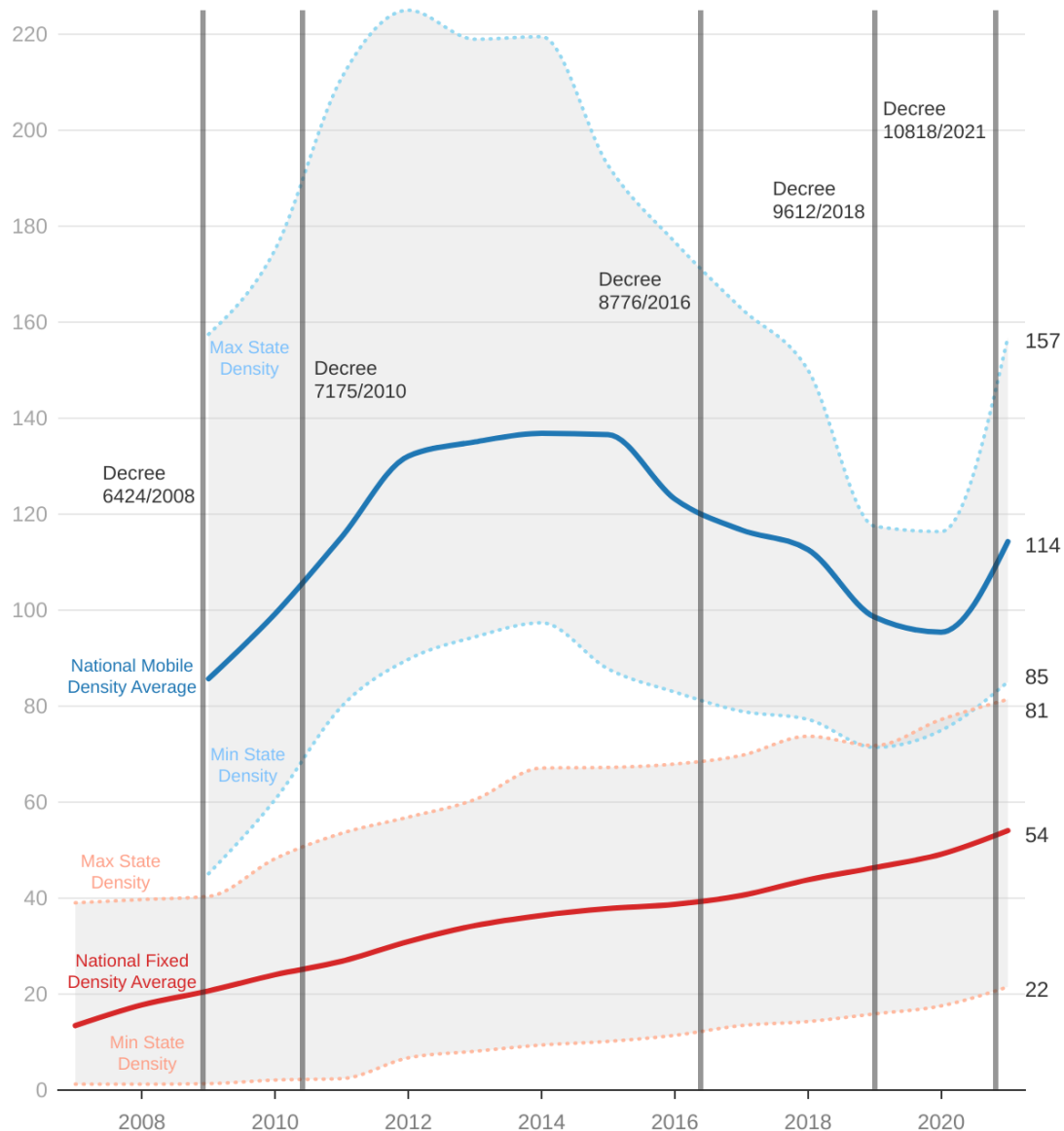
Over the years, the law guaranteed the expansion of broadband coverage through guidelines and goals by Anatel and funds to finance the required infrastructure. In addition, tax exemption policies facilitated access to ICTs<sup>2</sup>. Figure 1 shows the density accesses evolution for fixed broadband and mobile broadband along with the promulgation of universalization decrees and plans. The highlighted line shows the national average, while the dashed line shows the maximum and minimum values found among the 27 Brazilian states. From 2009 to 2017, Brasília - the country's capital - stood out for a cell phone density much higher than the national average. Today, São Paulo assumes this position as the state with 157 accesses per 100 inhabitants while Maranhão is in last position. Considering the density of fixed broadband, Santa Catarina is the state with 81 connected households per 100 households. Meanwhile, Alagoas, Maranhão and Tocantis are the 3 states currently with less than 25 houses connected.

