

Advanced Financial Instruments for Sustainable Business and Decentralized

Markets

Prof. Abhinava Tripathi

Department of Management Sciences

Indian Institute of Technology, Kanpur

Lecture 33

Week 11

INDIAN INSTITUTE OF TECHNOLOGY KANPUR

CBDCs : Background

INDIAN INSTITUTE OF TECHNOLOGY KANPUR

In this lesson, we will start the discussion with Central Bank Digital Currency background. We will put a set of questions that provide the intuition behind CBDCs. We will also provide some statistics briefly to understand the current state of progress across various Central Banks pertaining to the development of CBDC. Next, we will discuss the evolution of monetary system and the development of CBDC infrastructure in the last decade. Next, we will introduce the retail economic design of CBDCs. We will also provide the motivations for issuing CBDCs. We will also compare the dominant competing CBDC designs including wholesale vs retail, account vs token and direct vs indirect vs hybrid. We will understand the key differences and design considerations across these competing models. We will also discuss the key features and variants and pros and cons associated with these models. Lastly, we will discuss the implications of CBDCs for monetary policy,

financial stability and commercial banking.

We will conclude the discussion with a comparison between CBDCs and cryptocurrencies.



Background

- Is physical or paper cash really vanishing? How far is this process across the world? How big are the differences across countries?
- What exactly is a CBDC? What are the defining properties of a CBDC? What technical options are there? Depending on the combined features, what different types of CBDC might be conceived, and what properties would they each offer?
- What are the consequences – pros and cons as well as risks – of the various conceptions of CBDC for society at large (e.g., the power balance between state and individual, personal privacy), for citizens and businesses, for banks (e.g., business model), for central banks (e.g. role, size of the balance sheet) and monetary policy (e.g., the effectiveness of monetary policy transmission) as well as for financial stability (e.g., bank runs)?

INDIAN INSTITUTE OF TECHNOLOGY KANPUR

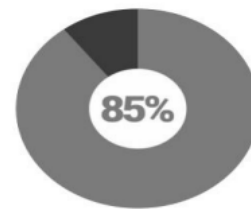
In this video, we will briefly introduce Central Banking Digital Currency i.e. CBDCs and ask a few relevant questions. To begin with, let us discuss a little bit about the background of monetary systems evolution. The evolution of monetary systems has often been viewed as a private sector development. However, the most significant and consequential shifts have been instigated by state responses to extraordinary events. Throughout the history, states have encouraged the development of monetary systems in order to support their geopolitical and economic expansion and the development of CB and Finance to accelerate and sustain the capitalistic system. Furthermore, large economic and political shocks like the Great Depression and the two world wars around 1914-18 and 1939-45 have triggered modification to the gold standard monetary system earlier. Likewise, in the most recent times, high competition amongst financial players, global upheavals such as the global financial crisis of 2008 and in the past three years, the Covid-19 pandemic and Russia-Ukraine conflict in Eastern Europe have intensified the demand for more adaptable monetary and fiscal policies that address contemporary needs while simultaneously mitigating emerging challenges for the financial system.

These challenges predominantly include increasing digitization, declining cash usage, ineffectiveness of monetary policy and widening social divisions in the backdrop of proprietary financial solutions such as fintech and cryptocurrencies, which threaten national economic sovereignty as well. Moreover, as the digital economy becomes increasingly important and reliant on privately owned digital platforms, with proprietary

and opaque rules potentially expanding into all-income passing metaphors, central banks are preparing for another intervention of epochal proportions with the help of these CBDCs. And therefore, in this backdrop, the rise of CBDC begs the following questions. First and very important, is physical or paper cash really vanishing? How far is this process taking place across the world and how big are the differences across countries? Next question that you would like to answer is what exactly is central banking digital currency or CBDC? What are the defining properties of a CBDC? What technical options are there? Depending upon the combined features, what different types of CBDC might be conceived and what properties would they have? What are the consequences that is pros and cons as well as risks of various conceptions of CBDC for society at large, for example, the power balance between state and individual, like the IBC, anonymity and so on. For citizens and businesses, for banks, for example, what would be the business model and would it threaten the banking as we see it now. For central banks, for example, the role of central banks, the size of the balance sheet that would be needed to run these CBDCs by central banks, their relationship with the monetary policy, for example, the effectiveness of monetary policies transmission with the help of CBDCs, whether it will improve or further deteriorate, as well as the financial stability of systems such as bank runs and financial crisis across global financial systems. The significance and importance of the CBDC can be gauged by the fact that almost 85% as per a survey 85% of central banks in the world currently are either studying or trying to create pilot projects of CBDCs.

Turbulence in cryptocurrency markets

- In 2022 and early 2023, crypto markets were turbulent.
- November saw the collapse of FTX, one of the largest crypto trading platforms.
- 2022 BIS survey: Nearly 60% of respondent central banks said that the emergence of crypto-assets and stablecoins has accelerated their work on CBDCs.
- Central bank (CB) Digital Currencies, or CBDCs, are a novel form of digital central bank (CB) money that represent the culmination of state efforts to manage this digital transition



of the central banks in the world are currently either studying or piloting CBDCs.

Source: Central Bank Digital Currencies and the future of money
<https://www.pwc.com/m1/en/media-centre/2021/documents/central-bank-digital-currencies-and-the-future-of-money-part1.pdf>

INDIAN INSTITUTE OF TECHNOLOGY KANPUR

In 2022 and early 23 crypto markets were very turbulent. In early May 2022, the crypto ecosystem was embroiled and there were a lot of troubles by the failure of various crypto asset providers including Tera, Tera's Unbacked Stablecoin, which was the third largest stablecoin at the time. As the turmoil continued and numbers saw the collapse of FTX, which was one of the largest crypto trading platforms, nearly 60% of the respondents as

per a 2022 survey. These were central banks, they said that the emergence of crypto assets and stablecoins has accelerated their work on CBDC. So they felt the impact of these crypto assets and the need to move towards CBDCs. Central banks and international standard bodies have stepped up monitoring the implications of crypto assets and are engaged in extensive international policymaking and standard setting to work to stand on regulatory approaches to crypto assets. One can say that central bank digital currencies, the CBDCs are a novel form of digital currencies money that represent the culmination of state efforts to manage this digital transition. They are designed to provide attractive instruments for both wholesale and retail functions as well as bolster central banks influence and control over the economy through new monetary fiscal policy tools and programmable capabilities. As with the power shifts in monetary policy, their introduction may have significant disintermediating effects on the financial system as we see today, such as disintermediation with commercial banks and some of the operations of private money providers. As we noted earlier, almost more than 85% of the central banks involved in CBDC research and 60% in experimental and 14% have started with some kind of live projects. So we can see there is a lot of movement with this CBDC. These are the data collected by this bank of international settlement. To summarize, in this video, we briefly introduced the reasons for rise of CBDCs, their evolution across last four to five years and we showed how multiple central banks are moving ahead at accelerated pace in the direction of creating different different digital platforms and technological projects to go ahead and advance with these CBDC projects.



In this video, we will formally introduce the concept of CBDCs and also discuss a few definitions and relevant issues associated with them.



CBDCs: Introduction

- Over the centuries, various forms of money have emerged to meet the economic needs of the time (e.g., Coins, banknotes, cheques, and credit cards).
- The digitalization of economies has far-reaching implications for many areas of economic inquiry, not least for monetary economics and the concept of money itself
- However, the payment landscape continues to evolve rapidly. This reflects significant changes in the payment preferences of households and firms, alongside innovation in underlying technologies.
- Central banks have adopted a more proactive stance by anticipating a future when innovation and the entry of new private forms of money will already have transformed the monetary system, rather than treating the current system as the benchmark

To begin with, over the centuries, various forms of money have emerged to meet the conduct needs of the time. These include coins, banknotes, cheques and credit cards and each innovation has its own way and properties. In recent decades, new payment technologies have been added to this list from phone-based mobile money to smartphone-based payment apps and from stable coins, one new form of central bank issued money in the form of CBDCs or central bank issued currency. The tried and trusted and resilient way to provide confidence in money in modern times is the role of independent central bank as a central counterpart. Next, the digitization of economies has far-reaching implications for many areas of economic inquiry, not the least for monetary economics and the concept of money itself. With the massive volumes of data that digital activity generates comes new opportunities and challenges for societies and the monetary system. The idea that central banks would issue digital forms of money for general use is a natural progression from the issuance of fiscal cash. In addition, banks have had access to digital forms of central bank money for several decades in the wholesale payment system. However, the debate on the issuance of digital central money that is accessible to ordinary users has picked up pace only very recently and initially policy reports took a cautious approach to the issuance. But the last years have witnessed significant debate and broadening of the topic around the CBDCs. With this, however, the payment landscape continues to evolve rapidly which reflects the significant changes in the payment preferences of households and firms alongside the innovation in underlying technologies. In this context, considerable research has been undertaken over recent years across jurisdictions into the potential role that a CBDC could play in the payment system in the future. Now, CBDCs refer to a new digital form of money denominated in a national currency that would be issued as a direct liability of the central bank. It could be designed for use by households and firms for everyday payments which could be likened to a digital

version of banknotes themselves. It could also be designed for use by a more limited range of market participants in a specialized payment and settlement systems. Furthermore, alongside the rise and fall of cryptocurrency, the emergence of global stablecoin proposals such as Facebook's Diem and increasing technological disruption in finance, central banks have adopted a more proactive stance by anticipating a future when innovation and the entry of new private forms of money will already have transformed the monetary system rather than treating the current system as the benchmark.



CBDCs: Meaning

- Central banks have begun to engage in research on CBDCs and, in some instances, also their development. According to a survey from late 2020, 86% of global central banks are conducting research on CBDCs, and as of July 2021, 56 central banks have publicly communicated their research or development efforts.
- CBDC is "a digital payment instrument, denominated in the national unit of account, that is a direct liability of the CB" (Group of Central Banks (2020))
- European CB (ECB) defines CBDCs as "an electronic form of CB money that could be used by households and businesses to make payments and store value".
- If introduced, they would form a new, third form of central bank money, in addition to (i) cash, which is available to the general public and (ii) overnight deposits by (mainly) banks at the central bank.

INDIAN INSTITUTE OF TECHNOLOGY KANPUR

To quantify these developments, we find as per the group of central bank survey that central banks have begun to engage in research on CBDCs and in some instances also their development. For example, according to surveys by BISS and various other central banks, in around 2020, 86 percent of the global central banks are already conducting some form of research on CBDC. And as of July 21, 56 central banks have publicly communicated their research or development efforts. Focusing on the retail and consumer facing aspects, CBDC are defined as a digital payments to mint denominated in the national unit of account that is a direct liability of a central bank. In another way, central banks define CBDC as an electronic form of central banking money that could be used by households and businesses to make payments and store value. There is another definition that additional form of central banking money that can be used for retail payments. Another definition that relates to facilitating an execution and settlement of cross-border transactions between financial instruments acting as wholesale instruments. Also, CBDC can be considered as a digital form of central bank money that is different from balances in traditional reserve or settlement accounts. With all these definitions, we can see that interest in this new form of money is increasing and central banks are researching and experimenting with the underlying technology. So, one way to define as European central bank defines CBDC as an electronic form of central banking money that could be used by

households and businesses to make payments and store value. Now, central bank digital currency CBDCs are a central bank liability in nutshell offered in a digital form and in the national unit of account. So, if introduced, they would form a new third form of central bank money in addition to cash. So, we know cash which is available to the general public and overnight deposits predominantly by commercial banks at the central bank. So, these CBDCs can be designed to be available to the general public for general purpose or retail uses or to the financial sector only which is like a wholesale application of CBDCs. So, to collect these points, in addition to central bank money, private money as well is made available to the general public. This may take the form of commercial bank money, for example, in the form of bank deposit. Although commercial bank money may be convertible into central bank money to exchange into cash, it is not issued by the central bank and is hence a liability of the commercial bank, not of the central bank. So, it would be interesting to see how CBDC managers or plays between these multiple aspects of the modern form of monetary system. From the perspective of deposit insurance, the risk associated with the commercial bank money and central bank money are distinct. Whether deposit insurance have to play a role in the case of future of CBDCs and if so, to what extent. Other forms of private money include cryptocurrency such as bitcoin or stable coins such as feather and dm. In a way that is similar to cash certain models of CBDCs, cryptocurrencies and stable coins allow some kind of peer to peer use that is exchange of these forms of money directly between users, not through intermediaries such as bank or central bank. To summarize this video, we discussed how monetary instruments have emerged over the history and the revolution, which is predominantly because of the need of the R or contemporaneous technological evolution resulting in a certain demand of a monetary instrument.

And in this backdrop, we noted why CBDCs have become very relevant today given the technological developments and need of the R. And therefore, multiple central banks are researching, experimenting and doing pilot projects with different forms and shapes and concepts of these CBDCs. We also tried to define CBDC with in a certain definition, though there are multiple such definitions possible depending upon the users such as retail, wholesale and so on. And we also noted certain crucial aspects of a conventional monetary system and how CBDC can fit its role in that system.

CBDCs : Retail Economic Design

INDIAN INSTITUTE OF TECHNOLOGY KANPUR

In this video, we will discuss the economic design of CBDCs in retail form.

The economic design of retail CBDC

- To start designing a CBDC, one first has to identify the problems it should solve, as well as what aspects of the monetary system it should preserve
- A retail central bank digital currency (CBDC) is electronic central bank money that – just like cash – is directly available to consumers and non-financial corporations
- The key consideration for issuing a retail CBDC is that current electronic retail money represents a claim on an intermediary, rather than functioning as the digital equivalent of cash

Cash, electronic payment instruments, and retail CBDC

Source: Central bank digital currency: the quest for minimally invasive technology
<https://www.bis.org/publ/work948.htm>

INDIAN INSTITUTE OF TECHNOLOGY KANPUR

In this diagram, we have shown different forms of monetary instruments for example, cash, which is a liability of central authority which is a central bank in India it is RBI. There may be consumer banking deposits where there is an intermediary commercial bank involved and the retail CBDC could assuming it's a direct liability or direct claim on central bank. This is one way of depicting this diagram. Now to start designing a CBDC, one first has to identify the problems it should solve as well as the aspects of monetary system it should preserve. Let us consider these in turn using the analogy with cash which already

achieves an important balance. Cash is a useful and secure means of payment. But its use as a saving vehicle is limited because it does not offer you too much interest. It is a liability of central bank so we rely on it but it does not offer us interest. Now we can think of CBDCs as digital equivalent to this cash which is as a retail instrument and in that sense, a retail central bank digital currency in the retail format is like electronic central bank money just like cash, which is directly available to consumers and non-financial corporations. The question of whether central bank should issue a retail CBDC is attracting a lot of attention from the market participants. But what are the specific problems that such a retail CBDC would address? What are the designs that offer actual solutions? And what are the potential side effects of the monetary and financial system in general and central banks in particular if a retail CBDC is issued? Now the key consideration for issuing a retail CBDC is that the current electronic retail money represents a claim on an intermediary rather than functioning as a digital equivalent of cash. So if you have a consumer deposit that predominantly we use is a claim on intermediary not on the central bank. This raises several issues as the intermediary might run into insolvency or some kind of fraudulent activity or technical outages. Cash is a direct claim on the central bank and while deposit accounts are claims on commercial banks. So deposits are claim on this commercial bank but cash is a claim on central bank itself. Commercial banks back some of these claims by holding reserves with central bank. So they have these reserves which back these claims or sort of deposits. But such value backing is never 100% is never full and therefore exposed to issues like bank run or major financial crisis nationwide systemic crisis. A CBDC that is unaffected by such financial crisis or bank runs must be a cash like claim that is a claim of central banking to create that trust on the instrument. Looking this way, a major concern is that in a cashless economy a financial crisis could create havoc by leading to situations in which some financial institutions have to freeze their retail clients deposits and thus impairing the ability of these clients to pay their bills.

