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Monetary Policy Implications of Central Bank Digital Currencies

Perspectives on Jurisdictions with Conventional and Islamic Banking Systems

Inutu Lukonga

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Monetary and Capital Markets Department (MCM)

**Monetary Policy Implications of Central Bank Digital Currencies: Perspectives on Jurisdictions
with Conventional and Islamic Banking Systems
Prepared by Inutu Lukonga***

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ABSTRACT: Central bank digital currencies (CBDCs) promise many benefits but, if not well designed, they could have undesired consequences, including for monetary policy. Issuing an unremunerated CBDC or a wholesale CBDC does not change the objectives of monetary policy or the operational framework for monetary policy. CBDCs can, however, induce changes in the retail, wholesale and cross border payments that have negative spillover effects on monetary policy, through their effects on money velocity, bank deposit disintermediation, volatility of bank reserves, currency substitution, and capital flows. Countries most vulnerable are those with banking systems dominated by small retail deposits and demand deposits, low levels of digital payments and weak macro fundamentals. Proposed CBDC design features, such as caps on CBDC holdings and unremunerating the CBDC can moderate disintermediation risks, but they are not sufficient. Central banks will need to ensure that unintended macroeconomic risks are comprehensively identified and mitigated.

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Glossary

Atomic Settlement	A conditional settlement that occurs if delivery and payment are both received at the same time.
Application programming interface (API)	Rules and specifications followed by software programs to communicate with each other, and an interface between different software programs that facilitates their interaction.
Distributed Ledger	A record of transactions held across a network of computers (nodes), rather than stored in a central location.
Distributed Ledger Technology (DLT)	Protocols and supporting infrastructure that allow computers in different locations to validate transactions and update records in a synchronized way across a network.
Digital Token	A piece of software with a unique asset reference, properties and/or legal rights attached.
Instant Settlement	Instant settlement eliminates any time gap between trading and settlement, so that settlement happens immediately once a trade has been agreed upon.
Interoperability	The technical or legal compatibility that enables a system or mechanism to be used in conjunction with other systems or mechanisms.
Real Time Gross Settlement (RTGS)	RTGS is the continuous process of settling payments in real time on an individual order basis without netting debits with credits.
Smart Contracts	Smart contracts are coded programs that are used to automate pre-specified transactional events based on agreed upon contractual terms.
Society for Worldwide Interbank Financial Telecommunications (SWIFT)	SWIFT is a global member-owned cooperative and the world's leading provider of secure financial messaging services.
SWIFT GPI	SWIFT GPI is a new facility that makes for quicker payments with full transparency on accompanying costs, while providing on-the-spot information on the status of transactions.
Sukuk	Sukuk refers to Islamic/Sharia-compliant bonds or Islamic investment certificates. Sukuk is structured according to international sharia standards and is asset-based securitization, not merely receivables.
Tokenization of CBDCs	Tokenization of financial assets is the conversion of financial instruments into digital objects and enables the transfer, storage, and trading of the assets in real time without intermediaries via digital channels.

Introduction

Central banks worldwide are actively exploring the implications of, and options for, issuing Central Bank Digital Currencies (CBDCs). In an increasingly digital economy where demand for central bank notes and coins is rapidly declining, issuing CBDCs is likely to become a necessity to preserve access to public money. Thus, although only a few countries have launched their CBDCs, there has been a rapid progression from conceptual discussions of the benefits and risks of CBDCs to targeted research and pilots. Even some of the countries that stated that they do not see an immediate need to issue a CBDC are also working to develop the capability to issue CBDCs. So, while the timing for issuance by countries remains uncertain, these trends suggest CBDCs could soon become mainstream.

CBDCs promise many benefits but, if not well designed, they can have adverse macroeconomic consequences, including for monetary policy. The monetary policy implications of CBDCs are an area of particular interest among global and national policymakers. The proposed foundational principles for CBDCs stipulate that CBDC designs should not compromise monetary or financial stability among other considerations [BIS 2020]¹. National policymakers are also, increasingly, considering CBDC designs that limit disruption to the current structure of their payment systems, and which minimize deposit disintermediation, such as intermediated distribution models for CBDCs, unremunerated CBDCs, and limits on CBDC holdings or transactions.

The body of literature on CBDCs has grown at a phenomenal pace, but the monetary policy implications of CBDCs have been studied in much less depth. Many central banks have published discussion papers or opinion pieces on how CBDCs might affect monetary policy, but comprehensive analytical assessments are just beginning to emerge. Moreover, whereas a two-tiered unremunerated retail CBDC is the design of choice among countries, and though countries are increasingly considering wholesale CBDCs (w-CBDCs), many of the existing studies have focused on the monetary policy implications of an interest-bearing and single tier retail CBDC.²

More recently, a few studies have emerged that analyze the monetary policy effects of unremunerated two-tier retail CBDCs but these, too, have been limited in scope. Many of the studies (Capela and Fleming (2020), Infante and others (2022) and Malloy and others (2022)) focus on the balance sheet effects. The risk transmission channels through which unremunerated intermediated retail CBDCs would impact monetary policy, or the relative importance of these channels are still largely unexplored. There is also a dearth of studies on the monetary policy implications of w-CBDCs in general and tokenization, in particular. The monetary policy implications of issuing CBDCs in jurisdictions with Islamic banks are equally unexplored.

¹ The foundational principles were developed by the Bank for International Settlements (BIS) and a group of seven central banks, including the Bank of Canada, Bank of England, Bank of Japan, European Central Bank, United States Federal Reserve, Central Bank of Sweden, and Swiss National Bank. The principles are summarized as: (i) Do no harm to wider policy objectives thus the CBDC should be consistent with the fulfillment of the central banks' mandates of maintaining price and financial stability as well as robust and reliable payments system (ii) Ensure coexistence and complementarity of public and private forms of money and (iii) Promote innovation and efficiency

² See literature review by Capela and Flemming (2020) and studies by Davoodalhosseini and others (2020); and Jian and others (2021). The misalignment between the literature and country choices could be attributed to the fact that CBDCs gained traction against the backdrop of low or negative interest rates that generated policy interest in developing instruments to eliminate the lower bound on interest rates and the studies preceded the country choices.

This paper provides a conceptual analysis of the monetary policy implications of issuing unremunerated two-tiered retail CBDCs and w-CBDCs, both in jurisdictions with conventional banking systems and those governed by Sharia'h rules. The paper discusses the mechanism through which CBDCs would affect monetary policy implementation and transmission, the nature and relative strength of the impact, and the policy and structural factors that could amplify or mitigate the impact.³ The study also formulates possible strategies to minimize unintended consequences of CBDCs on monetary policy and identifies areas where the frontiers of our knowledge can be further expanded. Quantitative analysis could not be undertaken since empirical data on CBDCs are still very limited in terms of the number of countries that have issued CBDCs and the length of time CBDCs have been in production.

The conclusions of the study are that CBDCs do not change the objectives of monetary policy, nor does it change the operational framework for monetary policy, but they can engender changes to retail, wholesale, and cross border payments that can have negative spillover effects on monetary policy implementation and transmission. Retail CBDCs can induce portfolio changes in the public's relative holdings of cash and deposits that impact money velocity, disintermediate bank deposits and increase volatility in commercial bank reserves at the central bank. If substantial, these outcomes can weaken the credit and interest rate channels for monetary policy transmission, impair the central bank's capacity to forecast reserves and conduct effective Open Market Operations (OMO), thereby weaken the effectiveness of money and inflation targeting (IT) regimes. Tokenization of w-CBDCs has potential to segment financial markets with adverse consequences for liquidity management and interest rate transmission. The use of CBDCs in cross-border payments can increase the risk of currency substitution in recipient countries and, in crisis periods, could increase the speed of capital flow reversals, thereby weakening domestic monetary authorities' ability to control monetary and exchange rate policies. These findings deviate from other studies (Andolfatto, (2021), Meaning, and others (2021), that suggest that the impact of CBDCs on monetary policy are marginal or even positive.

The paper also concludes that the biggest and immediate risks that CBDCs pose to monetary policy are deposit disintermediation and the related volatility in commercial bank reserves. Countries most vulnerable to deposit disintermediation are those with banking systems dominated by small retail deposits and a high share of non-interest-bearing demand deposits. The predominance of non-remunerated demand deposits and small retail deposits in Islamic banking systems elevates deposit disintermediation risks in jurisdictions with Islamic banking systems. CBDC designs, such as caps or non-remuneration, can minimize the adverse impacts of retail CBDCs on deposit disintermediation but significant residual risks remain that warrant policy attention. Increases in money velocity constitute an important channel through which CBDCs could impact monetary policy for selected countries where cash still accounts for a large share of transactions. The potential impact of tokenized markets on monetary policy are not yet comprehensively understood and need further review. Currency substitution and capital flow reversals present material risks for monetary policy but the use of CBDCs in cross-border payments could be a more medium-term issue.

The remainder of the paper is organized as follows: Following on the introduction, Section II provides a description of the CBDC design options, the intrinsic features of CBDCs that pose risks for monetary policy, and the degree of CBDC adoption in countries that have already issued CBDCs. This section also highlights the CBDC designs adopted by countries since the monetary policy implications of CBDCs largely depend on the design of the CBDC. Section III discusses the monetary policy implications of CBDCs, including the transmission mechanism and channels, the potential strength and speed of impact on monetary policy, and the

³ Remunerated or single tier CBDCs are not covered since almost all countries are considering non-remunerated two-tiered CBDCs.

implications of issuing CBDCs in jurisdictions with large Islamic banking systems. Section IV summarizes the study’s conclusions, proposes remedial strategies to minimize unintended effects of CBDCs on monetary policy and suggests areas for further work.

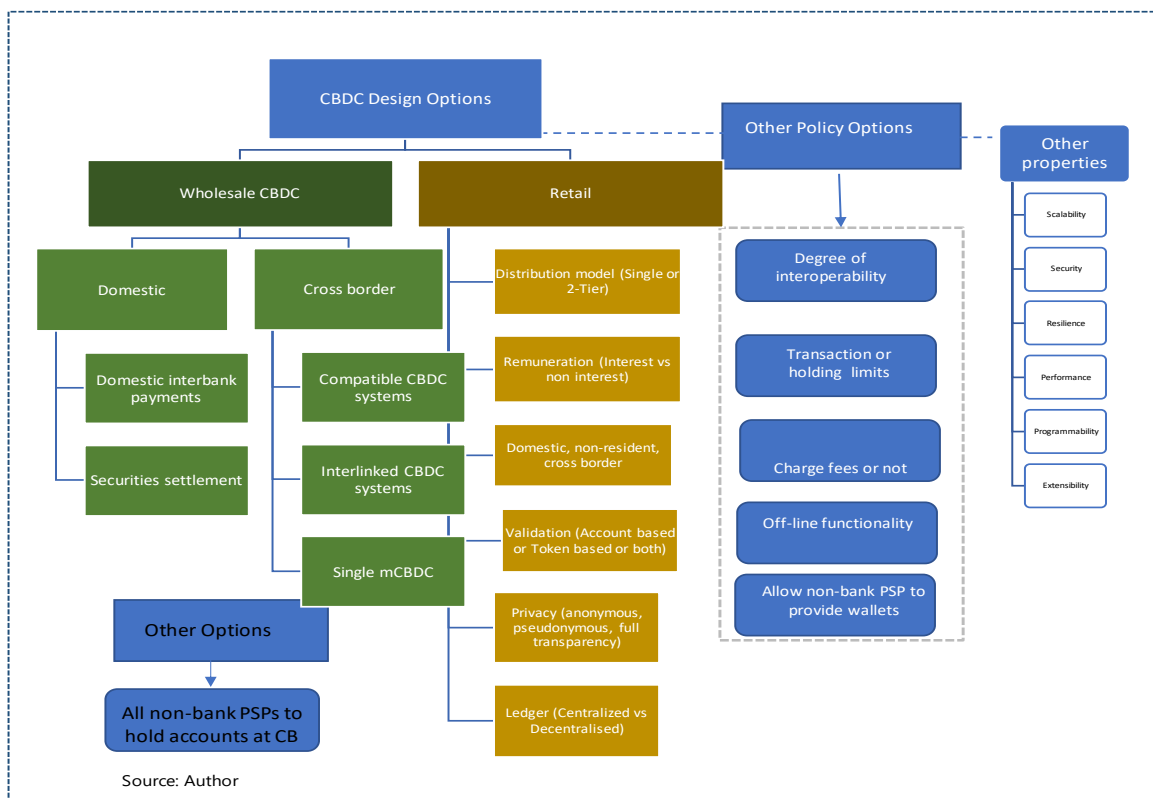
CBDC Design Options, Intrinsic Risks to Monetary Policy, and Country Choices

A CBDC is a payment instrument, denominated in the national unit of account, which is issued by the monetary authority and remains a direct liability of the central bank. “Retail CBDCs” sometimes referred to as “general purpose CBDCs” are designed for use by the wider economy in day-to-day payments and transfer transactions. “Wholesale CBDCs” are designed for use among financial intermediaries and are analogous to commercial bank reserves at central banks.

