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Dollar to Digital: Understanding the Risks of Retail CBDCs

Abstract:

With the emergence of centralized digital currencies, commonly known as cryptocurrencies, in the mid-2010s, governments across the globe began researching and discussing developing and implementing central bank digital currencies (CBDCs). This paper delves into the implementation of various CBDC models and the potential ramifications and transformations they bring to the financial landscape. Using a holistic lens, incorporating unbanked peoples, environmental impacts, privacy, and commercial and central bank implications, I explore the opportunities and challenges created through CBDCs. I take into account a plethora of major entities and their respective positions to broaden our financial perspective and gain better monetary agency.

Keywords: Centralized Digital Bank Currency, CBDC, CBDCs, CBDC Proposal, Digital Currency, Digital Money, Currency Innovation, Financial Governance, Digital Ledger, Digital Ledger Technology

Decentralized digital currencies, better known as cryptocurrencies, took the world by storm in the late 2000s. The first cryptocurrency, Bitcoin, emerged in 2009, created by a mysterious person or persons under the pseudonym “Nakamoto.” Since then, other cryptocurrencies have been developed, and digital trading marketplaces have been created. In 2021, Binance, the number one cryptocurrency exchange, reported having a transaction volume of \$7.7 trillion.¹ The quick rise in popularity gained the attention of many central banks and governments. Now, central bank digital currencies, or CBDCs, are poised to be the newest global currency systems and are set to transform the way financial transactions will be conducted. As of 2022, the United Nations reported that 105 countries were actively exploring CBDCs, with eleven countries already officially implementing their versions and twenty-one more in the pilot

¹ David Curry, “Binance Revenue and Usage Statistics (2023),” Business of Apps online, updated January 6, 2023, <https://www.businessofapps.com/data/binance-statistics/>

stage of development.² China—a global superpower—is one of the leading eleven countries that have already launched their version of CBDC, whereas Russia, India, and France are some of the nations operating within the pilot phase. Central bank digital currencies are captivating governments' attention worldwide, and the United States is no exception. The White House published an article in 2021 signaling its commitment to researching and developing CBDCs and exploring what their roles should be.³

Traditionally, in the United States, individuals pay for goods and services with either cash, checks, or electronic payments via debit and credit cards. Traditional electronic payments and central bank digital currencies superficially function alike, but have several key, underlying differences. The most prominent differentiation between the two is the issuer. Currently, when consumers engage in contemporary electronic transactions, financial institutions and payment processors are in charge of handling and verifying the agreed-upon exchange. Account balances in commercial banks represent quantities of legal tender—but are not legal tender in and of themselves. These institutions are also responsible for maintaining and updating the financial balance ledgers, ensuring the accuracy and security of digital transactions.

In contrast, central bank digital currencies would be issued directly by the central bank—in the United States this would be the Federal Reserve. Consider it akin to a government-funded and backed Bitcoin, or more specifically, a stablecoin.⁴ These digital

² United Nations, "World Economic Situation and Prospects: August 2022 Briefing, No. 163," United Nations, Published August 1, 2022, <https://www.un.org/development/desa/dpad/publication/world-economic-situation-and-prospects-august-2022-briefing-no-163/>.

³ The White House, *Technical Evaluation for a U.S. Central Bank Digital Currency System*, The White House, September, 2022, <https://www.whitehouse.gov/wp-content/uploads/2022/09/09-2022-Technical-Evaluation-US-CBDC-System.pdf>.

⁴ Stablecoins are a type of cryptocurrency with a 1:1 value pegged to a reserve of assets—like US Dollars. Cryptocurrencies are not backed by central banks, are not sovereign money, and their architecture provides anonymity, unlike current electronic payments.

currencies represent a direct claim on the central bank, effectively becoming legal tender. Central bank digital currencies can take many different forms and models, and the United States is currently undecided on which to implement. Dr. Michael Lloyd, a Senior Research Fellow at the Global Policy Institute—an international affairs think tank—previous Economic Advisor to the European Parliament, and author of *Central Bank Digital Currencies: The Future of Money*, presents four possible designs for retail CBDCs: direct, hybrid, intermediated, and indirect.⁵ CBDCs are a very new and niche economic topic, yet have widespread ramifications. Therefore, as CBDCs gain traction across the financial landscape, understanding their impacts will be crucial for consumers to maintain financial agency and stability.