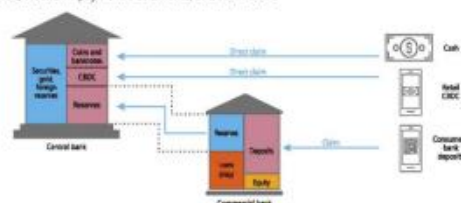
At the same time a CBDC should by no means displace the private sector. So if these commercial deposits they can be freeze if the bank runs into trouble.



The economic design of retail CBDC

- A main concern is that in a cashless economy, a financial crisis could create havoc
- A second – less discussed, but maybe even more important – aspect is the operational dimension and effectiveness of the payment system
- How a CBDC can live up to central banks' mandate to provide a universal means of payment for the digital era

Cash, electronic payment instruments, and retail CBDC



Source: Central bank digital currency: the quest for minimally invasive technology
<https://www.imf.org/publications/workingpapers>

INDIAN INSTITUTE OF TECHNOLOGY KANPUR

However, a 100% CBDC entirely relying on this it may create problems for the operations of some commercial banks as we know it. So a CBDC should not displace or replace the private sector. So the economic design of CBDC should not lead to massive relocation of funds away from the commercial to central bank which would happen if this retail CBDC is entirely relying on the central bank. A second and less discussed but important aspect is the operational dimension and effectiveness of the payment system. The customer facing side of real time payments including clearing, onboarding, enforcement of KYC norms, ongoing due diligence, dispute resolution and other related services are a major operational task which is generally customarily has been done by commercial banks and they have this core competence. This task is better handled by the private sector commercial banks rather than central banks. So that is why we should not think of replacing the commercial bank by putting this retail CBDC entirely leaving operations with the central bank. So these considerations bring to the fore the issue of how a CBDC can live up to the central bank's mandate to provide a universal means of payment for the digital era while at the same time giving the private sector the primary role in the retail payment system.

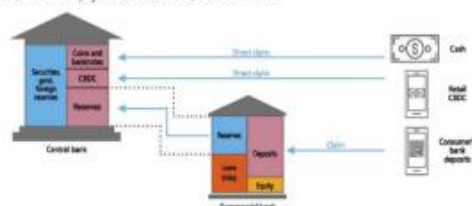
In this backdrop, design efforts have to be viewed against the backdrop of central bank's core mandate to provide a resilient and universally accepted means of payment.



The economic design of retail CBDC

- Cash is being used less and less as a means of payment
- Deposits, by contrast, are legal claims on the respective commercial bank
- There are the qualitative difference between CBDCs and existing electronic payment instruments
- Cash – despite its usefulness in payments – is of limited appeal as a store of value

Cash, electronic payment instruments, and retail CBDC



Source: Central bank digital currency: the quest for minimally invasive technology
<https://www.bis.org/publ/work548.htm>

INDIAN INSTITUTE OF TECHNOLOGY KANPUR

For centuries this has been a trend in cash but cash now is being used less and less as a means of payment and the surge of online commerce during the COVID-19 pandemic has accelerated this development. Should this trend prevail and cash no longer be generally accepted then central banks would have to develop a digital complement and accessible and resilient means of payment for this kind of digital era. On the payment side, cash is unique among all retail payment options as it is a direct legal claim on the central bank. Everyone can accept cash safely assuming that the received notes and coins will have a value in future transactions and central bank would honor its liability because they are the liability of central bank and thus notes and coins are recognized as legal tender which typically means that they must be accepted when redeeming the debt. In contrast, deposits are legal claims on the respective commercial banks. So bank transfers, cheque settlements or debit card charges from A to B bank merely change one or two commercial bank's promises as to who can withdraw how much cash on the list. Every commercial bank backs some of these promises with reserves at the central bank. These reserves. This also along with the bank equity increases the depositors confidence that a surge of withdrawal request can be fulfilled. So there's something backing my deposit but there always be a residual doubt that this value backing is never full and probably bank may not honor its commitment. Maybe a commercial bank might run into temporary solvency or liquidity issues or may go bankrupt and thus may not honor its commitment. In the former case, the payment process might be temporarily interrupted, delayed and in the latter case when the bank goes bankrupt, the claim might not even be fully honored or even if it is the legal process to regain the funds or compensation from the deposit insurance might take time. Sometimes even deposit insurance have its own limitations.

It does not fully insurance Europe. This showcases the qualitative differences between

CBDC and the existing electronic payment instruments. The latter might no longer be accepted in commerce whenever trust in the issuing commercial bank or other payment service providers is in doubt. A CBDC however would not rely on the soundness of commercial banks and could thus serve as an anchor for trust just as cash does today. And therefore, as a legal and electronic concept, a CBDC goes far beyond a central bank operated variant of non electronic payment instruments. On the other hand, a worry in this respect is that positioning a CBDC as the most secure digital payment instrument could also make it attractive as a saving vehicle. Household investments into a CBDC could substantially increase the balance sheet of central banks and crowd out deposits from the commercial bank. So jeopardize their business. As a result, the business models of commercial banks could be at risk since their source of funds would become more expensive or dry up altogether. Since commercial banks finance loans with deposits, a CBDC may negatively impact the economy in this fashion. So it may hamper the economic activity if the business goes away from these commercial banks entirely and the deposits go to central bank. So these concentrations underlie that cash despite its usefulness of payments is of limited appeal as a store of value. This is inherent to physical cash, particularly which carries no interest and is indeed costly to store in large quantities and over long horizons with the danger of damage, loss, theft and so on. As a consequence, the total outstanding stock of paper currency is moderate in the world across countries. For example, if we compare, for example, in case of US approximately \$5200 per capita in US cash and 3600 euro in the euro area. But if we compare that with the deposits of private households, they hold a large share of their wealth in the form of deposits with commercial bank for example, \$38,000 per capita in the US and 53,000 euros per capita in the euro area.

To summarize, we noted that the economic design of retail CBDC is a very important trade off between two aspects. First and foremost, it should have the property of cash that the interest of central bank and the ability or trust in central banking to return the money should things go wrong, I have that faith that my money will be returned that it will be redeemed and central bank will honor the commitment. At the same time, the 100% deposit should not go to central bank, because then in that case, the conventional business model of commercial banks to take deposits and fund economic activity and business and economy that will be replaced or jeopardized. So that interest of commercial banks and economic activity and economy should also be taken care of while designing a retail CBDC such that all the deposits should not be shifted lock stock barrel to the central banking. So it is a trade off between these two important considerations.

Timeline of CBDCs

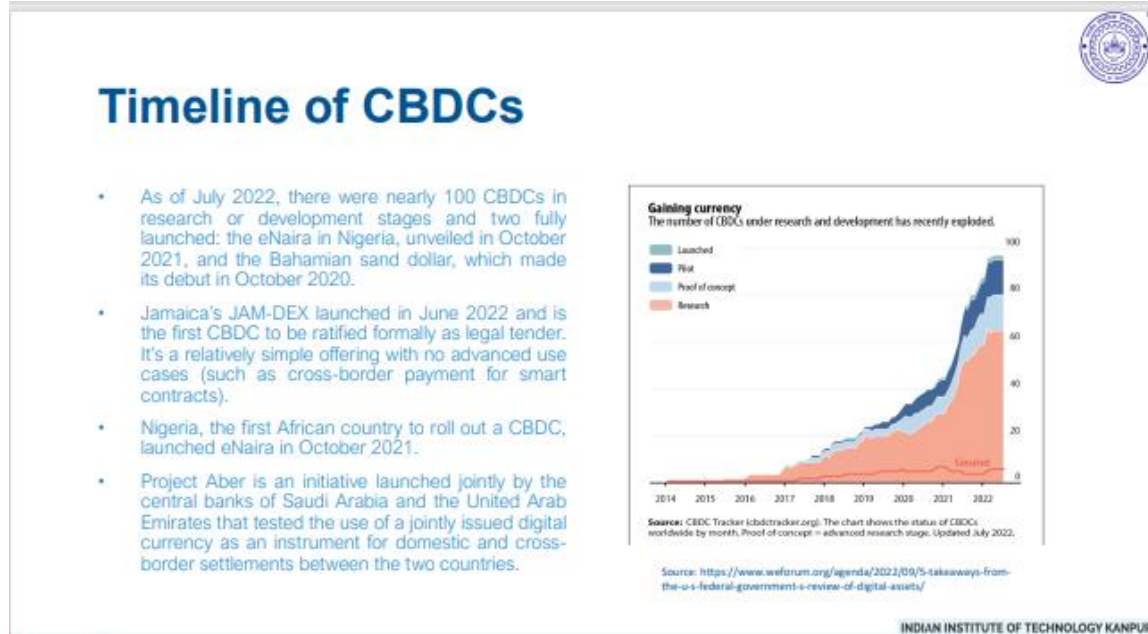
In this video, we will summarize the timelines of the rise of CBDCs over the last decade.

Timeline of CBDCs

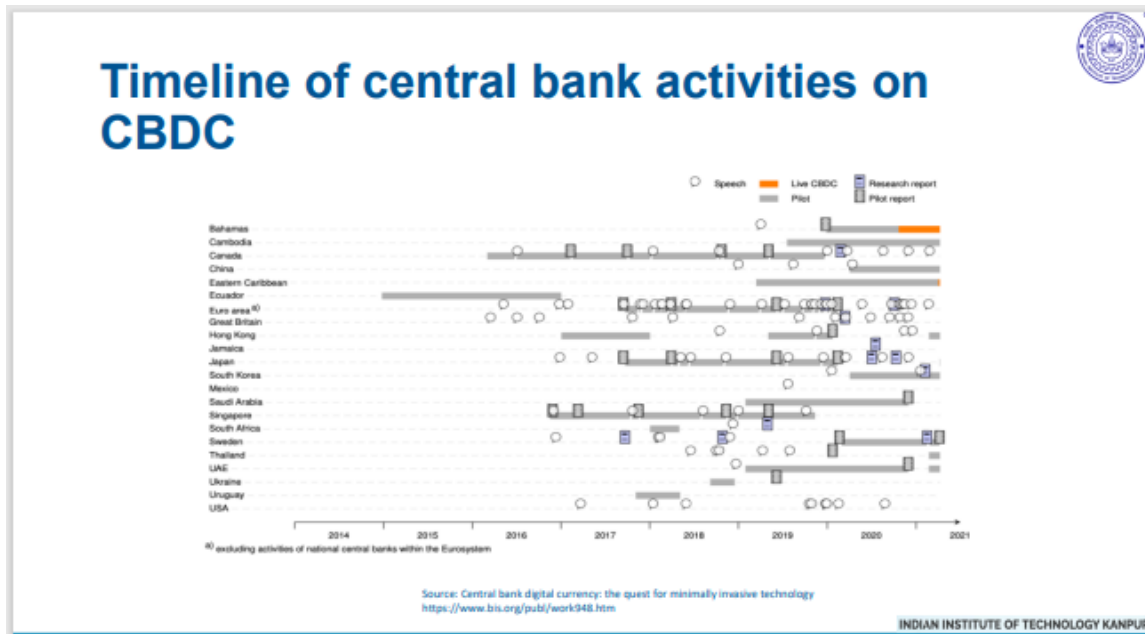
- Starting in 2015, central banks e.g. in Canada, the Netherlands, Singapore, and the United Kingdom ran internal experiments.
- From 2016 onward, a number of central banks launched research projects on digital currencies for wholesale purposes.
- The first publicly announced work on retail CBDCs was conducted by Sweden's Riksbank. In Sweden, cash use has been declining precipitously, and the Riksbank has initiated a societal discussion on access to a central bank payment instrument for the general public.
- Another particularly advanced CBDC project at present is the electronic Chinese yuan (e-CNY) of the People's Bank of China (PBC). Since 2020, this CBDC has been piloted in several cities in China. The e-CNY will be a cash-like liability of the PBC available to the general public – and to foreign visitors of China – through account-based interfaces.

Over the past several years, a number of central banks have started internal projects to better understand the technology of cryptocurrencies and more broadly the potential application of distributed ledger technology that is DLT on government issued digital currencies. Starting in 2015, central banks for example in Canada, Netherlands, Singapore and UK ran internal experiments. These generally concluded that at that point of time, digital ledger technology or DLT was not yet mature enough for its use in major central bank payment systems. From 2016 onwards, a number of central banks launched research projects on digital currencies for wholesale purposes.

For example, Project Jasper by Bank of Canada, Project Ubin as a tokenized form of Singapore dollar, E-Krona project on retail CBDCs by Sweden's Riksbank in 2017. Central bank of Bahamas issued the sand dollar and several others focused on DLT for the settlement of high value interbank payments. Some involved cooperation between central banks on wholesale CBDCs for cross-border payments. The first publicly announced work on retail CBDCs was conducted by Sweden's Riksbank. In Sweden, cash use has been declining precipitously and the Riksbank has initiated a societal discussion on how to access to central bank payment instrument for the general public. Over time, this named as E-Krona project has been further developed. Another particularly advanced CBDC project at present is the electronic Chinese Yuan or ECNY of People's Bank of China PBC. Since 2020, this CBDC has been piloted in several cities in China. This ECNY will be cash-like liability of the People's Bank of China available to the general public and to foreign investors of China through account-based interfaces. Meanwhile, around October 2020, the Central Bank of the Bahamas issued the sand dollar widely considered to be the first live retail CBDC. The sand dollar is issued through authorized financial institutions and allows accessibility to a digital valet for residents via either mobile phone application or a physical payment card. The Eastern Caribbean Central Bank ECCB launched its dCash in March 2021. dCash is distributed by licensed financial institutions and used for financial transactions between consumers and merchants as well as in P2P transactions. At present, around 87 countries representing more than 90% of the global GDP are exploring CBDCs.

