

Approaches to a Central Bank Digital Currency in Brazil

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Abstract

What would it look like if Brazil introduced a central bank digital currency (CBDC) for use by the public? A Brazilian CBDC would be issued by the Banco Central do Brazil, the nation's central bank, and would be available for anyone to use. This paper explores the general concept of CBDC, a topic that has garnered much interest among central bankers over the last few years. It will then delve into some of the Brazilian-specific implications of implementing a CBDC. There are many ways to design such a product. Rather than trying to deal with the full range of potential CBDC design, this paper will focus on three potential archetypes: 1) a simple electronic version of the banknote; 2) an account-based CBDC that pays interest, and; 3) digital interest-paying cash that can be shielded and unshielded to provide for anonymity.

1 Introduction

While the idea of a central bank digital currency (CBDC) is fairly recent, the concept of digital currency can be traced back to David Chaum's explorations into anonymous electronic money in 1983. Chaum intended for eCash, the product that his company created, to be issued by private banks. Anyone could withdraw funds in the form of eCash and anonymously spend it at retailers who had installed the requisite hardware. Due in part to the emergence of online card-based payments, eCash was commercially unsuccessful.

In 2009, inspired by Chaum's electronic money, Satoshi Nakamoto proposed Bitcoin, a pseudonymous electronic cash system. Unlike eCash, Bitcoin is not issued by commercial banks. Rather, a distributed population of competing miners is responsible for verifying transactions. New bitcoins are created as a reward for miners that complete the necessary work. This means that the bitcoin network has no single central operator or central point of failure. Bitcoins are globally available on a twenty-four hours a day, seven days a week basis.

Since bitcoin is not convertible into an underlying medium such as gold or another currency, the price of bitcoin floats relative to the national unit of account. These fluctuations are often dramatic, limiting the ability of bitcoins to serve as a medium of exchange.

Beginning in 2013, several commentators surmised that the way to fix this volatility was to have central banks copy the bitcoin source code with one alteration: allow the central bank to create and destroy tokens. This would allow them to peg the tokens to existing banknotes at a 1:1 rate while leaving other features like pseudonymity and censorship resistance intact.¹The idea for a central bank-issued cryptocurrency was initially styled Fedcoin, but the Bank for International Settlements (BIS) has since provided a more globally-inclusive term for Fedcoin: retail-facing central bank cryptocurrency, or CBCC (Bech and Garratt, 2017). The terms CBCC and CBDC are interchangeable in this paper.

*Thanks to Kevin Rutter, Bruno Batavia, and Thomas Leach for providing direction and feedback throughout the production of this report.

¹See Koning (2013), Koning (2014), Motamedi (2014), and Andolfatto (2015).

Central bankers around the world are exploring CBDCs. Given that the concept of a CBDC is relatively new, most research efforts to date have approached the topic at an abstract level. The analysis in this paper takes a more concrete approach by mapping out the implications of introducing a CBDC into an actual economy, that of Brazil. Brazil's central bank, the Banco Central do Brasil (BCB) has been one of the first central banks to begin exploring the possibility of issuing a CBDC.²

In the second section of this paper we provide a definition and background of CBDCs. In the third, we discuss several motivations for issuing a CBDC. In the fourth, we describe the considerations that go into designing one. In the fifth section, we provide further context by examining the current retail payment system within Brazil, the world's eighth largest economy. The sixth outlines the shared benefits and drawbacks of three different designs for a Brazilian CBDC: *MoedaElectronico* (ElectronicCash), a cash-like digital bearer instrument, *ContaBCB* (BCBAccounts), a bank account held at the central bank, and *MoedaHibrida* (Hybridcash), which has a mix of cash and account-like features. The seventh further examines the three models and compares them against each other. Each potential solution would aim to solve a different problem and would appeal to different consumers. We hope this paper inspires similar CBDC research.

2 A definition of CBDC

The BIS's Committee on Payments and Market Infrastructures (2018) has proposed two different types of central bank digital currency: wholesale CBDC and general purpose, or retail, CBDC. A wholesale CBDC would be limited to banks and other financial institutions. While transactions conducted over existing central bank wholesale systems require a direct connection to the central bank, wholesale CBDC tokens could be traded by banks on a peer-to-peer (P2P) basis. This would imbue wholesale CBDC with the banknote-like 'bearer' quality of passing from entity to entity without requiring a call-up to the central bank.

This report primarily concerns itself with the second form of CBDC: retail, or general purpose CBDC. A retail CBDC is a digital payments option provided by the central bank for use by the general public. Central banks currently limit their contact with the general public to banknotes and coins. With the advent of the internet and other forms of digital communications, the possibility of upgrading their connection to the public by providing a non-physical payments option has become more salient.³

The discussion over CBDC has evolved to a focus on the menu of features that might characterize the end product while skirting finer points about the underlying technology. These features include anonymity, variable interest rates, availability, and accessibility. Given the range of potential features, a CBDC could have large effects on monetary policy, the banking system, and the behavior of the money-using public. Presumably once this debate has settled on the best set of features for a proposed CBDC, economists can then turn the matter over to technologists who will be able to determine the best technical solution for implementing a CBDC, whether that be a blockchain or something else.

3 Central bank motivations for researching CBDC

The emergence of bitcoin has inspired a number of central banks to explore whether they should provide a digital version of the banknote. The Norges Bank (2018) and Riksbank (2017), the central banks of Norway and Sweden respectively, are concerned about declining usage of cash by their citizens. Were cash to disappear, say these central banks, existing payments systems would not be capable of replicating several important services that cash currently offers the public. These services include the provision of a risk-free alternative to private bank deposits and an independent back-up solution for the ordinary electronic payment systems in times of crisis. A CBDC would be able to provide continuity by providing the public with both of these services. The Norges Bank

²For instance, see Burgos and Batavia (2018)

³For more on the difference between retail and wholesale CBDC, see Garratt (2016)

emphasizes the ability of a CBDC to replicate cash’s openness. Specifically, banknotes ensure that everyone has access to the payments system as well as to legal tender, a universal means for settling debts.

Danmarks Nationalbank (2017), the Danish central bank, is skeptical of CBDC, noting that it is already possible for people to hold safe assets by purchasing government bonds or holding funds in government-insured bank deposits. As for the appeal to robustness, the Nationalbank argues that a CBDC would not be able to function as a sufficiently independent system because it would always be dependent on the electricity network.

Mojmír Hampl (2018), Vice Governor of the Czech National Bank, lists two monetary policy motivations for introducing a CBDC. These include the ability to set negative interest rates and a means of easily implementing drops of “helicopter money”. Engert and Fung (2017) argue that while it is difficult to design banknote systems to evade the effective lower bound to interest rates, it isn’t impossible. By breaking the one-to-one peg between banknotes and central bank deposits, for instance, a central bank can encumber banknotes with a negative interest rate (Agarwal and Kimball, 2015). This may be an easier way to evade the lower bound than entirely removing banknotes and introducing a CBDC. As for helicopter drops, Engert and Fung point out that they can be achieved via conventional methods like sending checks in the mail.

Declining seigniorage revenues is another motivation for issuing CBDC. Because central banks do not pay interest on cash, but harvest income from the assets backing their issue of banknotes, they earn significant profits. If banknote usage declines, then so will seigniorage. This might force a central bank to rely on government funding, and this could ultimately undermine its autonomy. While a CBDC might be able to halt declining seigniorage, Engert and Fung note that a central bank might have other means for increasing seigniorage, including charging higher fees to banks.

Financial inclusion is another motivation for introducing CBDC, but Engert and Fung dismiss this by noting that the private sector has been very successful in providing the unbanked with digital payments. They provide broad acceptance of M-Pesa in Kenya as an example.

The research has matured significantly, but most central banks continue to proceed gingerly. A few have begun to consider different design decisions for a potential CBDC implementation, including the Uruguay’s central bank, which is just finished piloting a CBDC project.⁴

4 The design elements of a CBDC

There are many features that must be considered in designing a general purpose CBDC. In this section we will focus on three of these elements: 1) the difference between a cash-like CBDC and an account-based CBDC; 2) the tradeoffs between anonymous, pseudonymous, and verified CBDC; and 3) the idea of keeping the interest rate on CBDC fixed at 0% or allowing variable positive and/or negative interest rates.