Background of Banks and CBDC Models

There is a significant and intentional difference between the central bank and other financial institutions, like commercial banks. Central banks are often governmental or quasi-governmental institutions responsible for regulating a country's monetary policy, issuing currency, overseeing the banking system, and maintaining economic stability. On the other hand, commercial banks are private or public institutions providing financial services to businesses and individuals, such as checking and savings accounts and loans. They operate under regulations provided by the central bank and handle day-to-day banking activities.

Next, it is vital to understand the two most discussed central bank digital currency model propositions: a direct CBDC model and a hybrid CBDC model. In the direct model, the central bank and individuals and merchants are in direct relation. CBDCs are a direct claim on the central bank and prove legal tender. The central bank would be in charge of updating financial ledgers, wholesale and retail, and would be responsible for day-to-day transactions—see **Figure**

⁵ Michael Lloyd, *Central Bank Digital Currencies: The Future of Money*, Agenda Publishing, 2023.

1a. The hybrid CBDC model, being a two-tiered system with commercial banks or payment processors as intermediaries, would behave relatively similarly to how contemporary electronic banking is conducted. It is important to note that for the hybrid model, there are two versions: a fully intermediated version and a semi-intermediated version—see also **Figure 1a**. In comparison to contemporary electronic commerce, there is a change in issuer, which institution is responsible for maintaining ledgers, and which is subject to provide payment services—see **Figure 1b**.⁶

⁶ The diagrams on the next pages are provided by two authors: Rainer Böhme and Raphael Auer. The first a professor of security and privacy and the latter a head at the Bank for International Settlements Hub Eurosystem Center:
<https://cepr.org/voxeu/columns/cbdc-architectures-financial-system-and-central-bank-future>

