Unequal Digitalization: The Trajectory of Online Inequalities in Brazil and the COVID-19 Pandemic

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Abstract

Since the onset of the COVID-19 pandemic, social distancing measures have been adopted globally, with crucial support from digital technologies. In social policies, the health crisis accelerated transformations such as telehealth, remote learning, and the digitalization of social protection programs. Although some evidence highlights the emergency role of digital technologies, little is known about how digital inequalities were affected by the pandemic, particularly in developing countries. This paper first examines trends in digital disparities in Brazil, showing that while there has been a significant reduction in digital inequalities in basic Internet access, disparities in usage have persisted over time, remaining deeply intertwined with broader socioeconomic and structural inequalities. Based on a time-series analysis, the paper also finds that the pandemic did not significantly alter the trajectory of adoption for several online activities, indicating a continued pattern in the dynamics of digital inequality. Finally, it shows how programs aimed at alleviating poverty were not sufficient mechanisms for enabling low-income and vulnerable populations to leapfrog traditional barriers to Internet adoption in the post-pandemic scenario. By presenting a temporal analysis, the study contributes to a deeper understanding of digital inequality trends in developing countries.

Keywords: Information and communication technologies; Internet; digital inequalities; social protection policies

Introduction

In March 2020, the World Health Organization (WHO) elevated COVID-19 – the disease caused by the new coronavirus (SARS-CoV-2) – to pandemic status. Social distancing measures were adopted worldwide by national and local governments on an unprecedented scale

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(Holz/Jacas/Robles 2024). In this context, digital technologies proved fundamental in ensuring access to information, the continuity of economic activities, the provision of public services, and access to social protection programs, telemedicine, telework, distance learning, and cultural enjoyment (CGI.br 2021).

In the field of social policies, the health crisis represented a major catalyst for substantial transformations. Educational policies were among the most affected sectors, with most schools closed and classes being delivered online. In the healthcare sector, there was also an acceleration in the use of remote care, such as telehealth applications, as well as their use for monitoring infected people and vaccine administration. One of the most disruptive policy strategies in the field was the adoption of digital technologies to deliver income transfer programs by several Latin American and Caribbean governments (Palma 2024), targeting the most vulnerable population by the use of mobile applications. Overall, the pandemic opened space for experimentation in delivering emergency social policies, especially in developing countries, where structural social protection deficits and demands for social protection and digital inclusion tend to be higher (Holz et al., 2024).

During the pandemic, more visibility was given to the issue of digital inequalities, since limited connectivity hindered the potential success of the digitalization of policies and services (Holz et al. 2024; Senne 2021). Although many countries have made significant progress in reducing the gap between those who have and do not have access to the Internet in recent years (CGI.br 2025), those who remain disconnected are the poorest, least educated, and oldest segments of the population. Moreover, available evidence shows that having access to the Internet does not guarantee that people can take advantage of the existing online opportunities. Thus, there are still differences in the types and frequencies of online activities that people perform, depending on their social and economic backgrounds (Senne 2022).

While some evidence exists on the emergency role of digital technologies during the pandemic, there is a lack of evidence assessing the trajectory of digital inequalities over time, particularly in developing countries. However, newly available post-pandemic data allow for understanding whether there is continuity in the trend of Internet popularization observed during the COVID-19 pandemic or if this pattern was interrupted in the post-pandemic scenario.

Moreover, little is known about the specific mechanisms that enabled low-income and vulnerable populations to "leapfrog" traditional barriers and adopt the Internet for carrying out public services and commercial transactions. In this context, research on the relationship between digital inequalities and policies targeting low-income groups – particularly social protection programs – remains limited.

To address some of those topics, the empirical analysis presented in this paper is divided into three parts:

- Part 1: How have digital inequalities evolved in Brazil over time (2001-2024), and to what extent was the increase in Internet access associated with the dissemination of online activities, such as information consumption and access to public and private services? (descriptive analysis)
- Part 2: To what extent did the COVID-19 pandemic influence the diffusion of online practices, to what extent did individuals' transitions to digital services follow the trends observed before the pandemic, or have those trajectories changed? (time series analysis)

- Part 3: Can social protection programs targeted to the low-income population affect the adoption of online practices in the post-pandemic scenario? (logistic regressions)

In the first part, we present a descriptive analysis of the trajectory of digital inequalities in Brazil, examining the dynamics of Internet access and use over time. By relying on a broader temporal perspective – normally absent in analyses produced in the Global South – it is possible to record the advances and continuities in terms of the deprivation of digital resources as well as the relative size of the differences between population profiles. In this section, we focus on the adoption trends of a set of online activities. By focusing the analysis on online practices, it is possible to better understand the tangible outcomes associated with Internet use, indicating that different opportunities arising from digitalization are taken advantage of in different ways by various profiles of Internet users.

To assess potential effects of the COVID-19 pandemic, in the second part, we compare the estimates of the prevalence of selected online activities with the expected values calculated using a historical time-series forecast. The evidence presented makes it possible to identify cases of acceleration or deceleration in the digitalization expansion trajectory in the post-pandemic period.

Finally, in the third part, we focused on the analysis of online practices among populations affected by social protection programs. While there is evidence that populations living in poverty have lower levels of adoption of digital technologies, it is also essential to assess whether participation in social protection programs is associated with the dynamics of digital inclusion. Thus, we adopted logistic regression models to assess the correlation between participating in social protection programs and performing online activities, controlling for known sociodemographic factors.

Overall, the analysis presented in the paper relies on a series of large-scale sample surveys conducted in Brazil since 2005 with individuals 10 years old or older (CGI.br 2025). The characteristics of Internet users in the country are measured using demographic variables such as age, sex, and color/race, which are commonly included in digital inequality studies (Galperin 2017). The available surveys also examine the online activities that individuals performed before and after the pandemic.

Due to its large territorial size and striking social inequalities, we consider that Brazil is an interesting case for the study of digital inequalities, allowing for testing hypotheses in a context of large shares of the population connected to the Internet in different conditions. The study also allows for an assessment of the post-pandemic scenario, in which large portions of the low-income population who were supported by social protection programs adopted a mobile phone application as their preferred means of accessing and receiving the benefit (CGI.br 2021).

Why do digital inequalities matter?

In recent decades, the Internet has become a public good. Promoting access to and use of the Internet has become a key objective for policymakers at different levels of government (Helsper 2014; ITU 2013; Sunkel/Trucco/Espejo 2014; van Deursen/Helsper 2017). The growing trend of Internet adoption was also present in the context of urban policies. This type of intervention has become critical, especially in metropolitan regions, where population density leads to new

experiences of using technologies in areas such as public safety, energy, education, health care, and mobility (Helsper 2014; Mossberger/Tolbert/Franko 2012; van Deursen/Helsper/Eynon et al. 2017).

Recently, the United Nations approved a "Global Digital Compact", setting out for member states the objectives, principles, commitments, and actions to ensure an "inclusive, open, sustainable, fair, safe, and secure digital future". Among the five objectives established by the UN is "closing all digital divides", including the commitment to connect all persons to the Internet, and recognizing the need for "strong partnerships and increased financial investments in developing countries from governments and other stakeholders."[2] Overall, the UN vision highlights that universal and meaningful connectivity has a role in unlocking the full potential of digital and emerging technologies and in advancing sustainable development.

But does access to the Internet effectively contribute to creating opportunities for social inclusion, or does it merely reflect (and in some cases exacerbate) pre-existing stratifications? To address this question, it is necessary to understand the origins of digital inequalities, or the extent to which pre-existing stratifications persist in the online environment.

The concept of "digital divide" – which emerged during the process of dissemination of commercial access to the Internet, in the mid-1990s – was initially characterized by a predominantly economic approach, dedicated to counting the number of individuals who had or did not have access to the Internet. From this perspective, the digital divide was addressed through sectoral telecommunication policies, such as price regulation and expansion of Internet coverage (DiMaggio/Hargittai/Celeste et al. 2004; Galperin/Ruzzier 2013; Hargittai/Hsieh 2013).

From the mid-2000s onwards, sociological criticism of a limited view of the digital divide shed light on a second layer of exclusion, which also came to be identified among those who overcame the access barrier, and became known as "second-level digital divide" (DiMaggio et al. 2004; van Deursen/van Dijk 2013; van Dijk 2005). Within the scope of the second-level divide, a profusion of studies found a correlation between online disparities and individual demographic characteristics. While in the first-level digital divide, there is a greater emphasis on economic factors such as poverty and family income, in the literature on the second-level digital divide, sociodemographic factors such as ethnicity, gender, and level of education are present with greater prominence (Dixon/Correa/Straubhaar et al. 2014; Helsper 2019, 2021).

