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Article

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Fast payment, credit and bank diversification: the impact of Pix adoption on the local credit market structure

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Abstract

Purpose – In this article, the research objective is to empirically investigate the effect of the adoption of the Brazilian instant payment system, Pix, on the local credit market structure and the diversification of the banking system in Brazilian municipalities.

Design/methodology/approach – By analyzing the data, in this study, we compile and align data from supervisory and public sources, covering the period from 2019 to 2022 in Brazil. As of 2014, Brazil was comprised of 5568 municipalities distributed across five regions: North (450 municipalities), Northeast (1792), Midwest (467), Southeast (1668) and South (1191), according to the Brazilian Institute of Geography and Statistics (IBGE). Our analysis relies on the volume and quantity of Pix to the outstanding credit operations in Brazil.

Findings – This article provides evidence that the widespread adoption of Pix has impacted the financial structure of municipalities. This analysis of banking concentration in the country and municipalities, based on banking relationships, helped us assess whether the adoption of Pix had any correlation with the increase in credit lines. Overall, the results from the statistical tables suggest that the adoption of Pix may be having a positive impact on the local credit market structure.

Originality/value – The originality contribution of the study is to initiate an investigation into the impact of this instant payment system, Pix, on the Brazilian reality. Pix was launched in 2020, amid the COVID-19 pandemic, and had significant numbers, such as over 61% of the adult population having at least one Pix key registered in a little over a year; about 100 million people made at least one payment with Pix; and more than 1.4 billion transactions per month, with 72% between individuals, as presented by the REB 2021.

Keywords Fast payment, Pix, Credit, Bank diversification

Paper type Research paper

1. Introduction

Electronic real-time processing, twenty-four hours a day, three hundred and sixty-five days a year, with immediate availability of funds/values for the recipient's use – this is the definition provided by the [European Central Bank \(ECB\)](#) for instant payments. This definition is also presented by the [Committee on Payments and Market Infrastructures \(2016\)](#) of the [Bank for International Settlements \(BIS\)](#) (2012, 2019), with the perspective that a fast payment ensures a final credit of resources to the beneficiary, i.e. with unconditional and irrevocable access to these resources. The same BIS Committee emphasizes that the terminology (“instant,” “immediate,” “real-time” or “faster” payments) and the characteristics of fast payments vary from country to country.

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Data availability: The authors do not have permission to share data.

The views expressed in this paper are those of the authors and do not necessarily reflect those of the Central Bank of Brazil (BCB).



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These terminological and attribute differences are related to the historical emergence of fast payments over time. Despite the early implementation of some fast payment features in payment systems in countries such as Japan (1973), Korea (1993, with mobile authentication since 2007), Mexico (1995) and Switzerland (1987), the new reality of real-time transfer processing, following the above definitions, began to emerge with more similar characteristics to those we have today in the United Kingdom with the UK Faster Payments Service (FPS) in 2008. Since then, payment systems have been emerging in countries such as China, with the Internet Banking Payment System (IBPS), widely used by Alipay (Alibaba) and WeChat Pay (Tencent), and the United States, with the development of FedNow under the scope of the Federal Reserve (FED).

Therefore, due to its globalization, it is important to reflect, as [Hartmann, Gijzel, Plooi, and Vandeweyer \(2019\)](#), on how fast payments are becoming the new normal. This global transformation of the instant payment system as a new normal brings a disruptive change that has altered the dynamics of financial flow, knowledge exchange and new forms of business, being central to new facets of economic activity that are unfolding. For example, the formalization of money transfers helps promote the financial inclusion of initially unbanked poorer families, contributing to explaining the effects of instant payments on the economy. Moreover, the ease of financial exchange generates forces of financial inclusion for families that can only prove their creditworthiness through transfer flows identified by financial institutions ([Rocher & Pelletier, 2008](#)).

Central Bank of Brazil (BCB) needed two years between the decision to create Pix, Brazil's instant payment system, its development and its actual launch. The decision-making process began in 2018 and was practically formalized in November 2020. However, the history of Pix is linked to the regulatory framework of Law No. 12.865/2013, which gave rise to payment schemes and granted the Central Bank the authority to regulate existing and new payment schemes, as well as their establishment, operation and oversight.

The definition of payment schemes, as described in the aforementioned law, refers to a set of rules and procedures governing the provision of a specific payment service to the public, which is accepted by a recipient, with direct access by end-users, payers and recipients. In addition to this definition, to aid in understanding the operation and commitment of Pix, the definition of a payment schemes' founder can be introduced as the legal entity responsible for the payment schemes and, when applicable, for the use of the brand associated with the payment schemes. Finally, we introduce the definition of a payment service provider, defined as a financial institution or payment institution that provides payment services to an end-user.

Pix is a payment scheme instituted by BCB that plays two important roles one as a regulator, establishing the operational rules, and another one as a manager of operational platforms. This two-tier structure promotes a standardized, competitive, inclusive, secure and open environment, enhancing the overall payment experience for end-users. Thus, Pix has the structure of a scheme with a payment service provider (PSP), which is the financial institution or payment institution where the receiving user maintains an account for credit receipt, with the founder of the scheme being the Central Bank, as the entity that establishes the rules. PSPs directly or indirectly access the Directory of Transactional Account Identifiers (DICT). Indirect access to the DICT by the initiating participant must be conducted through a Pix participant with direct access to the DICT, and all direct Pix participants must be direct participants in the [Instant Payments System \(SPI\) \[1\]](#), which is the centralized and unique infrastructure for settling instant payments between different institutions in Brazil. The operation of the SPI was conducted by the BCB and began in 2020.

