CBDC and Programmable Money

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National University of Singapore
Introduction:

- What is CBDC?

A digital payment instrument, denominated in the national unit of account, that is a direct liability of the central bank according to Bank of International Settlement’s (BIS) definition.

- Investigations on the implications of issuing a digital complement to cash:

  1. July 2021, ECB decided to launch a two-year investigation phase.
  2. Federal Reserve has been fully engaged in CBDC research and policy development and has focused on better understanding the underlying technologies and potentials.
  3. 19 April 2021, the Bank of England and HM Treasury announced the joint creation of a CBDC Taskforce to coordinate the exploration of a potential UK CBDC.
  4. China e-CNY or digital RMB is undergoing public testing since April 2020 as part of its Digital Currency/Electronic Payment (DCEP) Project.
CBDCS AROUND THE WORLD

Stage of Development
- Research Phase
- Currently Piloting
- Pilot Completed
- Launched

- **RESEARCH PHASE**
  - United States and Europe

- **CURRENTLY PILOTING**
  - Sweden and Hong Kong/Thailand

- **PILOT COMPLETE**
  - China and Singapore

- **LAUNCHED**
  - Bahamas and Cambodia
CBDC Definitions and Models:

- **There are 3 types of digital currency:**
  1. Central Bank Issued (CBI)
  2. Central Bank Authorised (CBA)
  3. Others

Digital Currencies - Features & Trust:

**Central Bank Issued (CBI):**
- Direct liability of Central Bank; Digital representation of own sovereign currency
- Type: Legal tender
- Examples: Project Libra by MAS in Singapore e-CNY

**Central Bank Authorised (CBA):**
- Not a direct liability of the Central Bank
- 100% backed by country’s own currency / a foreign currency, or other fiat currencies or reserves
- Type: Legal tender
- Examples: Programmable eCNY/DECP by PBoC in China, Project Bakong: Digital Riel & USD Digitised HKD under the Linked Exchange Rate System

**Others (1. DLT and 2. Non DLT):**
- 1a. Fiat Stablecoin: Central Bank / Corporate
- 1b. Non-Fiat Stablecoin: Corporate / Cryptography / Community
- 1c. Cryptocurrency: Cryptography / Community
- 2. Non DLT Fiat money: Central Bank/Corporate(s)
- 1a + 1b: May be issued by a corporate trust / foundation
- 1a + 1b: May be legal tender
- All other digital currencies issued by other entities / software

**Trust Components:**
- Central Bank
- Commercial Banks
- Delegated Issuer
- Other Reserves: Underlying

**ILLUSTRATION:**
- Central Bank
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SINGAPORE

PROJECT UBIN
PILOT PHASE

KEY SPECIFICATIONS
1. Partnership with a consortium of technology companies and world largest financial institutions like JPM, BoA and Credit Suisse
2. Tokenized fiat currency on distributed ledger

MOTIVATIONS
❖ Improving transaction security
❖ Enabling faster settlement
❖ Reducing payment cost
❖ Shape future commercial solutions that leverage DLT and tokenised fiat

Although the eventual goal is to shape future commercial solutions that leverage DLT and tokenised fiat (which would include CBDCs), the project’s impact on the financial system will only be seen in the years to come.

A BRIEF TIMELINE

Phase 1
Explored the use of DLT for Real-Time Gross Settlement (RTGS) functions, with a focus on privacy protection

Phase 2
Explored the use of a tokenized Singapore CBDC with blockchain technology to conduct inter-bank payments

Phase 3
Developed Delivery vs Payment capabilities for settling tokenised assets across different blockchain platforms

Phase 4
Tested and assessed cross-border payments with DLT systems under various alternatives models

Phase 5
Tested a prototype blockchain network for a multi-currency payments model in terms of interoperability and explored its value for wholesale banking purposes.

PARTIOR
DBS, J.P. Morgan and Temasek are leading the development of a digital multi-currency payments network, with pilot trials starting in 2021, to enhance transparency, traceability and immediacy of cross-border wholesale banking transactions.
Both HKMA and Bank of Thailand began a joint project, Inthanon-LionRock, to explore the feasibility of using distributed ledger technology (DTL) solutions and to promote greater collaborative learning amongst the involved parties.

