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CURRENCY

Narrow banks and
fiat-backed digital coins

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DIGITIZATION

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Narrow banks and fiat-backed digital coins

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ABSTRACT

We outline a framework for issuing fiat-backed coins to a wide set of end-users. We show that a narrow bank is an important part of this framework, needed to increase circulation and acceptance of such coins. We argue that fiat-backed coins issued by a purpose-built narrow bank have considerable advantages compared to central bank digital cash, and can be used to achieve improved financial stability and solve some of the more vexing problems affecting financial infrastructure.

1. INTRODUCTION

This article describes the concept of a fiat-backed digital coin (FBDC) and marries it with the idea of a narrow bank (NB). It outlines an approach to increasing FBDC acceptability and circulation from a small set of initial sponsors to a much wider (but still limited) group of potential users, such as small- and medium-sized enterprises (SME) and individuals, via a purpose-built NB. In short, the idea is to apply distributed ledger technology (DLT) to give a new lease of life to the old NB concept, and to use a NB as a centerpiece (glue) at the heart of a digital ecosystem. When properly designed, a NB can be used for several related purposes including issuance of FBDC. While we describe the concept of a NB in detail below, it is worth mentioning that such a bank has (almost) perfectly matching assets and liabilities, so that it is impervious to market and liquidity risks. In a nutshell, on its asset side, a NB has only central bank cash, or short-term government obligations, while on its liability side it has deposits and equity. In the old days, the assets would be solely in gold, later on a combination of gold and paper money, and finally, in our time, the assets would predominantly be electronic balances on deposit with the central bank.

While the idea of a NB is not new, it is not clear if a truly NB had been ever built. Currently, almost all banks are fractional reserve in nature, and are engaged in maturity transformation by maintaining long-term assets and short-term liabilities, thus opening themselves to risks of potential runs and other hazards, up to and including default.

We share the view succinctly expressed by Aristotle: "But money has been introduced by convention as a kind of substitute for need or demand; and this is why we call it money (νομισμα), because its value is derived, not from nature, but from law (νομοζ), and can be altered or abolished at will" (Aristotle, The Nicomachean Ethics.) In view of this quote, we wish to design FBDC in a manner compliant with all applicable laws, including the know-your-customer (KYC) and anti-money-laundering (AML) requirements.

FBDC, being a digital currency, naturally resides on a purpose-built distributed ledger. By now, building a distributed ledger system, which can function without a central authority, is well understood. Bitcoin, first described by S. Nakamoto (2008) in the seminal white paper, inspired the creation of more than a thousand of other cryptocurrencies, all with various degree of novelty and utility (if any). By construction, these currencies are native tokens, residing on a blockchain, and, as such, can be controlled by the agreed-upon consensus mechanism among agents maintaining and operating such a distributed ledger. However, until now, attempts to make real-world assets, first and foremost, fiat currencies, to be properly incorporated into a blockchain have been unsuccessful.[1] Yet, without a satisfactory solution to this all-important problem, it is not possible to make blockchains a part of the mainstream payment infrastructure.

We argue that for a consortium of sponsors (such as large banks), who are satisfactorily vetted in advance and able to pass the KYC and AML requirements, a fiat currency can be digitized with the assistance of the corresponding central bank, who agrees to convert some of the participating banks' reserves into digital tokens on a one-to-one ratio. This is the approach taken by Clearmatics, a software company based in London.[2] However, for a larger group of potential users, including, in addition to the original consortium member banks, some non-banking financial institutions, as well as SMEs and, possibly, individuals, direct participation of the central bank becomes problematic. We propose a solution, which boils down to building a special-purpose NB, whose operations are streamlined and safeguarded as much as possible in order to limit operational risks. This bank will keep fiat currency submitted by the users and issue digital tokens in return. These tokens will circulate within the group of users in a fast and efficient manner by utilizing distributed ledger mechanism, thus creating native tokens convertible into fiat currency at will. We emphasize that operational risks are always present, but this is true not only for the setup we are proposing, but for ordinary cash and bank deposits too, and, in all probability, to a larger degree.

2. DISTRIBUTED LEDGERS AND CRYPTOCURRENCIES

2.1 Background

For decades, little or no attention was paid to the infrastructure supporting the internal workings of the financial ecosystem. As a result, this infrastructure dramatically fell behind the actual demands of the marketplace. This fact became completely obvious during the global financial crisis (GFC), which put enormous stresses on the transactional infrastructure and pushed it almost to the breaking point. Currently,

[1] Tether is a representative example of such an attempt.
[2] The lead author is a member of their advisory board.

financial infrastructure is centered around private centralized ledgers maintained by individual banks, which are reconciled through the central banks' ledgers [see, e.g., Norman et al. (2011)].