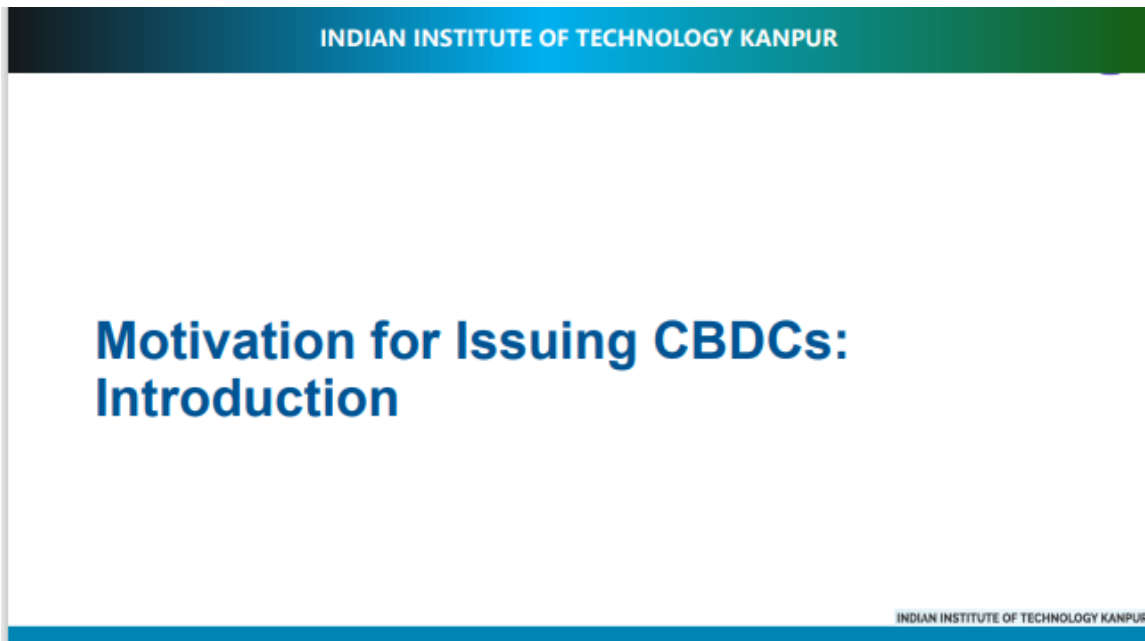


As of July 2020, there were nearly 100 CBDCs in research or development stages and two fully launched, the E-Naira in Nigeria unveiled in October 2021 and Bahamian sand dollar which may debut in October 2020.



This diagram aptly summarizes the growth of CBDCs as projects. For example, from mid-around 2015, we can see substantial rise, particularly the research one which is slightly orange color is the research, the light blue is the proof of concept, the dark blue pilot and this greenish color launched. So, we can see the large number of countries are in the research phase, though there are very few that are live. One example, Jamaica's JAMDEX launched in June 2020 and is the first CBDC to be ratified formally as Linger Tender. It is a relatively simple offering with no advanced use case. For example, cross-border payment for smart contracts. JAMDEX isn't broad blockchain based unlike Bahama sand dollar and the Eastern Caribbean Central Bank's D-DASH. Nigeria, the first country to roll out a CBDC in Naira in October 2021. Sub-Saharan Africa is poised to adopt CBDCs. The widespread use of M-PESA, a mobile money transfer service has established a strong social and financial infrastructure for the potential future use of CBDCs. Also, Project Abarizan initiative launched jointly by the Central Banks of Saudi Arabia and UAE that tested the use of jointly issued digital currency as an instrument for domestic and cross-border settlements between the two countries. So, Central Banks have only recently started to consider issuing retail digital currencies of their own. But the thinking behind it, back decades, for example, in 1985, David Shom set out his vision for anonymous electronic cash 35 years ago. Issuance of electronic money by the Central Bank was also suggested as early as 1987. Although Central Banks themselves were slow to embrace the concept, times have since changed with 86% as per one survey, 86% of Central Bank respondents said to a survey that they are searching on the topics and more than 46 said having launched design reports or prototypes. In this diagram, we can see various countries that have worked that are working as a research project or pilot project on CBDCs.

The grey ones are pilot and this is the live. So, we can see there is one, this one is the live. But there are many countries doing research from since 2015, a lot of companies are doing research and some are some have done with the research report, some are in the pilot report phase. So, this diagram gives a sort of timeline of different CBDC projects. Overall, it is clear that work on CBDCs has been underway at a number of Central Banks since around 2014, accelerating into 2020s. Now, it is accelerating. A stock take of all Central Bank publications shows that as of mid July 20, around 2021, at least 50 Central Banks had published retail or wholesale CBDC work. So, they have done their sort of blueprint, they have created at least three countries Ecuador, Ukraine and Uruguay have completed a retail CBDC project also a pilot project. Eight retail CBDC pilots are ongoing including in China, Korea and Sweden. While 40 Central Banks have published research on retail CBDC and 19 have announced research on development work on wholesale CBDC projects. To summarize in this video, we examined the evolution of CBDCs work by different Central Banks. We noted a large number of Central Banks have started since 2014-15 their work on CBDC. Many of them have conducted or in advanced phases of their research work on the CBDC. Some are working on wholesale while some are working on retail. In fact, in for some of these Central Banks as latest as 2021 and 2022, they have completed their pilot and they are ready for the roll out phase.



In this video, we will briefly discuss the motivation of Central Banks for coming up with CBDCs.



Motivation for Issuing CBDCs

Four trends have likely spurred central banks' interest in CBDCs:

- Plummeting cash usage
- Growing interest in privately issued digital assets
- Decreasing sense of central banks as payments innovators.
- Rising global payment systems

In particular, four trends have likely spurred the Central Banks interest in CBDCs. First is the plummeting cash usage. In Europe, cash usage declined by one third between 2014 to 2021. In Norway, only 3% of payment transactions are made with cash and this trend has forced Central Banks to reexamine their role in the monetary system.

Next is growing interest in privately issued digital assets. In the United Kingdom, 10% of adults report holding or having a digital asset like cryptocurrency. The European Central Bank says that as many as 10% of households in six large EU countries own digital assets. Consumers use of digital assets can be viewed as a potential challenge to the currency as a unit of measurement or unit of value. Third, increasing sense of Central Banks as payment innovators. CBDCs or Central Banks provide a new opportunity to lead strategic conversations on cash use cases in public food. Lastly, rising global payment systems. Many Central Banks seek to establish greater local governance over increasing global payment systems. Central Banks see CBDC as a potential stabilizing anchor of local digital payment systems. So, to summarize, we discussed four reasons plummeting cash usage, growing interest in privately issued digital assets, decreasing sense of Central Banks as payment innovators and rising global payment systems as four reasons why Central Banks are interested and rolling out with CBDCs.

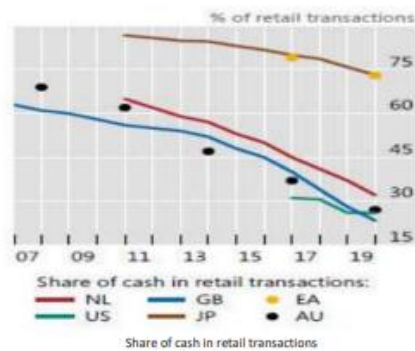
Motivation for Issuing CBDCs Part I: Decline in Cash

INDIAN INSTITUTE OF TECHNOLOGY KANPUR

In this video, we will discuss one major reason for motivation for issuing CBDCs by Central Banks that is decline in cash.

Declining Use of Cash

- The declining usability of physical cash has led to a growing number of central banks to consider the issuance of a cash-like electronic claim on the central bank that is also available to households, i.e. a retail CBDC.
- Cash is the only form of central bank money currently available to the public. At the same time, the overall use of cash is steadily declining, although regional differences are significant.
- Should this trend prevail, and cash no longer be generally accepted, central banks would have to develop a digital complement, an accessible and resilient means of payment for the digital era.



Source: CBDCs: an opportunity for the monetary system
<https://www.imf.org/publications/afp/afp2021a3.htm>

INDIAN INSTITUTE OF TECHNOLOGY KANPUR

Let us look at the share of cash as a percentage of retail transactions for different economies like US, Great Britain, Japan, Australia and so on. You can see there is a sharp drastic decline in use of cash. This declining usability of fiscal cash has led to a growing number of Central Banks to consider the issuance of a cash-like electronic claim on the Central Bank that is also available to households which is like a retail CBDC. The key difference between cash and today's electronic retail money is that the later the electronic retail money represents a claim on an intermediary bank, not the Central Bank, whereas the former, the cash is a direct claim on the Central Bank. This raises several issues as

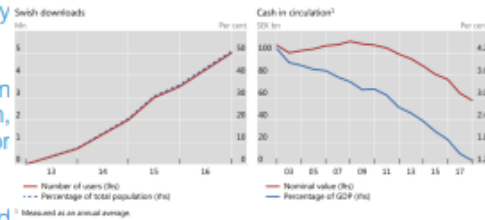
intermediary might run into insolvency, may be fraudulent or suffer technical outages and may not be able to honor that claim, that intermediary. For example, the collapse of the wire card and ensuing impairment of some electronic payment options foreshadow the importance of these considerations. Looking ahead, a concern is that if the use of cash decreases further to the point where it loses its universal acceptability, financial crisis could create havoc by leading to situations in which some financial institutions have to freeze their retail client's deposit, thus preventing their clients from paying their bills or these intermediaries honoring their commitments. We must note that cash is the only form of Central Bank money currently available to the public. At the same time, the overall usage of cash is steadily declining, although regional differences are significant. For example, the COVID-19 pandemic has led to a further decline in cash usage, but it remains to be seen whether this will have a lasting effect. The more the use of cash continues to decline, the higher the cost related to logistics and upholding cash infrastructure would weigh on the declining number of remaining users. Now, public money or cash may then come under increasing pressure of being substituted by private forms of money.

Central banks may find this concerning as the public's trust in the currency would then be fully dependent upon the trust placed by the public issuers of private money. These may well be regulated by supervised banks, but may also be non-bank issuers of cryptocurrencies and stable coins. The latter are at least of now less regulated, which may increase trust-related risks. Subsidizing the costs of cash handling or intervening with public policy, for example mandating banks to maintain a certain number of ATMs, this may slow down the decline of cash or safeguard its availability to a limited degree. Nevertheless, it is unlikely that such intervention can or should materially influence users' payment preferences. Lastly, should this trend prevail and cash no longer be generally accepted, central banks would have to develop a digital complement on an accessible and resilient means of payment for digital era. If this is absent or there is no sufficient cash available in times of stress, a conversion of commercial bank into risk-free central bank money such as banknotes would no longer be possible and making CBDCs available to the public as a digital cash-like form of central bank money may prove very helpful in such situations in safeguarding the confidence in the currency or nation central bank or fiat money or fiat currency. In this backdrop, let us take a case study of Sweden where the digital value or digital cash application which is SWISH, it is like UPI in India is rising exponentially. The downloads of SWISH that UPI digital cash application for instant transfer of cash online in a digital format. However, the cash circulation is declining very drastically whether you look at on nominal basis or as a percentage of GDP basis.



The Case of Sweden

- Sweden has one of the highest adoption rates of modern information and communication technologies in the world. It also has a highly efficient retail payment system.
- The demand for cash is dropping rapidly in Sweden. Many stores no longer accept cash, and some bank branches no longer disburse or collect cash.
- Will the payment system continue to be safe and efficient without cash?
- Considerations along these lines have led the central bank to propose to the government that digital central bank money held by the general public should also be given the status of legal tender.



Source: Compiled by: Central bank cryptocurrencies (page 10)
https://www.bis.org/pub/qtrpdf/q_qt1709f.pdf

INDIAN INSTITUTE OF TECHNOLOGY KANPUR

22

Now, Sweden has one of the most highest adoption rates for modern information and communication technologies in the world. It also has a highly efficient retail payment system. By the end of 2016, more than 5 million Swedish population has installed this SWISH mobile app which allows people to transfer commercial bank money with immediate effect whether day or night using their handheld device. Now, therefore, the demand for cash is dropping rapidly as we saw in this diagram and many stores no longer accept cash and some bank branches no longer disburse or collect cash. These developments are a cause of concern for Rix bank which is the first question arises, will the payment system continue to be safe or efficient without cash? Even if cash is not used every day, it is a backup option in crisis situations. Will those without access to bank services still be able to manage their payments? The Rix bank currently has a so called e-Krona project underway to determine whether it should supply digital central banking money to the general public. Considerations among these lines have led the central bank to propose to the government that digital central bank money held by the general public should also be given the status of legal tender. To summarize, in this video, we saw with the help of Sweden case study that usage of cash is declining. Cash is the central bank money and people are adopting less fiscal cash, they are leaving fiscal cash and adopting more and more digital money e-valleys. However, this digital money is not the liability of central bank but commercial banks and therefore during the crisis when these financial institutions and commercial banks are not able to honor their liability, maybe freeze the client's money or there is a bank run, then this digital money gets in trouble and loses the trust and faith of public at large.

Therefore, does it make an appropriate case for adopting a central bank digital currency which is the liability of central bank is an important question in the modern world.

Motivation for Issuing CBDCs: Part II

INDIAN INSTITUTE OF TECHNOLOGY KANPUR

In this video, we will carry on with our discussion regarding motivations for issuing CBDCs by central bank.

Motivation for Issuing CBDCs

The following factors drive the usage and adoption of CBDCs

- Insolvency risk of intermediary involved (e.g., bank or financial institution)
- Loss of universal acceptability of physical cash (e.g., Sweden)
- Due to the network effects inherent to money, new private players may quickly dominate the monetary system, leading to serious competition concerns and working against the public interest.

INDIAN INSTITUTE OF TECHNOLOGY KANPUR

The following are some other additional factors that drive the usage of and adoption of CBDCs by central banks. First, the insolvency risk of intermediary involved that is bank or financial institution. One key difference between cash and today's electronic retail money is that the later represents a claim on intermediary that is bank or financial institution whereas the former the cash is a direct claim on the central bank.

This raises several issues as the intermediary might run into insolvency, maybe fraudulent or may suffer technical outages. The collapse of VAC-ART and the ensuing impairment of some electronic payment options foreshadows the importance of some of the benefits

and considerations of these digital e-value or digital cash that we have today. Next, the loss of universal acceptability of physical cash. For example, we discussed the case study of Sweden. Looking ahead, a concern is that if the use of cash decreases further to the point where it loses its universal acceptability, a financial crisis could create havoc by leading to situations in which some financial institutions have to freeze their retail clients' deposits, thus preventing their clients from paying their bills.

For example, in Sweden, where cash use has already declined substantially, considerations along these lines have led the central banks to propose to government that digital central bank money held by the general public should also be given the status of legal tender. Another, due to network effects and market concentration inherent to money, new private players may quickly dominate the monetary system leading to serious competition concerns and collision and working against the public interest. So, the motivation for retail CBDC research and development are driven by global trends but also by country-specific circumstances. Broadly, CBDC should be seen in the context of digitalization of economies and the growing centrality of data, particularly personal data, both in the economy and the monetary system. The growing role of data brings many opportunities to reduce information asymmetries, cut costs, and enable new forms of money.

Yet, data also lead to new challenges for competition, privacy, and integrity, issues that the economics literature is only beginning to understand and grapple with. Due to network effects inherent to money, new private players may quickly dominate the monetary system, leading to serious competition concerns and working against the public interest, for example, issues related to data safety and privacy.



Motivation for Issuing CBDCs

These issues have been underscored by four developments:

1. Rise in interest in Bitcoin and other cryptocurrencies coupled with high volatility
2. Application in money laundering, ransomware attacks, and other financial crimes.
3. Advent of private sector-issued stablecoins
4. Entry of big tech into payments
5. Finally, the Covid-19 pandemic has accelerated the adoption of digital payment technologies

The issues that we have discussed are captured in the following four developments. First, there are rapid rise in interest in Bitcoin and other cryptocurrencies as compared with the traditional forms of money. However, cryptocurrencies are speculative assets rather than money and they are extremely volatile, making it difficult to use them as a means of payment.

