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CBDC:
Expanding Financial Inclusion *or Deepening the Divide?*

Exploring Design Choices that Could Make a Difference

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CBDC: Expanding Financial Inclusion or Deepening the Divide?

In recent years, policymakers around the world have been exploring Central Bank Digital Currency (CBDC). CBDC has the opportunity to play an important role as a public good, serving the public interest both as a *public money* (with value maintained by the central bank) and as a *public money technology* (with core infrastructure also maintained by the central bank or another public entity). Retail CBDC is the only digital, user-accessible money form that is a liability of the central bank. Because of these unique attributes, some commentators have suggested retail CBDC has the potential to expand financial inclusion.

However, few if any proponents have offered practical insight into how CBDC will promote greater access to financial services, especially amongst the unbanked or underserved. Assertions that CBDC could strengthen inclusion are difficult to prove because CBDC is not a specific payments instrument with common attributes across countries but rather reflects a broad range of instruments that could differ significantly in features and functions based on policy choices and the market environment in which it is issued. Moreover, we cannot answer whether a central bank should issue CBDC as a means of promoting financial inclusion until we consider carefully how the design of a retail CBDC will derive value from these attributes that could make it more accessible to all.

Consequently, this paper will not focus on whether a central bank should offer a CBDC to improve access to financial services but rather how a CBDC could be designed to support that same policy goal. After we understand the design and policy options, we will be better equipped to investigate the costs and benefits associated with those features of a CBDC and determine whether it makes economic sense for a central bank to issue CBDC as a means of promoting inclusion and what preconditions may be necessary for success.

In this paper, we ask what are the features of currency technologies, the aspects of peoples' lives, and the intersections of the two that CBDC designers need to understand most in order to create a digital currency that expands financial inclusion and operates in the public interest, rather than one that exacerbates or even creates a new digital divide for currency?

We approach this question differently from most existing literature on CBDC by focusing on users, especially society's most vulnerable, and investigating the problems that arise when using existing digital payment systems, such as mobile money, e-money, cards, and apps. We also consider users' experiences with cash, a type of non-intermediated

money that is perhaps the most inclusive payment instrument available today, in order to examine the differences between the two forms.

This project is an interdisciplinary effort with a three-pronged, iterative methodology, consisting of *design research* to identify the important open technical design choices and ways forward for CBDC; *infrastructure research* on existing money technologies to understand the broader public–private dynamics in which CBDC financial inclusion issues are centered; and *fieldwork* conducted with teams of research partners to understand the financial experiences of people in four low- and middle-income countries (India, Indonesia, Nigeria, and Mexico) to understand the ways existing money technologies are failing them or helping them flourish. To test initial findings and seek advice on avenues to pursue, we hosted three roundtable events throughout the course of this 15-month long project with a wide variety of stakeholders, including central bankers, regulators, global standards-setting bodies, international development organizations, technologists, academics, and consumer advocates.

To structure our analysis, we identified five differences in affordances between intermediated and non-intermediated currency. Affordances refer to what a user can do with a technology and the kinds of activity that object or platform enables and constrains.

Crucially, we argue, any digital currency is only as good for inclusion as the intermediaries through which people use it. Designing a CBDC that merely replicates the features of existing digital payment systems would not make a meaningful difference for financial inclusion.

Currency Affordances: Insights from User Research

In the following section, we identify key differences in affordances between cash—which is not intermediated—and existing digital money technologies such as bank deposits, e-money, faster payments, and cards, which are. We touch on some of the findings from our fieldwork that illustrate how these affordance differences impact financial inclusion and user well-being. We also raise some design considerations for CBDC. Much more detail on each of these affordances, including narratives from our fieldwork and technical implications for CBDC design, can be found in our full report.

Custody: Today's monetary landscape requires users to either custody funds themselves (in the form of cash) or deposit funds with an intermediary. Depositing funds with a custodial intermediary is typically viewed as more secure than holding cash and it enables funds to be transmitted electronically. However this also requires trusting intermediaries that, as our fieldwork demonstrates, may be plagued with problems. As a result, people default to cash. Especially for those who have very little money, cash affords much-needed control and certainty. CBDC designers should consider how to preserve the benefits of self-custody, which, for state-issued currency, is currently impossible in the digital realm. They can consider a wider range of custody designs opened up by new possibilities with digital currency technology.

Access: Cash transactions can be conducted by anyone via the mere physical exchange of currency, whereas making payments digitally today depends on external infrastructures and on intermediaries for access, including authentication and authorization. Digital funds are less accessible and thus less inclusive than cash. Identification remains a problem for many, and those without ID typically rely on informal solutions, which may entail exploitative social dynamics. In some countries, consumers who lack the full suite of identity documentation to open a traditional bank account may instead open a low volume, low transaction value account under regulations that permit simplified customer due diligence (sometimes called "tiered KYC") and require little identity documentation. But these accounts can be limited in how well they meet user needs due to restrictions on the value or volume of payments they can make. New digital identity programs may help, but consent and privacy need careful consideration. Reliable communications infrastructure remains a problem, so capability for offline transactions should be a priority.

Finality: Cash transactions settle instantly, but digital transactions entail processes of authentication, authorization, and settlement. There are many opportunities for things to go wrong. Errors and delays—and not being able to control or anticipate them—disproportionately affect those whose financial well-being is already precarious. A CBDC that makes funds available for reuse immediately would offer an advantage to users, but achieving finality at scale requires high-performance and fault-tolerant systems. Reversibility is also an important consideration. For those living in extreme poverty, success or failure in reversing payment can be the difference between eating and going hungry. Designing the process of dispute arbitration is an important challenge for CBDC design.

Data: Cash transactions typically do not produce data trails, whereas digital transactions do. Data leaks can have serious consequences, particularly for the most vulnerable. Increased datafication of users' routines and behaviors is a lucrative enterprise but puts users at risk of exploitation—including furthering indebtedness through behavioral micro-targeting—often without their consent. Encumbering CBDC with restrictions on how it may be spent may reduce users' control over their own money, particularly those who receive government benefits. Data-sharing can also have significant benefits to both system operators and users, such as better traceability and leveraging data to gain access to more services. Striking a balance between risks and rewards of data usage is critical to the design of CBDC. Smart decisions about privacy can yield many benefits, including building public trust and avoiding centralization of data vulnerable to attacks.

Distance: Cash transactions typically cannot be transmitted over distance, whereas digital transactions can, including remittances. Remittances are an important use case for CBDC. All of the problems that people encounter in other payment domains—such as lack of identification, connectivity issues, fees, settlement time, lack of recourse when things go wrong, and lack of privacy—are present and exacerbated in the context of remittances. There are several architectural options presently being considered for

cross-border CBDC, which might or might not address a subset of these issues. More research needs to be done to understand how these options impact user experience.

Looking Ahead

The question of trust is at the core of the decisions people make about their money, and will likewise be a key factor in any successful CBDC. We argue that in order for a CBDC to be *trusted*, it must first be *trustworthy*. Especially considering the rise of authoritarian regimes around the world, the acceleration of the surveillance state, and the increasing challenge of regulating the technology industry, it is far from self-evident that citizens *should* trust a CBDC. In order to be trustworthy for all, CBDC must be trustworthy to the most vulnerable.

Stakeholders should look for answers to address these concerns across the affordances of currency we identified. In our fieldwork, we have surfaced some ways that existing intermediated money forms are failing these tests. CBDC represents an opportunity to rethink the existing intermediary ecosystem. But doing so also comes with its own risks: if not designed well, it may offer no improvement on today's digital divides in financial services and could even make things much worse for users.

More research will be required to better understand user practices and possible ways forward for CBDC design. Throughout the course of our research, we have identified a range of issues that warrant deeper exploration:

- Evaluation research of the successes and shortcomings of the public adoption of existing CBDCs
- Systems design research on the technical trade-offs of key CBDC design decisions, such as transaction speed with reversibility and programmability, and offline access with security
- Privacy research on management of user data, with the goal of striking a safe and effective balance between operational issues, security concerns, and data ethics
- Research from a technical perspective about how specific innovations from decentralized cryptocurrency intermediaries might be deployed in relation to a CBDC
- Policy research on the role(s) of public, private, and civil society entities in the CBDC ecosystem, operations, and governance
- User experience research on cross-border CBDC payments—an important use case that is fraught with problems for the most vulnerable
- Public opinion research on trust, misinformation, and communication related to CBDC considering levels of distrust worldwide in existing institutions

Introduction

In recent years, policymakers around the world have been exploring Central Bank Digital Currency (CBDC). Retail CBDC is the only digital and user-accessible money form that is a liability of the central bank. It has the opportunity to play an important role as a public good, serving the public interest both as a *public money* (with value maintained by the central bank) and as a *public money technology* (with core infrastructure also maintained by the central bank or another public entity). Because of these unique attributes, others have suggested that retail CBDC has unique potential to expand financial inclusion. But this is untested, and it is not yet clear *if*—and, importantly, *how*—CBDC might fulfill its assumed potential.

Many of today's payment options, such as mobile money, were—like CBDC today—once promoted with the explicit promise of promoting financial inclusion. There have been some notable successes, such as M-Pesa in Kenya (see Suri & Jack, 2016), but it is clear that financial inclusion remains a problem. Accordingly, we ask: how might CBDC improve upon existing money technologies to better promote financial inclusion and serve the public interest?

> "Designing a CBDC that replicates the features of existing systems would not make a meaningful difference for financial inclusion."

What are the features of currency technologies, the aspects of peoples' lives, and the intersections of the two that CBDC designers need to understand most in order to create a digital currency that expands financial inclusion and operates in the public interest, rather than one that exacerbates or even creates a new digital divide for currency?

We argue that the design of a retail CBDC must be carefully considered in order to derive any value from these attributes. Designing a CBDC that replicates the features of existing systems would not make a meaningful difference for financial inclusion.

Crucially, we argue, any digital currency is only as good for inclusion as the interfaces through which people use it. An illustrative example—which we explore further in our fieldwork section—is privacy. A CBDC might employ privacy-protecting features. However, if everyone accessing that CBDC is required to do so through an intermediary that collects data, then the overall system cannot promise privacy, even if the underlying system does.

Therefore, in order to understand inclusion via digital currency, we have to understand how the infrastructures behind that currency are provided. As we explain, all digital money forms are in some way *mediated*—they rely on external infrastructure maintained by one or more system operators. In addition, most digital money forms are also *intermediated* in that they require an intermediary like a financial institution to access and use. Note that while "intermediation" has many meanings depending on context, we use it to refer to the work of organizations like banks, payment service providers, and platforms that conduct payments and other services on behalf of users.

This report focuses on intermediation and how it might affect the potential for CBDC to advance financial inclusion. We approach this question by investigating the problems that arise when using existing intermediated monies, such as mobile money, e-money, cards, and apps. We also consider users' experiences with cash, a type of non-intermediated money, in order to examine the differences between the two forms. To structure our analysis, we identified five differences in affordances between intermediated and non-intermediated currency. *Affordances* refers to what a user can do with a technology and the kinds of activity that object enables and constrains (Norman, 1988).

Understanding intermediation, and particularly the harms, frictions, and missed opportunities of existing privately-intermediated money, is also important because a consensus is currently emerging in favor of an "intermediated" model of a CBDC. This means that the central bank will issue and manage the currency and that an intermediary—typically a private financial institution—will provide all or most aspects of the customer interface.

It is not clear that the characteristics of intermediation in this model would differ significantly from existing systems. Policymakers are currently caught between two real but conflicting sets of motivations: on one hand, there is a need to be cautious and "do no harm." On the other, there is urgency to either modernize financial systems or face irreversible privatization of money itself—and therefore threats to monetary sovereignty. Under these conditions, it is easy to understand how policymakers might produce a CBDC that nominally replaces bank or e-money deposits, but does not innovate on the existing system in any meaningful way.

However, if we do not engage in more creative thinking about the new roles that intermediaries might inhabit, we could end up rebuilding the same system, to the same effect. Even worse, if we do not carefully consider the risks of designing new roles, we may actually end up building a system that is worse for financial inclusion and the public interest.

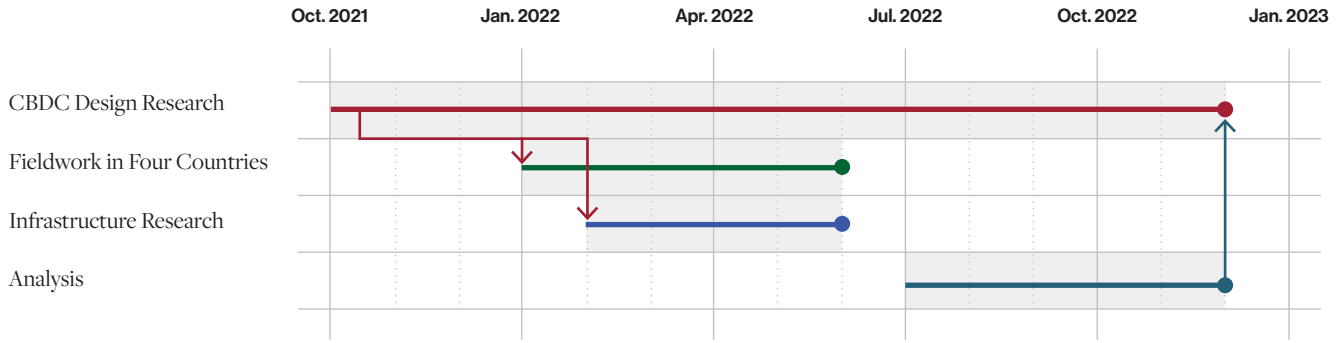
Our Project

This project is an interdisciplinary effort that brought together technological researchers who work on CBDC and cryptocurrency technology, socio-technical researchers who study money technology, and cultural researchers who study user practices and experiences. To take advantage of this opportunity, our methodology employed a three-pronged, iterative approach, consisting of:

1. Design research to identify the important open technical design choices and ways forward for CBDC;

2. Infrastructure research on existing money technologies to understand the broader public–private dynamics in which CBDC financial inclusion issues are centered; and

3. Fieldwork to understand the financial experiences of people in four low- and middle-income countries (India, Indonesia, Nigeria, and Mexico) to understand the ways existing money technologies are failing them or helping them flourish.



Graphic 1: Our Project Timeline and Overview

Fieldwork Partnerships

Mexico

Dr. Bernardo Batiz-Lazo
Northumbria University and
Ignacio González Correa
University of California, Davis

- Focus of study: remittance infrastructure between Mexico and the US
- Region: Mexico City
- Setting: urban
- Research methods: interviews, infrastructural analysis

Dr. Clément Crucifix
University of California, Irvine

- Focus of study: women, across age ranges and socioeconomic backgrounds, many of whom receive government transfers or remittances
- Region: Municipality of Hueytamalco, Northern Sierra of Puebla
- Setting: rural
- Research methods: interviews

Dr. Magdalena Villarreal
and **Ana Sofia Torres**
CIESAS Occidente

- Focus of study: families, workers in both the formal and informal economies, in Mexico/US border towns and center-of-the-country cities
- Region: Tijuana and Mexicali, Northern Mexico; Guadalajara and San Luis Soyatlán in Western Mexico
- Setting: urban, semi-urban
- Research methods: ethnographic observations, situational analysis, interviews

Indonesia

Kathleen Azali, Pradipa P. Rasidi
and **Maria Karienova**
Independent researchers

- Focus of study: activists, conventional taxi and rideshare drivers, and self-employed workers who navigate multiple e-commerce platforms
- Region: Greater Surabaya Area (East Java) and Jakarta
- Setting: urban
- Research methods: interviews, participant observation

Agus Indiyanto and team
Gadjah Mada University

- Focus of study: university students, office workers, civil servants, property businessmen, shop owners, homemakers, women with home-based businesses, farmers
- Region: Lampung, Temanggung (Middle Java), Jogjakarta, Kuningan (West Java), Samarinda (East Kalimantan)
- Setting: urban, semi-urban, and rural
- Research methods: interviews, survey, focus groups

Caroline Mangowal, Erlyn Shukmadewi, and **Amiril Zulhaj**
RISE Indonesia Research

- Focus of study: women entrepreneurs
- Region: Jakarta (Northwest Java)
- Setting: urban
- Research methods: interviews

Dr. Sunniva Sandbukt
IT-University of Copenhagen

- Focus of study: rideshare and delivery drivers and platform integrated digital wallets
- Region: Yogyakarta, south-central Java
- Setting: urban
- Research methods: interviews, ethnographic observation

India

Dr. Debashis Acharya and team
University of Hyderabad

- Focus of study: small business owners, self-employed workers, and university students
- Region: Greater Hyderabad, Muskanipet and Vallampatla (Siddipet District), Pochampally weavers village (Telangana state)
- Setting: urban, semi-urban, rural
- Research methods: interviews, ethnographic observation

Simiran Lalvani
University of Oxford

- Focus of study: food hawkers, home chefs, and app-based food delivery couriers
- Region: Mumbai, Maharashtra
- Setting: urban
- Research methods: interviews

Dr. Nima Yolmo
University of South Carolina

- Focus of study: working-class women managing households and small enterprises
- Region: Darjeeling, West Bengal
- Setting: semi-urban, rural
- Research methods: interviews

Nigeria

Dr. Betty Ackah
Simon Fraser University

- Focus of study: students, working professionals, and traders
- Region: various regions across Nigeria
- Setting: urban, semi-urban
- Research methods: interviews

Dr. Oludayo Tade and
Dr. Oluwatosin Adeniyi
University of Ibadan

- Focus of study: cash-dependent users (traders, musicians, elderly), and digital-dependent users (e-commerce traders)
- Region: South West region
- Setting: urban
- Research methods: expert interviews, user interviews

Dr. Olayinka David-West and
Immanuel Ovemeso Umukoro
Lagos Business School, Pan-Atlantic University

- Focus of study: understanding the demand and supply sides of the eNaira
- Region: primarily Lagos, collected data from 6 geopolitical zones
- Setting: urban
- Research methods: expert interviews, user interviews, focus groups

Context: What Is Central Bank Digital Currency?

A recent Bank for International Settlements (BIS) report revealed that around 90% of central banks are actively engaging in some form of research or work on CBDC (BIS, 2022). According to the Atlantic Council's CBDC tracker (2022), four CBDC projects have been launched (Nigeria, Jamaica, the Bahamas, and the countries of the Eastern Caribbean), 15 others are being piloted, 26 are in development, and 46 are in a research stage. These early projects and pilots still represent a nascent stage of development, and there remains much opportunity to determine CBDC goals, design, and operations.

This research primarily concerns what has been termed *retail* CBDC. Retail CBDC proposes to be a unique money form: it is different from commercial bank money, Fast Payment Systems (FPS), and e-money in that it is a liability of the central bank; it is different from cash in that it is entirely digital; and it is different from central bank reserves in that users, rather than institutions, can hold it directly. Retail CBDC is distinct from what is known as *wholesale* CBDC, which is a digital liability of the central bank that is limited to certain financial institutions and is not available to the general public.

The supply and value of CBDC would be maintained by the central bank according to policies geared to promote stability. This stands in contrast to private and/or decentralized digital currencies, which derive their value from the market; it also differs from stablecoins, whose value is determined by a variety of methods intended to reduce volatility.