Although for centuries this system served finance reasonably well, it has always been plagued with numerous issues, related to both domestic and foreign transactions. In the current framework, even simple cash transfers (not to mention transactions involving securities) are slow and, under certain circumstances, risky.

In Figure 1 we show a typical domestic bank transaction between Alice and Bob who have accounts at two different banks.

In Figure 2 we show a typical cross-border transaction between Alice and Bob who have accounts at two different banks located in their respective countries.

Fortunately, remarkable technological breakthroughs – mostly related to cryptocurrencies, distributed ledgers, and related concepts – simultaneously focused attention of key decision-makers and technical experts on the glaring need for transforming the financial infrastructure, and, at the same time, indicated how such a transformation can be accomplished.

2. DISTRIBUTED LEDGER DESIGN

2.2.1 Public versus private ledgers

A distributed ledger can be designed along several lines. The key question is whether a distributed ledger is needed in the first place. If the answer is affirmative, then two other questions need to be answered: (A) should the ledger be made permissionless or permissioned, or, equivalently, public or private; and (B) who, and via which mechanism, maintains its integrity. We feel that the FBDC carrying ledger should be semi-permissioned, so that everyone should be able to join, but participants should be known to the NB at the very least when they exchange fiat currency for tokens and, conversely, when they exchange tokens for fiat currency. In the interim, the participants probably can retain anonymity, even though the exact degree of anonymity is open to debate. It is clear that participants' identities have to be anonymous to other users; however, lawful legal authorities, under limited and well-defined conditions, should be allowed to uncover the true identities of participants.

2.2.2 CONSENSUS MECHANISMS

Given that different actors, whose interests are not aligned, are participants of the distributed ecosystem, it is imperative to design a mechanism for achieving consensus among them. Such a mechanism has to be able to tolerate Byzantine faults, both intentional and unintentional, as discussed by Castro and Liskov (1999), Lamport et al. (1982), and many others.

So far, the most successful practically implemented consensus mechanism is based on the competitive proof of work (PoW) [see Nakamoto (2008)]. However, by its very nature, this mechanism consumes enormous amounts of energy and is not suitable for large-scale applications. Accordingly, other options, including proof of stake, proof of burn, proof of age, and random selection of validators, have to be considered [see, e.g., Buterin (2013), Micali (2016)].

Figure 1: A sketch of a transaction between Alice and Bob, in which Alice sends Bob U.S.$100

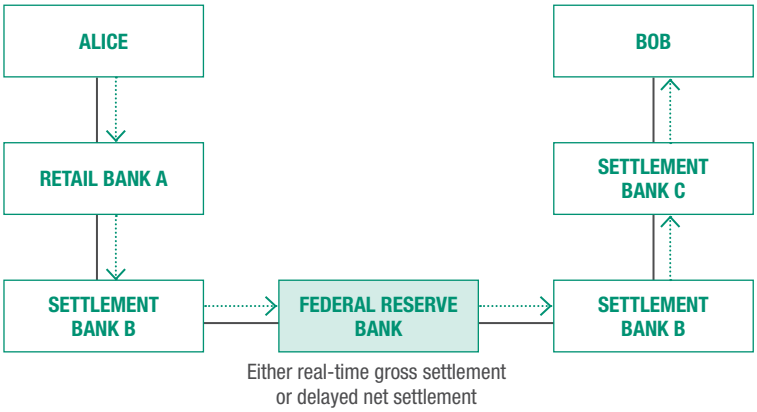


Figure 2: A sketch of a transaction between Alice and Bob, in which Alice sends Bob £100