The objectives of Brazil's instant payment system are to increase efficiency and competitiveness, stimulate the digitization of the payment market, promote financial inclusion and fill gaps in the currently available payment instruments according to Angelo

Duarte, Jon Frost, Leonardo Gambacorta, Priscilla Koo Wilkens and Hyun Song Shin (BIS, 2022b). Pix is an example of how the Central Bank support can influence the use of a new payment system by providing rule support and reliability to the user. Furthermore, an environment with a level of interoperability, as demonstrated by Pix, provides an additional stimulus to competition by promoting lower costs and greater financial inclusion.

Our paper relates to the emerging literature on the impact of Pix on the credit demand and bank diversification. Our main contribution is to shed light on the influences of a fast payment on lending behavior, more competitive banking system and financial inclusion.

Pix was launched in 2020, amid the COVID-19 pandemic, and it had significant numbers, such as over 61% of the adult population having at least one Pix key registered within just over a year; about 100 million people made at least one payment with Pix; and more than 1.4 billion transactions per month, with 72% between individuals, as presented by the REB 2021. The impact of financial inclusion brought about by Pix has increased possibilities by providing an alternative to dealing solely with traditional banks, enabling users to avoid high credit and debit card fees, and opening new avenues of credit access (BIS, 2022a, b). As more people participate in the financial system, a greater variety of credit line options are emerging.

According to the Treasury Department, the opening of businesses under the Individual Entrepreneur modality – which includes individual microentrepreneurs (MEIs) – reached 2.663.309 microentrepreneurs in 2020, representing an 8.4% increase compared to 2019. Small and medium-sized businesses usually lack a history of relationships with major banks, making it challenging to access credit. The creation of digital accounts for legal entities enables, through the transfer of money flows via instant payment systems, public and private banks to assess the financial capacity of the company to acquire credit.

It is possible to say that financial inclusion increased since Law 12.865/2013, Pix plays a significant role in this development. Pix has helped to make payment transactions cheaper than before, which in turn has made it possible to offer more affordable services to the neediest populations. The first step was the opening of the market, which facilitated the creation of payment institutions and improved access for populations previously underserved by banks. With Pix, the interest of the unbanked population in banking services increased. Before Pix, it was only possible to have pre- and post-paid accounts. While access for purchases and bill payments was already adequate, transfers remained expensive for a large part of the population due to fees associated with TED and DOC, both manners to make money transfer. Furthermore, receiving payments became cheaper and easier with Pix. Consider the evolution for low-income self-employed individuals, such as day laborers, bricklayers and popcorn vendors.

On Central Bank of Brazil website, payment institutions are defined as “those that enable citizens to make payments independently of banks and other financial institutions. With movable financial resources, such as through a prepaid card or a mobile phone, **users can carry funds and perform transactions without needing cash** (author’s emphasis). Thanks to interoperability, **users can also send and receive money to and from banks and other payment institutions** (author’s emphasis).”

The monetary authority, in the same publication, also highlights the importance of these payment services provided not only by payment institutions but also by financial institutions, particularly banks, finance companies and credit unions. The significance of Law 12.865/2013 is the subject of a separate article by the author.

Therefore, the objective of this research is not to discuss the cost of credit or how fintechs, peer-to-peer loan companies (SEP), direct credit companies (SCD) and banks compete to offer credit to their customers. Rather, the research aims to highlight the fact that Pix served as the driving force, or more precisely, the catalyst for developments that might have otherwise taken a longer time to materialize.

Thus, the greater the banked population, the more competition there is among players for customers and services. According to Box 7 of the BCB's 2021 Banking Economy Report, the opening of digital accounts promotes financial inclusion, not only at the individual level, as had been happening for some time with the entry of new players such as fintechs and companies from other sectors but also at the legal entity level. In the Brazilian case, the COVID-19 pandemic accelerated changes in how many Brazilians conduct their financial transactions, stimulating the digitization process. The increased access to online services heats the local financial and retail sectors. The population has easier access to other forms of financial transactions and credit lines. With the streamlining of financial exchanges, financial institutions can better determine the amount of credit that can be offered to customers.

This article examines whether the adoption of the Pix, Brazil's instant payment system, has changed the local credit market structure. We analyze a unique municipality-level data using a difference-in-differences approach, and we find that a widespread adoption of fast payments in municipalities associates with a more diversified local credit market. Our results suggest that the increased financial inclusion permitted by Pix, especially in those municipalities that adopted to a greater extent the fast payments solution, attracted more financial institutions to operate with local borrowers. This more diversified local financial ecosystem may explain the reduction in local bank concentration. Our event studies indicate that these structural changes were not short-lived, as our monthly point estimates are stable in a two-year window after the launch of Pix. So, we can say that this paper provides novel empirical evidence of potential changes in bank credit markets brought by fast payments solutions.

Regarding the data, aggregation by localities performed using monthly banking statistics with a public dataset maintained by the BCB at the bank branch and locality level. The Herfindahl-Hirschman Index (HHI) for local credit was calculated as the squared credit share of each bank in that locality.

The paper is organized as follows: [Section 2](#) presents the literature review. [Section 3](#) describes data and some stylized facts and explains our empirical strategy and how we tackle identification issues. [Section 4](#) presents our main independent variable. [Section 5](#) presents the empirical results. [Section 6](#) summarizes the final considerations.

2. Literature review

The theoretical and empirical literature present results regarding the effects of faster payment on credit supply. Some of these papers employ aggregate data on credit along with other macroeconomic proxies. For example, the level of local labor markets, to empirically evaluate this link. Although our work is aligned with this body of literature, our approach is innovative as we test whether the HHI, establishes a conceptual link between the volume and number of Pix transactions and outstanding credit operations in Brazil. In other words, it provides a measure of diversity within financial credit operations by using the HHI measure.