Figure 1a: Proposed CBDC Models

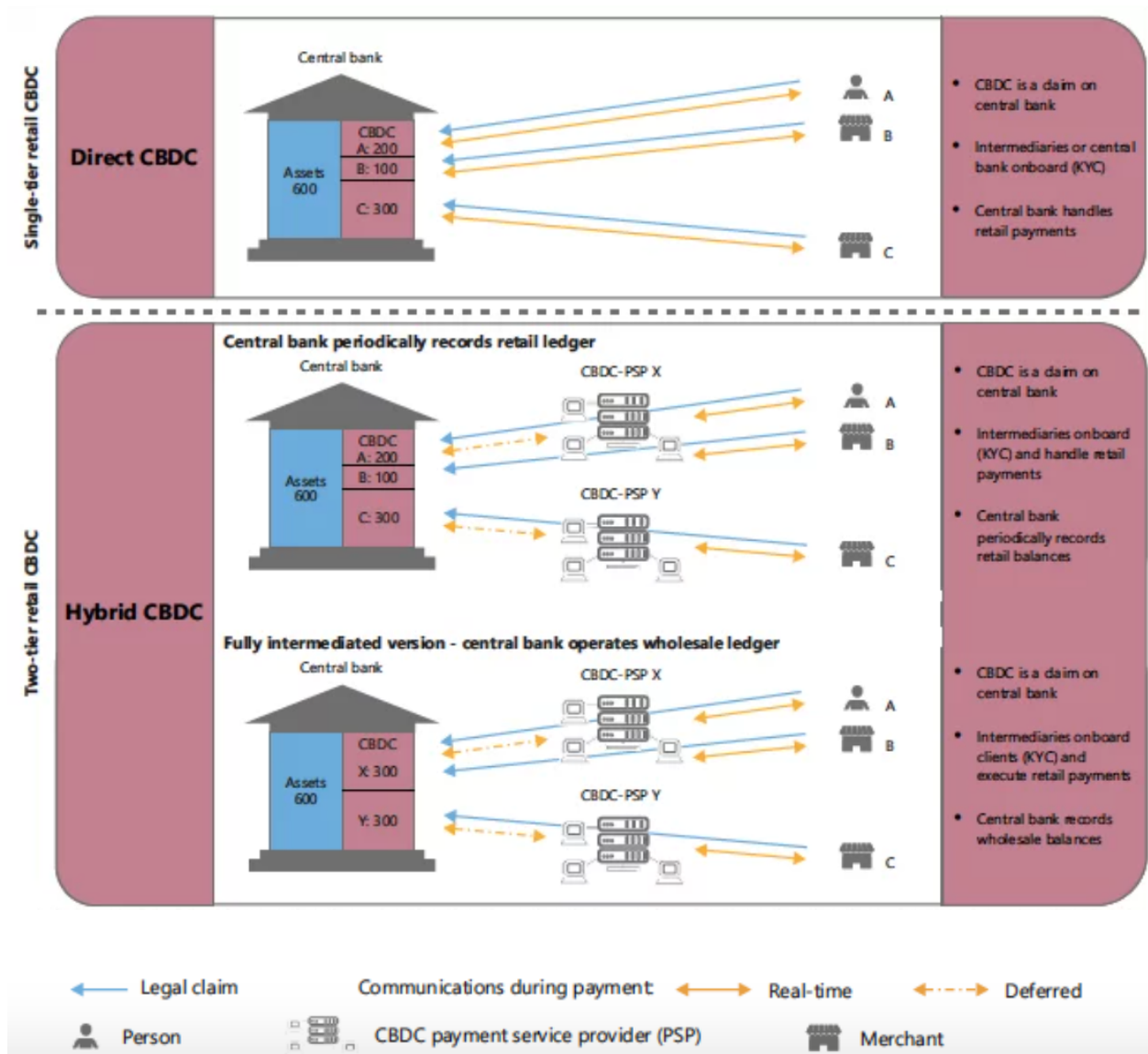
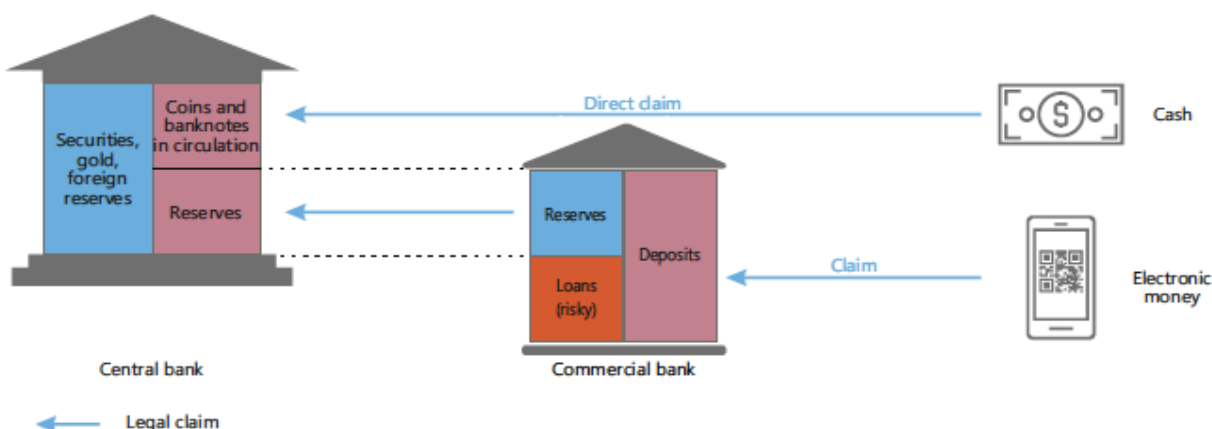