Beyond these basics, definitions start to vary. Existing and proposed models for CBDC offer different visions for the architecture of the system, the role of the central bank, and the role of the accompanying intermediary ecosystem (see Allen et al., 2020 for a discussion of design choices). Some definitions of CBDC include a "synthetic" model, which enlists private actors (such as a stablecoin issuer) to issue and manage the currency. There is debate about whether such a synthetic CBDC even qualifies as a CBDC since it is neither issued by nor a liability of the central bank (as discussed in a joint report by a group of central banks, see Bank of Canada et al., 2020).

> "Retail CBDC and other money forms are not mutually exclusive and, if CBDC is implemented, will coexist."

Retail CBDC and other money forms are not mutually exclusive and, if CBDC is implemented, will coexist. Many experts therefore advocate a cash-complementary rather than cash-replacement strategy (Maurer et al., 2018; de Sardan & Piccoli, 2018). And though the introduction of CBDC will likely impact the market structure of consumer financial services, it is not intended to (and likely will not) replace existing private banks and other intermediaries.

Retail CBDC is also unlikely to supplant people's desire to hold and use cryptocurrencies. Cryptocurrencies are seen as a mechanism for investing in use cases enabled by and built on top of underlying blockchain networks. This makes them of interest to speculators, whereas CBDC would not suit these preferences.

Potential Risks and Benefits

Risks of retail CBDC include increasing surveillance, disrupting financial stability, and creating a central point of failure. They

	Cash	Central Bank Reserves	Commercial Bank Money	E-money	Cryptocurrency	CBDC
Accessible to retail users	✔	✘	✔	✔	✔	✔
Digitally stored and transferred	✘	✔	✔	✔	✔	✔
Liability of the central bank	✔	✔	✘	✘	✘	✔

Table 1: Currency Types

could also accelerate the decline in use of physical cash, which itself could result in harms such as decreased privacy, increased financial exclusion, and potential disruptions to transactions when infrastructure fails. (On risks and benefits of CBDC, see, for example, Adrian & Mancini-Griffoli, 2019; Auer et al., 2021; Disparate, 2022; Dombret & Wunsch, 2022.)

Widely touted potential benefits of CBDC include financial innovation through programmability, creation of free or low-cost rails for digital payments, faster and more targeted distribution, and privacy by design (PbD). CBDC is an opportunity to create a new structural design for digital public money, including new data models, interfaces, roles and incentives, and access mechanisms. For example, one technical goal of CBDC is programmability, which is the ability for users to write software instructions to determine how their money might move in the future. This could offer users some of the rich applications and features we currently see in cryptocurrency.

Context: CBDC and Financial Inclusion

Financial inclusion is commonly cited as a motivating force behind CBDC implementation. The World Bank defines financial inclusion as the effort to ensure that "individuals and businesses have access to useful and affordable financial products and services that meet their needs, delivered in a responsible and sustainable way" (World Bank, 2022a). Although CBDC is envisioned as a tool for promoting financial inclusion, more research needs to be done to understand whether—and how—it can actually do this. Our research is part of that effort.

Financial inclusion is typically measured in terms of access to, enrollment in, and usage of financial service accounts. By these metrics, it remains a problem in today's world: around 1.4 billion people, almost a quarter of the world's adult population, remain unbanked (Kanovitz, 2022; World Bank, 2021a).

According to some analyses, CBDC may promote financial inclusion by providing unbanked individuals with the ability to transact digitally (Allen et al., 2019; Barr et al., 2021; Board of Governors, 2022; Foster et al., 2021). It also may modernize financial infrastructure, serving as a springboard to quality digital financial services for countries without robust infrastructure (Adrian & Mancini-Griffoli, 2022; Auer et al., 2022b; Hartinger, 2022; Taylor & Broløs, 2022). Moreover, it may target areas that are particularly burdensome to economically marginalized people, like remittances and cross-border payments (Didenko & Buckley, 2021; Barr et al., 2020). As part of this modernization, CBDC could allow for the disbursal of government benefits in a direct, rapid, and transparent manner—a challenge that is even more vital in banking deserts and under emergency circumstances (Auer et al., 2022b; Allen et al., 2020).

Even so, claims that CBDC will promote financial inclusion often lack explicit details about how CBDC may advance financial inclusion, especially in comparison to existing options. We argue that in order for CBDC to rise to meet the challenges of financial inclusion, its design must be carefully examined from policy, technical, and social angles.

In addition, financial inclusion agendas have been widely critiqued. Critics argue that financial inclusion efforts serve to expand the market for private financial services more than they improve the lives of intended beneficiaries (Schwittay, 2011; Kar, 2018; Ozili, 2020; Donovan & Park, 2022; Krippner, 2011; Natile, 2020; Prabhakar, 2021). Vulnerable populations are also targets for "predatory inclusion," whereby they are subjected to exploitative terms that offset the benefits of inclusion (Taylor, 2019; Odinet, 2021; Seamster & Charron-Chénier, 2017). Furthermore, poor people are often the test cases for exploitative technological arrangements because they have the least capacity for meaningful protest (Eubanks, 2018; Cheesman, 2022c).

These concerns prompted us to center digital divides in our research. Traditionally, the digital divide for financial services has meant that some people are obliged to use cash while other people are able to choose among cash and a range of digital financial services. As more people have access to mobile phones, the digital divide has grown to encompass the features of those digital financial services rather than mere access to them.

Despite their potential for positive impact, new financial technologies may fail to address existing divides or deepen them altogether. For example, a CBDC could be designed such that poor people have the same control over their money as wealthy people, or such that the system encumbers money with restrictions that deny, for example, government-aid recipients agency over their own spending. This report offers design considerations meant to prevent designers from making matters worse for those whose lives CBDC is intended to improve.

Designing CBDC for Financial Inclusion

CBDC may well offer a unique opportunity to design a digital currency that expands inclusion and the public interest. But in order for it to achieve this, its design and implementation must be carefully considered.

We suggest a two-pronged approach to CBDC design considerations. Designers should consider the operating model: how it is produced and maintained, and by which organizations. Designs should also consider the affordances of the currency: how it functions, what kinds of uses and activities it enables, and what kinds it constrains. These decision domains are interrelated: the design of the operating model can impact the affordances, and designing for particular affordances can impact the operating model.

We argue that in order to design a CBDC that expands inclusion and serves the public interest, CBDC designers should consider what kinds of affordances would most likely lead to that goal and, in turn, what kinds of operating models would support those affordances.

In the following subsections, we explore currency affordances and operating model design choices in greater detail. We use these concepts to guide the analysis of our fieldwork.

> "If a new CBDC's design merely replicates the existing intermediary ecosystem, it will likely replicate the same currency affordances... it may also replicate the same limits to inclusion."

CBDC Operating Model

CBDC operating models have been guided by an influential set of typologies that focus on the roles of the central bank and the accompanying intermediary ecosystem (see for example Allen et al., 2020; Auer & Boehme, 2020; OMFIF, 2019; World Bank, 2021c; Board of Governors, 2022). Although they vary in their terms and classification systems, most typologies include:

- A **unilateral model** in which the central bank handles all necessary operating functions for currency in-house
- A **synthetic model** in which the currency is issued by and is a liability of a private-sector actor, such as a stablecoin or an e-money issuer, but is backed by central bank funds
- Several **intermediated models** in which the currency is issued by and is a liability of the central bank, but some or all operational roles are assigned to intermediaries.

According to a recent analysis by the IMF, six existing CBDC pilots and projects all fall into the "intermediated" category (Soderberg et al., 2022), and the Atlantic Council's CBDC Tracker (2022) shows that out of 119 projects, none are actively pursuing the unilateral model (75 are still undecided). In concert with these findings, we argue that any functioning CBDC will likely most closely resemble the "intermediated model" because it will necessitate a variety of operational inputs from the central bank and beyond.[1]

Today, all existing electronic state-issued money forms available to retail users—like bank deposits, e-money, faster payments, and cards—are intermediated. This means that an organization like a bank or fintech agency provides an account to the user, deposits and custodies their funds, executes transactions on their behalf, and addresses compliance and security needs. When the user makes a deposit, the funds then become a liability of that intermediary.

When designing a CBDC meant to expand financial inclusion and serve the public interest, it is equally important to consider the design of the intermediaries that serve as an interface to it. If a new CBDC's design merely replicates the existing intermediary ecosystem, it will likely replicate the same currency affordances that the existing ecosystem produces. Consequently, it may also replicate the same limits to inclusion and other harms that the existing ecosystem perpetuates.

[1] *Indeed, detailed descriptions of "unilateral" CBDC anticipate some involvement from private-sector contractors and from public agencies beyond the central bank (see, for example, Berentsen & Schar, 2018).*

It is an open question whether or not central bank liability—uniquely offered among digital funds in retail CBDC—offers a significant financial inclusion benefit over other forms of digital money. For example, it is not yet clear that a retail CBDC would offer advantages over Fast Payment Systems (FPS)—payment rails often administered by a public entity that do not entail the creation of a new currency form—especially if the FPS did not require a traditional bank account and if the stored funds were insured. We suggest that some potential benefits of central bank liability would disappear if the channels through which people use the CBDC are not carefully considered.

Therefore, we argue, it is essential to understand the intermediation of money, how intermediation shapes money's affordances, and what those affordances mean for financial inclusion and the public interest.

"But the affordances of cash makes it a critical backstop against exclusion."

Currency Affordances

In order to study intermediation, we identified the differences in affordances between existing intermediated digital currency and the only state-issued money form available to users that is not intermediated: cash.

In many ways, cash is a remarkable money technology. In order to use it, all you have to do is hand it over. It is self-validating and self-clearing. It doesn't depend on any intermediaries to use or require any special devices or connectivity. For these reasons, cash remains an important part of the financial lives of many people, especially poor people. It is important to understand the affordances of cash in order to understand what might be lost if no non-intermediated money form is available to meet the needs cash uniquely serves for the most vulnerable.

Cash has many limitations: it can be lost, stolen, or destroyed; it can't be transmitted online. But the affordances of cash makes it a critical backstop against exclusion. It remains the lowest requirements payment mechanism above which some exclusion will always occur.

Key affordance differences between cash and digital money include the following:

- **Custody:** Cash can be held by the individual, whereas intermediated digital funds are held by and are a liability of the intermediary.
- **Access:** Cash transactions can be conducted by the mere physical exchange of currency, whereas intermediated digital transactions depend on external infrastructures and on intermediaries for access, including authentication and authorization.
- **Finality:** Cash transactions settle immediately and fully, whereas intermediated digital transactions typically entail some delay, may settle whole or in part, and may fail. Cash transactions do not have a technical process for reversals, whereas intermediaries may offer a resolution process.
- **Data:** Cash transactions typically do not produce data trails, whereas intermediated digital transactions do.
- **Distance:** Cash transactions typically cannot be transmitted remotely over distance, whereas intermediated digital funds can be transmitted over distance easily. This has important implications for remittances.

In our fieldwork, we explore the implications for financial inclusion and the public interest based on these five affordances. It is still an open question whether CBDC will be designed in a way that resembles the affordances of cash, existing forms of digital money, something in between, or something not yet anticipated. Regardless of the direction the CBDC takes, decision-makers' approach to these five affordances will be critical to its outcomes.

Intermediation is a Nuanced Concept

Again, while "intermediation" has many meanings depending on the context, we refer to the work of the "intermediaries" that conduct payments. Our work has shown that intermediation is a complex and nuanced concept. In our existing digital financial system, there are basically two alternatives: use an intermediary (such as a payment service provider) or use cash.

Digital payments depend on fallible software and infrastructure, in addition to an operator (or set of operators) who maintain the software as well as govern and run the infrastructure. Digital bytes can be easily copied, so there must be some mechanism in place to solve the so-called "double spend" problem—ensuring that a digital balance can be spent only once, and that there is no counterfeiting. This can be done by the operator either maintaining and updating a ledger of outstanding balances directly, or facilitating the distribution of digital currency on devices like smart cards with secure hardware.

Even a decentralized cryptocurrency has such a set of system operators, typically the set of computers that comprise the decentralized network, including the validators or miners that produce the blockchain ledger. It is important to note that with any digital currency, centralized or decentralized, there is always a system, run by some actors and maintained by others, ensuring the validity and continued operation of the currency: updating the ledger, preventing double spends, verifying and ordering transactions, maintaining and upgrading the software, and so on.

Maintenance of the system is as important as designing and developing it (see Vinsel & Russell, 2020). For example, if all work ceased on the Bitcoin software today, it could not operate without people in perpetuity. All software systems break and require intervention. Some problems can be anticipated—such as the integer overflow that will occur in the year 2106 (see Hertig, 2020)—while others cannot.

Accordingly, there is no such thing as a totally unmediated digital bearer asset. Cash is also mediated in the sense that it is carefully designed, manufactured, and distributed to make counterfeiting very difficult. However, cash is notably different from digital assets in that there is no device, network, or system operator that creates and validates the transaction at the time of payment.

We will need to think carefully about the role(s) and potential actions of device manufacturers and distributors in addition to network and system operators. How might they affect the ability of the digital asset to approximate cash and act like a bearer asset? (Even though, as described above, it can never fully do so.) For example, we must carefully consider the system operator's involvement in assigning users the ability to transact in the system in the first place, as well as how it is involved at the time of payment. What kind of frictions might the operator introduce? How might this affect users' ability to transact?

In addition to mediation by the system operator, we also have to consider the intermediary ecosystem. We distinguish between the *system operator* who runs the underlying transaction settlement infrastructure (and, in the case of a CBDC, might be the central bank or another public entity) and *intermediaries* or financial service providers, who might be public or private-sector actors who take on roles like provisioning user accounts, providing access, and helping with customer service.

CBDC Does Not Require Distributed Ledger Technology

There is confusion about the tradeoffs and benefits of blockchain or distributed ledger technology (DLT) and how it might be applied to CBDC. DLT might not be necessary, optimal, or even sufficient to achieve stated CBDC goals. The question of whether to use DLT technologies is really about governance and trust, with some related issues around performance, rather than about its capability to achieve specific features.

What is Distributed Ledger Technology?

DLT, or blockchain technology, is an umbrella term for many different specific techniques, systems, and designs, and we can pick and choose from these various technical attributes. DLT is often touted as a means to obtain new and innovative features like programmability, cryptographic designs for privacy, auditability, and real-time settlement. However, DLT is not the only way to achieve these features, nor is it even a guarantee of them (Bech & Garratt, 2017; IMF, 2022, Lovejoy et al., 2022). In fact, using DLT to achieve a particular feature might not make sense when considering the tradeoffs with governance and performance requirements.

There are two types of blockchains: permissioned blockchains, which have a known set of participants, or validators, to contribute to building the blockchain; and permissionless or public blockchains, which are open to any participant to join the network. Note that this terminology does not address who has read access to the blockchain or who is allowed to submit transactions to be considered for inclusion. A permissioned blockchain might limit who can read the ledger and who can submit transactions. In a permissionless blockchain, data is available to the public, but it might be encrypted or obfuscated so that the details are not visible in clear text, and anyone who can pay transaction fees can submit transactions.

Governance, Trust, and Performance

DLT is best suited to situations where there is no single trusted entity to run the architecture, or where it makes sense to distribute trust. Distributed governance could be useful when there are several equal partners but no centralized decision-making body, and instead of creating legal agreements to govern their interaction, the partners want to codify the rules of their engagement in software. This is usually not the case in retail or general-purpose CBDC, which is issued in the context of a single nation or currency union with a governing body. It might make more sense in cross-border wholesale designs, when a platform is governed by multiple distrusting partners. This should be considered in context with alternative designs based on a multilateral centralized entity, like CLS for FX settlement.

One could imagine a CBDC design where central banks issue tokens on permissionless blockchains, much as stablecoins are issued today. The central bank could control issuance and redemption of the digital currency but would give up other control to the governance of the underlying blockchain, which might be concerning. For example, the miners or validators in the blockchain network might decide to reverse or censor transactions (Narula, 2021).

A central bank could use blockchain technology in a centralized setting. However, it's not clear what benefit this provides, and DLT might not be a good fit if performance is a priority. Running all transactions through a single state machine with a byzantine-fault-tolerant distributed consensus protocol is usually lower performance than other more traditional distributed system designs (Lovejoy et al., 2022).

Rather than ask whether a CBDC uses DLT, it is better to ask whether the CBDC uses a ledger at all. And if it does, what kind of trust is assumed in the ledger operator?

Insights from Fieldwork

As we have argued, many existing CBDC proposals are intermediated. An important potential risk is that an intermediated CBDC will replicate the design—and therefore the harms—of existing intermediated money forms.

In order to identify ways that CBDC design choices might expand financial inclusion and best serve the public interest, we conducted fieldwork with in-country partners to investigate the problems that users face with existing money forms, both intermediated (all existing electronic systems) and non-intermediated (namely cash). Only one country in our sample, Nigeria, had launched a CBDC during our fieldwork.

To analyze our fieldwork data, we drew from the five key differences in affordances between intermediated and non-intermediated money systems—*custody, access, finality, data, and distance*. We also use this structure to organize our insights.

Fieldwork Contexts and Methodology

The insights we share in the following sections are drawn from our research in India, Indonesia, Nigeria, and Mexico. Each are low- or middle-income countries with distinct and rapidly changing technological ecosystems for payment services. In addition, each has significant public-interest money concerns relating to financial inclusion, with different underlying causes for each of those concerns.

In order to conduct this fieldwork, we collaborated with the Institute for Money, Technology and Financial Inclusion (IMTFI) at the University of California, Irvine to partner with 13 teams of researchers across the four countries. These teams collected data from over 200 interviews paired with situational analyses, 14 focus groups, and over 500 survey respondents. Respondents varied across gender, race, age, socio-economic level, and location, from rural to urban and semi-urban contexts. Among those interviewed were street-food hawkers in Delhi, women entrepreneurs in Jakarta, and families navigating remittances across the United States-Mexico border.

In each country, some teams used a unified research protocol we provided, which they then adapted to the context, asking common questions but localizing the details. Other teams developed unique context-specific protocols. For example, Debashis Acharya in India developed a unique observation and interview protocol to investigate a rural tourist village that was much touted as fully cashless after the state demonetization efforts of 2016 but has since reverted back to mostly using cash. This approach to data collection allowed us to identify both common and case-specific features of economic life across field sites.

> "An important potential risk is that an intermediated CBDC will replicate the design—and therefore the harms—of existing intermediated money forms."

About Our Insights

In the following sections, we explore fieldwork insights on existing money systems, both cash and digital. Each section corresponds with one of the key affordances introduced earlier, and takes a closer look at the ways in which that particular affordance can impact the design and efficacy of CBDC. In doing so, we demonstrate ways in which intermediated money forms create harm for vulnerable people. We also identify the limitations of cash in the contexts studied. Our ultimate goal is to identify how CBDC design choices might mitigate—or at least not exacerbate—these problems.

We draw on our findings to offer a set of technical design considerations for CBDC after each set of user insights. It is important to note that many of these technical considerations are interconnected. For example, identity considerations for access to the system have a strong bearing on factors for data trails and privacy. Our lists of technical considerations are not intended to be exhaustive, nor are they intended to offer a definitive set of instructions for how to build a CBDC. Instead, they highlight both warning signs and ways forward (IMTFI, 2013) for CBDC designers and stakeholders.

