May 10, 2022

The Board of Governors of the Federal Reserve System
Attn: Digital Innovations
Washington DC 20551

Ladies and Gentlemen,

Herewith, please find our feedback to the publication of January 20, 2022, titled "Money and Payments: The U.S. Dollar in the Age of Digital Transformation".

Thank you for the opportunity to provide this feedback.

Sincerely,

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CBDC Benefits, Risks, and Policy Considerations

1. What additional potential benefits, policy considerations, or risks of a CBDC may exist that have not been raised in this paper?

A potential benefit not mentioned in this paper is the degree of competition the Federal Reserve could introduce into the financial services market through the introduction of a CBDC.

When the internet was commercialized more than forty years ago, there were hundreds of companies innovating and attempting to establish themselves to serve consumers. Over the years, we see a dramatic reduction in choices and concentration of market power among just a handful of companies: Microsoft vanquished companies like Netscape, WordPerfect, Lotus, etc. and effectively became a monopoly in many segments of the software industry. We are also, currently, witnessing this in the "internet search", as well as the oligopolies of mobile operating systems, cloud service providers, etc. The extraordinary concentrations of market power by some companies is not always due to superior products and services; evidence shows that some of these companies abused their monopolies in one product to require buying an unfavorable one from the company - a practice known as "bundling", while others simply violated anti-competitive laws.

If one has been paying attention to business practices of financial institutions over the years, as well as press releases from the Consumer Financial Protection Bureau (CFPB), it is apparent that financial institutions are not exempt from anti-competitive or illegal practices to appease their shareholders.

Through the introduction of a CBDC and a well-formed policy that supports regulated nonbank service providers, the Federal Reserve can preserve a competitive marketplace for the delivery of financial services. Forcing innovative software companies to partner with a regulated depository institution is a barrier to encouraging competition – especially when the software company might have better risk-mitigation technology than financial institutions. By defining policies and requirements by which service providers can enable retail transactions with CBDC in the regulated nonbank financial service industry (without the need to partner with a regulated depository institution), the Federal Reserve can bring many innovative and cost-effective solutions to the market.

Secondly, the U.S. is witnessing inflation rates unseen in four decades. As the Federal Reserve starts using tools it possesses to reduce inflationary pressures, it must wait – sometimes for months – to see if its deterrents are having any effect. Retail CBDC accounts that pay interest pegged to the rate of inflation, will be a powerful addition to the Federal Reserve's arsenal with the ability to provide minute-by-minute feedback on consumers' reactions.

A risk under-emphasized by this paper is that of the Federal Reserve *not* introducing a CBDC in light of countries like China having introduced one already, and more than 100 others – including US allies – exploring the introduction of a CBDC. The Russian-Ukrainian war has highlighted how sanctions imposed by western countries are causing a rise in transactions with "crypto currencies", with news reports indicating that some countries are negotiating the purchase of oil and commodities denominated in yuan and rubles. To the extent countries like China and others make their CBDCs easier to transact with, notwithstanding the US dollar's strengths, the perception of the US Dollar appearing "stodgy" could rob it of its unique position in the world. While having a US CBDC does not alleviate issues created by sanctions, not having one encourages the use of alternate digital currencies for financing transactions. A US CBDC that makes transacting in digital currencies easier will continue to keep the dollar preeminent in international transactions.

2. Could some or all of the potential benefits of a CBDC be better achieved in a different way?

Innovative technology – the internet, cheaper and faster computing devices, mobile communications, open-source software – created the impetus for digital transactions that enabled faster, cheaper and better access to financial services. However, some entrenched players continue to hold outsize market-share in some segments, while frequent Consumer Financial Protection Bureau (CFPB) press releases highlight actions of some of these companies

that cause consumer harm. Signs of intense lobbying to prevent the Federal Reserve from introducing a retail CBDC only serve to preserve such entrenched interests.