4.1 Digital cash or digital accounts?

If central banks begin to offer a retail digital payments option, it could take two different forms. In one form, a CBDC would behave exactly like a digital version of a banknote. In another, it might behave like a regular bank account held at a commercial bank. It is also possible that the final product has elements of both.⁵

What differentiates a banknote from an account is that the parties to a banknote transaction do not need to double check with the note issuer that the banknote and its user are valid. Rather,

⁴According to SUERF (2018), the pilot lasted for 6 months from 17 November 2017 until 18 April 2018. “A volume of 20 million e-Pesos (equivalent of around EUR 550,000 as at June 2018) was issued. 10,000 mobile phone users, chosen on a first-come-first-serve basis, were involved. E-Pesos were generated at the central bank, transferred from the e-vault to users’ digital wallets, and could from there be used for payment transactions in registered stores and businesses as well as for peer-to-peer transfers among registered users.”

⁵For more on this distinction, see Mersch (2017) on the difference between account-based and value-based digital base money. This distinction goes back to the line that Roberds and Kahn (2009) draw between store-of-value systems and account-based systems.

possession of the banknote itself is sufficient to establish the owner’s right to that object. An appraisal of the note’s anti-counterfeiting features by the recipient of the note in turn guarantees that the instrument is not a fake. Given that mere possession is sufficient to establish ownership, the payor can effectively remain anonymous both to the issuer of the note—the central bank—as well as the payee, say a shopkeeper.

Because banknotes provide anonymity, they are also censorship resistant. To understand what this means, it might help to consider why bank accounts are not censorship resistant. In 2001, Huntingdon Life Sciences lost its connection to the banking system after the British public lobbied the company’s bank to drop it as a customer because of concerns that it was engaged in animal testing. Other banks were afraid to take on Huntingdon’s business for fear of attracting the attention of protestors. As a result, Huntingdon was censored from the banking system. In the end, the Bank of England had to step in and conduct Huntingdon’s business using a Bank of England account.

An effort to censor Huntingdon from the banknote system would have been far harder to achieve. Banknotes users do not have to connect to the issuing bank, the Bank of England, for verification prior to accepting or paying out a banknote, so there is no way for a central operator to prevent certain parties from using notes.

Finally, banknote systems are highly distributed, and therefore robust against attack and disaster. Since independent buyers and sellers do most of the work in processing a transaction, should the central bank be temporarily unavailable the system will continue to function. When a commercial bank fails, on the other hand, bank accounts cannot be used.⁶

If a CBDC is to be designed such that it replicate as many of the features of a banknote as possible, then a user’s inventory of CBDC would be stored in such a way that no connection to the central bank is required for a payment to proceed. Instead, a direct peer-to-peer link would be sufficient to pass the tokens on. Anyone who wants to use the CBDC would be free to do so without registering or providing identity. The ability to remain anonymous means that the system would be resistant to censorship. Finally, because value is stored in a distributed fashion, without the necessity for centralized verification, a CBDC would be robust against many sorts of disruptions that would otherwise cripple a centralized account-based payments system.

A CBDC could also be implemented as an account-based financial product. In fact, central banks have opened accounts for individuals in the past. The most recent to do so was the Central Bank of Ecuador through a product called Dineiro Electronico, a phone-based mobile money product. However, Dineiro Electronico does not seem to have attracted much usage among Ecuadoreans (White, 2018). Whereas technologies to create digital cash are relatively new and untested, account-based systems have been used for a long time.⁷

4.2 Anonymous, pseudonymous, or verified?

One of the most important and contentious features of a new digital retail product is anonymity. The argument in favor of anonymity is that in a liberal society, the public needs a payments conduit that allows them to transact without fear of being watched. Banknotes currently provide this conduit, albeit only in face-to-face commerce. An anonymous CBDC would upgrade the capability by allowing not only for face-to-face anonymous trade, but also remote anonymous trade over the internet. As the public’s cash acceptance declines and/or cash is phased out by authorities, an anonymous CBDC will ensure that society still enjoys financial anonymity.

The argument against an anonymous CBDC is that it would provide a more convenient payments medium for criminals and tax evaders.⁸ One compromise is to continue providing anonymous

⁶For instance, when an April 2018 upgrade at TSB Bank’s encountered problems, 1.9 million customers were locked out of their accounts for more than ten days. In September, ongoing criticism led to TSB’s CEO stepping down.

⁷Grym (2018) takes an opposing view to the digital accounts vs digital cash dichotomy, suggesting that it is physically impossible to create an electronic version of cash. A token-based money must always be physical, and digital money is always an account-based product.

⁸For instance, here is the Danmarks Nationalbank (2017): “Performing transactions without specifying remitter or recipient would also significantly increase the risk of money laundering, including tax evasion, and financing of terrorism.”

CBDC, but to put a ceiling on the amount that can be held. However, capping CBDC holdings leads to a different set of problems, including a breakdown in fungibility.⁹ Another possibility is to offer partial anonymity rather than full anonymity. By requiring some sort of verification process, authorities would be able to link transactions to identities, this information being useful in fighting crime. Counterparties like retailers would not have access to any information, providing payees with a limited form of anonymity.

A fully anonymous CBDC that attracts criminal usage may be desirable from a social welfare perspective. Should high denomination banknotes be banned, McAndrews (2017) has argued that an underground IOU payment mechanism run by organized crime could fill the vacuum. The involvement of organized crime would introduce a level of violence heretofore nonexistent and drag innocent and unwilling actors into supplying the underlying media for the criminal payments system. McAndrews deploys his argument in the debate on banning high denomination banknotes, but a scenario in which cash is removed and a non-anonymous CBDC takes its place is also subject to the McAndrews critique.

McAndrews likens the provision of high denomination banknotes (and therefore anonymous CBDC) to the public provision of clean needles and free condoms. Restrict free condoms and it is possible that the rate of sexual intercourse goes down. But this will lead to an increase in unsafe sex, unplanned pregnancy, and sexually transmitted diseases. Likewise, a decision to strip cash of its anonymity might encourage a few criminals to go legitimate, but it could very well drive all remaining criminals towards a more socially-disruptive payments alternative.

Central bankers have either provided lukewarm support to an anonymous CBDC or have roundly criticized the idea.¹⁰ The Danish central bank (2017), for instance, says that it would “not be appropriate or acceptable to make CBDC anonymous.” The issue of anonymity in payments is a complicated topic. Narayana Kocherlakota (2016), former CEO of the Federal Reserve Bank of Minneapolis, worries that economists do not know very much about the topic of anonymity and calls for the profession to model it more systematically. Rather than quickly dismissing an anonymous CBDC, central bankers have an obligation to their citizens to consider the role of anonymity in civil society.

4.3 Interest bearing or not?

Central banks currently provide the public with no pecuniary return on banknotes. Since inflation is generally positive, the real return on notes is negative. Despite generating a financial loss for their owners, banknotes remain popular as means of payment and store of value. If central banks decide to design a digital central bank payments option for the public, they must decide whether to pay interest or not. If so, how should the level of interest rates be set? Should accounts at the central bank or digital cash earn the same rate of interest that financial institutions earn on the accounts they keep at the central bank, or should they be paid less?

Paying interest on CBDC would encourage the public to switch from 0%-yielding banknotes to CBDC. However, the higher the interest rate the more that people will be encouraged to migrate away from privately-provided bank accounts. This would force banks to rely on alternative forms of debt or equity to fund lending. If these alternative forms of funding do not mesh well with the traditional banking business model, then banks may be forced to crimp lending or raise the costs of getting a loan. A retreat by the institution of banking would make society worse off.

On the other hand, if the central bank decides to pay interest to the public, but at an inferior rate to what it pays financial institutions, it will be criticized for favoring bankers over citizens.

The case can also be made for a permanently negative interest rate on anonymous CBDC. Because criminality and tax evasion impose costs on society, it may be worthwhile to design anonymous payments systems in a way that recoups some of the costs these activities impose. The existing banknote system already places an effective toll on criminality and tax evasion. Central banks fund themselves by issuing banknotes, a liability that obliges them to pay a 0% rate to their debtors, while investing the proceeds in treasury bills that yield 1-3%. This spread allows them to harvest

⁹See later section: Introducing a Brazilian CBDC: Commonalities between the three models.

¹⁰Ingves (2017) writes that: “perhaps it could contain some element of anonymity.”

significant profits off of banknote users, many of whom are illicit users who require the anonymity of large denomination notes. This toll revenue in turn flows back to tax payers via dividends that central banks pay to the government.

The toll on cash has historically been fixed due to the difficulty of burdening notes with a negative nominal interest rate. A CBDC, on the other hand, could be designed to have a flexible negative interest rate. This would allow a central banker to set the tax on anonymous currency at a level that more accurately recoups the costs of criminality and tax evasion.

4.4 Designing a CBDC for a specific country

The above discussions introduced the idea of CBDC, summarized recent research, and demonstrated the breadth of design decisions for a CBDC. There is no standard toolkit – every domestic economy could have separate motivations and design considerations. In section six of this paper, we will try and apply some of these ideas to Brazil. But first, we need to introduce the Brazilian retail payments system.