Figure 1b: Contemporary Financial System



Financial Inclusion Concerns

The desire for a centralized digital currency system often stems from a desire for greater inclusivity, with the stated aim of expanding financial services to unbanked individuals. To put this concern into context, consider that in 2021, the Federal Deposit Insurance Corporation (FDIC) estimated that approximately 5.9 million American households remained unbanked, lacking access to traditional bank or credit union services.⁷ Unbanked status tends to be disproportionately represented by specific demographic groups, including Black, Hispanic, disabled, and single-parent households. Institutions like the World Economic Forum, which play a pivotal role in central bank digital currency (CBDC) development, argue that CBDCs hold the potential to facilitate access to digital financial services for unbanked populations.⁸

⁷ Federal Deposit Insurance Corporation, "2021 FDIC National Survey of Unbanked and Underbanked Households," Federal Deposit Insurance Company, Last updated July 24, 2023, <https://www.fdic.gov/analysis/household-survey/index.html#:~:text=Key%20Findings,-National%20Unbanked%20Rate&text=An%20estimated%204.5%20percent%20of,a%20bank%20or%20credit%20union>.

⁸ World Economic Forum, *Central Bank Digital Currencies Global Interoperability Principles*, World Economic Forum, published June, 2022, https://www3.weforum.org/docs/WEF_Central_Bank_Digital_Currency_Global_Interoperability_Principles_2023.pdf

However, there are critical issues associated with this contention. At present, there is limited empirical data to affirmatively demonstrate the positive or negative impact of CBDC implementation on unbanked individuals. The claims about potential effects, both positive and negative, largely remain speculative. For instance, the notion of offering unbanked individuals the option of a central bank digital currency assumes several conditions: that they possess internet access, have the required identification, desire to engage with digital currency, possess sufficient digital literacy, and have the necessary hardware for accessing CBDCs. Conversely, there is speculation that CBDCs could potentially exacerbate financial exclusion. If CBDCs function in a manner similar to our existing digital monetary system, they may provide little to no genuine inclusion or incentive. According to the same 2021 FDIC report on unbanked individuals, of the 5.9 million unbanked American households, 1.28 million did not have the financial means for a bank account, 778,000 reported distrust of banks, and 495,000 reported avoiding banks to safeguard their privacy. The introduction of CBDCs may not address the underlying reasons why households either choose or are compelled to remain unbanked.

Commercial Bank Concerns

The introduction of decentralized digital currencies, such as Bitcoin and Ethereum, has prompted governments and central banks to consider creating their own digital currencies. This interest has grown, particularly with the rise of stablecoins. In response to these developments, certain governments have taken measures to ban the purchasing and selling of decentralized digital currencies within their territories—China, Qatar, and Egypt, to name a few. This concern arises from several factors, the main being the potential destabilization of commercial banks because of high cryptocurrency use.

Commercial banks play a vital role in the financial system. They safeguard depositors' funds, provide returns on deposits, and use deposited money to extend loans to creditworthy organizations that support public projects. Through these loans, banks earn a percentage of interest greater than what is offered to depositors. This symbiotic relationship benefits the loan recipient, the bank, the depositor, and society through public projects. However, because banks use deposited funds for lending, they are required to maintain a reserve of liquid assets to meet withdrawal demands. In the event of a bank's insolvency and an inability to repay the money used for loans, central banks step in to protect depositors, covering amounts up to \$250,000. Thus, commercial banks occupy a crucial position within the financial system, serving as intermediaries between depositors and borrowers, providing secure storage for funds, and facilitating financial transactions.

Cryptocurrencies pose a significant challenge to the financial system by potentially disrupting the traditional role of commercial banks. Cryptocurrencies operate without central oversight or centralized authentication—hence their alternative name, "decentralized digital currency." Transactions using a cryptocurrency like Bitcoin follow a distinct process: an anonymous sender, anonymous recipient, and transaction amount are generated; the transaction undergoes validation and authentication by an anonymous, decentralized network of nodes—computers—that process the transactional data; miners⁹ solve complex mathematical puzzles to secure different segments of the transaction, processing and irreversibly marking them as complete; once all sections are finished, the transaction is finalized, and balances are adjusted. All the participating nodes collaborate to establish a distributed ledger.