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<sup>2</sup> Decree #5,906/2006 exempted information and communication technologies (ICTs) such as smartphones, tablets, laptops, computers, etc., from the tax known in Brazil as IPI (tax on industrialized products)

The first universalization plan was created in 2008 with the objective of disseminating fixed broadband among all public schools. In 2010, the National Broadband Plan aims to promote digital inclusion under the guidelines of the Management Committee of the Digital Inclusion Program. Indeed, the expansion of connectivity is gaining momentum due to the economic growth environment. Hitt and Tambe (2007) point out that this transition from narrowband to broadband influenced an increase of 1300 minutes per month in Internet browsing, mainly caused by technological changes in the industry and the possibilities of online consumption. In 2016, the Intelligent Brazil program launched the goal of universal internet through the expansion of optical fiber in urban areas and mobile broadband in rural areas. Decree No. 9,612 of 2018 provides for public telecommunications policies more generally, revoking previous decrees. The last decree published at 2021 (Brasil, 2021) amends the 2018 decree, specifying the objectives of access and infrastructure.

Figure 1: Density evolution for fixed broadband (per 100 households) and mobile broadband (per 100 inhabitants) and universalization plans established.



Source: Anatel, BasedosDados

The structure required for the service (in addition to the Fixed Switched Telephone Service) is based on two important technical terms: the backbone and the backhaul. The former is vital to any telecommunication network as it allows the transmission, switching, routing and management of data and voice traffic. It is from this instrument that derives vicinal outputs, that is, secondary networks of interconnection allowing the signal distribution. Backhaul is the link between the core of the backbone and the end-user that connects the base radio stations (ERB), forming a connectivity network that drains the ERB traffic, and it can be radio or fiber (LCA, 2011). Anatel

monitors the quality of broadband according to Resolution number 574/2011 and 575/2011 over different aspects. But, there still exists a gap in coverage, mainly in poor areas of the country. Since 2008 the different legal provisions have provided for the installation of backhaul using fiber optics in all municipalities. However, just over 3,000 municipalities out of 5,570 have such technology. The law states that by 2024, 100% of the cities must have an optic fiber transport infrastructure with a minimum capacity of 10 Gbps installed in their headquarters.

The evolution of the internet has made possible a new dynamic in your use. Online activities are mostly communication, that is, sending messages and using social networks. Due to the many possibilities in the virtual environment, the Government established the *Marco Civil da Internet* and the General Law of Protection Data in order to ensure rights and duties for the use of the Internet guaranteeing freedom of expression and thought, protection of privacy and personal data, network neutrality and security, the online business model and the accountability of agents according to their activities<sup>3</sup>.

### 3 BROADBAND TECHNOLOGY DATA

The Multimedia Communication Service (SCM) deals with fixed broadband covering all municipalities under different types of connections, such as xDSL, metal cable, optical fiber, radio, and satellite. The main type is coaxial cable and metal cable because the xDSL technology uses the Switched Fixed Telephone Service infrastructure, like many other countries. In relation to Personal Mobile Service (SMP), this is, mobile broadband, the GSM technology is associated with 2G signal, while LTE is the technology from 4G supply and WCDMA for 3G signal. Figure 2 reveals, besides the distribution of the use of the technology, the concentration of accesses in the Southeast. The graph shows the gap that exists in the North region, basically due to geographical limitations, supply problems such as price, quality of service and demand. The data used refer to July 2021.