In fact, in many cases, they are used to facilitate money laundering, ransomware attacks, and similar financial crimes. Bitcoin, in particular, has few redeeming public interest attributes when its baseful energy consumption is taken into account. So it requires a lot of energy consumption for generating Bitcoins. For instance, it is estimated that the Bitcoin network currently uses as much electricity as needle ads.


A second development is the advent of private sector issued stablecoins. Distinct from other cryptocurrencies, stablecoins are designed to maintain a stable value through their backing of assets. As such, these are only as good as the governance behind the backing. Despite progress made from initial proposals, they still have the potential to fragment the liquidity of the monetary system and detract from the role of money as a coordination device. In any case, to the extent that the purported backing involves conventional money, stablecoins are ultimately only an extension of the conventional monetary system.

Another third development is the big tech entry into payments. And more generally, the disruption that platform-based business models and big data bring to the financial system. The huge volume of personal data that is collected and processed as an input into big tech business activity presents several challenges for central banks. The first is that the network effects makes the payment system prone to concentration and a huge market power within

2-3 players, as has already happened in countries worldwide, and enable the formation of data silos that entrench the market power of firms that have exclusive use of this data. So it is a concern related to data privacy and governance. However, both the competition and data governance imperatives need to be met while ensuring another very important third imperative that is ensuring the safety and integrity of the payment system against money laundering, ransomware attacks and other illicit activities.

Thus, digital innovation implies a triple imperative for the central bank in its role at the centre of monetary system i.e. competition, data privacy and the integrity of the payment system. Lastly, the COVID-19 pandemic has accelerated the adoption of digital payment technologies. A trend that recalls previous epidemics, with that shift, it has also accelerated central banks' work on CBDCs in some jurisdictions.

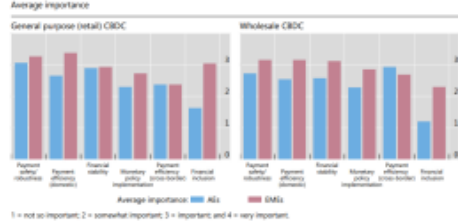
In the US, early versions of congressional proposals for the pandemic-related fiscal stimulus included references to a digital dollar as a means of quickly executing government-to-person payments as an alternative to credit transfers and slow and costly checks. The general global trends aside, the motivation for CBDCs differs across jurisdictions. A survey of global central banks highlights payment safety and robustness, payment efficiency, financial stability, monetary policy, cross-border payment efficiency and financial inclusion as some of the key motives for CBDCs and for general purpose retail CBDC as well as wholesale CBDC.



Motivation for Issuing CBDCs

- In advanced economies, central banks are researching CBDCs to promote safety and robustness or domestic payment efficiency, address risks to the safety of digital payments, and to reduce costs
- In emerging market economies (EMEs), financial inclusion is an important motivation.
- The domestic payment efficiency and payment safety have become nearly equally important as motivations in both AEs and EMDEs.
- Yet there are key differences (1) EMDE are more driven by financial inclusion (2) EMDEs also assign a higher weight CBDC as instrument of monetary policy

Average importance



1 = not so important, 2 = somewhat important, 3 = important, and 4 = very important.

Source: Rise of the central bank digital currencies: drivers, approaches and technologies <https://www.bis.org/pub/work880.htm>

26
INDIAN INSTITUTE OF TECHNOLOGY KANPUR

As we can see in this diagram. Based on the survey of central bank in advanced economies, central banks are researching CBDCs to promote safety and robustness and domestic payment efficiency, address risk to reduce the safety of digital payments and to reduce costs.

In other words, central banks see CBDC as an opportunity to address risks related to safety of digital payments, to reduce costs and to support central banks' mandates for the smooth functioning of retail and wholesale payments. Financial stability concerns are also an important driver of research and development work, particularly in the light of the threat that private alternatives to sovereign fiat currency may become dominant, issued by actors who are not accountable to the public and may not support the stability of the financial system. Moreover, especially in emerging economies, financial inclusion is an important motivation. Many central banks see CBDCs as a means of enhancing access to payment services for the unbanked, especially those without access to transaction accounts. Over the period, the motives of advanced economies and emerging market economies, central banks for consulting the issuance of a retail CBDC are converging.

The domestic payment efficiency and payment safety have become nearly equally important motivations for both advanced economies and emerging market economies. Both the advanced economies and emerging economy central banks are also attaching about the same weight to the financial stability and cross-border payment efficiency reasons. Yet, there are key differences. For example, the two key differences between advanced economies and emerging market economy motivations for issuing CBDCs are first, the retail CBDC network in emerging market economies is more often driven by financial inclusion related motivations as compared with advanced economies. Also, emerging market economies assign a higher rate to monetary policy implementation as a reason to explore or develop a CBDC.

To summarize, in this video, we discussed some additional motivations for the adoption of CBDCs and the experiment with CBDCs. The first is the rapid rise in interest in Bitcoin and other cryptocurrencies that compete with the traditional form of money. The second development is the advent of private sector issued stablecoins. The third is the entry of big tech into payments.

Lastly, the COVID-19 pandemic has accelerated the adoption of digital payment technologies. These developments have accelerated and acted as a catalyst for experiments of central banks with CBDCs. For central banks per se, their experiments with retail and wholesale CBDCs are driven by issues related to payment safety, robustness, payment efficiency, financial stability, financial inclusion, payment efficiency for cross-border and monetary policy implementation.

Motivation for Issuing CBDCs: Part III

In this video, we will conclude our discussion regarding motivation for issuance of CBDCs. We note that there are three phases for development regarding argument supporting CBDC issuance.



Motivations for issuing CBDCs

CBDCs issuance is informed and prompted by concurrent macro-economic events and changing trends in the financial system. Three main developmental stages can be identified:

- For much of the decade following the 2008 financial crisis, many CBs had to contend with persistently low inflation levels
- The emergence of fintech, cryptocurrencies and blockchain technology prompted discussions regarding a structural reform of the financial system
- More recently, the proliferation of foreign and private money solutions has been seen as a threat to financial sovereignty.
- Others: Examples include using CBDCs to address declining cash usage, preserving access to CB money in an increasingly digitized world and facilitating financial inclusion for all citizens.

The CBDC issuance is informed and prompted by concurrent macroeconomic events and changing trends in financial system. These three main development stages can be identified as follows. First, for much of the decade following the 2008 financial crisis, many central banks had to contend with persistently low inflation levels. So, there is a backdrop of persistent low inflation. Following the 2008 financial crisis, stimulating

efforts such as quantitative easing proved less effective than initially anticipated, leading to an increase in the size of financial market and meager growth in the real economy. In this backdrop of persistent low inflation, proposals for unconventional monetary policy utilizing government electronic money emerged.

It is argued that digital cash could eliminate the zero lower bound by charging negative interest rates, what we call as dimaraj fee on government electric money, central banks could increase spending and stimulate the economy. Naturally, households and firms would be incentivized to switch the dimaraj charge digital cash for other forms of money. And so limits on convertibility or the elimination of physical cash altogether would also be necessary. At the same time, there is also the physical utility of digital cash, especially through the provision of helicopter money. It is argued that by paying a high interest on CBDC, central banks can simultaneously stimulate the economy and increase the supply of money by instead increasing the value of an interest bearing CBDC relative to other monies.

Hence, the first stage in CBDC evolution was motivated by the need for expanding the monetary and fiscal policy toolbox and containing inflation. The emergence of fintech, cryptocurrencies and blockchain technology prompted discussions regarding a structural reform of financial system to achieve greater efficiency, cost savings, transparency and novel features. So this is regarding the improvements in payment systems application of CBDC in the same. During the mid 2010s, blockchain hype which peaked in 2017-18, the enterprise sector explored the potential of blockchain for cost savings and increased efficiency through ledger co-maintenance, programmability and disintermediation. However, these ambitions were not fully realized due to a range of factors including consensus overhead costs, technological complexity, implementation requirements, lack of suitability and need for firm control over infrastructure.

This brief exploration, however, influenced discussions on CBDC design choices and in particular the use of alternative technologies for CBDC infrastructure as a source of efficiency, cost effectiveness, interoperability and novel features. DLT or distributed ledger technology as we call it and blockchain and cryptographic secure tokens also act as alternative ledger and access methods for money. One can argue that the trade-offs from the perspective of the central bank, the financial system and in particular commercial banks and the end consumers perspective, but does not arrive at conclusive evidence as to what the options are ultimately the best. CBDC could result in substantial efficiency gains by avoiding withdrawal and crossing fees.

CBDC efficiency benefits in payment systems and cross-border transfers also. A group of central bank report 2020 also suggests that CBDC can provide a common method of

transfer between proprietary payment systems, making transactions cheaper and more efficient. This additional payment system can also enhance the resilience in payments according to the Bank of England 2020 report. The same report outlines that the benefits of efficiency and robustness can be brought to cross-border payments, although such matters are subject to political considerations. Finally, World Bank outlines how CBDCs could facilitate interoperability and standardization in cross-border transactions, limiting existing friction such as lengthy transaction delay costs due to intermediation, lack of traceability and transparency, hindering entry and money laundering AML and counter-tariff's financing checks. This explanation enforces the notion that novelty and impact of CBDC relies chiefly on political and procedural considerations and the potential expansion of the role of the central banking.

More recently, we have this proliferation of foreign and private money solutions and has been seen as a threat to financial sovereignty leading to CBDCs being promoted as a possible response. So, the threat of stablecoin and foreign CBDC to financial stability and sovereignty. In this second exploratory phase was succeeded by concerns stemming from the rising competition from private and foreign money. Decentralized stablecoins are a type of cryptocurrency that seeks to mitigate volatility by maintaining a stable price against a predator mine ledger. This target can be a financial asset, real asset, other cryptocurrency or a combination thereof but is most often the US dollar due to its status as global reserve currency and its stability.

Stablecoins are important for several reasons including reducing volatility in the cryptocurrency market, enabling crypto holders to maintain liquidity, providing a blockchain native unit of account and enabling much of the functionality of the decentralized finance that is defeat protocols. Additionally, they retain some of the desirable characteristics of non-stablecoin cryptocurrencies such as censorship resistance, borderless operation and decentralization and access. Owing to this utility, their use has increased over the past years yet stablecoins were also perceived by regulators as a potential threat to financial stability even more so than cryptocurrencies, owing to their positioning as payment instruments. In many cases, they utilize unproven stability mechanisms which often fail, negatively affecting first the financial entities which have stablecoin exposure, second individual investors and financial markets, third investor confidence in cryptocurrency and lastly their use as a payment instruments according to the Financial Stability Board report 2022. The G7 has expressed additional concerns which include issues with stablecoin governance, market integrity and pricing, tax compliance and as well as data, consumer and Mr.

Protection. For stablecoins that achieve global scale, they also cite potential concerns for financial stability and implementation and efficacy of monetary policy in G7. Moreover,

due to the market dominance of certain stablecoins such as Tether's, USDT, their potential failure has also been perceived as a potential systemic risk for the financial system and for the financial sector exposed in such assets, leading to direct regulatory intervention. Due to their substitutability in stablecoins, the introduction of CBDC has seen a way to mitigate negative effects described here. Lastly, in addition to these reactive developments, many sophisticated arguments have been put forward that did not directly relate to the then current economic events. These examples include using CBDCs to address declining cash usage, preserving access to CB money, central banking money in an increasingly digitized world and facilitating financial inclusion for all the citizens.

To summarize, in this video, we discussed three key developments supporting the issuance of CBDC. First, following 2008 crisis, the persistently low inflation levels resulted in search for modern financial monetary instruments that could help contain these low levels of soft inflation and kickstart the global economy. Second, the emergence of fintech cryptocurrencies and blockchain technology prompted the issuance of CBDC to cater to the needs of modern financial system. And more recently, the proliferation of foreign and private money solutions has been seen as a threat to foreign and financial sovereignty which also has resulted in motivation to issue CBDCs.



In this video, we will discuss the retail versus wholesale model of CBDC.



Models and Designs of CBDCs

- CBDCs can be either for wholesale use (i.e., by financial institutions) or retail use (i.e., by households and businesses – the general public).
- CBDCs can be either account-based, meaning that they rely on some form of identification, or token-based, meaning that they allow for anonymity in payments.
- CBDCs can be based on either distributed ledger technology (DLT) or conventional technological infrastructures. In most cases, CBDCs are being designed such that they preserve the **two-tier structure** of the monetary system, with a division of labour between the public and private sectors.

INDIAN INSTITUTE OF TECHNOLOGY KANPUR

We will compare and contrast between these two interesting models. As currently being discussed, CBDCs can be defined as a form of digital money denominated in the national unit of account which is a direct liability of the central bank. The CBDCs can be either wholesale used by financial institutions or retail used by households and businesses that is the general public. CBDCs can either be account based meaning that they rely on some form of identification like KYC norms and so on of banks or token based meaning that they allow for anonymity in payments. CBDCs can be based on either distributed ledger technology, DLT or conventional technological infrastructures. In most cases, CBDCs are being designed such that they preserve the two-tier structure of monetary system with a division of labour between public and private sectors.

So, in this backdrop, there are two types of CBDC that are being employed wholesale and retail.



Wholesale vs retail

- CBDCs can be either wholesale or retail.
- Currently wholesale efforts are more prevalent in advanced economies. In contrast, retail CBDC projects are more common in emerging economies.
- Retail CBDCs would primarily be utilized by individuals. People could use them essentially as digital cash, with the comfort of knowing that the currency is issued and backed by the country's central bank.
- A retail CBDC differs from existing forms of cashless payment instruments (i.e., credit transfers, direct debits, card payments, and e-money), as it represents a direct claim on a central bank rather than the liability of a private financial institution.



Source: Central Bank Digital Currencies and the future of money
<https://www.pwc.com/m1/en/media-centre/2021/documents/central-bank-digital-currencies-and-the-future-of-money-part1.pdf>

INDIAN INSTITUTE OF TECHNOLOGY KANPUR

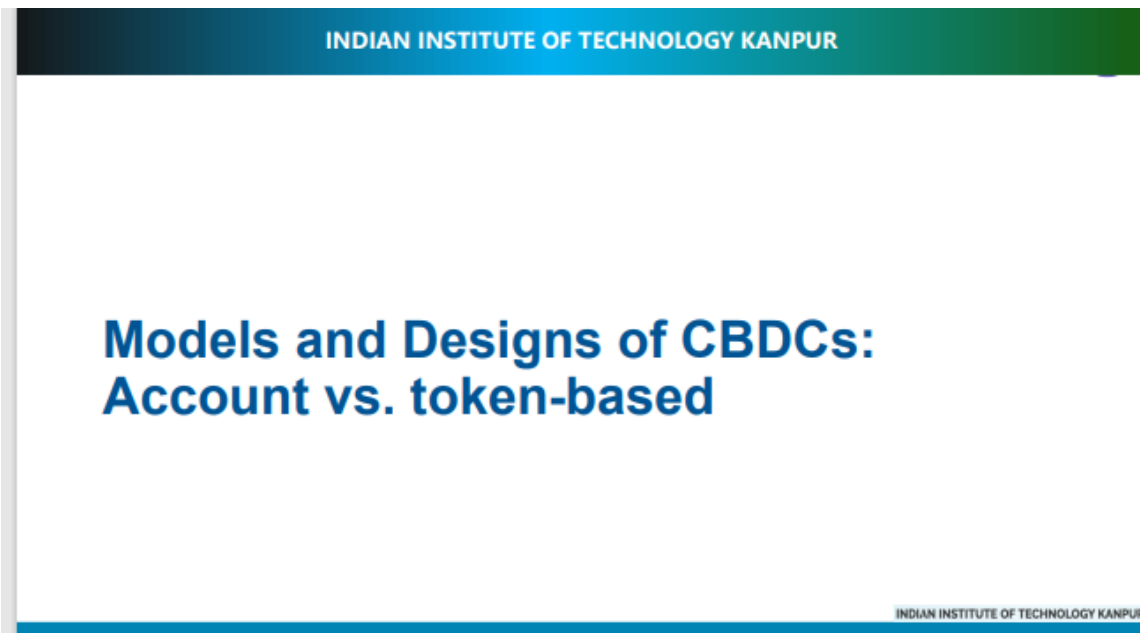
31

One way of categorizing CBDCs is to their implementation model and in this fashion, they can be categorized as wholesale or retail. In the wholesale model, access to central bank digital currencies is restricted to a limited group of commercial banks and tiering institutions. Conversely, in the retail model, access is widened to corporates and businesses as generally across the economy to all consumers.

