Information and communication technology in the Brazilian banking industry: does functionality matter?

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Abstract

A banking system is functional when it expands the potential to provide more liquidity to the economy, especially for development finance. The advances of Information and Communication Technology (ICT) can contribute to increasing banks' potential to offer more products and services, expanding their capacity to be more functional. Diversifying financial instruments can encourage them to operate with more profitable operations in the short term to the detriment of the supply of credit in the long term, decreasing their ability to be more functional. This article aims to analyze the relationship between ICT and the functionality of Brazilian banks between 1995 and 2016. We created an index of functionality. The Panel Data estimation verified an ambiguous impact of ICT on banks' functionality. The use of electronic devices and services for software-driven data processing and transmission has had a positive effect on this index. However, the influence of ICT on functionality was to enhance the negative effects of financial innovations on the supply of credit by banks because of the agents" incentives to invest in short-term and more liquid assets, vis à vis of financing long-term investments, harming the capacity for financing Brazilian development.

Keywords: Information and communication technology. Functionality. Banks. Brazil.

Tecnologia de comunicação e informação na indústria bancária brasileira: a funcionalidade importa?

Resumo

Um sistema bancário é funcional quando expande o potencial de fornecer mais liquidez à economia, especialmente para o financiamento do desenvolvimento. Os avanços da Tecnologia da Informação e Comunicação (TIC) podem contribuir para aumentar o potencial dos bancos em oferecer mais produtos e serviços, ampliando sua capacidade de serem mais funcionais. Caso contrário, a diversificação dos instrumentos financeiros pode incentivá-los a operar com operações mais rentáveis no curto prazo em detrimento da oferta de crédito no longo prazo, diminuindo sua capacidade de ser mais funcional. Considerando esses aspectos, o objetivo deste artigo é analisar a relação entre a TIC e a funcionalidade dos bancos brasileiros entre 1995 e 2016. Para tanto, foi criado um índice de funcionalidade. A partir da estimativa de dados em painel, verificou-se um impacto ambíguo das TIC na funcionalidade bancária. A utilização de dispositivos e serviços eletrônicos para processamento e transmissão de dados baseados em software teve um efeito positivo neste índice. No entanto, a influência das TIC na funcionalidade foi potenciar os efeitos negativos das inovações financeiras na oferta de crédito pelos bancos, devido aos incentivos dos agentes para investir em ativos de curto prazo e mais líquidos, *vis à vis* ao financiamento de investimentos de longo prazo, prejudicando a capacidade de financiamento do desenvolvimento brasileiro.

Palavras-chave: Tecnologia da informação e Comunicação. Funcionalidade. Bancos. Brasil.

Tecnología de la comunicación y de la información en la industria bancaria brasileña: ¿la funcionalidad importa?

Resumen

Un sistema bancario es funcional cuando expande su potencial para proporcionar más liquidez a la economía, especialmente para financiar el desarrollo. Los avances en las tecnologías de la información y la comunicación (TIC) pueden contribuir a incrementar el potencial de los bancos para ofrecer más productos y servicios, ampliando su capacidad de ser más funcionales. Sin embargo, la diversificación de los instrumentos financieros también puede inducirlos a priorizar operaciones más rentables y a corto plazo, en detrimento de la oferta de crédito a largo plazo, disminuyendo su capacidad de ser más funcional. Considerando estos aspectos, el propósito de este artículo es analizar la relación entre las TIC y la funcionalidad de los bancos brasileños entre 1995 y 2016. Para ello, se creó un índice de funcionalidad. A partir de la estimación de datos de panel, se verificó un impacto ambiguo de las TIC en la funcionalidad bancaria. El uso de dispositivos y servicios electrónicos para procesar y transmitir datos basados en software tuvo un efecto positivo en este índice. Sin embargo, la influencia de las TIC en la funcionalidad fue potencializar los efectos negativos de las innovaciones financieras en la oferta de crédito por parte de los bancos, debido a incentivos, por parte de los agentes, para invertir en activos a corto plazo y más líquidos, frente al financiamiento de inversiones a largo plazo, comprometiendo la capacidad de financiamiento del desarrollo brasileño.

Palabras clave: Tecnología de la información y la comunicación. Funcionalidad. Bancos. Brasil.

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INTRODUCTION

The banking industry operates in a complex and competitive environment, characterized by changing conditions which are highly dynamic and undergoes rapid changes due to technological innovation. Information and Communication Technology (ICT) has become fundamental by the banking strategies, achieving local and global competitiveness. Technological changes force the banking sector to adopt new modes of production and services but also enhance the variety of innovative devices available, which increases the speed and quality of financial services and products (Faria & Maçada, 2011; Frame & White, 2009; Llewellyn, 2009; Marszk & Lechman, 2019).

Technology has affected financial services in several ways. Despite some regulations and eventually other kinds of barriers, competition is increasing in the financial market. For example, services provided by fintechs[1], and the diversification of services related to consumer banking, asset and investment management, etc. Another example, in terms of financial information processing and transactions, Blockchain technology represents a revolution in payment and transaction systems. Specifically for the banking sector, ICT applications such as internet banking, customer relationship systems, communication infrastructure between bank branches and ATMs, credit analysis models and a wide range of structured products backed by different financial operations (Farhi & Cintra, 2009; Farhi & Prates, 2018; Marszk & Lechman, 2019; Meirelles, 2016).

Banks have reduced their traditional operating practices and diversified the sources of their revenues by charging fees for common services such as payment transactions, safe custody and account administration (Alawode & Kaka, 2012; Paula & Alves, 2003; Seccareccia, 2012). Starting from continued advances in technological changes, financial liberalizations and deregulation, the financial sector has changed their strategies in favor of the accumulation of financial capital over productive capital (Girón & Chapoy, 2012).

Information and Communication Technology (ICT) has been assimilated intensively by banks in order to increase their profitability and competitive advantage. In the operational area, it is adopting a new service structure to reduce costs. In the strategic area, competitive advantage is based on the introduction of financial innovations improving the creation of new differentiated products and services and also new ways to offer financial products (Frame & White, 2009; Meirelles, 2016). In order to increase profits and competitive advantages, banks have concentrated their operations on short-term (and speculative) investments *vis à vis* credit operations for productive activities of companies, implying a functional separation between financial and productive capital (Herman & Paula, 2011; Perez, 2002).