Throughout this section, we offer composite profiles of people and their financial lives, practices, and needs. We also offer short considerations of cultural and technical concerns relevant to CBDC design. On our website, we have compiled a suggested reading list of relevant research on these topics. We also link to ethnographic blog posts from our fieldwork research partners.

Insights Preview

People prefer to hold their money in different forms—both cash and digital—in order to exert control over their finances, mitigate complexity and uncertainty, and limit and anticipate fees. These preferences are particularly important for those who have the least money.

There are many deeply entrenched practical barriers to access to digital payments, notably lack of identification and infrastructural instability, including electricity and connectivity.

Lack of interoperability in digital payments makes it necessary to have access to different (even many) types of payments. The more powerful transactional partner (customers, employers, government, platforms) may require specific types of payments.

Being able to use funds immediately is a significant advantage of cash. Even "instant" digital payments may not authorize or settle reliably quickly. Time delays can exacerbate precarity.

Reversing transactions is a useful feature of digital payments. Not being able to dispute fraud or reverse an error can be catastrophic for the most vulnerable. However, not all transaction types require dispute resolution.

Where sophisticated commercial datafication of transactions exists, so too does a sophisticated landscape of marketing through real-time behavioral incentives. This can lead to indebtedness and undermine inclusion.

Lack of understanding or control in surveillant systems can lead to mistrust and impact both adoption and confidence. As it relates to CBDC, communication strategy is key, but so are systems of consent and redress.

All of the problems that people encounter in other payment domains—such as lack of identification, connectivity issues, fees, settlement time, lack of recourse when things go wrong, and lack of privacy—are present and exacerbated in the context of remittances.

Custody

Key affordance difference: Cash can be held by the individual, whereas intermediated digital funds are held by and are a liability of the intermediary.

When considering how a CBDC might be designed to meet user needs, one of the first questions to explore is custody of funds. Today's monetary landscape requires us to either custody funds ourselves (in the form of cash) or deposit our funds with an intermediary.

Both of these choices come with their own risks and limitations. Depositing funds with a custodial intermediary is typically more secure. Today, custodial intermediaries enable funds to be transmitted electronically, which is essential for participation in the economy in the digital age.

Depositing funds also requires trusting an intermediary, not only to remain solvent but to steward transactions in an adequate and timely manner and redress problems when they arise. Intermediaries charge fees, which can be costly and unpredictable. Intermediaries are plagued by other issues such as choke points over transactional flow, lock-in, lack of interoperability, and difficulty of exit.

These issues may lead people to default to cash, which seems more straightforward and predictable by comparison. Holding onto your own money is cumbersome and can even be dangerous. But it can also afford much-needed control and certainty, especially for those who have very little money.

CBDC designers should consider how to preserve the benefits of self-custody, which, for state-issued currency, is currently impossible in the digital realm.

"CBDC designers should consider how to preserve the benefits of self-custody, which, for state-issued currency, is currently impossible in the digital realm."

Control and Accountability

Custody raises issues regarding who controls funds and who is accountable for them. In Indonesia, research partners Kathleen Azali, Pradipa P. Rasidi, and Maria Karienova interviewed one man with strong feelings about his need to retain "sovereignty" over his money, arguing that cashless transactions prevented him from accessing his own money as none of the institutions involved could be held accountable in the case of a dispute:

> *"I work my fingers to the bone. I am rewarded for the work I do, [so] I should retain my absolute rights to do whatever I want [with that reward] as long as I don't infringe on anyone else's rights. But when this [reward, i.e., money] is being transformed into digital [forms], it reduces my rights. My own sovereignty to something that should have been of my own possession is no longer at 100%. It [my sovereignty] depends on... other actors. Actors whom I cannot hold accountable.*
>
> *"...Now, if we face yet another blackout [referring to the 2019 Java blackout]? Who wants to take responsibility? PLN [the state-owned electricity company]? The state? Who will be accountable?"*

This interviewee highlights that the question of custody is not just practical, but intimately linked to a sense of dignity. Giving up custody of funds means increasing one's dependence on payment infrastructures and the institutions that control them.

In Mexico, researchers Magdalena Villarreal and Ana Sofia Torres note that misuse of funds has been a public issue in the past and continues to shape people's perceptions today. They explain that several high-profile cases of financial fraud by savings cooperatives have had a serious impact on trust. When these organizations went insolvent, so did their members. Experiences like these affect people's trust in institutions and drive the desire to store money in the form of cash, gold, or other stores of value.

Complexity and Uncertainty

Across contexts, people demonstrated a clear desire to hold their own funds—at least some of the time. Doing so offers them shelter from a digital world that can seem—and indeed is—complex and ever-changing.

Using cash can reduce complexity. Our research partner Debashis Acharya and his team describe the use of cash in three Indian villages that were declared "cashless" as part of state demonetization efforts in 2016–17, but which reverted to using cash soon thereafter. Acharya explains that weavers living in one of these villages prefer to deal in cash to sell their handloom products and pay their suppliers, even though they have bank accounts and ready access to banks within their village. The son of one weaver commented:

> *"It's all about the weaver's mindset. The weavers don't want any complex transactions since they are focused on their design and product."*

Weavers retain the power to exercise this choice, unlike many other merchants who feel they must fall in line with customer preferences.

> "For many, a preference for self-custody is more a matter of maintaining control over their small earnings."

For many, a preference for self-custody is more a matter of maintaining control over their small earnings. Our partner Nima Yolmo researches cash-based community support systems for women in Darjeeling, India. A 56-year-old woman who sells fermented produce from her home, and who has a bank account with the State Bank of India, told her in an interview:

> *"I prefer to use cash, and it's not like there is a lot to go around. You keep hearing of all these scams all the time. I get messages about winning this thing or the other every other day; I am surprised at how much money and time the fraudsters seem to have. My daughter was talking about identity theft. It seems if your mobile phone is connected to your bank and gets a hold of your details, they can siphon off all your money; that surely would be the end. Who is to say what happens with all this technology?"*

This response highlights how technology can be viewed as a threat to financial security. Engagement with technology is filled with complexity, which here produces a sense of danger that she is unable to predict or manage. As a result, she views keeping money in the form of cash as safer than keeping it with a custodial intermediary.

Conversely, some others seemed to view self-custody of funds as its own security risk. Acharya cites several examples from India where people prefer to store their money digitally for fear being robbed of cash. He explains that India's Unified Payments Interface (UPI) has become popular among small vendors for this reason. One migrant construction worker living with twenty other workers stated that he does not keep cash because he cannot trust the people around him. His confidence in UPI increased after his mobile phone was stolen while he was traveling, but his money remained safe due to screen lock and UPI's personal identification number. Acharya found that his interviewees felt better about giving up control over cash as long as they could trust that they would be able to reliably access their money and that it would not disappear. As one college student told him:

> *"...as long as I know there is sufficient balance in my account, and know where the nearest ATM is, I feel safe."*

For this student—like so many others—the critical point is not the form that money takes, but rather that control of money is guaranteed.

The reliability and interoperability of the financial system are critical factors in people's decisions not to give up cash, and their decisions to maintain multiple different financial services. Ultimately, control over transactions means being able to move funds between different buckets (cash and digital accounts) reliably and when desired.

Problems can, of course, also stem from technical issues. In Nigeria, our partners Oludayo Tade and Oluwatosin Adeniyi provide an example of a musician who had no remaining cash and

no food in his house for his family. He gave his son his debit card to withdraw the last 5,000 naira (US $11.30) out of his account. The money was debited from his account but his son did not receive the cash. He commented:

> *"For over six hours the money was not returned to my account. Sometimes that is what discourages me. I can't really trust online transactions. If I had that money in my hand it would have saved the day. I was furious. My family must eat!"*

A combination of a pressing need and the uncertainty of whether the money would be returned produced undue stress and deprivation for this family. This is far from an isolated incident; it is a common occurrence among people who are in precarious financial situations.

Many issues can arise with transactions, including intermediary failure, intermediary choke points over transaction flow, intermediary lock-in, lack of intermediary interoperability, and difficulty of exit. For consumers, such issues can make money hard to track, increase transaction costs, and have a negative emotional impact. Because cash tends to be less prone to these issues, custody over it can be a safety net when other transaction methods fail. This is an important reason why people continue to use cash, and why central banks are reluctant to let it go out of circulation completely.

In contrast to cash, using CBDC will require more advanced digital and financial literacy (Auer et al., 2022a; DFSWG, 2022) and must be situated in a wider portfolio of policies, education initiatives, and services aimed at inclusion. Users may be required to learn to navigate new technologies and systems, while trying to avoid becoming the victims of fraud or economic exploitation.

Money Management

How and where people choose to hold their money is importantly linked to control over spending. Both cash and digital forms of money are an important part of earmarking and money management. The fact that people desire control over the decisions they make regarding money does not mean that they always prefer self-custody; rather, they want to have both options so that they can choose when to maintain custody and when to engage an intermediary (Dzokoto et al., 2016).

It is critical to note that people do not necessarily choose to use either cash or digital money at the expense of the other. As research partner Clément Crucifix in Mexico points out, what people value most is being able to choose between different money forms—cash, digital, cards—with different affordances. If we imagine that digital money is a replacement for cash rather than a complement to it, we miss key ways in which the self-custody option provided by cash is important to everyday money management.

> "What people value most is being able to choose between different money forms—cash, digital, cards—with different affordances."

Some people feel that they manage cash better than money stored digitally because it is materially tangible. In Indonesia, Azali and team report that an activist they interviewed felt that the shift to cashless transactions is upending people's connection with money due to a lack of touch. They explain:

> *"There are only numbers on the screen. It's unlike when we get a change. We touch it. Our brains calculate: we pay 4,900 [rupiah] (US $0.32), oh then the change must be 6,100 [rupiah] (US $0.39). We feel the one hundred coin. We put it into our pockets."*

On the other hand, some people feel they are able to manage their money better if it is held digitally rather than in cash. Azali and team in Indonesia spoke to a taxi driver who felt that e-wallets help him to be more frugal due to the unavailability of QR codes in many warung (shops) on the streets, especially since his main e-wallet is not as widely used in Jakarta. This self-imposed restriction keeps him from unnecessary purchases of snacks or cigarettes:

> *"I'm asking you now, if you're given money, let's say 250 thousand [rupiah] (US $16) in cash. Can you keep it in your pocket for two months without trying to spend it? No? Then saving money in an e-wallet helps you to be frugal.*

You would only use it to buy pulsa [prepaid SIM card funds], or something urgent. … If we received cash money and kept it in our pocket, we would be tempted. 'Ah, let's buy some cigarettes.'"

The contrasts above echoed across multiple in-country studies, underscoring the context-specificity of many everyday payment choices. The same form of payment that instills trust and confidence in one user can just as easily cause uncertainty or additional complication for another.

Maintaining control over money may also involve hiding it from others. It is useful to note that this practice often has gendered dimensions. The idea that digital financial tools help women keep their financial practices secret from men has been much discussed in literature on financial inclusion (Kusimba et al., 2017; Riley, 2019). But this can cut both ways: men also hide money from their spouses. In Indonesia, Azali's team found that men put aside "men's money" (*uang laki-laki* in Indonesian; *duit lanang* in Javanese) in digital accounts rather than in cash because:

"If you use cash it is so much easier to be tracked, especially in our culture where housewives generally are allowed to check out her husband's wallet."

Maintaining control over money is not simply a matter of individual versus institutional control. Instead, it is a highly social practice that is shaped by both formal and informal power relations, as well as by the affordances of the technical and infrastructural landscape.

As digital financial tools become more prevalent, people find new ways to manage and control their money. With digital finance, custody can rest in the hands of distant third parties, usually companies and strangers. Although individuals often have little choice but to sign up for such services, they continue to seek ways to maintain control of their funds, even when true custody is out of reach.

"Although individuals often have little choice but to sign up for [digital] services, they continue to seek ways to maintain control of their funds, even when true custody is out of reach."

Anticipating and Limiting Fees

Finally, fees and minimal balances can be unpredictable; accordingly, they may even act as disincentives for people to keep money in a bank account, platform, or wallet.

Crucifix notes that many institutions in Mexico charge fees that can range from 250–750 pesos (US $10–30). He observes that these costs are widely perceived as unfair in that they discriminate against people with limited resources. He cites an interviewee who complained about local banks charging account management fees to hold her small amount of savings:

"I feel it's not fair. They charge me a percentage and then they will use my money to do whatever they want. They move it, they lend it, and they make more money with it. It doesn't seem fair to me. If I'm saving money and I still have to pay… maybe it would be fair for someone who has a lot of money, but for those who don't have much money… That's something I'd like to change."

Crucifix also encountered numerous people who complained that the costs of maintaining an account with a financial provider are frustratingly opaque, with four people having been charged unexpected fees. Another interviewee told Crucifix that she had been the victim of what she described as "a robbery" at a retail chain that offers banking services:

"I had a savings account there. I had 20,000 pesos (US $1,000). I didn't move the money. I went time by time and deposited my money. They never told me that I had to make transactions each month, so they wouldn't charge me a fee. When I realized, in this account, I only had 600 pesos (US $30)…I asked the manager, 'What happened to the money?' 'Well, you didn't come. Each month you have to make transactions, if not, you lose your money.' It made me so angry. I told them that they were thieves. But I couldn't recuperate that money. Since then, I don't leave my money in there."

These numbers might seem high, but losses of this magnitude were not uncommon in our research. While not everyone had experienced an unexpected large loss due to fees of various kinds, many respondents had heard of someone who had. This is also true in the Global North: according to a 2021 study by the Federal Reserve Bank of Kansas City, even after significant regulatory overhaul of fees in the United States, high fees are one of the most commonly reported reasons for being unbanked (Toh, 2021). As Eubanks (2018) notes, the world over, it is quite expensive to be poor.

For small business owners as well, high and unpredictable fees can be burdensome. For instance, fieldwork by Caroline Mangowal, Erlyn Shukmadewi, and Amiril Zulhaj in Indonesia showed that their study cohort of women entrepreneurs were forced to pay unnecessary fees or accept losses in order to keep their digital merchant accounts activated.

One respondent had closed her food stall on a national holiday, yet received a notification stating that she must pay 1 million rupees (or about US $64) in commission fees to the GrabFood app she typically used. She immediately called and emailed the company to address the error, but received no immediate reply because it was a holiday. Consequently, she was forced to pay the incorrect commission fee in order to prevent her account from being indefinitely deactivated.

The "Spirit of Cash"

Custody over funds is not just a question of ownership and control. It can also be important for social and emotional reasons. In Nigeria, research partners Tade and Adeniyi explored why cash remained popular in Nigeria despite the introduction of the eNaira and the existence of many other digital payment options. They interviewed a range of people including traders, musicians, and the elderly, and concluded that people are "energized by the spirit of cash." They cite the case of a musician who plays at private parties. Guests often show their appreciation for his music by "cash spraying," a practice in which a person who is being praised through song throws cash onto the people dancing. Tade and Adeniyi explain that cash is used to buy *iyi* (honor) and acts as "an instant communication tool for social relations at social events and beyond." As the musician put it:

> *"Money itself is a spirit, if you see a young man or an average man that is very rich, the way he will be walking on the road will be different from someone who is just looking for what to eat in the morning. So the same way if you are singing and there is somebody coming out to spray you, before you know it, your spirit will be high.*
>
> *In this part of the world we believe that once you [are] sprayed it commands respect. People will want to know you and some people love attention. Spraying gives recognition, it gives respect, it makes you popular. In Yoruba land, unless there is no live show, spraying will continue but I don't think ATMs or transfers will hold water like cash."*

In this case and as many others reported, the materiality of cash makes it more symbolically and culturally meaningful than digital money. It is deemed more appropriate to use to express social meaning at physical events.

Small Merchants: Following the Customer

Rajesh, 34, an unmarried street hawker in Mumbai, India, comes from a poor family and did not have much possibility of education but still feels able to manage his finances.

Financial needs:

- Buy from small vendors, mostly cash
- Sell to customers in the street, still mostly cash but moving to digital (UPI)
- Pay occasional fines and agreements (hafta) with authorities to stay in business
- Manage personal expenses
- Deposit irregular savings for the future
- Avoid scams

Pain points:

- Expectation that he will follow the wishes of his customers with regard to payment
- Using point-of-sale systems for digital payments makes tracking and billing easier but is expensive
- Scams are many and it takes time to avoid/resolve them
- Opening hours in banks and availability of ATMs (for withdrawing cash and making savings) are limited

Finance-related items carried:

- Phone with UPI and some wallet apps
- Cash
- Bank account

Rajesh makes most of his business transactions in cash. He buys produce from very small vendors, and many of his customers prefer to pay for food in cash, as they do with most personal shopping. He has to pay fines for selling food in the street fairly often. He uses cash for this as it makes the transaction easier and negotiable. He pays some of his larger bills, such as rent, digitally.

Rajesh makes enough money to have small but very irregular savings. He has a bank account, but he deals with the bank through an agent because the opening hours don't support his late working hours. He makes his savings with a savings society that employs an agent who comes to his house at agreed times. This is more flexible than a savings society that requires a pledge to a regular savings commitment.

He is starting to follow his customers to digital solutions, as customers are attracted to the platforms' offers of cash back. These digital options have many benefits, including being fast and allowing transactions to be confirmed. He prefers to use UPI because it is cheap and offers clear verification—a green light turns on and an aural alert plays from the point of sale terminal—that payments have gone through. In the event of network breakdown, he asks the customer for a phone number to confirm payment at a later time. This is cumbersome. He has also experienced customers using fake apps to show that a transaction was made, and has lost money this way.

Ways Forward for CBDC Design: Custody

In existing digital payment custodial models, intermediaries control entirely how users can access, use, and move their funds. As we have seen, users—particularly the most vulnerable—have little recourse when they face problems with their intermediaries. In many cases, users do not even have a meaningful choice between competing intermediaries, and there are duopolies or near-monopolies of payment rails in many places.