Gender stratification has been highlighted since the very first studies on digital exclusion in the USA throughout the 1990s (Bimber 2000). Greater use by men of public access centers, even when controlling for age and ethnicity, was also found in quantitative studies in the field (Dixon et al. 2014). Age is also a relevant factor, with particular emphasis on the specific ways children and the elderly use the Internet (Van Deursen/Helsper 2015).

The relationship between Internet use and level of education was also a recurring theme in this literature. Empirical studies indicate that higher levels of education are positively correlated with the performance of more complex online activities. More educated people would also tend to use the Internet more actively, more oriented toward information, while less educated people would be mainly interested in entertainment activities (Senne 2022).

[2] Available at: https://www.un.org/techenvoy/global-digital-compact.

By moving the debate beyond material inequality – having or not having access to the Internet – the literature has also begun to incorporate new exclusion factors that were not present in previous metrics. This is the case with the growing importance of the debate on skills or competencies for the use of digital technologies, understood as the ability to use them in a way that allows individuals to increase potential benefits and reduce the possible harms/negative results associated with engagement with the digital world (ITU 2018). In the context of digital skills, both the operational skills necessary to use the Internet and the skills necessary to understand and use online content should be taken into account (van Deursen/van Dijk 2015). According to this literature, inequalities in digital skills reflect historical patterns of inequality. Those who are employed tend to have more skills than the self-employed and the unemployed. Skills also appear more pronounced among those with Higher Education, who live in urban areas, and males (ITU 2018).

More recent approaches to the origins of digital exclusion have sought to avoid explanations based only on structural conditions ("macro level") and/or individual characteristics ("micro level"). The effort to define a "meso" level of analysis has guided researchers in the field to investigate the context of Internet adoption and its relationship with territorial dynamics (Helsper 2019; Senne 2019). This is what happens with studies that explore neighborhood effects and their association with digital inclusion (Mossberger/Tolbert/LaCombe 2021). An emerging strand of studies also assesses the extent to which the adoption of information and communication technologies (ICT) depends on the combination of individual resources and the performance of offline social networks (Helsper 2021; van Deursen et al. 2017).

With the emergence of the COVID-19 pandemic, numerous studies focused on monitoring the impacts of digital inequalities on the response to the pandemic (Beaunoyer/Dupéré/Guitton 2020; Khilnani/Schulz/Robinson 2020) and the effects of social isolation practices on Internet adoption, particularly the shift from in-person activities to online environments (Nguyen/Gruber/Fuchs et al. 2020; Petrovčič/Reisdorf/Quan-Haase et al. 2024; Van Deursen 2020). Various studies reported an increase in digitalization (based on pre- and post-pandemic comparisons), with incentives for adopting remote practices in areas such as work, health, and education (Arpino/Pasqualini/Bordone 2021; Valla/Rossi/Gaia et al. 2025).

Among the few longitudinal studies on the topic, an increase in digital engagement during the pandemic was identified, followed by a decline in the adoption of online practices in the post-pandemic period – especially among older populations (Valla et al. 2025). However, those studies are based on comparisons between the pre-pandemic period and the data collected during the health crisis, without considering the behavior of digital inequalities in the post-pandemic period. The lack of longitudinal analyses in developing countries remains a gap, particularly when seeking to understand the effects on low-income populations.

In sum, the debate on the origins of digital inequalities is characterized by an expansion of its focus beyond access – even though this remains a necessary, but not sufficient, condition for being online. Thus, the field is marked by an important conceptual shift, moving from an approach based on the presence of digital resources (the digital divide) to the identification of more persistent and systematic patterns of social and digital disparities in certain groups, understood as "digital inequalities". In addition to the distance between those who are connected

and those who are disconnected, our perspective on digital inequalities also considers the disparities in activities performed on the Internet and digital skills that allow online engagement (Hargittai/Hsieh 2013; van Dijk 2005). This approach assumes a dynamic cycle of influences in which digital inequalities in access, use, and skills are both causes and effects of other social and territorial inequalities (Helsper 2021).

Thus, we assume that changes in the behavior of social inequalities are the aggregate result of a combination of different policies, given the reciprocal relationships between income and access to services (Arretche 2015). This choice is consistent with the economic debate that has pointed out that well-being does not depend exclusively on income, but on several other dimensions of life, such as health, the quality of social relationships, the environment, employment, and job satisfaction (Aaberge/Brandolini 2015; Atkinson 2003; Decancq/Fleurbaey/Schokkaert 2015). Therefore, we adopt a multidimensional perspective to understand digital and social inequalities, including both monetary and non-monetary variables.

Data and methods

Given the proposed questions, the research design relies on cross-sectional surveys on Internet access and use in Brazil (CGI.br 2025). In Part 1, a descriptive analysis of the results aims to identify patterns of Internet access and use in Brazil, including differences observed across factors such as age group, socioeconomic status, and level of education.

In Part 2, we adopt time-series analysis methodologies to determine the extent to which the adoption curve for online activities follows expected patterns in the post-pandemic period. To implement the analysis, we used the R package "forecast", which provides methods and tools for displaying and analyzing univariate time series forecasts, including exponential smoothing (ETS) and automatic ARIMA modeling. ETS and ARIMA models are the two most widely used approaches to time series forecasting and provide complementary perspectives. While ETS models are based on a description of trend and seasonality in the data, ARIMA models aim to describe the data's autocorrelations (Hyndman 2018).

Finally, in Part 3, we focus on the relationship between digital inequalities and policies targeting low-income groups – particularly social protection programs. Thus, the study estimates the probability of individuals performing online practices while being affected by social protection programs. The presence of a beneficiary of a federal social protection program was coded as 1 (yes), and 0 (no). Seven online activities were selected as dependent variables to test levels of online engagement, and binary logistic regressions were implemented for each one of them.[3] Apart from the association with social protection programs, regressions were controlled by gender (being a woman), race (being black or brown), level of education (up to primary education), and age (as a numeric variable).

[3] The selected variables were a) "Sending instant messages", b) "Using social networks", c) "Searching for a job or sending resumes", d) "Using the Internet for work activities", e) "Looking for financial information, making payments and other financial transactions", f) "Looking for information provided on government websites," and g) "Making online purchases".

Databases

The first statistics measuring computer access in Brazilian households were produced in 2000 through the National Demographic Census, conducted by the Brazilian Institute of Geography and Statistics (IBGE). In the following year, the National Household Sample Survey (Pnad), also conducted by the IBGE, included a new indicator on the connection of personal computers to the Internet. More comprehensive data at the national scale on Internet access and use have been available since 2005, when a module of the Pnad was implemented by IBGE with the support of the Brazilian Internet Steering Committee - CGI.br (IBGE 2007). The Pnad historical series was interrupted in 2015, when it was definitively replaced by the Continuous National Household Sample Survey (Continuous Pnad). In the present study, we used data from the Pnad (2001 to 2015) and the annualized databases of the Continuous Pnad (2016 to 2019).[4]

Since 2005, CGI.br, through its Regional Center for Studies on the Development of the Information Society (Cetic.br), has been conducting the *Survey on the use of information and communication technologies in Brazilian households - ICT Households* survey (CGI.br 2025), an annual household survey based on a probabilistic sample, representative of Brazil and with data disaggregated by the five macro-regions in urban and rural areas.[5] Given that *ICT Households* began to include rural areas only from 2008 onwards, part of the historical series was calculated using only the results for urban areas (2005 to 2024). Data for the year 2020 are not available, since the survey was not conducted face-to-face due to the most critical phases of the COVID-19 pandemic.

Overall, while Pnad allows greater regional disaggregation, the *ICT Households* survey details the uses of the Internet by individuals, including online activities related to communication, education, e-commerce, and electronic government.

Variables

The presence of computers connected to the Internet in households has been investigated by Pnad since 2001. With the introduction of the Continuous Pnad (2015), the indicator was discontinued, requiring harmonization for comparison purposes.[6] Pnad also measures, since 2001, the presence of mobile phones in households, which at the beginning of the time series were predominantly offline, but have more recently become the main devices connecting individuals to the Internet. Both the presence of a computer connected to the Internet and a mobile phone in households were processed at the individual level, counting individuals living in households

[4] A strategy for harmonizing the variables present in the two surveys was adopted to treat the differences between the samples and restrictions regarding comparability, which will be taken into account when interpreting the data.