Current wholesale efforts are more prevalent in advanced economies. In contrast, retail CBDC projects are common in emerging economies. So, we can say that currently wholesale efforts are more prevalent in advanced economies that have more developed interbank systems and capital markets. In contrast, retail CBDC projects are more common in emerging economies where financial inclusion is the main desired outcome. Now, a CBDC is a digital payment instrument denominated in the national unit of account which is a direct liability of the central bank. If the CBDC is intended for use by households and firms for everyday transactions, then it is also referred to as general purpose or retail CBDC.

These retail CBDCs would primarily be utilized by individuals. People could use them essentially as digital cash with the comfort of knowing that the currency is being issued and backed by the country's central bank. A retail CBDC differs from existing forms of cashless payment instruments, that is credit transfers, direct debits, card payments and e-money as it represents a direct claim on the central bank rather than the liability of a private financial institution. And in contrast to a retail CBDC, a wholesale CBDC targets a different group of end users. Wholesale CBDCs are meant for use between private banks, transactions, central banks and other financial institutions.

So, wholesale CBDC would serve a similar role as to lay reserves or set up bank balances and get central banks. However, wholesale CBDCs could allow financial institutions to access new functionalities enabled by tokenization such as composability and programmability. To summarize, in this video, we compared and contrasted between wholesale CBDC model and retail CBDC model. We noted that these two models serve different clientele and different set of transactions and different parties. For example, wholesale is meant for businesses, financial houses, central banks and transaction between banks while retail is more of a general purpose, but it can be used by individuals, small retail transactions, small ticket transaction set.



In this video, we will discuss another categorization of CBDCs design based on account-based or token-based model.



Account vs. token-based

- A token-based CBDC system would involve a type of digital token issued by and representing a claim on the central bank and would effectively function as the digital equivalent of a banknote that could be transferred electronically from one holder to another.
- A token CBDC is a "bearer-instrument" like banknotes, meaning that whoever 'holds' the tokens at a given point in time would be presumed to own them.



Source: Page 108 BIS Quarterly Review, March 2020
https://www.bis.org/publ/qrtrdf/r_qt20203.htm

INDIAN INSTITUTE OF TECHNOLOGY KANPUR

33

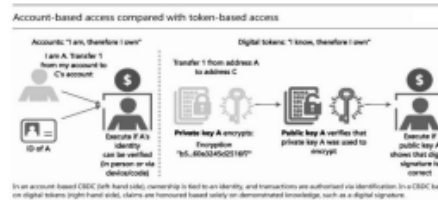
We can also structure CBDC design across token-based versus account-based model or a combination of both. Now, a token-based CBDC system would involve a type of digital token issued by and representing a claim on the central bank. And this would effectively function as digital equivalent of banknote that could be transferred electronically from one holder to another. A token CBDC is a sort of bearers instrument like banknotes, meaning that whoever holds the token at any given point in time would be presumed to own them as well. In contrast, an account-based system would require the keeping of record of balances and transactions of all the holders of the CBDC and indicate the ownership of the monetary balances.

For example, in this diagram, as we can see, in case of account-based system, some kind of identification KYC would be done at the central bank or at some bank level and basis if the identity can be verified, the ownership towards a certain amount of money would be made. While in the case of tokens, no such identity verification but more of a cryptographic mechanisms as we have already discussed those cryptographic mechanism would be employed for account maintenance and verification of transactions. Another difference between tokens and accounts is based on their verification.



Account vs. token-based

- A person receiving a token will verify that his ownership of the token is genuine, whereas an intermediary verifies the identity of an account holder
- In an account-based CBDC system, during the initial creation of each CBDC account, the identity of the account holder would need to be verified



Source: Page 108 BIS Quarterly Review, March 2020
https://www.bis.org/publ/qrtrpd/fr_qt2003.htm

INDIAN INSTITUTE OF TECHNOLOGY KANPUR

34

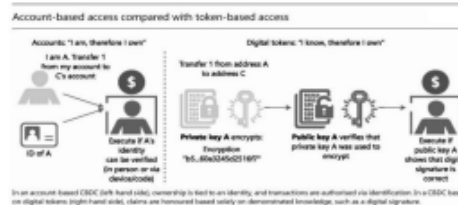
A person receiving a token will verify that his or her ownership of the token is genuine, whereas an intermediary verifies the identity of an account holder. Transactions in account-based system would involve transferring CBDC balances from one account to another and would depend on the ability to verify that pair had the authority to use the account and that they had a sufficient balance in their account.

Transactions in token-based CBDC might only depend on the ability to verify the authenticity of the token to avoid counterfeits just as in the case of paper currency rather than establishing the account holders identity. So, in that account-based system, we are verifying whether this user is genuine based on matching his KYC detail with him. So, the user is genuine, they can transfer the money while in token-based, there is no such verification of user identity and that cryptographic mechanism of asymmetry key cryptography and hash function and all those technologies will be employed for verifying and creating the transaction. Next in an account-based CBDC system during the initial creation of each CBDC account, the identity of the verified or the identity of the account holder needs to be verified.



Account vs. token-based

- In an account-based format, ownership of the CBDC is linked to an identity whereby a transaction is an update of the payer and payee balance. This type of format resembles the systems we use today for sending digital payments.
- In a token-based format, ownership of the CBDC is linked to a proof. Using cryptography, verifying digital signatures to execute and verify transfer is possible. Thus, a transaction is a change of ownership of a specific unit of account or token. In this sense, the tokenized format resembles ownership of cash.



Source: Page 108 BIS Quarterly Review, March 2020
https://www.bis.org/publ/qrtrpd/qrtr_q22003.htm

INDIAN INSTITUTE OF TECHNOLOGY KANPUR

And from that point onward, payment transactions could be conducted rapidly and securely. By contrast in a token-based system, the entire chain of ownership of every token must be stored in an encrypted ledger. In case of tokens on distributed ledger, new payment transactions are collected into blocks that must be verified before being added to permanently to the ledger. So, that cryptographic mechanism where miners come rush to verify the transaction and once verified it is added to the blockchain and so on. He said in an account-based format, ownership of the CBDC is linked to an identity whereby transaction is an update of the pair and pay balance and this type of format resembles the system we use today for sending digital payments. Also, in a token-based format, ownership of the CBDC is linked to a proof using cryptography verifying digital signatures to execute and verify transfer is possible.

Thus, a transaction is a change of ownership of a specific unit of account or token. In this sense, the tokenized format resembles the ownership of cash. Importantly, tokenized CBDCs along with other forms of tokenized money such as cryptocurrencies and stablecoins can be programmed. Such CBDCs represent programmable money whereby different logics are wired within the definition of money itself and where rules in payments between multiple peers can be automated. To summarize, in this video, we discussed and compared between two formats of CBDC that is account-based and token-based. We noted that account-based format is similar to our conventional deposit accounts with commercial banks where in order to do transactions, our identity needs to be verified while the token-based system or setup is similar to cash where anybody holding those rupees or fiscal cash amount can give it to somebody for the transaction purposes and the ownership will not verified.

Models and Designs of CBDCs: In conclusion

In this video, we will conclude our discussion about model design in CBDCs that we have discussed till now, for example wholesale versus retail and account-based versus token-based.



In conclusion

- CBDC may take various forms and based on its specific design features, it could give rise to different legal challenges
- Account-based CBDC would be booked in the accounts of the third parties holding accounts with the issuing central bank
- Value-based CBDC would be in the form of digitally stored tokens or units stored in the e-wallets of holders
- In CBDC, there remains a level of centralization, and bears no resemblance to cryptocurrencies in that sense
- Thus, CBDC often appear overlapping with the digital money (e.g., e-Wallets, bank deposits)

CBDCs may take various forms and based on the specific design features, it could give rise to different legal challenges. For example, a CBDC would be account-based or value-based or it can be issued only for wholesale purposes or retail purposes. Account-based CBDC would be booked in the accounts of the third parties holding accounts within the issuing central bank and the process of its transfer including the legal finality would be

conducted on the books of the issuing central bank. Account-based CBDCs would be similar to reserve balances with the only difference that besides commercial banks, account holders would also be natural legal persons. In contrast, the value-based CBDC would be in the form of digitally stored tokens or units stored in the e-value of holders but its transfer would be conducted and finalized in a decentralized or peer-to-peer fashion.

Similar to cash, this form of CBDC would possibly provide users with anonymity with regard to the central bank. Additional variations in design would include whether the CBDC is intended to substitute or complement bank deposits and cash, whether the holders of CBDC would be natural or legal persons or both, whether such currency should provide a level of anonymity at par convertibility and interest approval. Thus, the use of blockchain or DLT would not be necessary for CBDC as is the case with the e-Kruuna project of fixed bank. In any event, it seems that the main difference between CBDC and other cryptocurrencies are that in the former, that is the CBDC as the name suggests, there remains a level of centralization and less resemblance to cryptocurrencies in that sense. In account-based CBDC, both the legs of creation and settlement are centralized while in value-based CBDC only the creation and destruction of money centralized and the transaction settlement would be decentralized. In this sense, CBDC is not in line with the initial vision or the invention of cryptocurrencies as neither the use of blockchain technology nor its decentralization promise is likely to be implemented in the CBDC, it would be of no resemblance to the cryptocurrencies such as Bitcoin and its discussion under the rubric of cryptocurrencies would remain doubtful.

The CBDC may often appear overlapping with the digital money like e-Valley bank deposit series. Additionally, there is already digital based money in the form of commercial bank deposits with central banks for the purposes of wholesale settlements and the need for issuing CBDC for the wholesale purposes remain questionable. It might be said that the main advantage of CBDC over other cryptocurrencies lies in its stability because of its origins with and its liability as central bank money. It might be said that the main advantage of CBDC over other cryptocurrencies lies in its stability. However, in the absence of interoperability arrangements such as stability comes at the price of its geographic limit and its attachment to a single central bank. Unlike Bitcoin, in the absence of a fiat based global currency such as the proposed bank or envisioned by Eames, CBDC would only endure stability in relative terms as their value will continue to float against one another in the forex market.

Term rise, in this video, we discussed different aspects of CBDC pertaining to their design, for example, account based or value based wholesale or retail and the challenges related there in. He also noted that CBDC in its current common shape may not be an ideal solution, but it provides various ways forward as a new monetary instrument which

facilitates financial inclusion and monetary policy implementation and employs modern technologies in providing or catering to the needs of modern economic society.



In this video, we will discuss the technical architecture and distribution taxonomy of CBDCs.

Technical Architecture and Distribution

Possible technical architectures for CBDCs: Direct, indirect, and hybrid models

- In all three architectures, the CBDC is issued only by the central bank.
- In the indirect CBDC architecture** (top panel), this is done indirectly, and an ICBD in the hands of consumers represents a claim on an intermediary.
- This model is also known as the “two-tier CBDC” for its resemblance to the existing two-tier financial system. For consumers, this type of CBDC is not a direct claim on the central bank.
- China’s e-CNY, a CBDC pilot that relies on private-sector banks to distribute and maintain digital currency accounts for their customers.

Indirect CBDC (two-tier)
 (ICBD in the hands of consumers represents a claim on an intermediary.)

Direct CBDC (one-tier)
 (CBDC is a claim on central bank.)

Hybrid CBDC (two-tier)
 (CBDC is a claim on central bank.)

Legend: Issued (blue), Communications/dating payments (yellow), Real time (orange), Deferred (green), Person (A account based) or providers of future based (B), Merchant (M)

An overview of potential retail CBDC architectures

Source: The technology of retail central bank digital currency https://www.bis.org/publ/qrpd/fv_qt2003j.htm

INDIAN INSTITUTE OF TECHNOLOGY KANPUR

These include indirect, direct and hybrid methods.

Pursuant to our previous discussions, another way of categorizing CBDCs is according to their distribution models. The possible technical architectures for CBDCs include direct, indirect and hybrid models. In all the three architectures, the CBDC is issued only by the central bank. The central bank is by definition the only party issuing and redeeming

CBDC. We note that all three architectures could be either account or token based and might run various infrastructures.

In all the three architectures, the CBDC is only issued by the central bank. Let us discuss these choices one by one starting with the indirect CBDC architecture. In the indirect CBDC architecture, as shown in the top panel here, the issuance of CBDC is done indirectly with a two-tier kind of structure. We call it ICBDC, which is indirect CBDC. In the hands of consumer, it represents a claim on that intermediary. In the indirect model, the central bank will pass the digital currency token to the commercial bank. The central bank will pass the token to the commercial bank or a non-banking financial institution like a fintech entity, which will then distribute the currency to the retail.

It will distribute the currency and also handle the KYC and NT money laundering and all those kind of verification requirements. So the claim for the currency will be on the commercial bank or non-bank financial institution and not the central bank. This type of CBDC is also known as synthetic CBDC by the IMF. This model is also known as two-tier CBDC for its resemblance to the existing two-tier financial system. For consumers, this type of CBDC is not a direct claim on central bank, but a claim on intermediary like fintech.

China's CBDC pilot ECNY that relies on the private sector banks to distribute and maintain digital currency accounts for their customers is one such example. Let us examine this top panel in more detail. The term is equivalent to synthetic CBDCs and it is also called as two-tier CBDC structure for its resemblance to the existing two-tier financial system. For consumers, this type of CBDC is not a direct claim on central bank. Instead, the intermediary like a payment bank or fintech entity is mandated to fully back each outstanding indirect CBDC like liability to the consumer to retail customers via its holding of actual CBDCs or any other central bank money deposited at the central bank. So this CBDC, they are in the first year, they are dealing with the central bank, they are depositing some money, some monetary entity, monetary instrument which will back their liabilities with the retail customers.

So they will directly transact with the central bank and in turn they will issue these ICBDCs to their customers. They will do the KYC, anti AML, anti money-lotting checks and so on. Just as in today's system, intermediaries handle all the communication with retail clients, net payments and send payment messages to other intermediaries and wholesale payment instructions to the central bank. The latter settles CBDC accounts with finality. So central bank settles these CBDC accounts with finality, their accounts held with commercial banks.

Besides offering the convenience of today's systems based on intermediaries, the indirect CBDC also relieves the central bank of the responsibility of dispute resolution. So central bank is not involved directly with the retail clients. The retail clients claims are settled with finality by these commercial banks who in turn settle their claims with the central bank. The indirect CBDC also leave the central bank of the responsibility for dispute resolution as we said, for example, know your customer norms and related services.