Some parts of the world are using legislation to break down walls entrenched interests have built around financial records that can aid consumers in getting better products and services from the market. The Second Payment Services Directive (PSD2) in the European Union and Consumer Data Rights (CDR) in Australia, for example are forcing banks to allow software companies who have the consent of consumers, to download financial data from the banks' databases and compete with the banks to provide better products and services. While the U.S. has no such "open banking" regulation, some software companies are eagerly awaiting the CFPB's proposed rule for "Consumer Access to Financial Records", which hopes to open up the walls built by U.S. financial institutions. However, this is not enough.

Technology is enabling the creation of digital currency all over the world. While *public key cryptography* that enables transaction *authenticity*, *confidentiality* and *integrity* was introduced more than three decades ago, and the programmability of software data structures such as *linked lists* were known for more than sixty years, an innovative paper on blockchain combined elements of both technologies, while adding other capabilities, to solve certain technical problems in a unique manner. Blockchain gave rise to an explosion of investment – and speculation – around its capability. While the philosophical debate around blockchain is likely to continue for years to come, knowledgeable software companies can take advantage of this concept, combine it with traditional – and proven – data security capability to deliver innovative financial services to consumers at lower cost.

In a world where a coffee bean farmer in East Africa can communicate instantly with almost any wholesale or retail buyer in the world over the internet, it is archaic to force money to move through systems and infrastructure built for a different age. As responsive as the private sector is with the availability of products and services to serve such consumer needs in the digital age, the last few decades have provided the world sufficient evidence that the private sector can make decisions endangering the world politically, economically and financially when driven purely by the profit motive.

As well as existing products, services and financial technology have served the world in the past, anything short of a full-fledged retail CBDC from the Federal Reserve will serve to only handicap the CBDC's potential and to serve entrenched, and potentially, nefarious interests. The future demands better.

3. Could a CBDC affect financial inclusion? Would the net effect be positive or negative for inclusion?

Indeed, it could. The net effect would be positive if the following conditions were met:

1. CBDC must be legal tender;
2. USG agencies at all levels must enable support for CBDC to be received from, and disbursed to consumers where such transactions are appropriate;
3. The retail ecosystem should be encouraged to transact in CBDC through independent, royalty-free standards rather than technology-vendor driven associations. Mobile phone manufacturers should be given incentives to include such standards into their devices to enable rapid adoption. To the extent it is feasible, the Federal Reserve should coordinate the creation and deployment of such vendor-independent, royalty-free standards with other like-minded nations and the Bank of International Settlements (BIS) so CBDCs are not "balkanized";
4. The Federal Reserve should allow for the creation of regulated, non-depository service companies whose primary purpose is to enable transacting in CBDC – functioning much like payment processors in the credit-card industry - facilitating transactions without holding currency. Companies focusing on financial inclusion must be fast-tracked towards participating into this ecosystem as long as they meet security and privacy control requirements;
5. An identity policy and scheme must be defined and implemented to enable undocumented residents of the US to participate in the CBDC ecosystem. Even if they are not legally authorized to reside/work in the US, they are here. With an appropriate balance of policy, security, privacy and anti-money laundering (AML) controls, it is feasible to craft solutions that permit them to transact with CBDC without

exclusionary controls – or keeping them out of the digital age and subjecting them to usurious money-lenders in the analog ecosystem.

If any of these conditions cannot be satisfied, desired financial inclusion goals will remain unmet.

4. How might a U.S. CBDC affect the Federal Reserve's ability to effectively implement monetary policy in the pursuit of its maximum-employment and price-stability goals?

Maximum employment and price-stability is a function of many variables not exclusively under the control of the Federal Reserve. Interest rates and money supply are important determinants – but more depends on qualitative factors beyond the control of the Federal Reserve, such as:

- Access to education and training;
- A "level playing field" that ensures equal access to opportunity in many sectors;
- A reasonable safety-net that permits new entrepreneurs to take moderate risks with starting new businesses;
- USG agencies truly supporting small businesses rather than paying lip-service and buying from giant suppliers through small business resellers that add little value to the transaction.

Before the internet was invented, one could only envision the types of applications, tools and services that connectivity might foster. We have since learned that almost anything is possible once such an ecosystem is available and when creative minds develop new applications, tools and services.