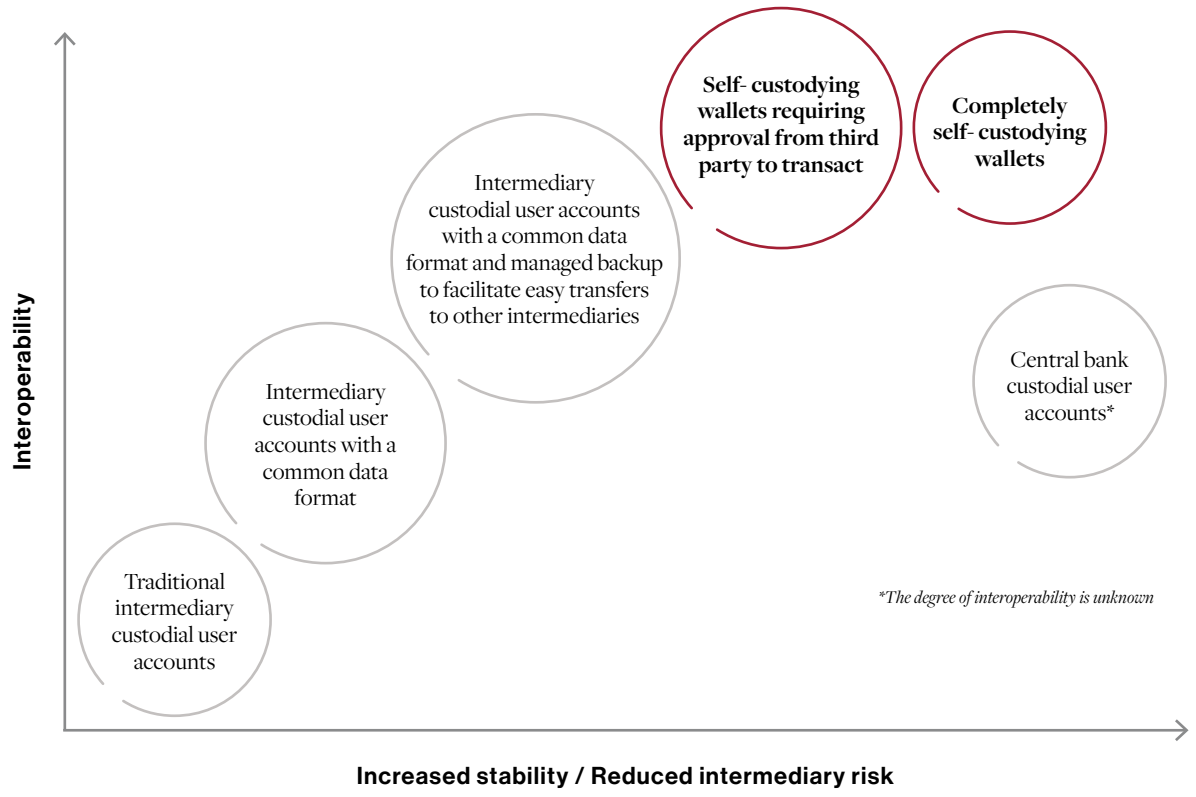
There are also issues with interoperability: it can be difficult or sometimes even impossible to pay across intermediaries, or to easily and cheaply withdraw funds from an intermediary. In addition to these concerns, large intermediaries that custody funds for many users create stability concerns; they might get hacked or go under, putting many users' funds at risk.

CBDC could be designed to replicate the existing digital intermediary fund system—requiring a third party, which may or may not be regulated, to guarantee deposits and to hold user funds. But CBDC could also be designed in innovative ways to capture some of the affordances of cash, including the potential for self-custody.

Key open questions include:

- Will CBDC support self-custody? If so, under what conditions and how?
- What kind of intermediaries are able to custody CBDC? What are the mechanisms for licensing and regulating these intermediaries?
- If a CBDC is held by a custodial intermediary, what kind of regulatory, operational, and technical mechanisms must be in place to continue to maintain the CBDC as a liability of the central bank?

There are a host of technical options for the design of the systems that enable access to (and custody of) funds. We have identified a non-exhaustive array of possible arrangements, as depicted in Graphic 2.



Graphic 2: *Opportunities for Innovation in Custody*

None of these is a panacea, of course. All require additional technical, regulatory, and social research. These options are not mutually exclusive, either; CBDC could certainly be designed to afford users with different options.

Lessons from decentralized cryptocurrency are instructive here. First, they have managed to separate custody (which is determined by who controls the keys to move the funds) from the transaction execution and settlement layer (which is usually managed by a network of computers in a decentralized network maintaining a ledger). This enables self-custody in a digital payment system.

Second, there is a popular saying in the crypto community that goes like this: "Not your keys, not your coins." This refers to the idea that unless a person holds the private keys associated with their cryptocurrency, they don't really own that cryptocurrency. Many cryptocurrency exchanges and other intermediaries are custodial. But there are other services that instead enable people to transact and trade in cryptocurrency without taking custody of their client's assets. Because cryptocurrency exchanges and intermediaries have faced significant fraud, attacks, and insolvency, many savvy users choose to keep their funds in wallets that allow them to retain their own keys.

"There is a popular saying in the crypto community: 'Not your keys, not your coins.'"

It's important to remember that self-custody comes with risks: the funds can be stolen or lost, and there is usually no form of redress once a transaction is complete. Managing cybersecurity is difficult, and many users might not want to take on the risk of full self-custody. Therefore we should not require them to do so, but should instead consider offering self-custody as an option to bolster users' overall welfare.

Access

Key affordance difference: Cash transactions can be conducted by the mere physical exchange of currency, whereas intermediated digital transactions depend on external infrastructures and on intermediaries for access, including authentication and authorization.

Many policy conversations about CBDC start with the question of whether it should be "token-based" or "account-based." Cash (essentially token-based) can be used by anyone, whereas existing digital intermediary funds require the creation of a user account, which typically entails verifying identity. Decentralized cryptocurrencies can work both ways: as a token and with account-based intermediaries (Garratt et al., 2020).

We argue that, rather than focusing on the question of token vs. account, it is more pertinent to instead consider the ways in which mechanisms of access to the system are designed in the first place.

When considering the question of access, it is important to remember that CBDC is not just a financial service, like a wallet or payment system. Rather, it is a unit of state-issued currency. So the question of access involves not merely access to financial services, but to money itself. The stakes for redesigning how access to money is gated are high, especially if cash use declines in the future.

Cash can be accessed by anyone, without ID, and regardless of their relationship to the state and other institutions. Despite its other drawbacks, cash is fully inclusive, in that it can be accessed by those who are temporarily or permanently excluded from institutions. This surfaces a number of important questions: who is allowed to use a CBDC? Will users need to create accounts to receive and transact in the CBDC? And if so, what will that process look like?

Identity and identification are of key concern. Also important are the barriers that already complicate access to existing intermediaries, such as technology, costs, and knowledge.

In this section, we explore how access to financial services is gated and granted, from initial access to everyday use.

Universal Access?

It should be noted that people's physical, cognitive, and other forms of difference impact their ability to access different currency forms. For example, the visually impaired face challenges interacting with bank notes. Central banks have addressed this by adjusting textures and bank note sizes, with varying levels of success (Sousa et al., 2020). The Bank of Canada is currently researching issues of universal access in relation to a potential CBDC (Miedema et al., 2020). Their research asserts that a CBDC should be as accessible as cash for people of all ages, for those with physical or cognitive challenges, in any geographic location, with or without smartphones, and both online and offline. To this end, they are exploring multiple formats for a CBDC, including online and mobile solutions, as well as deviceless solutions and custom devices. For example, a universal access device (UAD) might act as a "cash plus digital" solution, enabling digital inclusion for people who lack access to debit and credit cards, while also enabling accessibility for people with disabilities, who could load value to such a device without leaving home.

Varying Levels of Access

Villarreal and Torres in Mexico note that access is not binary and is instead a spectrum. While it is true that some of the poorest people may not have access to banking or internet services, most people do have some kind of access, which they classified as:

1. **Indirect access:** exemplified by the "lean-on" use of friends' and relatives' bank accounts or cards, use of another person's credit when one does not qualify on their own, or transfers and remittances, typically collected in cash.

2. **Initial or partial access:** exemplified by those who receive wages or government transfers in bank accounts, and often take out the total balance in cash whenever available. They may use debit cards or prepaid credit cards, or acquire credit cards online but only to make urgent payments.

3. **Complete access:** exemplified by those who are able to use a wider range of financial services to save, invest, build credit, and make payments and/or transfers. They may have accounts in multiple countries to facilitate remittances, and use their mobile phone or computer to manage their money.

Varying degrees of access can be found within the same community, and even within family networks (Horst &Miller, 2005; Sambasivan et al., 2018). In Mexico, Villarreal and Torres's team observed this firsthand in the case of Pedro, a man who wanted to buy a drawing tablet on a credit card-based Buy Now, Pay Later (BNPL) scheme. Lacking a credit card of his own, he asked family members if he could use theirs. His sister, Elena, agreed. Unsure of how to make online payments, she asked her son-in-law, Juan, to complete the transaction using his card. Elena immediately paid Juan in cash for the full cost of the drawing tablet, while Pedro then paid Elena back in informal installments.

Similarly, Crucifix investigated some of the collaborative processes used to navigate payments ecosystems for those without identification in Mexico. Many of his interviewees described the practice of *prestanombre* (lend-name), in which a person with good credit history and digital banking access borrows money to lend informally to a friend or relative. Those with this kind of institutionally powerful financial identity (Lauer, 2017; Swartz, 2020) become important mediators who reorient transactions toward people otherwise excluded from them (Maurer et al., 2013).

Community savings circles can also provide an account-sharing function. Yolmo in India cites an interviewee who formed a savings group with others "because we wanted to save some money and be able to help each other out in times of need." They collect 300 rupees (US $3.62) per month from each member and keep the money in a bank account held under the names of three members; other members of the group do not need a bank account or ID because they are only accessing the bank via the three account holders. Similar groups of varying degrees of formality were widespread in all four countries (see also an account in Kenya from Kusimba, 2018). In India, 67 million women are members of six million such Self Help Groups (World Bank, 2020).

> "It is essential that CBDC designs account for the power of social dynamics in securing access to funds when institutions and intermediaries fail."

These examples demonstrate how friends and family members play crucial roles in remedying lapses in financial access. It is important to note, however, that the informalities of these supportive infrastructures can be exploited by those who are officially in control of the funds, and participants stand to lose their lendings or savings if things go awry (Srinivasan & Orelia, 2015). Accordingly, it is essential that CBDC designs account for the power of social dynamics in securing access to funds when institutions and intermediaries fail.

A Question of Identity

A central distinction between a bearer asset like cash (which anyone can use) and existing digital intermediated funds is that the latter usually requires some kind of identification. Establishing a digital identity presents challenges to accessing financial services (DFSWG, 2022). Worldwide, many people still lack means of formal identification.

According to the World Bank (2022b), one billion people currently lack an official proof of identity. In low-income countries, 50% of women and 30% of men have no ID. In addition to the gender gap, the most impoverished 20% of people are the most likely to lack an ID. Asylum seekers, undocumented immigrants, and undocumented visitors are among those most likely to be excluded. In our sample countries alone, there are roughly 217 million adults without ID, according to the World Bank's 2021 Identification for Development database (ID4D, 2022). Even so, this figure does not account for undocumented immigrants, and it is assumed that children under 15 do not have ID.

While banking regulations such as Know Your Customer/Anti-Money Laundering (KYC/AML) compliance are an important part of law enforcement, they present a challenge for inclusion. The same people marginalized by the regulatory stringencies of traditional banking regulations—undocumented migrants, refugees, post-incarceration communities, the unhoused—are likely to face similar obstacles to transacting with CBDC.

Identity Alternatives

Because of the limitations of traditional forms of identification, a number of alternatives have emerged in recent years. Many new mobile money platforms offer a low tier account that can be accessed without ID. These models are only possible in countries where simplified customer due diligence or tiered KYC regulations is available for low value accounts, and those regulations plays an important role here.

Research partner Sunniva Sandbukt describes how, in Indonesia, apps such as GoPay, OVO, LinkAja, and Dana offer this feature. She explains that making an account with one of these apps is generally free, with basic accounts requiring an identifier like a phone number or email address—but no bank account or ID.

However, this model of access often comes at the expense of equity. Interoperability is limited: money can only exit the system in the form of payment to merchants or services. It cannot be transferred to another account. Customers may only upgrade their accounts by submitting a selfie holding their official identification.

Many states are currently developing digital identity frameworks. But as new forms of digital identity emerge, it is important to consider issues of consent and control of data (Cheesman, 2022b). How might a public interest identity intervention aligned with CBDC expand financial inclusion and better reorganize people's capacity to act in their own interest? What kind of technical and policy regimes would be necessary to make this possible?

Graphic 3: Populations Without Identification

Source: The World Bank's 2021 Identification for Development database (ID4D, 2022).
Note that according to estimates by the government of India, over 99% of the population are enrolled in Aadhaar, by the Unique Identification Authority of India (UIDAI, 2022).

The Power of Trust and Communication

Simply put, people who avoid using formal financial services because they do not trust banks are unlikely to find CBDC appealing. Some people prefer one-off financial interactions that do not require a lasting relationship, or that do not make visible and aggregate details of their life (Jackson & Massad, 2022). The issue of trust is closely linked to privacy concerns, as well as digital and financial literacy. Without understanding how a particular payment technology works, some people simply will not trust it enough to use it.

The eNaira in Nigeria is a good example of a system that seems well-designed for accessibility but has nonetheless experienced slow uptake. Our Nigerian research collaborators Olayinka David-West and Immanuel Umukoro explain that for many of their interviewees, a lack of trust in government and banks has hindered its uptake.

Research partner Betty Ackah shares a story from Nigeria of someone who had assumed that the newly launched eNaira was a mobile payment system similar to Kenya's M-Pesa. She asked the teller at the bank for more information about it, and was surprised to learn that the workers there had plenty of questions of their own:

> *"We only heard eNaira was starting—they did this big launch of it, budgeted so much to do the launch—and after it, nothing. Nobody is using it, nobody knows what went wrong. I asked our banker, 'OK, so eNaira is here. What do we need to do as an organization?' She was like, 'Don't let me lie to you. Even us at the bank we don't know what it's going to do, how it's going to be used.'"*

This story highlights the need for a comprehensive communication strategy that gives users insight and agency when considering the use of a new payment form. Such a strategy would take into account official messaging at the societal level, organizational messaging for workers who speak directly with users, and accessible messaging for end users themselves.

In the rare instances where a communication plan is cited as central to a CBDC project, as it was by the Bank of Mauritius (2022), it is typically in the form of a digital literacy plan to help users engage with the service more effectively, or tips for avoiding fraud. Interviewees across each of the countries, however, voiced a wider array of astute concerns. Listening to these concerns and curiosities about a new form of payment and providing accessible information about frequently asked questions may serve to build trust.

Sentiments based on previous experiences or stories heard from others serve as a filter for new information. In addition to legitimate accounts, influencers—who may be public figures or close contacts—may also spread unintentional misinformation or purposeful disinformation about new payment forms. Such communication can either encourage or discourage people to try a new payment form. In addition, money is itself a creature of network effects: in order for it to be useful and thus used, it must be used by a large network of transactors, both individuals and merchants.

No matter how efficiently a CBDC may function, successful user adoption will also depend on the formal and informal communication around it. People's perceptions of various payment options are heavily influenced by the impressions and experiences of those they trust. This is also true for the introduction of new coins and banknotes (see, for example, Dzokoto & Mensah, 2010). Ideas about new innovations are diffused through human communication networks, and people seek information from trusted contacts to overcome uncertainty about whether to try them (Rogers, 2003).

Access to Everyday Transactions

Initial access to financial services is just the beginning—people need to be able to consistently and reliably access those services, especially in times of need. In this section, we examine several problems that commonly impede access to everyday transactions: unstable infrastructure, authorization and speed of transactions, and interoperability between money systems.

The Problem of Unstable Infrastructure

Digital transactions are dependent on other infrastructural elements, such as electricity, mobile services, and underlying financial infrastructure. These elements are not always stable, meaning that access can be unreliable. An oft-cited critique of CBDC, along with other forms of digital finance, is that many people who are financially marginalized also lack access to mobile phones, electricity, cellular network coverage, and/or the Internet in the first place (Didenko & Buckley, 2021).

Neither infrastructure nor software work seamlessly. Payments may appear to have failed but have in fact been authorized, and vice versa. For people who are not accustomed to using digital financial tools, these infrastructure issues can be particularly difficult to navigate. And when access fails, either because users cannot complete a transaction or the transaction goes wrong, it is often the less powerful party who takes the loss.

Another issue with mobile financial services is that technological configurations limit what users can do. Given the global rise in smartphone ownership, financial service providers are increasingly turning toward more sophisticated apps for smartphones. But smartphone ownership is far from universal, and those who do have them may not be able to use apps as readily as providers assume. Irregular access to electricity and the Internet may impede usage, a user's phone's memory may be full, or their processor may not be fast enough. Accordingly, we cannot assume that smartphone ownership automatically equates with the ability to regularly access financial services via the device.

The costs of airtime, WiFi, and financial services can also be viewed as an infrastructure issue. Scale is important for the success of mobile money services because mobile and financial infrastructure are expensive to maintain, and finding a price that suits low-income customers while maintaining profitability is difficult. In addition, customers need reliable and convenient access through an extensive agent/merchant network. As one interviewee noted about eNaira , "if I have eNaira but can't spend eNaira anywhere I shop, it's useless."

Authorization and Speed

Daily access to accounts also depends on processes of authorization. In Nigeria, Ackah describes that the account holder usually needs to create a PIN or set up fingerprint recognition to access their account. To make transactions with the point-of-sale agent, the customer presents their bank card and inputs their PIN, receiving a receipt at the end of the transaction.

> "If I have eNaira but can't spend eNaira anywhere I shop, it's useless."

Speed can be an issue on both ends. Inadequate design can force a user to take many tedious steps to get to the point of authorization, only for authorization itself to be disruptively slow. Errors are also a problem: users may enter the wrong amount or select the wrong recipient, a problem often exacerbated by poorly-designed interface design, particularly on feature phones. Furthermore, authorization infrastructure can be buggy, indicating that a payment has been successful when it has not, or vice versa.

In some cases, payments are slow to authorize due to network issues. In Nigeria, David-West and Umukoro note that network failures are common, even in big cities like Lagos. When these occur, people feel embarrassed and frustrated when they don't also have cash to complete a transaction. System failure makes having some cash on hand at all times necessary.

Also in Nigeria, Ackah found network failures and delays with bank apps to be incessant. For example, for customers waiting to pay in a grocery store, a network issue can mean that customers cannot take their purchases home until the attendant receives a notification from their bank that the payment has been successful, which can take up to three hours. If the attendant

knows the customer, they may let them take their purchase home and transfer the money later, but this is never guaranteed. This example again highlights the importance of personal relationships in addressing lapses in access when infrastructures fail.

New payment solutions engender new forms of fraud. In India, Acharya and team describe an example from a small business owner:

> *"Sometimes customers say that they have paid, and that I will get money after some time, and they go away. But the money doesn't come to my account, rather goes back to the customer's account and I incur a loss. Some customers also use a fake app where they show the screen saying successful payment with my name as a payee, but the money doesn't reach my account. This is a new type of fraud practice which has come up recently."*

Designing a reliable system of authorization is a question of equity: usually the less powerful transactor takes the loss. Research partner Simiran Lalvani in Mumbai describes a street hawker who told the story of a well-dressed customer who claimed to have paid him, saying, "It will reach you, I have sent it." But when the payment never came through, the hawker said he would never call out to a customer as they were walking away and crossing the street,as it might adversely impact his own reputation.

Digital payments are presumed to make transactions faster and easier for both merchants and customers, but many platforms still require some element of manual data entry. Human error is inevitable, and sellers may be forced to take a loss if data is entered incorrectly and they cannot reconcile the records.

User Perspectives on Interoperability

Another important feature of daily access is interoperability between different money technology systems. While there are different types of interoperability, we focus on people's experiences of encountering the inability to send funds across different e-wallets and mobile money providers. Lack of interoperability can also slow down important transactions, and might even impede them altogether. These issues can thus complicate individuals' control over their own money by narrowing their payment options.

Interoperability can also be expensive. In Indonesia, for example, interoperability can subject routine transactions to various types of fees—transfer fees, administrative fees, top-up fees, etc. Mangowal and team note that interviewees saw these fees as "a scourge and a nightmare."