Design Options and their Implications for Monetary Policy

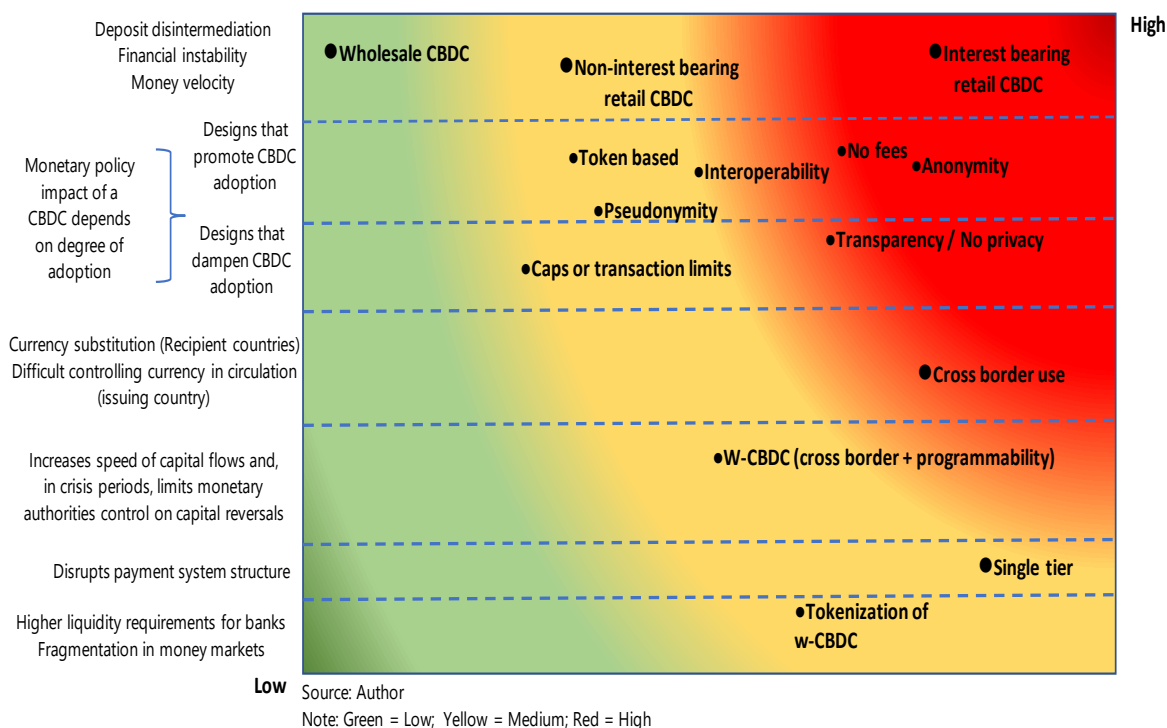
Within the broad categorization of retail and wholesale, CBDCs can assume a variety of designs. Figure 1 provides a taxonomy of the CBDC architectural design choices and Box 1 elaborates on the design features.

Figure 1. CBDC Design Options



The different CBDC designs have intrinsic characteristics that differ in their impact on monetary policy. The heatmap (Figure 2) below highlights CBDC designs that pose risks to monetary policy along a continuum of low to high.

Figure 2. Risks to Monetary Policy Inherent in CBDC Designs



Retail CBDCs have characteristics that pose greater risks for monetary policy than w-CBDCs as retail CBDCs have potential to cause deposit disintermediation irrespective of whether they are remunerated or not. Remunerating a CBDC elevates the disintermediation risks since it makes the CBDC a perfect substitute for all types of deposits and other low-risk assets, such as shares in money market mutual funds, Treasury bills, and other short-term instruments and this can reduce credit availability or raise credit costs for businesses and governments. An unremunerated CBDC is also a good substitute to non-interest-bearing demand deposits, and a retail CBDC that does not attract fees can be more attractive than demand deposits that may charge account management fees. Whether a country chooses a single tier or two-tier distribution model, the CBDC in a digital wallet resides on the central bank ledger and is not available to the commercial banks to lend out. A single tier CBDC, nevertheless, poses a greater risk to monetary policy since it can disrupt the payment system structure. The impact of a retail CBDC on monetary policy depends on the degree of CBDC adoption (BIS 2021a), thus design options (fully anonymity, token based, no fees and interoperability) that facilitate high adoption can amplify the risks to monetary policy while others (caps or transaction limit and full disclosure) that constrain adoption can moderate potential risks for monetary policy.

For w-CBDCs, central bank money is already available to monetary counterparties and some non-monetary counterparties in digital form, so a w-CBDC and central bank reserves operate in similar ways.

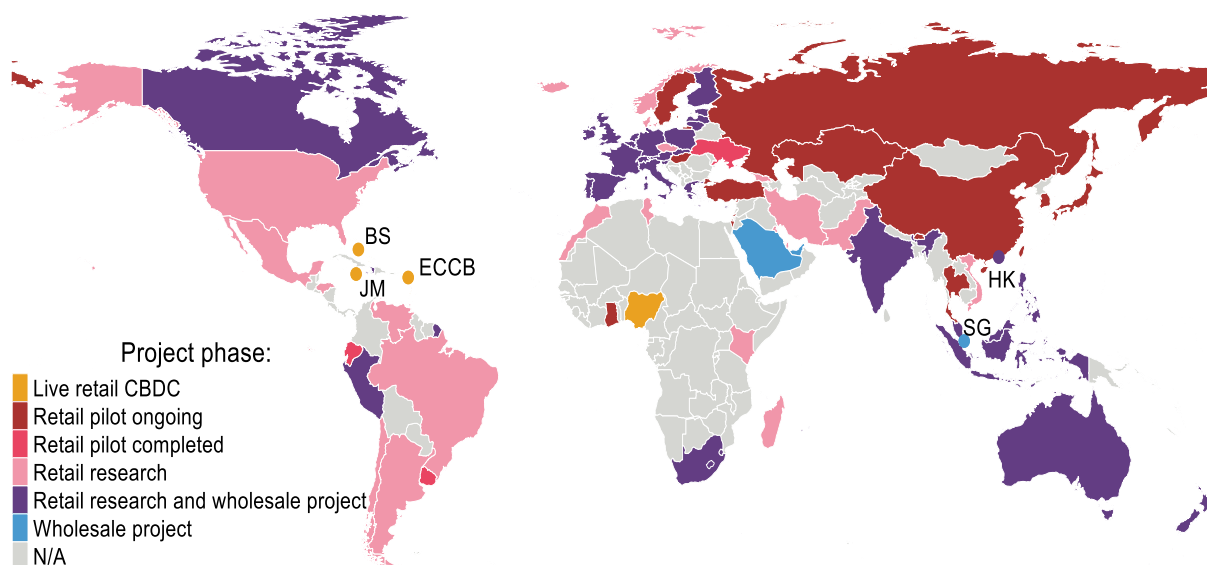
Disintermediation is not a risk if the w-CBDC continues to be restricted to regulated financial institutions and decisions to allow non-banks is a policy decision that is separate from the characteristics of a w-CBDC. The design feature of w-CBDCs relates to the programmability enabled by the application of Distributed Ledger Technology (DLT) in the transfer and recording of the funds which can facilitate additional functionalities, such as the tokenization of financial assets and the use of smart contracts to make money programmable to support automation and manage counterparty risks.

For cross-border use of retail and w-CBDCs, the design features that impact monetary policy is the programmability of CBDCs and tokenization that have a potential impact on capital flows.

Cross Country Trends and Choices

Many central banks are researching into or conducting pilot experiments to issue CBDCs. By end-December 2022, over a hundred countries were experimenting with CBDCs (Figure 3).

Figure 3. Status of CBDC Projects Around the World

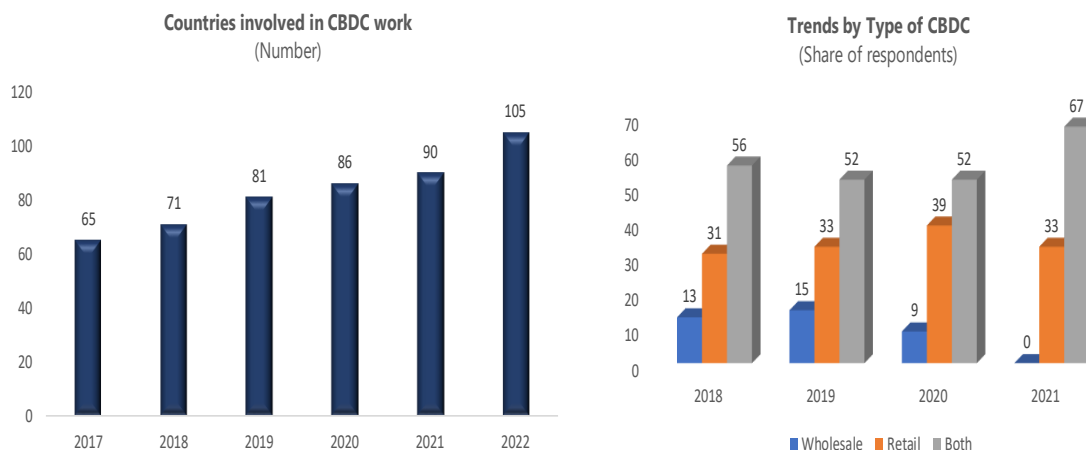


BS = The Bahamas; ECCB = Eastern Caribbean Central Bank; HK = Hong Kong SAR; JM = Jamaica; SG = Singapore. The use of this map does not constitute, and should not be construed as constituting, an expression of a position by the BIS regarding the legal status of, or sovereignty of any territory or its authorities, to the delimitation of international frontiers and boundaries and/or to the name and designation of any territory, city or area. Update 1 July 2022.

Source: R Auer, G Cornelli and J Frost (2020), "Rise of the central bank digital currencies: drivers, approaches and technologies", *BIS working papers*, No 880, August 2020 (data updated December 2022)

Note: The boundaries, colors, denominations, and any other information shown on the maps do not imply, on the part of the International Monetary Fund, any judgment on the legal status of any territory or any endorsement or acceptance of such boundaries

Most of the CBDC experiments focus on unremunerated retail CBDCs, but the number of countries that are experimenting with both retail and w-CBDCs has been growing rapidly (Figure 4). Assessments of the monetary policy implications of CBDCs, therefore, need to consider both unremunerated retail and w-CBDCs.

Figure 4. Trends by Type of CBDCs

Source: BIS and Atlantic Council

Retail CBDCs

Retail CBDC projects have made comparatively greater advances relative to w-CBDCs. As of December 2022, central banks from three countries (The Bahamas, Nigeria, and Jamaica) and the 8 member countries of the Eastern Caribbean Currency Union (ECCU) had already issued retail CBDCs.⁴ Several other countries (China, Ghana, India, Kazakhstan, Korea, Russia, Sweden, Thailand) had advanced to pilot stages and more than 90 countries were doing active research.

As many jurisdictions are still in the preliminary stages of CBDC research, several technical design questions have not yet been finalized. There is, however, a growing trend to align CBDC designs with the foundational principles to safeguard price and financial stability. Virtually all countries are considering unremunerated and 2-tier distribution model retail CBDC where financial institutions manage distribution and customer-facing activities.⁵ Many countries have indicated plans to put transaction limits or caps on the amount of the CBDCs that individuals, businesses, and other non-supervised financial institutions would be able to hold in the digital wallets.⁶ For cross border payments, the [BIS \(2021b\)](#) found that, out of 47 public retail CBDC projects, only 11 featured a cross-border dimension and data by [Atlantic Council](#) show a similar pattern.

The uptake of CBDCs has so far been low in countries where CBDCs are already in production or where the pilots are very advanced. In The Bahamas, two years after the launch, CBDCs are [reported](#) to account for less than 0.1 percent of currency in circulation (see also [IMF 2022](#)). In Nigeria, public adoption of the e-Naira

⁴ The ECCU includes Anguilla, Antigua and Barbuda, Dominica, Grenada, Montserrat, St. Kitts and Nevis, St. Lucia, and St. Vincent and the Grenadines.

⁵ The few countries experimenting with the technical design of a remunerated CBDC as an option include Norway and Sweden, but no decision has been taken in the matter.

⁶ To enable receipt of higher-value transactions, some countries (The Bahamas) require personal digital wallets to be linked to deposit accounts at domestic financial institutions, into which any excess holdings of the currency would have to be deposited, the so called “waterfall account” or “overflow approach”. A tiered approach is also being considered in several countries to promote financial inclusion.

[reportedly](#) remains at a meagre 0.15 percent, one year after the roll out. In Jamaica, since the CBDC, named JAM-DEX, went live in July 2022, uptake is [reported](#) to have been slow albeit increasing. In the ECCU, the digital currency (DCash) in circulation accounted for 0.16 per cent at end March 2022 (See [ECCB 2022](#)). The [Peoples Bank of China \(PBoC\)](#), which has been running several pilots, show that the e-CNY in circulation represented 0.13 percent of total currency in circulation (M0) at end December 2022.

The factors underpinning the low uptake vary across the countries. The reasons, in large part, include inadequate awareness, inadequate infrastructure integration with merchants and user comfort with existing mobile payments. Offline payment functionality has also not yet materialized because of technical issues. But more generally, new payment innovations have historically taken a long time to become mainstream as human habits tend to change gradually. Given more time, merchants may come to appreciate the benefits of accepting CBDCs because they don't have to pay fees as they do when receiving payment by credit cards.

Wholesale CBDCs

W-CBDCs are gaining ground but, while the scene is constantly evolving, no country has reached production stage yet. Many w-CBDC pilot experiments ([Ubin Phase 1](#), [Ubin Phase 3](#), [Inthanon Phase 1](#), [Banque de France](#)) tested scope for achieving domestic Delivery versus Payments (DVP) in securities settlement, Payment versus Payments (PvP) in cross-border payments, and liquidity optimization. More recent ones ([m-CBDC Bridge](#) and [Dunbar](#)) focused on achieving PvP in multi-currency cross border payments and some ([Ubin](#), [Helvetia Phase II](#)) have been experimenting with settling tokenized assets with w-CBDC.

Monetary Policy Implications of Issuing CBDCs

Monetary policy refers to the actions taken by a central bank or monetary authority to manage the supply of money in an economy to achieve macroeconomic objectives, such as price stability defined as low and stable inflation and sustainable economic growth.⁷ The monetary policy objectives or the frameworks for conducting monetary policy do not change when countries issue a CBDC. But, as a new payment instrument, a CBDC can induce changes to the retail, wholesale and cross-border payments that have important spillover effects on monetary policy implementation and transmission.

Monetary Policy Frameworks and Transmission Channels

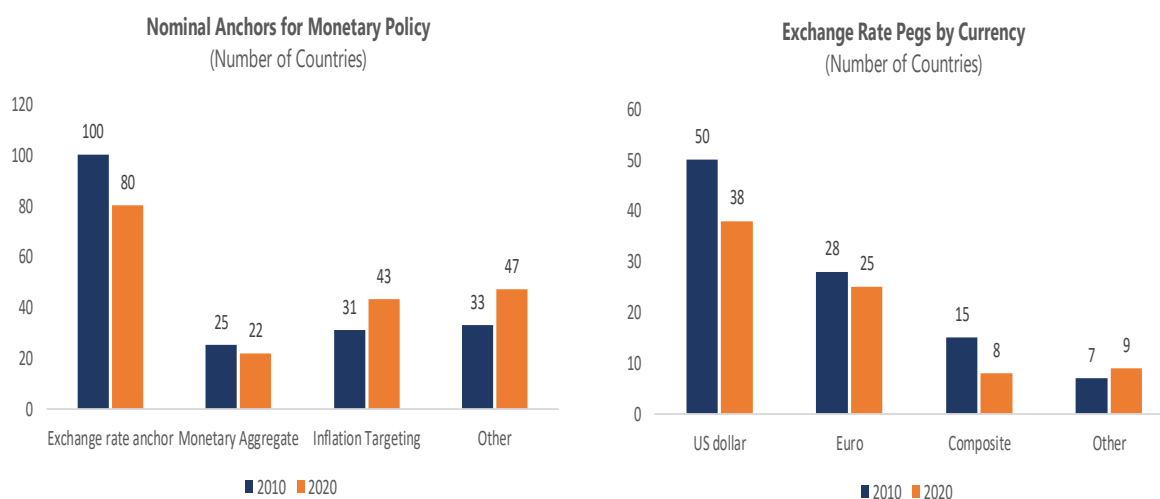
Monetary authorities typically conduct monetary policy within a clearly defined institutional, strategic, and operational framework to ensure effective implementation.