But the downside is that the central bank keeps no record of individual claims, only the intermediaries do. Whereas the central bank records only the wholesale holdings. So only the wholesale holdings of these commercial banks will be kept here, it will have no idea of what is happening on this leg or about the retail entities. Thus, the central bank cannot honor the claims from retail customers without the information from intermediary. And if the intermediary is under stress, determining the legitimate owner might involve a potentially lengthy and costly legal process with an uncertain outcome. This models regulatory and supervisory issues as well as those pertaining to deposit insurance are hence similar to those of today's system, what we have now.

Technical Architecture and Distribution

- **Direct Model:** all parties involved in the transaction will hold an account at the central bank
- The central bank will issue the currency and manage a permission system to clear transactions
- **The Hybrid Model:** central bank distributes CBDC to a regulated intermediary such as a commercial bank or fintech, which handles the transaction and the KYC and AML requirements
- In the other two architectures, consumers have a direct claim on the central bank. In the direct CBDC model (center panel), the central bank handles all payments in real-time and thus keeps a record of all retail holdings.

An overview of potential retail CBDC architectures

Source: The technology of retail central bank digital currency
<https://www.imf.org/publications/cipr/2023/01>

INDIAN INSTITUTE OF TECHNOLOGY KANPUR

Let us discuss the direct model. Under this model, direct model, all the parties involved in the transaction will hold an account at the central bank. So there is one central bank, there are no intermediaries, the retail parties are directly holding the account here. This CBDC that is issued is a claim on central bank directly a claim on central bank by these consumers. And all the KYC norm and such formalities are taken care of by the central bank itself.

And it also takes care of the retail payments. payments will be simply a transfer from one account to another and all claims will be backed by this central bank itself. The central bank will issue the currency and manage a permission system to clear transactions. In addition, KYC know your customer and anti money laundering AML and other compliance requirements will be taken care of by the central bank itself. Finally, let us come to the hybrid model. A big proportion of central banks are working on a hybrid model whereby the central bank distributes CBDC to a regulated intermediary, such as a commercial bank or fintech, which handles the transaction and the KYC requirements. So there is a intermediary which handles the KYC and other requirements which is given the CBDC by this central bank, which will ultimately do these intermediaries will do the KYC norms and so on AML with the clients.

However, importantly, the claim remains on the central bank. So the claim of these retail customers will be ultimate claim will be on central bank only. In the indirect CBDC architecture, this is done indirectly. And if you recall, we said ICBDC was in the hand of consumers which represented a claim on the intermediary itself, but here the claim is on the final central bank. In the other two architectures, that is hybrid and direct, hybrid and direct, the consumers have the claim on the central bank. In the direct CBDC model, as we saw here, the central bank handled all the payments in real time and kept record of all the retail holdings.

Models and Designs of CBDCs

- The hybrid CBDC model (bottom panel) is an intermediate solution providing for direct claims on the central bank while real-time payments are handled by intermediaries. In this architecture, the central bank retains a copy of all retail CBDC holdings, allowing it to transfer holdings from one payment service provider to another in the event of a technical failure.

Legend:
 - Legal claim: Dashed line
 - Person (if account based) or pseudonym (if token based): Person icon
 - Communications during payments: Double-headed arrow
 - Real-time: Yellow arrow
 - Deferred: Red arrow
 - Interbank: Double-headed arrow between banks

Overview of potential retail CBDC architectures:
 Source: The technology of retail central bank digital currency https://www.bis.org/publ/otpd/otpd17r_022003.htm

INDIAN INSTITUTE OF TECHNOLOGY KANPUR

Moreover, the hybrid CBDC model, which is shown here in the bottom panel is an intermediate solution providing for direct claims on the central bank while real time payments are handled by the intermediary.

So the real time transactions are taken care of by them, but ultimate direct claim ultimate final claim claimant is central bank, the counterparty central bank for these retail

customers. In this architecture, central bank remains or retains a copy of all the retail CBDC holdings. So it has to maintain all the copy because it is the ultimate final party where the claim will be made, allowing it to transfer holdings from one payment service to other in another in the event of technical failure. All the three architectures allow for either token or account based access.

To summarize this video, we discussed another way to categorize CBDC technical architecture based on the distribution. We noted that the first one is the indirect method, where there is an intermediary involved between central bank and the customer, the direct method, where central bank directly deals with the customers and an hybrid mode, where ultimate claim lies with the central bank, but intermediaries complete the transactional requirements, maintaining the book and doing the KYC norms. Each of these methods have their own advantages and disadvantages. We will further discuss these advantages and disadvantages in the next video.

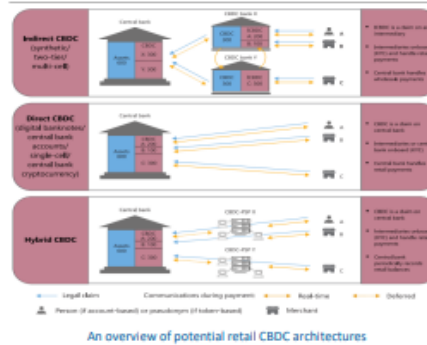


In this video, we will briefly conclude our discussion about hybrid direct and direct models and designs of CBDCs with their key differences and design consideration.



Key Differences and Design Considerations

- The key differences here are in the structure of legal claims and the record kept by the central bank
- The direct CBDC is attractive for its simplicity, as it eliminates dependence on intermediaries by doing away with them
- In the Hybrid model, a direct claim on the central bank is combined with a private sector messaging layer
- The hybrid CBDC would have both advantages and disadvantages vis-à-vis the indirect or direct CBDC architectures



INDIAN INSTITUTE OF TECHNOLOGY KANPUR

To begin with, the CBDC pyramids bottom layer here shows the legal structure of claims here, the structure of claim, the respective operational roles of the central bank vis-a-vis the customer and private institutions in making payments, KYC requirements and so on.

The key differences here are in the structure of legal claims and the record kept by the central bank. In the indirect CBDC model that we can see here, the top panel, the consumer has a claim on the intermediary. So the consumer has a claim on this intermediary with the central bank keeping record of only wholesale accounts. So central bank is only keeping record of wholesale transactions or wholesale accounts with these intermediaries or commercial banks.

In contrast, in the direct model here, the direct CBDC model central panel, the CBDC has a direct claim on the central bank. So these consumers have a direct claim on the central bank. And therefore, the central bank keeps record of all these accounts, it keeps record of all the balances and updates it with every transaction with these customers. The hybrid CBDC model shown here is an intermediate solution providing for direct claims on the central bank. So these customers have a direct claim on the central bank, but the intermediaries are handling the payments and transactions KYC norms and so on.

Let us examine this in more detail. So consider next to CBDC directly operated by central bank like this. Now the direct CBDC architecture shown in the central panel here, one version would comprise accounts managed by the central bank, all these accounts managed by central bank. Several private sector companies are developing token based variants or what you call as digital nodes. In this architecture, KYC and customer dual vigilance could be handled by the private sector or the central bank or any other public sector institution. The central bank however, would be the only institution handling the payment services.

In the direct CBDC model, it is attractive for its simplicity, as it eliminates the dependence on these intermediaries, no intermediary here doing away with them. However, this entails compromises in terms of payment systems reliability, speed and efficiency. One aspect is that building and operating technical capacity on this scale is often viewed as being better undertaken by the private sector. So generally it is considered that private sector intermediaries can do this KYC and operational requirements better as seen as today's credit card networks and so on. Second, even if the central bank were to build the necessary technological capability, the resulting CBDC might be less attractive to consumers than today's retail payment systems.


Electronic payments must be with connectivity outages or offline payments, which involves risk taking by intermediaries. Importantly, it is the customer relationship based on KYC that allows the intermediary to accept such risks unless the central bank were to take on the responsibility for KYC and customer due diligence, which would require a massive expansion of operations well beyond existing mandates. And it would find it difficult to provide this service. So central bank would find it very difficult to provide all these services which is the core competence of private sector intermediaries. In addition to these two pure direct and indirect options, one can also in research novel future solutions that merge the element of both the indirect and direct CBDC which is hybrid CBDC bottom panel model here.

In the hybrid model, a direct claim on the central bank is combined with the private sector messaging layer. So there is a private sector layer but the ultimate claim lies with the private sector. Again, variations on this theme might include both token and account based ones. One key element of the hybrid CBDC architecture is the legal framework that underpins claims, keeps them segregated from the balance sheets of the payment service providers and allows for portability. If these payment service providers or PSP is fail, holdings of the CBDC are not considered part of PSP as a state available to creditors. So ultimately, the CBDC is the claim on central bank.

The legal framework should allow for portability in bulk that is give the central bank the power to switch retail customer relationship from a failing PSP to a fully functional one. The second key element is the technical capability to enable the portability of holdings. Since the requirement is to sustain payments when one intermediary is under technical stress. The central bank must have the technical capability to restore retail balances. It thus remains and retains a copy of all the retail CBDC holdings, allowing it to transfer retail CBDC holdings from one PSP to another in the event of a technical failure.

Thus, the hybrid CBDC that we have discussed here would have both the advantages and

disadvantages vis-a-vis indirect and direct CBDC architectures. As an intermediate solution, it might offer better resilience than the indirect CBDC, but at the cost of more complex to operate infrastructure for the central bank. On the other hand, the hybrid CBDC is still simpler to operate than a direct CBDC. As the central bank does not directly interact with the retail users, it can concentrate on a limited number of core processes while intermediaries handle other services, including instant payment information.



Models and Designs of CBDCs

- Design efforts have to be viewed against the backdrop of central banks' core mandate to provide a resilient and universally accepted means of payment.
- The first consideration here concerns the balance sheet. The economic design of a CBDC should not cause a massive reallocation of funds away from commercial banks and to the central bank.
- A second consideration concerns the operational dimension and the efficiency of the payment system.
- Thus, central banks across the world are in the quest for technical and economic requirements for a "minimally invasive" design

INDIAN INSTITUTE OF TECHNOLOGY KANPUR

Now, we must note here that the design efforts have to be viewed against the backdrop of central bank s core mandate to provide a resilient and universally accepted means of payment. For centuries, this universal payment has been cashed, but cash is being used less and less as a means of payment and the surge of online commerce during the COVID-19 pandemic has accelerated this development.

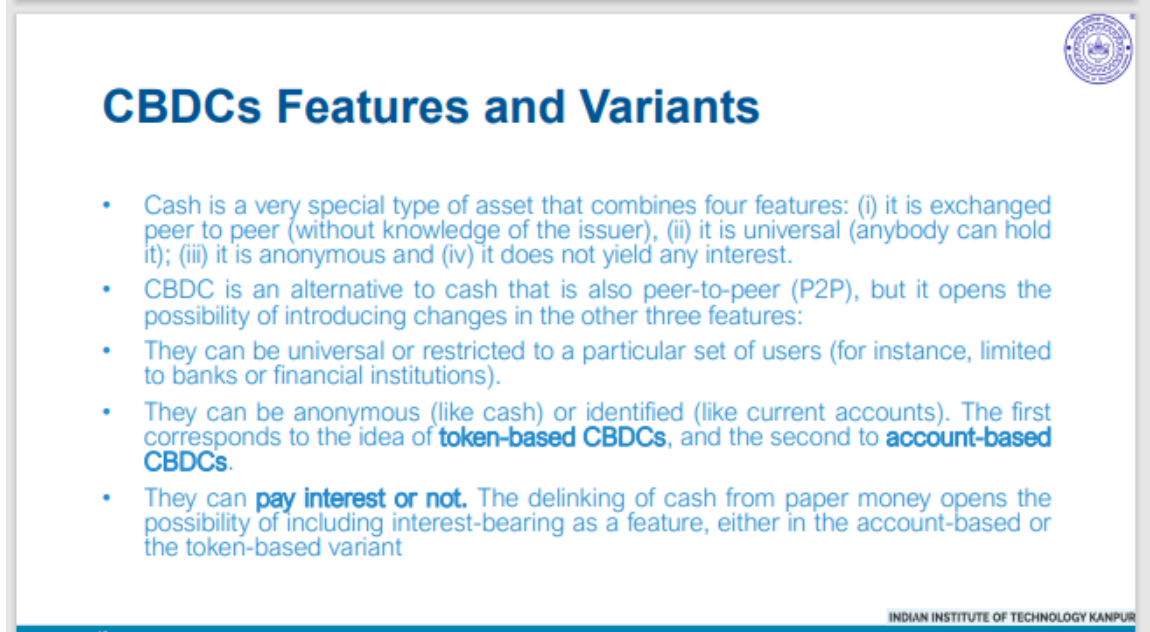
Should this trend prevail and cash no longer be generally accepted, central banks would have to develop a digital complement and accessible and resilient means of payment for the digital era. The first consideration here is regarding the balance sheet. The economic design of a CBDC should not cause a massive reallocation of funds away from commercial banks to the central bank. While central banks around the world are mandated to provide a universal means of payment, this by no means implies that they should offer savings accounts for the entire economy and jeopardizing the operations of commercial banks. A second consideration here concerns the operational dimension and efficiency of the payment system as well. The customer facing side of retail payments, including onboarding for payment accounts, authorization, clearing, settlement, dispute, resolution, compliance and anti-money laundering, AML and to counter the financing of terrorism rules are large operational tasks.

These tasks are arguably better handled by that intermediary private sector than the central bank. Thus, central banks across the world are in the quest for technical and economic requirements for a minimally invasive design, one that upgrades money to the needs of the 21st century without disrupting the tested two tiered architecture of the monetary system. To summarize, in this video, we compared and contrasted all the three architectures that is direct, indirect and hybrid. We noted that indirect system while there is a lot of thrust on the CBDC being the ultimate liability of central bank, thus creating trust and faith in this instrument among the public at large. However, at the same time, it diverts central bank from its core process where it has core competence and get engaged in other issues like KYC and other operational things where private sector can play a better role. Another extreme is the indirect CBDC structure where there is an intermediary who issues the CBDC or rather ICBDC to retail customers and consumers while the central bank only deals with these intermediaries in the form of wholesale banking.

Again, here because this ICBDC is not the liability of central bank in the hand of retail customers, it has less trust and faith. An intermediary structure which is hybrid structure is discussed where benefits of both the world are taken. For example, the operational process can be taken care of by the intermediary private sector like commercial banks while ultimately the CBDC remains the liability of central bank. So we discussed all these structures and their advantages and disadvantages.



In this video, we will discuss some of the variants of CBDC and their key features.



CBDCs Features and Variants

- Cash is a very special type of asset that combines four features: (i) it is exchanged peer to peer (without knowledge of the issuer), (ii) it is universal (anybody can hold it); (iii) it is anonymous and (iv) it does not yield any interest.
- CBDC is an alternative to cash that is also peer-to-peer (P2P), but it opens the possibility of introducing changes in the other three features:
- They can be universal or restricted to a particular set of users (for instance, limited to banks or financial institutions).
- They can be anonymous (like cash) or identified (like current accounts). The first corresponds to the idea of **token-based CBDCs**, and the second to **account-based CBDCs**.
- They can **pay interest or not**. The delinking of cash from paper money opens the possibility of including interest-bearing as a feature, either in the account-based or the token-based variant

INDIAN INSTITUTE OF TECHNOLOGY KANPUR

To begin with, cash is a very special type of asset that combines four features. It is exchanged peer to peer without the knowledge of the issuer.