This connection is highlighted through the analysis of credit diversification using locality level fast payments data from Brazil. To the best of our knowledge, our paper is the first to seek to establish this relationship. The research we initiate may assist in the development of public policies aimed at accelerating financial inclusion, especially among populations without access to banking services.

Our paper is closely related to [BIS \(2022a\)](#). They examine the case of Ant Group, which introduced payment services through QR codes, granting offline merchants access to digital payment services. The data collected from these services are utilized to determine credit provision to merchants. The findings indicate that the adoption of QR codes for payment services enables offline merchants not only to access credit from major tech companies but

also, by being included in the credit registry after receiving significant tech loans, to gain access to unsecured bank credit. Additionally, the authors report positive real effects of big tech credit usage, especially evident during COVID-19 pandemic, where the recovery in transactions was 20% more pronounced for users of big tech credit compared to non-users.

Our paper also relates to fintechs literature as [Ding, Chong, Kuo, and Cheng \(2017\)](#) who analyze fintech advancements toward to products and financial services becoming them more accessible to a part of population. The authors also discuss what is vital for achieving full financial and social inclusion for consumers living in regions without the infrastructure of an urban economy, or else, ensuring a level playing field helps shed light on financial inclusion and progress.

Regarding fintech and BigTech innovation, [Frost, Gambacorta, Huang, Shin, and Zbinden \(2019\)](#) also bring some information about payments. For example, the share of BigTech credit in total FinTech credit is highest in Korea, Argentina and Brazil, all of which have relatively small FinTech credit markets. China has the most pronounced activities on BigTech firms in credit provision, but credit activity would have also grown in other countries, although on a smaller scale. This is perhaps due to the presence of incumbent bank-based payment systems and, in some cases, regulation. In Latin America, Mercado Livre had outstanding credit of over \$127 million in Brazil, Argentina, and Mexico as of late 2017. The authors show that available data suggest that China is by far the largest market, with BigTech mobile payments for consumption reaching the United States, India, and Brazil follow at a distance, comparing the GDP of all of them. Brazil is characterized as one of the five emerging countries with rapid economic growth and an expanding middle class but without the traditional financial infrastructure to support this new demand. Relatively high proportions of the population are underserved by existing financial services providers, while falling prices for smartphones and broadband services have increased the digitally active population that financial technology firms target.

Following the impact of fintech innovation, [Claessens, Frost, Turner, and Zhu \(2018\)](#) use CCAF, Brismo and WDZJ data in cross-section to discuss the growth of FinTech and which have been the drivers of fintech credit. They analyze consumers in both advanced and emerging market economies who have increasingly adopted digital financial services that are more convenient. They define the development of fintech credit as credit activity facilitated by electronic platforms that are not operated by commercial banks. They work with GDP per capita and a squared GDP per capita.

In the context of social inclusion, fintechs play an important role, [Ding et al. \(2017\)](#) write about how a fintech holds boundless potential, once every day, new platforms and technologies are introduced to the market, challenging the boundaries of traditional business models. In China, for example, what generated substantial improvements in financial inclusion was transaction data obtained from the MYbank scoring system by firms to offer credit to their customers, who typically cannot provide sufficient documentation to apply for regular bank credit. The authors bring up the case of Ant Financial, which focuses on the underserved markets by the major Chinese banks: low-income individuals, especially those in rural areas. This fact is related to our results in this paper, as we observed a higher Pix adoption among low-income individuals.

Digitalization by technology provides higher lending flexibility, mobile phones and fintechs play an important role in the growth of market credit activities and finance. First, this kind of analysis helps shed light on the changing banking market structure wrought by technology, which allows more inclusion for the unbanked population.

[Cornelli, Frost, Gambacorta, Rau, Wardrop, and Ziegler \(2020\)](#) estimated that the flow of new forms of credit reached USD 223 billion and USD 572 billion in 2019, respectively. Data on mobile phones per 100 persons were included. The paper has documented the recent growth of fintech credit, provided by nonbank online platforms, and big tech credit, provided

by large companies whose primary business is technology, sometimes in partnership with traditional financial institutions. The authors assessed the economic and institutional factors driving the growth and adoption of fintech and big tech credit.

In the context of the federal QuickPay reform of 2011, [Barrot and Nanda \(2020\)](#) investigate the impact of faster payments on firm-level employment. According to the paper, QuickPay significantly accelerated payments to a subset of small business contractors of the US federal government, reducing the time taken from invoice approval to payment by half, from 30 to 15 days. For treated firms, the reform, therefore, permanently reduced the working capital needed to sustain a dollar of sales with the government. The acceleration impacted USD 70 billion in annual contract value, affecting a broad range of small businesses across virtually every industry sector and US County due to the massive footprint of federal government procurement.

Another example of government implementation, [Agarwal, Kigabo, Minoiu, Presbitero, and Silva \(2021\)](#) analyze the effect of a nationwide, government-subsidized microcredit expansion program that created an extensive network of community-focused savings and credit cooperatives (Umurenge SACCOs, henceforth U-SACCOs) across the 416 municipalities in Rwanda. The program resulted in more than 90% of Rwandans residing within three miles of a U-SACCO. Their identification strategy exploits time-series variation in the opening of U-SACCOs across municipalities, coupled with administrative microdata on the lending activities of all financial institutions. The paper uses a comprehensive credit register with detailed information on the universe of loans to individuals in the entire country for a total of nine years around the implementation of the program (2008–2016).