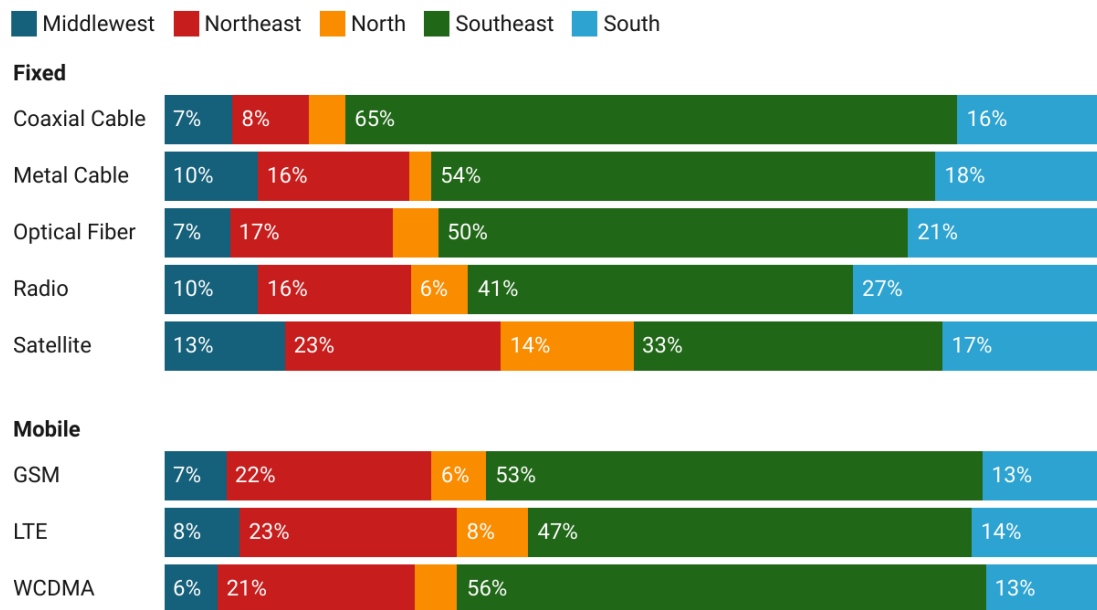
Following the methodology from Qiang, Rossoto and Kimura (2009) which evaluates the impacts of broadband on the business sector, productivity and the creation of new opportunities, Bizarria (2014) provides results for Brazilian municipalities

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<sup>3</sup> Civil Framework of the Internet by Law nº 12.965 from 2014 and *Lei Geral de Proteção dos Dados* by Law nº 13.709 from 2018 with the creation of National Authority for this purpose according Decree n 10.474 from 2020

showing that for each 1% increase in fixed broadband density, GDP per capita would potentially grow by 0.96%. According to Macedo and Carvalho (2013), broadband penetration in Brazilian municipalities is relatively higher when municipal GDP is concentrated in the areas of industry and services, and market competitiveness is higher when transmission technology is more diversified.

Figure 2: Types of fixed and mobile technology by region (2021, July).