The institutional framework for monetary policy is anchored by three pillars: (i) Independence and accountability, which provides the foundations of monetary policy; (ii) Policy and operational strategy, which guides adjustments to the policy stance and the monetary policy instruments to be deployed; and (iii) Communications, which convey decisions about the policy stance and rationale to the public.

⁷ Price stability is a principal but not sole objective of monetary policy. Central banks are also concerned about financial and payment system stability as well as economic growth.

The strategic framework aims to pin down expectations of private agents about the nominal price level or the central banks' effort to achieve that path using nominal anchors. The nominal anchors for monetary policy fall into four broad categories, including: (i) exchange rate targeting; (ii) inflation targeting (IT); (iii) money targeting; and (iv) "other" for which there is no explicit nominal anchor. There is currently a wide dispersion in the choice of these nominal anchors across countries, reflecting differences in the objectives to be achieved and the transmission mechanism deemed most suited to the economy (Figure 5).

Figure 5. Distribution of Countries by Nominal Anchor

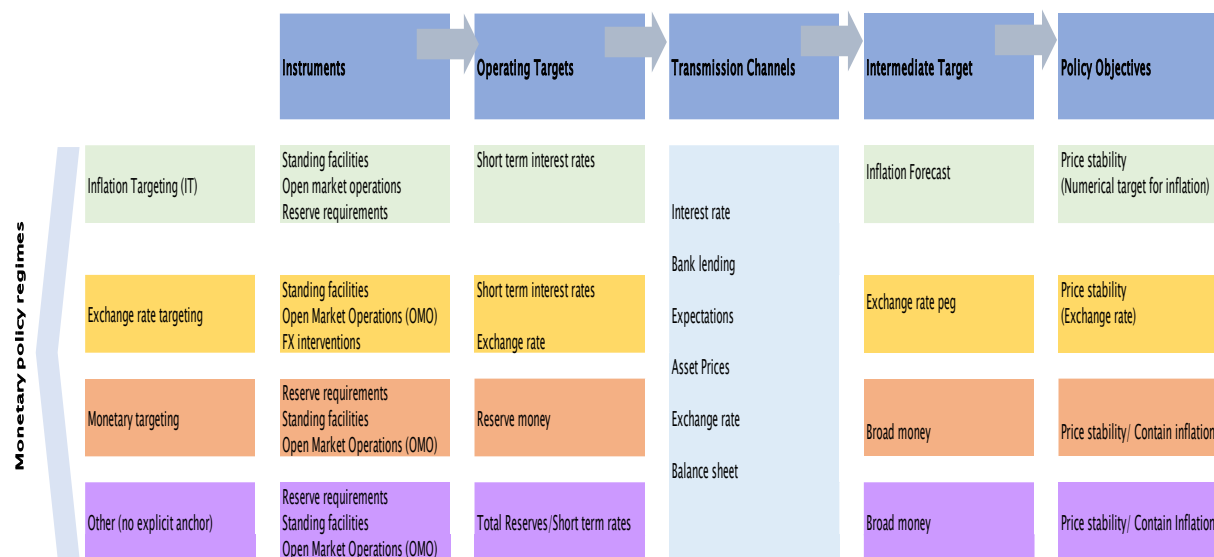


Source: Yearly reports on AREAER for 2010 and 2020

The operational framework for monetary policy consists of instruments, operational targets, intermediate targets, and ultimate goals (Figure 6). For intermediate targets, central banks can target the quantity (monetary aggregates) or can target the price (interest rate) depending on which target is considered to have a stable relationship with the ultimate goals (inflation) and a stable relationship with the operational targets. The central bank must also have the capacity to receive timely and accurate information on the intermediate goal.⁸

The central bank also forecasts liquidity or commercial banks' free reserves and estimates excess reserves to determine the scope of OMO needed to maintain the appropriate level of liquidity in the economy. The central bank chooses the monetary policy instruments that can be used either directly or indirectly to influence the established operational targets.

⁸ Intermediate targets are required because of the time lag between the implementation of monetary policy and the realization of the goals.

Figure 6. Operational Frameworks for Monetary Policy

Source: Author

Monetary policy decisions transmit to the real economy through multiple and reinforcing channels, including financial market prices (interest rates, exchange rates and asset prices), quantities (money supply and credit aggregates) and other channels (balance sheets and expectations). These channels vary across countries, reflecting differences in economic structure, developments in financial markets, the prevailing exchange rate regime, and instruments available to the monetary authorities. Financial institutions are the conduits through which monetary policy impulses are transmitted so interbank markets and need to efficiently allocate liquidity within the banking system, transmit monetary policy through the interest rate and credit channel and provide an effective price discovery.

How CBDCs Impact Monetary Policy Implementation and Transmission

A retail CBDC is simply a new form of money for households to pay for goods and services in their daily lives and a w-CBDC is also simply a new configuration of central bank money used in settlement.

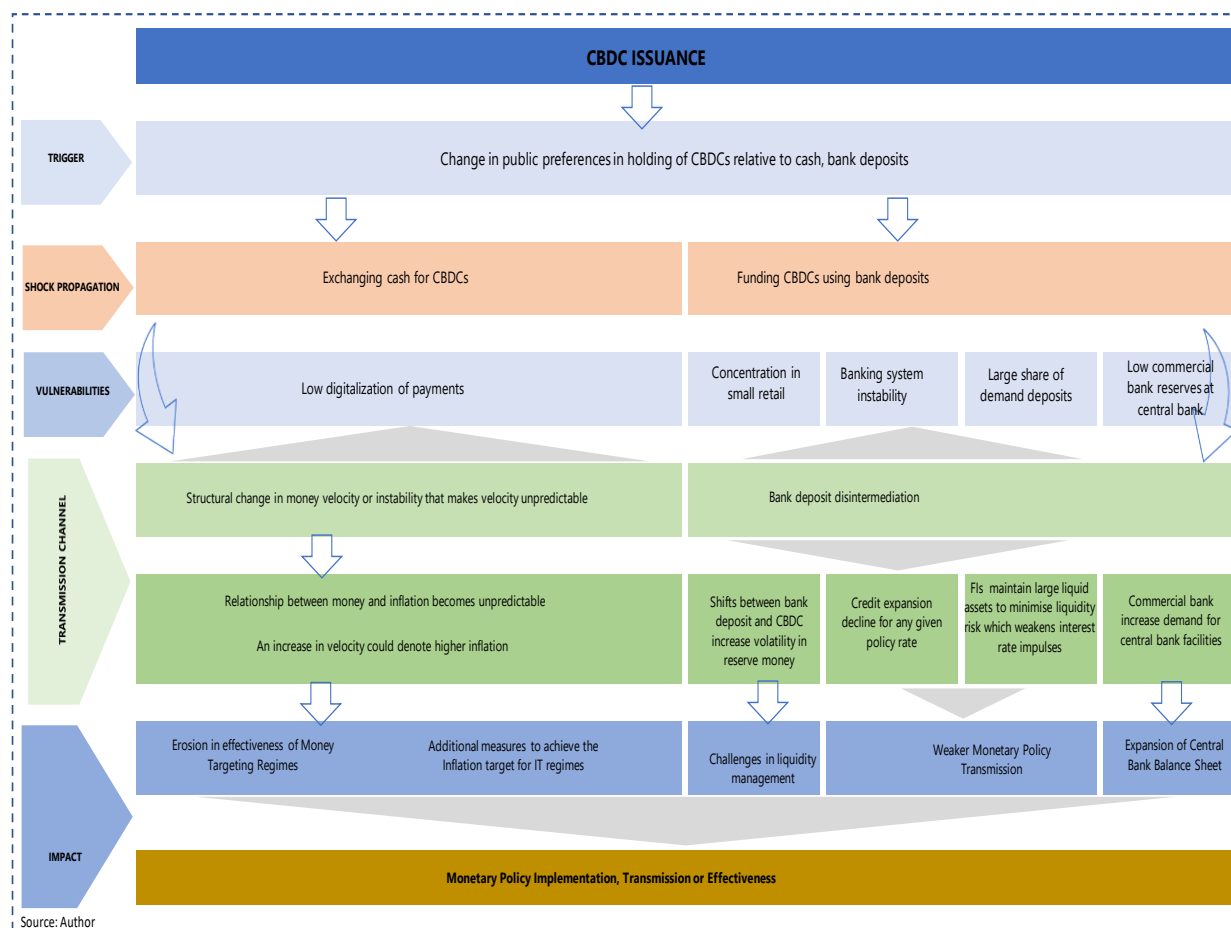
A CBDC can, however, act as an anchor for the wider monetary system, ensuring that the central bank continues to provide a means of payment that promotes trust and confidence in money and payments. A CBDC can also change the cost function of issuing central bank money and impact the seigniorage income which has implications for central bank independence to conduct monetary policy.

More fundamental, CBDCs can induce changes to retail, wholesale and cross border payments that have spillover effects on monetary policy implementation and transmission. Although the central bank is the sole issuer of CBDCs, it does not have control on how the public responds to the issuance of a CBDC and, therefore, does not have full control of the liability composition of its balance sheet. Commercial banks also do not have full control of the public's preferences between deposits and CBDCs as a means of payment.

Retail CBDCs ⁹

Retail CBDCs can trigger a complex web of mutually reinforcing interactions that have a cumulative negative effect on monetary policy implementation and transmission (Figure 7). As a new payment instrument, the introduction of a CBDC can result in some households and businesses exchanging some of their cash holdings and deposits into CBDCs. If large, the changes in the public’s holdings of cash and deposits can cause changes in money velocity, bank disintermediation and volatility of commercial bank reserves. These outcomes can erode the effectiveness of money targeting regimes, weaken the lending and interest rate channels, and impair central banks’ capacity to forecast commercial bank reserves on which OMO are based.

Figure 7. Channels through which CBDCs Impact Monetary Policy



⁹ Substitution between CBDCs and other electronic money are not covered in this paper, but it is expected that such substitution could have a neutral to marginal impact on velocity.

Exchanging Cash for CBDCs

Exchanging cash for CBDCs does not impact monetary policy through the balance sheet. Instead, it affects monetary policy by either causing a structural increase in money velocity, by increasing the volatility of money velocity or changing the revenues from seigniorage. These outcomes can erode the effectiveness of money targeting regimes, impact implementation of IT regimes or affect the independence of the central bank in conducting monetary policy.

Physical cash and CBDCs are just two kinds of central bank money and substituting one for the other alters the asset composition of households' balance sheets and the liability composition of the central bank's balance sheet without changing the size of the balance sheets (Table 1). The balance sheet of commercial banks registers no changes in composition or size since commercial banks may only have an operational role in transferring funds from cash to CBDC.¹⁰

Table 1. Balance Sheet Effects of Exchanging Cash for CBDCs

Household Balance Sheet		Commercial Bank Balance Sheet		Central Bank Balance Sheet	
Assets	Liabilities	Assets	Liabilities	Assets	Liabilities
Deposits	Other	Loans	Deposits	CB Operations	Commercial Bank Reserve Accounts
CBDC		Reserve Accounts at CB	CB Loans	Other	CBDC
+100 Digital Cash		Other	Capital		+100 Digital Cash
Cash		Balance of Operations	Balance of Operations		Cash
-100 Fiat Money		0 Local currency	0 Local currency		-100 Fiat Money
Balance of Operations	Balance of Operations	Balance of Operations	Balance of Operations	Balance of Operations	Balance of Operations
0 Local currency	0 Local currency	0 Local currency	0 Local currency	0 Local currency	0 Local currency

Source: Author

Exchanging cash for CBDCs can, however, bring about structural changes to or instability in money velocity. Cash payments require physical proximity for the payer to transfer value to the payee and there are inherent delays between the time the cash is received and when it is deposited in the banking system. By contrast, because CBDCs are digital, transactions can be conducted remotely, and the digital wallet of the recipient is immediately credited. This rapid turnover in payments can engender structural increases in money velocity or cause money velocity to become unstable.

Instability in money velocity affects the relationship between money, inflation, and GDP and erodes the effectiveness of money targeting regimes. Money targeting regimes are predicated on a stable relationship between the intermediate target (money supply) and policy objectives (inflation). Instability in money velocity implies that the relationship between money and inflation is no longer predictable and achieving the intermediate target (broad money) may not produce the desired outcome on the goal variable (inflation) (Box 2). Indeed, this breakdown in the relationship between monetary aggregates and goal variables, such as inflation and nominal income, is part of the reason why many countries shifted to IT regimes.

¹⁰ Commercial banks' new role from intermediary to custodian may affect its profit and loss account (P&L) if there are fees levied for managing wallets but the secondary effects via the P&L are outside the scope of this report.

A structural shift in money velocity implies that the relationship between money and inflation can still be stable and predictable, but an increase in velocity may denote higher inflation. When either the quantity of money (M) or the velocity of money (V) or their combination increases faster than real GDP, then prices will increase in proportion to how much MV exceeds output growth. Countries that have adopted IT regimes would have to undertake some additional monetary operations to achieve the desired inflation rates.

CBDCs also have potential to affect central banks' revenues from seigniorage because of the potential to alter the relative cost function of issuing currency.¹¹ CBDCs can reduce the operational costs related to the printing, storage, and transportation of banknotes, but they can also introduce new costs and alter the demand for cash. Depending on the direction of change in seigniorage income, central banks may increase or reduce reliance on the government for operational funding, and changes in seigniorage income has implications for the central bank's independence in designing and implementing monetary policy.