A US retail CBDC is in the same place as the Advanced Research Projects Agency (ARPA) experiment with the *intergalactic computer network* was half a century ago: lots of promise and trepidation, but with limited ability to visualize the potential for positive change. Much as ARPA moved ahead to build the internet, the Federal Reserve should move ahead to create a retail CBDC. With appropriate privacy controls, macro-data generated from applications, tools and services that support the CBDC will provide the Federal Reserve with new tools that might better effect monetary policy. Nothing ventured, nothing gained.

5. How could a CBDC affect financial stability? Would the net effect be positive or negative for stability?

Any new form of money with the backing of the Federal Reserve is bound to create waves – not just in the US, but around the world.

Much as our ancestors evolved from using shells and beads, we must plan to evolve from paper and coin in the digital age. While many transactions appear to be digital in the current environment, much of the technology and infrastructure that underpins today's digital environment was created many decades ago. It does not have the end-to-end *authenticity*, *confidentiality* and *integrity* controls that are necessary to support a trustworthy store of value or a means of exchange. A truly trustworthy digital currency must be designed from the ground-up to serve the rest of the 21st century and beyond.

This is where a CBDC can help. It represents an opportunity to "reboot" digital payments to learn from our mistakes of the last few decades and create something better to serve humankind for the future. Notwithstanding the friction that exists within banking regulations and schemes across the world, the U.S. Dollar enjoys extraordinary trust everywhere. The world has taken note of the extraordinary wealth the internet has created for the U.S. While the internet may not have been primarily responsible for these economic benefits, the Gross Domestic Product (GDP) of the U.S. alone went from less than $4T to more than $20T in the last 40 years – the years the internet was commercialized and made available to the world.

Could the CBDC create such wealth for adopters around the world? It is too early to tell, but a few self-sufficient countries are not waiting to find out – they are plunging into it for better or for worse. The vast majority, however, are waiting for the U.S. to make its move. If any nation has the creativity, resources and regulatory framework to make a success of it, in the eyes of many nations, the U.S. does. Given the ubiquity of the internet, mobile devices,

availability of capable software technology, the U.S. has a once in a generational opportunity to create a framework that can bring more financial stability to the world – not just for the U.S. alone:

- In the hope that nations that "hitch their wagon" to the U.S. CBDC will see similar growth in GDP as the U.S. did with the internet, some countries will choose to align their financial regulatory frameworks more closely with the U.S. financial system;
- As a global, inter-operable CBDC ecosystem grows, authoritarian countries will find themselves increasingly isolated from the prosperity that will accrue to a rules-based ecosystem. While China will have the heft to build a CBDC ecosystem in conjunctions with other authoritarian nations, kleptocrats and despotic leaders, nonetheless, crave the imprimatur of the U.S. Dollar with their ill-gotten wealth; such individuals and nations will find themselves with fewer options in a financial ecosystem that is significantly tightened to support a U.S. CBDC;
- International trade will become easier and less expensive as more companies and individuals transact with the U.S. CBDC directly;
- Innovative software companies from all over the world will be encouraged to create products and services that interact with U.S. CBDC, thereby bringing innovation faster and cheaper to the world, rather than in regional pockets.

Might a U.S. CBDC create sufficient prosperity on earth that some of the problems we see currently evaporate? It is probable; however a half-hearted attempt that preserves inefficiencies of the current financial system will only exacerbate the divide from the "haves" and the "have nots". Only a "rebooted" digital payments infrastructure that builds *authenticity*, *confidentiality*, *integrity* and agility into its foundations will be able to deliver benefits the new ecosystem promises to deliver. CBDC represents that opportunity.

6. Could a CBDC adversely affect the financial sector? How might a CBDC affect the financial sector differently from stablecoins or other nonbank money?

It is important to acknowledge that failures within private money ecosystems caused the 2007-2008 global recession. But for taxpayer bailouts, the US might have fared worse consequences than it did. While policies enacted since then will (hopefully) mitigate a similar recurrence, the ecosystem needs invigoration that can prepare us for the rigors of the 21st century.