[5] The ICT Households sample is designed by cluster stratification, in multiple stages, and systematically selected with probability proportional to the population size (PPS) of individuals 10 years old or older. In 2019, 36 strata were defined with conglomerates by federative unit, capital, and non-capital municipalities. For nine federative units, metropolitan regions were also considered and, for the North region, five federative units were consolidated. These strata were used for the probabilistic selection of municipalities.

[6] The variable used to investigate the presence of computers connected to the Internet derived from the question "To access the Internet in this household, does any resident use a personal computer (desktop or portable, such as a laptop, notebook, or netbook)?" In this wording, data collection privileges the use of computers within the household, rather than the ownership of a connected computer as one of the durable goods available in it.

with these devices. Even though the indicators do not prove their effective use, they serve as a useful proxy for access to digital technologies – a necessary but not sufficient condition for use.

Internet use was operationalized through a variable measured at the individual level, according to standards recommended by the International Telecommunication Union (ITU 2014) – which considers any use of the Internet in the three months prior to the survey. The estimates for Internet use were taken from the *ICT Households* survey.

Online activities – measured by the *ICT Households* survey between 2005 and 2024 and harmonized in order to allow comparability – were also included in the analysis.[7] Despite limiting the analysis to individuals 10 years old or older living in urban areas, the data allow for a better assessment of inequalities in use.

Among the sociodemographic variables, those that showed greater significance in previous literature on digital inequalities were privileged (Galperin 2017). The age group of respondents, calculated based on age as a numerical variable, was divided into six ranges (10 to 15 years old, 16 to 24 years old, 25 to 34 years old, 35 to 44 years old, 45 to 59 years old, and 60 years old or older). The level of education was aggregated into three groups (up to complete elementary education, up to complete secondary education, and incomplete tertiary education or higher). The color and race variable also follows the national statistical office (IBGE) categorization, comprising five self-declared groups. To assess the intersection between color/race and gender, an additional variable was created to compare white men and women and black men and women.

The variable "socioeconomic class", based on consumption items and education, was also considered. The economic classification is based on the Brazilian Economic Classification Criteria (CCEB) established by the Brazilian Association of Research Companies (Abep). This classification considers the possession of durable items within the household, the level of education of the declared head of the household, the paving of the location, and the type of water access network in the household. The indicator was aggregated into three levels: high (AB), medium (C), and low (DE).

To estimate income level, we adopted the official minimum wage as a reference. Despite the limitation for international comparability, the thresholds have the advantage of being associated with national social protection policies. In Brazil, the minimum wage acts as an important reference point – or indexer – for determining and adjusting various salaries and social benefits. While it is not an official or universal indexer for all earnings, many payments across the public and private sectors are directly or indirectly linked to the minimum wage.

Finally, two social protection programs were considered in the analysis: the Bolsa Família program (BFP) and the Continuous Cash Benefit Program (BPC, or Benefício de Prestação Continuada in Portuguese). The Bolsa Família Program (BFP) is a conditional cash transfer program with national coverage in Brazil that aims to support families living in poverty or extreme poverty. The Continuous Cash Benefit Program (BPC) is a non-contributory pension system available to older people over the age of 64 and those unable to work due to disability.

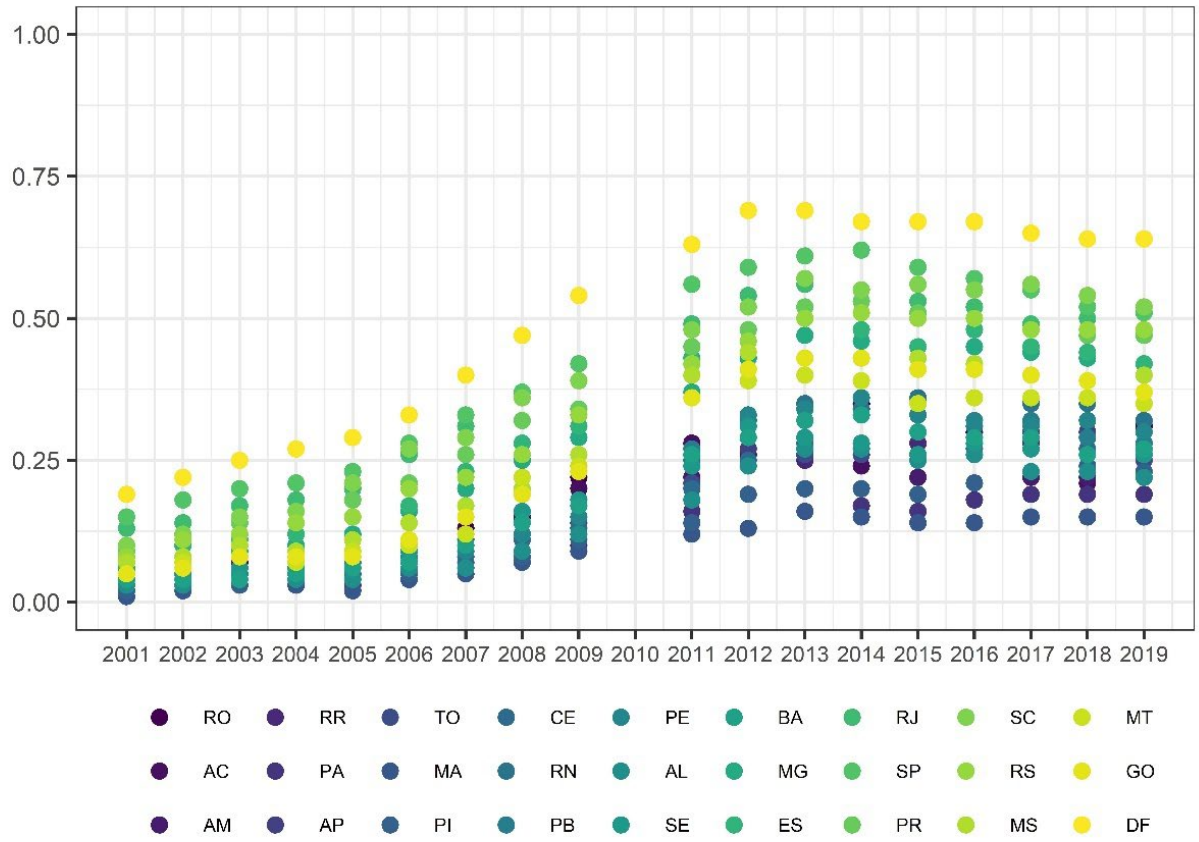
[7] The analysis considered the activities: "Sending instant messages", "Using social networks", "Searching for information on health or healthcare services", "Reading newspapers, magazines, or news online", "Making voice or video calls", "Looking for financial information, making payments and other financial transactions", "Looking for information provided on government websites", "Creating or updating blogs, Internet pages or websites", and "Taking distance learning courses".

Results

Part 1: Segregated expansion: How did Internet use spread in Brazil?

Initially, it is relevant to understand how digital inequalities vary over time, based on a characterization of the phases of Internet diffusion in the country, with a focus on household access. From the point of view of access – despite the persistence of significant disparities regarding Internet quality and connectivity –, it is possible to state that, throughout the historical series, digital technologies have tended to be incorporated in most households. The analysis confirms previous surveys indicating that the gap between those who have and those who do not have access to the Internet have decreased substantially over time, especially if we consider the perspective of universal access to mobile devices.