Exchanging Bank Deposits for CBDCs

Funding CBDCs by drawing down deposits affects monetary policy through its impact on deposit disintermediation and related increase in the volatility of commercial bank reserves at the central bank. Disintermediation weakens the credit and interest rate channels in the monetary policy transmission process and volatility in reserves erodes the central banks' capacity to forecast reserves and conduct effective OMO.

When clients fund their CBDC wallets by drawing down their deposits, commercial bank deposit liabilities decline and on the asset side commercial bank reserves at the central bank decline, thus the overall size of the commercial bank balance sheet size declines (Table 2).¹² For the central bank, substituting bank deposits for CBDCs results in a mere change in the liability composition of its balance sheet, as the decline in commercial bank reserves is offset by a corresponding increase in CBDCs. Household balance sheets merely register a change in asset composition.

Table 2. Balance Sheet Effects of Substituting Bank Deposits for CBDCs

Household Balance Sheet		Commercial Bank Balance Sheet		Central Bank Balance Sheet	
Assets	Liabilities	Assets	Liabilities	Assets	Liabilities
Deposits	Other	Loans	Deposits	CB Operations	Commercial Bank Reserve Accounts
-100 Local Currency Deposit			-100 Local Currency Deposits		-100 Local currency
CBDC		CB Reserve Accounts	CB Loans	Other	CBDC
+100 Digital Cash		-100 Local currency			+100 Digital Cash
Cash		Other	Capital		Cash
Balance of Operations	Balance of Operations	Balance of Operations	Balance of Operations	Balance of Operations	Balance of Operations
0 Local currency	0 Local currency	-100 Local currency	-100 Local currency	0 Local currency	0 Local currency

Source: Author

CBDCs in digital wallets reside on the central bank ledger and are not available to the commercial banks to lend. All else held constant, the decline in bank deposits and the corresponding decline in commercial bank reserves reduces available bank credit to the economy. This could increase the cost of bank credit that, in turn,

¹¹ Seigniorage from bank notes and CBDCs is equal to the face value of the instruments multiplied by the prevailing interest rates less production and other costs. The seigniorage also depends crucially on the demand for the CBDCs and bank notes.

¹² The impact of reserve requirement for the balance sheet of the central bank has not been considered here.

could curtail demand for credit. As conventional monetary policy relies on the ability of the central banks' policy rate to impact the amount of credit supplied by banks to the economy (households and businesses), the decline in bank credit reduces the importance of bank lending in the overall monetary policy transmission process.

Deposit disintermediation could also impact monetary policy through the financial stability risk channel. Whereas deposits can be withdrawn anytime, loans are contractual and cannot be recalled before their maturity. A sudden large withdrawal of deposits could, therefore, cause liquidity risks that morphs into bank insolvency. Banking system stress can lead to market segmentation as healthy banks avoid providing liquidity to the weak banks thereby weakening monetary policy transmission through the interest rate channel which is important for countries with IT regimes.

Substituting bank deposits for CBDCs could also cause volatility in commercial bank reserves that complicate liquidity management capabilities of both the commercial banks and the central bank. If deposit transfers into CBDCs are large, frequent, and unpredictable, commercial bank reserves at the central bank (autonomous factors) could become highly volatile and can affect monetary policy through several mutual reinforcing channels.

- Central banks need to accurately predict the inflows and outflows of funds to and from the commercial banking system in connection with the operation of the payment system, to enable it to achieve monetary policy targets, particularly short-term interest rate targets. Significant volatility in the commercial bank reserves makes it difficult for a central bank to forecast components of its balance sheet to accurately determine the size and frequency of OMO.
- Volatility in commercial bank reserves could engender commercial banks to hold much larger reserves to meet not only daily payment flows, but also potential outflows from extra deposit withdrawals to fund CBDCs particularly in stressed market environments. The need to hold higher liquid buffers reduces funding available for long-term lending and weakens the credit channel.
- Hoarding of liquidity can also affect the transmission of policy rate changes to interbank markets, which is central to the effectiveness of IT regimes. For any given policy rate, banks might have to offer higher deposit rates than otherwise or raise more funding from higher cost and/or more volatile sources which could translate into higher lending rates and reduced credit to the private sector.

If commercial banks choose not to reduce the asset side in step with declining deposits, and the interbank market does not quickly redistribute liquidity through the banking system in response to the shock, cash strapped banks will have to seek recourse to central bank financing. The central bank's balance sheet will, in the event, increase by the same amount (100 LC). The composition of the central bank's assets and liabilities would change as follows: on the assets side claims on commercial banks would increase and on the liability side currency issued would increase by a corresponding amount. The balance sheet of the commercial bank would return to its previous level (Table 3).

Table 3. Balance Sheet Impact of Central Bank Operations to Compensate for the Decline in Deposits

Household Balance Sheet		Commercial Bank Balance Sheet		Central Bank Balance Sheet	
Assets	Liabilities	Assets	Liabilities	Assets	Liabilities
Deposits	Other	Loans	Deposits	CB Operations	Commercial Bank Reserve Accounts
-100 Local Currency Deposits			-100 Local Currency Deposits	+100 Local Currency	-100 Local currency
CBDC		CB Reserve Accounts	CB Loans		+100 Digital Cash
+100 Digital Cash		-100 Local currency	+100 Digital Cash	Other	CBDC
Cash		+100 Digital Cash	+100 Digital Cash		+100 Digital Cash
Balance of Operations	Balance of Operations	Other	Capital		Cash
0 Local currency	0 Local currency	Balance of Operations	Balance of Operations	Balance of Operations	Balance of Operations
		0 Local currency	0 Local currency	+100 Local Currency	+100 Local Currency

Source: Author

Wholesale CBDCs

W-CBDCs are similar to reserves and do not affect monetary policy implementation or transmission through balance sheet effects. Rather, w-CBDCs affect monetary policy by enhancing payment system efficiencies and inducing changes in the market structure.

When a central bank issues w-CBDCs, financial intermediaries can “pay” for their w-CBDCs in the RTGS system with a transfer from their reserve balances. The liability composition of the central bank balance sheet, therefore, changes with the increase in w-CBDCs offset by a decline in commercial banks’ reserves. Financial intermediaries’ balance sheets register equivalent changes in the asset composition (Table 4). Once issued, w-CBDC can be transferred between financial intermediaries within the DLT platform without affecting the central banks’ balance sheet. Intraday w-CBDC (issued during the business day and redeemed each night) would not impact the size of the central bank balance sheet. Since a w-CBDC is aimed at interbank settlement and other financial transactions between financial institutions, it does not lead to deposit disintermediation or digital runs.

Table 4. Stylized Balance Sheet Involving W-CBDC

Public		Financial Intermediaries		Central Bank	
Liabilities	Assets	Liabilities	Assets	Liabilities	Assets
	Cash (100)		Reserve balances (200)	Reserve Balances (200)	
			Vault Cash (100)	Cash (100)	
Total	100		300	300	
With a CBDC					
Public		Financial Intermediaries		Central Bank	
Liabilities	Assets	Liabilities	Assets	Liabilities	Assets
	Cash (100)		Reserve balances (100)	Reserve Balances (100)	
			W-CBDC (100)	W-CBDC (100)	
			Vault cash (100)	Cash (100)	
		Total	300	300	

Source: Author

Efficiency of the payment system is vital for effective conduct of monetary policy and the stability of monetary policy impulses. Figure 8 shows that many countries have already introduced RTGS that enable real time settlement of interbank payments in central bank money with immediate finality, implying limited additional utility of w-CBDC for interbank clearing. Indeed, early-stage pilots in countries whose domestic interbank payment systems were already efficient did not point to strong value from w-CBDC for domestic interbank payments¹³. W-CBDC can, however, leverage DLT, which enables the use of smart contracts. The potential for w-CBDCs to be embedded with logic, or programmability presents opportunities for innovation and new functionality.¹⁴ Among other benefits, a w-CBDC can extend current operating hours more easily, insofar as the use of smart contracts/programmability fosters more autonomous operations with a minimum level of human intervention as well as enable the continuous reconciliation of the ledger [[R3 CBDC Report](#)].¹⁵

Figure 8. Main Systems Used for Large Value Payments



Source: World Bank

Note: The boundaries, colors, denominations, and any other information shown on the maps do not imply, on the part of the International Monetary Fund, any judgment on the legal status of any territory or any endorsement or acceptance of such boundaries

A w-CBDC is not a prerequisite for DvP in securities settlement but w-CBDCs can enable settlement in central bank money which reduces requirements for risk capital, clearing funds and settlement liquidity. The application of DLT has potential to change the way in which the storage, recordkeeping, and transfer of digital assets are done and can bring fundamental changes not only to the technological architecture, but to the financial market structure as well. DLT can also facilitate innovation in securities issuance and settlement, such as the tokenization of financial assets. The availability of a CBDC on DLT can allow the integration of payment and trading of securities, shorten the standard settlement cycle, facilitate atomic or near real time settlement, DvP, and enable straight-through-processing or fully automated transaction processing of securities settlement. Smart contracts and programmability allow for new forms of conditionality of payments, requiring that a

¹³ Examples include the phase one trials of the Bank of Canada's Project Jasper, the South African Reserve Bank's Project Khokha, and the European Central Bank and Bank of Japan's joint Project Stella

¹⁴ Smart contracts use computer protocols to execute, verify, and constrain the performance of a contract and can automate decision-making, by allowing self-executing computer code to take actions at specified times and/or based on reference to the occurrence (or non-occurrence) of an action or event.

¹⁵ An RTGS system would be limited to API programmability which is not built into the platform itself.

payment only settles on condition of delivery of another payment or assets, and this could enhance the DvP mechanism in RTGS systems (BIS 2021c).

An unintended consequence of financial market tokenization is the potential for market segmentation. The introduction of a w-CBDC design model that differs substantively from legacy fiat central bank reserves may cause market participants and markets to trade a w-CBDC as a separate product, thereby fragmenting the interbank market. Market segmentation would reduce the efficiency gains and limit the pass through of central bank monetary policies while shorter settlement cycles may increase liquidity requirements. Suboptimal market efficiencies may also arise if w-CBDCs trade over separate market infrastructure without any interoperability or limited interoperability with the broader financial market ecosystem. Shortening the settlement cycle to T+0 may require participants to prefund their accounts which would increase liquidity requirements. Thus, how a DLT arrangement is designed to handle counterparty credit risk could have a significant impact on the participants' liquidity needs and the transmission of monetary policy.

Cross Border Use of CBDCs

The use of CBDCs in international transactions aims to broaden the application of central bank money to non-residents. Central bank money in electronic format is currently only accessible to resident local banks and cannot be used in cross-border and off-shore transactions. In securities settlement systems, while resident local banks can settle their treasury securities purchases in central bank monies, cross-border and off-shore transactions are settled in commercial bank monies. In foreign exchange transactions, non-resident banks cannot hold an account at the host central bank, and trading parties cannot exchange claims directly using central bank money, thus the foreign currency can only be held by a correspondent bank. The correspondent banking model involves several intermediaries that result in high costs, long transaction chains and long settlement periods.¹⁶

The utility of a CBDC, therefore, rests in its possible use by non-residents and its exchange properties that can help create a greater symmetry between access to and transactions in national securities and other financial instruments in national currencies. CBDCs would be exchanged for CBDC to achieve PvP in real time, thereby collapsing trading and settlement into a single operation. In securities and other financial instrument trading, CBDCs would allow for settlement of securities in central bank money in cross-border and off-shore transactions with CBDCs as the cash leg to settle conventional or token-based securities in a DvP operation.

The cross-border use of CBDCs has monetary policy implications for both issuing and recipient countries.

- For the issuing countries, if foreign demand for their CBDCs is high, the corresponding increase in currency outside the country would negatively affect the issuing country's ability to control monetary aggregates. The corresponding capital inflows could exert appreciation pressures on exchange rates which, depending on the share of imports in the consumer basket, could have implications for inflation and monetary policy implementation.

¹⁶ In some corridors, it can take as long as 3 - 7 days due to several frictions, which include fragmented data standards, lack of interoperability, complexities in meeting compliance requirements, including for AML/CFT and data protection purposes, different operating hours across different time zones and outdated legacy technology platforms.

- For the recipient countries, increased currency substitution reduces monetary authorities' control over domestic liquidity by limiting the component over which the authorities have direct influence. Though substitution into CBDCs is no different from traditional “dollarization” that occurs in countries that have suffered from high inflation and large exchange rate volatility, the convenience and easier accessibility of reserve asset CBDCs facilitates substitution at a faster pace and larger scale. An increase in the degree of currency substitution generated by increased use of foreign CBDCs would also have a negative effect on seigniorage for the recipient country.
- For both issuing and recipient countries, faster access to cross border settlement could cause liquidity to flow rapidly from one currency asset market into another. The increased speed in cross border payments could amplify capital flow volatility that affect the domestic monetary authorities' ability to manage exchange rate and monetary policy. An upsurge in the use of w-CBDC for cross-border settlement could also result in higher and possibly more volatile intraday demand for central bank money. Access to intraday w-CBDC by non-resident banks could increase demand for the overnight reserves held by resident banks acting as correspondents. If this were to happen, this may affect liquidity management by market participants, the price for liquidity and, consequently, the transmission of monetary policy.

Strength and Speed of the Impact on Monetary Policy

CBDCs are not yet prevalent, so assessments of risks to monetary policy are conceptual, prospective, and contingent on many unknowns related to the likely scale and speed of uptake of the CBDCs. History, however, shows that while past financial technological innovations have not upended the capacity for central banks to conduct effective monetary policy, sudden reversals of capital flows, deposit runs, liquidity gridlocks, dollarization and volatility in commercial bank reserves have posed major challenges for financial stability, exchange rate and monetary policy that prompted changes in collateral policies and emergency liquidity facilities. Thus, while the introduction of CBDCs may not upend the conduct and effectiveness of monetary policy, the risks they pose for monetary policy implementation and transmission are material and will require policy consideration.

Retail CBDCs, Deposit Disintermediation and Changes to Money Velocity

Retail CBDCs, if quickly and widely adopted, could pose material risks to monetary policy implementation and transmission through a complex web of interactions related to the impact on deposit disintermediation, volatility in commercial bank reserves and money velocity. The probability of the risks materializing depends largely on the scale and pace of CBDC adoption and the overall impact on monetary policy could be time variant between the inception, steady state, and crisis environment.