**Motivations**

1. Improve wholesale cross-border network payment systems between both countries
2. Overcome pain points in current traditional monetary systems - inefficiencies, high costs, limited traceability, complex regulatory compliance

**Key Specifications**

- Create cross border network to conduct instantaneous cross border fund transfers and interbank fund transfers between HKD and THD
- Enhance Liquidity Management efficiency through automatic currency token conversion
- Provide real time monitoring, regulatory compliance and enforcement
- Provide payment atomicity in all payment transaction by preventing partial database updates
- Enhance system resiliency through allowing independent malfunction of individual node
- Promote greater transaction privacy through maintaining disclosure on a need-to-know basis

**A Brief Timeline**

- **2017**
  - HKMA and Bank of Thailand began their separate Proof-of-Concept (POC) for their wholesale funds transfer among their participating banks

- **2018**
  - To further improve the wholesale CBDC systems and include more central banks

- **2021**
  - Joint research project reflects a broader collaborative trend of central banks working together to test wholesale CBDC use cases via pilot programs
  - Further enhance the collaboration between central banks of the two jurisdictions with regards cross-border funds transfer research and to further bolster the local financial services industry through such technology development
China

At the Forefront of Retail CBDCs

**Key Specifications**

1. Instant transaction
2. Offline usability
3. Use without bank account
4. Likely interoperable with WeChat Pay and Alipay
5. Capable processing 300,000 transaction per second
6. Multi-tier, multi-functional wallets for managed anonymity

**Motivations**

❖ Maintaining sovereignty and control over digital currencies and curbing demand for private cryptocurrencies
❖ Improve payment efficiency and liquidity
❖ Promoting financial inclusion
❖ Drive internationalisation of the RMB by increasing ease of use overseas

**A Brief Timeline**

- 2016: China Ministry of Industry and Information Technology issued a white paper on China technology and Application Development, the first time blockchain technology is included in the 13th Five-Year Plan.
- 2017: The People’s Bank of China officially established the Digital Currency Research Institute and promoted the application of new technologies such as blockchain and artificial intelligence.
- 2019: The People’s bank of China promoted the development of China’s legal digital currency as one of the eight key task in 2nd half of 2019.

The People’s Bank of China officially established the Digital Currency Research Institute and promoted the application of new technologies such as blockchain and artificial intelligence.

Conducted test in several cities across China. Announced plans to launch during Winter Olympics.
CAMBODIA

KEY SPECIFICATIONS

1. Fiat-backed, representative of tokenized Cambodian Riel or US Dollars, thereby reducing liquidity risk
2. Permissioned append-only distributed ledger, with core infrastructure maintained by NBC
3. Byzantine fault-tolerant consensus is also used to validate transactions

MOTIVATIONS

- Financial and corporate inclusion
- Promote use of local currency, thereby trying to de-dollarize an economy which still heavily reliant on the daily use of the U.S. dollar
- Reduce the use of cash-based transactions will help mitigate risks related to counterfeit currency and fraudulent cheques, and other financial crimes.

A BRIEF TIMELINE

2017
Initially established with the government aiming to tap into the increasing number of internet users in the country

Bankong’s transaction time stands around 3-5 seconds and its throughput at nearly 2,000 transactions per second

28 OCT 2020

Reached 9.7 Mil people and 14.8 Mil mobile internet subscribers

Promises scalability at acceptable costs

BENEFITS

- Free of charge transactions, businesses save costs on developing their own payment network
- Increased network effect encourages financial institutions to develop new services for the largely unbanked

MORE PLANS

- Eventually plans to allow cross-border payments to serve domestic workers abroad
- Plan to continually scale up network and create a financially-inclusive ecosystem

Key goal of National Bank of Cambodia (NBC) has always been financial inclusion.