By offering a CBDC, the Federal Reserve can unleash a wave of innovation and competition that benefits consumers all over the world:

1. The velocity of money will increase, leading to consequential economic benefits for all. While most consumers and businesses currently have the ability to move money electronically, not only are the costs higher than they need be, but the more economically disadvantaged participants in the economy bear higher costs for those financial transactions. With a ubiquitous CBDC that can be transacted at lower costs, more people will be encouraged to use it – replacing cash, checks and/or money orders – that will increase the number of transactions;
2. New financial services will be spawned that benefit more consumers at lower costs. Large companies that invest in creating systems to manage financial products and services are encumbered with legacy products that are, sometimes, unable to evolve rapidly to changing market conditions and needs. Smaller companies with innovative ideas and solutions are hindered by their inability to access consumer financial data and/or connect to the Federal Reserve (since they are not depository institutions); this prevents them from bringing their innovation to serve the financial market. With access to retail CBDC through a transparent framework, companies that meet the Federal Reserve's regulatory requirements will be able to enabled to bring their innovation to market faster;
3. Global pandemics will cause milder economic disruptions to nations where CBDC exists. As rapidly as Congress passed legislation to distribute cash to individuals adversely affected by the recent pandemic's lockdown, the State of California alone lost more than $10 billion through fraud as it attempted to distribute money to unemployed Californians through the Employment Development Department (EDD). The Internal Revenue Service (IRS) also reported nearly $2 billion in fraud related activities in 2021 alone

from the pandemic relief funds. With a CBDC designed to operate on stronger and more secure infrastructure and applications, it is possible to not only distribute relief funds rapidly to registered and authorized retail CBDC accounts, but it is also possible to eliminate such fraud with appropriate technical security controls.

Undoubtedly, the introduction of CBDC will cause short-term disruptions to some incumbents since their applications are unlikely to have the most advanced security capability (*authenticity*, *confidentiality* and *integrity*) that eliminates/minimizes fraud. However, as ecosystems adapts to CBDC, with applications that have the appropriate security and privacy controls, we will see vast improvements in the financial sector.

CBDC offers a singular advantage that no stablecoin can offer – the full backing of USG, with a mandate to benefit all residents/citizens of the US. This alone may serve as a disincentive for private money speculation (who may presume that taxpayers can be counted on to bail them out because "banks are too big to fail"). With a retail CBDC backed by a Central Bank that will not fail, an alternative network for digital money will exist; as such, private money will bear the full risk of speculative investments without burdening taxpayers.

7. What tools could be considered to mitigate any adverse impact of CBDC on the financial sector? Would some of these tools diminish the potential benefits of a CBDC?

It is our opinion that the goal of the Federal Reserve should be to focus on the benefits that residents/citizens of the USA will derive from the introduction of CBDC, without regard for the adverse impact of CBDC on the financial sector. While the Federal Reserve must certainly make sufficient information available to adopt CBDC (as it is doing so with the FedNow Service), it is impractical to expect that every company and financial institution will do so. Some companies may simply choose not to adopt CBDC for a variety of reasons, while "rent seeking" and unethical institutions are bound to lose with the introduction of the CBDC. They is simply unavoidable as technology evolves. For those who cannot adopt CBDC for lack of resources, the Federal Reserve must focus on enabling the bottom 80% of institutions within the financial sector should be provided open-source tools, lower costs, incentives and support to adapt to the requirements of CBDC.

8. If cash usage declines, is it important to preserve the general public's access to a form of central bank money that can be used widely for payments?

Absolutely! We are witnessing a global phenomenon where consumers are seduced to eliminate the burden of carrying cash from their lives; but, this leaves them forever beholden to private companies for transactions. Given that private companies must primarily focus on shareholders rather than the general public, this can have disastrous consequences for society as cash eventually disappears from the economy. While electronic payment transactions are, indeed, more convenient for a majority of transactions, the Federal Reserve has an obligation to preserve the general public's ubiquitous access to a central bank electronic money so they may always have an alternative to private electronic payment services.