The capital accumulation represents an ambiguous role in economic growth. On one hand, the expansion of financial markets and the increasing involvement of banks in the market are important in the process of economic growth by enabling greater volumes of traded assets, increasing liquidity and credit. On the other hand, it could halt the process by extending speculative activities that increase the level of financial fragility, instability and crises (Keynes, 1936, 1973). In order to understand this dynamic, the Post Keynesian (PK) approach discusses the concept of functionality.

Following this theoretical approach, the aim of this paper is to analyze the relationship between ICT and the functionality of Brazilian banks between 1995 and 2016. The central hypothesis of this article is that by contributing to the advancement of new products, services, faster and more interconnected transactions, ICT may impact negatively on the functionality of the Brazilian banking system, which traditionally focuses on short-term, more profitable and less risky operations vis à vis long-term financing, which involves more uncertainty. This study covers this period due the intensive use of ICT in terms of the strategic and in the operational side. This period contemplates from the advances of financial openness in 1995 to the beginning of the Brazilian internal recession culminating in the impeachment of President Dilma Rousseff (2016). From this year, the Brazilian political and institutional scenario deteriorated, which would require the incorporation of new elements to explain a new political and economic context. For this reason, the data and analysis were made until 2016. Because the Brazilian financial system is typically bank based, our analysis will focus on the banking system.

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[1] FinTechs is a term that emerged from the union of the words financial and technology financial technologies, involving the application of a variety of advanced technologies to support the development of the financial sector (Wang, Xiuping & Zhang, 2021).

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For this purpose, this article was divided into 3 sections, except this introduction. Section 1 presents the relationship between ICT, financial innovation and the banking functionality. Details on methods, data and the estimation are explored in section 2. Results are discussed in section 3. The final remarks are presented in the last part.

RELATIONSHIP BETWEEN BANKING FUNCTIONALITY, ICT AND FINANCIAL INNOVATION

What is banking functionality and why is it important?

Many of the most important influences on the banking system towards creating a productive sector (Gross Domestic Product – GDP) consist in provisions of finance (credit supply), which carry out the plans of productive investments to economic development[2]. The level of investment represents the main link between the financial system and economic development. This relationship is discussed using several approaches, but this paper is following the Post Keynesian which contends that investments play a central role in an entrepreneurial economy and that saving is not precondition for investments, which depends on aggregate supply and demand (Keynes, 1936, 1973). On the demand side, the investments are realized if entrepreneur's expectations related to the future income of its capital assets are optimistic. On the supply side, finance is mainly determined by the banks' willingness to actively create deposits and credit. The amount of investment depends on the financing conditions created by the financial system to support them (Hermann & Paula, 2011).
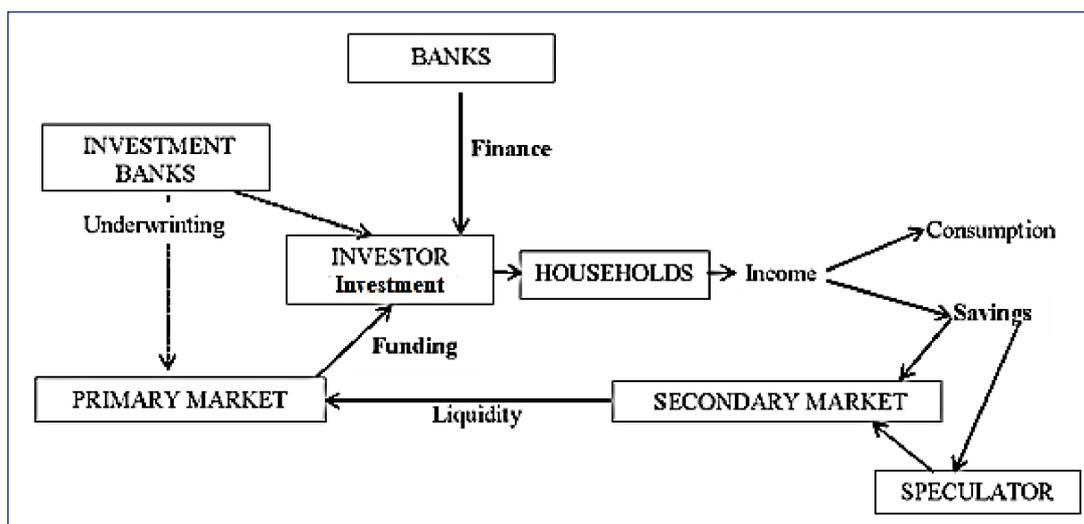
According to the Keynesian Theory, the provision of finance by banks allows the investment expenditure to be implemented without the existence of previous savings. The savings, a result of the multiplied income of the investment decisions, channeled to the capital market, funds the short-term debt of the investors. In 'Treatise on Money', Keynes attributes to banks two distinct sets of services to carry out finance: provider of money and provider of resources. In the first case, it offers a substitute for state money, acting as a clearing house, and transferring current payments by means of accounting entries on the credit and debit sides. While a provider of resources, it receives deposits from the public and employs in the purchase of securities or in lending to industry and commerce primarily to meet the demands of working capital. "Credit is the pavement along which production travels; and bankers if they knew their duty, would provide the transport facilities to just the extent that is required for in order that the productive powers of the community can be employed to full capacity" (Keynes, 2013, p. 197).

According to Davidson (1986, p. 101) one of the most difficult aspects of the theory of money is to distinguish between the short-term (finance) and the long-term (funding) financing of an investment project. In a production monetary economy, investment is undertaken when banks decide to provide liquidity through short-term lending (finance). This financing, intended for working capital, results from the increase in the bank's loans. Once the investment is initiated, the income from the investment increases the level of savings, which in turn is used to acquire long-term securities in the capital markets for the constitution of long-term financing of companies (funding)[3]. The funding may be sufficient to link contractual commitments and repay bank loans that will be short-term revolving funds to enable financing from other firms (Davidson, 1986). When these conditions are observed, the financial system operates in a functional way and it is to enable financial growth to be economically stable as shown in figure 1.

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[2] Economic development is well recognized as a complex phenomenon, which involves not only economic growth (increase of aggregated output in a purely quantitative sense), but also and mainly structural changes (new sectors, goods and services; institutional and social changes).
[3] According to Keynes, the process of transformation of short-term liabilities into long-term liabilities finance-investment-savings-funding.

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Figure 1
Finance-Investment and Savings-Funding Circuit (FISF)

Source: Adapted from Carvalho (1992).