→ 100% smartphone penetration but only 22% of population above 15 year old have a bank account

❖ Financial and corporate inclusion
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CAMBODIA
BAKONG
LAUNCHED

KING SPECIFICATIONS

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### CENTRAL BANK DIGITAL CURRENCY (CBDC)

- Issued and regulated by a trusted central monetary authority in the nation
- Business Design: Wholesale or Retail
- Ledger Designs: Token Based or Account Based

#### PROS
- FAST
  - No intermediaries, directly linked to central banks
- AND EFFICIENT
  - Less administrative burden, lower costs
- FOSTERS ECONOMIC GROWTH ALONGSIDE DIGITAL INNOVATION
  - Creates a new economic activity and growth
- AFFORDABLE
  - No need for intermediaries, cheaper for consumers and merchants
- COMPETITIVE
  - Foster competition among private sector intermediaries, set standards for security and innovation
- FINANCIAL
  - Enable the unbanked to access financial services
- INCREASES EFFECTIVENESS OF MONETARY POLICIES
  - Allows the central bank to control money supply, influencing interest rate policies

#### CONS
- STRUCTURAL DISINTERMEDIATION OF BANKS
  - Lesser deposits, shrinkage of commercial loans
- LESS THREAT TO SUSTAINABILITY OF BANKS
  - Lower risk for banks
- INCREASED FINANCIAL RISK
  - Risk of bank runs as transfer to CBDC accounts can be done with no restrictions
- DATA PRIVACY & CYBERSECURITY RISKS
  - Cyber threats due to CBDC model being open to many users

#### FACTORS FOR OPTIMAL INTEGRATED ECOSYSTEM

<table>
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<tr>
<th>US</th>
<th>EUR</th>
<th>JPY</th>
<th>HKN</th>
<th>CHN</th>
<th>SGD</th>
<th>CAM</th>
<th>BHS</th>
<th>SGP</th>
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<td>9</td>
<td>8</td>
<td>7</td>
<td>6</td>
<td>5</td>
<td>4</td>
<td>3</td>
<td>2</td>
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</tbody>
</table>

- **Score Tally According to 10 Critical Enablers**
  - Digital literacy and user experience
  - Strong Security Framework
  - Fast and Stable Network
  - Accessiblity, security, interactivity
  - Compliance
  - Client-Centric
  - Data Privacy Protection
  - Interoperability
  - Value Transfer
  - Adoption
  - Skills, Knowledge, and Skills

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**CAMBODIA BAKONG - LAUNCHED**
- Fiat-backed, representative denominated in USD or Reel
- Utilises permissioned-appended only distributed ledger with Byzantine fault-tolerant consensus
- Key goal of financial inclusion; aims to cater to the large population of unbanked and underserved Cambodians
- Hopes to encourage financial institutions to develop services for the unbanked by eliminating the need to build their own payment network

**BAHAMAS SAND DOLLARS - LAUNCHED**
- Issued by Central Bank of The Bahamas through authorised financial institutions (AFIs)
- Aims to increase efficiency of payments, greater non-discriminatory financial inclusion and strengthen national defences against illegal uses of cash.
- Online/Offline Functionality
- No interest rate, limited to domestic use

**CHINA DIGIPY - PILOTING**
- Partnership amongst 7 stated-owned companies
- Main motivation of maintaining sovereignty, curb demand over private cryptocurrencies and promoting internationalization of RMB
- Interoperable with WeChatPay and Alipay
- Supports instant transaction, offline payments up to 300,000 transaction per second

**SINGAPORE PROJECT UBIN - PILOTING**
- Transformation of financial system through blockchain and DLT by helping MAS and the industry better understand the technology and the potential benefits it may bring through practical experimentation
- 5-year multi-phase project started since 2016
- MAS’s collaboration with international financial institutions during Project Ubin could lead to the future commercialization of tokenized fiat for multi-currency cross-border payments

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**Appendix 3: Overall Infographic**

**EUROPE - RESEARCHING**
- Digital Euro symbolizes progress and integration in EU
- Digital Euro to be accessible to all and offer an alternative payment method
- Guarantees Eurozone citizens costless access to a simple, universally accepted, safe & trusted means of payment

**USA - RESEARCHING**
- US Federal Reserve continues to research the costs and benefits of pursuing CBDCs
- Help citizens gain access to easy payments & banks account, wrestling in safer & cheaper payments