9. How might domestic and cross-border digital payments evolve in the absence of a U.S. CBDC?

Since the Bank of International Settlements (BIS) is already committed to Nexus, an instant cross-border payments infrastructure is a given. However, the goal of Nexus is to enable cross-border payment flows within existing payment infrastructures. While this will deliver cross-border payments within 60 seconds (if all goes well), it does not envision the possibility of new products and services that a U.S. CBDC might enable in an environment where multi-CBDC economies are available.

Before the internet was invented and commercialized, the world had a communications system that was "instant": Morse code, Telex communications, etc. When the internet came to be, early products and services merely transplanted existing communication applications and schemes to the internet to make it faster and cheaper. However, the richness of what the internet enables today took decades of innovations.

The same is true of CBDC. Not only must we introduce a retail U.S. CBDC, but we must also participate in efforts to foster multi-CBDC. We cannot imagine what will result two decades from today unless we unleash the creativity that it will engender.

10. How should decisions by other large economy nations to issue CBDCs influence the decision whether the United States should do so?

Given that the introduction of CBDC by China is the one that matters, it is paramount that the USA introduce a CBDC expediently. What is at stake is not the payments ecosystem or the preeminent position of the U.S. Dollar, but the very soul of democracy.

Based on events of the last two decades, it is evident that China will not transition to a democracy in the near future. However, its ability to surpass the USA as the world's largest economy is strengthened with the introduction of the Chinese CBDC (among other contributing factors). The moral, political and economic consequences of a bloc of authoritarian nations upstaging a bloc of democratic nations cannot be overstated. And, if the most powerful of authoritarian nations shows leadership in an important segment of the global economy, it has the potential to create the nexus for a new world order in which the U.S. may not play an influential role.

By creating an inter-operable retail CBDC, based on a governance model supported by like-minded democratic nations, the United States will continue to offer the world an alternative. Given the current strength and position of the U.S. Dollar, it is imperative that the U.S. not be left behind in this race for ideology.

11. Are there additional ways to manage potential risks associated with CBDC that were not raised in this paper?

Much as the creators of the internet could not foresee all its benefits and drawbacks before its inception, it is impossible to foresee everything with the introduction of a U.S. CBDC. However, important lessons can be learned from the failures of some parts of the internet - the Federal Reserve should put in safeguards from the outset to prevent similar mishaps. Specifically:

1. Notwithstanding the Internet Engineering Task Force (IETF) establishing royalty-free standards for establishing the *authenticity*, *confidentiality* and *integrity* of messages at the application layer nearly three decades ago – Secure Multi-purpose Internet Mail Extensions (S/MIME) – the vast majority of the internet ignored these standards even as the capability became ubiquitous within electronic mail messaging systems two decades ago.
   The Federal Reserve must mandate the use of technical standards that guarantee similar security controls within CBDC transactions – from end-to-end within applications – not just at the network layer as it is performed currently;

2. The vast majority of attacks to applications, systems and networks originate in the use of "shared secret" authentication schemes and protocols. Passwords, one-time passcodes (OTP), knowledge based authentication (KBA) are some examples of "shared secrets" which result in *scalable* attacks that compromise everybody when a single attack is successful.
   The IETF, once again, established royalty-free standards – X.509 Public Key Infrastructure Certificate – for the use of *passwordless* authentication based on *public key cryptography*, more than two decades ago. While deployed in some scale within government agencies, this capability is largely ignored in consumer facing applications even within banking and fintech sectors. This has resulted in more than 10,000 data-breaches with more than 11 billion sensitive data records compromised over this period.
   Newer protocols – Fast Identity Online (FIDO) – using *public key cryptography* have more recently become ubiquitous on all desktop/laptop and mobile platforms, and have been successfully demonstrated in multiple NIST National Cybersecurity Center of Excellence (NCCoE) projects as providing high-assurance authentication. Updated guidance from the Federal Financial Institutions Examination Council (FFIEC) in 2021, reference one such NIST NCCoE project – Multifactor Authenticator for e-Commerce - as an example of how to mitigate authentication risk for higher risk transactions with FIDO technology.
   The Federal Reserve must mandate the use passwordless authentication using public key cryptography for

all CBDC transactions; this will provide assurances that the single largest cause of data breaches is eliminated from CBDC infrastructure;