5 The Brazilian retail payments system: Where are we today?

The breadth of Brazil’s payment system and unique types of payments solutions make it a particularly interesting country to evaluate. There are about 210 million people across the world’s eighth largest economy. Paper-based instruments, such as cash, check, and boleto de pagamento are still widely used. Digital payments, particularly through mobile banking, have grown in recent years — a noteworthy development in a country with 100% cell phone penetration, a majority of which are smartphones. The growth of mobile banking has also accompanied increasing internet penetration.

Below, we review the different methods for retail payments that are currently in place. In particular, we review cash, check, boleto de pagamento, direct debit and credit, and payment cards, and provide some context related to their use.

5.1 Methods of payment

Physical cash Physical cash serves an important role in everyday purchases, small-value transactions, and in the underground economy. According to the BCB (2018), 29% of Brazilians receive their salary in the form of cash. Cash offers consumers and businesses the advantages of no fees, convenience, anonymity, and no default risk. Cash payments also do not require a bank account, which slightly less than a third of Brazilians do not have (World Bank, 2017). The amount of physical cash in circulation indicates that there remains robust demand for banknotes and coins (BIS CPMI, 2017).

Several different entities incur costs along the cash cycle, which includes production, storage, custody and distribution. The Casa da Moeda do Brasil manufactures physical cash and coins, the Banco Central do Brasil (BCB) issues, stores and distributes currency, the Banco do Brasil—Brazil’s largest national bank—custodies and distributes currency, and commercial banks deposit and withdraw money from the BCB or the Banco do Brasil. Once introduced into the economy through commercial banks, there are also various distribution points, such as ATMs, Point of Sale (POS), and correspondent locations for individuals to receive or deposit physical cash.

Physical cash faces some unique challenges in Brazil. According to Burgos and Batavia (2018), cash transportation costs in Brazil are higher than in most countries, due to security requirements. The movement of cash often requires armored cars, helicopters, and other protected vehicles. Brazilian ATMs cost 60% more than the global average due to the need for additional security features. In more remote parts of Brazil that do not have banking access, the Brazil postal service has often facilitated access to physical cash for the public. In some cases, the postal service was forced closed

these branches, due to risk of theft, eliminating the only access point for cash by people in these cities.

Checks Relative to other countries, people in Brazil still use a large amount of checks. However, the volume of check transactions is declining as consumer preferences shift to credit transfers and payment cards (BCB, 2005).

Payment cards Payment cards, both debit and credit, play an important role in the retail payment system. In its 2018 survey on payments, the BCB found that 52% and 48% of survey participants respectively used debit and/or credit cards. Cards are especially popular in larger payments, accounting for 59% of survey participants' payments between R\$100 to R\$500. Payment cards facilitate payments at point-of-sale and, increasingly, online or mobile transactions.

Brazilian consumers often finance the purchase of goods or services with credit cards through installments. These installments allow consumers with lower incomes to space out their payments for goods over time, increasing these consumers' ability to finance large purchases. However, clients may lose track of their cash flow giving rise to other problems such as over-indebtedness, exacerbated by steep interest fees in the country.

Boletos de pagamento Boletos de pagamento are bar-coded payment slips that allow bills and invoices to be paid by a pre-established date. They have historically been printed, and then paid at a bank cashier, ATM, lottery house, or supermarket with cash.

Boletos de pagamento provide a means for those who do not have bank accounts or payments cards to make online purchases. After visiting a website and initiating a purchase, the buyer can print a slip, take it to the nearest agent, and pay the amount in cash. The website owner, upon receiving confirmation of payment, can send the merchandise. In addition to being popular with the unbanked population, the slips are used by those who are uncomfortable with sharing credit or debit card data on the web.

Since boleto de pagamento fees are generally lower than payment cards, retailers allow boleto de pagamento payments to occur at a discounted price to incentivize people to use them. They are also preferred by retailers over the installment payments common with credit cards, as they are a one-time payment. Like cash, payments slips can be counterfeited and have been used to launder money and run phishing scams. To combat malicious activity with the boleto de pagamento system, new regulations require the registration of each slip with the Câmara Interbancária de Pagamentos (Interbank Payment Clearinghouse, CIP). This may ultimately increase their costs. Additionally, in 2009, CIP launched a system that provides electronic versions of payments slips that can be paid through internet and mobile banking channels, reducing the number of paper-printed slips.

Credit transfer Credit transfers are customer-initiated payments that move funds from a payer's account to the payee's account. Interbank payment instructions are sent from the payer's bank to the beneficiary's bank through Brazil's interbank clearing and settlement systems. Brazilians have several different choices for making credit transfers. Documento de Crédito (Document of Credit, DOC) payments typically settle the next day and are limited to amounts below BRL 4999.99 (\approx US\$1200) while Transferência Eletrônica Disponível (Electronic Funds Transfer, TED) payments, for higher payment values, can settle in near real-time.¹¹

Boasting a volume of 10.21 billion transactions in 2016, credit transfer is the method of payment with the highest total value of transferred in Brazil (BIS CPMI, 2017). Credit transfers are entirely digital and require both sides of the payment to hold a bank account.

Direct debit Direct debits are often used for recurring payments such as utility, water, electricity and telephone bills. With these payments, the person who wishes to pay a bill, say a utility bill, preauthorizes their bank to accept funds transfer requests initiated by their utility. Before the payment is due the utility sends the invoice to the bill payer upon which their account is automatically debited. These payments are entirely digital, though notices and confirmations regarding them may come in paper form. Brazilian direct debit volumes registered at around 5.34 billion transactions in 2016 (BIS CPMI, 2017).

¹¹TED payments are similar to wire payments in the U.S., which use Fedwire, while a DOC payment is similar to an ACH push payment in the US, which uses FedACH.

5.2 Distribution channels

Distribution channels allow the use of the aforementioned payment instruments. These include banking branches, ATM and point-of-sale (POS) networks, and other modern ways of accessing the financial system such as computers and mobile.

Commercial banks A recent report showed there are 33,420 bank branches in Brazil, and the top ten commercial banks control almost 90% of the industry's assets (BIS CPMI, 2017). Banking activity is largely concentrated in the south.

According to the World Bank (2017), more than two-thirds of the population of Brazil has a commercial bank. That number has increased over the last decade thanks to the 2004 introduction of Bolsa Familia, a government program that provides direct transfers of funds to families. In order to receive these funds, Brazilians must have a bank account. However, some Brazilians only use these accounts to receive their payments upon which they withdraw the funds in cash form.

ATM terminals ATM terminals allow their users to use payment cards to withdraw cash and make deposits, transfer money, check balances and statements, buy cellphone credit, print checks, and initiate credit transfers without visiting a banking branch. Each Brazilian bank has historically maintained its own proprietary ATM network. Interoperability between ATM networks has improved, but remains a challenge in some areas. A consortium of banks owns the shared ATM network Banco24Horas.

Point of Sale (POS) terminals POS terminals are provided to merchants to facilitate card transactions. These terminals read payment cards from individuals by using magnetic tracks or chips, leading to an exchange of information/data between merchants and card issuers with the authorization and registering of transactions.

Correspondents Correspondents play an important part in distribution and providing payment services. These are non-financial institutions that act as agents for banks by offering banking and payment services to customers that do not have direct access to the Brazilian banking system. The number of accounts and services handled by correspondents, such as lottery stores and post offices, peaked at 5.1 billion transactions in 2016, up from 1.3 billion in 2011 (Deloitte, 2017).

Empresa Brasileira de Correios e Telégrafos (ECT), the Brazilian post office, is a key correspondent. Because their service hours are different from those of commercial bank, and because they have a nationwide network, correspondents like ECT allow consumers who do not have access to commercial bank branches or digital payments apps to pay bills or make small withdrawals.

Remote access/internet/mobile Smartphone and internet payments are increasingly important for banking services. In 2017, mobile banking remains the most popular channel for Brazilians to access banking services, with 25.6 billion transactions—up from 18.6 transactions the year before (Deloitte, 2018). This represents 35% of total retail banking transactions. Mobile payments are likely to continue to grow as a retail payment channel, particularly for people without direct access to the banking system. Given the sizeable role that online banking now plays in Brazil, more than half of all retail banking transactions are digital.

Even though smart phone penetration is high, internet penetration is relatively low. In 2016, 38.85 percent of the Brazilian population accessed internet from their mobile device. This figure is expected to grow to 53.23 percent in 2022. These limitations may hinder the potential for a smartphone-based in the short-term, particularly in areas that currently have poor internet coverage.