⁹ Miners are individuals or organizations that allocate their computing power to this process, validating transactions by solving complex algorithms. Miners are incentivised to do this by reward of a small amount of cryptocurrency used in the transaction.

Governments and central banks are motivated to preserve financial stability and decentralized currencies are a potential threat. In pursuit of this goal, some nations are developing their own digital currencies. However, these central bank digital currencies come with potential problems. The launch of a retail digital currency from a central bank can generate excitement. Many people may withdraw funds from commercial banks at a rapid pace, seeking to exchange them for CBDCs. This situation, known as a bank run, can lead to an outflow of deposits from banks, potentially resulting in bank failures and undermining the overall economic stability. The International Monetary Fund also makes a note of this possibility: “To the extent that CBDC competes with bank deposits, whether remunerated or not, [...] in turn could undermine the deposit franchise value of commercial banks.¹⁰” Ironically, the approach to central bank digital currencies may have the very impact it is intended to prevent.

Another issue that could stem from the centralization of a digital currency is a lack of intermediaries. It is important for commercial banks to serve as intermediaries because competition exists, and there is a failsafe if the bank goes insolvent—the Federal Reserve. Having a central bank as an extra layer of financial protection acts as a trust anchor for the economy, and having a choice about where to store money is important for individual financial liberty. In order for everyday consumers to retain individual financial agency, commercial banks must remain in their present role. This allows competition, innovation, intermediation of funds for public projects, and safe storage of monetary funds with the central bank acting as an insurance for commercial bank insolvency.

¹⁰ Gabriel Soderberg, et al., “How Should Central Banks Explore Central Bank Digital Currency?” *A Dynamic Decision-Making Framework*, International Monetary Fund, September 8, 2023: 12, <https://www.imf.org/-/media/Files/Publications/FTN063/2023/English/FTNEA2023008.ashx>

Central Bank as the Sole Bank

The Federal Reserve is responsible for enacting monetary policy to keep the economy stable. Primarily it does this by adjusting interest rates and reserve requirements of commercial banks. These processes allow them to influence inflation, or stimulate growth. Raising interest rates makes it more expensive to borrow money, discouraging borrowing and spending, whereas lower interest rates promote borrowing and spending. If the central bank were to take on central bank digital currencies, the Bank Policy Institute mentions the possibility of negative interest rates as a monetary policy tool.¹¹ Negative interest would punish stagnant CBDCs by making individuals and businesses pay a percentage of owned funds, continuously over intervals, until the central bank is satisfied—heavily influencing the spending of money. In addition, a technical report by The White House mentions the availability to introduce holding limits of CBDCs on persons or organizations,¹² ensuring users cannot attain more than a set amount of CBDCs.

Moreover, there is a heated debate about whether the central bank should gain the amount of responsibility and power that comes with CBDCs. Majority Whip Tom Emmer, House of Representatives, of Minnesota’s 6th District, proposed legislation that would not allow the Federal Reserve to receive this power. He defends his bill, the *CBDC Anti-Surveillance State Act*: “If not designed to be open, permissionless, and private—emulating cash—a

¹¹ Bill Nelson, “The Benefits and Costs for a Central Bank Digital Currency for Monetary Policy,” Bank Policy Institute, published April 15, 2021, <https://bpi.com/the-benefits-and-costs-of-a-central-bank-digital-currency-for-monetary-policy/#:~:text=If%20the%20interest%20rate%20were,incentivized%20to%20purchase%20other%20assets>.

¹² The White House, *Technical Evaluation for a U.S. Central Bank Digital Currency System*, The White House, September, 2022, <https://www.whitehouse.gov/wp-content/uploads/2022/09/09-2022-Technical-Evaluation-US-CBDC-System.pdf>.

government-issued CBDC is nothing more than a CCP-style surveillance tool that would be used to undermine the American way of life.¹³ This amount of surveillance, to some, is beneficial—making it easier to oversee Anti-Money Laundering, Know Your Customer, and Counter-Terrorist Financing adherence.