Deposit Disintermediation

Deposit disintermediation constitutes a high probability and high impact risk for monetary policy implementation and transmission if CBDCs become more prevalent across countries. The impact of deposit disintermediation on monetary policy is amplified by the potential for commercial bank reserves to become volatile. Interbank markets also do not act as a good conduit of policy rates during periods of volatile liquidity flows.

Deposit disintermediation weakens the credit channel in monetary policy transmission, and if the deposit disintermediation is not transitory, the central bank may have to provide longer-term and targeted lending operations with adverse consequences for the central banks' Lender of Last Resort (LoLR) function. Sudden huge reductions in commercial bank reserve balances can also drive-up money-market interest rates, destabilize financial markets and make it difficult to forecast reserves needed to determine the amount of intervention in OMO.

Conceptually, the deposit disintermediation could be more pronounced in banking systems with a large share of small retail transaction deposits and demand deposits.

- Small transactional retail deposits are the perfect candidates for transferring to digital wallets. Caps on holdings of CBDCs in digital wallets may not be binding on small retail deposits if they fall below the limit. Since the limit is on the transaction amount and not on the number of persons withdrawing, “*en mass*” opening of digital wallets can collectively result in a sizeable share of deposit outflows for a bank.
- Deposit disintermediation could occur on a large scale even if the CBDCs are not remunerated, since CBDCs are close substitutes of non-interest-bearing demand deposits.
- Financial inclusion facilitated by a CBDC cannot compensate for the disintermediation because CBDCs reside on the central bank ledger and are not available to commercial banks for lending. The tokenization of retail CBDCs to encourage financial inclusion may even have the unintended consequences of encouraging those segments of the population not to use the banking system.
- Limits or caps on amounts that the public is allowed to maintain in CBDC wallets could also entail some operational challenges that may be difficult to enforce if clients maintain more than one digital wallet. The central bank or some other agency would, need to monitor digital wallets to enforce compliance with the set limit on CBDC holdings or technological solutions will need to be developed.

The liquidity conditions in the banking system and the response of banks to the sudden withdrawal of deposits could mitigate or amplify the risks. The impact on monetary policy will be more pronounced if bank reserves are generally low or if there is uneven distribution of the reserves across the banks. The impact could also vary depending on whether commercial banks make up for the decline in deposits by borrowing from the interbank market or seek recourse to central bank financing.

- In a scenario of universal excess reserves in the banking system, the decline in deposits would merely translate into lower excess reserves and the potential impact on monetary policy would be muted.
- Where the distribution of liquidity is uneven, liquidity strapped commercial banks could turn to the interbank markets to borrow or could try to raise deposit rates to attract deposits. Depending on the volumes demanded from the interbank market, interbank interest rates could rise and so would lending rates. Raising deposit rates could impact other money markets if there is a shift of funds to the banking sector from other financial segments.

- In a scenario of tight liquidity, a shift from bank deposits to CBDCs could lead to fluctuations in commercial bank reserves and as minimum required reserve limits become a binding constraint, the disintermediation could lead to structural liquidity deficits. If many financial institutions experience a simultaneous shortage of liquidity and draw down their self-financed reserves, seek additional short-term debt from secured and unsecured credit markets, or try to sell-off assets to generate cash, the general level of short-term interest rates in secured and unsecured markets could rise and asset prices could fall as everyone tries to sell at once. Lending rates could again increase and curtail bank credit.
- If system wide liquidity shortages occur, the central bank could feel the pressure to provide liquidity to institutions to fulfill its financial stability mandate and prevent a sudden spike in short-term interest rates. Depending on the collateral availability, the central bank may have to increase its balance sheet size and could also change the collateral policy.
- Although there has been little correlation in recent years between the expansion of central bank balance sheets and inflation in both advanced and emerging market economies, an expansion in central bank lending has potential to increase inflationary pressures that are persistent making it difficult for countries with IT regimes to achieve their inflation targets.

The risks are highest in crisis times when the precautionary motive surpasses the transaction motive but could also be high at the inception of CBDCs when there is “*en-masse*” opening of CBDC wallets by the public. The impact will also depend on the speed of CBDC adoption.

- In the inception phase, following the introducing a CBDC, the lure of a new instrument could attract the public to test the new payment instrument. An “*en masse*” opening of digital wallets would result in sizeable deposit outflows amplified by the number of withdrawals even if the amounts may be low.¹⁷
- If the shift to CBDCs is rapid, the dislocation can be significant but if it is gradual and stretched over time, the impact could be moderate. In the latter case, the existing monetary policy toolset will ensure that banks have enough liquidity with the help of the central banks standard liquidity provision and absorption operations, thereby creating the conditions for the formation of money market rates near the key rate. Where the shift is rapid, commercial banks may not be able to adjust positions efficiently to the shock or may not have adequate collateral.
- In the tail-risk event of economic or financial turmoil, demand for cash tends to go up as the precautionary motive surpasses the transaction motive. A retail CBDC, like cash, is fully guaranteed by the central bank, it is credit and liquidity risk free and provides greater security than cash. The ease with which CBDCs can be transferred increases the risk of runs on financial firms. While deposit insurance could soften the motivation of bank depositors to pull their money in reaction to bad news, it may prove insufficient to prevent large shifts from traditional bank accounts into CBDC accounts.
- In both the transition and crisis scenarios, banks may have to scramble for alternative funding sources or central bank financing. If commercial banks exhaust their collateral, the central bank will need to

¹⁷ It is also possible that the uptake of CBDCs could be slow in the initial phase in which case the monetary policy impact would be minimal. End-users are mostly indifferent when it comes to paying in central bank money or bank money, and payment decisions will likely be dominated by acceptance and convenience.

expand acceptable collateral or lend uncollateralized, and depending on the quality of the collateral, the risk on the central bank balance sheet could increase. Increased demand for central bank financing could lead to a spike in the repo and policy rate and force the central bank to provide reserves to commercial banks. An expansion of the central bank balance sheet, if not accompanied by a corresponding increase in output could lead to higher inflation.

Countries that have issued CBDCs have not seen widescale withdrawals of deposits into CBDCs, but it is too early to infer long term trends. Uptake of CBDCs could increase as the public become more familiar with the payment instrument and infrastructure is put in place to enable merchants accept CBDCs.

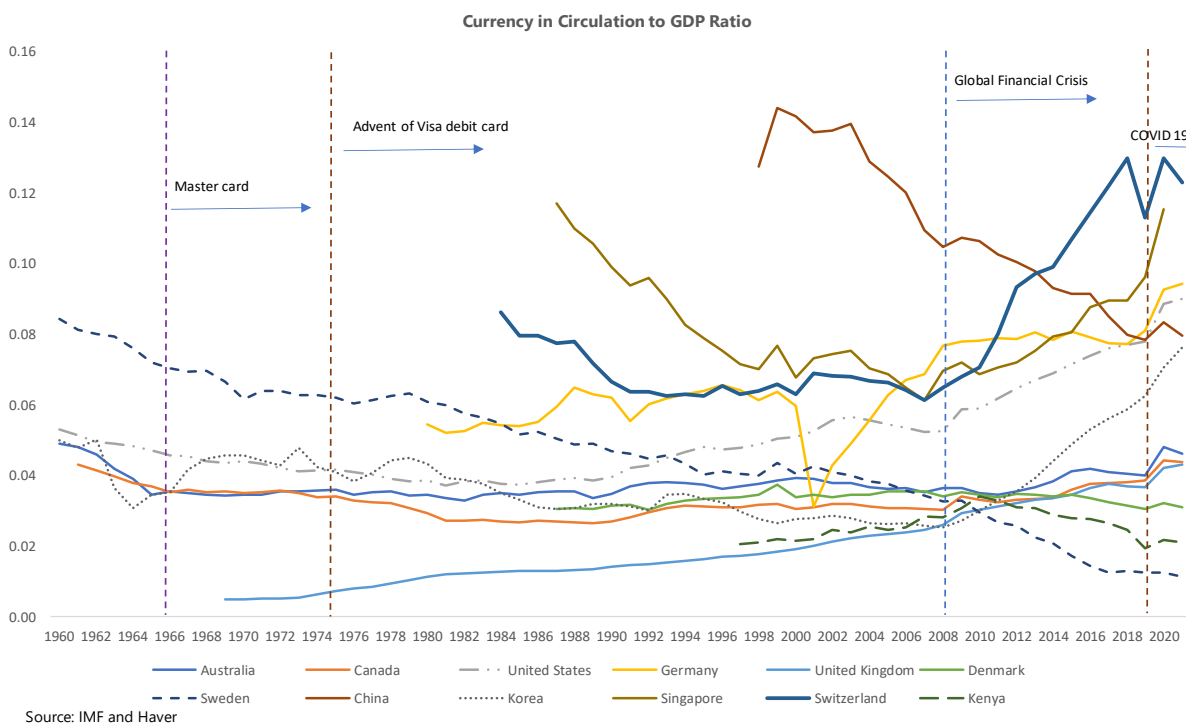
Central banks will need to enhance their liquidity management before the behavioral response of households and businesses become clearer and the financial sector are able to adjust in a timely and cost-effective way. Prudential liquidity requirements and the ability to draw on central bank liquidity facilities provides a degree of cushion against the risks, thus the capacity and flexibility of the central bank to manage liquidity and the effectiveness of the LoLR will be very critical in mitigating risks to monetary policy. But deposit disintermediation introduces uncertainty as to whether banks need short term funding operations or longer-term funding and raises the risk that central banks could transform from their current market stability role as a “*Lender of Last Resort*” to a “*business-as-usual source of funding*” for regulated financial institutions.

Changes to Money Velocity

The impact of changes in money velocity on monetary policy is likely to be pronounced where cash still accounts for a large share of transactions, the scope for digitalization of payments is high and countries pursue money targeting regimes. The probability of the risks materializing is, however, difficult to predict ex-ante because demand for cash can be affected by several countervailing factors, including macro-financial conditions such as the interest rate level and GDP growth, privacy concerns, deficiencies in payment infrastructures and sociological preferences.

The experiences of many advanced economies show that digitalization of payments coincided with significant declines in cash in normal times. The introduction and adoption of credit cards and debit cards as well as other retail payment innovations such as Automated Teller Machines (ATMs) between 1960-2000 was accompanied by a significant decline in currency in circulation relative to GDP (CIC/GDP) in many economies, including Canada, China, New Zealand, Sweden, Switzerland, United Kingdom, and United States (Figure 10).¹⁸

¹⁸ In Sweden demand for cash has declined unabatedly reflecting increased adoption of electronic payments, such as [Swish](#) that facilitated digital P2P payments, refusal of some businesses to accept cash, and high levels of digitalization in society and the banking sector ([Misch 2021](#)). In China and Kenya, where mobile money innovations increased significantly, the CIC/GDP registered significant and sustained declines.

Figure 9. Changes in Currency in Circulation to GDP

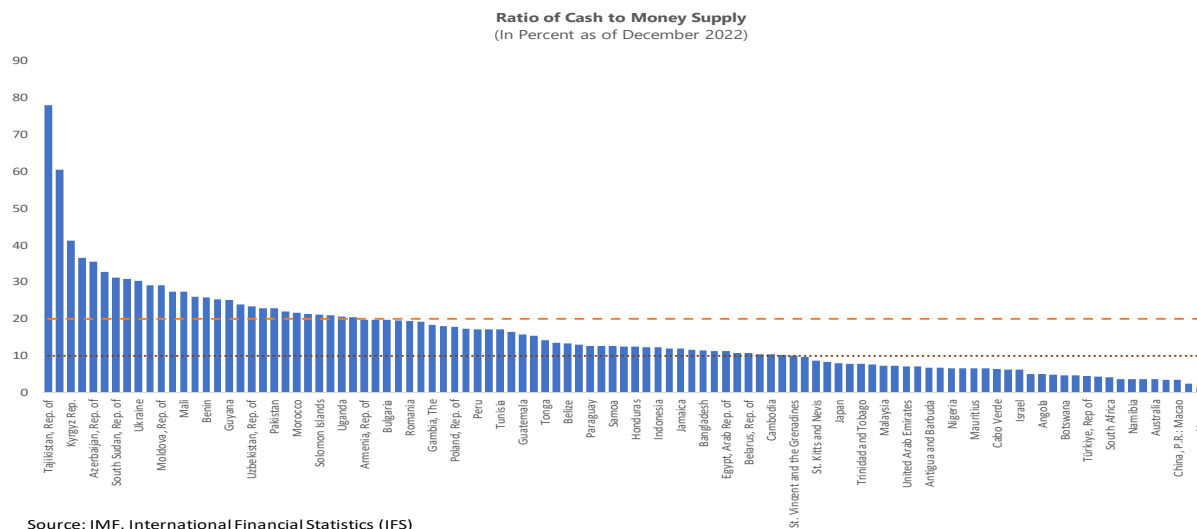
The empirical data also shows that, in periods of economic uncertainty or low interest rates, the precautionary motive can outweigh the transaction motive, and this can offset the effects of payment innovations. The period since 2000 witnessed continued payment innovations, such as e-money in advanced economies and mobile money in emerging market and developing economies (EMDEs), but the period also coincided with expansionary monetary policy and low interest rates that appear to increase demand for cash despite the payment innovations.¹⁹ Consequently, many countries registered a moderation in CIC/GDP after 2000 and a reversal in trend in the aftermath of the Global Financial Crisis (GFC) and the COVID 19 pandemic as both events increased uncertainties about economic prospects.

But assuming no frictions that render demand for fiat cash to be inelastic, such as privacy concerns and cultural preferences,²⁰ several countries have potential to register large changes in money velocity. Though cash usage has declined in many countries, there are still a significant number of countries where the share of cash in money supply remains very high, thus the scope for digital payment adoption is large (Figure 10).

¹⁹ Zero to negative interest rate environments reduce the opportunity cost of holding cash and, in such an environment, the best form of risk-free liquid asset is no longer the short-term government bonds but cash.

²⁰ For instance, in the Middle East, the success of the Hawala transfer system has limited adoption of mobile money and even when making online transactions there is still a preference for Cash on Delivery (COD) (Lukonga 2018).