**SWEDEN E-KRONA - PILOTING**
- The potential rollout of eKrona allows new payment service providers to enter without relying on banks’ legacy settlement infrastructure
- Potentially provides new forms of payment services and increases market competition

**HONG KONG AND THAILAND - PILOTING**
- Adopt CBDC DLT solution to improve wholesale cross-border network payment systems between HKA and BGL and their participating banks
- Overcome pain points in current monetary systems - efficiencies, high costs, limited traceability, complex regulatory compliance
- Overall bolster the local financial services industry through such technology development

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Done by: Adeline, Adrian, Charmayne, Gordon, Karl, Rayson, Yun Xuan

Adapted from AY20/21 FIN4721 Group 4’s Report on CBDCs. Dated 5th April 2021.
• Talking at a BIS lecture, Mark Carney, the former Governor of the Banks of England and Canada, gave his views on the future of money.

• He believes stablecoins should have access to a central bank’s balance sheet, provided they meet a number of requirements.

• Carney noted that new forms of money would make bank funding costs more expensive.
• “These higher funding costs should not dissuade central banks from pursuing reforms that offer the public greater choice and better service,” said Carney.

• “Banks are a means to an end, not ends in themselves. And will have to adapt to a much more competitive environment.”

• This is similar to recent statements by his former colleague Sir John Cunliffe, Deputy Governor of the Bank of England.

• Turning to cryptocurrencies, Carney is not optimistic about their valuations – with the possible exception of one that could end up being treated as digital gold.

• He believes that CBDCs and regulated stablecoins will dominate. “Tokens at the heart of programmable networks will have to remain just that, of token value,” said Carney.

• “This is not to dismiss either NFTs or decentralized finance. Quite to the contrary. Their scope of application is exceptionally broad,” said Carney.
New Money and Digital Assets

- Metaverse
- Cryptocurrencies
- Fungible and Non-Fungible Tokens
- DeFi

Assets are immutable in a decentralised metaverse.

Assets are duplicated in the physical and virtual world.

Virtual properties and human can generate income in the metaverse,

Machine and robots can generate income in the physical world.
## Today's Cryptocurrency Prices by Market Cap

The global crypto market cap is $2.30T, a 5.25% increase over the last day. Read More

### Trending
1. ADAUP ADAUP (+2.85%)
2. Ronin Gamez RONGM2Z (+18.91%)
3. Only Up $UP (+913.85%)

### Biggest Gainers
1. Teradec Jones TBC (+248.25%)
2. Flokcinics FOLOKIN (+1696.48%)
3. Millimeter MM (+1334.79%)

### Recently Added
1. Bavya Bonfire FIRE
2. Decimal DEL
3. Spain National Fan Token SNTF

### Cryptocurrency Prices

<table>
<thead>
<tr>
<th>#</th>
<th>Name</th>
<th>Price</th>
<th>24h %</th>
<th>7d %</th>
<th>Market Cap</th>
<th>Volume (24h)</th>
<th>Circulating Supply</th>
<th>Last 7 Days</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Bitcoin BTC</td>
<td>$54,692.91</td>
<td>-9.28%</td>
<td>-31.62%</td>
<td>$1,029,397,302,041</td>
<td>$50,420,004,868</td>
<td>18,336,525 BTC</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Ethereum ETH</td>
<td>$3,570.42</td>
<td>+3.98%</td>
<td>+25.58%</td>
<td>$420,764,445,436</td>
<td>$22,518,015,538</td>
<td>117,818,231 ETH</td>
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<tr>
<td>3</td>
<td>Binance Coin BNB</td>
<td>$438.30</td>
<td>-0.38%</td>
<td>+19.30%</td>
<td>$73,886,067,567</td>
<td>$1,945,518,418</td>
<td>168,137,038 BNB</td>
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</tr>
</tbody>
</table>
Top DeFi Tokens by Market Capitalization

The DeFi crypto market cap is $136.09B, a -13.66% increase over the last day.

