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Development of Central Bank Digital Currencies in Emerging Markets and Developing Economies

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Abstract

The newest innovation in currency is Central Bank Digital Currencies. Central Bank Digital Currencies present many intriguing opportunities and pitfalls for central banks of Emerging Market and Developing Economies. Central banks need to be cautious when designing a Central Bank Digital Currency because the design will greatly influence the benefits and risks associated with the project. There will be significant consequences for the success of a Central Bank Digital Currency due to the type of network used and the methods of identity verification included in its design. Key motivations for the development of a Central Bank Digital Currency are the creation of new monetary policies, the ability to implement targeted subsidies, and increased financial inclusion. Motivations that should be particularly beneficial for many Emerging Market and Developing economies is increased efficiency and reduced costs of remittances and international transfers of a Central Bank Digital Currency. The potential benefits of a Central Bank Digital Currency are substantial, but they come with significant risk as well, such as structural bank disintermediation and systemic failure due to insufficient technological infrastructure. If a central bank in an Emerging Market and Developing Economy designs a Central Bank Digital Currency well and addresses major limitations for making one, there will be substantial benefits to be gained from the endeavor.

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I. Introduction

The digital revolution has been a consistent driver of progress for humans for the past century. Thanks to the development of computers and smartphones, the digital revolution has reached all aspects of human life, from work to leisure to sports. The newest thing that is being digitalized is currencies. Initial digitalization of currencies has been in cryptocurrencies, which are either privately or collaboratively owned. Digital currencies issued from the central bank of a nation have primarily been experimental pilot programs so far, but a few countries have issued Central Bank Digital Currencies (CBDC) in a limited capacity. In section I this paper will discuss what CBDCs are, how they function, and the existing private cryptocurrency options available. There are some integral design considerations for countries when releasing a CBDC. The design of CBDCs will be explored in section II. Central Banks will need to determine what the purpose of the CBDC they are releasing is, which will instruct them in what type of CBDC they should develop. In section III this paper will discuss why developing a CBDC would be beneficial for Emerging Market and Developing Economies (EMDEs). An important benefit is that it would create new possibilities for different types of monetary policy and promote economic growth in the private sector. Additionally, a CBDC would be more efficient than cash management, and could significantly improve financial inclusion. If the technology was developed with interoperability and cross-border payments in mind, the costs of remittances and movement of capital internationally would be reduced. Despite the significant upside the development of a digital currency would provide a nation, there are still substantial concerns that must be addressed before implementation. In section IV this paper will discuss the limitations on development of a CBDC. Section IV will discuss how the main roles that retail banks fulfill in the current economy could become obsolete depending on the decisions a central bank makes

when creating and maintaining a digital currency. The loss of this historic purpose could cause harmful levels of structural bank disintermediation. A CBDC could be an incredibly beneficial new financial instrument for EMDEs, however, it is integral to its success that it is well designed and implemented with purpose.

II. Explanation of CBDCs

A digital currency or virtual currency is an alternative method of payment to cash, that is exclusively represented digitally. Digital currencies are generally made through an encrypted algorithm that employs blockchain technology. In 2008, "Satoshi Nakamoto proposed the encrypted digital currency Bitcoin", which was the "first fully distributed digital currency" (Zhang et al., 2021, 53589). As the "largest cryptocurrency by market capitalization at $1. 01 trillion" (Sim and Nicolle, 2021,1), Bitcoin has had a huge impact on the market as the market leader. In particular, its use of blockchain technology has popularized the technology and made it into an almost defining feature of current digital currencies. The basic "data structure" of blockchain is blocks, which contain a "block header which verifies the validity of the block" and contains "metadata which describes the block" (Raj et al., 2021, 24). An important distinction is the difference between tokens and coins. Coins have their own public network that anyone can join, and they fulfill all of the traditional roles of a currency (Bonpay, 2018, 1). Tokens are digital assets or represent some utility. Tokens can be private and can fulfill many roles such as smart contracts or representing a share in a business (Bonpay, 2018, 2). Coins are mined through computers solving incredibly complex algorithms. The price of many private digital currencies

is based in part, on supply of the coin. The supply of the coins depends on the complexity of the algorithms that must be solved to get them, and the technical capability of the people mining it. Blockchain networks are either peer-to-peer networks, for example Bitcoin, or they are structured modular networks that have multiple levels of nodes, which fulfill separate roles. Structured modular networks would be better for CBDCs because of their more diverse utility that would allow it to better satisfy the needs of a CBDC. Traditional digital currency systems use "unified wallet software as a node carrier" (Zhang et al., 2021, 53591), this software allows for interaction between users through transactions on a peer-to-peer basis. Nodes in this system generally fulfill many roles, but their primary roles are to maintain the "ledger database and receive digital currency rewards from local mining" (Zhang et al., 2021, 53591). Modular blockchain systems use alliance chains that are semi-centralized. Due to the semi-centralized nature of the modular design, the design of the "alliance chain is more flexible", which allows for a "faulty part [to] be repaired separately" (Zhang et al., 2021, 53591). Also, the modular design system allows for "repeated processing work" to be reduced, and "more resources are saved" due to the collaborative nature of the modular system (Zhang et al., 2021, 53591). The implementation of a central bank digital currency will probably utilize blockchain technology, and even seemingly insignificant design choices for the system could have dramatic effects on a nation's economy.

Private digital currencies have become so popular, that one has become the legal tender of a country. On September 7th, 2021, El Salvador became the first country to "adopt Bitcoin as a legal tender" (Nugent, 2021, 48). Taxes are payable in Bitcoin, and the law "obliges all businesses to accept it" as well (Nugent, 2021, 48). The decision to make Bitcoin into an official currency for El Salvador will have serious implications for their economy. El Salvador may

benefit from increased financial inclusion due to the ease of accessing the digital wallet of Bitcoin compared to the costly demands of providing physical private banking. To encourage the proliferation of use of Bitcoins throughout the economy, "$30 worth of Bitcoin" were distributed to every Salvadoran citizen (Nugent, 2021, 48). Despite this, "almost 70% of the population is still unbanked" and "86% of the businesses contacted said they had never conducted a transaction using Bitcoin" by March, 2022 (Brigida and Schwartz, 2022, 2). The economy of El Salvador will presumably benefit from increased foreign direct investment, since it is the first nation to adopt Bitcoin as legal tender. Also, the government has stated that it will "offer permanent residency to anyone who spends three Bitcoin" within the country, and people will not "have to pay capital-gains tax in the country on any profits made if the cryptocurrency's value increases" (Nugent, 2021, 50). El Salvador should see increased investment from savvy investors seeking to profit from the tax opportunities and innovative endeavors of El Salvador in this realm. However, adopting a private digital currency as legal tender is incredibly risky for a central bank. The Central Bank is giving up on the ability to take certain monetary policy actions that are impossible without complete control of a currency. The value of Bitcoin is very volatile, which could seriously harm the health of El Salvador's economy if the value of Bitcoin drops significantly. For example, in January 2022 the price of bitcoin fell almost 50%, which reduced "the value of the country's Bitcoin holdings by potentially tens of millions of dollars" (Brigida and Schwartz, 2022, 6). An especially concerning long term consideration for El Salvador's Bitcoin experiment, is that many countries are working on developing a CBDC. If those projects are successful, those countries may seek to regulate private digital currencies. If there is increased international regulation on private digital currencies, the value of Bitcoin will plummet, since investors will no longer be able to enjoy the freedom and financial benefits

Bitcoin provides and seek alternative investments. Adopting a private digital currency was a radical endeavor for El Salvador, and the long-term results of this choice are very uncertain. However, the enormous amount of control that a central bank gives up in such a scenario is inadvisable.