Consumer preferences in the retail payment market in Brazil are changing very quickly alongside new technologies. As different payment methods and instruments become more popular, and the private sector innovates, more and more Brazilians are getting access to both payment and financial services. Could a CBDC address reach of the market that the private sector does not currently address? We explore that question in the next section.

6 Introducing a Brazilian CBDC

In this section of the paper we build upon the previous sections—the general design elements of a CBDC and the particulars of Brazil’s payment system—to examine the payment niches that a Brazilian CBDC might address. This is a particularly difficult task given that there are many ways to design a Brazilian CBDC. The aim of this paper is to provide three high-level archetypes with the hope of inspiring future research.

To simplify things, we’ll begin by fleshing out three different templates, or profiles. We will then consider the strengths and weaknesses of each type of CBDC within the context of the Brazilian economy. Here are the three types:

1. **MoedaElectronico (Electronic Cash):** this is the most cash-like of the three CBDCs. It pays neither positive interest nor docks negative interest and is anonymous. Like cash, it is a bearer token.
2. **ContaBCB (BCBAccounts):** this is the most account-based of the three templates. Accounts are non-anonymous and pay interest, like a normal bank account.
3. **MoedaHíbrida (Hybridcoins):** provides a mix of cash and account-like features, including the ability to pay a varying positive and negative interest rate, while offering users the choice between anonymity or not.

6.1 Common design elements of each of the three models

The three CBDC models have a number of common design elements.

- **Availability:** They each function twenty-four hours a day, seven days a week.
- **Sharing of costs across various stakeholders:** As in the case of banknotes, central banks would outsource many of the tasks of maintaining the CBDC network to the private sector. The most important of these is distribution. Brazilian individuals and businesses would be able to purchase CBDC via third-party private financial providers, including banks and mobile money resellers. To get one-reais worth of CBDC, the buyer would have to submit R\$1 in banknotes or coins to the third-party, or R\$1 worth of bank deposits.
- **Fees:** Like cash, there would be no transaction fees.
- **Supplement or replace?** The three Brazilian CBDC templates are intended to be short- to medium-term supplements to the existing stock of coins and banknotes. In the long-term they are likely to replace cash.¹² Given that CBDC could eventually replace cash, it is necessary is to carefully weigh all the unique services that would be lost if coins and banknotes were to completely disappear. If society deems these services important, a CBDC should be designed so that it can recreate them.
- **No CBDC ceiling:** One option is to put a ceiling on the amount of CBDC that individuals can hold. This would limit flight out of bank accounts into CBDC and prevent significant illicit usage if the CBDC is anonymous. One problem with imposing a ceiling is that it fixes the supply of CBDC. If the public’s demand for CBDC is high relative to the fixed supply then it will trade at a premium to cash, the central bank effectively becoming an issuer of two non-fungible currencies (Mersch, 2017). The second problem is that assuming that the CBDC is pseudonymous or anonymous, there is no way to limit per-person holdings given that personhood cannot be established. To avoid the problem of lack of fungibility and evasion of caps, each of the three Brazilian CBDCs proposed in this paper comes without a ceiling, allowing for unlimited CBDC holdings and thus a flexible, rather than fixed, supply of currency.

¹²In places like Norway and Sweden, the displacement of cash is being driven by decisions made by individuals and businesses, many of whom prefer digital payments to cash. Although cash in circulation continues to grow in Brazil, in the long-term it may eventually follow the same path as Sweden and Norway. It is also possible that the process of de-cashification could be led by the central bank, say via a policy of high denomination banknote withdrawal followed by banning medium-denomination notes, as advocated by Rogoff (2016).

The following two sections outline the benefits and drawbacks that all three models share relative to cash.

6.2 Shared benefits

Cost savings

The current banknote system requires printing presses, ink, high security warehouses and depots, vaults, sorters, packaging, armoured vehicles, and more. These costs are borne by a combination of parties including: the BCB, more specifically the taxpayer; Brazilian commercial banks, which by virtue of their promise to convert between deposits and banknotes are large handlers of cash, these costs being passed on to their customers; and retailers who must store enough cash on premises to meet the demand for small change as well as absorbing the costs of shipping cash to the bank for deposit.

By cutting out most of this physical infrastructure and replacing it with an instantaneous electronic rail, a digital or dematerialized replica of the banknote system would provide society with the same set of services as the existing physical banknote system while requiring far less resources to operate, the resulting cost savings flowing through to Brazilian taxpayers, shoppers, and bank customers.

Reduces the likelihood of physical bank runs

Some commentators worry that in a world with CBDC, the speed at which depositors could drain their accounts dramatically increases, and this boosts the odds of bank runs.¹³ Somewhat mitigating this concern is the fact that small Brazilian depositors are currently protected by a private sector-led deposit guarantee fund (Fundo Garantidor de Créditos), and are thus unlikely to run on banks during crisis. Furthermore, corporations and other large actors have always had the option of instigating a rapid “digital bank run” into short-term government debt during times of stress. So introducing a CBDC in the place of banknotes does little to change the already-available set of options available to economic actors during a crisis.

The speed at which CBDC can be transferred relative to banknotes may even be a point in favor of a CBDC-based system. Banks that are facing panicked depositors who want cash must request new banknotes from the central bank, requiring physical transportation. Until these notes arrive, a highly visible lineup will grow in front of the bank, exacerbating the original panic. With CBDC, requests from a commercial bank to the central bank for a top-up of digital currency would be filled in just a few seconds. With no lineups, the viral nature of the panic is reduced (Koning, 2018).

Promotes financial inclusion

In both developed and undeveloped countries, many people choose to avoid frequenting banks or are prevented from opening bank accounts, say because of stringent identity requirements. They are thus cut off from anything other than face-to-face payments with banknotes and coins. A digital government-provided currency could be designed as a means for reaching out to the roughly 30% of Brazilians who currently do not have a bank account and rely on cash.

Facilitates digital P2P payments

Brazilians already have many options for making digital retail and bill payments. Those who have access to the banking system can make purchases using payment cards or settle bills using direct debit. Boletos de pagamento can be used by unbanked Brazilians for making digital payments to businesses and governments. As for direct person-to-person payments, Brazilians with bank accounts can use credit transfer systems DOC and TED. However, payments can only be made during bank operating hours, and not at nights or on the weekends. Both payment types are generally priced at around BRL 15 (\$US4).

This leaves a gap. Brazilians, both the unbanked and banked, do not have a 24/7 means for making cheap, quick, low-value person-to-person digital payments. A CBDC could fill this gap.

¹³This view is best exemplified by the Bank of England governor Mark Carney (2018): “. . . a general purpose CBDC could mean a much greater role for central banks in the financial system. Central banks may find themselves disintermediating commercial banks in normal times and running the risk of destabilizing flights to quality in times of stress.”

6.3 Shared drawbacks

Financial disintermediation

If depositors prefer holding CBDC to deposits, then the BCB will disintermediate banks, this in turn impinging on the ability of Brazilian commercial banks to make loans. Some types of CBDC would be more prone to this problem than others.

Potential competition with the private sector

Even if there is significant unmet demand for services such as online anonymity, it is not necessarily the case that the central bank should provide these services. In North America, privately-provided prepaid debit and credit cards are capable of fulfilling the demand for anonymous online purchases. Likewise, in Brazil the boletos de pagamento system provides a digital and anonymous payments option. Rather than directly competing with these private sector initiatives, perhaps central banks should step back and play a regulatory role instead.¹⁴

In some cases there may be a barrier to entry that prevents the private sector from providing certain payments services. But as Fung and Halaburda (2016) point out, it might be better that the government removes that barrier rather than imposing a CBDC on the market place.

As for the argument that a CBDC promotes financial access, the case of Kenya's M-Pesa payments network shows that it is possible for the private sector to make large inroads into reaching those without bank accounts. In the U.S., prepaid debit and credit cards have become a relatively popular means for those without bank accounts to make digital payments. In Canada, traditional banks have achieved a bank penetration of 99%. Issuing a CBDC in order to promote financial inclusion may impede these private efforts.¹⁵

7 Three distinct models for a CBDC in Brazil

7.1 MoedaElectronico

Of the three templates for CBDC, MoedaElectronico is designed to be the most cash-like. MoedaElectronico tokens are bearer instruments. They exist as independent digital tokens on an individual's device rather than as a book entry in a central bank-managed database. Instead of requiring a call to the central bank to expedite a transaction, transactions occur bilaterally between devices. Like banknotes, MoedaElectronico tokens are designed with an inflexible 0% interest rate.

Anyone can begin to accumulate MoedaElectronico without having to go through a pre-approval process. Similar to banknote payments, transfers of MoedaElectronico are non-trackable. Just as any deposit of banknotes into the Brazilian banking system in excess of 10,000 reais must be reported for anti-money laundering purposes, there would be an equivalent ceiling placed on the amount of MoedaElectronico that could be deposited into the banking system without being flagged.