Central control and oversight of CBDCs is an invasion of privacy and may have serious effects on individual liberties. Consider the recent Canadian Freedom Convoy and the actions taken place by the Canadian government during that protest. The Freedom Convoy was a protest involving upwards of 18,000 people and protested the government's vaccine mandates. The government invoked the Emergencies Act, allowing them to freeze the bank accounts of approximately 200 protestors, restricting nearly \$8 million.¹⁴ While the circumstances are not the same, it serves as a stark reminder that digital financials can be weaponized against the civilian population. Allowing the United States Federal Reserve to have direct control and oversight of individual financials, places them in a unique position of power, fully able to instrumentalize the monetary system against inhabitants.

Speed and Energy Consumption

Starting in 2016, the Massachusetts Institute of Technology, commonly known as MIT, and the Federal Reserve Bank of Boston initiated a hypothetical CBDC development project codenamed Project Hamilton. One proposed benefit of central bank digital coins is the speed of settling transactions. In their development, the collaborators managed to create an architectural

¹³ “Emmer Reintroduces CBDC Anti-Surveillance State Act,” Emmer House, September 12, 2023, <https://emmer.house.gov/2023/9/emmer-reintroduces-cbdc-anti-surveillance-state-act#:~:text=Since%20the%20117th%20Congress%2C%20Whip,issued%20central%20bank%20digital%20currency.>

¹⁴ Zimonjic, Peter, “Most bank accounts frozen under the Emergencies Act are being released, committee hears,” *CBC* online, published February 22, 2022, <https://www.cbc.ca/news/politics/emergency-bank-measures-finance-committee-1.6360769>

design for CBDCs that can handle 1.7 million transactions per second (TPS).¹⁵ Transactions per second is simply a measure of how many transactions can be settled, or completed, by the network per second—higher TPS offers better scalability. Furthermore, this system would operate twenty-four hours a day, seven days a week—with the exception of potential power outages. Compare this to Bitcoin or contemporary payments with Visa: Bitcoin executes, on average, seven transactions a second, and Visa is capable of settling 1,700 transactions per second.¹⁶

Furthermore, massive amounts of energy may be needed to process and authenticate digital currency transactions depending on the digital architecture and encryption. According to the Rocky Mountain Institute, Bitcoin mining consumes more energy annually than some other countries, like Sweden, and Bitcoin mining in America alone produces roughly the same amount of CO₂ emissions as all the diesel used by the United States railroad.¹⁷ If CBDCs are going to use the same blockchain technology that Bitcoin uses—spread across a myriad of nodes, each validating segments of a transaction—then the environmental concerns are likely to be monumental. It seems extremely unlikely that the United States could adhere to the United Nations' 2030 Agenda, which includes reducing carbon emissions by 45% by 2030 and by 2050 having net zero emissions. Gaining faster settlements is hardly worth the costly effects on our environment.

¹⁵ Federal Reserve Bank of Boston and Massachusetts Institute of Technology Digital Currency Initiative, "Project Hamilton Phase 1 Executive Summary," Bostonfed, published February 3, 2022, <https://www.bostonfed.org/publications/one-time-pubs/project-hamilton-phase-1-executive-summary.aspx#1ce6ee5c-8752-49b4-b3e7-74ff415b80c9>

¹⁶ "Transactions Per Second (TPS) Meaning," Ledger online, updated July 18, 2023, <https://www.ledger.com/academy/glossary/transactions-per-second-tps>

¹⁷ Samuel, Huestis, "Cryptocurrency's Energy Consumption Problem," Rocky Mountain Institute online, published January 30, 2023, <https://rmi.org/cryptocurrencys-energy-consumption-problem/#:~:text=Bitcoin%20alone%20is%20estimated%20to,fuel%20used%20by%20US%20railroads>

The e-CNY

China is the largest proprietor of CBDCs worldwide with their CBDC, e-CNY. They have adopted the hybrid model, which splits the payment system responsibilities. The Chinese central bank, the Public Bank of China (PBoC), maintains and oversees the financial ledger while intermediary banks manage all retail transactions. The PBoC offers a digital wallet interface so retailers can “own” CBDCs stored on smart devices. They offer various digital wallets coinciding with different levels of provided personal identification. The smallest wallet only requires a phone number and can hold up to 10,000 yuan (\$1,366), make transactions of up to 2,000 yuan (\$273), and have a max transaction per day limit of 5,000 yuan (\$683). To be able to open wallets that can account for larger amounts of e-CNY, users must divulge more personal information.