The value of private digital currencies is traditionally very volatile because the value of these coins is tied to the capabilities of the miners and investor sentiments. Traditional private digital currencies do not have their value tied to an asset or backed by the full faith and credit of a country. A safer alternative to cryptocurrencies are stablecoins. Stablecoins are private digital tokens that stabilize their value algorithmically with monetary policy or by pegging the value to a separate asset. Algorithmic stablecoins try to achieve "price stability with their own algorithmic monetary policy" (Chaum, 2021, 6). Adopting an algorithmic stablecoin would be an unattractive option for central banks because the value of their nation's currency would be subject to the goals of a private institution that may have very different objectives. The most attractive type of private digital tokens for a central bank would be an asset-based stablecoin. In particular, asset-based stablecoins that are pegged to a strong currency or other stable and successful asset would be most appealing. Despite the increased stability that an asset-based stablecoin can provide, it would not come without issues. An asset-based stablecoin is still privately owned, which would create conflicts of interest. Also, since stablecoins are provided virtually they are available to international investors. If there is an external shock to the digital currency, even if it isn't within the country adopting the stablecoin, the price could experience very high volatility. Private digital currencies are very interesting innovations that merit continued research into their value for the international financial markets, but for central banks

the lack of control they provide over their value would make it difficult to achieve specialized economic goals, such as inflation targets.

A central bank digital currency or CBDC is a virtual version of a country's currency that is legalized tender. Similar to cash or a government bond, a CBDC would be backed by the full faith and credit of the issuing central bank, which would make it almost risk-free. The notable success of cryptocurrencies such as Bitcoin, and virtual payment through credit cards or apps such as Venmo or Alibaba have been strong motivators for the development of a CBDC throughout the globe. The success of Bitcoin in facilitating efficient transactions in a digital format has driven a large part of the push for CBDCs as central banks seek to stay relevant as the world enters a new monetary era. Additionally, many countries are already seeing a significant decline in the use of cash, in part because of the increased use of credit and debit cards. Sweden in particular is rapidly becoming a cashless society, only "11% of Sweden's payments were made using cash" in 2021 (Alonso et al., 2020, 13). Additionally, the "amount of cash in circulation has been cut in half since 2007" in Sweden (Alonso et al., 2020,13). For Sweden, developing a CBDC is necessary for the government to mitigate the risks that would be present in a cashless society. Throughout the world, the use of debit or credit cards to pay through digital means has rapidly proliferated as the ease of those transactions has promoted their use. The efficiency of virtual payments alone will continuously push the development of virtual payment systems and CBDCs as access to smartphones expands.

The major differences between a CBDC and a cryptocurrency are due to the differing purpose of their offerings. Some of the defining aspects of cryptocurrencies are their anonymity and the lack of price regulation by a central organization. Due to the peer-to-peer network system that cryptocurrencies employ, their users enjoy a degree of anonymity that cannot be

found with card payments with traditional currencies. This anonymity is very attractive to investors that are seeking to avoid government oversight of their transactions. Unfortunately, this also means that criminals have started utilizing cryptocurrencies because of the anonymity they provide. On the other hand, one of the purposes of developing a CBDC would be to enable the government to track the use of its currency and collect metadata on consumer spending. Also, a central bank would certainly employ monetary policies to influence the price so it can constrain or grow the economy. Cryptocurrencies, on the other hand, would have no need to constrain their growth because they are also investment instruments, so an increase in value would only benefit people that possess it.

III. Design of CBDCs

The design choices that are made when creating a CBDC are integral to its success in achieving its intended goals. The first decision that must be made in creating a CBDC is deciding if it will be a wholesale CBDC or retail CBDC. Wholesale CBDCs are intended for exclusive use between financial institutions and the central bank. The purpose of Wholesale CBDCs is to facilitate the "settlement of large interbank payments or to provide central bank money to settle transactions of digital tokenized financial assets" (Boar and Wehrli, 2021, 4). Retail CBDCs on the other hand are meant for commercial use by the general populace in a similar capacity to traditional currencies. Wholesale CBDCs could be beneficial for a country, but the utility is limited and a retail CBDC has significantly more beneficial opportunities for the purpose of EMDEs.

The next challenge for providing a CBDC is determining how it will be provided to users. A central bank must decide whether or not it wants to set up its own system for users to store their CBDCs, or if they want to include private banks as intermediaries. A central bank may initially find the notion of having complete control over the system appealing, but attempting this would come with serious concerns. The first concern would be that central banks would not have any prior experience with the management of individual accounts. This lack of experience would make designing a comprehensive and secure system with relatively high user accessibility a costly and monumental task. The social systems and much of the technical infrastructure required to make a useable system has already been developed by private banks. Many private financial institutions already provide digital wallets that could operate similarly to how a digital wallet for a retail CBDC could work. An additional challenge that would result from a central bank solely operating the management of the account and distribution of the CBDC, is that it would lead to structural bank disintermediation. If people shift their cash to the CBDC and store it with the Central Bank instead of private banks, private banks would lose one of their primary traditional roles. The loss of this role could seriously harm the health of the private banking sector. If the private banking sector is not too robust, it would not be too problematic to exclude them. However, if private financial institutions are well established in the economy, including them in the account management process would be the least disruptive choice.