For Studart (1995, p. 64) a financial system is considered functional when "it expands the use of existing resources in the process of economic development with the minimum chance to increase in financial fragility and other imbalances, that may halt the process of growth for purely financial reasons". For Carvalho (2010, p. 9): "A functional financial system in supporting economic development has to fulfill two essential functions: i) provide financial resources to support the production process and the realization of investments in volume and in appropriate terms; ii) create financial assets with the return and risk profiles demanded by private agents in order that they can accumulate wealth". For Paula and Hermann (2011), the most functional financial system is one in which the financial structure efficiently provides financing and funding at the lowest possible cost and thus supports financially stable growth.

For the Post Keynesian approach, the financial system plays an ambiguous role in the economy. Its role as a provider of liquidity (finance) facilitates investment and the generation of ex post savings to consolidate long-term obligations (funding), but also contributes to exacerbate the instability of the economy when speculation predominates in markets. Although the action of speculators in the secondary markets guarantees a continuous trading of financial assets, which ensures greater liquidity to these assets, this action is losing this functionality, due to the predominance of speculative operations in search of greater profits. This statement may be better understood in Keynes's quotation "speculators may not cause harm when they are only bubbles in a constant stream of endeavors. But the situation becomes serious when the enterprise becomes bubbles in the speculative whirlwind" (Keynes, 1936, 1973).

From the Brazilian case, some peculiarities in the '*FISF*' circuit can be observed. The process of short-term financing is similar to the typology. Banks are providers of liquidity and the capital market is not a predominant source of long-term financing (Paula, 2014). For this reason, some banks (especially the public ones) perform part of the long-term financing (funding) being denominated as Universal banks. However, the banking system needs to contribute to economic development, even in the context of crises that require reducing uncertainties and mitigating their effects. This is the central feature of banking functionality and for this reason it is an important feature.

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The relationship between ICT and banking functionality

The emergence and the rapid growth of innovations driven by the development of ICT have created a greater facility for financial and non-financial institutions when carrying out operations in the financial market, especially by buying and selling of assets or financial securities that can take place in orderly form in the capital markets (Lechman & Marszk, 2015). The merging of large conglomerates participates in this through off-balance-sheet transactions with derivatives or financial products and services that are the consequence of technological and financial innovations (Girón & Chapoy, 2012).

The growth of financial markets and significant shift from the investment of productive assets toward financial assets began with financial deregulation and liberalization becoming securitized was the biggest cause of the current financial crisis (Rochon, 2012). The prudential regulation and the intense competition forced the banks to increasingly use securitization, derivatives and off-balance sheet transactions to evade the regulatory guidelines and to obtain new sources of revenue (Carvalho, 2010). These financial innovations significantly changed the process of banking operations (nature of banking activities) and also the market structure (organizational changes).

The activity of commercial banking has shifted away from its traditional role of financing production (productive sphere) and evolved to profit-making transactions, especially, as result of securitization (Seccareccia, 2012). The banks are acting increasingly on capital markets and performing typical functions (financial intermediation) of institutional investors abandoning their traditional activities, bringing about the seventh stage of development bank added to the six stages already defined by the typology of Victoria Chick[4].

Farhi and Prates (2018) argue that the main feature of this stage is to establish links between the balance sheets of banks and nonbank financial institutions (institutional investors), and not the loss of importance of banks as providers of liquidity. According to these authors: "This seventh stage is characterized by interpenetration, so almost inextricable, between the banking system and called Global Shadow Banking System[5], enabled by credit derivatives and structured products backed by different credit operations", which allows non-banking financial institutions to gain access to highly profitable credit operations. The unusual increase in these financial products have led to financial fragility because of the strong speculation on asset prices for the purpose of capital gains in the short term.

The Shadow Banking System is not regulated or supervised by the prudential standards of the Basel Accords, acting in parallel to and under the protection of banks in highly leveraged transactions. This process is a result of fundamental changes in the financial system, such as innovative and regulatory changes that led to the decline of the traditional banking model, in the face of competition from nonbanks and their products. Wang et al. (2021) analyzed the potential impact of financial technology (Fintech) on the banking sector. In terms of competitiveness, the traditional banking business have lost market share to shadow banks and Fintech creditors, because the latter are not subject to the same regulations as conventional banks, which allows them to get more technological advantages.

This new configuration of the financial system multiplied and globally redistributed the risks in the system as well as the losses resulting from them for a variety of financial institutions transforming the last financial crisis in an international and systemic phenomenon (Farhi & Prates, 2018). Minsky (1992) already highlighted that the capitalist economy was linked by capital assets and by complex and sophisticated financial relations. The author formulated the hypothesis of financial instability to explain the unstable behavior of the economy, where banking credit was the main form of financing and the cash flow from companies was the source of payment of debts. After the financialization process, the hypothesis of financial instability was reformulated to consider the financial relations and their implications on the behavior of the economic system, which cannot be restricted only to the analysis of the liability structure of businesses and the cash flows.

This hypothesis remains valid, requiring only that we incorporate new sources and their applications arising from deregulation, innovation and integration of financial markets. The expansion of the resources implies an increase in the degree of fragility of the economy, however its requalification is due to the predominance of finance capital over production and to global

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[4] In the last two stages of this, according to the author, banking has undergone substantial changes such as the emergence of the practice of liability management, securitization of receivables and off-balance-sheet operations.

[5] The Global Shadow Banking System covers institutional investors (insurance companies, pension funds, investment funds, conventional hedge funds and Special Investment Vehicles – SIV) that came to negotiate portfolios consisting of products and high-risk assets. In this sense the shadow banking system is a set of institutions that act, as banks, in highly leveraged transactions in intermediation of credit and funding in the short term strongly interconnected with the banking system, but which are outside regulatory frameworks (Farhi & Cintra, 2009; Financial Stability Board [FBS], 2012).

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interdependent transactions between the banking and financial system. Despite these changes, the trend of endogenous generation of fragility and instability in other institutions of the financial system follows the same logic as the banking system, which certainly gives it a different degree of intensity (Corrêa, 1996; Deos, 1998).