In 2021 there were roughly 261 million digital wallets.¹⁸ Considering that China has a population of 1.41 billion, this equates to roughly 18.4% of the population with digital wallets. The Atlantic Council shows that the average balance for individual digital wallets is roughly three yuan, equivalent to forty-one cents. This low, average balance of wallets lends reasonable suspicion of low CBDC use. In fact, the Chinese government had to make incentives for creating and using digital wallets, such as giveaways of large amounts of CBDCs. It's important to note that CBDC development is still very recent; however, based on the Chinese model and implementation of e-CNY, interpretations lead to a lack of participation within the country. It is

¹⁸ Anaya Kumar, “A report Card on China’s central Bank Digital Currency: the e-CNY,” Atlantic Council, published March 1, 2022, <https://www.atlanticcouncil.org/blogs/econographics/a-report-card-on-chinas-central-bank-digital-currency-the-e-cny/>

unknown how much money, resources, and time were spent developing China's CBDC, but CBDCs may not have been worth it.

It is also worth noting that, given current tensions between China and Taiwan, China stands to gain from spearheading a global shift towards CBDCs. Validating and operating CBDCs involves massive amounts of computers. And all computers need computer chips, this is true from cars to phones to servers. Taiwan produces over sixty percent of the world's semiconductors and over ninety percent of the world's advanced computer chips.¹⁹ If both China annexes Taiwan, and countries continue moving towards adopting CBDCs, China is put in a supreme position to make money and control the industry.

Conclusion

In response to cryptocurrencies, like Bitcoin, governments and central banks are putting in massive efforts to devise regulatory policies and architectural designs of possible CBDC models. There are many different proposed and piloted models; direct and hybrid models are the leading approaches. Decisions for choosing a model are likely to take time, as a significant adjustment to a nation's financial ecosystem should. Going digital involves a degree of sacrificing individual privacy for convenience, as digital currencies will leave digital signatures and trails. Each model, however, has the potential to offer unsubstantiated advantages, struggling to find a balance between inclusivity and privacy, environmental concerns, competition and liberties, and disintermediation of banks.

¹⁹ "Taiwan's dominance of the chip industry makes it more important," The Economist online, March 6, 2023, <https://www.economist.com/special-report/2023/03/06/taiwans-dominance-of-the-chip-industry-makes-it-more-important>

As CBDCs continue developing, the public must engage in informed discussions and research. The only way for consumers to partake in the shifting financial landscape is through gaining an understanding of proposed central bank digital currencies. Armed with this understanding, the public can make informed decisions to protect individual financial stability and agency. For instance, citizens in the United States may call their state representatives and voice their opinions—potentially leading government officials to create anti-CBDC bills like Majority Whip Emmer of Minnesota. In addition, inhabitants can more confidently decide where to spread and store types of currencies, whether choosing to compile more physical assets, like gold, silver, or cash, retaining individual privacy of wealth and transaction decisions. Or by committing to CBDCs when it is most advantageous, like during any incentive periods, including lotteries like China enacted or potential positive interest for CBDCs. How consumers determine to accept or reject CBDCs ultimately requires a foundational understanding of the changing digital financial landscape.