3. Data

We compile and merge public and proprietary datasets to run our empirical specifications. First, we extract Pix data from November 2020 to October 2022, a proprietary dataset maintained by the BCB that provides from the only centralized infrastructure for instant payments settlement between different payment service providers in Brazil, Instant Payment System (SPI). We extract number of Pix, that is, transactions settled daily in SPI (transactions settled in the participant's books), considering payment orders and financial volume of Pix, that is, transactions settled daily in SPI (transactions settled in the participant's books), considering payment orders. We take the daily total PIX volume per municipality in Brazil, and we aggregate as monthly data. Although the adoption of Pix affected each population level and each region of the country differently, the volume transacted was high. Around 17 million Brazilians who had never made a bank transfer made a Pix for the first time, as reported in the 2021 Financial Citizenship report.

We extract bank branch data from January 2019 to July 2022 of the Monthly Banking Statistics by Municipality (ESTBAN), a public dataset maintained by the BCB that provides summarized balance-sheet information for each bank branch in Brazilian municipalities over time. We aggregate ESTBAN balance sheet data across branches for each municipality taken in a time.

Regarding localities, we extract sociodemographic and geographical municipality-level data information from the [Brazilian Institute of Geography and Statistics \(IBGE\)](#) public dataset. We collect the GDP per capita and population from all the 5,570 Brazilian municipalities since 2020 to 2022.

We also compile COVID-19 epidemiological bulletins from the Ministry of Health (public data) from February 2020 to March 2022 to construct a variable of prevalence (accumulated cases) and deaths accumulated in each locality. These bulletins contain the number of COVID-19 cases per municipality daily.

These four datasets allow us to connect information about how the use of Pix is correlated with financial inclusion, borrowers, credit operations, increased banking competition and regional socioeconomic conditions. Our methodology correlates a measure of concentration and diversification of the local financial system, HHI, with the adoption of Pix based on volume of Pix at municipal level. This concentration measure is the HHI, which in our model is the dependent variable. The HHI was constructed by the authors from ESTBAN data using the formula below:

$$HHI\ credit_{it} = \sum_{b \in B_{it}} \left(\frac{Total\ Credit_{ibt}}{City\ level\ of\ Total\ Credit_{ibt}} \right)^2 \quad (1)$$

in which i and t index locality, and time (from January 2019 to July 2022). B_{it} is the set of banks in municipality i at time t . This index then fluctuates between 0 and 1, in which higher values indicate more concentrated markets. In the extreme, when it reaches 1, the market is a monopoly.

We use operations from ESTBAN dataset to construct $HHI\ credit_{it}$ rates as dependent variables in the second specifications. We construct this variable as the sum of the total credit divided by the level of total credit for each city, squared for the calculation of credit HHI. The $HHI\ credit_{it}$ is the square of the credit share for each bank present in that municipality. The variable $Total\ Credit_{ibt}$ was constructed from entry 160 of credit operations from Estban. Estban dataset were used also to construct variable $City\ level\ of\ Total\ Credit_{ibt}$, the sum of $Total\ Credit_{ibt}$. They are shown in [Appendix A](#) that reports the summary statistics of variables of the empirical specifications in this paper. The dataset involves financial and economic indicators for municipalities.

Plus, according to information from the [Central Bank of Brazil \[2\]](#), Estban data are by municipality and are generated monthly with information from the Monthly Banking Statistics, covering the monthly position of the balances of the main balance sheet items of commercial banks and multiple banks with a commercial portfolio, by municipality, headings of Cash, Deposits, Securities, Loans, Financing, Rural Financing and Real Estate Financing. These variables are calculated in proportion to the gross domestic product (GDP). So, this way, we can have an idea of how much of the population has access to credit operations and, consequently, financial inclusion.

From this context, we choose the HHI index because of the number of contexts we can use it, once we can measure concentration in many different areas, as it serves as a screening element for regulators and as a planning tool for policy makers. On [Federal Reserve](#), we can find an HHI specification very similar to ours, in which “. . . HHI is used in a variety of industries. In the case of banking, the HHI is calculated by summing the square of the share of deposits for each bank within a particular geographical area.”

We highlight that Brazil is a continental country with very heterogeneous areas in terms of size, demography, wealth, income and human development. In [Appendix A](#), we can see information about population, as locations that have a high population average compared to other locations, which shows population heterogeneity and even population concentration in some areas. In relation to GDP, heterogeneity continues, that is, there is a concentration of wealth in certain locations. In relation to GDP per capita, this difference decreases since there is a more symmetrical distribution of per capita wealth between locations. When comparing population, GDP and GDP per capita data with Pix volume data, we noticed that there is a correlation between the data, as the average Pix volume is around nine times greater than the median. In this way, the differences between these locations are considered when designing our strategy. It is important to control for differences between locations to ensure they do not influence our results. Some variables are created and placed in the pre-Pix period and in the

post-Pix period so that there is no claim of endogeneity and thus proving that there was an external factor for the correlation.

COVID-19 variables are placed as covariates to control whether there are other factors (that we are not controlling) influencing Pix. Regions with higher prevalence of COVID-19 are more likely to enforce public health measures such as broad social distancing, lockdowns and quarantines. These measures can significantly impact economic activities, including credit and consumption, potentially leading to a decrease in local economic activity. [Appendix A](#) illustrates that certain regions exhibit a notably high average number of COVID-19 cases, with some experiencing higher mortality rates than others.

Thus, it is important to include this variable to address potential confounders in our empirical setup. This inclusion is crucial for arguing that fluctuations in Pix volume are not solely attributed to individuals being confined to their homes during the pandemic. If a municipality is facing a high intensity of COVID-19 cases, locals would be prompted to stay home more frequently, affecting their utilization of Pix for payments, thereby potentially correlating COVID-19 with credit-related variables, such as the HHI in the credit market. Moreover, amidst this pandemic, one could argue for the government's support during the COVID-19 pandemic was related to the local intensity of COVID-19.