Private banks losing their role as the main holder of savings for the majority of citizens could significantly impact credit lending. Credit lending from banks currently, is allowed due to people and businesses and individuals storing funds with them. If a CBDC is designed to not include private banks, banks may start lending with higher down payment percentages, or at higher interest rates, or stop lending completely. The flexibility that credit lending from banks

provide is a key aspect of the success and growth that modern economies enjoy. Credit lending from private banks enables people to establish and grow small businesses that would struggle to solicit funds from other investors. If businesses cannot easily acquire funds for new ventures or to expand current ones, economic growth should substantially decline because it will be more difficult for them to react to market trends and fleeting opportunities. In addition to its impact on credit lending to businesses, the housing market could be significantly impacted as well. If home buyers are forced to fully fund any purchase with digital tokens, there will be far fewer purchases of homes because of the lack of ability to acquire the necessary funds and extend payments over long periods of time through mortgages. Instead of buying homes, people will be pushed into renting for longer, which will make it more difficult for them to save for a house. Structural bank disintermediation on a large scale would have a devastatingly disruptive effect on an economy with an extensive bank industry, but for EMDEs with less developed banking sectors the benefits could significantly outweigh the risks.

Another important design decision, is if the CBDCs will be held in accounts, or if it will be token based. This decision will determine how transactions are verified, and it has serious security implications. A token based CBDC would verify transactions through a "digital token that represents each CBDC unit" with a cryptographic key (Didenko and Buckley, 2021, 23). Token based CBDCs take the burden of verifying the identity of the users involved in the transaction off of the regulating body. With a token based system, anyone with access to the private key associated with the account can access the funds within it. The burden of security would rest solely on the individual or organization that possesses the key information. Contrary to a token based system, the burden of security primarily relies on identity verification from the central bank or its delegated representatives in an account based system. For an account based

system, the CBDC would be stored in an account that resembles a traditional bank account. An account based CBDC system would only be feasible if "strong identity verifications were in place" because of the importance of identity to ensuring security (Didenko and Buckley, 2021, 24). If the identity verification infrastructure is in place or relatively easily attainable it would be better to utilize the account based system because of the increased convenience that comes with storing the CBDC in a digital wallet. However, if it is not feasible to attain the required level of identity verification, then it is imperative that the token based system is used.

One of the key design features of a CBDC that is currently being discussed and explored in CBDC development projects is whether or not to integrate Distributed Ledger Technology (DLT). In a DLT based system, "multiple data storage points (nodes) are connected with each other and store all data simultaneously, and together constitute the common ledger" (Didenko and Buckley, 2021, 26). Transactions in a distributed ledger require consensus among multiple nodes of a consistent form of verification. There are various potential methods of verification among the nodes that could be utilized, one example of this would be a proof-of-authority system (PoA). A PoA system relies on the ability of the system to assess the reliability and reputation of identities. In a PoA system, there are "validators [that] add new data to the ledger" (Didenko and Buckley, 2021, 26), validators are determined based on the reputation of their identities. The successful facilitation of financial transactions determines the reputation and status of validators because the "identity of all validators is known" (Didenko and Buckley, 2021, 26). The benefits of using DLT is that these methods of verification provide substantial security benefits due to the increased checks on the authenticity of any transaction. Unfortunately, the increased security from DLT does come with a significant drawback. Verifying the authenticity of transactions takes time, and would "reduce overall transaction speeds compared to centralized systems"

(Didenko and Buckley, 2021, 26). The reduced transaction speed from DLT would have a limited impact in smaller economies with substantially fewer transactions, but it would increase the burden of identity verification as well, which may be difficult in and of itself for some EMDEs.

In contrast to DLT, a centralized system places the burden of verification on a consistent authority. A centralized system may be preferable for some central banks because of its simplicity, and the proven reliability of the system due to its current use by many private digital currencies. For centralized ledgers, "control is in the hands of a trusted administrator to make changes to the database" (Didenko and Buckley, 2021, 26). This does simplify the verification process for any transaction compared to a distributed ledger, but it is less safe because less rigorous tests would occur on transactions. The most important choice that a central bank must decide on in relation to utilizing DLT or not is what they want to prioritize more, transaction speed or security. There is no inherently wrong decision that could be made, but the larger the economy is, the greater the ramifications of slower transactions there will be. For smaller EMDEs, such as the many developing island nations, DLT would be the optimal decision because of the improved security of the system and the limited impact slower transaction speeds would have. Additionally, if it utilizes a structured modular network with two type of transaction verifications, some of the transaction speed issues could be resolved. If it is an account based system, it could be designed to not require as many verifications for account-to-account or smaller transactions, and only require more rigorous testing on transactions involving large sums, digital assets or smart contracts (Zhang et al., 2021, 53593). The design of a CBDC is one of the most important aspects of development of a CBDC. It is imperative that the decisions made during the design process reflect the primary goals and motivations for its

development. Central banks should not copy the design of another country's CBDC, instead they should assess the decision making process of other central banks that have implemented a CBDC and use their understanding from that process to design their CBDC with their own nation's objectives in mind.

IV. Motivations for Development of CBDCs

A very compelling reason for widespread use of a CBDC by the general public is the increased efficiency and the convenience that it would provide. The ability to instantaneously make and receive payments with the digital equivalent of cash would be incredibly beneficial for businesses and people. Use of CBDCs by a business could drastically improve parts of their financial statements and reduce time spent handling and accounting for cash. The reasons why many small businesses prefer that people purchase their products with cash instead of credit cards are that they do not receive payment immediately from credit card transactions, the bank the credit card is from will take a percentage fee of the transaction, and it is not guaranteed that the customer's account will have sufficient funds to cover the transaction. The delay in receiving payment results in a monetary loss for a business due to the concept of the present value of money. The present value of money means that a dollar today is more valuable than a dollar tomorrow because of the loss in reinvestment opportunity and inflation. The delay in receiving payment also creates accounts receivables and prevents the business from representing the transaction in the cash flow statement until the credit card company approves the payment. Reducing accounts receivable amounts would improve a business' cash conversion cycle

because their Days Sales Outstanding (DSO), which is calculated by dividing the accounts receivables balance by sales per day, would significantly decrease. The cash conversion cycle improving should add to the value of the company by improving their cash flow statement. The company would be more attractive to investors due to the reduced risk evident from the improved cash flow statement. Additionally, the costs associated with credit card transaction can be very substantial for businesses with high volumes of credit card transactions. The elimination of those costs would increase their profits per transaction, since the business would not have to pay intermediaries' fees. The ease of completing a transaction with a virtual payment is one of the key drivers of the widespread use of credit and debit cards and the growth of cryptocurrencies. Almost no one would choose to deal with the hassle of constantly counting change and wasting resources on protecting it if there was a convenient alternative. The ability to make credit-risk-free virtual payments would be an incredibly compelling motivator for the adoption of a CBDC for central banks because of the stimulus it should provide for the private sector of the economy.