It is universal. Anybody can hold it in the physical form. It is anonymous. So if you are holding the physical cash, you don't have to provide your identity or any of such KYC verification. It does not yield any interest. So if you are holding physical cash, you will not get any interest. Now here CBDC provides an alternative to cash that is similarly a peer to peer exchange, but it opens the possibility of introducing changes in the other three features.

Let's discuss them one by one. First and foremost, CBDC can be universal or restricted to a particular set of users. For example, it can be limited to banks or financial institutions. CBDCs can be anonymous like cash or identified like current accounts. So that feature is there. The first cash feature corresponds to the idea of token based CBDCs and the second account based CBDCs like current accounts.

They can pay interest or not. The de-linking of cash from paper money opens the possibility of including interest bearing as a feature either in the account based as well as in the token based variant.



Pros and Cons of the Different Variants

These options can be combined in several ways to generate different modalities of CBDCs. There are basically four possible objectives:

- I. To improve the working of wholesale payment systems;
- II. To replace cash with a more efficient alternative;
- III. To enhance the instruments available for monetary policy, especially when confronted with the zero lower bound
- IV. To reduce the frequency and cost of banking crises. How do these objectives match with the different options that CBDCs open as compared to cash?

Now these options can be combined in several ways to generate different modalities of CBDC. The choice depends crucially on the objectives pursued with the introduction of CBDCs.

There are basically four possible objectives. One, to improve the working of wholesale payment systems. Second, to replace cash with a more efficient alternative. Third, to enhance the instrument availability for monetary policy, especially when confronted with the zero lower bound, low interest rates. Reduce the frequency and cost of banking crisis and how do these objectives match with the different options of CBDC that open as compared to cash. So let us discuss them one by one. If the objective is to improve the functioning of wholesale payment system and assuming that digital ledger technology or distributed ledger technology would in future be more efficient than RTGS that we have today, you may introduce CBDCs that are only accessible to banks and other financial institutions that participate in the wholesale payment system.

The resulting CBDC would be restricted, identified and non-interest bearing. Restricted because the general public will not have access to it. Identified because participants will be known by the rest and non-interest bearing because payment systems rely on fixed nominal amount accounts, although they are normally accompanied by yield bearing, whether positive or negative accounts in the central bank to and from which these institutions move funds in the context of their liquidity policy. The central bank which in traditional RTGS is at the centre of the system would be in the scheme just like any other player, although it may retain control over certain features of the system, like for instance admission and membership. The next aspect if it is the aim is to replace cash with a more efficient alternative means of payment, then you would introduce a CBDC that is

universal, anonymous and non-interest bearing, universal like cash which can be used by anyone who holds it, anonymous because this is an essential feature of cash and non-interest bearing to emulate cash. Why would the authorities wish to replace cash with a digital variant? Among other reasons, cash logistics are costly to issue circulate and retire cash requires an expensive infrastructure and also to fight counterfeit.

It deteriorates over time, it is dirty and transmits diseases and it generates crime, theft, falsifications, counterfeits. A digital variant would be much more efficient, cleaner and safer. Next, if authorities want to enhance the instruments of monetary policy, then in particular in the proximity of zero lower bound, they would introduce a CBDC that is universal, anonymous and yield bearing. It should be universal because you want to reach the public and ultimately replace the banknotes in the hands of the population. Yield bearing because you want to exploit the opportunity that digital money provides of carrying interest rates either positive or negative and anonymous also for similarity with cash.

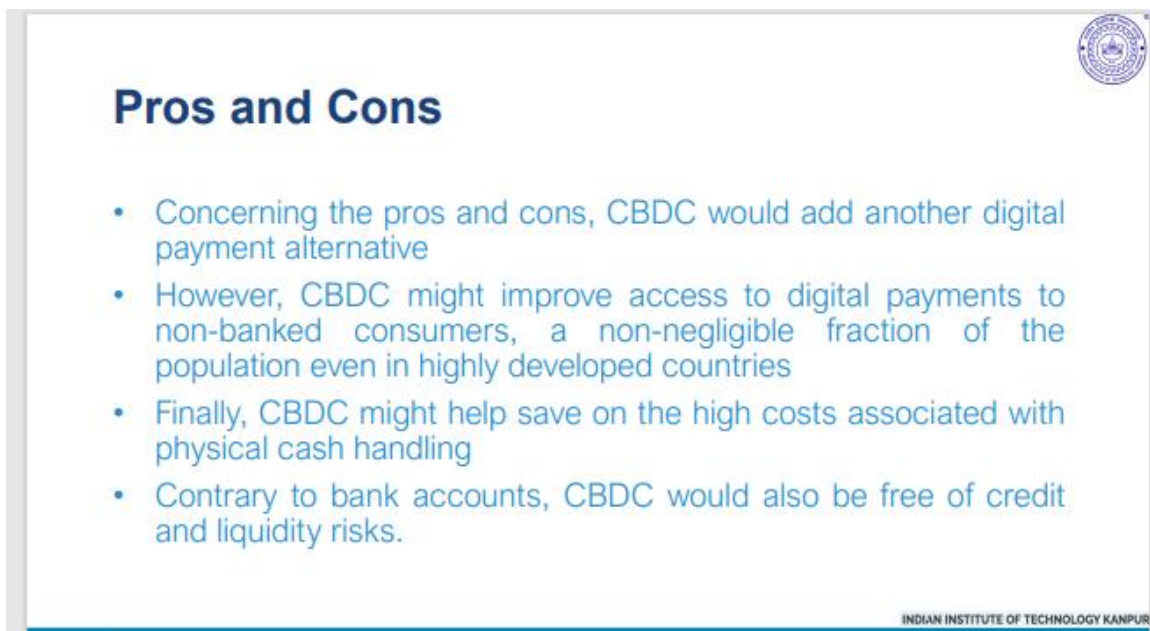
Although it could be identified too but for reasons of clarity of different models this option is reserved for the next variant. As mentioned here, interest rates may be positive or negative. Historically, the positive interest rates are much more frequent than the latter but the objective of this proposal being overcoming the problems of zero lower bound or close to zero negative interest rates, the proponents are rather thinking on negative rate situations. If the aim of introducing CBDC is to reduce or even eliminate the likelihood of destabilizing impact of banking crisis, then the modality would be universal, identified and non-interest bearing. Universal because the idea is to open accounts for the population in the central bank, identified like the case of bank deposits. Non-interest bearing because like in the previous variant, you want to differentiate option 3 and 4, last and second last option.

Although the possibility of combining both features, identified and interest bearing is always an option. The logic behind this proposal is that banking crisis are the result of fractional reserves which implies that side deposits with fixed nominal value are behind longer term credit whose value is uncertain. If the central bank provides deposits to the population, the provision of payments would be dealing from the provision of credit card and following this logic, most banking crisis can be avoided. To summarize, in this video, we discussed modalities of different CBDC variants and their key features. We noted that depending upon the objective, the modalities can differ across three properties. One, anonymity, whether more anonymous or identified, interest bearing, whether they should offer interest or not and lastly, their accessibility, whether they should be widely accessible universally or there should be some restriction.

Depending upon four objectives, for example, if the objective is to improve the functioning of wholesale payment systems or to replace cash with a more efficient instrument or to use or make it as an instrument of monetary policy, particularly when the low interest or negative interest rate regimes and lastly, to avoid banking crisis or to counter banking crisis. Depending upon the objectives, one can tailor the CBDC on these three parameters and generate a very efficient instrument of monetary policy.



In this video, we will discuss various pros and cons of different features of CBDC.



To begin with, CBDC has nothing to do with private crypto assets such as Bitcoin. The

former would be currency like cash and be governed by the same set of standards and stability as fiscal cash. While the latter is not currency but just an asset not backed by any clear governance mandate laws or other assets. Concerning the pros and cons, CBDC would add another additional payment alternative. However, given the already large range of electronic payments options available and resulting existing strong competition, the marginal value of central bank's additional involvement in an area already well served by the private sector appears to be small. However, CBDC might improve access to digital payments to the non-bank consumers, a non-negligible fraction of the population even in highly developed countries.

Whether this potential advantage would indeed materialize depends on the reasons why these groups are non-bank. For example, maybe cost of banking, remoteness, lack of digital literacy and this needs further exploration and research. Finally, CBDC might help save on the high cost associated with fiscal cash handling which is estimated to cost around half percent of GDP in EU countries. Regarding CBDC's role as a store of value, again fiscal cash involves high storage costs estimated in the order of 0.

5 to 1% of the value store and compared to quite negligible storage costs of CBDC. Moreover, contrary to the bank accounts, CBDC would also be free of credit and liquidity risk. However, this advantage might deprive private banks of a major source of funding which in the euro area currently makes up for 20% of the euro area banking systems funding with potentially adverse consequences for the cost and supply of bank lending. CBDC might even trigger a digital bank run. In any event, CBDC would likely push banks' business models towards narrow banking.

The most important issue is whether it should be traceable or to guarantee as best as possible anonymity as the cash perfectly does. Let us discuss some concerns around CBDCs. While central banks are enthusiastically exploring the potential of CBDC, there are some challenges to be considered as well. When money becomes digital, it also becomes traceable and therefore taxable. McKinsey analysts anticipate this to become a major hurdle through voluntary adoption.



Concerns around CBDCs

- Lack of technological stability: In January 2022, the digital version of Eastern Caribbean D-Cash went offline for two months because of technological issues.
- There are also concerns that the business case for CBDCs is weak. It may take more effort for central banks to develop infrastructure for digital currencies than can be justified by the relatively meagre reward.
- Also, CBDCs may not confer the increased speed as predicted: many developed countries now activate instant payments using legacy (non-blockchain) infrastructure.
- Central banks in some nations, such as Canada and Singapore, have come to the conclusion that there isn't currently a strong case for digital currency.

So, this issue, another issue is lack of technological stability. In January 2022, the digital version of Eastern Caribbean D-Cash went offline for two months because of technological issues. There are also concerns that the business case for CBDC is weak. It may take more effort for central banks to develop infrastructure for digital currencies that then can be justified by relatively meager reward. Also, CBDCs may not confer the increased speed as predicted. Many developed countries now activate instant payments like UPI in India using legacy non-blockchain infrastructure.

In fact, central banks in some nations such as Canada, Singapore have come to the conclusion that there is not currently a strong case for digital currency.



Debate Around CBDCs

- One important issue is whether CBDC should be interest-bearing.
- Next issue is the privacy of transactions; a choice that is centred around political sphere and personal freedom
- An important challenge is also cyber-security and resilience to technical failure and hacking

Another important issue here is whether CBDC should be interest bearing. This choice would affect the central bank's role, scope of monetary policy action and seigniorage. The monetary transmission mechanism would become more immediate and absent fiscal cash, negative interest rates would become fully feasible. If CBDC were remunerated, it would also become a closer substitute to commercial bank accounts and facilitate digital bank runs. Seigniorage would fall due to the interest paid on CBDC, but it would increase through savings on cash handling and increasing demand for central bank liabilities.

The overall impact is not so clear, ambiguous and requires more exploration and research. This issue is around the privacy of transactions, a choice that is centered around political sphere and personal freedom. Weighing the pros and cons of the privacy of payment transaction is a choice that does not belong to central banks alone, but also to the political sphere as it affects the heart of personal freedom and modern liberal democracies. This is also linked to the question whether CBDC would be token based or account based. The former would be able to safeguard the privacy better, the token based while the account based would imply a huge IT and human resource efforts by central banks. Another important challenge here is the cyber security and resilience to technical failure or hacking. Finally, there are a number of legal issues to be clarified in this aspect such as the legal tender nature of CBDC, whether this would imply that every citizen will need to have a technical means to use it and whether central banks need authorization by government to use it.

To summarize, in this video, we discussed various pros, cons and debate points around CBDC. We noted that CBDC is not a one fit all solution and there are certain positives and negatives. And in fact, there are questions not only related to technical aspects, but also question related to democracy, democracy, freedom and those personal freedom value that we hold dear to modern democracies. And therefore, before implementing CBDC, all these features and issues need to be taken considered.

Implications of CBDCs: Part I

INDIAN INSTITUTE OF TECHNOLOGY KANPUR

In a series of next two videos, we will discuss the implications of CBDC issuance on monetary policy, financial stability and commercial banking.

Alongside a fast changing and intense policy debate on CBDC technology and privacy, a growing academic literature has emerged on the natural economic implications of CBDC introduction. This academic literature centers around three main themes.

Monetary policy and financial stability



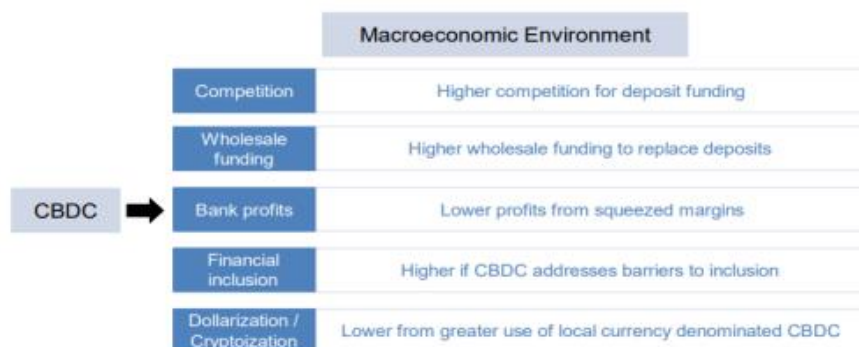
1. First is the effect of CBDC issuance on commercial banks and aggregate lending or investment.
2. The second theme concerns CBDCs as a new monetary policy tool.
3. Third are the effects of introducing CBDCs on financial stability, i.e., the ability of the financial system to absorb shocks and, thus, the likelihood of financial crises.

INDIAN INSTITUTE OF TECHNOLOGY KANPUR

53

First is the effect of CBDC issuance on commercial banks and aggregate lending and investment. The second theme concerns CBDC as a new monetary policy tool. And third, what are the effects of introducing CBDC on financial stability, that is the ability of financial system to absorb shocks and thus the likelihood of financial crisis.

Commercial Banks



Source: IMF- Implications of Central Bank Digital Currencies for Monetary Policy Transmission
<https://www.imf.org/en/Publications/fintech-notes/Issues/2023/09/15/Implications-of-Central-Bank-Digital-Currencies-for-Monetary-Policy-Transmission-538517>

INDIAN INSTITUTE OF TECHNOLOGY KANPUR

Let us discuss the impact of CBDCs on macroeconomic environment, starting with the competition. We expect a higher competition for deposit funding. CBDC could raise competition for bank deposit funding. By offering a CBDC, the central bank introduces commercial banks to make their deposits more attractive and increases the cost of funds for commercial banks. It can adversely impact aggregate lending and investment. Commercial bank deposits are used as a means to pay some digital transactions, where cash is not accepted by sellers.

Banks however cannot satiate the economy with deposits because they face some governance issue. They need to hold some assets as collateral and their net worth has to be positive. As a result, deposits carry a liquidity premium and they pay a relatively low interest rate, making them a cheap and preferable source of funds for banks. However, the low interest rate reduces the value of deposits as a means of payment because it increases the opportunity cost of holding funds in deposits. It has low payment efficiency in that sense.