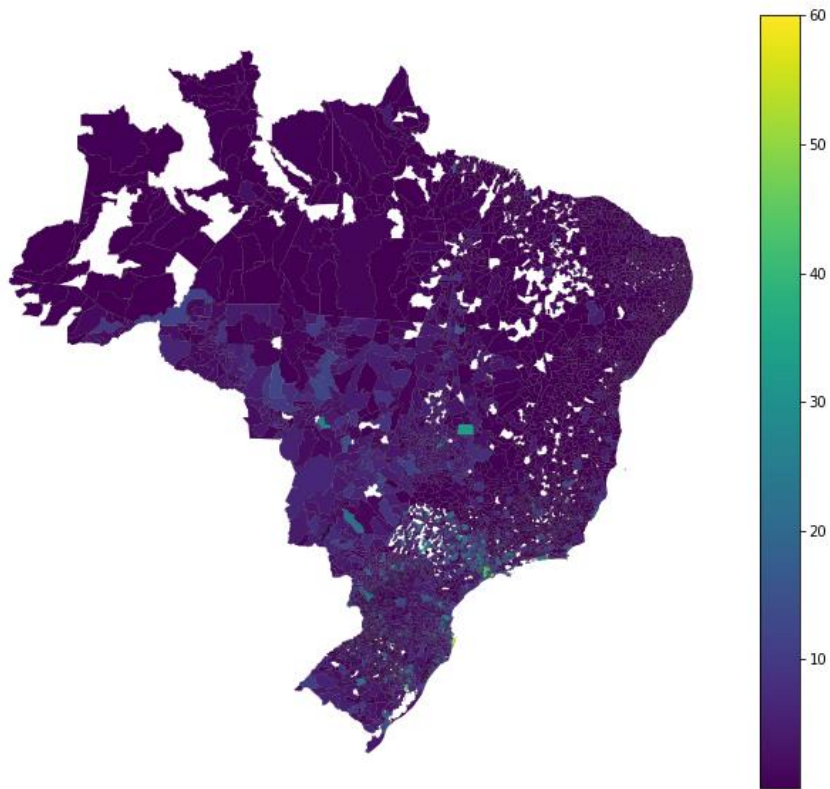
Source: Anatel, BasedosDados

The available data also covers suppliers information and connection bandwidth and speed. Many studies analyze economic and social behavior based precisely on the change in these characteristics. Falck *et al.* (2014) shows that the introduction of high-speed internet in Germany increased the consumption of entertainment, reducing the voter's political information, and thus impacting the voter turnout in the elections.

#### 4 FIXED BROADBAND DENSITY

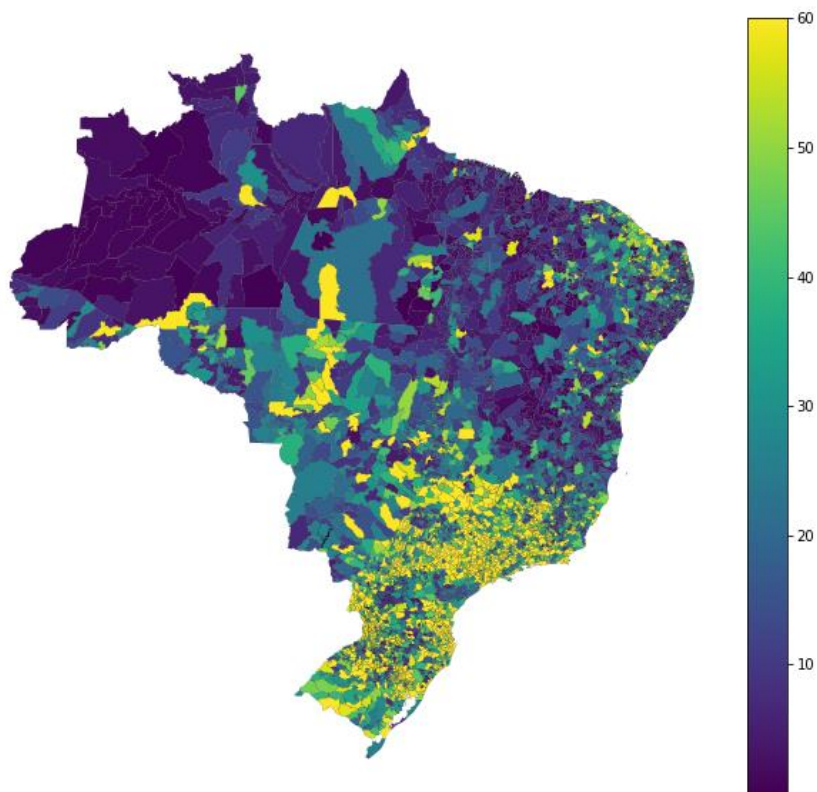
The fixed broadband data from Anatel and Internet Management Committee (Comitê Gestor da Internet – CGI) shows the constant growth for high-speed broadband internet. Figure 3A and 3B show the evolution of fixed broadband density per 100 households in Brazil between 2007, March and 2021, July. In 2007, only 5,004 municipalities have available data and half of the municipalities have approximately 0.55 subscriptions per 100 households. In 2014 the median was approximately 14 accesses per 100 households and finally, in 2021, the average coverage was 32%.