An essential role of central banks is to maintain stable prices through monetary policy tools. Central banks influence monetary policy through three major tools which are open market operations (the fed funds rate), reserve requirements, and discount window lending. In the United States the primary tool of the Fed, open market operations, is conducted through "buying existing US Treasury securities in the secondary market" (Clark, 2017, 6). The purchase of those securities, "expands the reserve base and increases the ability of depository institutions to make loans and expand money and credit" (Clark, 2017, 6). When those securities are purchased, the Fed Funds rate in the market for overnight reserves will go down, stimulating the economy; when the Fed sells securities the Fed Funds rate goes up and slows the economy down. Central

banks can also manipulate the reserve requirements of other institutional banks. The Fed will "specify what portion of customer deposits… banks must hold as vault cash or in deposit at the Fed" (Clark, 2017, 7). Although this tool is "used rarely" (Clark, 2017, 7), it does have a significant impact on the liquidity of banks and is an important resource for a central bank. The Fed funds rate is the "target interest rate set by the Federal Open Market Committee" (Clark, 2017, 7), which is the rate at which banks borrow and lend reserve funds from each other overnight. Monetary policy tools have been essential for central banks across the world to navigate economic crises such as the Great Recession or the Covid-19 pandemic and promote healthy economic development within their respective country.

One of the most intriguing products of the development of a sovereign digital currency is that it would enable central banks to utilize new monetary policy tools. Innovation of a viable non-redundant new monetary tool to enrich a central banks metaphorical toolbox is incredibly difficult to develop, and it is even more difficult to garner support for its implementation. However, if a central bank agrees to develop one, the ability to determine the CBDC interest rate and quantity would be a practically guaranteed benefit. If a user's CBDC was held by the government in a digital account through an app or website, the central bank would have the capability to directly determine the quantity or price of the currency. This new monetary policy tool could "contribute to the stabilization of the business cycle" through active manipulation of the price by the central bank (Bindseil, 2019, 306). The ability to directly influence the value of the national currency should be particularly attractive to EMDE's that experience substantial amounts of currency volatility. Additionally, this may help limit the impact of currency speculation on volatility. Since the creation of derivatives for currency markets, increased trade volume and outsized speculation has drastically impacted volatility in EMDEs with weak

currencies. For example, in Mexico in the 1990s, "financial derivative had an increasing impact on the currency crises of Mexico" (Hayali, 2014, 1). Financial derivatives had an "immediate destabilizing effect on the volatility of the spot exchange rates" of their currency (Hayali, 2014, 1). Stabilization of the business cycle would be beneficial for the economy because it would not go through the traditional ups and downs of an economy and could instead maintain more stable and predictable growth. Another benefit of this new monetary instrument is that it would be an incredibly effective response to "shocks to private money demand and private money creation" (Bindseil, 2019, 307). A major goal of many economists is limiting the effect of shocks to the economy because as long as stability and efficiency is maintained the economy should grow. So, the more predictable the economy is the easier it will be for the government and corporations to efficiently allocate their resources because they will not have to be as concerned about a shock. The design and implementation of the CBDC would determine how a central bank would use the monetary policy, but it would be an incredibly effective new tool for central banks to influence the money supply and economy. Traditionally, central banks have maintained the ZLB due to the potential ramifications of exceeding it, and have used alternative methods such as quantitative easing to achieve similar monetary policy goals. However, if the amount of physical cash in circulation is decreased to an insignificant enough amount and digital cash in the form of a CBDC is held primarily in virtual accounts that the central bank can affect, then implementing negative interest rates would be feasible. The ability to implement negative interest rates would enable a central bank to provide "strong monetary stimulus in a sharp recession/financial crisis" (Bindseil, 2019, 306). In a financial crisis aid in the form of negative interest rates could help avoid "unemployment" and avoid the negative side effects of other "nonstandard monetary policy measures" (Bindseil, 2019, 306). Implementing monetary policy in this way would be

more intrusive and obvious than traditional tools of central banks, but ultimately it is only more direct and transparent than their common tools. Directly implementing negative interest rates in a physical cashless society would not have any greater economic impact than traditional tools, but it would be quicker and more directly felt by average citizens. Negative interest rates may be a very impactful tool for central banks in the future after the introduction of a CBDC, but it would require physical cash to be almost non-existent, which most countries are still years or decades away from.

In addition to enabling a central bank to more directly set interest rates, a CBDC may enable Central Banks to overcome the Zero Lower Bound (ZLB). The ZLB exists because if there are negative interest rates, the central bank would essentially be charging banks to hold reserves at the central bank (Dyson and Hodgson, 2021, 6). Negative interest rates may alter behavior from participants in this market. Banks may convert their reserves into cash instead of bearing the charge with the central bank. Also, they may "raise charges for running current accounts", which would incentivize the banks customers to then "hold their cash rather than leave it with their bank" (Dyson and Hodgson, 2021, 7). The common reason for a central bank to lower its interest rates is because the economy is or soon will be entering into a recession and the central bank wants to shift financing behaviors throughout the economy in order to stimulate growth in the economy.

Another potential tool that a CBDC would result from a CBDC is the ability to implement targeted subsidies. A targeted subsidy would allow a government to directly compensate citizens for taking certain actions. China has been using this feature of the pilot program of the digital yuan to compensate "local workers for transport" for the 2022 Winter Olympics (Muir, 2020, 2). The benefit of being able to do this is that the government does not

need to use indirect methods to incentivize this behavior, such as paying the workers' employer more for the work. Instead, they can efficiently subsidize the behavior by adding the money directly to a worker's digital wallet. The ability to implement targeted subsidies would be particularly helpful when an important industry in a country's economy is stagnating or declining. One sector that could benefit from this is the restaurant industry. In a situation where there is a rapid and drastic decline in sales at restaurants due to an external force, a targeted subsidy would be very beneficial. The best way to implement a targeted subsidy in this situation would be to compensate customers for purchasing from restaurants. Not only would the restaurants financially benefit from their increased sales volume, it would encourage and reward consumers for spending instead of saving their money. Additionally, the rise in transactions that would occur in this scenario due to reduced saving and increased transactions in the economy should raise GDP. A targeted subsidy is not only relevant or applicable to the restaurant industry, most industries including farming, transportation, or energy could all benefit from targeted subsidies if used correctly. The ability to use targeted subsidies is not something that would solely interest the governments that would be using them. Targeted subsidies should appeal to central banks as well despite them not being the ones actually implementing them because when done properly they would improve the economy. Central banks would not personally be able to utilize this tool to benefit the economy, but they should generally take actions to facilitate the ability of the government to use beneficial tools such as targeted subsidies.