Respect to the endogenous generation of fragility and instability, the Post Keynesian approach highlights that the developed financial markets can help enhance the liquidity of assets and the allocation of *ex post* savings favoring economic growth; markets are able to do the mediation between the demanders of securities and firms wishing to fund their short-term liabilities and term them into long-term ones (Studart, 1995). The more liquidity to assets, the expansion of markets, the use of these assets to finance the investment, encouraging savers to provide the funding which stimulates investors to spend these monetary resources on new investment projects. Otherwise, financial markets can be a source of instability created by the action of speculators. When these agents dominate markets, financial practices (focused on the short term) appear with the aim of affecting the assets prices and anticipating these changes in the market (Hermann & Paula, 2011)[6].

The expectations of the incomes of long-term investments are more uncertain, since they are under the control of the time and a poor knowledge base. The aim of investors is not applying their capital in long-term investments to earn an income from the interest rate of these investments throughout their maturation, but rather to have capital gains through a favorable change in the conventional basis evaluation, or speculation (Keynes, 1936, 1973). Thus, the investors try to anticipate changes in the prices of financial assets in the market, in order to obtain capital gains from these operations, selling the assets at their highest price and buying them at their lowest price. This process of buying and selling assets grew both in quantity and speed of transactions as a result of technological and financial innovations. Financial capital seeks the appreciation of purely fictitious speculative assets with the difference between the purchase price and sale by negotiating roles in the markets. The gain of these applications is not channeled to the productive sector, but rather, directed to the speculative operations (Mollo, 2008).

Banks compete with non-financial institutions and seek profits by financing activities or applications deemed more profitable, innovating in the acquisition of assets and liabilities through trading. According to Palley (2002, p. 220): "In such a system, banks become a form of mutual fund, with their assets (loans, and so forth) providing the backing for their deposits. This mutual fund of banks leads to the notion of mutual fund e-settlement money".

As a result of these innovations, the functionality of the banking system from the circuit 'Finance-Investment-Savings-Funding' has been passed over by financial speculation inherent to banking development. The dominance of finance exacerbated the priorities of financial institutions to more lucrative short-term results at the expense of long-term activities, which include productive investments. Especially banks have created financial innovations to diversify the operations between assets and liabilities. Such flexibility in the composition of the balance sheet increased financial instability, since it enabled the realization of more complex and interconnected operations. Due to the greater difficulty of imposing regulation, this resulted in the expansion of speculative operations and in the amplification of the effects of a contraction of liquidity (instability).

The ICT can increase the bank's functionality when uncertainty is ignored, it means, when the state of expectations, the reduction of liquidity risk, transaction costs and information asymmetry can be obtained by the probabilistic calculations, increasing the liquidity premium of assets and the supply of credit. However, Keynes points out that "The liquidity premium resembles, in part, the risk premium, but it differs in part from the difference between the best calculations we can make of the probabilities and the confidence with which we will do it" (Keynes, 1936a, 1973b, p. 167). When the state of expectations changes due to uncertainty, the liquidity preference of banks increases by modifying their portfolio decisions, which in turn, result in reduced functionality for economic growth (Paula & Alves, 2003).

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[6] The speculative operations are activities to forecast the psychology of the market, anticipating the changes in market expectations and not the income of long-term investment, see Keynes (1936, 1973, p. 167).

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ICT and financial innovations: is the Brazilian banking industry functional?

The Information and Communication Technology (ICT) enabled the application of a variety of advanced technologies to support the development of the finance industry (financial technology or Fintech). As stated by Wang et al. (2021), the fintech covers the digital innovations and innovations in business models in the financial sector. Recently, core innovations included the use of blockchain technologies, artificial intelligence, cloud computing, new digital consulting and trading systems and mobile payment systems have developed very quickly.

Marszk and Lechaman (2019) studied the relationship between the information and communication technologies (ICTs) and the financial development in 32 emerging and developed economies in the period from 2004 to 2014. The result of this study pointed out that ICTs are a prerequisite for the creation and diffusion of financial innovations. ICT encompasses all aspects of computers (hardware and software), information systems, telecommunications and office automation used for storage, processing and retrieval of data, which are transformed into information, it means, every innovation in information processing, telecommunications and related technologies (Berger, 2003; Maçada, Becker & Lunardi, 2005; Marszk & Lechman, 2019).

The ICT has enabled has sped up the dissemination of information, data storage and retrieval by specialized software resulting in reduced transaction costs, capture, processing and dissemination of data and information, increased efficiency and changes to the structure of bank income. Due to the effects of ICT, the financial innovations have quickly expanded to circumvent the banking regulation system. Frame and White (2009) define financial innovation as something new that reduces costs and risks, or provides an improvement in the products, services and financial instruments. According to these authors, financial innovations can be grouped as new products (credits, mortgages, and derivatives) or services (internet banking and the electronic transfer of funds), new production processes (credit scoring and specialized software) or new organizational forms (virtual banks – existing only online and without physical branches).

The banks are always trying to find new ways to manage their portfolios and use the financial innovations to make profit. They are under pressure to innovate to circumvent regulatory constraints or to increase its competition among institutions (Minsky, 1986). The rapid growth and large volume of financial innovations enabled and boosted by ICT have encouraged banks to adopt new options, applications and resources (Llewellyn, 2009; Zendron, 2006). ICT has allowed the creation and the rapid growth of a number of financial innovations such as derivatives and securitization. This multiplicity of financial instruments increases the flexibility and complexity of the composition of the balance sheet and banking operations. The banks started to make transactions off balance sheets with non-financial institutions, generally unregulated (Global Shadow Banking System[7]).

The ICT directly affects how managers make decisions and plan what products and services are offered as they expand the circulation of more financial assets in several markets. It has changed the way of banking operations and expanded the variety of innovative devices available to increase the liquidity of assets which depends on the speed of trading, dismemberment, pricing and transfer risks of specific assets between these various markets (Mishkin & Strahan, 1999).

In addition to the changes in the balance sheet structure of financial institutions, ICT has increased the operational efficiency of banks. Alawode and Kaka (2012) analyze the survey data of selected banks in Nigeria with respect to their use of ICTs. In this study, they verified an increase of Internet access, use of internal network and SMS alerts, the adoption of security measures and automated payment systems in all banks. Luka and Frank (2012) indicate that investment in ICT systems and infrastructures by the Nigerian banking industry has become a key element in productivity and growth of operations.