Figure 3A: Fixed Broadband density in 2007.



Source: Anatel, BasedosDados

Figure 3B: Fixed Broadband density in 2021.



Source: Anatel, BasedosDados

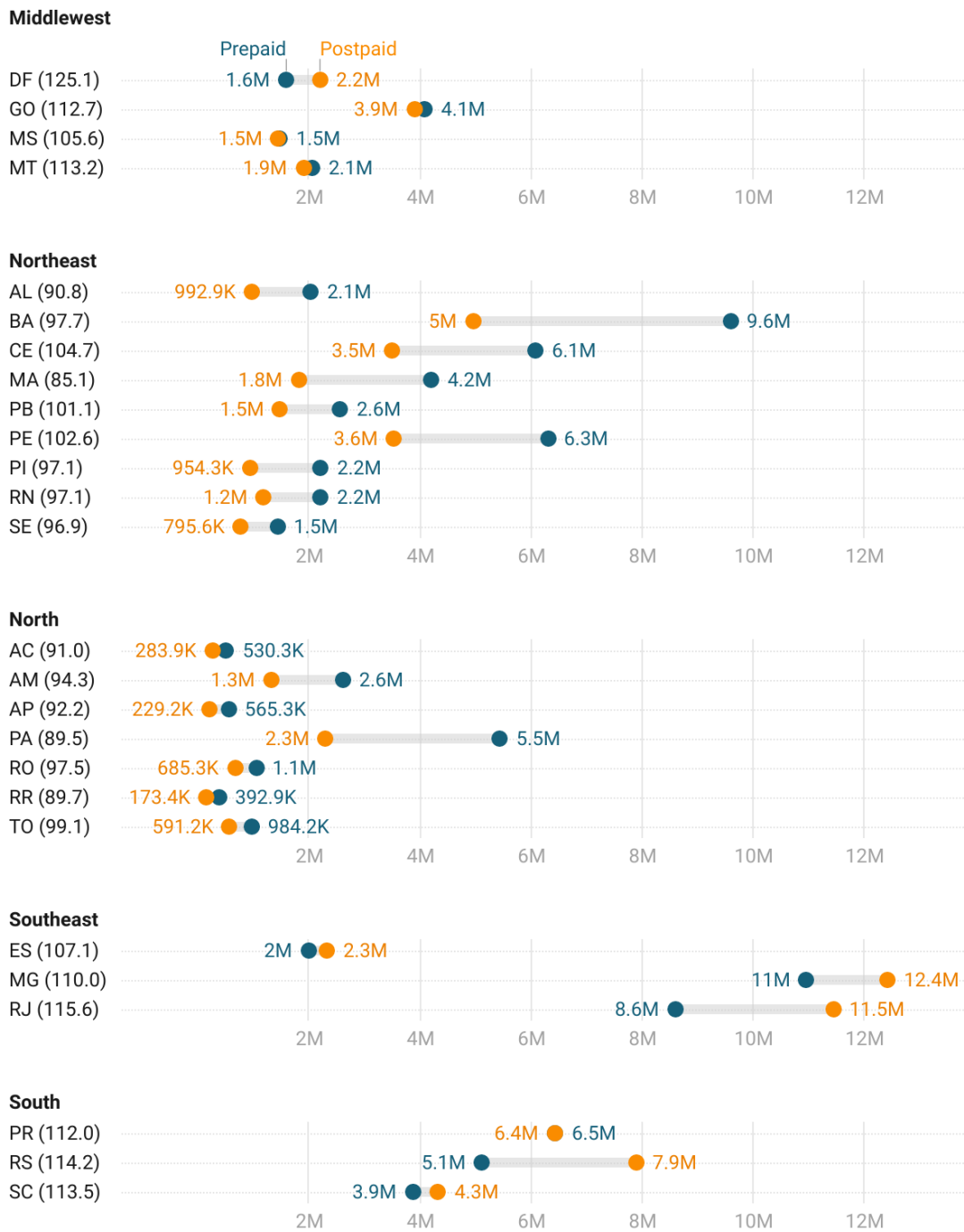


The diffusion of technology has generated changes in the connection of Brazilians due to the higher quality offered, such as faster data transmission and greater durability. Today, the greater percentage of optical fiber use is concentrated in the Northeast. Nascimento *et al.* (2018) use bandwidth as an instrumental using a Bayesian approach to evaluate how broadband investment impacts different economic sectors in Brazilian municipalities. It is important to think about a data collection that broadens the speed spectrum  $>34\text{Mbps}$ , such as the methodological change that occurred in 2011, once these data certainly reserve disparities in speed among Brazilian users.

## **5 MOBILE BROADBAND DENSITY**

The role of mobile broadband is extremely important to understand the connection of Brazilian inhabitants to Internet services, especially amongst the poorest layer of the population. Code areas are the smallest data granularity available between 2009 and 2018. Starting in 2019, the microdata carry information on total municipal accesses and currently, the median is 81 households connected in 100 houses. São Paulo and Federal District are the states with higher density.

Figure 4: Total accesses by modality, state and region (2021, July).



Source: Anatel, BasedosDados

Figure 4 show the states and density respectively, besides the volume for payment modality clustered by region. It is possible to note economic disparities for access by states evidenced with the range gap between prepaid and postpaid plans, especially in Northeast and Southeast. The state of São Paulo was removed because it was an outlier in the total number of subscriptions. The density is higher than 1,5 per person according