Figure 10. Cash as a Ratio of Money Supply

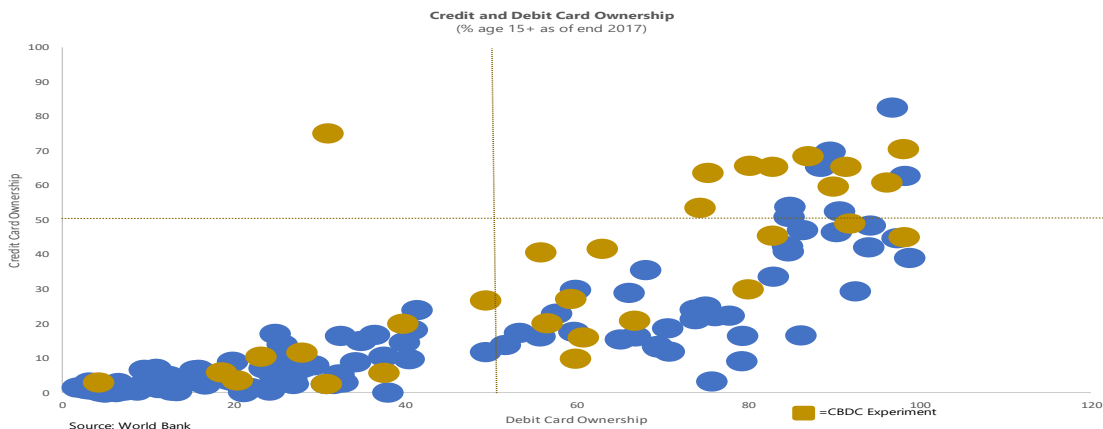


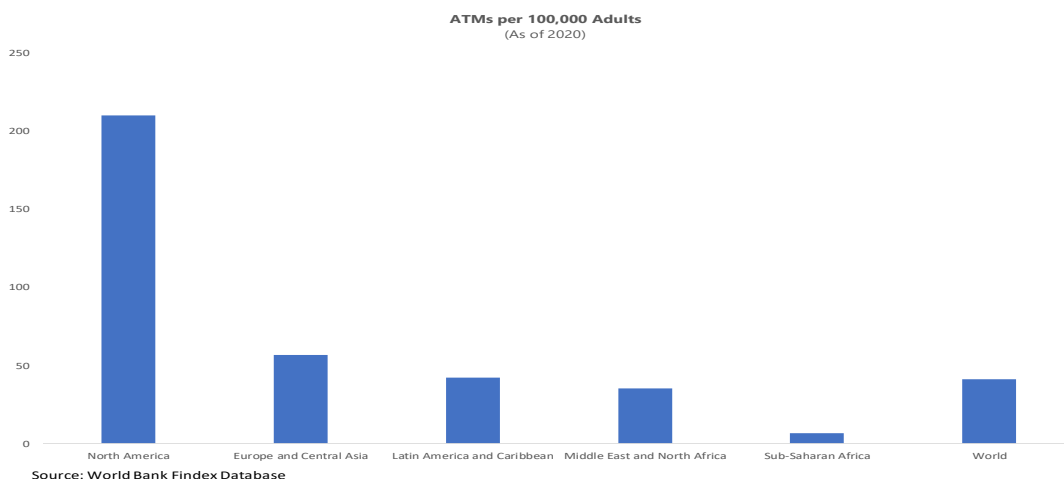
Source: IMF, International Financial Statistics (IFS)

The low penetration of private digital payment instruments, such as credit and debit cards and the low share of ATMs in EMDEs suggests substantial scope for countries to adopt CBDCs. There is currently a digital divide between advanced economies and many EMDEs and between the urban and rural areas. The penetration ratio of debit and credit cards, in many EMDEs show that less than 50 percent of the population have access to the electronic payments. Similarly, the penetration rate of ATMs is very low in EMDEs requiring these countries to hold much higher level of cash. As debit and credit cards require a bank account, and fees and charges are sometimes high, a CBDC that is available to the unbanked and charges no fees or lower fees could appeal to a broader segment of the population especially given the growth of e-commerce and the need for digital means of payment to be able to participate in that market.

Figure 11. Penetration of Debit, Credit Cards and ATMs

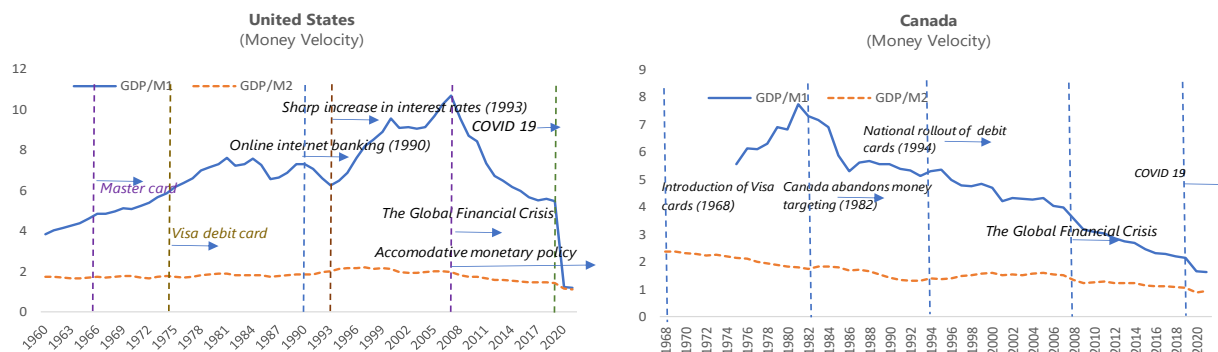
Penetration of debit and credit cards remains below 50 percent in many countries

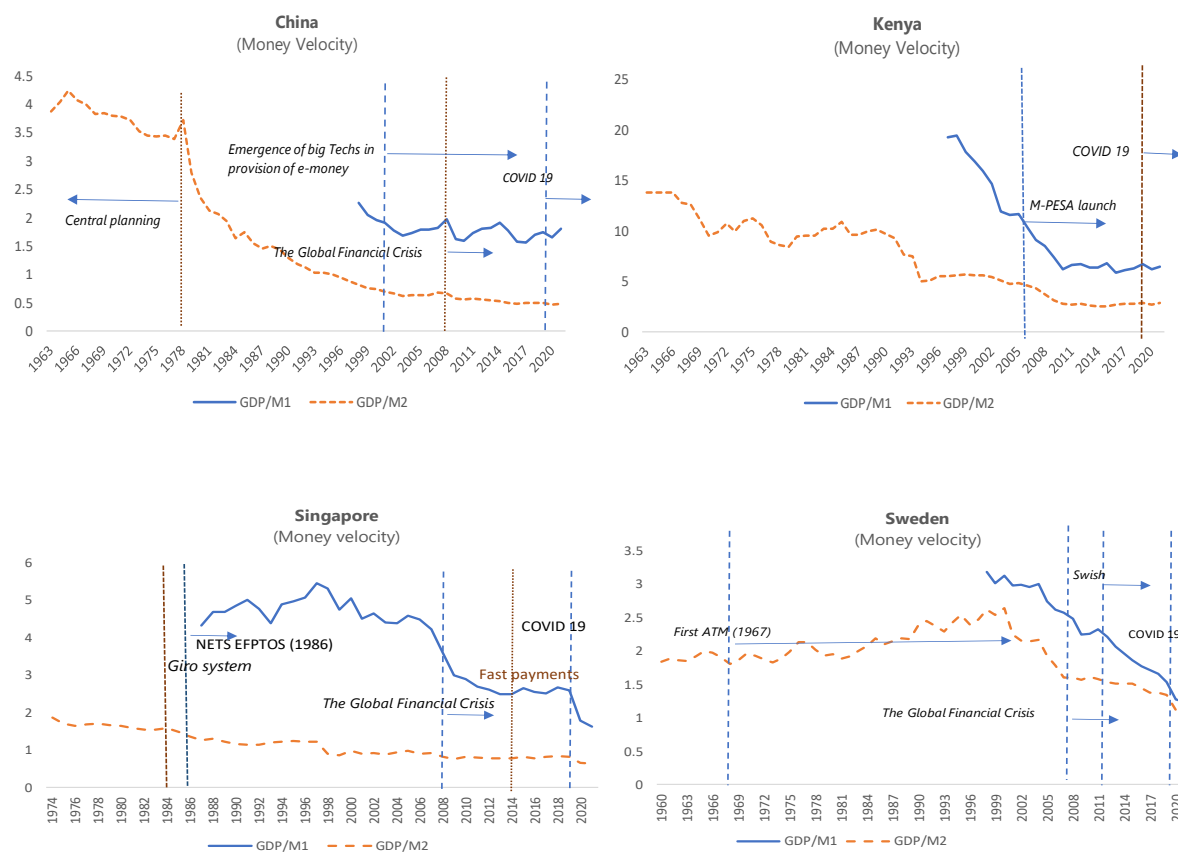




Empirical data for selected advanced economies also show that digitalization of payments was accompanied by a structural shift and instability in money velocity, but macroeconomic factors dampened the effects on money velocity. In countries that registered significant degrees of digitalization (the United States, Canada, China, Kenya, Singapore, and Sweden) money velocity for M1 registered significant instability (Figure 7). Money velocity for M2, that is more influenced by policy, income trends, money demand, price level, and interest rates, registered more moderate structural changes and volatility. In the United States, the increase in income velocity of M1 between 1960 and 2008 coincided with important payment innovations while periods of economic uncertainty in the aftermath of the GFC and the pandemic witnessed sharp declines in income velocity of M1. In [Canada](#), the sharp increase in money velocity (M1) coincided with the introduction of visa cards but the trend reversed and became unstable after 1982 when Canada abandoned the money targeting regime. In China, the transition from a command economy to market-based policies overshadowed developments in payments, but volatility in money velocity increased with the expansion of mobile money around 2002.

Figure 12. Technological Developments and Money Velocity





Source: Haver and International Monetary Fund

Empirical studies also confirm that the changes in money velocity can erode the effectiveness of money targeting regimes. The studies by (Isard and Rojas-Suarez (1986), (Nizam M 2021; Zhou, G.Y 2018)) found that, in Canada and in the United States, increased adoption of e-money was associated with changes in cash management accounts for businesses, instability in the relationship between M1 nominal income and interest rates, and an impaired money targeting framework. These shifts in money velocity associated with financial innovation contributed to the Canadian decision to abandon the practice of monetary targeting in 1982, and to the decision by the United States to adjust their aggregates and de-emphasize M1 in the early 1980s. In the United Kingdom, financial innovation altered the previous relationships between M1 and national income prompting the authorities to change the intermediate targets.

The extent to which technological induced changes in money velocity can cause inflation, however, warrants further analysis. Conceptually, an increase in velocity may denote higher inflation because when either the quantity of money (M) or the velocity of money (V) or their combination increases faster than real GDP, then prices increase in proportion to how much MV exceeds output growth. In a study by KOÇ Ümit and ŞAHİN Hasan (2021), the variables related with the electronic payment systems have statistically significant effects on inflation. But thus far, there is a dearth of studies that establish a causal relationship between payment innovations, money velocity and inflation.

Forecasting how CBDCs would impact money velocity will require further work and well specified quantitative analysis for which data may not be available in the immediate time horizon. Trends in how innovations in digital

payments have impacted cash in circulation and money velocity should be taken as indicative since CBDCs have a different risk profile from private digital monies. CBDCs will also be introduced as additional to other digital payments and the impact of incremental innovations is not linear.

W-CBDCs, Tokenization and Financial Market Segmentation

The potential impact on monetary policy implementation and transmission of issuing a w-CBDC are somewhat uncertain, both in terms of magnitude of effect and probability of occurrence. Currently, although there is much optimism regarding the promise of DLT, “proof of concept experiments” are still in early stages and the real-world applications could be years away from full implementation. If DLT is widely adopted, the tokenization of financial markets that it could enable could constitute a double-edged sword, enhancing efficiencies in security settlement but also increasing risk of market segmentation.

The potential risks of market segmentation arising from the tokenization of financial assets and associated liquidity challenges will need to be better understood. Some pilots, such as [Project Helvetia](#), that experimented with selling tokenized assets in central bank money indicate that the introduction of w-CBDC could potentially lead to some segmentation of the money market, which could negatively affect the efficiency and liquidity of the money market. The risk of market fragmentation and inefficiencies would increase if w-CBDC is designed to be used in a separate payment rail and not interoperable with the current system. Liquidity reduction would occur in both markets because financial institutions would have to operate and maintain balances in two systems. This could alter market structures and require significant amount of liquidity for settlement while potentially fragmenting the supply of liquidity, necessitating the need for novel liquidity-saving mechanisms and the development of new money markets for immediate and intraday liquidity.

The efficiency gains of using DLT and their implications for monetary policy will also need further analysis. By shortening the time between the trade and settlement, especially for DvP or instant settlement, DLT can reduce the replacement cost risk, but increase liquidity requirements associated with the need to prefund positions.²¹ There is also the question of interest rate setting mechanism if settlement moves to 24/7.

Cross-Border Use of CBDCs, Currency Substitution and Capital Flow Volatility

The cross-border use of CBDCs, if it becomes a widespread reality, could affect monetary policy for both issuing and recipient countries. The risks could be higher for recipient countries and more elevated in crisis periods. The status of CBDCs experiments also suggest that the risks are more a medium-term concern than immediate.

For issuing countries, risks to monetary policy of issuing CBDCs with cross border functionality appear to be manageable. The availability of CBDCs across borders does not in itself guarantee demand for the CBDC, since demand for foreign currencies is derived from the need to finance trade and financial products, as a store of value or for speculation, and the value of a country’s central bank money is linked to the credibility of the central bank that issues it and the strength of its macroeconomic performance. The impact on monetary aggregates of increased demand for a country’s currency could be inconsequential. Over \$950 billion in U.S.

²¹ The liquidity impact is because other settlement systems offer netting, meaning less cash is needed for payment at one point in time.

dollar banknotes were held by foreigners at the end of the first quarter of 2021, accounting for roughly half of total U.S. dollar banknotes outstanding (Bertaut and others 2021) but this has not upended the United States Federal Reserve's ability to conduct monetary policy. Appreciation pressures from surges of capital inflows have had a negligible impact on inflation in the United States (Matschke J and Sattiraju A 2022). Issuing countries could also design the CBDCs to restrict access to non-residents, though the nature and effectiveness of such designs are still prospective and uncertain.