Certain people, often merchants, are tasked with facilitating interoperability by maintaining accounts with multiple providers. In all countries studied, there were reports of merchants prominently advertising various digital payment methods. Customers might only have one type of e-wallet, or they may have multiple e-wallets but only enough money in one of them. By essentially serving as network-switching points, merchants make it possible for money to move efficiently despite the fact that it can only move through siloed channels.

Many times, individuals create liquidity and interoperability in the system. For example, our research partner Sandbukt (2021) has previously written about the ways in which Indonesian rideshare drivers often serve as makeshift exchange agents, often at personal expense to themselves. When riders pay with cash, they can opt to receive the difference in the form of a "top-up" deposit via the e-money provider of their choice. Drivers make this transfer using their own balance and without any transaction fees. If a rider pays with a large denomination bill, the driver might have to use the entire balance of their own account to complete the top-up digitally.

To add further complexity, drivers and the company split the earnings 80/20. If the rider pays digitally, this is straightforward: the driver receives 80% of the cost of the ride in their wallet. However, if the payment is made with cash, the driver receives 100% in cash, but now owes the ridesharing company 20%, which is listed as a debt on the app. If the driver doesn't have funds in their app account to cover their debt to the company, they take on additional "debt rides" to make up the difference. Some drivers are happy to sell their digital balance, while others prefer not to. The different apps give drivers different degrees of control over these types of exchanges.

Ways Forward for CBDC Design: Access

Questions of access are at the heart of CBDC design: Who can access the digital currency system? What infrastructural elements will their access rely on? What happens if infrastructure fails?

In this section, we have explored both the benefits and barriers produced by cash and existing forms of digital money. For instance, cash can be transferred in isolation, without checking any other requirements. That being said, physical cash obviously comes with physical constraints—a billion dollars weighs 10 tons and therefore cannot be moved around the world at the speed of light. Digital funds can be moved much faster, but are also more vulnerable to certain kinds of spam, fraud, and other criminal activities.

In existing digital systems, access is usually gated through intermediaries, who provide users with an account relationship that includes, among other things, identifying the user and ensuring compliance with regulation. Intermediaries are therefore involved in the approval and execution of every transaction, vesting them with considerable power over customers' funds. Digital payments also rely heavily on infrastructural elements such as electric grids and internet connectivity. Finally, there are several social barriers to access, including digital and financial literacies, and concerns about trust.

Key open questions include:

- What are the mechanisms that gate access to the system in general? Who can use the CBDC and who cannot? Is an account required?
- What kinds of identification are required? Who manages, authenticates, and is responsible for identity compliance?
- If there are accounts, can a person have more than one account? Can an account be shared by more than one person?
- What is required to be able to send funds? What is required to be able to receive them?
- Who is involved in completing transactions? Who can prevent or hinder a transaction from being confirmed?
- What kind of offline options are available? How are they provisioned?

Identity is an important concern for designing the mechanism of initial access to CBDC:

- From a technical perspective, a CBDC should be designed to work with as few assumptions about how identification is provided as possible. That way, it can operate in different and changing identification paradigms, including those which do not have strong identification systems in place.
- Designers must likewise keep policy objectives in mind to prevent money laundering and the financing of terrorism, proportionate to the level of risk involved.
- Many states and private entities are currently developing digital identity frameworks that might prove beneficial for CBDC adoption. At the same time, though, these will beget new questions relating to issues of consent and control of data.
- Interoperable digital identity standards could enable an ecosystem of identity providers. One way forward is to imagine an ecosystem of regulated identity attesters who can give users credentials to transact based on varying levels of KYC. For example, a user might be able to gain a credential to transact $100/day by walking into a grocery store and getting a refillable card.
- In order to mitigate this problem for the eNaira, the Central Bank of Nigeria has expanded their existing three-tiered KYC regulatory framework to include a new "Tier 0" for those without a bank account. This basic access to the CBDC requires a photo, some personal information, and a telephone number. Under this framework, users have daily transaction and account balance limits that decrease as KYC tier increases. Merchants with the highest level of access, for example, would have no limit on transaction and account balances.

Offline transactions are another technical concern for access:

- CBDC design should provide ways for transactions to take place without access to electricity, internet connection, or other means of contacting intermediaries or system operators in the moment.
- It may be beneficial to consider offline designs in which the service provider pre-guarantees a certain amount of funds that can be transacted with before connection is restored.

The Launch of Nigeria's eNaira

In October 2021, Nigeria became the first African country to roll out a retail CBDC, the eNaira, as part of a larger push toward a cashless economy. Its stated goals included improving cross-border payments, increasing financial inclusion, facilitating cheaper and faster remittances, and enabling direct stimulus payments to the poorest citizens, whom government programs often failed to reach (Olagunju, 2021). Nigerians also face high inflation and a rapidly depreciating currency, and therefore have already been enthusiastic investors in cryptocurrencies, ranking eleventh in the world for crypto adoption (Osae-Brown et al., 2022). Accordingly, initial interest in eNaira was seen as promising, with its website registering around a million hits in its first 24 hours even before its official launch (PYMNTS, 2021).

The eNaira is accessible to consumers via a mobile "speed wallet" app, with financial institutions and registered agents serving as intermediaries. Users were originally required to fund their wallet via a bank account. In August 2022, however, the government introduced a lower tier of access that allowed those without a bank account to access the wallet via a four-digit code, albeit with a much lower restriction on daily transactions (Central Bank of Nigeria, 2022). About 64 million Nigerians (out of a population of about 200 million) do not have an account with a financial institution or mobile money platform, and over half of those do not have an account with a regulated institution such as a bank or microfinance institution (World Bank, 2021a). The addition of the new Tier 0 thus opened the eNaira up to a significant portion of the population.

By August 2022, the wallet app had been downloaded 840,000 times, retained about 270,000 active users, and had been used to complete transactions with 4 billion naira (US $9.3 million) since its inception (Crawley, 2022). Still, adoption has moved rather slowly due to a variety of issues. The initial eNaira launch was delayed by 24 hours to give banks more time to integrate their systems with the wallet, and then was briefly removed from several app stores for unnamed policy violations (Idris, 2021). Users have given it poor reviews for unreliable performance, and the Central Bank of Nigeria has stated that it will not be held financially responsible for errors arising from usage. At present, Nigerians are still unfamiliar with how eNaira works, unsure of how it differs from cryptocurrency, and leery of trusting the Central Bank to safeguard their money.

Finality

Key affordance difference: Cash transactions settle immediately and fully, whereas intermediated digital transactions typically entail some delay, may settle whole or in part, and may fail. Cash transactions do not have a technical process for reversals, whereas intermediaries may offer a resolution process.

Cash transactions settle instantly: one party gives the other money, and that's it. There is no distinction between authorizing the transaction and it settling with finality with the receiver. There is also no technical mechanism for reversals. If a person wants their money back, they have to convince the other person to give it back to them.

In contrast, digital funds require some process of mediation between the transaction being authorized and the funds finally settling with their recipient. This usually takes time. Transactions may settle in whole or in part, and could even fail entirely despite having been successfully authorized. Sometimes this mediation is visible to the transactors and sometimes it isn't. In addition, digital transactions usually include a process for dispute resolution that is beyond the purview of the two parties directly involved in the transaction.

In this section, we delve deeper into the concept of transaction finality by exploring processes of settlement, dispute resolution, and reversal.

Finality and Temporality

Whether or not a payment "goes through" is an issue of both authorization and settlement: Was it properly initiated? Have the funds resolved in the destination account? This subsection uses data from our research partners to consider how customers and merchants alike experience the period between initiating and settling their transactions.

Time delays can exacerbate precarity (Vines et al., 2014). When payments are delayed, it can create suspicion around the person making the payment until the payment settles. In Nigeria, Ackah describes a case in which a woman transferred money to her son's school to pay for his fees. The payment took four days to arrive. In the meantime, the woman feared that the school would suspect her of faking the payment and felt helpless in the face of this delay.

Delays in finalizing transfers and payments mean that, until the transaction settles, the recipient of the funds is essentially extending credit to the payment platform and must raise additional working capital to subsidize any funds that have not yet settled. This was described as a problem by individuals and businesses alike, but it was a particular issue for small-scale entrepreneurs, as identified by Azali in Indonesia.

> "Delays disproportionately affect those who have the smallest financial cushions to rely on until payments settle."

Even when there is a strong instant payment system, as there is in India, some payments are delayed by design. Research partner Lalvani in Mumbai described how food couriers face liquidity challenges due to temporal cycles of payment. She describes how the delivery platforms require that couriers pay out from their digital account to the platform when they reach 1,500 rupees (US $18.12) in cash or digital payments. However, couriers are paid salaries into their digital accounts only once a week. This means that they may not have the funds to cover all cash payments owed to the platform in their account.

Whatever the reason, settlement delays—and not being able to control or anticipate them—disproportionately affect those who have the smallest financial cushions to rely on until payments settle. Conversely, offering payments that do settle instantly can drive adoption. For example, Lalvani described a hawker who adopted PayTM for just this reason. When he felt comfortable that settlement was reliably real-time, he switched from instant to daily payments to simplify his transaction records.

Reversals and Dispute Resolution

On occasion, people (and organizations) may wish to reverse certain transactions. Reversals may stem from a variety of

circumstances, most commonly from mistakes (payments sent incorrectly or in the wrong amount); disputes (payments sent that are no longer agreed upon); and scams (payments sent fraudulently or under coercion). As we have noted before, the stronger party in a transaction (usually the recipient) generally has power over whether a transaction will be reversed or not.

The right to reversal also differs depending upon the payer's socioeconomic status. In middle- and high-income economies, customers tend to expect that reversibility is an option, particularly for digital payments. In poorer countries, particularly when consumer protections are less developed and/or enacted, there may be limited recourse for low-income people to receive a transaction reversal.

This matters because mistakes can carry significant consequences for vulnerable people. For those living in extreme poverty, success or failure in reversing payment can be the difference between eating and going hungry. Transaction reversibility should therefore be a serious consideration in discussions of financial inclusion.

"For those living in extreme poverty, success or failure in reversing payment can be the difference between eating and going hungry."

An example from Indonesia illustrates the kinds of issues that can arise when the details of a transaction are disputed by one of the parties involved. Research partner Agus Indiyanto and team describe an example in which a poultry farmer bought a motorbike on the Facebook marketplace worth around 7.5 million rupiah (US $500). After making a down payment of 2.5 million rupiah (US $167), the seller informed him that the price had increased. This incident has since led the farmer to use cash to safeguard himself in these kinds of situations.

People often choose which payment method to use based on ease of reversibility. A payments provider or platform with a clear policy and procedure can make reversibility much easier than negotiating a settlement with strangers.

However, not all providers and platforms provide an easy means of reversal. In India, Lalvani explains that payment apps such as PayTM and PhonePe do not assist parties with payment disputes; instead, users must resolve them themselves. Commercial banks are not always better: in Nigeria, Ackah encountered one interviewee who complained that banks tend to take a long time to resolve disputes and sometimes fail to resolve them at all.

Disputes between individuals are also frequent. Lalvani describes a case in India in which a food delivery worker erroneously paid 50,000 rupees (US $604) to the wrong person because he chose the wrong name from a list in the payment app. He used the app to contact the accidental recipient, but the message did not go through because the recipient did not have his number stored in his phone. Instead, he had to contact the person via text messages. He did eventually get the money back, but it is important to remember that outcomes like these are never guaranteed. In interpersonal disputes, the disputing party must rely on the good faith of the other person to correct similar mistakes.

Ways Forward for CBDC Design: Finality

A CBDC that can be designed to mimic the certainty and instant settlement of cash could provide people with substantial relief from the problems that frequently accompany delays in digital transactions. Making funds available for reuse immediately offers a clear advantage to users over existing intermediated payment systems, but it also has technical trade-offs. Achieving finality depends on the role of intermediaries, the CBDC's underlying technical architecture, and how disputes are handled (if at all). It is important to note that settling transaction disputes does not fall within most central bank mandates. In fact, doing so eliminates one of the most cited benefits of CBDC: settlement finality.

Key open questions include:

- Is there a time delay between authorization and settlement?
- Do all transactions settle with the main ledger?
- When are transactions reversible? Are reversed transactions actually new, compensating transactions, or are they true reversals?

- How does dispute resolution work? Is there dispute resolution in all transactions? Who arbitrates dispute resolution?

- How is fraud managed?

Considerations for finality include:

- Achieving finality at scale requires correct, consistent, and durable high-performance systems. These should be built with fault tolerance in mind. Existing distributed ledger technology (DLT) systems are limited in the scale at which they operate and might not be the right architecture for CBDC if very low latency and very high throughput are required. We can still consider innovations in blockchain systems without using an underlying DLT architecture (Lovejoy et al., 2022).

- Supporting both finality and offline transactions might require tradeoffs or compromises in CBDC design. Offline transactions, by definition, cannot settle immediately on the CBDC operator's system.

Considerations for reversibility include:

- Digital payment systems that expand financial inclusion in the public interest must be designed to account for the fact that there might be technical errors: computers or software can fail, and messages can be dropped. One technique to plan around this is that systems can be designed so that it is always safe for the client to retry sending a transaction. (Most well-designed cryptocurrencies, for example, offer a property called replay protection, which means sending a transaction twice will never double-debit the funds.) This can help alleviate the need for some types of intervention. However, there might be other types of problems that require redress, which means CBDC ecosystem designers will have to consider how to address mistakes or disputes.

- If all transactors use intermediaries, those intermediaries could deal with chargebacks and disputes much as today. Replicating the existing system for handling chargebacks might replicate its drawbacks, which include the challenge that those handling the risk of chargebacks might not be incentivized to onboard users or merchants without strong reputations and credit histories.

- All transaction reversibility involves some arbitration protocol. Designing this process with financial inclusions and the public interest in mind is key. It is important to understand local contexts and power dynamics. What organizations might play a role in arbitration?

- CBDC also presents new opportunities for handling disputes and fraud (Narula et al., 2022). Given programmability features, a CBDC transaction could be written so that the payment is time locked for a certain period and involves credentials for a mutually chosen third party negotiator who can change how the funds are directed. If a dispute is filed before the dispute period has expired, the negotiator steps in to determine if the payment should go through or not.

Considering Human Infrastructure

When it comes to financial technology, what may seem like a frictionless system from the outside is, in many cases, dependent on human infrastructure to make it work.

In our fieldwork, across all countries and in all contexts, we found numerous examples of humans stepping in when infrastructure failed. The work of human infrastructure is not evenly distributed—precarious workers are more frequently obliged to take it on—and neither is the benefit—it is usually the more powerful party who is able to take

advantage of it. Human infrastructure is also not universally positive: people can and do regularly abuse power given the opportunity. We highlight many related cases throughout this report. Nearly all existing systems were designed to rely upon human infrastructure and were layered on top of existing social relations.

In India, Acharya describes the example of a 35-year-old woman who runs a shop selling groceries, confectionery, and a micro-ATM service. She explains:

> *"The majority of the customers come to me mainly for cash withdrawal, not for cash deposit. I charge ten rupees (US $0.12) for every thousand rupees (US $12) withdrawn. The majority of my customers are people with pensions, elderly, or people with disabilities. They cannot make frequent visits to the bank so come to me for withdrawal. My husband visits the houses of the people and offers the banking service at their doorstep."*

What looks like automated disbursement actually entails work from people who are not staff of the social-care apparatus, but without whom that apparatus would not function. She and her husband are paid a fee for providing the ATM, but they are not explicitly paid for their labor.

Sometimes this human infrastructure is formalized. In all four countries, agent-based banking and microfinance services are common. In these systems, agents visit remote towns and even go to clients' homes to collect their savings and distribute cash. In these cases, clients and account holders are often known to each, and agents thus identify the clients for institutional purposes.

These services are necessary for the successful implementation of many rural banking and microfinance services, and they are useful for many rural people. However, they afford significant intermediary power to individual agents. Crucifix reported from Mexico that many clients he interviewed could not remember the name of their bank, but did know the name of the agents who attended them. The client's welfare is dependent on the conduct of the agent, who may engage in intimidation, scamming, and other malfeasance.

Most of the time, human infrastructure does not take on a moral valence, it is just a key part of how systems work on a daily basis.

Acharya also points to a postmaster in Telangana who is responsible for running the operations of the Indian Post Payments Bank (IPPB), an Aadhar-based savings and money transfer system. He reports that money often gets "stuck": that is, it's not available for withdrawal nor is it in the customer's account. When this happens, he has to call a manager, and it can take days to resolve the problem. Because he is the visible representative of the system, some customers treat him with blame, suspicion, and impatience. As a result, he is only willing to offer IPPB services to individuals he knows and trusts will understand in case something goes wrong.

How can we learn from these insights into human infrastructure to build better intermediation and solutions that reflect people's needs and practices? New financial technology like CBDC can be designed in one of three ways: 1) background these insights by ignoring them but continuing to rely on them; 2) attempt to obviate them, which is probably impossible or, in any case, has not yet been achieved; or 3) embrace them and attempt to mitigate their potential to exploit all parties.

Cash, Cards, and Crypto: A Case from Nigeria

Adanna, 41, was born in Lagos and still lives there with her husband and two children. She runs a pastry business, and her husband drives a taxi. Most of her family live in Lagos, but she has a sister who lives in the United Kingdom who sends her money occasionally.

Financial needs:

- Buying pastry ingredients from suppliers
- Receiving payments from customers
- Managing her family's expenses
- Saving money

Pain points:

- Getting ahold of cash
- Giving change to customers
- Paying for point-of-sale transactions
- Paying for remittances and waiting for their delayed receipt

Finance-related items carried:

- Phone
- Wallet
- Cash
- Debit card
- Receipts

With her pastry business, Adana receives payments either in cash or via bank transfers in naira, cryptocurrency, British pounds, and US dollars. When she needs cash, she withdraws it from a point-of-sale machine to receive digital payments from clients who have placed large orders. She relies on point-of-sale kiosks to withdraw cash because ATMs are unreliable: they regularly break down, run out of cash, and have long queues.

Adana uses mobile-phone transfers primarily for transactions like paying tuition fees and at the grocery store. She makes online payments to buy things like bulk groceries, streaming service subscriptions, and phone data and call credits, and to send money to her parents. She is able to pay some market sellers with bank transfers.

At home, Adana splits financial obligations with her husband. She pays for the electricity bills and groceries while her spouse pays for other bills, including cable, all of which are handled digitally using bank cards or electronic transfers.

With respect to savings, Adana's decisions about where to save her money are influenced above all by interest rates, which is why she prefers using cryptocurrencies as a store of value. She appreciates the privacy that the cryptocurrency wallet affords her. She thinks that cryptocurrency platforms make transactions easier and faster, and are largely profitable as a store of value compared to keeping her money in naira. She has not yet used eNaira because it is usually not available in the places where she shops.

Data

Key affordance difference: Cash transactions typically do not produce data trails, whereas intermediated digital transactions do.