Aliyu and Tasmin (2012) studied the relationship between efficiency (operational costs) and the usage of ICT, which can lead to lower costs, though the effect on profitability remains inconclusive as of the effects of ICT depend on other factors, such as skilled workforce, issues of increasing trustworthiness of in information system and competition in finances. Wang et al. (2021) analyses the impact of financial technology (fintech) on efficiency of 113 commercial banks in China from 2009 to 2018, which was revealed that, in general, the development of fintech improved the traditional business model, risk control, reduced operating costs, increasing the profitability and competitiveness of commercial banks and financial institutions.

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[7] This term was first used by Paul McCulley, executive director of the world's largest resource manager, PIMCO (Farhi & Cintra, 2009).

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Lechman and Marszk (2015) estimated the relationship between ICT and financial innovations in Brazil, Mexico, Japan, South Korea and the United States between 2002 to 2012. By the statistically significant result, a strong and positive relationship between ICT and financial innovations was evidenced in Japan, Mexico, the United States and South Korea; while in Brazil it was relatively weak, although it remained positive.

In Brazil's case, Hermann and Paula (2011) argue that the Brazilian financial system is sophisticated when compared to other developing countries. The banking sector has one of the most developed clearing systems of the world; financial markets have developed some sophisticated financial instruments, like different sorts of derivatives and other types of financial assets. According to these authors, the Brazilian financial system is efficient in terms of operations (mainly in case of operational efficiency and sophistication of banking technology) due to the use of ICT, but cannot be considered efficient enough to offer financing and funding to the economy.

The ICT has reduced operating and transaction costs and also made the use of financial instruments more potentiate, which increased the liquidity of assets in the stock market. Despite this, banking credit has been offered mainly for the short term because they quickly switch positions of applications between themselves, seeking higher interest rates, which can compromise the financial stability, especially for long-term financing. For this reason, financing in Brazil remains characterized, mainly, by working capital, being the National Bank for Economic and Social Development (BNDES) the main alternative for long-term financing (Hermann & Paula, 2011).

The banking system still has an important role in the financing of companies in Brazil. The consolidation of long-term debt in the capital market is only possible for large companies (Herman & Paula, 2011; Martins, 2012). According to these authors, the banking system is not functional, prioritizing its resources for short-term financial applications to the detriment of productive investments. In Brazil, the finance-funding circuit is not complete. Most companies have access to short-term credit lines (finance) provided by banks. Funding, which is the extension of debt in the capital market, is accessible only for large companies. This relationship between functionality, credit and ICT will be dealt with in the following section, in the empirical part of the work.

EMPIRICAL ANALYSIS ON THE IMPACT OF THE INFORMATION AND COMMUNICATION TECHNOLOGY ON FUNCTIONALITY OF BRAZILIAN BANKS

As stated at the beginning of this work, the aim of this article is to analyze the relationship between ICT and the functionality of Brazilian banks. The period 1995 and 2016 is covering important milestones in recent Brazilian economic history such as the financial deregulation process, the advances of ICT in the financial sector, the consolidation of the *Plano Real*, the last financial crisis and the economic recession followed by the impeachment of President Dilma Roussef (2016).

The bank's balance sheet datas were obtained from the Central Bank of Brazil website. The period of accounting date is semiannual, from June 1995 to December 2016. Monetary values were deflated by the General Price Index - Internal Demand (IGP-DI), updated to December 2016.

The sample was chosen by the share of banks in the National Financial System (NFS) in terms of monetary value of assets, which it represents 83% of overall assets. Twelve (12) public and private commercial banks and two (2) investment banks – the National Economic and Social Development Bank (BNDES) and *Banco do Nordeste do Brasil* were considered (see Table A.1 in the Appendix).

In order to check the impact of ICT and financial innovations on the functionality of the Brazilian banking system, an indicator of functionality was calculated from the accounting data[8] based on the following equation:

$$IF_{i,t} = \alpha + \beta_1 TECH_{i,t} + \beta_2 BSD_{i,t} + \beta_3 SELIC_t + \beta_4 LPB_{i,t} + \upsilon_i \quad (1)$$

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[8] The processing of data was made following the explanation: the data banks ABN AMRO and Unibanco are present from June 1995 to June 2007. It is noteworthy that in 2008, the bank was acquired by Itaú Unibanco and ABN AMRO by the consortium formed between RBS, Fortis and Santander. The data bank Nossa Caixa is included from June 1995 until June 2008, when it was bought by the Bank of Brazil. As for the bank Votorantim, the "Banco do Brasil" bought 50% of its capital. The inclusion of these acquired banks was necessary given their importance in the National Financial System (NFS).

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The variables considered in the estimation were the indicator of functionality of the banking system ($IF_{i,t}$); a quantitative measure of ICT ($TECH_{i,t}$); the proxy of financial innovation ($BSD_{i,t}$); the interest rate of the economy ($SELIC_t$) and the liquidity preference of the banks ($LPB_{i,t}$). The error term (Ui) consists of an idiosyncratic error μ_i and a random error term ε_i. The subscripts on the variables represent the total sample (selected banks), denoted by i, and the period of analysis, denoted by t delimiting the period (1995-2016). Further explanations will be given below.

The index of functionality of the banks to economic growth consists of two indicators: i) the supply of funds and the channeling of these resources from the banks to the real economy (Gross Domestic Product - GDP), and ii) the degree of financial fragility of the banking system associated with the expansion of supply of these funds. The first indicator is a measure of the willingness of the banking system to provide the needs of finance to the real economic sector. The credit ratio on Gross Domestic Product (GDP) shows the availability of the banking sector to supply credit to productive sectors, becoming more illiquid. The second one, the degree of financial leverage, reveals an increase of the risk level of operations (instability of banking system) when there is an excess of optimism in the economy. According to Minsky (1986), financial leverage occurs because the banks make applications that are financed by their own resources and third-party resources. When the proportion of debt in relation to equity (own resources) increases providing an imbalance between source and application of funds, the bank gains more leverage. These operations result in an increase of risk and return.

The appropriate combination of own resources and third-party resources in order to make the maturity and amount of the assets compatible with the requirements of liabilities and the expected return of investments is a form of managing the involved risks in the operations. To measure these risks, we made use of the Degree of Financial Leverage (DFL) indicator and calculated it the following way:

$$DFL = \frac{ROE}{ROA} \qquad (2)$$

The indicator ROE measured Return on Equity (Net Profit/Net Worth). This index was defined by Minsky (1986) as the rate of profitability. The increase in financial leverage caused a higher risk of insolvency of the entity, if a change in expectations occurs abruptly.