References

- Curry, David. “Binance Revenue and Usage Statistics (2023).” Business of Apps online. Updated January 6, 2023. <https://www.businessofapps.com/data/binance-statistics/>
- “Emmer Reintroduces CBDC Anti-Surveillance State Act.” Emmer House. Published September 12, 2023. <https://emmer.house.gov/2023/9/emmer-reintroduces-cbdc-anti-surveillance-state-act#:~:text=Since%20the%20117th%20Congress%2C%20Whip,issued%20central%20bank%20digital%20currency.>
- Federal Deposit Insurance Corporation, “2021 FDIC National Survey of Unbanked and Underbanked Households,” Federal Deposit Insurance Company, Last updated July 24, 2023, <https://www.fdic.gov/analysis/household-survey/index.html#:~:text=Key%20Findings,-National%20Unbanked%20Rate&text=An%20estimated%204.5%20percent%20of,a%20bank%20or%20credit%20union.>
- Federal Reserve Bank of Boston and Massachusetts Institute of Technology Digital Currency Initiative. “Project Hamilton Phase 1 Executive Summary.” Bostonfed. Published February 3, 2022, <https://www.bostonfed.org/publications/one-time-pubs/project-hamilton-phase-1-executive-summary.aspx#1ce6ee5c-8752-49b4-b3e7-74ff415b80c9>
- Hayes, Herman. “What is TPS in crypto? Which crypto has the highest TPS?” Bitkan. Published February 2, 2023. <https://bitkan.com/learn/what-is-tps-in-crypto-which-crypto-has-highest-tps-11300>
- Huestis, Samuel. “Cryptocurrency’s Energy Consumption Problem.” Rocky Mountain Institute online. Published January 30, 2023. <https://rmi.org/cryptocurrencys-energy-consumption-problem/#:~:text=Bitcoin%20alone%20is%20estimated%20to,fuel%20used%20by%20US%20railroads>
- Kumar, Anaya. “A report Card on China’s Central Bank Digital Currency: the e-CNY.” Atlantic Council. Published March 1, 2022. <https://www.atlanticcouncil.org/blogs/econographics/a-report-card-on-chinas-central-bank-digital-currency-the-e-cny/>
- Lloyd, Michael. *Central Bank Digital Currencies: The Future of Money*. Agenda Publishing, 2023.

Nelson, Bill. “The Benefits and Costs for a Central Bank Digital Currency for Monetary Policy.” Bank Policy Institute. Published April 15, 2021,
<https://bpi.com/the-benefits-and-costs-of-a-central-bank-digital-currency-for-monetary-policy/#:~:text=If%20the%20interest%20rate%20were,incentivized%20to%20purchase%20other%20assets>

Soderberg, Gabriel, John Kiff, Herve Tourpe, Marianne Bechara, Stephanie Forte, Kathleen Kao, Ashley Lannquist, Tao Sun, and Akihiro Yoshinaga “How Should Central Banks Explore Central Bank Digital Currency?” *A Dynamic Decision-Making Framework*. International Monetary Fund. September 8, 2023.
<https://www.imf.org/-/media/Files/Publications/FTN063/2023/English/FTNEA2023008.ashx>

“Taiwan’s dominance of the chip industry makes it more important.” *The Economist* online. March 6, 2023.
<https://www.economist.com/special-report/2023/03/06/taiwans-dominance-of-the-chip-industry-makes-it-more-important>

The White House. *Technical Evaluation for a U.S. Central Bank Digital Currency System*. The White House. September, 2022.
<https://www.whitehouse.gov/wp-content/uploads/2022/09/09-2022-Technical-Evaluation-US-CBDC-System.pdf>.

“Transactions Per Second (TPS) Meaning.” *Ledger* online. Updated July 18, 2023.
<https://www.ledger.com/academy/glossary/transactions-per-second-tps>

United Nations, "World Economic Situation and Prospects: August 2022 Briefing, No. 163," United Nations, Published August 1, 2022,
<https://www.un.org/development/desa/dpad/publication/world-economic-situation-and-prospects-august-2022-briefing-no-163/>

World Economic Forum. *Central Bank Digital Currencies Global Interoperability Principles*. World Economic Forum. Published June, 2022.
https://www3.weforum.org/docs/WEF_Central_Bank_Digital_Currency_Global_Interoperability_Principles_2023.pdf

Zimonjic, Peter. “Most bank accounts frozen under the Emergencies Act are being released, committee hears.” *CBC* online. Published February 22, 2022.
<https://www.cbc.ca/news/politics/emergency-bank-measures-finance-committee-1.6360769>