3. It is fashionable these days to assume the "cloud" provides an answer to all of one's information technology needs. However, it is our opinion that the "cloud" poses an enormous risk to something as critical as the CBDC infrastructure. Not only have attackers shown that Uber, Capital One, Twitch and many other companies can be completely compromised in the cloud, but the Bank of England's July 2021 Financial Stability Report identifies the cloud as presenting a risk to financial stability. The Governor of the Bank of England, Andrew Bailey, has gone on record that "secrecy" and "opacity" are prevalent in cloud deployments, and that cloud security is "of particular concern".

   While we believe that the cloud offers some capabilities that can be taken advantage of within information technology deployments, this must be done so with applications that have been designed from the ground-up to ensure sensitive data and transactions remain impervious to attacks in the cloud. The Federal Reserve must mandate that applications prove beyond reasonable doubt that sensitive data and transactions can never be compromised in a cloud.

12. How could a CBDC provide privacy to consumers without providing complete anonymity and facilitating illicit financial activity?

With the right balance of policy, procedures and technical controls, the Federal Reserve can balance the conflicting goals of consumer privacy with its objectives to prevent illicit financial activity. Specifically, the Federal Reserve can mandate that:

1. Participants are "on boarded" into the CBDC ecosystem only after specified "know your customer" (KYC) controls are satisfied;
2. Participant accounts (of the Sender/Payer) in the CBDC ledger are anonymized (through encryption and tokenization), while transactions involving those accounts remain publicly visible – particularly to the IRS and law-enforcement. Where details of specific transactions might leak the identity of participants, those details of transactions must also be anonymized;
3. Companies creating software facilitating CBDC transactions maintain a company-wide "transaction trail" of anonymized transactions that remains publicly visible;
4. Very small transactions – say, $20 or less – of a certain frequency within a defined period, may remain completely anonymous (for the Payer and Payee) if the policy chooses to support higher levels of privacy in the transaction trail. *It should be noted, however, even completely anonymous transactions might be traceable if the software facilitating such CBDC transactions adheres to KYC regulations with appropriate controls to prove compliance to such regulations;*
5. Companies creating software facilitating CBDC transactions are required to implement end-to-end security within the application software without having to rely upon network and system controls to provide that security. It would not be amiss for the Federal Reserve to require such software to be independently tested and certified to meet specific control requirements before being permitted to participate in the CBDC ecosystem;
6. When transactions need to be made visible to law enforcement and/or other regulatory authorities, this must be done through digitally signed warrants that are placed within the software company's transaction trail whose transactions are audited. Where necessary and justified, select details of the warrants may be anonymized; however, such anonymized search warrants must be subject to due process as prescribed in the Freedom of Information Act (FOIA).

13. How could a CBDC be designed to foster operational and cyber resiliency? What operational or cyber risks might be unavoidable?

While monetary and transition risks cannot be discounted, it is crucial to recognize that CBDC – unlike all other forms of money that preceded it – completely depends on computer technology to maintain the confidence of the general public. As such, the importance the Federal Reserve must accord to cyber risks cannot be overstated. The

technology industry has the distinction of being the only segment of the economy whose products and services are unregulated in the U.S. As a consequence, more than 10,000 publicly disclosed data-breaches have occurred in the US with more than 11 billion sensitive records disclosed. This is simply unacceptable!