Advantages of MoedaElectronico

1. Lower odds of disintermediation relative to other CBDC types

The likelihood of mass adoption and the ensuing disintermediation of banks depends the degree to which CBDC and bank accounts are natural substitutes for each other. If a CBDC is designed to be a digital replica of a banknote, then it is not necessarily the case that people who already prefer bank-provided accounts to cash will suddenly prefer a digital version of cash.

¹⁴For example Charles Kahn (2018) writes: "As they try to get out of the paper money business, I think the future of central banks and payments authorities is no longer in privacy provision but in privacy regulation, in holding the ring as different payments platforms offer solutions appropriate to different niches with different mixes of expenses and safety, and with attention to different parts of the public's demand for privacy."

¹⁵These concerns are somewhat diminished given that a CBDC could allow the private sector to build a competitive marketplace of new CBDC-related services, like wallets and applications.

The Banco Central do Brasil's target for the SELIC overnight interest rate is currently at 6.5% in September 2018. Commercial banks have a legal obligation to pay a SELIC-linked rate on savings accounts (conta poupança). This currently works out to around 6% per annum on savings accounts.¹⁶ Chequing deposits (conta corrente) receive close to 0%. Brazilian banks provide account holders with functionality that automatically moves funds from savings accounts to chequing accounts in the event that an electronic payment is made, cash is withdrawn, or a cheque cashed. This ensures that an account holder can always hold the maximum amount of funds in the interest-yielding portion of their account.

From the perspective of a consumer who is seeking a safe and relatively liquid store of value, MoedaElectronico is inferior to a Brazilian deposit since shifting out of deposits into a CBDC entails losing out on the current 6% yield. The only type of customer that is likely to migrate out of the banking system to MoedaElectronico and incur its lack of interest are those who have been using bank-mediated systems to digitally store value or make payments that they would otherwise have preferred to do anonymously. But this is not likely to be a large group. Thus, MoedaElectronico is unlikely to cause significant shift out of Brazilian bank deposits.

2. Preserves and enlarges Brazil's anonymous safe zone

In Brazil, cash is currently the only way to access financial anonymity. Censorship resistance proceeds from anonymity, since a payments system that is incapable of tracking its users cannot ostracize them. If cash is due to be retired in the long-term, MoedaElectronico has the advantage of preserving anonymity and censorship resistance.

Fung and Halabarda (2016) point out that transactions may be foregone when none of the existing payment systems provide for anonymous online trade. Similarly, it could be that a large number of transactions are currently being made in Brazil using payments systems that fail to provide preferred levels of privacy, consumers settling for the next best solution rather than the best one. A CBDC like MoedaElectronico that provides some degree of anonymity would improve the welfare of anonymity-seeking Brazilians who either avoid online transactions or grudgingly making second-best payments.

3. Precludes dollarization and a criminalization of Brazil's underground payments system

By eventually replacing cash with an equally anonymous payments option, the development of an underground monetary system run by criminal organizations and the violence that might accompany this system is precluded. It also wards off potential dollarization. Should Brazilian paper currency be replaced with a non-anonymous CBDC, the underground economy may resort to U.S. dollars. This dollarization might spread into the formal economy, leading to a loss of the BCB's monetary sovereignty. An anonymous Brazilian CBDC would preclude a backdoor dollarization of Brazil.

4. Lower operating costs than account-based CBDC

Account-based CBDC like ContaBCB, will likely have to meet the same know-your-customer (KYC) requirements as private banks. The BCB would either have to take on the task of verifying millions of potential customers, or contract with private Brazilian banks to verify CBDC users. Banknotes, on the other hand, are exempt from KYC requirements. A digital form of cash like MoedaElectronico would presumably enjoy the same exemption as banknotes. If so, by adopting MoedaElectronico the BCB would be able to avoid the expense of establishing costly procedures for verifying CBDC users.

5. Fewer central points of failure than account-based CBDC

The banknote system is a highly robust payments system. If the BCB is temporarily disabled, decentralized exchanges of Brazilian banknotes can continue unimpeded. A digital currency that is hosted on a central server lacks this robustness. When the server encounters difficulties, the payments system will experience crippling down-time. Since MoedaElectronico does not require an ongoing connection to a central server, it mimics cash's robustness.

6. BCB financial strength and independence are maintained

¹⁶Banks are required to pay interest on savings accounts using a formula that is linked to the SELIC rate. For the formula, visit <http://www4.bcb.gov.br/pec/poupanca/poupanca.asp>

Seigniorage is the difference between the costs of issuing banknotes and the revenues on assets held by the BCB. Because the BCB currently pays a 0% interest rate to the owner of a banknote but earns a SELIC-linked return on the asset backing that note, the BCB's seigniorage on any given note issue is significant. This per-note seigniorage rate is multiplied across the entire base of note-using Brazilians to get the BCB's total seigniorage. This base of note users is a large one because banknotes are popular as both a licit and illicit means of exchange and store of value.

Should it replace banknotes, MoedaElectronico will adopt the 0% interest rate, which means that each unit of central bank money will continue to throw off as much seigniorage income as before. The base of licit users might shrink as habitual users of banknotes migrate towards bank deposits rather than a less familiar technology such as MoedaElectronico. However, because MoedaElectronicos are anonymous whereas bank accounts are not, it is likely that the entire base of illicit users of banknotes will migrate to a new anonymous payments technology. This means that the BCB will probably preserve a large proportion of its seigniorage-generating capabilities as it moves from banknotes to MoedaElectronicos.

A central bank's ability to conduct independent monetary policy is often linked to its financial strength. Banknote related revenues afford the central bank the ability to easily cover salaries and other operating expenses, leaving plenty of room for the central bank to pursue its monetary policy goals without having to rely on the executive branch providing financial aid. Since a MoedaElectronico system maintains the same seigniorage-generating capacity as a traditional banknote system, presumably BCB independence will not be reduced.

Disadvantages of MoedaElectronico

1. Uncapped usage by criminals and tax evaders

Since the highest denomination note in Brazil is the R\$100, it is burdensome to store and handle large quantities of R\$100s. These costs impose a soft cap on cash holdings by Brazilians. Because its digital nature reduces storage and handling costs, MoedaElectronico makes it easier and cheaper for Brazilians to engage in anti-social behavior such as crime and tax evasion.

2. Direct competition with boletos de pagamento and other payments methods

Because MoedaElectronico does not pay interest, Brazilians are unlikely to prefer it to bank-provided deposits as a store of value (see advantage 1 above), and so there is unlikely to be a large shift out of savings deposits into CBDC. However, Brazilians may prefer it over a host of payments options. Both Brazilians with bank accounts and those without can make internet purchases by using boletos de pagamento. Other payments alternatives include credit cards, debit cards, TED, DOC, cheques, and direct debit. MoedaElectronico would directly compete with these options by offering a single alternative for making a variety of payments, including purchasing goods and services on and off the internet, making P2P payments, and settling bills.

To balance out the conveniences of using MoedaElectronico as a payments medium with the drawback that it does not pay interest, Brazilians may decide to keep just a small amount of CBDC in their possession. For instance, perhaps the average Brazilian holds just R\$40 (US\$10) in CBDC on hand, topping this amount up whenever the balance is spent down. This allocation to CBDC would come at the expense of a \$R40 reduction in the amounts they might otherwise allocate to transactional deposits or a reduction in the number of boletos de pagamento that they use. While this would not represent a large leakage from the banking sector, it would still hurt the profitability of banks, since banks earn a significant chunk of recurring revenues off of fees arising from payments.¹⁷

A reduction in payments-related profit flows to the banking sector might have knock-on effects for the Brazilian public further down the line. Banks might decide to make up for reduced payments income by increasing the costs of getting a loan. If it becomes harder for Brazilians to get a loan from a bank they may turn to non-banks, but non-banks may not be able to provide these services as

¹⁷ Assuming that the average Brazilian holds just R\$40 in CBDC, and a population of almost 200 million, then CBDC issuance will come to R\$8 billion or US\$2 billion. This is tiny relative to savings deposits of R\$744 billion (US\$190 billion).

efficiently as banks. Correspondents may be forced to close as payments-related business, especially bill payments, dries up.

3. The poor and unbanked are (still) subject to the inflation tax

The BCB currently targets inflation of 3% to 6%. Over the last ten years, inflation has been as high as 10.7% in 2015 to 2.95% in 2017, and currently lies near the low end of that range.¹⁸ This means that cash users face an implicit tax of around 4.5% or so per year.