4. Pix adoption across municipalities

This section defines our main independent variable: *High Adoption of Pix_i*. We measure the high adoption of Pix from the volume of Pix transactions. We merge ESTBAN database with monthly the Pix and IBGE databases. The first step to construct the independent variable is to calculate the mean of volume of Pix transactions for each municipality from November 2020 to October 2022. Then, we discretize this continuous variable into a binary variable named *High Adoption of Pix_i* to identify municipalities with a high adoption of Pix as follows. We set *High Adoption of Pix_i* = 1 for all municipalities *i* in the upper median of the distribution and 0, otherwise.

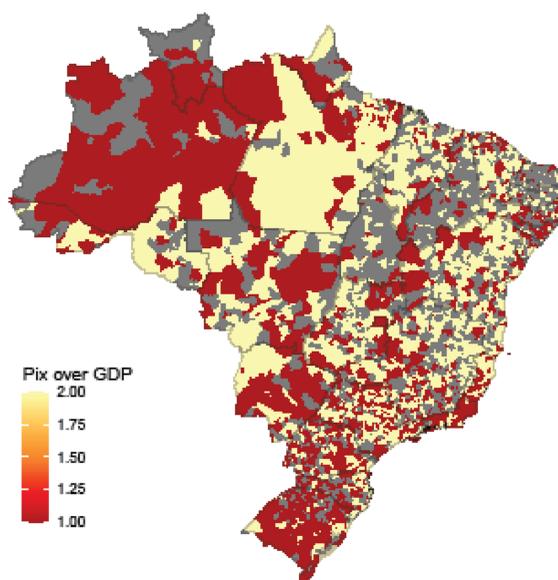
[Figure 1](#) displays the geographical distribution of the average volume of Pix over GDP (before the discretization into the variable *High Adoption of Pix_i*). We can see how well Pix adoption can be related to the banking population in localities in small cities in regions far from the big capitals of the southeast. One of the factors that could explain its influence on credit demand and supply on the population who did not have the opportunity before is the possibility to make money transfer transactions through digital accounts. The potential effects due to the relationship between the high adoption of Pix and the banking of the population helped by fintechs are important for the research.

[Figure 2](#) displays the geographical distribution of our main independent variable *High Adoption of Pix_i*. We can see in which locations and regions the adoption of Pix has occurred. The map shows that it has been widely accepted in the northern and northeastern regions of the country. These are areas where the population may not be as banked as in other regions of the country.

We now examine how our binary variable *High Adoption of Pix_i* correlates with municipality-level observables. For that, we use *High Adoption of Pix_i* as the dependent variable and the municipality-level variables as covariates. We test this hypothesis empirically. We run the following econometric specification in a cross-section:

$$\mathbf{High\ Adoption\ of\ Pix}_i = \beta^T \times \mathbf{Covariates}_i + \varepsilon_i \quad (2)$$

in which *i* indexes the municipality. $\mathbf{Covariates}_i$ is a vector of observables at the municipality level composed of the following terms: the local COVID-19 prevalence as a share of the local population during 2020; population, GDP per capita and HHI credit (evaluated using [Eq. \(1\)](#)) in 2019.



Note(s): *Geographical distribution of a binary variable of *Pix* over GDP. Here, we can see the *Pix* distribution according to GDP and how they are related. Colors from dark red to yellow represent a widespread use of *Pix* related to GDP. Gray localities represent places without occurrences of *Pix*.

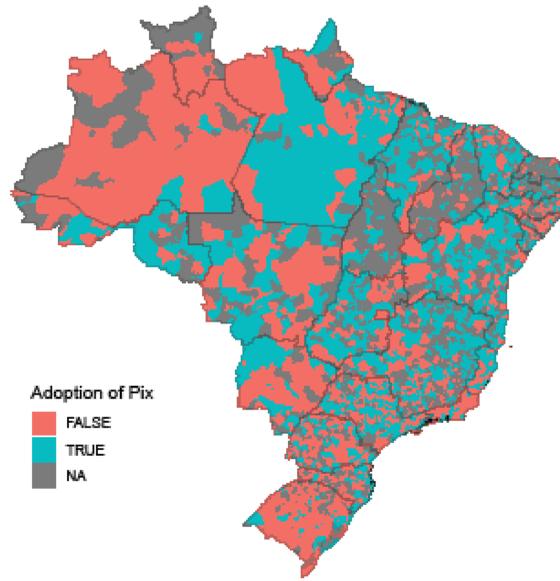
Source(s): Authors' (2023)

Figure 1. Spatial *Pix* over GDP in Brazilian municipalities

Table 1 reports the coefficient on a standard deviation scale. There is a significant association among population, GDP per capita and $HHI\ credit_{it}$. Municipalities with less wealth adopted less fast payments solution: a one-standard-deviation increase in the municipality's GDP per capita is associated with a decrease in the local *Pix* adoption by -30.51% . GDP per capita denotes significance of 1% that the adoption of *Pix* has banked the population and made locations more attractive for banks to invest in.

In the Table 1, we observe that GDP per capita is lower, while adoption of *Pix* is higher, and our negative relation between *Pix* adoption and GDP per capita can be compared to the findings of Claessens *et al.* (2018), once their results suggests that there is more fintech credit activity in those jurisdictions with a less competitive banking sector. The regression results found by the authors confirm that an economy's fintech credit volume per capita is positively associated with GDP per capita. Nonetheless, the negative coefficient estimates on squared GDP per capita suggests that such effects become less important at higher levels of development.