While the answer to question #11 provides examples of mandates the Federal Reserve may specify to mitigate risk, given the significance of the CBDC initiative, it must go further and ensure that CBDC security supersede all other factors – especially "user experience" (aka UX) factors – when establishing the CBDC. To this end, the Federal Reserve should review Atlantic Council's Strategy Paper on "A Nonstate Strategy for Saving Cyberspace" and adopt elements of the specified strategy where appropriate. Additionally, this author has published an opinion on forbes.com titled "Disruptive Defenses are the Key to Preventing Data Breaches"; while the tactical measures specified in the article might appear daunting on the surface, based on more than two decades of work in cyber risk mitigation, this author advocates technologists to incorporate the specified measures into their applications as a "standard operating procedure".

14. Should a CBDC be legal tender?

Without a doubt!

CBDC Design

15. Should a CBDC pay interest? If so, why and how? If not, why not?

Yes, it should.

The U.S. is currently witnessing inflation rates unseen in four decades. Savers – especially, retired ones – are most affected as inflation eats into the value of their cash holdings. If the Federal Reserve had a tool to guarantee that savers' cash holdings are not devalued during inflationary times, it will incentivize consumers to hold cash leading to a reduction in inflationary pressures in the market. While private financial institutions could, technically, offer interest rates that were equal to, or better than inflation rates, they generally do not because they have neither an incentive nor a mandate to do so unless compelled by competitive forces. CBDC accounts that pay interest is a natural solution to this problem.

With Federal Reserve issued retail CBDC accounts, consumers can be paid interest on their CBDC holdings, pegged to the rate of inflation (adjusted at a frequency determined by Federal Reserve policy). As inflation rates move up or down, interest on CBDC can move commensurately. The higher the inflation rate, the greater the incentive for consumers to move their non-cash holdings to CBDC – thereby decreasing inflationary pressures in the market. This incentive will also work during recessionary periods should inflation rates become negative.

Secondly, the Federal Reserve will have the ability to receive "real-time" feedback automatically as it sees its holdings of CBDC go up or down depending on inflation rates in the market – it will not have to wait for weeks or months to learn if its inflation fighting tactics are having any effect on markets.

An approach for paying interest on CBDC is as follows:

1. Upon the creation of CBDC, the Federal Reserve creates a *CBDC* account within its ledger, similar to its *Cash* account;
2. It debits its *Cash* account by some chosen value – say 25% of its holdings – and credits its *CBDC* account with an equal amount of CBDC;
3. As consumers enroll for *Retail CBDC* (***rCBDC***) accounts and transfer their cash to their *rCBDC* account from external sources, consumers' *rCBDC* accounts are credited while their cash accounts are debited at

external sources. Commensurately, Federal Reserve's *Cash* account will be credited with consumers' transfers while its *CBDC* account is debited;
4. When interest accrues within consumers' *rCBDC* accounts, the Federal Reserve's *CBDC* account is debited, crediting consumers' *rCBDC* accounts when paid;
5. As the Federal Reserve's *CBDC* account dwindles, it continues to debit its *Cash* account and credit its *CBDC* account;
6. When increasing numbers of consumers enroll for *rCBDC* accounts, the Federal Reserve should see positions of its *Cash* and *CBDC* accounts change, eventually achieving a state of equilibrium within a narrow range reflecting the ebb and fall of demand for cash and CBDC;
7. Assuming rational investors, inflation rates should also achieve equilibrium barring adverse natural and political events.

Introducing *rCBDC* accounts and paying interest, pegged to the rate of inflation, would be the financial equivalent of shifting (no pun intended) from manual transmission controls to automatic transmission in automobiles – the speed of the vehicle (rate of inflation) automatically adjusts the gear (interest rate) at which the vehicle (economy) operates.

16. Should the amount of CBDC held by a single end-user be subject to quantity limits?

The introduction of a U.S. CBDC is bound to create some disruptions. Market participants will naturally want to observe how CBDC are received, and how the technical infrastructure will perform. Since the CBDC's primary function is to offer a cash-equivalent instrument to enable smoother and less expensive transactions (while enabling inclusion and being green), the Federal Reserve should, initially, limit the amount of CBDC held by single end-users to meet the instrument's primary goal. As markets adapt to CBDC, the Federal Reserve should increase quantity limits based on the performance and stability of the technical infrastructure.