For recipient countries, the risks to monetary policy from currency substitution, sudden capital flow reversals and reduced seigniorage could be significant, particularly in crisis periods. The convenience and ease of access to reserve asset currencies that the CBDC would enable and the security of CBDCs compared to cash could incentivize the public to hold foreign CBDCs, particularly in those in countries with weak macro-fundamentals. Several pilots (m-CBDC Bridge, Project Dunbar) have shown technical successes in CBDCs' ability to speed up the cross-border transactions. If CBDCs lead to faster cross border transactions, the increased speed could enable capital flow volatility which present challenges for exchange rate and monetary policy.²² Greater use of foreign CBDCs could also lower seigniorage for the domestic central bank.

In normal times, central banks may be able to adapt their operations as they have in previous episodes of technological changes in the financial sector. Cross border payments, though still inefficient, registered significant technological changes over the past decades but those developments have not upended capacity to conduct monetary policy. In the retail payments sector, there are several Apps that enable the opening of wallets for cross-border payments without the need to create local accounts and technological developments have facilitated faster transfers of remittances. In the wholesale segment, cross border payment arrangement such as the SWIFT's global payments initiative (GPI) facilitates completion of transfers within few minutes, or a day and payments are traceable. There are also several regional initiatives that are addressing cross border payments.

The risks to monetary policy from currency substitution and capital flow reversals could, on the other hand, present major challenges, particularly in crisis times. Historically, sudden outflows of capital have had adverse effects on exchange rate and monetary policy of many countries. During the United States taper tantrum of 2013, the normalization of interest rates led to sudden outflows of foreign capital which led to the depreciation of exchange rates and a weakening in the capacity of several countries to conduct effective monetary policy.²³ If the financial system is not sufficiently deep, an increase in the speed of cross border transactions could affect the stability of the financial sector and weaken monetary policy transmission. Regulatory factors, such as Capital Flow Measures (CFMs) can put some breaks on outflows if foreign CBDC do not bypass traditional intermediaries and controls through which foreign exchange measures and other regulatory requirements are typically enforced. But there is a lack of clarity on whether the programmability features of CBDCs could make it difficult or easier for domestic monetary authorities to enforce capital flow measures (CFMs).

The probability of the risks materializing is, however, low in the near term as cross border use of CBDCs will require countries to issue the CBDCs first and to ensure that their platforms are interoperable, or they have a

²² During the United States taper tantrum of 2013, the normalization of interest rates in the United States led to sudden outflows of foreign capital which forced Egypt to cancel successive treasury bill auctions as foreign investors withdrew from local debt markets causing domestic bond yields to increase. Selected countries (Egypt, Pakistan, Bahrain) resorted to central bank financing of fiscal deficits.

²³ Egypt had to cancel successive treasury bill auctions as foreign investors withdrew from local debt markets causing domestic bond yields to increase. Selected countries (Egypt, Pakistan, Bahrain) resorted to central bank financing of fiscal deficits.

common platform. The use of CBDCs in cross border payments has become a centerpiece of global initiatives efforts to address current pain points in cross border payments but realizing the promise could take several years. Though the foundational principles advocate for the incorporation of cross border functionality in the CBDC design earlier in the process, the transition from experimental proof of concepts and pilots to production could face significant political hurdles.

- Concerns over the geopolitical implications of a foreign CBDC circulating at home and the prospect of foreign countries obtaining information on their citizens could present a major constraint to the adoption of foreign CBDCs. There are also national security concerns that could arise from sharing critical infrastructures with other central banks
- If geopolitical concerns are overcome, there are still many technical and legal challenges that will need to be resolved before the use of CBDCs in cross border transactions become a reality. The pilots on cross border CBDC schemes have, thus far, involved a few countries and questions remain about the scalability of platforms if the number of participants increase. Participation in w-CBDC projects remains concentrated among economies whose currencies are convertible and tradeable in international foreign exchange market. It, therefore, remains to be seen whether the platform model would work for developing countries with non-convertible and less liquid currencies.
- There are also several other technical questions that are yet to be resolved. These include interoperability among different CBDCs which may operate on diverse national DLT or not use DLT at all; access criteria for non-local banks particularly when central banks do not supervise those banks directly; and how to simplify the cross-border payment flow while respecting regulatory differences. There are also uncertainties associated with the macroeconomic implications of w-CBDCs; investment and maintenance cost of new infrastructures; legal and regulatory frameworks; AML/CFT compliance; and privacy protection. On the infrastructure side, questions remain about technology standardization; risk management; operational and information-sharing concerns; network governance arrangements; data warehousing; and the choice of custody model. (BIS 2022a).

Implications for Jurisdictions with Islamic Banks

Shariah principles which govern Islamic finance prohibits *Riba or Usury* (interest payments) and *Gharar* (speculation) and these requirements have implications for CBDC designs, the use cases, the monetary policy implementation and transmission and potential impact.

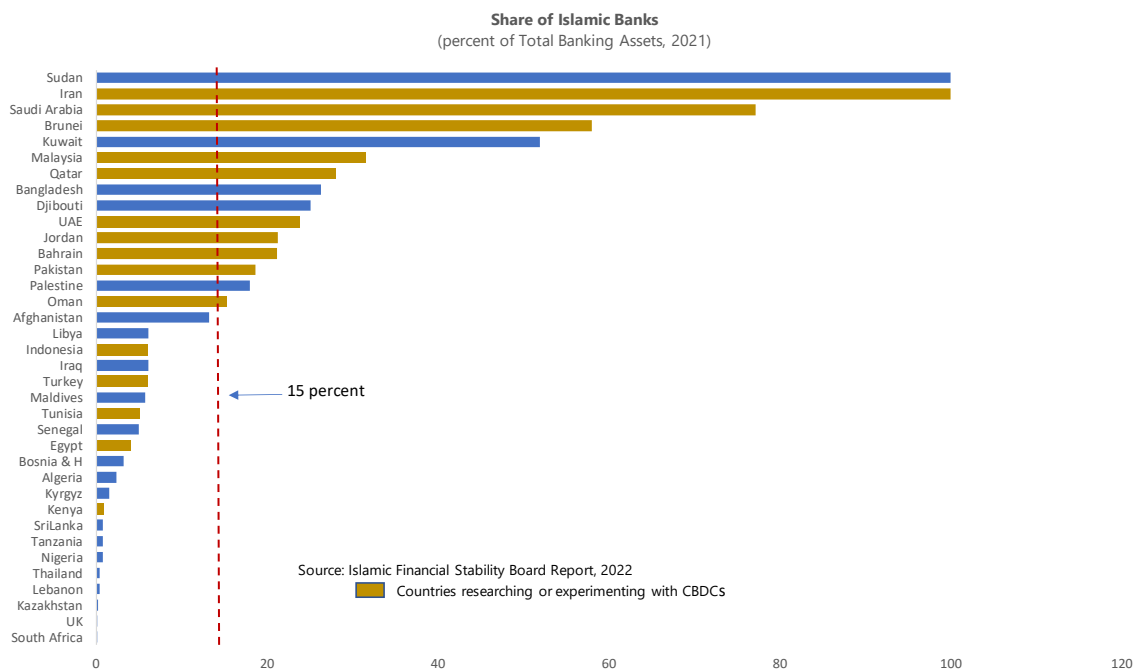
Overview of Islamic Financial Systems and Monetary Policy Frameworks

Islamic banking has grown rapidly in value, market share and geographical reach and is projected to continue to expand. Though Islamic finance accounts for less than 2 percent of global finance, Islamic banking is systemically important in 15 jurisdictions.²⁴ Two countries (Iran and Sudan) have fully fledged Islamic banking system in which the banking system follows Islamic rules and monetary policy is fully conducted by Shariah-

²⁴ Systemically important banking systems is defined as 15 percent or more of the total banking system.

compliant instruments. The remainder have implemented dual-financial systems in which Islamic banks (IBs) exist alongside conventional (non-Islamic) banks, either as subsidiaries or Islamic windows (Figure 13).

Figure 13. Jurisdictions with Large Islamic Banking Sector and Share of Unremunerated Accounts



Of the 34 countries with Islamic banking, 10 countries are experimenting with retail and w-CBDCs. Among these, one country (Iran) is a fully-fledged Islamic banking system and the remainder have dual banking systems.

The conduct of monetary policy in jurisdictions with Islamic banks does not differ materially from conventional banking systems. Monetary policy frameworks also stipulate the nominal anchor, the operational targets, and intermediate targets and monetary policy works through prices or quantities. The objectives of monetary policy are similar, albeit for the partial modification to add equitable distribution to the traditional objectives of price stability and economic growth.

Currently, jurisdictions with large Islamic finance sectors have mostly adopted exchange rate targeting regimes as the nominal anchor for monetary policy (Figure 14). None of the countries operate an IT regime, one country (Bangladesh) operates a money targeting regime and the other three (Pakistan, Malaysia, and Sudan) have no explicit nominal anchor.

Figure 14. Monetary Policy Regimes in Countries with Islamic Banks as of end 2020

Monetary Policy Frameworks and Exchange Rate Arrangements in Countries with Islamic Banks as of end 2020

Exchange Rate Arrangements	Exchange Rate Anchor				Monetary Aggregate Target	Inflation Targeting	Other
	US Dollar	Euro	Composite	Other			
Currency Board	Djibouti			Brunei Darussalam			
Conventional Peg	Bahrain Jordan Oman Qatar Saudi Arabia United Arab Emirates						
Stabilized Arrangement	Iran				Bangladesh		Sudan
Other Managed Arrangement			Kuwait				Pakistan
Floating							Malaysia

Source: Annual Report on Exchange Arrangements and Exchange Restrictions (AREAER)

The exchange rate peg has been successful in anchoring inflationary expectations at low levels. But given the open capital account regime, the peg restricts the independence of monetary policy, and macroeconomic management mostly relies on fiscal policy as high oil prices have supported banks' liquidity through strong deposits inflows from government and government-related entities. There has also been a reliance on prudential regulation, and various controls to achieve the desired balance between price stability and growth.

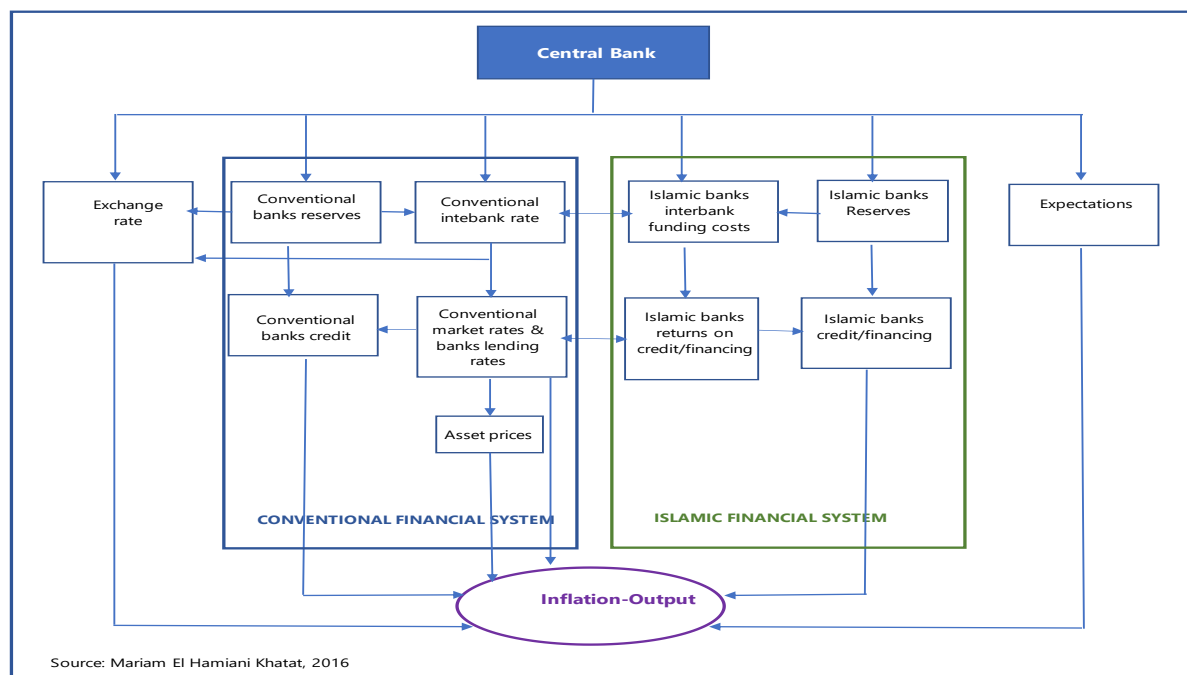
The need to comply with Sharia'h principles, however, complicates monetary policy implementation. Conventional mechanisms of liquidity management — interbank market, secondary market financial instruments, central bank discount window and Lender of Last Resort (LOLR)— that are based on interest are not permissible for Islamic banks. Central banks, therefore, need to either modify traditional instruments or to develop new Sharia'h compliant monetary policy instruments and interbank and capital markets.

The availability of Shari'ah-compliant money market instruments for interbank transactions and liquidity management vary across countries but the market is mostly underdeveloped. A few countries (Malaysia, Bahrain, Indonesia) have made advances in developing Sharia'h compliant liquidity management tools and interbank markets, but many others do not have any Islamic repo facilities with central banks or have a very limited offering. The basic infrastructure necessary for a market-based Islamic monetary policy (Islamic money and Sukuk markets) are also lacking.²⁵ Islamic banks, therefore, tend to hold more cash than necessary.

²⁵ These constraints include differences in sharia interpretation, lack of standardization and regulatory hurdles faced by Islamic banks.

In countries with dual banking systems and where conventional money markets are fairly developed, Islamic banks evolve in an interest rate dominant environment and there can be arbitrage between conventional and Islamic financial systems with returns on profit sharing investment accounts being correlated with prevailing interest rates (Figure 15). In some jurisdictions, Islamic banks do not participate in conventional monetary operations and interbank markets, creating segmentation between Islamic and conventional money markets.²⁶

Figure 15. Monetary Policy Transmission in Jurisdictions with Islamic Banking Systems



Where Islamic finance is still embryonic, there is often no Islamic finance equivalent to money market or government securities yield curves that can serve as references to price Islamic banks credit (Mariam El Hamiani Khatat, 2016). As a result, some Islamic banks tend to rely on conventional interest rates to price their Murabahah and Ijarah contracts. But even when resorting to conventional interest rates to price Islamic credit, Islamic banks can be more-or-less reactive to changes of conventional policy rates, thus monetary policy transmission through the interest rate channel will be less effective.