Additionally, a one standard-deviation increase in local $HHI\ credit_{it}$ is associated with a decrease in the *Pix* adoption by 24.26% . Therefore, a higher concentration of banks is associated with a lower probability of high *Pix* adoption. This could have several possible explanations. It could suggest that *Pix* can, indeed, be associated with more banked people. This provides some evidence in favor of the argument that regulatory arbitrage with the mandatory participation of larger institutions (as regulator, the BCB determined the participation in *Pix* of banks and other payment institutions with more than 500,000 transaction accounts) boosts banking activity in general, making it less concentrated. Finally, we do not find a statistically significant result relating local COVID-19 intensity and fast payments adoption.



Note(s): *Geographical distribution of the *Pix* adoption across Brazilian municipalities. We measure *Pix* adoption by the binary variable High Adoption of *Pix*_{*i*} to identify municipalities with a high adoption of *Pix* as follows. We set High Adoption of *Pix*_{*i*} = 1 (red) for all municipalities *i* in the upper median of the distribution and 0 (blue), otherwise. Municipalities in gray absence of local data

Figure 2. Spatial high adoption of *Pix* in Brazilian municipalities

Colors represent a widespread use of high adoption of *Pix*. Gray localities represent places without high adoption of *Pix*

Source(s): Authors' (2023)

Dependent variable Model	<i>High Adoption of Pix</i> (1)
Constant	-2.97e-5 (0.0165)
<i>Variables</i>	
<i>COVID-19 mean prevalence over population</i> _{<i>i</i>}	0.0203 (0.0181)
<i>Population</i> _{<i>i</i>}	0.0453** (0.0160)
<i>GDP per capita</i> _{<i>i</i>}	-0.3051*** (0.0327)
<i>HHI credit</i> _{<i>i</i>}	-0.2426*** (0.0172)
<i>Fit statistics</i>	
Observations	3.219
<i>R</i> ²	0.12720
Within <i>R</i> ²	0.12615

Note(s): This table presents coefficient estimates of the empirical specification in Eq. (2). The dependent variable is the High Adoption *Pix*_{*i*}, which takes the value of one for all municipalities *i* in the upper median of the distribution and zero, otherwise. We use the following vector of observables at the municipality level: the local COVID-19 prevalence as a share of the local population during 2020; population, GDP per capita and HHI credit (evaluated using Eq. (1)) in 2019. We cluster errors at the municipality level. The continuous covariates are in standard deviation scale. *, ** and *** denote significance at 10, 5 and 1%, respectively

Source(s): Authors' (2023)

Table 1. First regression model with high adoption of *Pix* as a dependent variable

5. Empirical results

Our methodology associates banking variables in localities with daily Pix volumes, aggregated monthly, carried out by individuals and legal entities as recipients and payers. Our empirical strategy allows us to compare credit results based on the volume and number of Pix with credit operations operated in localities in Brazilian regions.

We can observe [governments](#) and regulatory authorities use HHI index to verify the competitiveness of financial markets to implement policies to encourage competition, such as the use of laws and resolutions. The Brazilian case of this policy is the mandatory participation, in [Pix](#) scheme, for financial institutions and payment institutions authorized to operate by the Central Bank of Brazil with more than five hundred thousand active customer accounts, including demand deposit accounts, cash deposit accounts, savings and prepaid payment accounts.

Therefore, the HHI index can help policy makers and governments to identify sectors where concentration is high, and there is a demand for policies to promote competition and improve market efficiency.

Therefore, our first hypothesis is that the adoption of Pix correlates with the increase in concentration levels in the credit market (HHI) at the local level in Brazil. We can explain this hypothesis by analyzing some facts. Firstly, Pix is a fast, cheap, modern and accessible payment method for the entire population, since one does not need a bank account to use the system. As a digital account or payment platform has fewer document and bureaucracy requirements compared to those required to open bank accounts, it is now possible to make payments via Pix, promoting the financial inclusion of unbanked people.

By making transfers by simply entering the cell phone number or CPF number (Individual Taxpayer Registration) of those who will receive the amount, the need for intermediaries between accounts is eliminated, allowing greater clarity on the financial flow of a specific individual or legal entity. This flow ends up becoming a guide for granting credit, in addition these financial institutions also offer credit, thus allowing them to compete with traditional banks in the credit granting market.

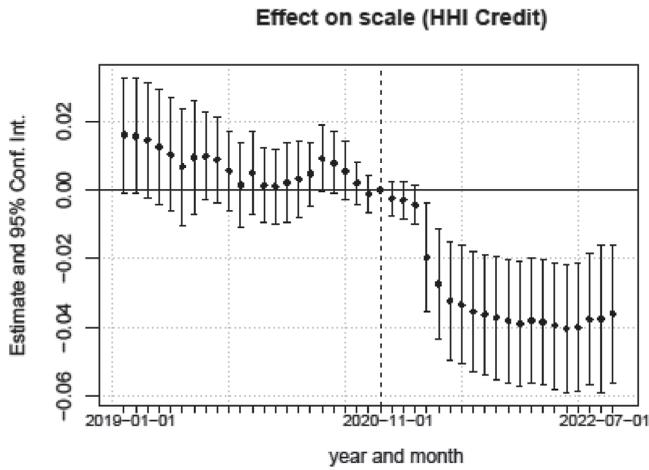
Understanding how Pix affects the financial structure of municipalities is very relevant. The analysis of banking concentration in localities, based on banking relationships, helps us associate the high adoption of Pix with the change in local credit structure. Thus, greater adoption of Pix, greater diversity in the financial system, more players in a market, more competitive it will be and the less market power companies will have.