data from 2021, July. The prepaid plan accounts for almost 49.5 million, while postpaid plans account for 23 million.

## **6 CONCLUSION**

This paper presents the current scenario of the access in broadband and density of penetration in Brazilian municipalities analysing Anatel microdata. Much has been studied about the broadband impact in society over social and economic outcomes, still, the academic literature that analyzes this impact in Brazil is scarce. The increase in fixed broadband subscriptions, mainly fiber optic technology and implications such as improvements in bandwidth, can be instruments to evaluate outcomes Brazilian society.

With the coronavirus pandemic, the necessity of connectivity is urgent for remote work, education access, and telemedicine. In comparison with OECD countries, Brazil has a density of fixed broadband access close to the rate of Latin American countries (Chile, Mexico, and Colombia). An analysis of mobile broadband shows that density is 115 accesses per 100 inhabitants in front of developed countries like France, Germany, and Canada (ITU, 2020).

Our analysis can also help policymakers to refine the regulations that exist and to be a point of reflection on service needs, especially in the North and Northeast regions, and an objective plan for improvements in transmission media, bandwidth or even the implementation of new technologies, such as the 5G signal. We need more transparency into where investments with the Service Fund for Telecommunications Service are being implemented, especially since the mobile sector received the major part of the Fund, but the subscriptions are decreasing over the years. Also, we must think about policies that target the poorest part of the population, so that the way we interact with the internet today and its possibilities is a guaranteed right for all Brazilians, from access to ICT equipment to broadband subscriptions.

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