Those who want some shelter from this tax can keep money balances in the form of interest-yielding bank deposits. But some 30% of Brazilians do not have a bank account, and thus bear the full brunt of the inflation tax, which amounts to a loss of purchasing power relative to banked Brazilians. Because poor Brazilians tend to depend more on cash than other demographic groups, the tax on cash is a highly regressive one, taking a larger percentage of income from low-income earners than from high-income earners.

A digital form of cash has the technical ability to pay interest to its owners, thus removing the tax. However, like physical cash, MoedaElectronico does not pay interest, so one regressive tax is replaced by another.

4. Fails to implement the Friedman rule

According to Friedman (1960), the lack of a pecuniary return on banknotes represents a significant cost to society. To avoid holding 0% notes overnight, merchants must incur so-called shoe leather costs as they race to their bank before closing time in order to make deposits, bankers in turn shipping the stuff as fast as they can to the central bank to swap for interest-yielding central bank balances. Lucas (2000) estimates the cost of this unproductive activity at around 1% of GDP. If the pecuniary return on government-issued retail money was improved by replacing non-interest yielding banknotes with interest-bearing CBDC, then inventories of retail central bank money would be less onerous and wasteful shoe-leather costs could be avoided. MoedaElectronico fails to implement the Friedman rule because it preserves paper money's 0% interest rate.

5. Potential for long-term disintermediation of banks

In the long-term, Brazil could eventually become a low-rate/low-inflation nation, like Europe, Japan, and the U.S. If so, SELIC-linked savings account rates will likely be much lower. At that point, MoedaElectronico would be much more competitive with Brazilian bank deposits as a store of value, and the migration of savers from the banking system to CBDC could become a problem.

6. Brazil's zero-lower bound still exists, impeding BCB monetary policy

With the SELIC overnight interest rate target is currently at 6.5%, the BCB is far from the zero-lower bound. However, it is conceivable that Brazilian nominal rates decline to much lower levels in the future. In this context, if the BCB tries leans against a crisis by driving rates into negative territory, a massive run into 0% cash would begin. After all, a 0% return is always better than a negative return. To prevent this run, the BCB might hold off from implementing the appropriate negative interest rate policy.

A CBDC that replicates the same interest rate features of cash maintains the 0% lower bound. In fact, it may even make the zero-lower bound more binding. Due to its physical nature cash has high storage costs. In Switzerland's case, for instance, the public has accepted interest rates as deeply negative as -0.75% without switching out of deposits into banknotes, the implication being that storage costs of Swiss banknotes must be at least 0.75%.

Whereas Switzerland's highest value note—the Sfr 1,000—is worth US\$1000, Brazil's highest value banknote is the 100 reais note, which is worth around US\$25. This means that the costs of storing Brazilian currency is likely to be much higher than storing Swiss currency, giving the BCB the ability to set an even deeper negative interest rate than the Swiss National Bank.

Because CBDC is digital, it does not incur storage costs. So in a world in which MoedaElectronico eventually replaces physical cash, the public will be much more trigger-happy when it comes to switching out of a negative-yielding deposit into central bank money. Put differently, Brazil's

¹⁸See "Inflation Targeting in Brazil" Available at: <http://www.bcb.gov.br/pec/metas/InflationTargetingTable.pdf>

effective lower bound would be higher than it is now if it issued MoedaElectronico in the place of cash, and thus BCB monetary policy would be more constrained.

7.2 ContaBCB

The BCB currently provides accounts to commercial banks. A ContaBCB system would extend this privilege to individuals, corporations, and other members of the Brazilian public. ContaBCB account holders could make instantaneous payments with each other with an app, or use an associated debit card to purchase goods and services in stores. There would be no costs to using this service.

ContaBCB accounts would not be capped and would bear competitive interest linked to the overnight SELIC rate. Balances would pay negative interest if the BCB guided SELIC into negative territory.

Brazilians would be required to provide identification in order to open an account. Movements of account balances would be traceable by the BCB. This means that ContaBCB cannot provide anonymity, although it can be designed to offer a degree of privacy. For instance, while user behaviour may not be cloaked from the operator of the system, the central bank, users may be able to retain their anonymity vis a vis the counterparty they are transacting with, say an online retailer.

Advantages of ContaBCB

1. Provides Brazilians with unlimited access to risk-free remunerative digital money

Brazilian banks have access to risk-free remunerative digital money, but Brazilian corporations and individuals do not. Those who want access to a risk-free interest-yielding money can hold government-insured private and public bank deposits, which are currently protected by the Fundo Garantidor de Credito, the national deposit insurance scheme, up to BRL 250,000 (US\$267,000). For those who have maxed out their insured deposit capacity, government-issued Financial Treasury Bills (LFT - Letra Financeira do Tesouro) and National Treasury Bills (LTN - Letra do Tesouro Nacional) provide a liquid risk-free short-term investment alternative. However, LFTs and LTNs cannot be used as a payments medium.

Brazilians can get additional access to risk-free payments media via banknotes, which do not face holding limits. MoedaElectronico, if it were introduced, would enable unlimited risk free balances. But neither banknotes nor MoedaElectronico pay interest. Furthermore, banknotes do not provide the opportunity for digital payments. Since the largest denomination is the 100 reais note (US\$25), users can expect to incur significant storage costs. Given these limits, ContaBCB provides individuals and corporations with a means for owning risk-free interest-yielding digital money balances above the deposit insurance ceiling.

Unlike MoedaElectronico, ContaBCB implements the Friedman rule. Banknotes and MoedaElectronico users are implicitly taxed because each instrument yields less than a risk-free bank deposit.¹⁹ To minimize this tax, individuals and businesses must constantly hold less than their preferred allocation to government-provided money. This effort incurs shoe leather costs as repeat trips to the bank must be made to deposit 0%-yielding currency. Implementing the Friedman rule involves a removal of this tax and associated shoe leather costs. The payment of interest on banknotes is one of the ways to achieve this. In the case of ContaBCB, this is achieved by paying a SELIC-linked rate on ContaBCB balances.

2. The ability to catch criminals and tax evaders leads to a “clean” payments system

¹⁹While it is difficult to design banknotes such that they yield positive interest, it isn't impossible. McCulloch (1986) and Goodhart (1986) independently arrived at a solution: introduce a periodic lottery based on note serial numbers. Kimball Agarwal (2015) have also proposed breaking the one-to-one peg between banknotes and central bank deposits and implementing the Friedman rule by having banknotes slowly rise in price. So while a CBDC can implement the Friedman rule, it certainly isn't the only technology that can do so; traditional banknotes can also implement it.

High denomination banknotes—typically a central bank’s chief revenue generating line of business—are often used as a paper trail cloaking tool for criminals and tax evaders. Unlike cash or MoedaElectronico, access to ContaBCB would require users to open an account prior to making payments. Because the account approval process would require the giving-up of personal information, payments would be linked with identities, the resulting paper trail making it easier for authorities to catch illicit users.²⁰ Rather than risk getting caught, criminals and tax evaders would turn to alternative payments systems. This cleansing of BCB-provided money would put the BCB on a morally higher ground than they are now and reduce potential political fallout from its involvement in servicing criminals.

3. Reduced reliance on deposit insurance means a decline in moral hazard

In Brazil, deposits issued by both private banks and publically-owned banks are insured up to a maximum of R\$250,000 per person. Since depositors know they will be bailed out in case of a bank failure, they needn’t monitor their investment. This removes some of the investor-imposed constraints that would otherwise govern bank lending behavior, and may lead to riskier investment decisions by lenders. These risky decisions ultimately manifest themselves in bank failures and costly tax-payer funded bailouts.

SELIC-linked ContaBCB accounts would serve as a direct competitor to bank deposits. As Brazilians migrate out of the banking system to ContaBCB, the quantity of deposits subject to deposit insurance would contract, thus reducing the amount of lending not subject to rigorous investor-imposed constraints. This might have the effect of reducing the occurrence of bailouts. MoedaElectronico, on the other hand, maintains the status quo. The 0% interest rate means that MoedaElectronico will not attract savings that is currently lodged in banks and subject to deposit insurance.

4. Help shelter the poor and unbanked from the inflation tax

Since the poor have a greater dependency on cash as a store of value and medium of exchange than the wealthy, that means they disproportionately bear cash’s low return. By moving unbanked Brazilians out of 0%-yielding cash into an equivalent government-provided product that earns the SELIC rate, the BCB can reduce the regressive inflation burden that the unbanked population must face. Because it continues to offer a 0% interest rate, MoedaElectronico maintains this burden.