The Return on Assets (ROA) measures the overall effectiveness of management in generating profits with its available assets, which is expressed by net profit/assets adjusted. The adjusted assets (total assets less fitting banking and government bonds) reflects the best measure of the degree of risk aversion of the bank, as well as the ability to absorb possible losses arising from risk assets, since government bonds serve as secondary reserves (Paula & Alves, 2003).

The ratio between these two indices shows the degree of financial leverage (DFL=ROE/ROA). The elevation of the DFL means that assets are financed with more third party capital than with their own resources. As the DFL increases, the bank will have a higher ratio of leverage and be more vulnerable to financial risk. In this case, the ROE is greater than the ROA. This means that the assets are being financed by more third party capital and less equity. In regards to the index of leverage, (measure of instability), the ratio Credit/GDP (credit supply) obtains the indicator of functionality (IF) presented by expression 3:

$$\mathbf{IF} = \frac{CREDIT/GDP}{DFL} \qquad (3)$$

This indicator of functionality captures two main functions of the banking system, namely, the provision of finance and funding. The first function measures the amount (volume) of resources allocated towards the economy by ratio credit/GDP; while the second measures the creation of financial assets with a different profile of return and risks, that is, the degree of financial fragility.

The indicator measures the functionality of the banking system when it expands the use of existing resources to the economic development process generating financial fragility minimum. Thus, the higher ratio credit/asset and the lower the degree of financial leverage (DFL), the higher the level of functionality and when the opposite occurs, the lower functionality of the banking system is expressed as lower credit supply and greater financial fragility.

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The technology ($TECH_{i,t}$) is measured by the sum of the sub-account denominated in OTHER in the balance sheet (Box A.2 of appendix). This sub-account quantifies the ICT infrastructure by investments in communication systems (communication equipment, computers and software) and in electronic data processing (Faria & Maçada, 2011; Maçada et al., 2005). The ICT infrastructure, used by banks, covers internet access, internal networks (wire and wireless), SMS alerts, substitution of postal mail, ICT security measures, authentications (digital signatures) and automated payment systems (automatic teller ATM machine and Electronic Funds Transfer) corresponding to the value of ICT investments.

The variable $BSD_{i,t}$ accounts for the operations with bonds, securities and derivative instruments in banking activities. This account is a good proxy of financial innovation; security trading allows the creation of new products and services through the process of securitization and derivative instruments.

The Monetary Policy Committee (COPOM) determines the reference rate of the SELIC. It is an important variable to explain the functionality of the banking system, since this interest rate reflects the macroeconomic environment, and alters the composition of bank balance sheets. The SELIC has direct and indirect impacts on the provision of funding. Directly, a variation of this interest rate causes changes in risk behavior of agents, thus altering the composition of their portfolios. Indirectly, the monetary policy uses this instrument to control the inflation rate, causing impacts on effective demand, and consequently, the growth of the product and the decisions of productive investment.

The index of liquidity preference of the banks (LPB), defined as demand deposits/credit, describes the strategies of individual banks, which determine, in part, the composition of their balance sheets. Banks with more conservative financial strategies tend to have higher liquidity preference than those who adopt more aggressive strategies (Crocco, 2010). This kind of strategy can affect the functionality of the banks in economic development. In addition to individual strategies, changes in expectations in economic performance affect the strategies of all banks simultaneously, for example, in terms of the behavior of liquidity preference is widespread. While the uncertainty in the economy increases the liquidity preference for all banks, a reduction in uncertainty causes the opposite behavior in banks. For example, a lower degree of uncertainty in the economy, reflected in the SELIC rate, causes a reduction of this indicator (LPB).

RESULTS

The technology and financial innovations contribute to the modernization and expansion of the financial system. However, the development of the banking system should be measured not by its size but rather by its functionality (Crocco, 2010). As stated by this author, the banking system can possess higher total assets in relation to GDP, but a significant portion of this asset may be allocated in financial circuits and not in productive ones. Information and communication technology led to the acceleration and the rapid growth of a number of financial innovations. These financial innovations have enabled new application options and acquisition of resources, increasing the flexibility and diversification of banking activities.

The diversification of applications did not necessarily result in expansion of the financing to productive investment. An econometric analysis will verify to what extent, the technological and financial innovations affected the functionality of the Brazilian banking system. Table 1 presents empirical results of the effects of these innovations on banking functionality in Brazil.

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Table 1
Effects of innovations on functionality of Brazilian' banks

Index of Functionality – IF	Dynamic panel	Random effects	Fixed effects
Ln (BSD)	-0.233 (0.022)*	-0.209 (0.101)**	-0.217 (0.110)***
Ln (TECH)	0.714 (0.025)*	0.663 (0.108)*	0.663 (0.113)*
Ln (SELIC)	-0.307 (0.042)*	-0.270 (0.152)***	-0.289 (0.162)***
Ln (LPB)	-0.210 (0.019)*	-0.336 (0.138)**	-0.357 (0.144)**
Constant	-10.086 (0.557)*	-9.972 (2.121)*	-9.761 (2.312)*
R^2			0.44
Wald chi2(4) Prob > chi^2	58.21 0.0000	433.30 0.0000	
Hausman test- chi2(4) Prob > chi^2		11.50 0.0215	11.50 0.0215
Sargan test- chi2(442) Prob > chi2	10.793 0.846		
Number of the observations	553	553	553

, **, and * imply significant at 10, 5 and 1 percent significant levels respectively ($p < 0.10$; ** $p < 0.05$; * $p < 0.01$).

Instruments for differenced equation in model Dynamic panel: Account 1.1.0.00.00-6 – Cash and cash equivalents (Box A.2)

Source: Elaborated by the authors.

The Hausman test shows the effects fixed are consistent under both hypotheses. However, this estimation still has an endogeneity problem due to the correlation between the explanatory variables (SELIC and LPB) and the dependent variable (index of functionality), violating the assumption of strict exogeneity, resulting in biased and inconsistent estimates. In order to correct this bias the Dynamic Panel was adopted.

The negative coefficient (-0.233) of the financial innovations (Ln BSD) is consistent with the hypothesis that the information and communication technology potentiated the creation of financial innovations to make faster profits without implying a greater supply of funding to the productive sector. According to Martins (2012, p. 41), "the Brazilian financial system cannot be qualified as strictly functional for development, since the supply of long-term funding is still a limiting bottleneck for investment expansion and, consequently, for the development of the Brazilian economy".