It is not inconceivable that the amount of CBDC that can be held by a single consumer will become another tool in the Federal Reserve's arsenal to effect monetary policy. It would be natural to allow the Federal Reserve to vary this amount to effect monetary policy as it it does currently with interest rates.

17. What types of firms should serve as intermediaries for CBDC? What should be the role and regulatory structure for these intermediaries?

Any company that can meet and comply with the regulatory requirements of the CBDC initiative should be permitted to serve as intermediaries for CBDC. There is neither a monopoly on creativity nor competence, and the Federal Reserve as well as the U.S., will be best served with many participants choosing to serve different markets with their ingenuity.

Since non-depository institutions are unlikely to hold CBDC or have similar privileges as depository institutions, the Federal Reserve should create a different regulatory structure to govern non-depository institutions without compromising on security and privacy controls.

18. Should a CBDC have "offline" capabilities? If so, how might that be achieved?

Yes, it should. But, it need not be introduced on Day 1. Offline transactions will require many participants to adapt to different kinds of communication protocols. Depending on the devices that will choose to implement CBDC for online/offline transactions, the control requirements are likely to be different and this will require more time for adoption. It is recommended that the Federal Reserve adopt offline capabilities on a graduated deployment schedule to moderate expectations and disruptions to CBDC introduction.

19. Should a CBDC be designed to maximize ease of use and acceptance at the point of sale? If so, how?

Given the significance of a U.S. CBDC introduction, it will be prudent to set expectations to the market that security must take priority over convenience.

Despite some of the most advanced security technology being available for decades, private companies have persisted in using the weakest security and privacy controls within their applications, and are singularly responsible for the thousands of data breaches and billions of sensitive records being compromised. It does not matter if the company is a million, billion or a trillion dollar company: they have all been breached. This sorry state of the internet is simply because the vast majority of private companies have prioritized convenience over security.

When it comes to cybersecurity, it is our observed opinion that private companies respond to the stick more than the carrot. Consequently, if the Federal Reserve intends to build a stable and secure CBDC infrastructure for the long-term, it should stipulate strong security and privacy controls, and create the appropriate infrastructure to enforce those requirements.

20. How could a CBDC be designed to achieve transferability across multiple payment platforms? Would new technology or technical standards be needed?

CBDC represents a transition to a new ecosystem. Since almost every country is investigating an introduction of its own CBDC, it behooves the Federal Reserve to work with the BIS and establish global standards to facilitate interoperability. The standards must be open, royalty-free and available to anyone in the world – without cost – to implement.

New standards are definitely likely. However, there are many existing standards that can be updated to meet the challenge. Given that cryptography will play a central role in security CBDC, the design must incorporate algorithm agility and state-of-the-art security controls. In light of the data breaches of the last two decades, an abundance of caution is not unwelcome.

21. How might future technological innovations affect design and policy choices related to CBDC?

One cannot predict everything accurately in the technology world – everything is a matter of probability. As such, the Federal Reserve must make the assumption that principles and standards are the most important arbiters of success in an environment of continuous change. We have many tools in today's technological arsenal that can be applied to build a safe and secure technological ecosystem for CBDC; all that is required is the discipline to learn, adapt and apply the chosen principles/standards to craft the solution.

22. Are there additional design principles that should be considered? Are there tradeoffs around any of the identified design principles, especially in trying to achieve the potential benefits of a CBDC?

Software design, architecture and languages are like “hair styles of the geek world”. Every generation of software developers believes that the only viable technology to solve a specific problem is whatever is in fashion this year – and this is usually a function of the marketing messages of technology companies that invent a specific widget. As a consequence, we are at a point in technology history where we are living in software techno-babble. Senior executives responsible for delivery of information technology solutions are at the mercy of billion/trillion-dollar giants and have little understanding of what their application developers are doing. By the time, the company is in the news for the latest security breach, those programmers have long departed.

The Federal Reserve would be wise to emphasize its focus on principles and standards. And, build a regulatory environment with the resources to enforce those principles and standards.