Localities become more attractive, as the flow of transactions gained visibility, attracting banks and financial institutions to operate in municipalities, reducing concentration and increasing competitiveness. If the Instant Payment System allows greater access for the population to have an account, this could make it more attractive for banks to operate in the localities. We test this hypothesis empirically. We run the following econometric specification:

$$y_{it} = \alpha_i + \alpha_t + \beta \text{Post}_t \times \text{HighAdoptionPix}_i + \gamma^T \text{Post}_t \times \text{Controls}_i + \varepsilon_{it} \quad (3)$$

in which i and t index municipality and time, respectively; y_{it} is the dependent variable, HHI credit_{it} ; α_i is fixed effects for municipalities; α_t indicates time fixed effects; Post_t is a dummy variable equal to 1 after November 2020 and 0 otherwise. We cluster errors at the municipality level once observations over time from the same municipality tend to be correlated. As the control variables are an average (or fixed in a single period) of the year 2020 (prior to the launch of Pix), they only vary across municipalities, which would lead to perfect collinearity with municipality fixed effects. To avoid this issue, we included an interaction of Post_t with our control variables, the *features* COVID_i , POP_i , PIB_i . To address the concern of endogeneity, the control variables are also fixed with values before the launch of Pix.

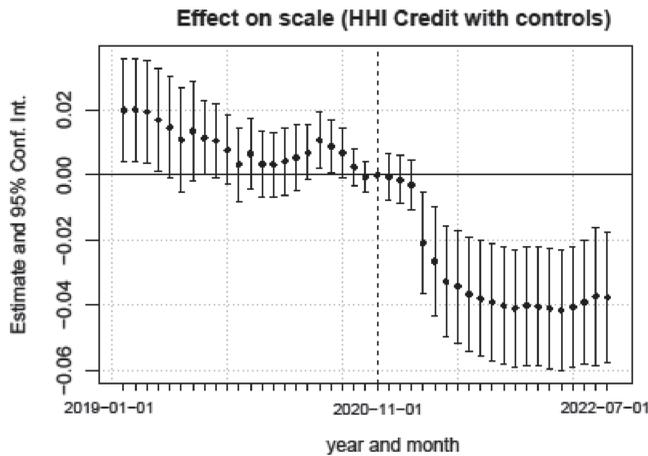
We also adapt our baseline specification to an event study format to examine parallel trends. For that, we replace the step variable Post_t in [Equation \(3\)](#) with time pulse variables (a dummy for each time point). [Figures 3 and 4](#) display the estimated β and coefficients at each time point



Note(s): Event study (parallel trends check). We run specification in Eq. (3) without controls from the beginning of 2019 up to July 2022. Figure 3 displays the estimated coefficients for each month. We replace the step variable $Post_t$ with time pulse variables (a dummy for each time point). Vertical bars denote the 95% confidence interval

Source(s): Authors' (2023)

Figure 3.
Event study without controls



Note(s): Event study (parallel trends check). We run specification in Eq. (3) with controls from the beginning of 2019 up to July 2022. Figure 4 displays the estimated coefficients for each month. This time, the figure plots the movement of the HHI influenced by the controls, $COVID_t$, POP_t , PIB_t , before and after Pix adoption in November 2020. We replace the step variable $Post_t$ with time pulse variables (a dummy for each time point) Vertical bars denote the 95% confidence interval

Source(s): Authors' (2023)

Figure 4.
Event study with controls

for the $HHI_{credit,t}$ as dependent variable when we run without and with controls, respectively. Our event study shows that the local HHI appears to be moving at the same rate and direction in municipalities before the launch of Pix for municipalities regardless of their ex-post Pix adoption. However, after the launch of Brazil's instant payment system, areas with high adoption of Pix experienced a greater drop in HHI relative to those that adopted Pix to a lesser extent. Therefore, our empirical results point to a decrease in the concentration (or increase in diversification) of the local credit market for municipalities with a high Pix adoption after the launch of the instant payment's system. We find no significant differences in our outcomes of interest between the two event studies with controls and without the inclusion of controls.

We observe that, after the adoption of Pix, the decrease in concentration in local credit markets occurred only after the first three months of 2021. First, the adoption of Pix was mandatory to all financial institutions and other entities authorized to operate by the Central Bank of Brazil that had more than 500 thousand active accounts. Some optional banking institutions could operate Pix, following the rules, if there would be some problem with the apply, many of them had to return for the initial phase, which could last up to 5 months until it began to operate. In this way, there was a gap in the timing in which financial institutions joined the Pix system. Another explanation for the gap in the first three months of 2021 is that from April 2021, the Central Bank authorizes cash transfer via Pix for emergency aid beneficiaries through the digital account paying for this benefit, previously this type of account was not part of the instant payments system (SPI), except cash transfer to accounts with the same name as the beneficiary could not be made via Pix. In addition, during this period, there were more transactions due to the withdrawal of the Severance Indemnity Fund for Employees (FGTS) that were made through the same digital account. Those events as FGTS withdrawals and emergency aid may have driven the use of Pix.

In summary, the high adoption of Pix experienced both the largest increase in banked people and the largest decline in banking concentration since Pix, a fact that could have been helped by fintechs (according to Box 7, 2021 Banking Economy Report of the Central Bank of Brazil, the opening of digital accounts promotes banking at the individual and firm level). The development of fintech credit can benefit financial inclusion and financial system diversity.

Table 2 reports the coefficient estimates of Eq. (3). Column (1) shows that the model without controls on a standard deviation scale. The concentration of local credit markets decrease by 4.20% for each municipalities high a high adoption of Pix compared to those that do not adopted as much the fast payment solution. This result is consistent with our time-varying results obtained using event studies before. In Column II, control variables were interacted with the $Post_t$ dummy. In fact, the treatment effect hardly changes, and both show significance at 1%. Our empirical finding using proprietary data highlights how adoption of Pix by Brazilian people affected bank concentration and the demand and lending credit.

The results reported in.