Figure 1: Percentage of households with computers connected to the Internet, by Federative Unit (2001-2019)[8]



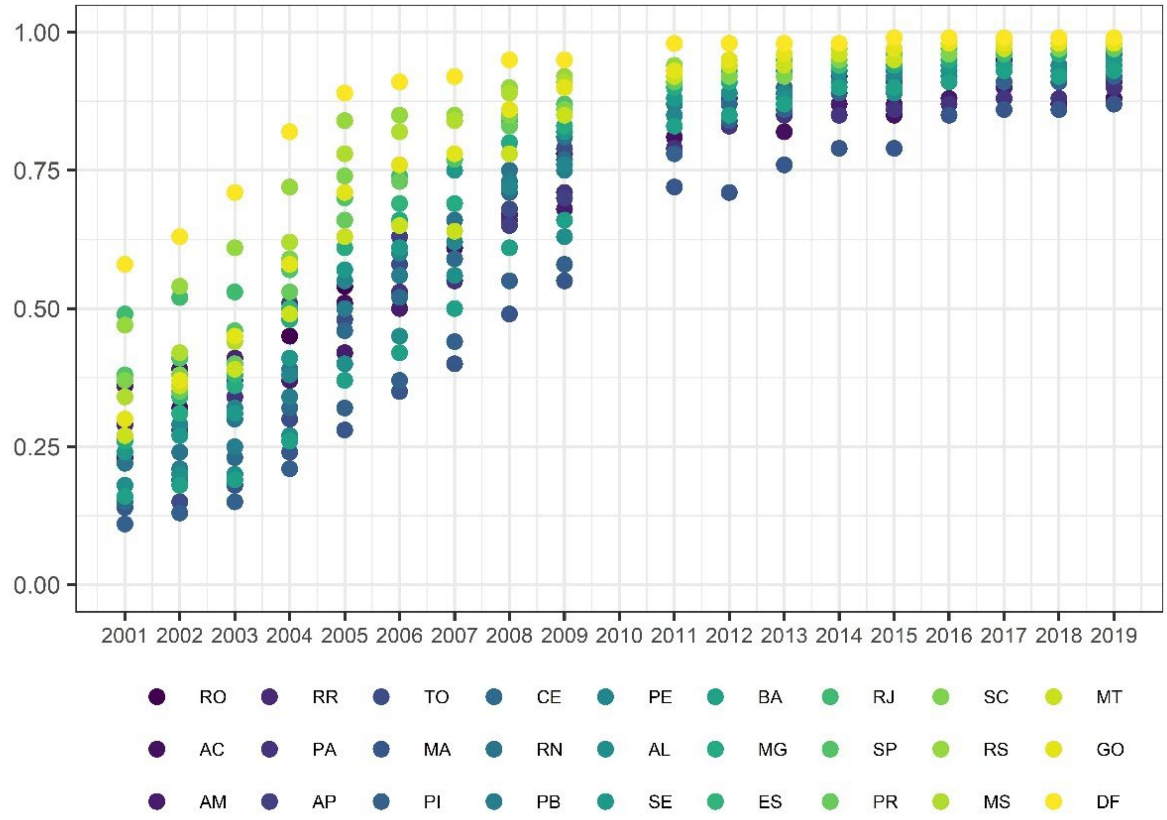
Source: Pnad and Continuous Pnad, IBGE.

[8] The abbreviation of the Brazilian Federative Units refers to: Acre (AC), Alagoas (AL), Amapá (AP), Amazonas (AM), Bahia (BA), Ceará (CE), Distrito Federal (DF), Espírito Santo (ES), Goiás (GO), Maranhão (MA), Mato Grosso (MT), Mato Grosso do Sul (MS), Minas Gerais (MG), Pará (PA), Paraíba (PB), Paraná (PR), Pernambuco (PE), Piauí (PI), Rio de Janeiro (RJ), Rio Grande do Norte (RN), Rio Grande do Sul (RS), Rondônia (RO), Roraima (RR), Santa Catarina (SC), São Paulo (SP), Sergipe (SE), Tocantins (TO).

Data from the Pnad and Continuous Pnad, collected between 2001 and 2019, allow us to evaluate differences in the penetration of computers connected to the Internet in households in each state (Federative Unit). The results show that in the initial phase of Internet diffusion (2001 to 2005), there was less territorial inequality, with low levels of presence of this device throughout the country (Figure 1). During the massive expansion phase (2006-2012), inequality gradually increased between states, to the detriment of those located in the North and Northeast regions. In the last phase (2013-2019), marked by the popularization of mobile devices and the interruption of the rise in computer ownership, high levels of territorial inequality remained, ranging from 64% in the Federal District (DF) to 15.4% in Maranhão (MA).

From the perspective of territorial inequalities, mobile phones follow a different path compared with computers. While the periods of greatest disparity are seen at the beginning of the series (2001 to 2005), at the end of the series (2013 to 2019), the presence of mobile phones was quite universal, with estimates above 80% for all states (Figure 2). The data thus indicate that devices such as computers were not present in most of the poorest households or those located in the poorest states of Brazil, while mobile phones expanded their presence rapidly throughout the country, a trend that has implications for the diffusion of online practices.

Figure 2: Percentage of households with mobile phones, by Federative Unit (2001-2019)



Source: Pnad and Continuous Pnad, IBGE.

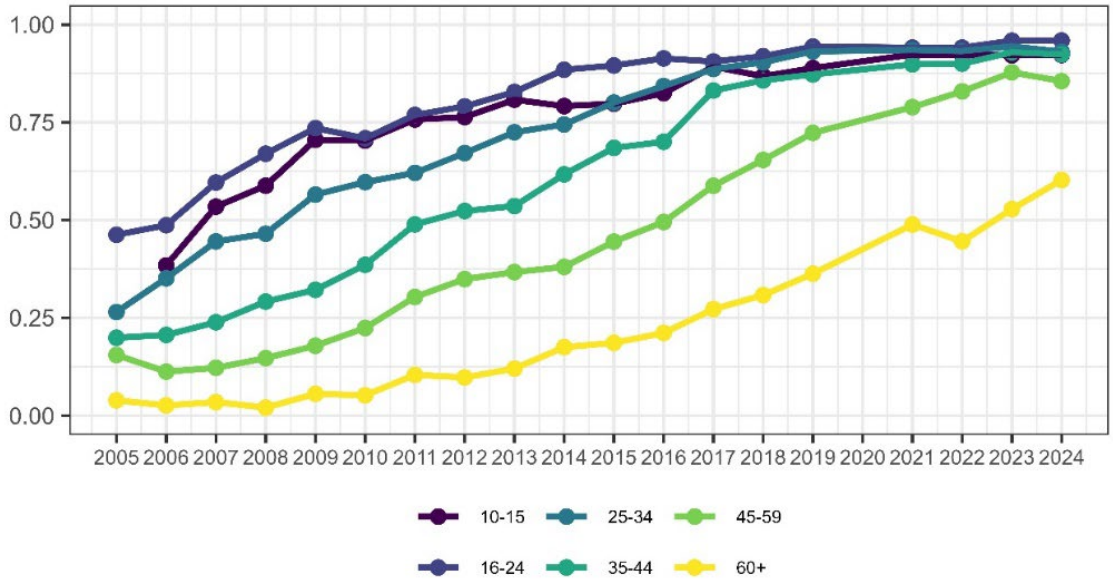
Overall, the available results, including the post-pandemic years, also confirm that sociodemographic variables – such as socioeconomic class, level of education, and age group – are highly correlated with disparities in Internet usage. Although the time series shows convergence in use

among individuals 10 to 44 years old at the level of more than 80% of the population living in urban areas, only around 60% of individuals 60 years old or older, in turn, were Internet users in 2024. Despite advances in the percentage of elderly people who are online in recent years, the generational gap – or the gap between average use in younger and older age groups – persists in basic Internet use in 2024 (Figure 3).

Socioeconomic status (SES) is also a relevant variable for understanding patterns of Internet adoption. Among individuals living in higher socioeconomic status households,[9] Internet use remains above 80% throughout the entire period (Figure 4). Advances in Internet use in the low SES, especially since 2014, are not enough to equalize this group compared to the higher SES.

In 2018, for the first time, the share of individuals in low SES households using the Internet reached around half of the population (48%). The country's growth curve follows the increase in Internet use among individuals in medium SES, the largest strata in absolute numbers. In short, there was an intensive reduction in inequality in Internet use over the period if we take socioeconomic status into account, with the late inclusion of a significant portion of the poorest sectors of the population.