<table>
<thead>
<tr>
<th>#</th>
<th>Name</th>
<th>Price</th>
<th>24h %</th>
<th>7d %</th>
<th>Market Cap</th>
<th>Volume (24h)</th>
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</tr>
</thead>
<tbody>
<tr>
<td>11</td>
<td>Terra LUNA</td>
<td>$43.69</td>
<td>-2.23%</td>
<td>-26.97%</td>
<td>$17,664,354,484</td>
<td>$1,568,839,014</td>
<td>402,416,753 LUNA</td>
</tr>
<tr>
<td>12</td>
<td>Uniswap UNI</td>
<td>$25.71</td>
<td>-3.50%</td>
<td>-10.35%</td>
<td>$15,843,111,947</td>
<td>$492,618,121</td>
<td>611,643,724 UNI</td>
</tr>
<tr>
<td>13</td>
<td>Avalanche AVAX</td>
<td>$61.90</td>
<td>-3.04%</td>
<td>-5.45%</td>
<td>$13,768,160,098</td>
<td>$1,002,503,700</td>
<td>220,288,577 AVAX</td>
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<tr>
<td>15</td>
<td>Chainlink LINK</td>
<td>$27.79</td>
<td>-4.98%</td>
<td>-20.92%</td>
<td>$12,745,814,508</td>
<td>$1,202,463,486</td>
<td>456,509,554 LINK</td>
</tr>
<tr>
<td>19</td>
<td>Wrapped BitcoinWBTC</td>
<td>$54,538.07</td>
<td>-8.84%</td>
<td>-31.21%</td>
<td>$11,316,927,628</td>
<td>$413,661,687</td>
<td>207,270 WBTC</td>
</tr>
</tbody>
</table>
### Top Collectibles & NFTs Tokens by Market Capitalization

Listed below are the top crypto coins and tokens used for Collectibles & NFTs. They are listed in size by market capitalization. To reorder the list, simply click on one of the options - such as 24h or 7d - to see the sector from a different perspective. Learn more about NFT collections here.

<table>
<thead>
<tr>
<th>#</th>
<th>Name</th>
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</thead>
<tbody>
<tr>
<td>23</td>
<td>Axie Infinity AXS</td>
<td>$138.31</td>
<td>-7.93%</td>
<td>-87.28%</td>
<td>$8,340,362,123</td>
<td>$2,431,578,262</td>
<td>80,907,500 AXS</td>
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<tr>
<td>30</td>
<td>Tezos XTZ</td>
<td>$6.19</td>
<td>-4.33%</td>
<td>-42.04%</td>
<td>$7,082,310,180</td>
<td>$1,007,514,856</td>
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<td>32</td>
<td>THETA THETA</td>
<td>$6.56</td>
<td>-1.04%</td>
<td>-30.88%</td>
<td>$6,588,710,321</td>
<td>$590,247,439</td>
<td>1,000,000,000 THETA</td>
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<tr>
<td>65</td>
<td>Chilliz CHZ</td>
<td>$0.3078</td>
<td>+5.17%</td>
<td>+22.80%</td>
<td>$1,809,206,175</td>
<td>$333,428,439</td>
<td>5,911,076,911 CHZ</td>
<td></td>
</tr>
<tr>
<td>76</td>
<td>Decentraland MANA</td>
<td>$0.7741</td>
<td>+2.26%</td>
<td>+21.39%</td>
<td>$1,407,112,137</td>
<td>$116,608,938</td>
<td>1,816,569,291 MANA</td>
<td></td>
</tr>
</tbody>
</table>
Questions

- Close to USD3T Market Cap (soon will be larger than currency in circulation and gold with the expansion of the metaverse).
- How will this affect asset allocation of households with the metaverse?
- How will this affect retirement planning?
- How will this affect labour income?
- How do you value these currencies and digital assets?
- Are these new money having the same behaviour as Venture Capitals or Bonds or Equities?
- Is programmable money a new monetary tool?
- How will the regulation on Crypto and CBDC change the landscape?
Acknowledgement

CDBC slides are prepared by AY 20/21 FIN4721 Group 4: Adeline, Adrian, Charmayne, Gordon, Karl, Rayson, Yun Xuan