Financial innovations have increased the proportion of financial assets in relation to production in order to stimulate short-term and speculative operations. Such operations increased rapidly in order to raise the profits of financial institutions (financial leverage). Banks, in pursuit of these lucrative opportunities, directed their resources to the applications in financial assets rather than the supply of credit to productive investments in the medium and long term (Minsky, 1986; Mollo, 2008; Studart, 1995).

The technology related to computers, software and statistical resources enabled a more accurate assessment of the risks and also the standardization of loans, encouraging the expansion of standardized short-term credit. This increase of credit had a positive effect on the level of functionality (0.714). The technology (ICT) allowed the creation of several types of instruments for the creation, standardization and conditions of access to credit (in terms of costs, maturity, collaterals, etc.), reducing the operating costs. It is emphasized that credit supply is short term and intended, in large part, for consumption and working capital. This result corroborates the works of Faria and Maçada (2011), Maçada et al. (2005), and Mishkin and Strahan (1999).

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The interest rate (Ln SELIC) and the liquidity preference (Ln LPB) greatly contributed in reducing the functionality of the Brazilian banking system. The increase in interest rates, to control inflationary pressures, reduces the return on investment projects and, on the other hand, increases the rates of return on financial assets, producing an impact (-0.307) on the credit supply and implying a reduction in functionality of the bank. The banking behavior in Brazil has been determined by the high rates of interest and by conditions in which the government has managed its internal debt. At the same time, banking strategies are determinants for the portfolio allocation. It has been dominated by short term behavior and high liquidity preference that have resulted in a low credit supply and high banking spread (Martins, 2012; Paula & Alves, 2003).

The results of our study corroborate with Lechaman and Marszk (2015). In short, the relationship between the advancement of ICT and its impact on financial development, can be considered as dual. On the one hand, ICTs offer opportunities for dynamic financial development, which is made possible by mitigating information asymmetries and free data flow. On the other hand, it can increase price and volume fluctuations of the assets traded, causing greater exposure to the risk and volatility. The increase in the volatility may generate more instability in the financial system and for this reason, regulatory adjustments are necessary in order to mitigate some problems such as potential systemic risk.

The indicator of liquidity preference explicitly shows the strategies of banks in relation to macroeconomic uncertainty. Given the uncertainty, banks focused on short term transactions, giving more importance to liquidity than the profitability of investments. The negative relationship of liquidity preference on the indicator functionality (-0.210) translates into less willingness of banks to offer credit when uncertainty exacerbates a low degree of confidence in expectations of expected returns on investment. In this scenario, banks prefer to provide more liquid assets in their portfolios, causing credit rationing. The high preference for liquidity induces the banks modifies their portfolios by carrying out mainly short-term[9] operations with some collateral, reducing long-term loans and consequently reducing the functionality. The analysis of the behavior of the variables that make up the index of banking functionality is being shown in Graph 1. The Brazilian National Financial System (BNFS) is based on the banks being classified according to Zysman's typology of the credit-based system. The analysis was limited to the credit market because it represents the biggest weight in the structure of Brazilian National Financial System (BNFS) financing while the stock market has smaller participation in BNFS.

Graph 1
Indicators of the banking functionality in Brazil
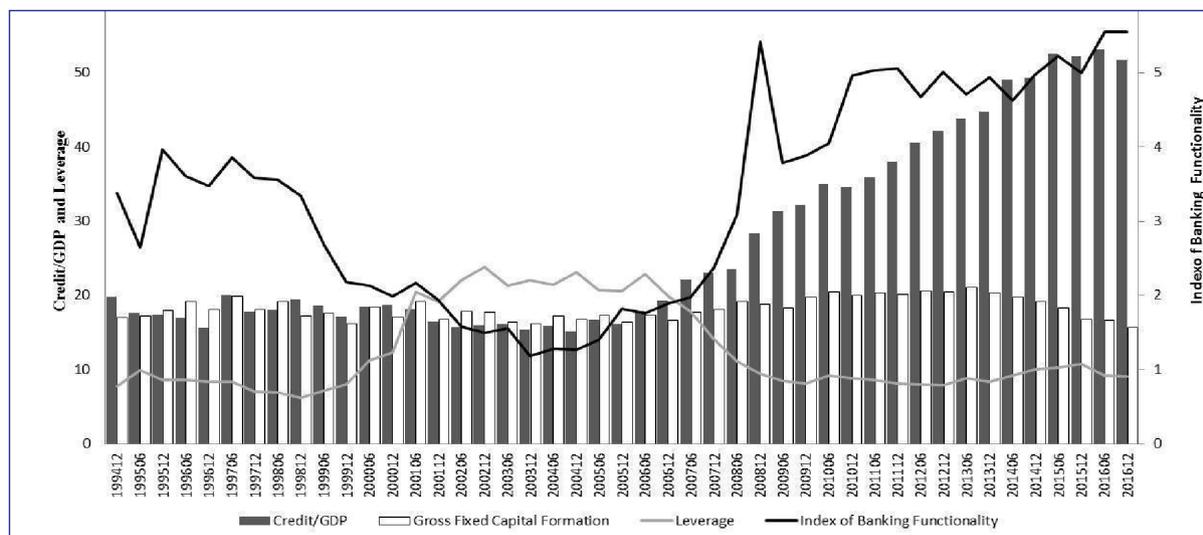
Source: Elaborated by the authors.

_____
[9] The most liquid operations on the balance sheet are the account cash and cash equivalents (Box A.2 of the appendix).

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The Graph 1 shows that indicator of functionality increased in the period between 2007 and 2016. The level of leverage had a more moderate rhythm of growth and it was lower than the ratio credit/GDP. After the last financial crises, the Brazilian government amplified the credit supply through public banks, especially in the National Bank of Social and Economic Development (BNDES) to minimize its effects.

The volume of financial resources going towards the productive sector, expressed ratio by Credit/GDP, grew significantly between 2007 and 2016. Despite this increase in credit supply, the functionality of the banks was not sufficient for economic growth because the provision of resources itself was limited. The supply of short- and medium-term funds destined to be used as consumer credit and working capital instead of investments. The banks' credit supply increased between 2007 and 2016 without a corresponding increase in investment demand (Gross Fixed Capital Formation). Probably the lack of supply of long-term funds limited the investment, and therefore, the expansion of growth of Brazilian economy as stated by Herman and Paula (2011) and also in Martins (2012). The functionality index presented strong oscillations reflecting the rapid changes in the portfolio decisions of the banks and still only refers to the financial part of the circuit presented in the literature review.