Figure 3: Internet users, by age group (2005-2024) – percentage of the population in urban areas

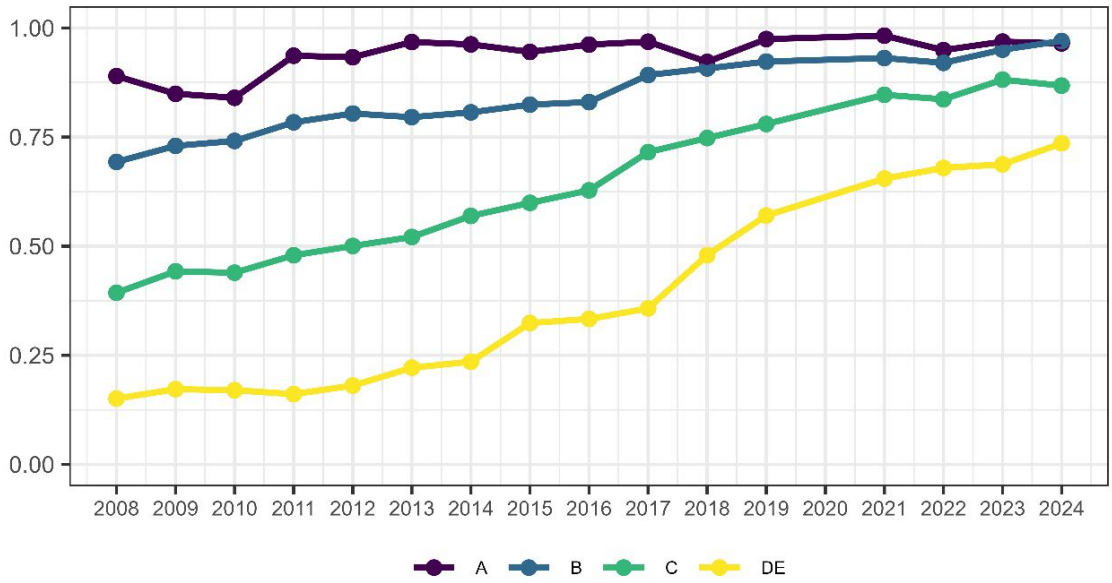


Source: Brazilian Network Information Center (NIC.br).

Regarding the level of education, the population group formed by those who started Tertiary Education maintained estimates above 80% throughout the time series (Figure 5). There was an increase in the percentage of Internet users among individuals who had completed up to Secondary Education, reaching estimates similar to those observed among individuals with Tertiary Education by 2021. Those with only Primary Education, in turn, consistently showed lower levels of Internet access. In 2017, for the first time, nearly half of the group with up to Primary Education was connected to the Internet, highlighting the greater challenges in achieving universal Internet access among the least educated segments of the population.

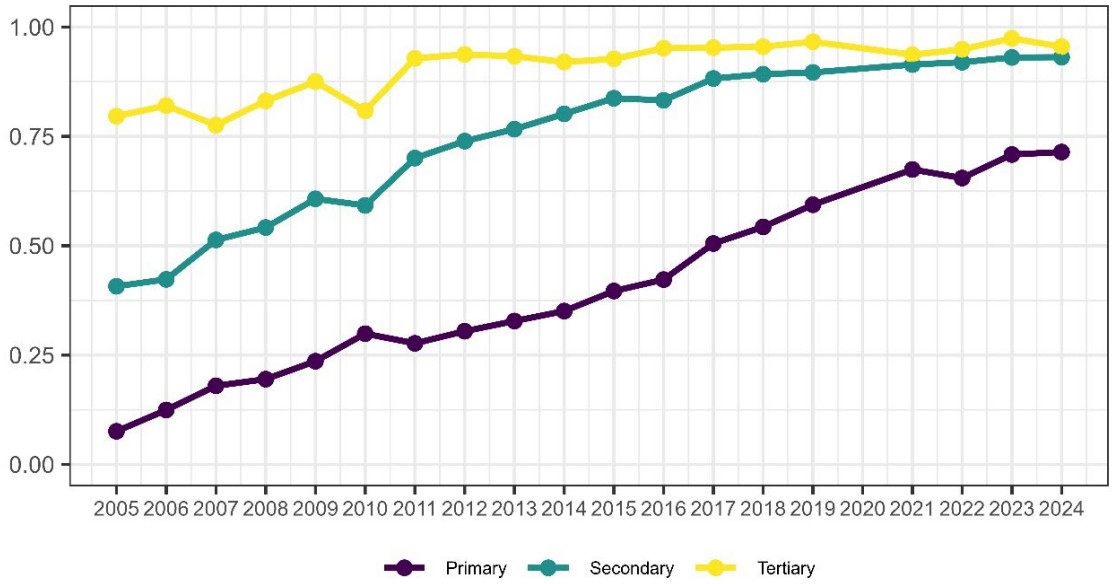
[9] According to Abep's classification.

Figure 4: Internet users, by socioeconomic status (2005-2024) – percentage of the population in urban areas



Source: Brazilian Network Information Center (NIC.br).

Figure 5: Internet users, by level of education (2005-2024) – percentage of the population in urban areas



Source: Brazilian Network Information Center (NIC.br).

The available data also show that greater presence on the Internet was not sufficient to eliminate inequalities regarding online engagement, especially when we observe specific practices. To evaluate the behavior of online activities over time, the performance of activities monitored between 2005 to 2024 was considered. Activities that were maintained the longest in the survey's historical series were prioritized.

A typology of online activities was developed by categorizing practices according to their prevalence over time. For analytical purposes, the adoption curves were categorized according to two complementary criteria:

- The ratio between the total number of Internet users and the total number of practitioners of a given online activity, which tells us how many times greater the number of Internet users is in relation to the number of individuals who carry out each activity.
- The interquartile intervals of the ratios are obtained for each activity each year. Lower variability in ratios over the period was interpreted as greater "inclusiveness" in the distribution. In other words, as Internet users grow, those who practice these activities tend to grow at the same rate.

The activities analyzed were classified into 4 groups (Table 1).

Table 1: Categorization of online activity groups from the ICT Households survey (2005-2024)

	Heterogeneous growth (does not follow growth in the number of Internet users)	**Homogeneous growth (accompanying an increase in the number of Internet users)**
Lower adoption	(1) Low adoption and restrictive growth	(3) Medium adoption and inclusive in terms of growth
Higher adoption	(2) Medium adoption and restrictive in terms of growth	(4) High adoption and inclusive in terms of growth

The first group was comprised of activities carried out by a reduced number of users and with growth rates that do not keep up with the advancement of the Internet among the overall population, being restricted to a certain "digital elite", formed by a limited group of practitioners across the entire time series. "Taking distance learning courses" and "Creating or updating blogs, Internet pages or websites" are among the activities that, throughout the historical series, are restricted to a small portion of the population.

The second group of activities shows a higher degree of adoption compared to the previous one. The growth trajectory, however, presents greater variability in relation to the increase in the number of Internet users. Thus, these are activities with a less inclusive trajectory, such as "Looking for information provided on government websites".

The third group comprises more inclusive activities, in the sense that its growth curve follows that of the increase in the number of Internet users. Its dissemination, however, occurs at a medium level, not being practiced by substantial portions of the population. "Reading newspapers, magazines, or news online" and "Looking for financial information, making payments, and other financial transactions" are among these activities.

Finally, we grouped the activities with a dissemination classified as inclusive – whose growth follows the increase in the number of Internet users –, and which are carried out by a large contingent of users. This is the case with the use of "Instant messaging" and "Social networks".

Both activities share a communicative nature and are of broad interest to various age groups and socioeconomic strata (Figure 6).

While the use of social networks, instant messaging, and – more recently – voice calls was rapidly adopted across the population of Internet users, financial inclusion remains out of reach for a significant share of individuals. At the same time, distance learning courses tend to be used by fewer individuals. Just as online public services, which could make life easier for elderly people with disadvantageous mobility conditions, they do not seem to be spreading at the same speed compared to other groups of the population.

Overall, the increase in Internet access is not directly associated with the diffusion of all online practices. The adoption curves for specific activities reveal very different trends, depending on the type of activity carried out online – which confirms the existence of a second-level digital divide among Internet users. On the one hand, the data series shows the persistence of a "digital elite" – young, from higher classes and educated – capable of systematically carrying out more sophisticated online activities. Also, the timid progress in activities such as carrying out financial transactions or searching on government websites indicates that such services are not necessarily conditioned by an increase in Internet use. Thus, while there has been a significant reduction in digital inequalities in terms of basic access to the Internet, disparities in usage persist over time, remaining deeply intertwined with broader socioeconomic and structural inequalities.