5. Remove the zero-lower bound

Because cash pays a 0% interest rate, it is difficult for the BCB to set negative interest rates during a crisis. MoedaElectronico would preserve the zero-lower bound on Brazilian interest rates. Should ContaBCB be introduced as the eventual replacement for cash, the zero-lower bound would be dismantled. The interest rate on ContaBCB is a function of the BCB’s target for SELIC, the Brazilian overnight interest rate. As the BCB reduces its target for SELIC, the rate on ContaBCB falls automatically. Should the BCB require a negative SELIC rate, this will pass through to ContaBCB balances.

Disadvantages of ContaBCB

1. Higher resource costs than MoedaElectronico

One of the selling points of MoedaElectronico was its lower resource costs compared to cash. ContaBCB requires that each user go through a verification process, raising the costs and hassles of administering the system.

2. Central point of failure would reduce robustness

Whereas cash and MoedaElectronico are transferred bilaterally, all transactions using ContaBCB must be processed by a central server. When this server goes down, the entire payments system is unavailable. So the eventual replacement of cash with ContaBCB reduces the stability of the payments system.

3. Higher odds of bank disintermediation than MoedaElectronico

²⁰Even if ContaBCB allows for accounts to be opened under a pseudonym, it could still provide a degree of traceability. For instance, if the BCB were to provide law enforcement authorities with large amounts of pseudonymous payments data, the authorities might be able to reverse engineer the real identities of users.

MoedaElectronico yields 0% and is therefore uncompetitive with banking deposits given Brazil's current high nominal interest rates. As a government-issued monetary liability that pays competitive interest and is explicitly designed as a bank account, ContaBCB is much more likely to pull depositors away from private banks. In response, banks will be forced to rely on longer-term forms of financing, such as Financial Bills (LF - Letra Financeira), which have a minimum maturity of two years, and Bank Certificates of Deposits (CDBs – Certificados de Depósito Bancário). These forms of financing may be more costly to banks, leading them to reduce lending and/or raising lending rates.

4. In the long-term, sacrifices financial anonymity and censorship resistance

During ContaBCB's coexistence period with banknotes and coins, Brazilians will continue to have an anonymous payments option that is open to everyone. But once cash is demonetized, they will lose the ability to transact anonymously. Because new users must present themselves to the authorities to open a ContaBCB account, it becomes possible to censor certain types of Brazilians from the payments system. This would not be possible if a MoedaElectronico system were adopted.

Like other centralized systems, ContaBCB would be subject to attempts to hack the system for user information. With banknotes and MoedaElectronico, on the other hand, there is no way to retrieve data about its users. If ContaBCB is to replace cash, then Brazilians who are concerned about data breaches leading to the theft of personal information will no longer have a safe payments option.²¹

5. Criminals won't use it, leading to growth of an underground monetary system and dollarization

By continuing to offer a *verifiably* anonymous payments system like cash or MoedaElectronico, the government can keep organized crime out of the business of providing anonymous payments, and thus maintain the safety of society.²² However, if cash is phased out and replaced by ContaBCB, the incentive for an underground monetary system will emerge, one likely run by a Brazilian criminal organizations. The methods used by these criminal organizations to administer the underground monetary system could lead to growth in rates of violence and murder, which are already at a relatively high rate.²³ Alternatively, the U.S. dollar would be adopted as the criminal means of payment, leading to dollarization of large parts of Brazil's economy and a loss of monetary control by the BCB.

6. Criminals won't use it, leading to a collapse in seigniorage and reduced independence.

Low criminal uptake was listed earlier as an advantage of ContaBCB (advantage 2), since it put central bankers on a higher moral plane than in a world with cash or MoedaElectronico, and thus less susceptible to political attack. However, there is a negative side to the lack of criminal uptake. Central banks such as the BCB currently generate large amounts of seigniorage revenues from users of high denomination banknote. For each 100 reais bill in circulation, the BCB holds an asset that earns SELIC—currently at 6.5%—or higher. Since the BCB does not pay interest to the owner of the 100 reais note, it gets to keep all of the interest income for itself. This independent stream of income provides the BCB with leeway to pursue a non-political and technocratic monetary policy.

If the BCB puts an end to cash and introduces ContaBCB in its place, and criminals and tax evaders turn to alternative underground monetary and payments systems or to a dollar-based

²¹Kahn (2018) draws attention to the importance of an unhackable payments option: "In all financial infrastructure, the more direct concern, of course, is the possibility that through neglect or incompetence the operator might allow others to get at the payments information thereby providing fraudulent access to users' identities and to the deposits in their accounts. And with ready examples of breaches at all levels, the concern about this type of privacy is real."

²²If the system is not verifiably anonymous, criminals cannot be sure that the system does not enable tracking and will turn to underground alternatives or U.S. dollars. Cash is verifiably anonymous because anyone who holds it can be sure that there are no tracking technologies embedded in a note. Nor are serial numbers recorded at the point-of-sale. A digital system like Zcash is also verifiably honest since the code is open source and can be audited for back doors. ContaBCB could never be verifiably anonymous because it is not open source. A user cannot be sure that the central processor is not tracking transactions data. It might be possible to make MoedaElectronico verifiably anonymous by implementing it on a Zcash-style blockchain.

²³According to UNODC data, Brazil ranks twelfth in terms of homicides per 100,000 inhabitants in 2016, and leads the world in total homicides at 61 thousand.

system, then the BCB will lose a large chunk of its seigniorage-generating criminal clientele. This lack of criminal uptake and resulting plunge in BCB financial strength has the potential to increase the BCB's reliance on the executive branch of the government if it is to hit its inflation target.

7. Even licit use will hurt BCB seigniorage

The BCB currently pays no interest to its retail clientele because banknotes are a unique product on which the BCB has a monopoly. If it wants to get into the much more competitive business of providing accounts to Brazilians, the BCB will have to pay a competitive interest rate. But once the BCB starts to pay positive interest to its retail customers, its costs will rise dramatically—and its financial strength will be diminished.

8. Cannibalize private efforts to innovate and provide access to the unbanked

Financial technology companies, or fintechs, are actively trying to provide innovative upgrades to Brazil's payments system. If the BCB were to become active in providing not only a competitive store of value, but one that is highly liquid, fintechs may be less willing to compete.

Banks and traditional financial institutions are also making attempts to update their business models to better serve Brazilians. For instance, Brazil boasts a system of *correspondentes bancário*, or correspondent banking network, whereby large banks partner with non-bank businesses like retailers, pharmacies, and post offices to provide banking services. These correspondent agents offer Brazilians simplified access to the financial system in the form of payments, deposits, and withdrawals; flexible operating hours; easier receipts of social benefits; and reduced travel time for accessing banking services payments. Since enabling legislation was passed in the late 1990s and early 2000s, the system has provided many previously unbanked with banking services.

Bill payments make up a large portion of the business done by correspondents—if ContaBCB is introduced it could become a popular transactions medium, removing some of the underpinnings for the success of correspondent banking in reaching unbanked and underbanked populations.

7.3 MoedaHíbrida

MoedaHíbrida combines elements of MoedaElectronico and ContaBCB. Like cash and MoedaElectronico, MoedaHíbrida tokens are transferred bilaterally without requiring any sort of call to a central operator to validate the transaction.

MoedaHíbrida has two different modes. If the user decides to hold shielded MoedaHíbrida tokens, then all transactions made with those tokens are completely anonymous and untrackable. The user can decide to unshield his or her MoedaHíbrida tokens so that all transactions can be seen.²⁴Shielded MoedaHíbrida tokens will be subject to a negative interest rate of, say -5% per annum. Unshielded MoedaHíbrida tokens will receive a competitive SELIC-linked interest rate.²⁵

MoedaHíbrida tokens can be purchased at retailers, banks, and other participating agents without requiring an identity check, although a flag may be placed on any transaction involving the deposit (or withdrawal) of more than a fixed threshold of MoedaHíbrida tokens into (from) the banking system, similar to how cash transactions are currently treated.²⁶

²⁴An analogy can be made to the cryptocurrency Zcash. Zcash users have the option to use two kinds of addresses: transparent addresses and shielded addresses. When a transparent address is included as a sending or receiving address, the value transferred is publically recorded on the blockchain. An analysis of transaction patterns using transparent addresses may allow for the identities of Zcash users to be retrieved. Shielded addresses are not visible in the Zcash blockchain, so transfers are entirely private.

²⁵Penalized anonymity is not a new idea. Houldsworth (2013) proposed the Crime Pays System as an art project. Under this system, digital payments would be either “light” or “dark”. The default transaction type would be light, and free to the end users. With dark transactions, advanced cryptographic techniques would make the payment completely invisible, leaving no trace of the exchange. A small levy in the region of 10-20% would be paid per transaction. Benshalom (2012) suggests that the costs that anonymous transactions impose on society be internalized through a tax imposed on cash withdrawals from financial service institutions. There would be no tax on using or depositing cash.