In addition to improving the efficiency of employing monetary policy and facilitating domestic financial transactions, a CBDC designed with international applications in mind could promote significant growth in the private sector. In order to achieve that growth, it is necessary

that a system for improving the speed and ease of cross-border transactions is developed. Improving cross-border transfers and payments is important to maximize the rewards reaped from developing this capability. For countries that receive high levels of remittances from citizens living and working abroad, recipients of those remittances would experience significantly higher levels of financial security. Businesses with international dealings would benefit most from improved cross-border payments. Consumers may benefit from lower prices, but it would likely be to a lesser extent. Fiji and Somoa are prime examples of the benefits that could be gained from prioritizing the development of cross-border transaction capabilities in a CBDC for an EMDE. In Fiji, 23. 3% of adults have sent or received remittances, 39. 3% saved money at a formal institution, and 79. 5% were formally banked in 2020 (Didenko and Buckley, 2021, 10). Fiji would greatly benefit from a CBDC because the costs associated with the remittances people are sending and receiving would be significantly reduced. The reduced costs would increase the amount of funds that lower economic percentile groups have access to. This would enable them to spend more, which would stimulate the economy and improve quality of life factors. Additionally, some people may be able to save more due to the reduced costs, which would make them more resistant to costly uncontrollable events such as a medical issue in the family or natural disasters. Fiji is overall a good candidate for a CBDC as well because of the amount of financial inclusion they have. Since a majority of their adult population are formally banked, but less than half actually saved money at a formal institution, access to financial institutions is limited. The lack of entrenchment of the financial sector into the economy suggests that bank disintermediation should not be too high, and that there is still a significant need for further financial inclusion.

On the other hand, Somoa could benefit more from the development of a CBDC with cross-border payment capabilities included, but it may struggle more to effectively implement one. In Somoa, 58. 3% of adults sent or received remittances, 11. 1% saved money at a formal institution, and 39% were formally banked in 2020 (Didenko and Buckley, 2021, 10). 58. 3% sending or receiving remittances is a very high amount, and clearly demonstrates the necessity of limiting transaction fees for remittances as much as possible. For context, in 2020 remittances consisted of 25. 3% of Somoa's GDP; in Japan, which is a highly developed island nation, remittances were. 1% of GDP (The World Bank). Remittances have a pivotal role in Somoa's economy, and even small reductions in costs or efficiency could have substantial impacts on its economic development. Remittances have become even more important for Fiji and Somoa because of the Covid-19 pandemic. In 2020 alone, "transfers to Fiji and Somoa increase[ed] by as much as 400%" (Didenko and Buckley, 2021, 15), and that amount is likely to have increased even more in 2021 and 2022 as the pandemic has continued on. Reducing the costs of remittances would demonstrably be beneficial to the economy of Fiji or Samoa. Additionally, it would help them achieve some of their United Nations Sustainable Development Goals, such as the "elimination of remittance corridors with costs higher than 5 percent", and "reduction of transaction costs of migrant remittances to less than 3 percent" (Didenko and Buckley, 2021, 16). Somoa may have some difficulties developing a CBDC due to their current financial inclusion and access to banking being so limited, but if they could successfully launch one, the rewards that they could reap could revolutionize their economy.

For EMDEs with high geographic dispersion, in particular nations that are still developing their financial sector, the creation of a CBDC could stimulate rapid development of their financial sector. Countries with high geographic dispersion struggle to provide adequate

banking and financial services in the more rural regions of their countries because it is not profitable for banks to establish a physical presence in those regions. Private retail banks are ultimately profit-seeking businesses. So, even if they often help improve financial inclusion, they generally will not extend their services to regions that are not profitable or unstable to avoid losses. It is important that governing bodies and central banks undertake measures to increase financial inclusion for people the private sector is not willing to accommodate without incentive. Tunisia has "already started the process of digitizing its national currency" (Alonso et al., 2020, 5). There is a great demand for financial services in Tunisia with a reported interest from approximately "81% of the [population] interested in banking services, especially microcredit" (Alonso et al., 2020, 5). If Tunisia finishes developing their e-dinar, they could provide banking services to "2. 5 to 3. 5 million people… and 250,000 to 450,000 small businesses" (Alonso et al., 2020, 5). High geographic dispersion limits the access to traditional banking services that people have, which makes it difficult for them to manage their cash. A CBDC would eliminate this issue of storing and using cash as long as those people had access to the app or website that the currency was being stored and distributed on. Also, with their money stored securely in the cloud, it would be less risky for a bank or lending institution to provide financial services to these underserved individuals. In Africa, there is an essential need for increased banking. Africa has a banking rate that has historically been "less than 20%" (Alonso et al., 2020, 7), a CBDC could help permeate those poorer areas that banks are unwilling to physically enter. The expansion of the financial sector and its greater capacity to serve those people would rapidly aid the economic development of those regions. Financial inclusion would improve the "effectiveness of financial intermediaries by increasing the number of financial actors in the financial system" (Alonso et al., 2020, 7). On a macroeconomic scale, financial inclusion is

correlated with “growth, employment and poverty and, therefore, reduced inequality” (Alonso et al., 2020, 7). Access to smartphones would still be a barrier to entry in countries with high geographic dispersion and high poverty rates However, with the development of ever cheaper smartphone options and the permeation of older models throughout the world, this should not be too high a barrier of entry by the time a digital currency is distributed. Overcoming geographic dispersion and developing the financial sector is an incredibly persuasive motivator for developing countries.

The issues that geographic dispersion cause would not only be resolved in the long term, but also in the short term in regards to providing economic relief. Natural and non-natural disasters can cause situations in which physically providing economic aid is imperative, but very difficult and inefficient. In the wake of Hurricane Dorian and the issues that the Bahamas had providing financial relief to the many remote islands in its territory, the central bank of the Bahamas decided to rapidly develop its own retail CBDC. The Sand Dollar, the Bahamas’ CBDC, was the world’s first CBDC to be released. A large motivation for this decision was the logistical challenge of trying to provide physical cash as disaster relief to “more than 700 islands spread over 500 miles” (Adams, 2021, 6). The Sand Dollar will empower the government to directly deposit money into people’s accounts as a rapid form of disaster relief. This would drastically reduce the costs and time associated with flying cash to the many islands of the Bahamas. As part of their development of the CBDC, the central bank “built the infrastructure and technology to manage the Sand Dollar” (Adams, 2021, 7). In many ways the Bahamas were in an ideal situation to develop and release a CBDC. There was a significant need because of the high geographic dispersion and the serious need for increased financial inclusion. Additionally,

the government had the funds to finance the creation of the required infrastructure, and the banking system wasn't highly developed yet so bank disintermediation was not too high.

A recent example of the beneficial impact the ability to "helicopter drop" money would provide is evident from the Covid-19 stimulus bills in the United States, and the stimulus checks that were provided to American citizens. Approximately "70 million Americans were forced to wait for 30 days or more to receive their direct payments via paper check" (Demarco, Bernard, 2020, 1). In the modern age, where billions of dollars are being digitally transferred every single day, it is unacceptable in a highly developed economy that it took that long for people to receive financial relief. Wide distribution of a CBDC throughout an economy would have enabled the government to "helicopter drop" money almost instantly all throughout the country (Bindseil, 2019, 307). The ability to provide rapid financial relief should be particularly interesting to EMDEs, since the immaturity of their economy often means they are very susceptible to financial crises. CBDCs could become an important modern economic relief tool of the new era to deal with major shocks.