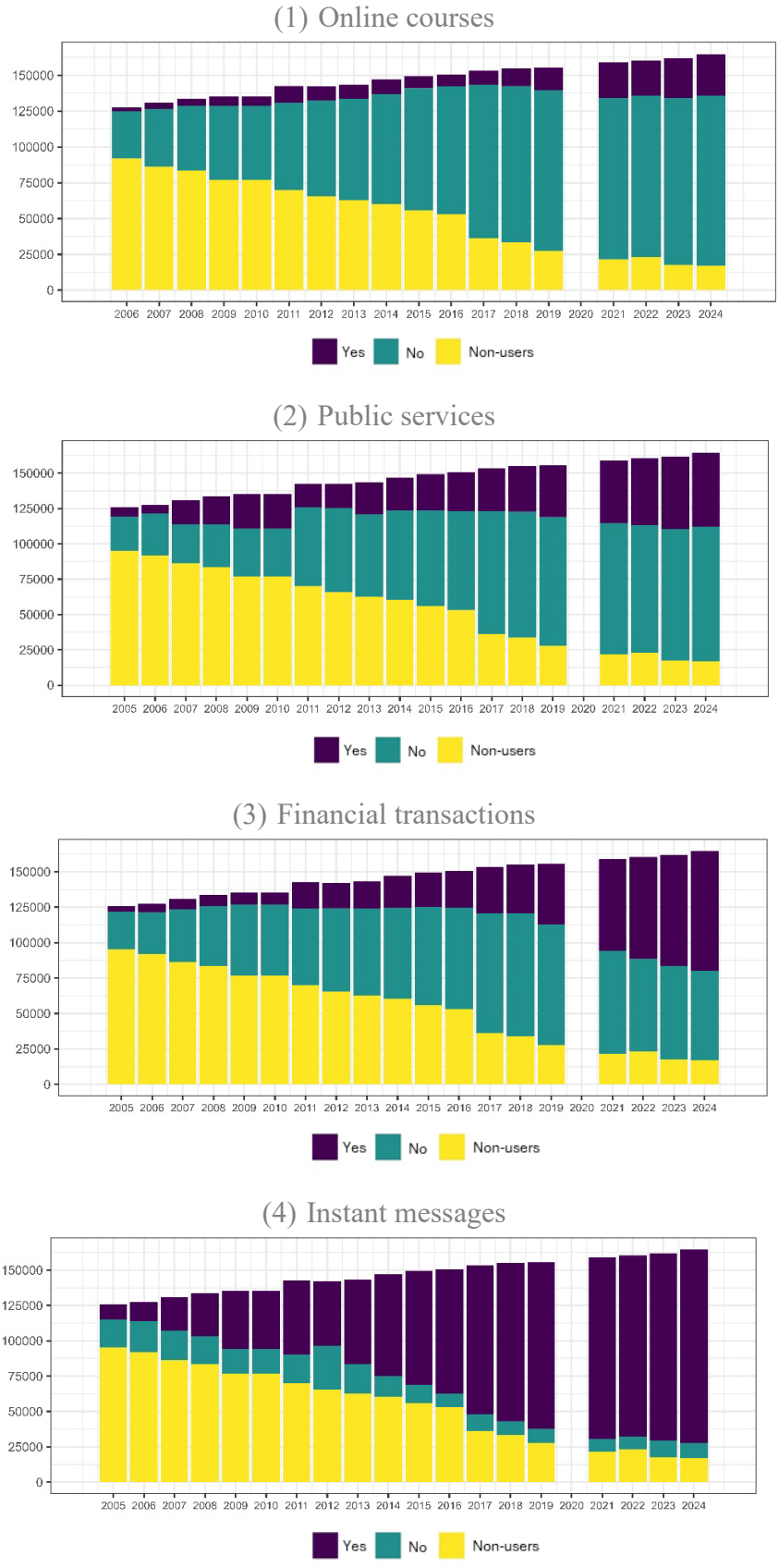
Part 2: COVID-19 pandemic and the diffusion of online practices

Given the known patterns of diffusion of digital technologies in Brazil, we now set out to investigate the extent to which the COVID-19 pandemic – as an exogenous event with widespread economic and social impacts – could have generated any discontinuity in the observed trends. To address this issue, we chose to compare the observed prevalence of online activities in the post-pandemic period (survey estimates) with forecast post-intervention estimates assuming no intervention occurred (time series forecasting models).

The forecast was based on the proportion of individuals living in urban areas and who carried out the online activities monitored in the period (2005 to 2019). The selection of the best model in each online activity was determined by a range of summary measures of the forecast accuracy (see Appendix 1).[10]

[10] Among the limitations is the fact that the methodology used for the projections does not consider auxiliary or intervening variables.

Figure 6: Selected online activities by group (2005-2024) - population estimates in urban areas



Source: Brazilian Network Information Center (NIC.br).

Figure 7: Online activities - Group 1 (2005-2024) - population estimates in urban areas

The results obtained using forecast models were then compared with the observed estimates measured through sample surveys (Figure 7). Communication activities, including instant messaging and voice calls, which most Internet users engaged in prior to the pandemic, experienced growth that lagged behind pre-pandemic levels. Although the measurement did not consider the frequency of use – which may have intensified after the pandemic – the results indicate that the penetration of this type of resource was already almost universal, with non-users concentrated in more vulnerable segments of the population. The growth in the use of social networks, in turn, maintained the pace observed in the pre-pandemic period, suggesting no relevant effects associated with the COVID-19 crisis.

Despite the implementation of social distancing measures, the growth in the performance of transactional activities, such as the search for health information and access to online public services, remained similar to the expected growth observed in the time series. The results indicate no major expansion of these practices after the pandemic.

The most pronounced growth in relation to the historical series was observed in financial transactions. The observed growth was higher than the expected increase during the period (forecasted by the model), indicating an acceleration in the digitization of commercial transactions following the emergence of the pandemic. In the context of increasing economic deprivation and limitations on income generation, digitalization may have accelerated during the period. Although the accelerated adoption of this online activity is a marked trend in the post-pandemic period, the data presented do not allow us to determine whether the pandemic directly caused this shift, independently of other variables that may have influenced the outcome. In this case, further investigation is needed to clarify the mechanisms underlying this development.

Among practices restricted to a "digital elite", a significant increase occurred in the number of individuals taking distance learning courses, although still at very low levels when considering the whole population. The observed estimates for users who created or updated blogs, webpages, or websites were below the expected growth for the period.

Thus, in general terms, the empirical analysis indicates the persistence of patterns in the diffusion of online practices over time. Although it is not sufficient to fully disclose the mechanisms that reinforce this persistence, the results suggest that the incentives for digitalization that emerged during the health crisis were not enough to accelerate and equalize the adoption of online practices across the entire population – particularly among the most vulnerable groups. In the following section, we turn our attention to the role of social protection programs in this context and to the extent to which such strategies can serve as mechanisms that influence the adoption of digital technologies.

Part 3: Online practices among populations targeted by social protection programs

In the field of economic well-being, substantive attention has been given to the relation-ship between Internet access and income generation in the labor market. From an employment point of view, there is a set of studies that associate the provision of broadband Internet with employment growth (Crandall/Lehr/Litan 2007; Jayakar/Park 2013), or that find positive effects of its adoption on the employment rate, with greater impacts on rural and more isolated areas (Atasoy 2013). Some studies find positive effects only among more qualified workers (Falck

2017), or among certain sectors of the economy that are more dependent on human capital (Gutiérrez/Gallego 2016). Regarding income generation, new evidence indicates a significant contribution of digital technologies to maintaining income levels among more vulnerable populations, even though it does not necessarily cause real gains or improvements in living conditions or better jobs (Senne 2022).

However, there is a lack of studies exploring the relationship between online engagement and income associated with social protection programs and the possible results of those policies for overcoming digital inequalities. Do individuals covered by income transfer policies have greater incentives to be online, and can they benefit from online opportunities at similar levels as the rest of the population?

In order to investigate the relationship between online engagement and income transfer social protection programs, we chose to estimate the probability of individuals performing online activities while they are living in households that contain any beneficiary of the included income transfer Federal programs (BPC and BFP).

Descriptive analysis shows that individuals targeted by social protection programs, as expected, present higher levels of poverty and social vulnerabilities. Overall, social protection beneficiaries are more prevalent in rural areas (44.9% in the BFP) in comparison to urban locations (23.8%). The results are aligned with the profile of rural areas in Brazil, which present lower socio-economic conditions and a higher percentage of the population under poverty. Huge differences are also observed when comparing income and socio-economic status. In the case of BFP, around half of the population lives in low-income households targeted by the program. Regional disparities are also relevant, with the poorest regions of the country (North and Northeast) having a higher share of social protection beneficiaries (see Appendix 2).

Individual conditions found in the results are also consistent with the literature on social inequalities. The most frequent profiles of individuals living in households that received transfers from social protection programs were female and black-female, with low income and low education (see Appendix 3). The main difference between the two policies analyzed in this study is the age group: Bolsa Família (BFP) is associated with households with children, while the BPC, by design, targets the elderly population.