When the central bank issues an interest bearing CBDC, banks have to adjust the remuneration on their deposits, that is their interest on deposits. Since otherwise, deposit holders would convert them into a better remunerated CBDC. Hence, bank deposits become a more expensive source of funds for banks and thus impacting banks negatively. While they become a more sort of the means to pay, impacting deposit holders in a positive manner. Thus, by virtue of offering a safe store of value and an efficient means of payment, deposits may leave banks in favor of the CBDC, leading to a decrease in deposit funding

available

to

banks.

The magnitude of this impact depends on the extent to which the CBDCs and attractors substitute for deposits. Caps on individual holdings will also limit switching from deposits to CBDCs. Next, talking about wholesale funding, higher wholesale funding may replace deposits. CBDCs could increase bank share of wholesale funding. To the extent that there is an outflow of deposits to CBDCs, bank could replace deposit shortfalls with wholesale funding. CBDCs could lower bank profits and squeeze margins.

If banks raise deposit rates to compete with CBDCs or if funding costs increase from a shift towards wholesale funding, then bank profits will decrease to the extent that higher costs cannot be entirely passed through to the higher lending rates. Next, financial inclusion. Higher CBDC can address barriers to financial inclusion. Although not a silver bullet, CBDCs present opportunities for improving financial inclusion and expanding access to financial services for the unbanked. CBDCs may serve as an initial entry point to a digital financial account that leads to the opening of bank account and create access especially when banks distribute CBDC in a two tier system.

The magnitude of effect depends on the extent to which a CBDC addresses the barriers to financial inclusion in a given country. Lastly, dollarization or cryptoization. CBDCs could help de-dollarization or counter the cryptoization. So, it will be lower from greater use of local currency denominated CBDCs. In dollarized or euroized economies, the introduction of CBDC could encourage a greater use of the local currency by making it a more attractive use of payment. In particular, with the rise of other forms of digital money denominated in foreign currency such as stablecoins, a CBDC can prevent the local currency from being supplanted.

However, CBDC would not address deeper issues having currency substitution related to a country's monetary policy framework and central banker division. To summarize, in this video, we discussed the impact of CBDC introduction for macroeconomic environment. In particular, we discussed first the issue related to competition with commercial banks and we said that higher competition is expected for deposits. We also noted that higher wholesale funding to replace the deposits, commercial bank deposits. We also noted that increase in CBDC introduction could lead to lower bank profits, lower profits with squeeze margins. We also anticipate higher financial inclusion, higher CBDC issuance could address this barrier to inclusion and de-dollarization or cryptoization.

We expect the dollarization to or cryptoization to become lower as more interest in the local denominator, in local currency denominator CBDC may be there.

Implications of CBDCs: Part II

In this video, we will conclude our discussion regarding implications of CBDC for monetary policy and financial instability and risk mitigation concerns.



Monetary Policy

- Monetary policy entails the coordinated effort of the central bank to manage the amount of money in circulation in order to achieve low inflation and sustainable economic growth
- Many central banks hold the view that CBDC may enhance monetary policy because CBDC is considered to be a tool to broaden the monetary system, enhance payments, reduce the cost of issuing central bank money and increase seigniorage income
- If migration of cash and bank deposits to CBDC occurs in large frequencies and volumes, it could weaken the effectiveness of monetary targets
- The following four key aspects are important (1) Whether remunerated; (2) Accessibility; (3) Anonymity

To begin with, monetary policy entails the coordinated effort of central bank to manage the amount of money in circulation in order to achieve low inflation and sustainable economic growth. Central banks usually perform their monetary policy function within a specific monetary policy framework. Many central banks hold the view that CBDC may enhance monetary policy because CBDC is considered to be a tool to broaden the monetary system, enhance payments, reduce the cost of issuing central bank money and increase syringe income.

Since CBDC is a payment tool, CBDC issuance will not necessarily change existing monetary policy framework, rather it will only lead to changes in payment flows and the change in payment flows will have spillover effects on the transmission of monetary policy. Generally, when CBDC is introduced, some households and businesses would want to migrate some of their cash and deposits to CBDC. If migration of cash and bank deposits to CBDC occurs in large frequencies and volumes, it could weaken the effectiveness of monetary targets and also may weaken the lending channel and interest rate channel of monetary policy transmission. Cash to CBDC migration would affect monetary policy by increasing the fluctuation of money velocity and changing the revenue from seigniorage. While bank deposit to CBDC migration would affect monetary policy, so the impact of CBDC on bank disintermediation and the fluctuation in commercial bank reserves with the central bank.

If significant bank deposit to CBDC migration occurs, it would reduce commercial bank deposit liabilities and lead to a reduction in commercial bank reserves in central bank balance sheet. It will also weaken the lending and interest rate channels of monetary policy transmission and reduce central bank's ability to manage the volume of money in the economy. Lastly, CBDC does not alter the basic mechanics of monetary policy, rather it has the potential to enable timely transmission of monetary policy.

The implications of central bank digital currency, CBDC for monetary policy essentially depends on the way it is designed and its degree of usage. In particular, it would depend on the following four aspects. These are the four important aspects. First, whether the CBDC is remunerated or non-remunerated. Second, accessibility, whether it would be widely accessible just like physical currency or limited to wholesale customers such as banks as in the case of central bank reserves. And lastly, the anonymity, whether it will be anonymous like physical currency or ownership will be identifiable like bank deposits which leads the trail of different entries.



Financial Stability

- Widespread CBDC adoption could lead to significant financial stability risks in the absence of regulatory price and quantity controls on CBDC usage.
- Widespread adoption of a **remunerated CBDC** could encourage more people and businesses to migrate some of their cash and bank deposits to CBDC to benefit from attractive CBDC deposit rates.
- The resulting disintermediation could lead to disorderly disintermediation and lead to heightened liquidity risks.
- Sustained disintermediation will also reduce the amount of credit available to banks and raise borrowing costs for households, firms, and the government.
- This would reduce both loan demand and loan supply, decrease bank profit, reduce bank liquidity, and increase the risk of bank panic when banks are not able to pay their depositors, leading to increased bank fragility or financial stability risk.

Next, coming to the financial stability aspect of it, widespread CBDC adoption could lead to significant financial stability risk in the absence of regulatory price and quantity controls by central bank on CBDC usage.

Widespread adoption of remunerated CBDC could encourage more people and businesses to migrate some of their cash and bank deposits to CBDC to benefit from that active CBDC deposit rates. The resulting disintermediation could lead to disorderly disintermediation and may lead to heightened liquidity risk as we have seen worldwide when new instruments are calculated and there is lot of public interest around them. Sustained disintermediation will also reduce the amount of credit available to banks and raise borrowing cost for households, firms and government. This would reduce both loan demand and loan supply, decrease bank profits, reduce bank liquidity and increase the risk of bank panic when banks are not able to pay their depositors leading to increased bank fragility and financial stability risk. Now that we have discussed the risk of introduction of CBDCs on monetary policy and financial stability, let us discuss the risk mitigation aspect.

Both commercial and central bank can take certain steps to mitigate CBDC-introduced financial stability risk and monetary risk.



Implications of CBDCs

- Commercial banks can mitigate CBDC-induced financial stability risks by raising the interest rate paid on customer deposits to make them more attractive to bank depositors.
- Borrowing from the interbank market to augment any shortfall in customer deposits, but such borrowing may come at a high cost for banks.
- Alternatively, the central bank can mitigate financial stability risks by introducing regulatory price and quantity controls on CBDC. For example, (a) introduce daily or weekly limits on the number of bank deposits to CBDC deposit migration that can be made, (b) introduce daily CBDC transaction value limits, and (c) consider introducing differentiated limits

For example, commercial banks can mitigate CBDC-induced financial stability risk by raising the interest rate paid on the customer deposits to make them more attractive to bank depositors, thereby retaining customer deposits, retaining deposit funding, reducing liquidity and credit risk, decreasing bank fragility and reducing financial stability risk. Commercial banks can also mitigate the decline in customer deposits caused by CBDC disintermediation by borrowing from the interbank market to augment any shortfall in customer deposits but such borrowing may come at a high cost for banks. Alternatively, the central bank can mitigate financial stability risk by introducing regulatory price and quantity controls on CBDC. For example, introduce daily or weekly limits on the number of bank deposits to CBDC deposit migration that can be made, introduce daily CBDC transaction value limits and lastly, consider introducing differentiated limits.

To summarize, in this video we discussed how introduction of CBDCs can affect monetary policy and financial stability at a macroeconomic level. We also noted how banks and central banks can coordinate and put different quality and price controls to deal with such instability in the financial system.

CBDC vs Cryptocurrencies

INDIAN INSTITUTE OF TECHNOLOGY KANPUR

In this video, we will briefly compare between CBDCs and cryptocurrencies.



Cryptocurrency vs CBDCs

CHARACTERISTIC	CRYPTOCURRENCIES	CBDCs
Means of payment	Accepted by a small number of retailers	Universally accepted, legal tender
Store of value	Tend to be volatile, depends on market price	Stable, consistent with central bank price stability mandate
Unit of account	Own unit of account	Fiat currency (e.g. Australian dollars)
Governance	Typically decentralized, relies on consensus between large number of entities.	Centralized
Transaction verification	Typically, a large number of competing entities	Small number of trusted entities

Source: Digital Currencies
<https://www.rba.gov.au/education/resources/explainers/cryptocurrencies.html>

INDIAN INSTITUTE OF TECHNOLOGY KANPUR

Let us start comparing cryptocurrency with CBDC attributes. The first is means of payment. Cryptocurrencies in its current form and shape are accepted by very small number of retailers. Not at every shop or book store you can go and buy stuff with cryptocurrency. However, as per the current plan, when CBDCs are rolled out, they would be like any nationwide currency and like any currency, they would be like legal tender and universally accepted like dollar or rupee.

Next, as a store of value, we have already seen the experiment with cryptocurrency. They tend to be volatile, extremely speculative and they move with market price. So they are

very sort of volatile. However, CBDCs are expected to be more stable and they are expected to be more consistent with the central banks price stability mandate. That means because they are linked to a particular currency, for example India's rupee or US dollar, they are supposed to be more stable in that sense as a store of value. Next, unit of account. Now cryptocurrencies are their own units of account and given their volatility, they are not exactly easier to measure the value of any other goods or services.

In contrast, CBDCs because they are linked to fiat currencies like US dollar or Indian rupee, they are supposed to be or they can be used as a unit of account which is a very important property of a currency. For example, one rupee whether it is a CBDC or any other form of deposit of one rupee, it is expected to be of same value. In terms of governance structure, cryptocurrencies are totally decentralized. Typically, they follow distributed ledgers, blockchains and they rely on some kind of consensus protocol like proof of work based on large number of nodes or entities on the blockchain network.

In contrast, CBDCs are expected to be centralized like run by central bank where central bank runs the operations and various governance aspects sometimes with or without help of intermediaries like commercial banks. Lastly, we have transaction verification. Cryptocurrencies typically employ a large number of competing entity called miners for transaction verification. They employ distributed ledger technology on a permissioned or permissionless blockchain to verify transactions in a decentralized manner. In CBDCs, there is a small number of trusted entities like central bank or some commercial bank if it is indirect or hybrid model to verify, perform KYC kind of things to verify the entities and therefore verify the transaction and execute the transaction. So it is more of a small number of trusted entities that are doing the verification KYC and other things while on cryptocurrencies, it is more of a competing entities through cryptographic mechanism, they are doing the transaction verification.

To summarize this lesson, we noted that with decreasing usage of cash and technological advancements in the payment systems, various central banks are experimenting with different forms of CBDC and are currently in different stages of development. Over the last century, various monetary instruments have evolved due to the contemporaneous demands from public at large and driven by technological standards at that point of time. The same goes with CBDC as digital payment instrument. A very simple economic design of CBDC may include it as a direct liability of the central bank where CBDC may act as digital cash. We noted that over the last 10 years, multiple countries have started working on their respective models of CBDCs and currently are at different stages including research, proof of concept, pilot and some of them have launched as well.

The four key developments have accelerated the central bank's interest in CBDCs. These

include falling fiscal cash usage and rising interest in privately owned digital assets, decreasing faith in central banks as payment innovators and rising advancements in global payment systems. One key aspect here is the rising insolvency and liquidity risk with the private payment system such as commercial bank deposits. The concerns also pertain to the issues related to data privacy, governance, anonymity and money laundering, ransomware attacks and financial crimes. Though the motivations of advanced economies and emerging economies are different, for example, advanced economies are interested in CBDCs as instruments of multi-policies while emerging market economies are more interested in them as instruments of financial inclusion.

In addition, rise of big tech companies in payment solutions and emergence of Fintech has also acted as catalyst in the rise of CBDCs. Based on the conventional two-tier structure, CBDCs can be of two kinds wholesale and retail. Retail CBDC can be used by individuals and wholesale CBDC can be used by commercial banks for clearing the central banks like we have bank reserves in the current system. The second classification is account-based versus token-based. The account-based CBDC would have commercial banks having verified accounts of customers, having CBDCs similar to deposit accounts, thus no anonymity will be there.

In fact, for transactions, the identity of customer is of paramount importance. In case of token-based CBDC, it is like cash and no identification proof is needed. Anybody having a token is rightful owner and can use it for transactions. Another classification is based on technical architecture and distribution. This includes indirect CBDC or ICBDC. This follows the two-tier structure where ICBDC is a claim on an intermediary like commercial bank.

This intermediary would have to handle all the KYC and operational aspects and retail payments as well. The central bank handles the wholesale payment by this intermediary and keeps account of this intermediary transactions. In case of direct CBDC, the CBDC is a direct claim on the central bank. Central bank keeps all the record of transactions and handles the retail payments itself. In the hybrid approach, CBDC is a claim on central bank. However, intermediaries conduct KYC and other documentation requirements and periodically maintain the retail balances.

The key features of CBDC that are important in design considerations are the access to CBDC, whether it is universal or restricted, anonymity, that is whether it is account-based and needs KYC or token-based and maintains anonymity, whether CBDC pays interest or not. The key objectives of CBDC are as follows. First, to improve the working of the wholesale payment systems.

Second, to replace cash with a more efficient alternative and third, to enhance the instruments available for monetary policy and lastly, to reduce the frequency and cost of banking crisis. The key debate around CBDC are the following aspects. First, the technological uncertainty. Second, whether the CBDC should be interest-bearing or not and third, with anonymity or the lack of it comes the debate about personal freedom and privacy concerns and lastly, the issue of cyber security, financial crime and resilience to technical failure. In addition, there is concern around CBDC for its potential impact on lending and investing by commercial banks.

Another concern is its impact as monetary policy tool and on financial stability. CBDCs are expected to increase competition, decrease bank profits, may lead to higher financial inclusion and less dollarization. Lastly, we compared CBDCs with cryptocurrencies. Here, CBDCs are more suitable as a means of payment, store of value and unit of account as compared to cryptocurrencies. Moreover, the governance of CBDC is done in a centralized manner while cryptocurrencies rely on the consensus between large number of entities on the blockchain network. The transaction verification is done by the central authority for CBDC while a large number of public participants, that is the nodes on blockchains for cryptocurrencies are needed for transaction verification. Thank you.