Table 2, in which we focus on two models (without controls and with controls), complement the results and finding in BIS (2022a). These authors show that the use of QR payments increases the probability of credit access/use for small and micro businesses and that this has positive effects on firms' business volumes, including during the pandemic. They used a difference-in-differences model, with the dependent variable being the logarithm of transaction volume for firm i and time t . In our study, the dependent variable is the HHI.

BIS (2022b) results show that transaction volume increased 9.6% more for firms that had access to big tech credit (treated group) than firms with similar characteristics that did not have access (control group). The results of the baseline model, in Table 3 Column I, show a decrease in HHI of 4.20% after the launch of Pix, suggesting that market concentration is considered low.

Dependent variable Model	(1)	<i>HHI credit_{it}</i> (2)
<i>Variables</i>		
<i>Post_t</i> × <i>High Adoption Pix_t</i>	-0.0420 *** (0.0082)	-0.0403 *** (0.0086)
<i>Post_t</i> × <i>COVID-19 mean prevalence over population_t</i>		0.0053 (0.0046)
<i>Post_t</i> × <i>Population_t</i>		-0.0066 ** (0.0033)
<i>Post_t</i> × <i>GDP per capita_t</i>		4.13 × 10 ⁻⁵ (0.0057)
<i>Fixed-effects</i>		
Municipality	Yes	Yes
Year month	Yes	Yes
<i>Fit statistics</i>		
Observations	136,765	136,765
<i>R</i> ²	0.97638	0.97640
Within <i>R</i> ²	0.00458	0.00535

Note(s): This table presents the coefficient estimates of the empirical specification we run in Eq. (3) where there are controls, the features *COVID_t*, *POP_t*, *PIB_t*. The dependent variable is the *HHI credit_{it}*, which takes values up to one. We use the following vector of observables at the municipality level: the local COVID-19 prevalence as a share of the local population during 2020; population, GDP per capita, and HHI credit (evaluated using Eq. (1)). The COVID-19 mean prevalence over population variable is a period during COVID-19. The High Adoption Pix variable is our main independent variable. The continuous covariates are in standard deviation scale. We cluster errors at the municipality level. *, **, and *** denote significance at 10, 5, and 1%, respectively

Source(s): Authors' (2023)

Table 2. Second regression model with HHI credit as a dependent variable

6. Conclusions

This paper investigates the role of Pix on bank lending and on bank competitiveness. Using Pix datasets with volume and number of transactions, we analyze increase in lending credit at bank branch. We build a baseline model that did not consider differing bank institution from financial institution. Then, we explore how lending credit responded to the use of Pix since November 2020 to October 2022. We examined data from GDP, COVID-19 and Population.

To identify the impact of Pix, Brazil's instant payment system on credit markets in Brazil, we employ a difference-in-differences approach empirical strategy. We do not account for the particularities of each credit type in our analysis. Our empirical setup viewed COVID-19, GDP and Population as control variables. We control COVID-19 at the locality level since they can influence credit-taking decisions. Our baseline model revealed that high adoption of Pix is related to a rise in the banking of the local population. This fact improves access to credit, making these municipalities more attractive to banks for offering credit to the population as a greater variety of credit options presents more choices. It is possible to see a decrease in the degree of concentration of the main credit sectors HHI. The results of the dependent variable, HHI, showed that there is a relationship between high adoption of Pix and a decrease in the degree of banking concentration, thus illustrating greater banking diversity, better distribution and possible growth in the banked population.

When considering high adoption of Pix as a dependent variable, the results do not change and highlighted the role of digitalization on banked people and on the credit market. First, people who did not have before banking accounts, do not have the chance to do a money transfer, with digitalized banks, people have more flexibility to have a digital account, so more opportunity to receive and to transfer money with no tax. Our findings revealed that Pix accelerate digitalized process of the population, providing lending flexibility. One channel

behind our results is financial inclusion promoted largely by fintechs and non-banking institutions. In general, our results indicate that the effect on the diversification of the local credit market was more pronounced in regions with less financial development. This again highlights the extent to which financial inclusion has benefited a part of the population that previously had no access with the introduction of a cheap fast payments system.

Finally, this article also provides evidence that the widespread adoption of Pix has impacted the financial structure of municipalities. This analysis of banking concentration in the country and municipalities, based on banking relationships, helped us assess whether the adoption of Pix had any correlation with the increase in credit lines. Overall, the results from the statistical tables suggest that the adoption of Pix may be having a positive impact on the local credit market structure. The results are statistically significant. However, it is important to note that our results hold in the short term. Further research is needed to understand the long-term impacts of fast payments systems on local credit markets. So, our results show that high adoption of Pix has relation with the access to lending credit and more effectively strengthening financial inclusion, both boosted by the role of digitalization. The examination of how the widespread adoption of Pix has impacted the financial structures of municipalities and regions in Brazil will be the subject of next research.

The objective of this research is to be the first to construct a timeline starting since the introduction of Law 12.865/2013, progressing through fintechs, the People's Loan Society (SEP), the Direct Credit Society (SCD), and culminating with payment schemes such as Pix and credit scheme. So, this is one of the timeline.

Notes

1. "The Instant Payment System (SPI) is the only centralized infrastructure for instant payments settlement between different payment service providers in Brazil. The SPI, operated by the BCB, will be launched in November 2020. The SPI is a Real Time Gross Settlement (RTGS) system, which means transactions are settled as soon as they are processed, on a one-to-one basis. Once settled, transactions are final and irrevocable. The instant payments (Pix) are settled in specific-purpose accounts held at the BCB by the direct participants of the system. To safeguard the resilience of the system, no overdraft is allowed, which means the account cannot have a negative balance."
2. <https://www.bcb.gov.br/estatisticas/estatisticabancariamunicipios>

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Further reading

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Supplementary material

The supplementary material for this article can be found online.

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