Sharia'h Principles and CBDC Designs

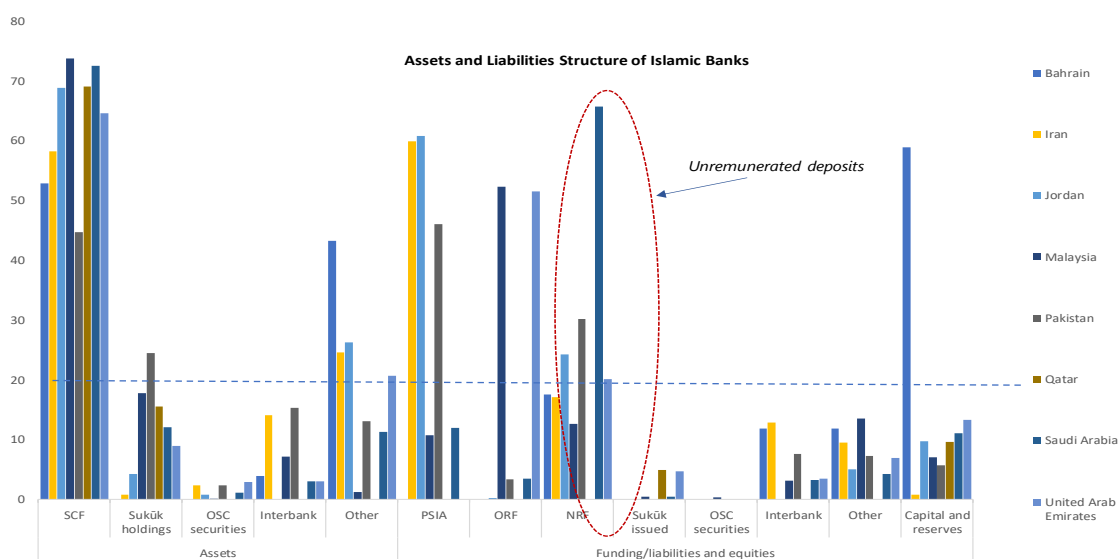
Issuing a CBDC in an Islamic setting raises several complex design issues. Shariah principles prohibit interest payments, thus remunerated CBDCs are either not an option or the central banks have to design a CBDC that incorporates a profit-sharing mechanism. There is also a question of how tokenized financial markets would operate in an Islamic banking setting. The prohibition of speculation implies that CBDC cannot be used for foreign exchange derivatives transactions.

²⁶ Islamic banks' clients can be indifferent to the level or changes in returns of the PSAs or cost of Islamic credit mainly due to their deep religious beliefs.

Potential Impact on Monetary Policy Implementation and Transmission

Bank disintermediation constitutes one of the principal channels through which CBDCs can affect monetary policy in jurisdictions with Islamic banking system. Due to the prohibition of interest payments, unremunerated deposits account for a very large share of bank liabilities with some countries ranging between 30 and 70 percent (Figure 15). As CBDCs are perfect substitutes for unremunerated demand deposits, the large share of unremunerated deposits elevates the disintermediation risk.

Figure 16. Balance Sheet Structure of Islamic Banks



Source: Islamic Financial Stability Board Website
 Notes:
 SCF = Total Shari'ah-compliant financing (excluding interbank financing) Total Shari'ah-compliant financing (excluding interbank financing)
 OSC securities = Other Sharia compliant securities
 ORF = Other remunerated funding

The risk of bank disintermediation in jurisdictions with Islamic banks is further heightened by the predominance of retail deposits in bank funding. GCC Islamic banks' funding profiles continue to benefit from strong retail networks, a high share of low-cost customer deposits and low reliance on wholesale funding, all of which support the stability of their funding base. Their liquidity is supported by a good proportion of liquid assets (in the form of cash balances with central banks and held-to-maturity domestic sovereign sukuk) relative to their customer deposit base. The predominance of small retail deposits is a double-edged sword. While small retail deposits constitute a stable source of funding, it also means that the caps on holdings in CBDC digital wallets intended to minimize disintermediation into CBDCs might not be binding.

Finally, the underdeveloped Islamic finance markets increase the risk that if deposits are used to fund CBDCs the ability of the central bank to mitigate liquidity risk might be constrained. Islamic banks cannot access interest-bearing liquidity facilities available to conventional banks due to sharia-restrictions. Meanwhile, Islamic liquidity management instruments (ILMI) continue to develop slowly due to unsupportive regulations, sharia-compliance complexities, limited standardization, the small number of Islamic banks and the underdeveloped financial sectors in many of the countries (Fitch 2022). Sukuk have emerged as a principal collateral for OMO

in Islamic countries but while Sukuk markets have registered growth, they are still concentrated in Malaysia and the GCC countries and there is a tendency to hold them to maturity reducing tradeable volumes. The market segmentation and lack of adequate sharia-compliant money market instruments for liquidity management limit the Islamic banks liquidity management capacity while underdeveloped Sukuk market in most countries limit available collateral and constrains the effectiveness of a LoLR.

Conclusions and Policy Strategies

Assessments of the monetary policy implication of CBDCs are still largely conceptual and tentative. Data are not yet sufficient to undertake empirical analysis as only a few countries have issued CBDCs and the period that the CBDCs have been in production is short. The impact of a retail CBDC on monetary policy also depends on the degree and speed of adoption, which is difficult to determine ex-ante while that of w-CBDCs will depend on the degree to which DLT is widely adopted. Thus far, countries that have issued CBDCs have witnessed very little uptake, but it is still too early to deduce long term trends. Inference from the monetary policy impact of past innovations in digital payments has to be interpreted with caution because CBDCs have a different risk profile from private monies. For w-CBDCs, although there is much optimism regarding the promise of DLT, the risk implications are not yet fully understood.

The conceptual analysis, nevertheless, suggests that CBDCs do not change the objectives of monetary policy or the operational framework for monetary policy but CBDCs can induce changes in the retail, wholesale and cross-border payments that have spillover effects on monetary policy implementation and transmission. Retail CBDCs can alter the public's portfolio holdings of CBDCs relative to cash and deposits and increase the volatility of money velocity, deposit disintermediation and the volatility of bank reserves. These outcomes, in turn, weaken the interest rate and lending channel in the monetary policy transmission mechanism, reduces the capacity to forecast reserves and conduct OMO, and erodes the effectiveness of money and IT regimes. W-CBDC could enable tokenization of assets and enhance efficiencies in securities settlement systems but the potential for market segmentation could undermine the efficiency gains and needs to be better understood. The use of CBDCs in cross border payments could increase currency substitution risks in recipient countries and speed up capital flows, all of which can impact domestic monetary and exchange rate policies.

The risks to monetary policy of issuing CBDCs will vary across countries, financial systems and across time. Countries most vulnerable to deposit disintermediation are those with banking systems that have large shares of small transactional retail deposits and demand deposits and where banking system liquidity is unevenly distributed or there is a structural liquidity deficit. Jurisdictions with Islamic banking systems could be more vulnerable to deposit disintermediation because of the predominance of unremunerated deposits and retail deposits in banks. The underdeveloped nature of Islamic financial markets and Sharia'h compliant liquidity management tools could also limit the central banks' scope to respond to liquidity shocks. Countries with payment systems that have low levels of digital payments could see significant changes in money velocity. As CBDCs become mainstream, the inception phase could be most challenging because of '*en masse*' opening of the digital wallets and commercial banks may not yet be ready for the sudden shock to their deposit base. The crisis period could be equally challenging as the precautionary motive could lead to a surge in CBDC adoption.

The design of CBDCs could moderate the risks but substantial residual risks remain, thus further safeguards are needed to manage unintended macroeconomic consequences of CBDCs. Caps on CBDC holdings or transaction limits may not be binding for banks with small retail transaction deposits and enforcing the caps on

the amount of CBDCs that can be held in a digital wallet may also entail some operational challenges. Issuing unremunerated CBDCs will not stop disintermediation given the similarities with non-remunerated demand deposits. Programmability can help address some of the pain points in cross border payments and enhance greater efficiencies, but it may make it difficult to contain rapid reversals of capital flows, impacting monetary policy directly and indirectly through the exchange rate.

A multifaceted strategy is, therefore, needed to comprehensively identify the macro financial risks and strengthen liquidity management. As part of the preparations for issuing CBDCs, central banks should ensure that the macroeconomic risks that CBDCs pose are understood, identified, managed, and mitigated. Countries need to assess potential demand for CBDCs in their countries, understand the deposit structure of banks and the vulnerabilities to deposit disintermediation, evaluate the effectiveness of proposed measures (caps) to minimize deposit disintermediation, assess potential changes in money velocity and how that might affect the effectiveness of the monetary policy regimes. For cross border use of CBDCs, there is a need to understand from a practical perspective how a cross-border payment infrastructure with CBDCs could be set up and from a macro-financial perspective, understand the likely impact on cross-border flows, possible financial stability risks and currency substitution. Strengthening liquidity management capabilities of both commercial banks and central banks will be critical in mitigating liquidity risks that could arise if CBDCs are funded by bank deposits.

Further research is needed in several areas. There is a need to better understand: (i) the macro-financial implications of financial market tokenization, including the potential for market fragmentation, the liquidity and interest rate implications, and the potential to interoperate with the market for central bank reserves; (ii) how the programmability of assets and smart contracts could impact capital flow volatility in cross border payments and capital flow measures; and (iii) whether the central bank should be the lender of last resort to the foreign banks if they are short of domestic CBDCs or if an increased use of w-CBDC for cross-border settlement could result in higher and possibly more volatile intraday demand for central bank money. A related question is whether access to intraday w-CBDC for non-resident banks increase demand for the overnight reserves held by resident banks acting as correspondents and how this may affect liquidity management for market participants, the price for liquidity and the efficacy of monetary policy implementation.

Overall, the risks to monetary policy of issuing a CBDC are material and deserve policy attention but they do not appear insurmountable. Past technological innovations in payments have not upended monetary policy, thus it can be expected that the impact of CBDCs on monetary policy will be manageable even if some adjustments are inevitable. Technological advances in payment systems are also seldom used at their maximum capacity, thus the changes associated with the issuance of a CBDC could be gradual, rather than a spasmodic process.

Box 1. Taxonomy of Retail CBDC Designs**Distribution model (Direct or Single Tier CBDC model vs indirect, two tier or intermediated models):**

In the single-tier CBDC model, the Central bank issues the CBDC, distributes to end customers, keeps records of all transactions, and undertakes the onboarding and know your customer (KYC) procedures. In the “indirect”, “two-tier” or “intermediated” models, the central bank issues the CBDCs, banks distribute to retail clients and assume the function of customer on-boarding including AML compliance.

Remuneration (Interest bearing vs non-interest bearing): Interest bearing CBDCs attract interest payments akin to deposits while non-interest bearing does not pay interest and are more akin to cash.

Validation models (Account based CBDC vs Token based): In an *account-based design*, the CBDC is tied to an identification scheme, such that all users need to identify themselves to access it. In a *Token based CBDC* the digital currency is authenticated and not the user.

Privacy: Privacy in a CBDC goes beyond binary choices of anonymity or full disclosure. System designers have a range of choices around the type of information to keep private and who to keep it private from. Privacy is the degree to which holdings and transactions data are hidden from participating entities. The entities are many and could include the central bank, the commercial bank, non-bank payment service providers, government institutions and the general public, and each with a varying degree of visibility to holdings and transactions.

Ledger technology: The back-end infrastructure underpinning the provision of CBDCs could be centralized, with all transactions recorded in the central bank’s ledger. It could be decentralized by using distributed ledger technology (DLT) where either end users, or supervised intermediaries acting on their behalf, would authenticate any payment. Central banks could opt for a hybrid. In both a hybrid and an intermediated architecture, the central bank can choose to run the infrastructure to support record-keeping, messaging, and related tasks, or delegate these tasks to a private sector provider.

Caps, limits, and overflow accounts: Caps or limits restrict the amount of CBDC held by households and businesses to minimize disintermediation risks and digital runs. To ensure that households and firms can accept incoming payments at all times, any funds in excess of a cap could be transferred automatically to a linked commercial bank deposit account – the so-called overflow approach.

Box 2. The Quantity Theory of Money and Money Demand

According to the quantity theory of money, a rise in the stock of money should lead to a proportionate rise in nominal GDP ($P \cdot Y$), assuming velocity, defined as the rate at which money is exchanged to purchase goods and services, is constant.

$$M \cdot V = P \cdot Y \quad (1)$$

- M= Money stock
- V= Velocity of money stock circulation defined as the average frequency with which a unit of money in a specific time under the assumption of a given level of money supply
- P = Price level
- Y = Volume of transactions of goods and services (real GDP)

This equation can be reconstructed into growth rates by transforming the variables into logarithms and time derivatives. This transformation leaves us with equation (2), which can be simplified into equation (4).

$$\partial(M) + \partial(V) = \partial(P) + \partial(Y) \quad (2)$$

Given that velocity is assumed to be constant, the variable for the growth rate of velocity drops out when taking its derivative ($\partial(V) = 0$). In addition, the growth rate of the price level equals the inflation rate, denoted as π . Thus, $\partial(P) = \pi$. This leaves us with equation (3).

$$\partial(M) = \pi + \partial(Y) \quad (3)$$

In turn, since the growth rate of real GDP multiplied by the rate of inflation equals the nominal growth rate of GDP ($\pi + \partial(Y) = \partial(\text{NGDP})$) the equation states that the growth rate in the money stock should equal the growth rate of nominal GDP, as seen in equation (4).

$$\partial(M) = \partial(\text{NGDP}) \quad (4)$$

If velocity is constant over time, then a percentage rise in the money supply will lead a corresponding percentage rise in nominal GDP and this change could happen through an increase in inflation, an increase in real GDP, or some combination of the two. If velocity is changing over time but in a constant and predictable way, then changes in the money supply will continue to have a predictable effect on nominal GDP. If velocity changes unpredictably over time, then the effect of changes in the money supply on nominal GDP becomes unpredictable.

This basic equation shaped the way central banks conducted monetary policy for many years as it implies that an increase in the growth rate of the money leads to equal increases in nominal GDP. Central banks could target the money supply by conducting either expansionary or contractionary monetary policy through open market operations. The reason why velocity is assumed to be constant is because historically, payment mechanisms changed very slowly.

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PUBLICATIONS

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