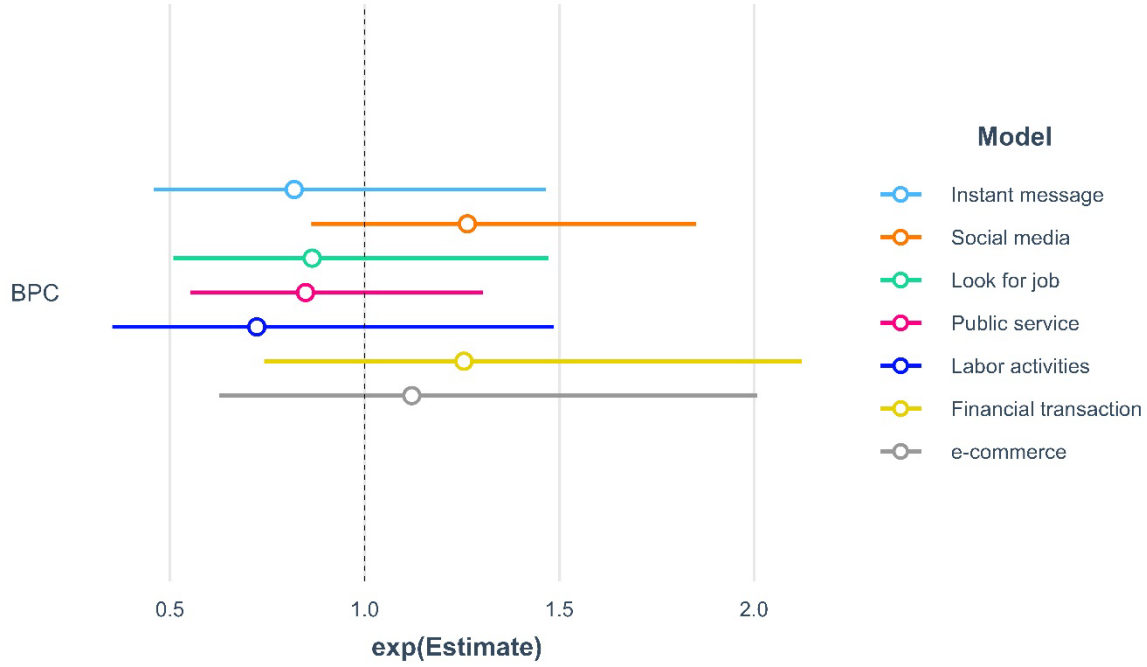
Regarding variables associated with the quality of Internet use, the main differences observed were between the presence of computers and fixed broadband (Table 2). In the case of BFP, the proportion of households with computers is about 24 percentage points lower among individuals targeted by the programs. Internet use, frequency of use, and mobile phone ownership were similar among households with or without beneficiaries of social protection programs, which indicates that they are more disseminated in the overall population from different sociodemographic backgrounds.

Results obtained by logistic regression models show important differences depending on the program included in the models. For the BPC, no significant differences were found among the variables observed (Figure 8). Thus, the probability of engaging in those practices was not correlated with living in a household receiving program benefits. The result is particularly relevant given the program's focus on the elderly population, indicating that the income increase associated with the transfer is not sufficient to substantially impact the level of adoption of online practices in those strata.

Table 2: Percentage of individuals living in households with BPC and BFP beneficiaries, by conditions of connectivity and Internet use (2023)

	BPC		BFP	
	Yes	No	Yes	No
Internet use	79.2%	84.5%	85.4%	83.7%
Daily Internet use	78.4%	82.6%	83.6%	81.8%
Mobile phone ownership	86.2%	88.4%	86.7%	88.7%
Households with Internet	84.8%	88.8%	86.8%	89.1%
Households with computers	36.3%	45.4%	27.5%	51.0%
Fixed Broadband (cable/fiber optic)	50.3%	60.0%	52.7%	61.7%

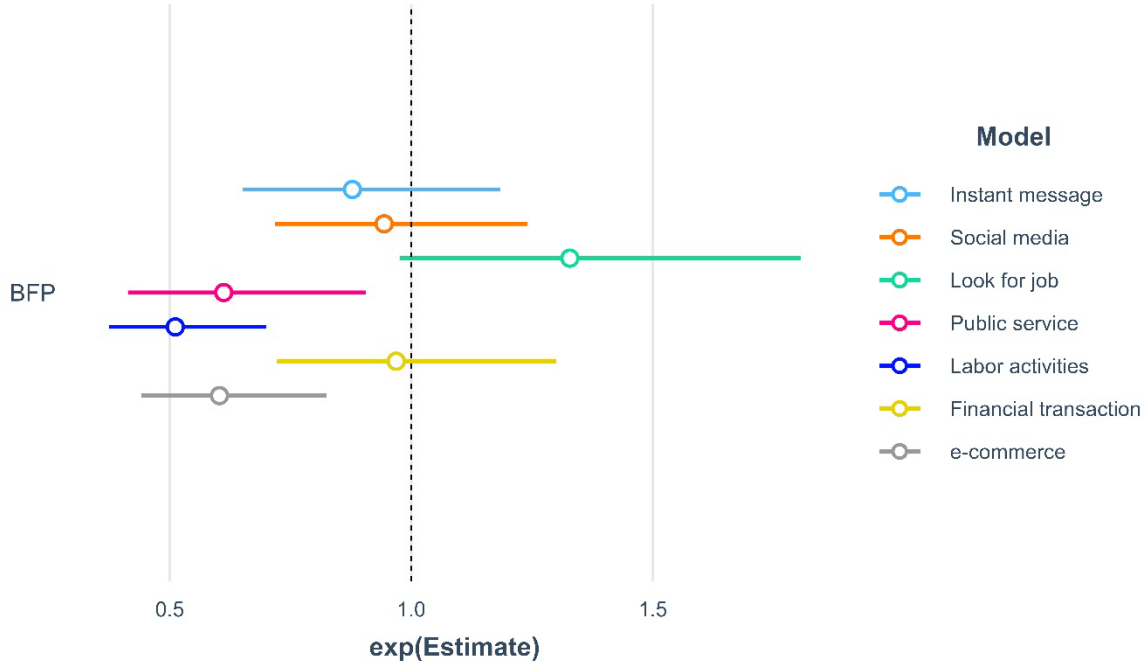
Figure 8: Predicted probabilities for households with BPC beneficiaries in relation to engagement in selected online activities (2023)



For the BFP, significant differences were found between individuals living in households affected by the program and those who performed activities such as engaging in public services, labor activities, and e-commerce (Figure 9). The models show that the likelihood of adopting these activities is lower among the program's beneficiaries.

No significant differences were found in the use of communication tools (such as social networks or instant messaging), activities traditionally adopted by a large number of Internet users. Online financial transactions, also used by social programs to implement income transfer, were not significantly different. The probability of looking for a job was higher among individuals living in BFP households, although within the limits of the confidence intervals.

Figure 9: Predicted probabilities for households with BFP beneficiaries in relation to engagement in selected online activities (2023)



Overall, results show that the level of education was one of the main predictors of the performance of the selected online activities. No statistically significant relations were observed by race (black or brown). Gender differences were present depending on the activity: being a man predicted the use of the Internet in labor activities and financial transactions, but no significant differences were found in other activities. The same results were observed among households that received BPC benefits.

In the case of the BPC, no differences were found between beneficiaries and non-beneficiaries of the program regarding digital practices. Given the characteristics of the program – designed to assist the most vulnerable segments of the population, including the elderly, without necessarily targeting the poorest population –, the results of the models confirm that presence in the program does not affect engagement in online activities in a statistically significant way.

As for the BFP, which clearly has a more redistributive design and focuses on the poorest, it is possible to notice greater disparities between beneficiaries and non-beneficiaries in some of the variables analyzed. Regarding connectivity conditions, being in the program is not associated with Internet use in the last three months, as well as daily use. Owning a mobile phone is another factor distributed equally between beneficiaries and non-beneficiaries. This indicates, on the one hand, that the spread of mobile connectivity to the poorest segments of the population, observed even more increasingly in the context of the COVID-19 pandemic, has made it possible to increase equity in the basic access to the Internet.