A necessary feature for a CBDC to replace physical cash is the ability to quickly and easily exchange it between individuals. There are already private companies, such as Venmo or Alipay, that are involved in this activity for cash, but there are costs involved in this for their users. Since these companies need to pay for the clearance of transactions, they charge customers for expedited transactions. In addition to actual monetary costs, there is time lost in the effective realization of transactions through these applications. Due to using these external middlemen to settle the transaction, there is a delay in accessing new funds from an individual's bank account. In order to truly reflect the capabilities of physical cash it is necessary that individuals are able to exchange the CBDC as seamlessly and efficiently as possible. There

should not be any delay in the realization of the transaction in either bank accounts other than the system's verification of the transaction, which should be a negligible amount of time. It is an unfortunate reality for those companies that this part of their business would become redundant, but a CBDC would not effectively compliment or replace physical cash without this feature.

Despite the potential losses in the private sector due to a CBDC capable of facilitating transactions between individuals, this capability should still be highly motivating for central banks. This would be motivating for central banks because it would help resolve one of the primary limitations of CBDCs. It will be discussed more further in the Limitations for Development of a CBDC section of the paper, but one of the primary limitations for CBDCs is motivating end-users to adopt the new currency. Even though it could bring convenience into people's lives, the adoption of the new currency will likely be a slow drawn out process as people hesitate to adapt to the new technology. Even radical measures such as distributing all government employee salaries in the new CBDC will have a limited effect on use of the CBDC. Improving the rate of end-user adoption is important because the benefits of a CBDC will be severely limited if only a small portion of the population is using it. The more people there are actively using and engaging with the CBDC, the greater the impact of it. The ability to make peer-to-peer transactions with a CBDC would be an effective motivator for those already using those services and individuals exploring the uses of a CBDC. Very small businesses and content creators may find this feature very attractive as setting up a payment system takes time and money. The ease of receiving payments through this will drive usage by these groups. The adoption of a CBDC with peer-to-peer payment capabilities may have some repercussions in the private sector if those companies fail to adapt. However, those negative consequences should be inconsequential for a central bank, and are justified by the increase in usage that would result.

One of the most controversial differences between a traditional cryptocurrency and a CBDC is the level of anonymity and the tracking of transactions. For cryptocurrencies such as Bitcoin, one of their more attractive characteristics for many investors is the anonymity that users enjoy. Through the use of blockchain technology, the identity of Bitcoin users is almost fully protected. Anonymity to that degree would be impractical, if not completely unfeasible for a digital currency controlled by a central bank. Since Bitcoin is not controlled by any central organization, there is no overarching entity that can be held responsible for illegal transactions conducted with the currency. The lack of accountability for those illegal actions disincentivizes the community in control of Bitcoin to take measures to reduce those actions and reduce the privacy that they enjoy. On the other side of the spectrum, central banks would prefer to track as much user data as users would be willing to put up with. Monitoring user data would serve two main purposes for a central bank, it would inform monetary policy and economic research, and help combat fraud and money laundering. Tracking data would allow the central bank to compile vast amounts of aggregate data on consumer spending habits. The abundant data available would make it possible for the central bank and the government to specialize their monetary and fiscal policies to stimulate economic growth. As a sovereign nation's official currency, it would be important that transactions conducted with it could be monitored to prevent fraud. Depending on its design a CBDC could be relatively anonymous, but that would ultimately be up to the government and central bank issuing the currency.

Another reason for central banks in EMDEs with less secure private banking sectors would be enabling individuals to store their money risk-free. A CBDC would be issued by a bank and therefore be backed by the full faith and credit of the government just like traditional currency or Treasury bonds, a CBDC would be effectively risk-free. Storing their money in a

CBDC instead of in a bank would "for the first time in monetary history" make it possible "to pay and save in a credit-risk-free digital currency" (Viñuela, 200, 9). The inherent stability of the financial system as a whole would improve substantially because the risk of bank liabilities would no longer be relevant in terms of the money supply, since bank runs would no longer be an issue. This benefit does unfortunately coincide with losing the flexibility of bank credit, so a central bank will need to determine what is most important for their economy. The benefits of a credit-risk-free digital currency would be incredibly attractive to people in EMDE's countries because the security and continuity of their banks is not something that they can take for granted. A CBDC will be particularly effective in countries with inefficient banking systems and low financial inclusion. Not only would a CBDC avoid the risks of storing money at a private bank, but it would also avoid the risks of personally physically possessing cash on someone's person or in their house. Most people still keep cash in their wallet as they go about their day, and in situations where accessing a bank is difficult people will hold onto their savings within their homes. This is a very insecure way of possessing their personal funds, and leaves people very exposed to theft. If those people converted their cash to a CBDC, the only security concern they would have to deal with is preventing people from accessing their digital wallet. However, as long as any virtual theft is not due to actions of the individual, the burden of account security lies on whatever entity is maintaining the digital wallet system. The essentially risk-free nature of a CBDC would be a motivation for end-users to adopt it quicker. Since, reducing the time it takes for its use to spread so the benefits of it are realized faster should be a goal in implementation of a CBDC for a central bank, the risk-free nature would be a motivation for the central bank as well.

A couple areas that a CBDC would improve that are not strictly under the objective of a central bank, but important nonetheless, are its benefits for public health and the environment. The virtual nature of a CBDC means that there is no direct physical contact required for any exchanges of the currency to occur. The constant handling and exchange of physical cash means that it rapidly gets dirty, and often is exposed to people that are sick with transmissible diseases. From a public health standpoint, reducing people's exposure to these potentially harmful substances would be incredibly beneficial. Also, it is becoming increasingly evident that global pandemics are a serious concern currently due to the Covid-19 pandemic and increasing global population density rates. The risk of spreading disease through physical exchanges of cash is something that can be limited with minimal negative consequences, so it would be irrational to not pursue it.

A CBDC would be much better for the environment than physical cash or private digital currencies. Physical cash needs to be produced, which creates industrial waste and pollution. Since a CBDC is just a record on a digital ledger, the only physical pollution from its creation is the minute amount of energy it would take to record it in the ledger. Although private digital currencies are created virtually as well, there creation process is far more complex and polluting. Generally, individual tokens of a cryptocurrency are created by mining it through the solving of incredibly difficult series of algorithms by computers. The estimated energy consumption for Bitcoin alone was 115 terawatt-hours in 2020 (Aratani, 2021, 1). The amount of pollution that energy consumption on this scale produces is immense, and could have serious negative ramifications for the global climate crisis. CBDCs on the other hand do not need to be mined to be created, so they would be an ideal substitute for facilitating transactions compared to private digital currencies. Improving public health and the environment are not goals that fall under the

traditional scope or objectives of a central bank, however, a central bank would be remiss to ignore the externalities of a CBDC in decisions regarding development and implementation.