The question of who collects data, who can access it, and what they can use it for has been a major point of controversy in financial services (Sadowski, 2019; Westermeier, 2020, Zuboff, 2019). User data is sensitive information that must be stored correctly to maintain privacy. Data leaks, then, can have serious consequences for users, particularly for the most vulnerable. To make matters worse, increased datafication of users' routines and behaviors has turned the storage and transfer of data into a lucrative enterprise itself. This puts users at risk of further exploitation, often without their knowledge or express consent.

Systems are opaque and ever-changing, meaning that people may lack the information needed to make informed decisions about their own data. The integration of payments into platforms through which much of everyday life is already channeled creates a sense of inescapability from data collection. Accordingly, people may feel like they have very little actual agency when it comes to how their data will be stored and handled, making true consent difficult to achieve.

Interest in cryptocurrencies has risen, at least in part, in response to concerns about data privacy. But most people who use cryptocurrencies—and certainly those in our studies—use them for investment rather than for payments. For most people, cash is one of the only payment options widely available that offers a reprieve from surveillance. Cash also makes taxation policy transmission exceedingly difficult, which is also why cash is preferred over digital payments in the small, medium, and micro enterprises segment. Many people see surveillance as inextricably linked to control (Ericson & Haggerty, 2006).

However, data-sharing can also have significant benefits. It permits interoperability between platforms and programs. For instance, a key tradeoff exists between privacy and the transparency necessary for KYC/AML (Allen et al., 2020). Striking a balance between these risks and rewards of data usage is critical to the design of CBDC.

Anonymity, Privacy, and Data Sharing

If kept affordable and not publicly provisioned, the value proposition for CBDC—and especially its intermediary ecosystem—lies in transactional data. This would mark neither a departure nor an improvement on existing systems.

> "A CBDC with commercial surveillance would mark neither a departure nor an improvement on existing systems."

CBDC could represent a reprieve from otherwise inescapable commercial surveillance. But it could also generate unprecedented levels of data about a user's personal and financial life: banking patterns, personal and business associations, communication methods, addresses, travel, medical conditions, and political affiliations and involvement. Surveillance of this transactional data could have repressive, discriminatory implications. Moreover, the potential for state surveillance may discourage potential CBDC users who are already marginalized by (or wary of interfacing with) the government and formal financial systems (Atako, 2021).

Across all the locations we studied, most interviewees expressed some degree of concern about the abuse of their personal data. Their worries stem in part from risks of abuse, fraud, and/or theft, but also from fears about surveillance in general. These concerns are shaped by the degree to which people trust governments, banks, and platforms. Ultimately, many interviewees felt they had no choice but to opt-in to systems they did not understand and could not (see for example, Srinivasan et al., 2018; Ossandón et al., 2017).

For many, there is a sense of inevitability to surveillance. People know that their privacy is *networked*—even if they are being cautious about their privacy, they know that it is nearly impossible

for an individual to maintain privacy when their transaction and communication partners do not or cannot (Marwick & boyd, 2014). While it may not be possible for people to stop using systems due to concerns about privacy, this feeling of inefficacy may have a cultivation effect in undermining trust in institutions and in the efficacy of democratic processes (see Barnes, 2006; Hargittai & Marwick, 2016; Hoffmann et al., 2016; Draper, 2017; Dencik & Cable, 2017; Dencik, 2018). Across all cases, surveillance was linked to control and behavior modification: whether through debt, market, or restrictions on transactions.

Debt and Data

When it comes to accessing loans, poor people are often caught between two bad options: informal systems, which can lead to serious harassment, or formal systems, which can tether people to a low credit score (and thus to a life of permanent exclusion) if not managed well (see for example Kolling, 2022).

In Indonesia, Azali and team spoke with a woman who sought to avoid regulated lenders because the fees were perceived to be higher and because of "system avoidance" (Brayne, 2014), a tendency for those who have had negative experiences with surveillant social institutions in the past, such as engagement with law enforcement, to avoid other institutions that keep formal records, such as medical, financial, and educational institutions.

To do this, she borrowed 3 million rupiah (US $191) from an unregulated *pinjol* (online lending) app that charged 500,000 rupiah (US $32) per week in interest. When she couldn't cover the repayments, she downloaded another pinjol app to pay the first, then another, and another. Eventually she had 11 apps in total, which she used only to pay the interest.

She registered for these apps using her mobile phone, making her number available to the lenders. They began calling and making numerous threats, including sexual threats. They also spread her phone number around WhatsApp in an effort to intimidate her.

To put an end to the harassment, she ultimately took out a loan from an unlicensed online lender. This saved her from their threats, but it also subjected her to higher interest rates and fees. Now she fears that her bad credit—now "official" in the eyes of regulators—will follow her forever.

Indeed, another Indonesian respondent found legal online lenders to be just as predatory as illegal ones. "It's such a trap, and can suffocate people too. They're all *pinjol*, it's just that they come from more reputable, established backgrounds," she said of these registered lenders.

She complained that lending offers were becoming virtually inescapable. Credit was offered by mobile payments providers for even the smallest of purchases: another Indonesian interviewee talked about being pushed to use mobile BNPL options for a meal at fast food chain McDonald's.

> "For people on the margins, the availability of more data may actually intensify particular forms of exclusion."

For many with a thin credit file, the use of novel (or previously invisible) transactional data could mark a huge improvement in their ability to access credit. However, it also could ossify abstracted representations of marginalized people's financial lives and creditworthiness.

For example, imagine a poor person who struggles to access a loan due to their thin credit history. They are told that they can share rental history data to augment their file, but that history reveals that they have missed rental payments in the past. They may have even chosen to prioritize other bills over rent because they were aware of what impacted their credit and what didn't. This data would create a new, more comprehensive picture of their credit history that is viewed as more accurate and could further solidify their exclusion from access to credit (see Maurer & Wrapp, 2020; Pasquale, 2015). Thus, for people on the margins, the availability of more data may actually intensify particular forms of exclusion from necessities like basic banking services and access to credit.

As BNPL and other forms of on-demand consumer micro-lending become more ubiquitous, it is important to consider how the repayment data generated from these loans will impact the credit status of those who would benefit the most from fair lending. It is also important to consider advances in the gamification of payment, which we discuss in the following subsection.

Gamification and Marketing Through Payment

Indonesia, in particular, is characterized by a landscape saturated with rewards, discounts, and incentives meant to motivate customers to use certain digital payment platforms. Also widespread is *gamification*, a marketing technique that appeals to customers using the psychology of gaming. Payment platforms thus may incorporate elements such as points, competitions with others, and time limits into their interfaces.

These tactics are only possible because they leverage transactional and other social data. They remake payment itself into a tool for marketing. But instead of merely collecting information about users in order to market to them, these tactics seek to directly influence behavior in highly granular ways. Gamified payments thus offer a concerning development in the next frontier of consumer surveillance, in which users are subject to micro-incentives meant to influence their spending and may even encourage them to take on debt (see, for example, Maurer et al., 2019).

In the context of these incentives, digital payments are aggressively marketed as a superior way to access certain services, and cash is framed as a more "expensive" way to pay. For instance, Sandbukt examined the color schemes used within payment app interfaces, noting that they frequently deploy green versus red to emphasize how "cheap" it is to use e-money compared to cash.

Also in Indonesia, Azali and team explain how payment platforms attract customers by offering large discounts and promotions. They give the examples of PayLater Kredivo, which offered a discount of 50,000 rupiah (US $3.30), and GoPay, which offered 8,750 rupiah (US $0.60). In Mexico, Crucifix mentions the case of an interviewee, Roberto, who can purchase goods from a shopping platform called MercadoPago because he has a five-star rating there. Sometimes he buys things for his family so that they can get discounts.

These kinds of marketing schemes both necessitate and threaten a public option for digital money. In a world of exploding financial targeting, having access to a money form that is free from gamification is more important than ever. At the same time, such an option stands less of a chance of adoption because users are heavily driven by incentives to use channels that may not serve their own long-term interest.

Social Surveillance and Control

Across our projects, many interviewees, particularly the most vulnerable, were concerned about the way various money technologies enabled surveillance by those who had power over their lives. Hiding cash and obfuscation of transactions from family members was common, but there was also much concern about surveillance by employers and government benefit case managers.

> "In a world of exploding financial targeting, having access to a money form that is free from gamification is more important than ever."

In Mexico, Crucifix found that women who received government payments acutely felt as though they were being surveilled by government workers, merchants, and other members of the community. This experience was shaped by the Prospera program, which ran from 2012 to 2018, which stipulated how much money they were supposed to spend for school, food, clothes, and other expenses. One respondent reported feeling as though her transactional behavior was being scrutinized even though she used her funds as provisioned by aid programs. She felt like government workers did not trust her to make decisions about her money that were right for her family.

These concerns become more acute with technological change. Barkway (2022) describes how Canadian welfare recipients were wary of the shift from paper checks to payment cards because they saw the cards as an extension of their relationship with caseworkers, whom they saw as adversarial. As a result, they carefully curated their purchase practices to produce financial data that they believed comported with caseworkers' vision of a "deserving" welfare recipient. The introduction of the cards thus placed a new burden on a marginalized population.

In some visions of CBDC, novel features could be used to codify social judgment into official policy, which could ultimately place technical constraints on money. Those who receive government benefits could easily find themselves robbed of agency over payments, and forced to negotiate complicated and abstract systems in order to make basic purchases for themselves and their families.

Indeed, in many places, welfare benefits cards already have built-in controls on what users can purchase. For example, in the United States, users of Electronic Benefits Transfer (EBT) cards cannot purchase prepared food. This includes whole rotisserie chickens, which are typically a loss leader for grocery stores and less expensive than whole uncooked chickens, and are thus an ideal purchase for impoverished families (Swartz, 2020).

A related example from our research partner in Indonesia relates to vulnerable sex workers. Azali's team observed that these individuals go to great lengths to keep their identity secret, such as maintaining multiple phones and accounts and sharing personal information indirectly or not at all. Some visions of CBDC prioritize cracking down on all illicit trade. If sex workers—many of whom are also members of the most vulnerable populations—are excluded from payment channels, they will likely face serious threats to their safety and survival (see, for example, Albert et al., 2021; McDonald et al., 2021; Blunt & Wolf, 2020; Swartz, 2020).

"Those who receive government benefits could easily find themselves robbed of agency over payments, and forced to negotiate complicated and abstract systems in order to make basic purchases for themselves and their families."

Ambivalent Benefits of Data Trails

Although participants have real concerns about privacy, surveillance, and control, there are also many instances in which leaving a data trail is desirable. Data can create opportunities that expand inclusion, such as credit products and personal finance and budgeting applications, as well as newer applications that automate financial decision making (see for example Plaitakis & Staschen, 2020; Vidal & Plaitakis, 2022). Indiyanto and team cite a civil servant in Indonesia who stated in an interview:

> *"From a technical point of view, I prefer digital, because I can trace the expenses. We don't need to make expense records. If it's cash, honestly I can't control it."*

Being able to draw on documentation of digital payments can be helpful in the case of disagreement over the delivery of a product. In Nigeria, David-West and Umukoro note that when people buy a secondhand car they prefer to pay by making a bank transfer to the dealer. That way they can ensure they have a record of the transaction.

For small merchants, digital financial tools both help in making and receiving payments but also in digitizing business processes. The utility of these systems becomes clearer when they are suddenly not available. For example, in Mumbai, Lalvani notes that one restaurant owner used to track expenses in Excel but now uses a point-of-sale system that includes inventory services management. When the WiFi is down (and it often is) and staff have to calculate and bill tabs manually, it can be very disruptive.

Data trails can add formality, legitimacy, and traceability to an informal or questionable transaction. They also provide reassurance to merchants, customers, and peers. These visible benefits of data trails frequently outweigh the invisible risks in everyday life.

Managing Spending: Living and Shopping in Indonesia

Dewi, 58, a mother and poultry egg distributor lives in the rural area where she grew up. Her daughter Aditya lives in Jakarta and does freelance work. Dewi is worried about her because she has been in debt several times.

Financial needs:

- Paying supplier
- Getting paid from customers
- Paying bills
- Shopping for groceries
- Occasional online shopping

Pain points:

- Queuing at the bank to enter cash sales in account
- Having to deposit sales late
- Paying bills on mobile device
- Digital payments and Buy Now, Pay Later (BNPL) that has added to her daughter's debts

Finance-related items carried:

- Wallet with cash
- Phone with mobile payment app

Dewi prefers dealing in cash and face-to-face. She has to pay her egg suppliers on their bank account and to do that, she travels to a nearby city at night every four to five days to deposit the money from her sales, or she gets her son to do it. She does not like to go to the bank in the village because she has to queue, and she does not want people she knows to see her sales.

Dewi pays for all her personal shopping in cash. She only pays certain bills by mobile phone. When she occasionally shops online for larger items, she always uses Cash on Delivery. That way she only pays when she has received the goods and she can tip the deliverer.

Dewi says that her daughter has tried to make her use digital wallets like GoPay for her shopping, but she is worried by the many stories of scams. She has also heard that data are not safe and that they may be shared outside the platform. She does not like that many of the wallets are connected to shopping platforms that offer promotions and cashback to make new customers go digital. They have also recently started offering BNPL with promotions. Her daughter has used these and has overspent, and now Dewi has to help her meet the payments.

Ways Forward for CBDC Design: Data

It is hard for any currency system that does not respect human dignity and the right to privacy to make honest claims about expanding financial inclusion and serving the public interest. Accordingly, designers of such complex systems have an ethical responsibility to protect users from harm. Doing so is easier said than done, and will depend heavily on whether or not these issues are at the core of CBDC design. To do so, designers will need to consider online and offline capabilities, modes of data storage, and overall storage capacity. They will also need to weigh relevant policy interests, business models, user needs, and practical issues in order to create the safest, most effective designs.

Key open questions include:

- How can systems be designed to meaningfully offer consent and choice for users? What are models that would balance AML/CTF (Anti-Money Laundering and Counter-terrorism Financing) considerations and anonymity?
- What is the minimum amount of data that is necessary to perform and settle the transaction?
- Who collects and holds what forms of data? Who is able to access that data? Under what circumstances can they do so?
- Can senders and recipients be pseudonymous/anonymous from the central bank during transactions? From intermediaries? From each other?
- How is data security risk and liability managed and allocated?
- Do users have the ability to move their data between providers? Can they take their data out of the system in a usable format?
- Are there restrictions on how money can be spent which might limit user agency?

Smart decisions about privacy can yield many practical benefits, including:

- Building public trust to drive adoption and acceptance
- Maintaining inter-currency competitiveness
- Ensuring central bank independence from other government functions
- Avoiding centralization of data vulnerable to hackers and nation-state attacks

How might CBDC designers strike a balance between the risks of data-sharing and its benefits?

- The most secure data is data that is not collected. The more user data any one entity has access to, the more power they exert over users' privacy. This leaves users more vulnerable to cybersecurity issues and other abuses overall.
- It is possible to design CBDC in a way that the central bank (or CBDC operator) sees very little user data, if any at all. Some designs could even show as little as the mere fact that a transaction is settling. Designs such as these would protect user data, but still may not eliminate all the threats to their privacy within the larger CBDC ecosystem.
- CBDC offers the opportunity to be more purposive about creating friction and barriers to what kind of data is exposed and to whom. It is worth considering dividing data between different roles in the overall CBDC ecosystem (wallets, intermediaries, identity providers, etc.) and relying on the fact that they are different entities.
- Privacy-protecting measures should consider users' needs and routines in their design. For instance, the European Central Bank (2022) suggests a model in which "low value and low risk" transactions might be anonymized while higher value transactions will require additional data. Measures such as this might better suit customers' needs while also taking steps to safeguard their data and protect their privacy.
- When considering surveillance and control, it is important for policymakers and technologies to clarify definitions, goals, and user protections. There are many novel and potentially useful opportunities for *programmable money* that might make building a CBDC worthwhile, but the term should not be conflated with *restricted money*, which is only one possible use case of programmable money (see also Deutsche Bundesbank, 2020; Usher et al., 2021).

Distance

Key affordance difference: Cash transactions typically cannot be transmitted remotely over distance, whereas intermediated digital funds can be transmitted over distance easily. This has important implications for remittances.

Globalization and digitization have transformed the geography of payment. Opportunities for entrepreneurship and employment increasingly require payment across distances. In this section we explore the ways in which payment is shaped by distance, focusing largely on financial activities that cross borders.

We examine unique issues faced by migrants, as well as the particularities of sending and receiving international remittances. Villarreal and Torres's research highlights some strategies people have developed to manage distance and geography as they relate to transactions.

Although much of our focus here is on borders and transnational geography, it is also important to underscore how distance and population demographics similarly shape domestic remittances. India, for instance, has large urban-to-rural remittance corridors, while Indonesia's vast archipelago can also complicate or delay payments.

Life Across Borders

When people cross borders, so does their money. People living in border regions may make frequent crossings just to go about the business of their daily lives, such as running errands, going to work or school, visiting friends and family, or seeking medical care. Some people, especially migrants, may even wish to maintain access to financial services in multiple countries. Borders complicate money management by imposing exchange rates and fees, but may also present new opportunities for remitting money between countries (Horst & Taylor, 2014).

In most cases, the ways in which cash moves across borders tend to mirror larger political relations between the two countries. For instance, a wealthier country's currency will likely be dominant over its neighbor's, both in rate of circulation and in the exchange rates offered. Residents who cross into a wealthier country to work are likely paid in that country's currency, and customers shopping across the border may need to obtain the stronger currency in order to make purchases. Maintaining access to financial services in two countries can be difficult.

In Mexico, Villarreal and Torres's team carried out research in Tijuana and Mexicali, both near the United States border. In their interviews, they found that people wishing to participate in both economies incurred extra costs or administrative requirements, such as maintaining two phone numbers or street addresses, in order to access banking services. Some banks in the United States impose rules that Mexican nationals cannot comply with, forcing them to close their accounts altogether.

Focus on Eastern Caribbean's DCash CBDC Pilot

The Eastern Caribbean Central Bank (ECCB) launched DCash, its CBDC pilot, in March 2021. It currently serves Anguilla, Antigua and Barbuda, Dominica, Grenada, Montserrat, Saint Kitts and Nevis, Saint Lucia, and Saint Vincent and the Grenadines. A key motivating factor behind developing a CBDC in the Eastern Caribbean was the difficulty of moving cash from one island to another, particularly in the event of natural disasters such as hurricanes. Indeed, the region's DCash CBDC pilot is a good example of how alliances may be enacted to overcome geographic and national barriers (ECCB, 2022). It is also a reminder that not all CBDC are nation-based: some, including DCash and the proposed digital euro, are regional alliances. These examples illustrate how central banks are putting thought into the ways in which cross-border interoperability might be achieved to foster financial inclusion.

On the other hand, living in a border region may also present unique advantages in terms of access to financial services. People may be able to access bank accounts, transfer services, and more on both sides of the border. This allows people to receive money from different sources (such as employers or family members) and may also reduce transaction fees.

Life across borders can also present difficulties for people who have migrated from a distant country. Villarreal and Torres give the example of Martin, a man who emigrated to Mexico from Haiti. He had only been living in Mexicali for a few months at the time of the interview and did not yet have the legal documents needed to open a bank account.

Remittances: A Key Challenge

Remittances present a global challenge for CBDC design. The World Bank (2021b) estimates that in 2021, global remittances grew by 7.3%, reaching a total of US $589 billion. CBDC that is remittance-friendly and interoperable, both with other CBDC and with existing payments systems, is critical to ensuring uptake. Moreover, the potential of CBDC to remit at low cost may contribute to financial inclusion goals.