However, when observing the digital practices of individuals in households benefiting from the BFP, it is evident that activities potentially associated with opportunities for well-being – such as making purchases online, using public services, and carrying out work activities – are reported significantly less frequently by program beneficiaries, even when these factors are con-

trolled for educational level, gender, race, and age. The result confirms the evidence in the literature of a second-level digital divide, in which Internet users present disparities in online practices. Moreover, the results indicate that programs aimed at alleviating poverty were not sufficient mechanisms for enabling low-income and vulnerable populations to leapfrog traditional barriers to Internet adoption.

Conclusion

The results obtained for Brazil show that the trajectory of digital inclusion in the country is marked by the persistence of digital inequalities, despite the delayed inclusion of the most vulnerable sectors into the online environment. The series of cross-sectional sample surveys available for the country also reveals that individuals' access to the Internet is not sufficient to increase equity in the adoption of online practices and the generation of tangible benefits from online opportunities. Although access to the Internet has increased substantially over the period, with a significant reduction in inequalities between users and non-users, engagement in online practices has not advanced equally for all strata of the population. Among the most striking differences are the variations in socioeconomic status and levels of education.

The COVID-19 pandemic emerged as a disruptive moment, during which social distancing measures created incentives for the migration of practices and services to the online environment. However, the results indicate that the pandemic does not seem to have affected the trajectory of online activities uniformly, suggesting the presence of more permanent determinants that restrict broad digitalization. Among the most significant increases was the rise in online financial transactions, a result that converges with the economic impacts experienced during the pandemic. In this period, along with the emergence of the COVID-19 pandemic, other factors can also affect online transactions, including the popularization of online payment methods, such as Pix – an electronic payment system launched by the Central Bank of Brazil (BCB, as per its acronym in Portuguese) in late 2020. Thus, further investigation is needed to evaluate the role of digital transactions in the post-pandemic scenario.

We also focused on the analysis of online practices of beneficiaries of social protection programs in the post-pandemic context. In convergence with the results presented for other sociodemographic variables, carrying out communication activities, such as the use of instant messaging and social networks, was weakly associated with participation or not in social protection programs. More sophisticated activities, such as conducting financial transactions and public services, appear in smaller proportions among individuals targeted by those policies. In short, the evidence reinforces the conclusion that pre-existing stratifications shape the dynamics of digital inequalities, and that income-transfer incentives are not sufficient measures to counteract them.

Among the policy implications of the results, it is critical to consider multiple effects of Internet access and use among the most vulnerable population. Previous research in the country indicated greater resilience in facing poverty among those who were able to use the Internet, mainly due to labor income and not due to greater access to income transfer programs (Senne 2022). Even though getting online is not necessarily correlated to finding better jobs (such as formal jobs), the use of the Internet can have a significant impact on access to sources of income,

in a market characterized by high informality. Therefore, the association between social protection programs and the promotion of connectivity can generate important short-term results. From this point of view, at least in periods of economic or social crises, the combination of measures to stimulate connectivity associated with income transfer programs can be a promising path.

Thus, while social programs aimed at alleviating poverty may have some impact in ensuring minimum conditions for Internet access, our findings suggest that they are not sufficient to alter the broader landscape of digital inequalities in terms of online practices. From this perspective, changes in the patterns of digital inequality appear to have been less influenced by the pandemic — and by the policies implemented to address it — than might have been expected based on studies that monitored the period.

In sum, the maintenance of disparities in the use of online opportunities, even when controlling for similar demographic profiles, could mean a reinforcement of inequalities in the long term. The data are consistent with the literature on socio-digital inequalities, indicating that the provision of network access is not sufficient to promote equity in terms of online opportunities. Future analysis is needed to incorporate other aspects, such as digital skills and the intersectionality of inequality markers.

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Appendix

Appendix 1: Selected forecast models and results by online activity

	Point Forecast	Lo 80	Hi 80	Lo 95	Hi 95	Model
Instant messaging						
2020	0.773933	0.66763	0.880236	0.611357	0.93651	ets
2021	0.820308	0.707633	0.932983	0.647986	0.99263	ets
2022	0.866683	0.747633	0.985734	0.684612	1.048755	ets
2023	0.913059	0.787629	1.038488	0.721231	1.104886	ets
2024	0.959434	0.827621	1.091247	0.757843	1.161024	ets
Voice calls						
2020	0.651566	0.582549	0.720582	0.546013	0.757118	arima
2021	0.693899	0.596295	0.791504	0.544626	0.843173	arima
2022	0.736233	0.616693	0.855774	0.553412	0.919055	arima
2023	0.778567	0.640534	0.916601	0.567463	0.989672	arima
2024	0.820901	0.666575	0.975228	0.584879	1.056923	arima
Health services						
2020	0.398516	0.367433	0.429599	0.350978	0.446053	ets
2021	0.421333	0.39025	0.452416	0.373796	0.46887	ets
2022	0.44415	0.413067	0.475233	0.396613	0.491688	ets
2023	0.466968	0.435885	0.498051	0.41943	0.514505	ets
2024	0.489785	0.458702	0.520868	0.442248	0.537323	ets
Public services						
2020	0.249186	0.232985	0.265388	0.224409	0.273964	arima
2021	0.263895	0.240983	0.286807	0.228854	0.298936	arima
2022	0.278604	0.250542	0.306665	0.235687	0.32152	arima
2023	0.293312	0.26091	0.325715	0.243757	0.342868	arima
2024	0.308021	0.271794	0.344248	0.252616	0.363426	arima
Social networks						
2020	0.627489	0.593629	0.66135	0.575704	0.679274	ets
2021	0.648808	0.614948	0.682669	0.597023	0.700593	ets
2022	0.668786	0.634925	0.702646	0.617001	0.720571	ets
2023	0.687506	0.653646	0.721366	0.635721	0.739291	ets
2024	0.705048	0.671188	0.738909	0.653263	0.756833	ets
Financial transactions						
2020	0.247538	0.185915	0.309162	0.153294	0.341783	ets
2021	0.26116	0.19485	0.32747	0.159748	0.362573	ets
2022	0.274782	0.203794	0.345771	0.166215	0.383349	ets
2023	0.288404	0.212738	0.364071	0.172683	0.404126	ets
2024	0.302026	0.221675	0.382377	0.17914	0.424913	ets
Blogs and webpages						

2020	0.161411	0.127787	0.195036	0.109988	0.212835	ets
2021	0.170273	0.134803	0.205743	0.116026	0.22452	ets
2022	0.179134	0.141818	0.216451	0.122064	0.236205	ets
2023	0.187996	0.148834	0.227158	0.128103	0.247889	ets
2024	0.196857	0.155849	0.237866	0.134141	0.259574	ets
Online courses						
2020	0.107266	0.090444	0.124088	0.081539	0.132993	arima
2021	0.113564	0.089774	0.137354	0.077181	0.149948	arima
2022	0.119863	0.090726	0.149	0.075302	0.164424	arima
2023	0.126161	0.092517	0.159806	0.074707	0.177616	arima
2024	0.13246	0.094844	0.170075	0.074932	0.189988	arima

Appendix 2: Percentage of individuals living in households with BPC and BFP beneficiaries, by location, socioeconomic status, region, and family income (2023)

		BPC	**BFP**
Total		6.3%	26.6%
Location	Urban	5.9%	23.8%
	Rural	8.9%	44.9%
SES	High	1.9%	6.1%
	Medium	6.9%	23.0%
	Low	8.7%	48.2%
Region	North	11.5%	44.6%
	Northeast	7.1%	41.8%
	Southeast	4.5%	16.6%
	South	5.8%	20.3%
	Center-West	9.1%	21.3%
Family income	Up to 1 MW	7.8%	51.7%
	More than 1 MW	6.1%	19.1%

Appendix 3: Percentage of individuals living in households with BPC and BFP beneficiaries, by gender, intersection of gender and race, individual income, and level of education (2023)

		BPC	BFP
Total		6.3%	26.6%
Gender	Female	6.8%	30.4%
	Male	5.7%	22.5%
Gender-race	White-male	5.2%	17.1%
	Black-male	5.8%	24.7%
	White-female	5.9%	19.4%
	Black-female	7.5%	37.3%
Income	Up to 1 MW	9.3%	37.5%
	More than 1 MW	4.5%	19.0%
Education	Primary	8.5%	34.2%
	Secondary	5.8%	28.1%
	Tertiary	2.7%	7.8%
Age	10-15	4.9%	44.0%
	16-24	3.1%	33.6%
	25-34	8.0%	33.5%
	35-44	6.4%	25.5%
	45-54	6.9%	24.0%
	60+	7.3%	8.3%