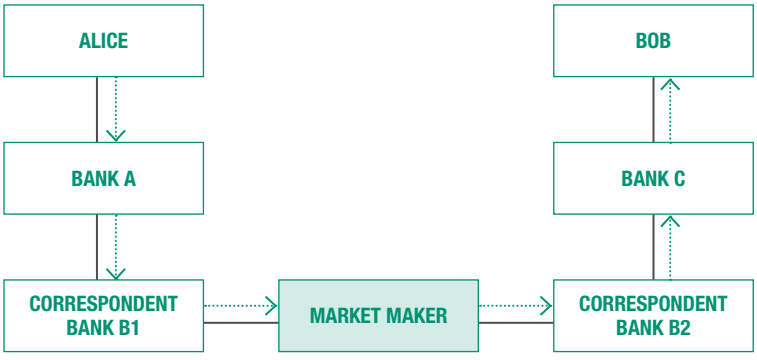
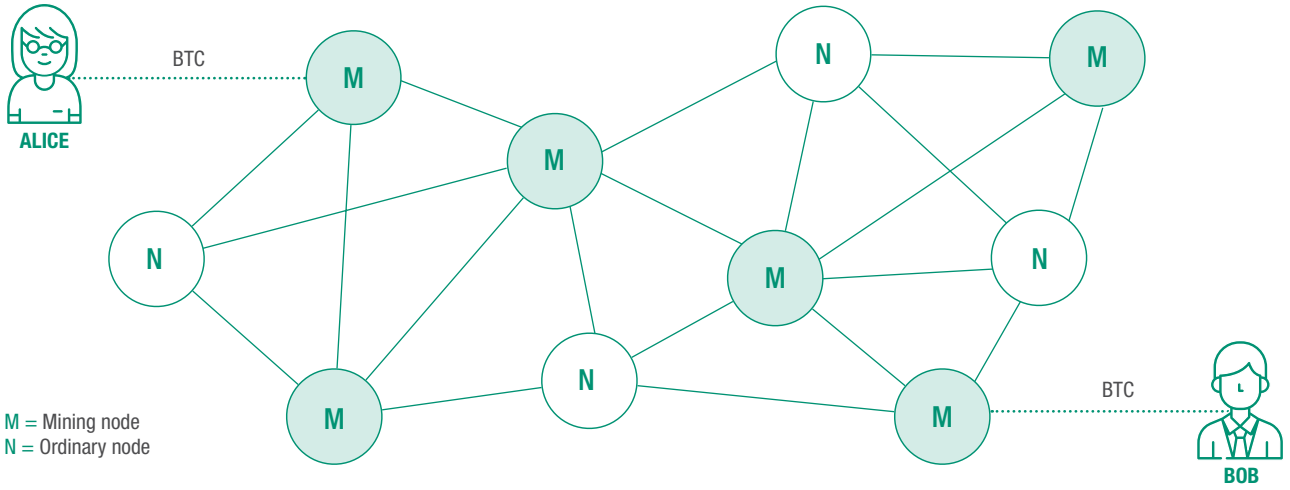


Figure 3: A sketch of a transaction between Alice and Bob, in which Alice sends Bob a BTC



For the large-scale applications, we are leaning toward using validators or notaries, running full nodes and verifying transactions along the lines of majority votes, as, for example, done in the Ripple protocol [Schwartz et al. (2014)].

2.3 Bitcoin setup

Recently, DLT attracted a lot of attention from both the industry and the general public. Astonishing success of Bitcoin demonstrates that a distributed ledger without central authority can function in a coherent and Byzantine fault tolerant fashion in real life. While very impressive from a technical standpoint, in its original form Bitcoin is not suitable for high finance. The reasons are simple – the system is pseudonymous, does not solve the all-important KYC and AML requirements, is not scalable by design as its throughput speed is no more than seven transactions-per-seconds (TpS), and consumes enormous amounts of electricity. Moreover, the volatility of Bitcoin is very high, which precludes it from being useful for transactional purposes, not to mention for lending and borrowing. Some observers even argue that the dominant raison d'être of Bitcoin is to facilitate illegal activities.[3] In addition, by construction, Bitcoin is a native token, which lives on the distributed ledger, while fiat currencies and other financial assets do not reside there. As a result, Bitcoin cannot solve the delivery versus payment (DvP) problem. While in theory it is easy to move Bitcoin from one address, represented by a public key to next, it is not possible at all to ensure the movement of currency, goods, and services in the opposite direction. Since there are no laws regulating these movements, the whole system is prone to all kind of malfeasance. In Figure 3 we show a typical transaction between Alice and Bob who have pseudonymous Bitcoin accounts identified by their public keys.[4]

2.4 FBDC setup

Having said that, Bitcoin setup can be used as a prototype for building a distributed ledger more suitable for interbank transactions and other financial purposes. Several issues need to be resolved before this goal can be achieved:

- The ledger has to be made at least semi-private (if not private) in order to meet KYC requirements.
- A right balance has to be struck between privacy and accountability in order to satisfy the AML requirements.
- An industrial strength and highly efficient method for maintaining consensus on the ledger, capable of handling hundreds, or even thousands, of TpS, needs to be designed.
- And, most importantly, a satisfactory method for solving DvP has to be found.[5]

[3] Given that records of Bitcoin transactions are preserved in perpetuity, it might not be as good as believed for such activities.

[4] In real life, even movements from native Bitcoin addresses are performed with assistance of digital currency exchanges, such as Coinbase, which is orthogonal to the very idea of decentralization.

[5] Here, FBDC is coming into play. FBDCs, being fully fiat-backed tokens, reside on the ledger; since they are backed by the fiat currency at a one-to-one ratio, the corresponding DvP problem is solved naturally.