FINAL REMARKS

The Brazilian financial system can be characterized as a bank-based model, which reflects the importance of this sector for the Brazilian economy. Therefore, having a functioning financial (and especially banking) system is important to provide adequate sources of finance for the economy. In this sense, from a post-financial deregulation scenario, the aim of this article was to analyze the relationship between ICT and banking functionality from 1995 to 2016.

The advancement of new products, services, faster and more interconnected transactions, ICT may impact negatively on the functionality of the Brazilian banking system, which traditionally focuses on short-term, more profitable, and less risky operations vis à vis long-term financing, which involves more uncertainty. That is, how ICT affects the ability of banks to contribute to long-term financing in order to stabilize the economy. Technological changes in the banking industry arose from the financial innovations and expanded the possibilities for strategic decisions on the balance sheets of these institutions, because they make changes more flexible in terms of the composition and portfolio allocation.

The results obtained in this paper converge with Zendron (2006), whose work highlights that this flexibility is an incentive to banks to act in a less functional way, expanding their potential to operate in short and more profitable operations, even though this may intensify financial fragility in crisis contexts. According to the theory of liquidity preference, this logic of banking operation affects the long-term expectations of entrepreneurs, the expenditures; the interest rates and the availability of funds to finance investments. It was captured by the results of this paper.

According to the results, it was verified that the index of functionality increased due to an expansion of credit and the creation of resources in Brazil between 2007 and 2016, especially due to the countercyclical measures adopted by the Brazilian government in the post-international financial crisis context. During this period, the functionality was amplified as credit supply increased without verifying a rise of financial fragility that halted the process of growth for purely financial reasons.

In spite of the increase of functionality, the provision of resources was relatively limited. The supply of short- and medium-term funds destined to the consumer credit and the working capital prevailed, instead of investments. In summary, although ICT has positive impacts on banks' operational activities, its relationship with functionality is negative. This result shows that, for the sample considered in this study, the strategy of short-term gains has been prioritized to the detriment of long-term investment financing, characterizing the Brazilian banking system as non-functional. Also, the lack of development projects and inadequacy in terms of long-term funds supply limited the investment, which was one of the main factors that undermined the financing of Brazilian development.

Finally, it is important to highlight that the empirical strategy chosen for this paper is following the most relevant factors considered by the literature about banking functionality, incorporating the ICT's. Studies with this emphasis are still relatively scarce for Brazil, which justifies this research. Although this is a relevant effort, it is not enough to cover a dynamics process.

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For this reason, future research to provide broader and more robust evidence needs to be carried out. In order to improve the analysis, new studies about the effects on the functionality should consider: i) new trends and business model in the financial system powered by ICT's (such as fintechs, new products and services, derivatives); ii) a new proxy for financial innovation, iii) the impact of ICT on banking functionality considering different economic cycles.

Another challenge is improving management practices. The advancement of ICT's, by providing the emergence of new, more integrated, and flexible business models, will demand an ecosystem with more creativity, more agility and partnerships between IT's firms and banks. In this sense, making these new products, services and businesses expand the access of families, companies, and other institutions to different types of financing, at less risk and cheaper, is also imperative for economic and financial development.

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APPENDIX

Table A.1
Financial institutions selected in the sample from 1995 to 2016

	Banking Institutions	C*	Origin/Capital	City	UF	Assets Mean (R$ in millions)	Assets Mean (%)
1	Banco do Brasil S.A	Yes	Federal public	Brasília	DF	236,000	16.73
2	Banco Bradesco S.A	Yes	National private	Osasco	SP	217,000	15.36
3	Caixa Econômica Federal	No	Federal public	Brasília	DF	170,000	12.07
4	Banco Itau S.A	Yes	National private	São Paulo	SP	141,000	10.01
5	BNDES	No	Federal public	Rio de Janeiro	RJ	118,000	8.39
6	Banco Santander S.A	Yes	Private/foreign control	São Paulo	SP	100,000	7.09
7	Unibanco-União Bcos Bras S.A.	Yes	Private/foreign market share	São Paulo	SP	32,800	2.32
8	HSBC Bank Brasil S.A	Yes	Private/foreign control	Curitiba	PR	29,900	2.12
9	Banco Safra S.A	Yes	National private	São Paulo	SP	28,100	1.99
10	Banco ABN Amro Real S.A	Yes	Private/foreign control	São Paulo	SP	27,600	1.96
11	Banco Votorantim S.A	Yes	Domestic private	São Paulo	SP	22,000	1.56
12	Banco Citibank S. A	Yes	Private/foreign control	São Paulo	SP	19,100	1.35
13	Banco do Nordeste S.A	No	Federal public	Fortaleza	CE	17,800	1.26
14	Banco Nossa Caixa S.A	No	Federal public	São Paulo	SP	13,100	0.93
TOTAL ASSETS OF THE BANKS						1,172,400	83.00
TOTAL ASSETS OF THE NACIONA FINANCIAL SYSTEM (NFS)						1,412,550	100.00

C* means Conglomerate and UF = Unity of the Federation. The banks with the superscript number were purchased by the bank corresponding to the number.

Source: Elaborated by the authors based on Central Bank of Brazil. Top 50 Banks in Brazil.

Box A.2
Financial Institutions Accounting Plan of the Brazil (COSIF)

Codes (account number)	Accounting titles (description)
1.1.0.00.00-6	**Cash and cash equivalents**
1.3.0.00.00-4	**Securities and derivative financial instruments**
1.6.0.00.00-1	**Credit Operations**
1.6.1.00.00-4	Discounted credit rights and loans
1.6.2.00.00-7	Financing
1.6.3.00.00-0	Rural financing
1.6.4.00.00-3	Real estate financing
1.6.5.00.00-6	Financing of securities
1.6.6.00.00-9	Financing of infrastructure and development
2.2.0.00.00-2	**Fixed assets**
2.2.9.00.00-9	Others* (communication system, data processing system, security and transport system)
4.1.0.00.00-7	**Deposits**
4.1.1.00.00-0	Demand deposits

Others* consists of the subaccounts: communication system, data processing system, security system and transport system.

Source: Elaborated by the authors based on COSIF.