Remittances between family members are particularly relevant in both Mexico and India. In Mexico, research partners Bernardo Bátiz-Lazo and Ignacio González-Correa focused specifically on transfers of resources from people working in the United States to their relatives in Mexico. In these situations, remittances can be a double-edged sword: they provide receivers with necessary funds for everyday expenses, but may also incentivize receivers to remain in informal, cash-based economies. From a financial perspective, remittances may be personal and relatively short-lived.

Bátiz-Lazo and González-Correa note that Mexican migrants in the United States often prefer cash transactions due to bad experiences with banks and fintech platforms, as well as general concerns about crime. Even transfers across long geographic distances include a significant cash component, with Bátiz-Lazo and González-Correa estimating that about 90% of remittance funds start and end as cash. Funds are deposited in cash, transferred, and then withdrawn again as cash by recipients.

Fees can be burdensome for those who send and receive remittances. International banks charge high fees to make remittances and may also take a cut of the exchange rate. However, navigating the confusing and ever-shifting landscape of fintech cross-border payment providers can be even more taxing. From a user perspective, some fintech platforms seem to offer transfers with lower fees, but may offer poorer exchange rates, leading to more expensive solutions overall. Fees and exchange rates also vary over time, and the lowest cost service might change month to month.

> "All of the problems that people encounter in other payment domains... are present and exacerbated in the context of remittances."

Many remittance senders complain about the uncertainties of tracking remittances once they've been sent. In the case of failure, the sender and beneficiary have to deal with at least two separate companies in two different countries. There is no single, cross-border consumer protection body for when things go awry.

Cross-border remittances are complicated by many factors, such as geography, infrastructure, changing business models, and individuals' own attitudes and preferences about money. As Taylor and Broløs (2022) found in their research on remittances in Brazil, this complexity makes it difficult to make decisions about the best way to transmit remittances in a particular context.

All of the problems that people encounter in other payment domains—such as lack of identification, connectivity issues, fees, settlement time, lack of recourse when things go wrong, and lack of privacy—are present and exacerbated in the context of remittances. Remittances are an important use case for CBDC, and understanding how to design them in the public interest requires more research from social, technical, policy, and economic angles.

The Journey of a Remittance: A Case from Mexico

Isela, 20, is a Mexican migrant who recently started working as a vegetable picker in Soledad (Salinas Valley), California. Isela is single with a basic education. She wants to help support her mother, Luisa, in Jaripo, Michoacán, Mexico.

Financial needs:

- Getting paid
- Shopping for personal needs
- Paying bills
- Sending money to her mother in Mexico

Pain points:

- Withdrawing her pay in cash to start the remittance process
- Finding someone to advise her on the process
- Fees and poor exchange rates reducing the amount that goes to her mother
- That her mother must travel to get the payments
- Worry about possible fraud and theft

Finance-related items carried:

- Wallet
- Prepaid debit card
- Cash
- Receipts
- Phone
- Identification

Although Isela is undocumented, she has a bank account in the United States opened by her employer where she receives her pay through a prepaid debit card. She uses cash to pay for her own needs while saving as much as possible to send to her mother.

She sends remittances in a traditional way that starts and ends in cash and goes through agents and remitters. This is because she needs advice on the process and particularly because she is not sure that her mother is able to receive the money in any other way than from a trusted person. Luisa's phone is old, the internet connection unstable, and she is not confident about using social media communication. Sending a remittance involves the following steps:

1. Isela asks a co-worker for help finding an agent of a Mexican company to transfer money (therefore she is not likely to shop around).
2. She withdraws money from the ATM and hands it to the agent, getting a receipt and a time and place for her mother to collect the money.
3. She will pay a fee to the agent or remitter as well as accept the exchange rate offered
4. The remitter will transfer the money to an aggregator in Mexico who will then find a "payer," usually a small shop where Luisa can pick up the money at the agreed time.

Consider an alternative scenario in which Isela's mother had her own bank account or a prepaid card. Both options would require the services to be interoperable between the two countries. The process might be much faster, but it could incur multiple costs and it is likely that her mother would still have to locate an ATM to withdraw cash.

Isela has a friend, Camila, who also transfers money to her own mother, who has a bank account. Camila is trying to find a cheaper and easier way to pay. She has identified three digital alternatives:

- Camila can go to her bank branch and send the money to Mexico (bank transfer) as a remittance for a banked person. The bank in the United States will contact another bank (correspondent) to pay her mother's bank the money in Mexico.
- Camila could use the online services of remitters like Western Union or MoneyGram. This entails filling out a form and it charges the cost of the remittance to her bank account in the United States. She would still pay similar costs but the transaction would be faster and easier.
- Camila is tempted to try using one of the fintech providers, which would allow her to transfer money through a fintech app over the phone. The fintech provider does not charge a fee. She has heard, however, that their exchange rate is really poor.

Ways Forward for CBDC Design: Distance

In designing a CBDC, we need to think about liminal geographies: people who cross borders frequently, and places where money crosses borders frequently. We need to think about the limits to use (for migrants, tourists, foreign workforce members, and businesses). If controls are draconian, they could negatively impact the most vulnerable or lead to lack of adoption in these regions.

Key open questions include:

- What opportunities exist to safely and securely design CBDC without requiring specific national identification, especially given that the people living around or across borders are especially at risk of not having the appropriate identity credentials?
- How do various architectural models for cross-border CBDC exchange impact users?
- How can a single CBDC be designed to improve cross-border speed, reduce costs, and increase welfare, and what opportunities exist to co-design CBDC in different currencies to improve the exchange experience?
- What kind of international standards will need to be set to facilitate not just wholesale cross-border transactions but also remittances in CBDC?

There are several architectural options presently being considered for cross-border CBDC. More research needs to be done to understand how these options impact user experience:

- Some key concerns for users include speed, costs, privacy, tracking of transactions, and redress of problems.
- Will CBDC be available for use by immigrants, asylum seekers, border residents, migrants, undocumented people, and others who frequently cross borders? If so, how? What protections need to be developed to serve these populations?
- There is no single, cross-border consumer protection body for remittances. How might new designs consider user redress?
- Especially when considering cross-border multi-CBDC architectures, policymakers and technologists need to be aware of how the data collection and protection practices of one country's system impact the final privacy properties of all transactions.

Looking Ahead

In this report, we have argued that the success of CBDC relies heavily on the design of their operating model, how that model shapes affordances, and how those affordances serve users' needs and fit into their existing financial routines. Our fieldwork generated many rich and nuanced examples meant to bolster designers' comprehension of the social realities of several key payment affordances: custody, access, finality, data, and distance.

In the following subsections, we consider how our research might influence future conversations about CBDC itself and financial inclusion in general. We conclude by highlighting opportunities for further research.

Rethinking Intermediation and the CBDC Operating Model

In each of our fieldwork insight sections, we offered considerations for the design and implementation of CBDC. These are essential concerns because, as we demonstrate, intermediated currency is only as effective for inclusion as its intermediary ecosystem is. In this section, we consider more holistic ways forward for considering CBDC operating models, particularly how they are intermediated.

When considering intermediation from a technical and operational perspective, it is clear that intermediation can be "unbundled" into many distinct concepts. For example, payment intermediaries today do many different things: they custody funds for users, authorize transactions based on identity, execute transactions, offer account services, and so on.

Thus, we find that descriptions of the intermediated model of CBDC render it both too broad and too specific to be as useful as it could be for thinking about how the design of digital currency could expand digital inclusion and serve the public interest. It is too broad because it attempts to contain a wide decision space within a single category, when in fact a CBDC could be provisioned in part by a central bank and in part by other organizations in many different configurations. It is too specific because it does not take full account of the options that sit in this wide decision space.

Specifically, articulations of the intermediated model generally assume that a commercial bank or fintech will provide most operational roles not handled by the central bank. There is no technical reason why account functions could not be unbundled, with different organizations providing different services to the user. They do not need to be bundled into one intermediary or even one type of intermediary.

Rethinking intermediation could dramatically alter the account relationship as it has been conventionally understood. In existing models, most account functions flow from the custodial intermediary. This has consequences for financial inclusion in the public interest, particularly in terms of choice, recourse, interoperability, and ability to exit. It also concentrates infrastructural power and risk to users.

> "There is no technical reason why account functions could not be unbundled, with different organizations providing different services to the user."

For example, it is possible to imagine a CBDC system in which the following attributes are possible: the CBDC is issued by and remains a liability of the central bank, such that every transaction settles with the central bank; retail customer interface is handled by a robust ecosystem of public and private intermediaries; access to the central bank transaction settlement engine is provided through a cryptographic key wallet that may be self-provisioned by the user for low-value transactions; both compliance and dispute resolution are on-demand services provided by a similarly robust ecosystem of tech firms.

New kinds of intermediaries may, for example, increase competition and offer new opportunities to design customized products tailored to the needs of small groups of users. However, unbundled intermediation may also lead to market fragmentation and discord, and therefore may be particularly hard to regulate.

Nevertheless, the opportunity exists that by rethinking intermediation and unbundling the intermediary relationship, we can expand the range of possible CBDC design options and increase the flexibility of tactics to achieve financial inclusion and public-interest policy goals. What kinds of organizations might qualify and how?

Stakeholders should consider a full range of organizational considerations: who can or should take on the intermediation of CBDC, and how should they be governed? What relevant stakeholders are being left out of the conversation, and how might that impact the usefulness and adoption of CBDC? It is useful to consider a range of organizations that might play a role, such as:

- The public sector beyond the central bank: meaningful involvement across agencies could present an opportunity to create alignment across various money technology reform agendas.
- Civil society and financial-inclusion organizations: both traditional (e.g., NGOs) and non-traditional (gig worker unions, mutual aid groups, platform cooperatives) organizations might bring new ideas that meaningfully expand financial inclusion and the public interest.
- The private sector beyond traditional models of the commercial bank: CBDC might serve as a platform for innovation and competition.

It is also important to consider the question of scale. In order to reap the social and economic benefits of a diverse ecosystem, CBDC policymakers should consider the role of medium-sized and regional organizations like credit unions, community banks, community development financial institutions, and universities.

Finally, we want to take seriously the possibility of self-provision for some roles in some circumstances. In most cases, people should not be responsible for maintaining their own financial cybersecurity systems, which would be necessary for self-custody; however, there may be some instances in which it makes sense for some users. CBDC should not be designed to rule out this possibility.

It is important to consider the full spectrum of mechanism considerations: in what perhaps novel ways might those roles be provisioned and governed? With established mechanisms of provisioning services and a host of powerful new tools from the decentralized digital currency world, how might we take advantage of these instruments to achieve CBDC goals? Some examples of recent technologies that can facilitate CBDC design and delivery include stablecoins, multisignature escrow, self-custodying wallets, conditional payments, cryptographic credentials, zero-knowledge proofs, and more advanced smart contracts.

As we consider new ways of provisioning the CBDC intermediary ecosystem, we want to stress that we need not limit focus to the technical. Although they are largely beyond the scope of this report, it is also essential to consider the full range of available legal and regulatory tools. Many existing problems can be solved via legal rather than technological tools. This is especially important to consider if we foresee that intermediary functions will be unbundled into different service providers and not regulated in a package under a bank.

> "We argue that in order for a CBDC to be trusted, it must first be trustworthy."

Rethinking Financial Inclusion

The question of trust is at the core of the decisions people make about their money, and will likewise be a key factor in successful CBDC rollout. We have addressed the important role of both formal and informal communication networks in the cultivation of trust, and we have pointed to the lack of trust our respondents have in existing systems, even as they feel compelled to use them.

But the concern here is even larger. Amid a global crisis of faith in institutions (see for example Castells, 2018; Bennett & Livingston, 2020), what will be the fate of a technology like CBDC that sits at the intersection of some of the least trusted institutions, namely technology, finance and governance?

We argue that in order for a CBDC to be *trusted*, it must first be *trustworthy*. Especially considering the rise of authoritarian regimes around the world, the acceleration of the surveillance state, and the increasing challenge of regulating the technology industry, it is far from self-evident that people *should* trust a CBDC.

In order to be trustworthy for all, CBDC must be trustworthy to the most vulnerable. We argue, then, that in order to fully address the potential social benefit of CBDC, we need to push beyond questions of inclusion.

- How can CBDC offer infrastructural equity to users, allowing them access on reasonably equal terms?
- Does a CBDC concentrate infrastructural power—the ability to control the system and traffic over it? Does it offer mechanisms of redress to counter this power?
- How does the technology promote, limit, and assign power, dignity, consent, and agency?

These questions about fair processes in the key social institution of money (Rawls, 1971; Sen, 2009) are essentially questions about what Cheesman (2022a) calls financial infrastructural justice.

In order to assess these questions, stakeholders should look for answers across affordances of currency. In our fieldwork, we have surfaced some ways that existing intermediated money forms are failing these tests.

The need for a public option for digital currency infrastructure is especially pronounced as the technology sector, particularly fintech, weathers a downturn in venture capital and other investments. As more and more transactions are conducted through private digital intermediaries, what happens when the profit model for those intermediaries is challenged? As a publicly provisioned infrastructure maintained by the central bank, CBDC has an opportunity to fill important economic and social needs as an infrastructure that is insulated from market changes.

We have also been particularly concerned with digital divides in money itself. State-issued currency has long played a role as a public infrastructure for transactions. Cash is monetary "mass media" that replaced a tiered and siloed monetary cacophony in which poor people used scrip, petty coin, and deprecated notes, and rich people used banks notes and letter of credit (Simmel, 1971; Helleiner, 1998; Swartz, 2020). With cash, the money form itself was equal, even if the amounts were not.

> "We should be concerned that the future of money technology will look like the past: private, plural, segregated, and unequal."

Some argue that these currency "divides" have never truly been left behind (Birch, 2017; Swartz, 2020; Scott, 2022). After all, in many places in the world, some people have to pay a fee every time they pay while others earn rewards. Those who primarily use cash are increasingly limited in where their money can be spent. Whether CBDC will succeed in truly expanding financial inclusion will depend on whether it ameliorates or exacerbates these inequalities.

We should be concerned that the future of money technology will look like the past: private, plural, segregated, and unequal. If CBDC is not designed with care, it could deepen and even create new digital divides. This could mean a new two- (or multi-) tiered monetary order, with some money forms for poor people and other forms for the wealthy. How can CBDC be designed to prevent this?

Recommendations for Further Research

This report has offered an introductory survey of key techno-social concerns for CBDC and its intermediary ecosystems. More research will be required to better understand user practices, bases of infrastructural power, and possible ways forward for CBDC design. Throughout the course of our research, we have identified a range of questions that warrant deeper exploration. Although we encourage collaborative and interdisciplinary perspectives whenever possible, we have grouped the following opportunities for additional research into three main approaches.

From a social perspective:

- Socio-technical research on cybersecurity, scams, and fraud to anticipate and address the novel environment that CBDC implementation would produce
- User experience research on cross-border CBDC payments, an important use case that is fraught with many problems for the most vulnerable
- Public opinion research on trust, misinformation, and communication related to CBDC considering worldwide levels of distrust in existing institutions
- Evaluation research on the successes and shortcomings of the public adoption of existing CBDC models

From a technical perspective:

- Research on how specific innovations from decentralized cryptocurrency intermediaries might be deployed in relation to CBDC
- Systems design research on the technical trade-offs of key CBDC design decisions, such as transaction speed with reversibility and programmability and/or offline access with security
- Investigation into techniques that allow secure access toCBDC while also preventing fraudulent or spam transactions in a paradigm where strong user identity cannot be relied upon to gate access to the system
- Privacy research on management of user data, with the goal of striking a safe and effective balance between operational issues, security concerns, and data ethics

From an economic and policy perspective:

- Policy research on the role(s) of public, private, and civil society entities in the CBDC ecosystem, operations, and governance, including central banks and traditional financial institutions but also beyond them
- Research to examine the benefits of central bank liability compared to other mechanisms of safeguarding the value of funds
- Econometric research on the costs of CBDC relative to existing systems, such as cash, commercial bank/wire transfers, Fast Payment Systems, and mobile money
- Macroeconomic research on how the launch of a CBDC might affect financial stability, including the potential for the disintermediation of credit creation

Bibliography

Adrian, T., & Mancini-Griffoli. (2019). *The Rise of Digital Money*. IMF. https://www.imf.org/en/Publications/fintech-notes/Issues/2019/07/12/The-Rise-of-Digital-Money-47097

Adrian, T., & Mancini-Griffoli, T. (2022, September). *Bullet train*. IMF. https://www.imf.org/en/Publications/fandd/issues/2022/09/Bullet-train-Adrian-Mancini-Griffoli

Albert, K., Brundige, E., & Lee, L. (2021). FOSTA in legal context. *Human Rights Law Review*, 52(3), Article 3.

Allen, M., Esser, A., & Cooper, B. (2019). *Central bank digital currency (CBDC) and financial inclusion*. Cenfri. https://cenfri.org/publications/central-bank-digital-currency-cbdc-and-financial-inclusion/

Allen, S., Grimmelmann, J., Juels, A., & Prasad, E. (2020, July 23). Design choices for central bank digital currency. *Brookings*. https://www.brookings.edu/blog/up-front/2020/07/23/design-choices-for-central-bank-digital-currency/

Atako, N. (2021). Privacy beyond possession: Solving the access conundrum in digital dollars. *Vanderbilt Journal of Entertainment & Technology Law*, 23(4).

Atlantic Council. (2022). Central Bank Digital Currency Tracker. *Atlantic Council*. https://www.atlanticcouncil.org/cbdctracker/

Auer, R., & Boehme, R. (2020). *The technology of retail central bank digital currency*. https://www.bis.org/publ/qtrpdf/r_qt2003j.htm

Auer, R., Frost, J., Lee, M., Martin, A., & Narula, N. (2021, December 1). Why Central Bank Digital Currencies? *Liberty Street Economics*. https://libertystreeteconomics.newyorkfed.org/2021/12/why-central-bank-digital-currencies/

Auer, R., Banka, H., Boakye-Adjei, N. Y., Faragallah, A., Frost, J., Natarajan, H., & Prenio, J. (2022a). *Central bank digital currencies: A new tool in the financial inclusion toolkit?* https://www.bis.org/fsi/publ/insights41.htm

Auer, R., Frost, J., Gambacorta, L., Monnet, C., Rice, T., & Shin, H. S. (2022b). Central bank digital currencies: Motives, economic implications, and the research frontier. *Annual Review of Economics*, 14(1), 697–721.

Bank of Canada, European Central Bank, Bank of Japan, Sveriges Riksbank, Swiss National Bank, Bank of England, Board of Governors of the Federal Reserve, & Bank for International Settlements. (2020). *Central bank digital currencies: Foundational principles and core features*. https://www.bis.org/publ/othp33.htm

Bank of Mauritius. (2022). *Financial Literacy*. https://www.bom.mu/financial-literacy

Barkway, K. (2022). Surveillance potential: Exploring how unbanked social assistance recipients in Toronto, Canada negotiated a mandatory transition from cash to cards. *Punishment & Society*.

Barnes, S. B. (2006). A privacy paradox: Social networking in the United States. *First Monday*.