²⁶In Brazil, banks are required to file suspicious transactions reports (STRs) and currency transaction reports (CTRs) with the Council for Financial Activities Control (COAF) for all transactions in excess of BRL 100,000. Additionally, where there is a suspicion of money laundering and the amount involved is less than BRL 100 000 such transactions must be reported to COAF.

Advantages of MoedaHíbrida

Many of the advantages of MoedaHíbrida map to advantages of MoedaElectronico or ContaBCB so they will not be repeated.

| | |
|--|--|
| 1. Preserves and enlarges society's anonymous safe zone | <i>See advantage 2 in the MoedaElectronico section</i> |
| 2. Precludes dollarization and a criminalization of Brazil's underground payments system | <i>See advantage 3 in the MoedaElectronico section</i> |
| 3. Fewer central points of failure than ContaBCB | <i>See advantage 5 in the MoedaElectronico section</i> |
| 4. Unshielded coins provide the non-criminal population with the opportunity to hold remunerative risk-free money | <i>See advantage 1 and 4 in the ContaBCB section</i> |
| 5. BCB financial strength and independence are maintained | <i>See advantage 6 in the MoedaElectronico section</i> |
| 6. Removes the zero-lower bound | <i>See advantage 5 in the ContaBCB section</i> |
| 7. Lower operating costs than account-based CBDC | <i>See advantage 4 in the MoedaElectronico section</i> |
| 8. Reduced reliance on deposit insurance means a decline in moral hazard | <i>See advantage 3 in the ContaBCB section</i> |

Advantage 5 (BCB financial strength and independence are maintained) deserves some fleshing out. A MoedaHíbrida system would levy a negative nominal interest rate on shielded coin users, say -5%. Assuming that the demand for anonymous payments is relatively inelastic, a MoedaHíbrida system could extract even more revenue off of criminals than banknotes which, due to their fixed 0% rate, are a relatively inflexible means for taxing criminals. The stream of income from illicit shielded usage of MoedaHíbridas would help fund the positive interest rate that the BCB pays to unshielded MoedaHíbrida holders. This would leave the BCB with enough financial strength to cover its remaining operating costs and hit its inflation targets.

The distinct advantage of MoedaHíbrida is the following:

9. Anonymous usage of the payments systems is targeted with a corrective tax

Unlike MoedaElectronico, MoedaHíbrida does not provide anonymity free of charge. The interest rate on shielded MoedaHíbrida tokens can be permanently targeted at some negative interest rate to capture a recurring flow of revenues from owners who desire shielding. These revenues will compensate society for the costs of dealing with illicit usage of shielded MoedaHíbrida tokens, including law enforcement and lost tax revenues. By internalizing the cost of cash-based evading taxes, it is possible that tax evasion will be reduced.

Disadvantages of MoedaHíbrida

| | |
|--|---|
| 1. Interest on unshielded MoedaHíbrida tokens means higher odds of bank disintermediation than MoedaElectronico | <i>See disadvantage 3 from the ContaBCB section</i> |
| 2. Cannibalize private efforts to innovate and provide access to the unbanked | <i>See disadvantage 8 in ContaBCB section</i> |

The distinct disadvantages of MoedaHíbrida are the following:

3. Criminal and licit users of anonymity are placed in the same basket

By placing a negative interest rate on shielded MoedaHíbrida balances, the BCB will be taxing both licit and illicit users of anonymous payments. Since the tax is designed to internalize some of the costs of criminality and tax evasion, it hardly seems fair to include licit users of shielded

MoedaHíbrida tokens—who are not engaged in tax evasion or crime—in this dragnet. Including both users in the same bucket could have the effect of subtly ostracizing licit usage of shielded coins.

4. Potential to hurt the central bank’s reputation and attract political flak

High denomination banknotes are a major facilitator of criminal transactions and tax evasion. Serving criminals has been a role that central banks like the BCB have unwittingly come to play over time rather than one that they have officially adopted. A central banker can easily wave away concerns about criminal usage as an accidental byproduct of its historically main function; providing notes to meet society’s legitimate demand for a difficult-to-counterfeit circulating medium.

By issuing a novel shielded digital currency and charging for this service, a central bank is tacitly acknowledging its heretofore unofficial role in serving a criminal clientele. Having made this role official, the central bank will open itself up to political attacks that it is complicit in aiding criminals. Even though the underlying logic of taxing a bad rather than banning it is a sound one, this puts the central bank into the same moral battleground as a government that has decided to provide drug users with free needles and heroin. Central bankers would have to be willing to wage an ethical war with social conservatives, one that might take up a large amount of their time and resources.

8 Conclusion

While the issues involved in introducing a Brazilian CBDC are complex, the thorniest issue of them all is anonymity. Like banknotes, an anonymous Brazilian CBDC would attract criminals and tax evaders. Paper money is an old technology that was introduced to Brazil in the 1700s, long before concerns about money laundering, income tax evasion, and drug smuggling had emerged. Anonymity was incidental to the role that banknotes played as a convenient payments medium. In some sense, the production of banknotes has been grandfathered into the system—it would be hard to imagine them being introduced today from scratch. But as Bech and Garratt (2017) point out, in the case of CBDC, the provision of anonymity (or not) becomes a “conscious decision,” and this complicates matters.

One route is to avoid the introduction of a product that attracts usage by anonymity-seeking criminals and tax evaders. Like all central banks, the BCB has a reputation to uphold. Nor are central bankers accustomed to entering into controversial philosophical debates over anonymity or any other topic. However, if the BCB chooses to introduce a non-anonymous CBDC while eventually removing cash, it will have to deal with the consequences of Brazil’s informal economy adopting an alternative to BCB-provided money, whether this alternative come in the form of an influx of U.S. dollar banknotes or an underground payments system run by Brazilian criminal networks. In the case of the former, the BCB might lose some of its ability to run independent monetary policy; in the latter, it is likely that Brazil—already suffering from significant amounts of violent crime—would experience even more violence.

The informal economy’s shift to a non-BCB provided payments alternative might occur even if the BCB intends to issue non-anonymous CBDC while also committing to permanently provide cash. Like people who participate in the formal economy, people in the informal economy have a demand for digital forms of payments. This demand may eventually drive the emergence of an underground digital alternative to cash that offers anonymity, perhaps a cryptocurrency like bitcoin. Like many other central banks, the BCB will have to decide if it is content to potentially cede the illicit digital payments space to an underground alternative by issuing non-anonymous CBDC, or if it wants to occupy that space by issuing anonymous CBDC and, perhaps, strategically targeting users with an appropriately sized tax.

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Table 1: Map of the Characteristics of the Three Types of Brazilian CBDC

| | MoedaElectronico | ContaBCB | MoedaHíbrida |
|---|--|--|--|
| Ability to disinter-mediate banks | High. Designed as a bank account and pays competitive interest rates. However, this also means lower reliance on deposit insurance | Minimal. Lack of interest will attract a different user than those who use bank deposits | High. SELIC-linked interest rate on unshielded coins would be as remunerative as a savings deposit. Reliance on deposit insurance would be reduced |
| Existence of a central point of failure | Transactions must be processed through a central server, reducing stability of payment systems | Does not require a central server, mimicking cash's robustness | Does not require a central server |
| Anonymity and censorship resistance | Payments are linked with real-world identities | Preserves anonymity and censorship resistant | Preserves anonymity for a fee, taxing both licit and illicit users at the same rate |
| Removes the zero-lower bound on interest rates | Yes | No | Yes |
| Operating costs | Higher administrative expenses to meet KYC requirements and interest payments. | No additional operating expenses as it is exempt from KYC requirements and does not pay interest | No additional KYC operating expenses, negative interest rate on shielded coins offsets interest costs on unshielded coins |
| Criminal usage | Unlikely to attract significant usage due to lack of anonymity. May incentivize growth of informal monetary systems | Anonymity and low storage and handling costs will promote use by criminals and tax evaders | Anonymity and low storage and handling costs will attract criminal users, but subjects them to a tax |
| Provides Brazilian corporations and individuals with unlimited access to interest-bearing risk-free money and shelters the unbanked from the inflation tax | Yes. Earns the SELIC rate so that unlike cash, users have no exposure to cash's low return and high inflation risk | No. With a 0% interest rate, cash's regressive inflation tax is maintained. | Yes. Consumers and businesses who value anonymity will not earn interest but those willing to forgo anonymity will earn a SELIC-linked return |
| Implements the Friedman rule | Yes | No | Yes, for unshielded coins. No, for shielded coins. |
| Preserves BCB seigniorage | No | Yes | Yes |



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