Greater access to financial services and traditional banking services would be a very important motivator for Central banks that have populations with access to the prerequisite technology, but not those services. As previously discussed there is a massive emerging market for those services in Africa and developing island nations. Access to those services would enable people in underserved areas to save some of their income and make investments in the economic development of their businesses or towns. People would be able to maintain healthier and more secure lifestyles by spending money on more elective goods that would help improve their overall quality of life. Another benefit access to digital banking would provide for areas with high geographic dispersion, is that people would not have to take time out of their incredibly busy schedules to travel to a bank.

V. Limitations for Development of CBDCs

When assessing the viability of a new currency, it is integral that major concerns are addressed before progressing into the development stage. A major concern in regards to the distribution of a CBDC is the impact it will have on the retail banking industry and other forms of currencies. Structural bank disintermediation should be a serious concern for any central government when considering development because the retail banking industry could be completely changed if one of its major roles at the moment is removed. Structural bank disintermediation would occur when on an industry-wide scale banks' consumers started

withdrawing funds to reinvest elsewhere. Whether structural bank disintermediation is a good or bad thing is dependent on one's stance, but some "advocates of sovereign money see bank disintermediation as precisely the goal of CBDC" (Bindseil, 2019, 312). Bank disintermediation would occur if people saw the central bank as a safer place to store their money than traditional banks. Thus if households could "substitute commercial bank deposits with CBDC" (Bindseil, 2019, 313), banks would face a funding loss and disintermediation. Another issue that may arise if bank disintermediation occurs is "the central bank would benefit from an unfair advantage in deposit collection and amass undue power and market share" (Bindseil, 2019, 313). With such an unfair advantage over traditional banks, the central banks would be tempted to abuse their regulatory powers to further strengthen their influence. Also, if the central bank is in such an unbalanced position in regards to deposits, there would be an issue of inefficient credit allocation that would arise. There would be inefficient credit allocation due to the shifting roles of banks and the lack of interest the central bank would have in the provision of credit. It is important that a central bank undertakes measures to limit wide-scale bank disintermediation because of the destabilizing effect that would occur from it. A max exodus of funding from banks could inspire a wave of bank runs that would only serve to put more pressure on the banks, and may even cause a recession if the bank runs become systemic.

A major concern for central banks of EMDEs when deciding to develop a CBDC or not will be whether or not their country has the necessary infrastructure to justify creating one. The main infrastructure issues will be banking infrastructure, identification infrastructure, and technological infrastructure. Assessing whether or not they have the necessary retail banking infrastructure in place already is a very complex issues. Part of what makes this difficult is, that as discussed earlier, if the retail banking industry is already too entrenched into the economy

there may be very high levels of bank disintermediation. On the other hand, it would be easiest for a CBDC to utilize preexisting digital wallet systems through retail banks, as opposed to the central bank having to create an entirely new system itself. This is the method that the Bahamas used when creating their Sand Dollar, but for an economy with a highly developed financial sector this would be more disruptive than productive. For many EMDEs, increasing financial inclusion will be one of their primary goals for developing a CBDC, so they are unlikely to have a well-established retail banking industry. However, designing an entire digital wallet system would be costly and time-consuming so it would be best if there is some framework and infrastructure already in-place for them to build off of.

Identity verification is one of the key barriers to the success of a CBDC. Without a robust and reliable system of identity verification, developing an effective CBDC would be unfeasible. In the Pacific Island Countries (PIC) in particular, a serious issue is that there are vast portions of their populations that do not possess any formal form of identification (Didenko and Buckley, 2021, 15). For example, "it is estimated that 80% of the people of Papua New Guinea lack any clear form of identification" (Didenko and Buckley, 2021, 15). Without any way to verify such a high portion of the population, it would be impractical to attempt to implement a CBDC despite the need for the benefits it would provide. As part of the development of a CBDC, it would be reasonable for improving a country's national identification system to be part of that initiative. However, there are some issues with blindly pursuing that as part of the initiative. Attempting to provide new formal identification for a large portion of a country's population would be incredibly expensive. Also, such an endeavor would likely take a lot of time. It would especially be a slow process in countries with high geographic dispersion, which is very common in EMDEs. The issue of having a strong identity verification

system could be avoided to an extent through the use of a token based system instead of an account based system. However, a token based system puts a higher burden on individuals to maintain the security of their transactions. Wherever reasonable, it would be best to avoid relying on individuals to maintain their security because it leaves a lot of room for human error and malicious behaviors to detract from the safety and reliability of the system. The established national identification infrastructure of a country can be both a limitation and an opportunity for development of a CBDC, and it should be determined on a case-by-case basis whether or not it is an actual barrier to development.

Identity verification and security of the CBDC will be a major area of concern for any central bank looking to issue one. The security of the currency is a justified concern as well because blockchain is not an infallible technology. Despite blockchain providing high levels of security, there have been significant hacks recently that have resulted in vast amounts of money being stolen. For example, "$600 million in Ether [was] stolen from NFT Gaming Blockchain" in March, 2022 (Ponciano, 2022, 1). Additionally, $14 billion in cryptocurrencies was sent to "illicit cryptocurrency addresses" in 2021 (Ponciano, 2022, 2). These digital attacks are happening on banks as well, so it is not just cryptocurrencies that are facing these concerns. A digital currency does provide some inherent risk in the form of the potential for it to be hacked. If a central bank cannot provide a sufficient level of security for their currency, people will lose trust in the currency and the value may plummet. Providing necessary security and reimbursing users when there are breaches would be a large ongoing expense. It is important that this cost is accounted for when planning the CBDC because major security failures could have irreparable effects on the value of the currency and their economy.