Barr, M. S., Harris, A., Menand, L., & Xu, W. (Michael). (2020). *Building the payment system of the future: How central banks can improve payments to enhance financial inclusion* (SSRN Scholarly Paper No. 3664790).

Barr, M. S., Harris, A., Menand, L., & Thrasher, K. (2021). *Should central banks use distributed ledger technology and digital currencies to advance financial inclusion?* (SSRN Scholarly Paper No. 3849051).

Bech, M., & Garratt, R. (2017). *Central bank cryptocurrencies* [BIS Quarterly Review]. https://www.bis.org/publ/qtrpdf/r_qt1709y.htm

Bennett, W. L., & Livingston, S. (Eds.). (2020). *The Disinformation age: Politics, technology, and disruptive communication in the United States*. Cambridge University Press.

Berentsen, A., & Schar, F. (2018). *The Case for Central Bank Electronic Money and the Non-case for Central Bank Cryptocurrencies*. Federal Reserve Bank of St. Louis. https://research.stlouisfed.org/publications/review/2018/02/13/the-case-for-central-bank-electronic-money-and-the-non-case-for-central-bank-cryptocurrencies

Birch, D. (2017). *Before Babylon, beyond Bitcoin: From money that we understand to money that understands us*. London Publishing Partnership.

BIS. (2022). III. The future monetary system. *BIS Annual Economic Report*. https://www.bis.org/publ/arpdf/ar2022e3.htm

Blunt, D., & Wolf, A. (2020). *Erased: The impact of FOSTA-SESTA and the removal of backpage*. Hacking//Hustling.

Board of Governors of the Federal Reserve System (2022). *Money and payments: The U.S. dollar in the age of digital transformation*. https://www.federalreserve.gov/publications/files/money-and-payments-20220120.pdf

Brayne, S. (2014). Surveillance and system avoidance: Criminal justice contact and institutional attachment. *American Sociological Review*, 79(3), 367–391.

Castells, M. (2018). *Rupture: The crisis of liberal democracy*. Wiley.

Central Bank of Nigeria. (2022). *eNaira design paper*. https://enaira.gov.ng/about/design

Cheesman, M. (2022a). *Infrastructure justice and humanitarianism: Blockchain's promises in practice*. University of Oxford. https://ora.ox.ac.uk/objects/uuid:3a375a60-85b2-4953-bc04-5cae34021df1

Cheesman, M. (2022b). Self-sovereignty for refugees? The contested horizons of digital identity. *Geopolitics*, 27(1), 134–159.

Cheesman, M. (2022c). *Web3 and communities at risk: Myths and problems with current experiments*. Cambridge: Minderoo Centre for Technology and Democracy.

Crawley, J. (2022, August 19). *Nigeria's CBDC eNaira used for nearly $10M worth of transactions since October*. https://www.coindesk.com/policy/2022/08/19/nigerias-cbdc-enaira-used-for-nearly-10m-worth-of-transactions-since-october/

DFSWG, Digital Financial Services Working Group (2022). *Central Bank Digital Currency—An opportunity for inclusion in developing and emerging economies?* Alliance for Financial Inclusion. https://www.afi-global.org/publications/central-bank-digital-currency-special-report/

de Sardan, J. P. O., & Piccoli, E. (Eds.). (2018). *Cash transfers in context: An anthropological perspective*. Berghahn Books.

Dencik, L., & Cable, J. (2017). Digital citizenship and surveillance: The advent of surveillance realism: Public opinion and activist responses to the Snowden Leaks. *International Journal of Communication, 11.*

Dencik, L. (2018). Surveillance realism and the politics of imagination: Is there no alternative? *Krisis: Journal for Contemporary Philosophy*, 1, 31–43.

Deutsche Bundesbank. (2020). *Money in programmable applications: Cross-sector perspectives from the German economy.*

Didenko, A. N., & Buckley, R. P. (2021). *Central bank digital currencies: A potential response to the financial inclusion challenges of the Pacific*. Asian Development Bank. https://www.adb.org/publications/central-bank-digital-currencies-financial-inclusion-pacific

Disparte, D. A. (2022, Summer). The case against central bank digital currencies. *The International Economy*, 54-68.

Dombret, A., & Wunsch, O. (2022, Spring). The case for central bank digital currencies. *The International Economy*, 54–59.

Donovan, K. P., & Park, E. (2022). Algorithmic intimacy: The data economy of predatory Inclusion in Kenya. *Social Anthropology/Anthropologie Sociale*, 30(2), 120–139.

Draper, N. A. (2017). From privacy pragmatist to privacy resigned: Challenging narratives of rational choice in digital privacy debates. *Policy & Internet*, 9(2), 232–251.

Dzokoto, V. A., & Mensah, E. C. (2010). Making sense of a new currency: An exploration of Ghanaian adaptation to the new Ghana cedi. *The Journal of Applied Business and Economics*, 10(5), 11–18.

Dzokoto, V. A., Appiah, E. N., Chitwood, L. P., & Imasiku, M. L. (2016). The Changing Face of Money: Preferences for Different Payment Forms in Ghana and Zambia. *Journal of Applied Business and Economics,* 18(4).

ECCB, Eastern Caribbean Central Bank. (2022). DCash: *About the Project*. https://www.eccb-centralbank.org/p/about-the-project

Ericson, R. V., & Haggerty, K. D. (2006). *The new politics of surveillance and visibility.* University of Toronto Press.

Eubanks, V. (2018). *Automating inequality: How high-tech tools profile, police, and punish the poor.* St. Martin's Press.

European Central Bank. (2022). *Digital euro: Privacy options*. https://www.ecb.europa.eu/paym/digital_euro/investigation/governance/shared/files/ecb.degov220404_privacy.en.pdf?39c27f3bda85972b8070c318bb4e3578

Foster, K., Blakstad, S., Gazi, S., & Bos, M. (2021). *Digital currencies and CBDC impacts on least developed countries (LDCs). Dialogue on Global Digital Finance Governance.* (United Nations Development Programme. Technical Paper 1.2). https://www.undp.org/sites/g/files/zskgke326/files/2021-06/UNDP-UNCDF-TP-1-2-Digital-Currencies-and-CBDC-Impacts-on-Least-Developed-Countries-LDCs-EN.pdf

Garratt, R., Lee, M., Malone, B., & Martin, A. (2020, August 12). Token- or account-based? A digital currency can be both. *Liberty Street Economics*. https://libertystreeteconomics.newyorkfed.org/2020/08/token-or-account-based-a-digital-currency-can-be-both/

Hargittai, E., & Marwick, A. (2016). "What can I really do?" Explaining the privacy paradox with online apathy. *International Journal of Communication*, 10(21).

Hartinger. (2022, May 11). Emerging economies are pioneers of CBDCs. *OMFIF*. https://www.omfif.org/2022/05/emerging-economies-are-pioneers-of-cbdcs/

Helleiner, E. (1998). National currencies and national identities. *American Behavioral Scientist*, 41(10), 1409–1436.

Hertig, A. (2020, August 7). Fixing this Bitcoin-killing bug will (eventually) require a hard fork. *CoinDesk*. https://www.coindesk.com/tech/2020/08/07/fixing-this-bitcoin-killing-bug-will-eventually-require-a-hard-fork/

Hoffmann, C. P., Lutz, C., & Ranzini, G. (2016). Privacy cynicism: A new approach to the privacy paradox. *Cyberpsychology: Journal of Psychosocial Research on Cyberspace, 10*(4).

Horst, H., & Miller, D. (2005). From Kinship to Link-up: Cell Phones and Social Networking in Jamaica. *Current Anthropology,* 46(5), 755–778.

Horst, H. A., & Taylor, E. B. (2014). The role of mobile phones in the mediation of border crossings: A study of Haiti and the Dominican Republic. *The Australian Journal of Anthropology,* 25(2), 155–170.

ID4D, World Bank. (2022). Global Data Set | *Identification for Development*. https://id4d.worldbank.org/global-dataset

Idris, A. (2021, November 19). *Africa's first e-currency is off to a shaky start in Nigeria*. Rest of World. https://restofworld.org/2021/the-inside-story-of-nigerias-shaky-launch-of-africas-first-e-currency/

IMF. (2022, September). *Digital Money 101 Explainer*. https://www.imf.org/en/Publications/fandd/issues/2022/09/Digital-Money-101-explainer

IMTFI, The Institute for Money, Technology & Financial Inclusion. (2013). *Warning signs & ways forward: Digital client uptake*. The University of California, Irvine. https://www.imtfi.uci.edu/files/docs/2014/imtfi-dpcu2-digital-lores.pdf

Jackson, H., & Massad, T. G. (2022, March 10). The treasury option: How the US can achieve the financial inclusion benefits of a CBDC now. *Brookings*. https://www.brookings.edu/research/the-treasury-option-how-the-us-can-achieve-the-financial-inclusion-benefits-of-a-cbdc-now/

Kanovitz. (2022, August 5). Banks' financial inclusion initiatives are too narrow. *OMFIF*. https://www.omfif.org/2022/08/banks-financial-inclusion-initiatives-are-too-narrow/

Kar, S. (2018). *Financializing Poverty: Labor and Risk in Indian Microfinance*. Stanford University Press.

Kolling, M. (2022). Selling hope on credit: Women's livelihoods, debt and the production of urban informality in Brazil. *Contemporary Social Science,* 17(3), 262–275.

Krippner, G. R. (2011). *Capitalizing on crisis: The political origins of the rise of finance*. Harvard University Press.

Kusimba, S., Yang, Y., & Kunyu, G. (2017). *Dynamic networks of mobile money among unbanked women in Western Kenya*. Institute for Money, Technology, and Financial Inclusion.

Lauer, J. (2017). *Creditworthy: A history of consumer surveillance and financial identity in America*. Columbia University Press.

Lovejoy, J., Fields, C., Virza, M., Frederick, T., Urness, D., Karwaski, K., Brownworth, A., & Narula, N. (2022). *A high performance payment processing system designed for central bank digital currencies. Cryptology ePrint Archive.*

Marwick, A. E., & boyd, danah. (2014). Networked privacy: How teenagers negotiate context in social media. *New Media & Society, 16*(7), 1051–1067.

Maurer, B., Nelms, T. C., & Rea, S. C. (2013). "Bridges to cash": Channeling agency in mobile money. The Journal of the Royal *Anthropological Institute, 19*(1), 52–74.

Maurer, B., Musaraj, S., & Small, I. V. (2018). *Money at the margins: Global perspectives on technology, financial inclusion, and design*. Berghahn Books.

Maurer, B., Wrapp, M. K., Middleton, C., Dzokoto, V., & Fan, J. (2019). *The lessons of fintech apps: Design matters for personal finance*. Filene Research Institute. https://filene.org/learn-something/reports/the-lessons-of-fintech-apps-design-matters-for-personal-finance

Maurer, B., & Wrapp, M. K. (2020). *Fairness and Accountability for Algorithms in Financial Services*. Filene Research Institute. https://filene.org/learn-something/reports/fairness-and-accountability-for-algorithms-in-financial-services

McDonald, A., Barwulor, C., Mazurek, M., Schaub, F., & Redmiles, E. M. (2021, August 11). *"It's stressful having all these phones": Investigating sex workers' safety goals, risks, and practices online.* Proceedings of the 30th USENIX Security Symposium. https://www.usenix.org/conference/usenixsecurity21/presentation/mcdonald

Miedema, J., Minwalla, C., Warren, M., & Shah, D. (2020). *Designing a CBDC for universal access* (No. 2020–10). Bank of Canada. https://doi.org/10.34989/san-2020-10

Narula, N. (2021, September 23). *The technology underlying stablecoins*. https://nehanarula.org/2021/09/23/stablecoins.html

Narula, N., Dryja, T., Saad, M., Oest, A., & Xu, S. (2022, October 14). CBDCs present new opportunities for handling disputes and fraud. *OMFIF*. https://www.omfif.org/2022/10/cbdcs-present-new-opportunities-for-handling-disputes-and-fraud/

Natile, S. (2020). Digital finance inclusion and the mobile money "social" enterprise: A socio-legal critique of M-Pesa in Kenya. *Historical Social Research / Historische Sozialforschung*, 45(3), 74–94.

Norman, D. (1988). *The design of everyday things*. Basic Books.

Olagunju, D. (2021). Nigeria's eNaira Is not an economic panacea. *Foreign Policy*. https://foreignpolicy.com/2021/12/07/nigeria-enaira-economy-digital-currency-foreign-reserves/

Osae-Brown, A., Fatunde, M., & Olurounbi, R. (2022, October 24). Digital-currency plan falters as Nigerians defiant on crypto. *Bloomberg.com*. https://www.bloomberg.com/news/articles/2022-10-25/shunned-digital-currency-looks-for-street-credibility-in-nigeria

Ossandón, J., Ariztía, T., Barros, M., & Peralta, C. (2017). Accounting in the margin: Financial ecologies in between big and small data. *Civitas: Revista de Ciências Sociais,* 17(1), e1–e26.

Ozili, P. K. (2020). Financial inclusion: A strong critique. (MPRA Paper). University Library of Munich, Germany. https://ideas.repec.org/p/pra/mprapa/101813.html

Pasquale, F. (2015). The black box society: *The secret algorithms that control money and information*. Harvard University Press.

Plaitakis, A., & Staschen, S. (2020, October). *Open Banking: How to Design for Financial Inclusion.* CGAP.

Prabhakar, R. (2021). *Financial inclusion: Critique and alternatives*. Bristol University Press.

PYMNTS. (2021, September 27). *Nigeria's central bank preps for launch of eNaira digital Currency*. https://www.pymnts.com/cbdc/2021/nigeria-central-bank-preps-launch-enaira-digital-currency/

Rawls, J. (1971). *A theory of justice*. Belknap Press.

Riley, E. (2019). *Hiding loans in the household using mobile money: Experimental evidence on microenterprise investment in Uganda*. NOVAFRICA Conference on economic development in Africa.

Rogers, E. M. (2003). *Diffusion of Innovations* Free Press.

Sadowski, J. (2019). When data is capital: Datafication, accumulation, and extraction. *Big Data & Society,* 6(1), 1-12.

Sambasivan, N., Checkley, G., Batool, A., Ahmed, N., Nemer, D., Gaytán-Lugo, L. S., Matthews, T., Consolvo, S., & Churchill, E. (2018). *"Privacy is not for me, it's for those rich women": Performative Privacy Practices on Mobile Phones by Women in South Asia.* 127–142.

Sandbukt, S. (2021). *Top-up with driver: Digital money, transactional aspirations, and peerhood in Yogyakarta, Indonesia.* IT-University of Copenhagen.

Schwittay, A. F. (2011). The financial inclusion assemblage: Subjects, technics, rationalities. *Critique of Anthropology,* 31(4), 381–401.

Scott, B. (2022). *Cloudmoney: Cash, cards, crypto, and the war for our wallets.* Harper Collins.

Seamster, L., & Charron-Chénier, R. (2017). Predatory inclusion and education debt: Rethinking the racial wealth gap. *Social Currents*, 4(3), 199–207.

Sen, A. (2009). *The idea of justice.* Harvard University Press.

Simmel, G. (1971). The Metropolis of Modern Life. In D. Levine (Ed.), *Georg Simmel on Individuality and Social Forms* (p. 324). Chicago University Press.

Soderberg, G., Bechara, M., Bossu, W., Che, N. X., Davidovic, S., Kiff, J., Lukonga, I., Griffoli, T. M., Sun, T., & Yoshinaga, A. (2022). *Behind the scenes of central bank digital currency.* IMF. https://www.imf.org/en/Publications/fintech-notes/Issues/2022/02/07/Behind-the-Scenes-of-Central-Bank-Digital-Currency-512174

Sousa, L. P., Veras, R. M. S., Vogado, L. H. S., Britto Neto, L. S., Silva, R. R. V., Araujo, Flávio. H. D., & Medeiros, F. N. S. (2020). Banknote identification methodology for visually impaired people. *2020 International Conference on Systems, Signals and Image Processing (IWSSIP).*

Srinivasan, J., & Oreglia, E. (2016). *Intermediaries, Cash Economies,and Technological Change in Myanmar and India.* Institute for Money, Technology and Financial Inclusion (IMTFI). https://escholarship.org/uc/item/9x78p9nn

Srinivasan, J., Bailur, S., Schoemaker, E., & Seshagiri, S. (2018). Privacy at the Margins |The Poverty of Privacy: Understanding Privacy Trade-Offs From Identity Infrastructure Users in India. *International Journal of Communication,* 12(0).

Suri, T., & Jack, W. (2016). The long-run poverty and gender impacts of mobile money. *Science, 354*(6317), 1288–1292.

Swartz, L. (2020). *New money: How payment became social media.* Yale University Press.

Taylor, E. B., & Broløs, A. (2022). *Money and payments in low income Brazil.* SICPA.

Taylor, K.-Y. (2019, September 24). Predatory inclusion. *N+1.* https://www.nplusonemag.com/issue-35/essays/predatory-inclusion/

Toh, Y. L. (2021, October 21). *Prepaid Cards: An Inadequate Solution for Digital Payments Inclusion.* Federal Reserve Bank of Kansas City. https://www.kansascityfed.org/research/economic-review/prepaid-cards-an-inadequate-solution-for-digital-payments-inclusion/

UIDAI, Unique Identification Authority of India. (2022). *Aadhaar Dashboard.* https://uidai.gov.in/aadhaar_dashboard/

Usher, A., Reshidi, E., Rivadeneyra, F., & Hendry, S. (2021). *The positive case for a CBDC.* Bank of Canada.

Vidal, M. F., & Plaitakis, A. (2022, July 8). *How Can Data Sharing Support Inclusion?* CGAP. https://www.cgap.org/blog/how-can-data-sharing-support-inclusion

Vines, J., Dunphy, P., & Monk, A. (2014). Pay or delay: The role of technology when managing a low income. *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, 501–510.

Vinsel, L., & Russell, A. L. (2020). *The innovation delusion: How our obsession with the new has disrupted the work that matters most.* Currency.

Westermeier, C. (2020). Money is data – the platformization of financial transactions. *Information, Communication & Society, 23*(14), 2047–2063.

World Bank. (2020, April 11). *In India, women's self-help groups combat the COVID-19 (Coronavirus) pandemic.* https://www.worldbank.org/en/news/feature/2020/04/11/women-self-help-groups-combat-covid19-coronavirus-pandemic-india

World Bank. (2021a). *Global Findex Database 2021.* World Bank. https://www.worldbank.org/en/publication/globalfindex

World Bank. (2021b). *Remittance flows register robust 7.3 percent growth in 2021.* World Bank. https://www.worldbank.org/en/news/press-release/2021/11/17/remittance-flows-register-robust-7-3-percent-growth-in-2021

World Bank. (2021c). *Central bank digital currency: A payments perspective.* https://openknowledge.worldbank.org/handle/10986/36765

World Bank. (2022a). *Financial Inclusion: Overview.* https://www.worldbank.org/en/topic/financialinclusion/overview

World Bank. (2022b). *Open Data.* https://data.worldbank.org/

Zuboff, S. (2019). *The Age of Surveillance Capitalism: The Fight for a Human Future at the New Frontier of Power* (1st edition). PublicAffairs.

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