Technological infrastructure could easily be the biggest or smallest infrastructure concern for a central bank. Parts of the technological infrastructure that are necessary for the success of a CBDC is access to smartphones, cellular or internet network availability, and electricity. CBDCs are dependent on its users readily having access to this infrastructure because without it consumers would be better off using physical cash that does not have these technological barriers to use. The penetration of smartphones into the market is important because the "level of cryptography involved" and the "need for greater accessibility of mobile wallets" necessitates their use for CBDCs (Didenko and Buckley, 2021, 36). Smartphone proliferation and use is something that would be incredibly difficult for a central bank to address. Theoretically their government could purchase and distribute smartphones to every citizen, but this would be incredibly expensive and a lack of participation from individuals that want to limit the government's influence on their personal life. Providing electricity, and cellular or internet connection is significantly easier for a government to influence, but they are still substantial barriers in less developed countries. The issue of providing electricity is very prevalent in the PICs where "more than eight million people… have no electricity supply, and access to electricity is lowest in high-population countries" (Didenko and Buckley, 2021, 6). Providing electricity to a majority of the population in countries such as the PICs will be very challenging because of their high geographic dispersion, environmental and geographical barriers, and efforts from environmental groups to prevent the creation of this infrastructure. Natural barriers such as dense forests or particularly mountainous regions could make it very costly and difficult to create adequate electricity infrastructure. Additionally, activists concerned about the impact of developing this infrastructure on the environment or the beauty of the land may take measures to prevent or limit development. The issue of providing internet or cellular connection runs into

very similar problems as electricity. However, there may be more external support for improving internet access because it would be beneficial for large international corporations if more people could access their products. If the expenses could be justified to one or a group of these companies, they may fund the development along with the government. As long as enough of the population has access to electricity and can connect to the internet, then those issues can be ignored, but if it is a substantial amount then it would need to be addressed before development could continue. Adequate technological infrastructure is an absolute condition for the success of a CBDC, but is also one of the most difficult issues to quickly address if it is an issue.

A potentially major limitation for a central bank when choosing to develop a CBDC is concerns over end-user adoption and interest in a CBDC. End-user adoption of a CBDC is important because a CBDC has the potential to be disruptive to the economy, and without enough participation in the CBDC it will be difficult to justify bearing that risk. One reason that people may not decide to use the national currency is a lack of faith in the government. For example, in 2017 the Venezuelan president Maduro created a state cryptocurrency called the Pietro (Alonso et al., 2020, 15). However, there is now "broad consensus that the Pietro is failing because there is no confidence in the government that supports the cryptocurrency" (Alonso et al., 2020, 15). Although the Pietro is not a CBDC, the lessons from its failure are still important to consider when developing a CBDC. Lack of confidence in the value of the currency is not the only reason end-users may not be interested in using a CBDC. In societies that have only recently developed, or are currently developing and still primarily rely on physical cash for transactions there would be substantially less interest. The governor of the South African Reserve Bank, while explaining why they were not actively developing a CBDC, said

that “millions of South Africans still depend on cash for daily transactions” and that “not everyone has Internet access or a digital wallet” (Alonso et al., 2020, 16). Their decision was based on the belief that there was not a need or desire for cashless transactions in South Africa, and that it would reduce financial inclusion instead of improving it. Lack of end-user interest could be problematic especially for the early success of a CBDC, but ultimately it should not be a major barrier for development. As long as the required infrastructure is in place for a CBDC, its use by citizens is inevitable if the central bank and government work together to proliferate it. Some steps that the government could take is using the CBDC for rewards programs, or compensating government employees with the CBDC. Additionally, the central bank could provide more favorable rates to retail banks that convert their cash holding into the CBDC. With the necessary infrastructure in place, use of a CBDC may rise slowly, but it should be relatively inevitable with enough effort.

The security of digital wallets in an important area for a central bank to address before implementation. If a central bank elects to cooperate with retail banks and store digital wallets with those banks, then most of the burden of preventing hacking or fraud would be on those banks. It would still be imperative for the central bank to conduct its own, or higher an independent firm, to test the security of those accounts. This would significantly limit the necessary spending for ensuring the security of accounts. A central bank could also design its own account-based system. Even ignoring the heavy costs of such an endeavor, this would put a lot of completely unnecessary liability on the central bank that could be avoided. In a token-based system, the central bank would need to ensure that the virtual ledger has sufficient security. Individuals that possess the tokens would need to protect their token’s key. This would increase security concerns because there would be no way to assess the identity of the individual

that has the token's key. It would be far easier for someone to get away with stealing the cryptographic key to a token over stealing account information. The amount of investment into security that is necessary to ensure the smooth operation of a CBDC in an economy would be highly dependent on the design choices made in its development.

VI. Conclusion

The literature analysis conducted throughout this paper suggests that the development of a well-designed CBDC by a central bank would have significant benefits for an EMDE. The issue of how to make a well-designed CBDC is discussed throughout the paper, but fundamentally relies on a central bank to make informed decisions based on the development and needs of their economy. Some key motivations identified were improved financial inclusion, economic growth in the private sector, and access to new monetary tools for the central bank. Important limiting factors on the development of a CBDC were structural bank disintermediation, having the necessary bank, identification and technological infrastructure, and ensuring a sufficient level of end-user adoption.

The implications of this paper are that central banks in EMDEs should seriously consider the development of a CBDC because the potential benefits are substantial. The issue of low financial inclusion is a consistent problem for EMDEs and a CBDC could greatly benefit this. Additionally, EMDEs that do not yet have the necessary infrastructure to successfully implement a CBDC, should target development adjectives that would facilitate the future development of a CBDC. The findings of the study strongly suggest that central banks of EMDEs should continue

researching and developing CBDCs because they could have massive positive or negative consequences for an economy.

A couple limitations of the study are that it is relatively broad in focus and it contains limited evidence of the impact of fully-implemented CBDCs. The broader nature of the literature analysis makes it an ideal starting point for a central bank or interested parties of EMDEs to structure and focus discussions on development of a CBDC. However, since it is broad, it is necessary that a central bank look elsewhere to determine the importance or relativeness of the questions the paper poses to them. Due to the limited number of fully-implemented CBDCs, there is limited material evidence of their impact on an economy, most research is theoretical. Therefore, some of the findings and conclusions made in this paper may not accurately reflect future discoveries.

The study addresses the benefits and concerns that arise for EMDEs when developing a CBDC. Other relevant areas of research would be whether or not highly developed economies should develop a CBDC. Many of the motivations for an EMDE to develop a CBDC are irrelevant for highly developed countries because those issues have already mostly been resolved. Also, some of the limitations, such as structural bank disintermediation, may have far greater implications in a more developed economy.

This study examined the motivations and limitations for development of a Central Bank Digital Currency in an Emerging Market and Developing Economy. It found that there were a few necessary design decisions that must be made prior to development, and that those decisions could help create or resolve problems in the implementation of a CBDC. The motivations identified provide a strong case for most EMDEs to pursue a CBDC because of the benefits that could be gained. Many of the key limitations on development could be avoided through design

choices, or can be utilized as development goals for future development of a CBDC. The decision on developing a CBDC is an important one, that central banks of EMDEs should address in the near future to avoid losing out on any benefits from the development of one. Future researchers should continue to assess the performance of active CBDCs and monitor trends in development among the world's central banks.

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