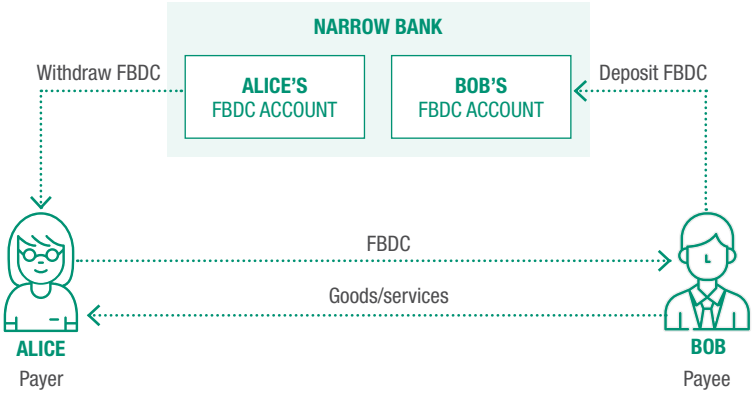
The validators (or notaries) responsible for the ledger integrity should be known in advance and licensed. They should be paid for their services a small fee, say a percentage of the transaction size they approve. This fee has to be denominated in FBDC, so that their interests and desires to maintain integrity of the ecosystem are properly aligned with their activities. In order to ensure Byzantine fault tolerance of the proposed setup, validators have to create their own versions of the ledger, and propose these to the rest of validators. Several rounds of voting take place until two-thirds majority is reached. In this regard, our approach is somewhat similar to the one used by Ripple [see Schwartz et al. (2014)], and can be viewed as a variation of the well-known Byzantine fault tolerant algorithms.

In order to provide an efficient and expedient transaction processing, individual notaries are assigned to particular subsets of all addresses. In this setup, a quorum verifies its portion of the ledger. And the full ledger is reconstructed out of these portions.

The only mechanism for injecting new coins in the distributed ledger is as follows. A participant has to have a conventional fiat account, either directly in the NB or with another commercial bank. They transfer the desired amount of fiat currency to the NB. The NB, in turn issues FBDC and transfers them from its public key address to the public key address provided by the participant. Thus, in effect, the participant becomes a shareholder in the NB rather than a depositor. Conversely, when a participant in the ledger wishes to receive fiat currency in exchange for their FBDCs, they transfer FBDCs from their public key to the public key of the bank, who, in turn, credit fiat currency either to the account on its own ledger or to a designated account in a different bank at a one-to-one ratio. Once a FBDC is born, it starts its journey from one address, represented by a public key, to the next. In this setup, the integrity of the distributed ledger is maintained by notaries.

In an alternative setup, coins are actually numbered and the list of numbers is maintained by the NB (although NB is unaware of which participant hold which number) in the blind-signature framework introduced by Chaum et al. (1990). Every time a coin changes hands, the new owner sends the number for checking by the NB, who compares it with the list of spent coins it maintains. If this particular coin has not been spent, it is retired, and a new coin with a new random number is issued to the designated owner. If the coin had been already spent, a transaction is rejected. The number is naturally blind-signed by the NB with its secret key, in order to prevent forgery and fraud.

Figure 4: A sketch of a transaction between Alice and Bob, in which Alice sends Bob 100 FBDCs



In Figure 4 we show a typical transaction between Alice and Bob, both having FBDC accounts.

We emphasize that the FBDC is a special case of the Digital Trade Coin (DTC), backed by a pool of real commodity assets, which is currently being developed at MIT, see Lipton and Pentland (2018) and Lipton et al. (2016).

3. ENTER A NARROW BANK

3.1 History

Modern banking originated in the High Middle Ages and blossomed during the Renaissance and the early modern period, mostly in the form of fractional reserve banking. From the beginning, fractional reserve banking firms were prone to collapse. For instance, in Florence the Bardi, Peruzzi, and Medici companies (to mention but a few) all failed.

Not surprisingly, the narrow banking idea was pursued by visionaries, financial reformers, and regulators for hundreds of years [see, e.g., Pennacchi (2012), Dittmer (2015), Roberds and Velde (2014), narrowbanking.org, and references therein]. From time to time, actual attempts to build a NB have been undertaken. For instance, in 1361 Venice's Senate prohibited lending out depositors' money, thus, in effect, making Venetian banks narrow. However, this prohibition was systematically circumvented, with associated bank failures to follow. In particular, the largest bank of

Pisano & Tiepolo failed in 1584, was converted into a state bank, and defaulted again in 1619. In 1609 the Bank of Amsterdam was chartered as an NB, but soon after started to lend its reserves in secret. As a result, in 1791 it failed and was taken over by the city.

Eventually banks, pursuing their own self-interests, became much more narrow than they were in the Renaissance, the early modern period, or are today. During the nineteenth century, British and American commercial banks followed the real bills doctrine and lent predominantly for short maturities. Bank loans mostly financed short-term working capital and provided trade credit, with maturities of two to three months, and were collateralized by borrower's personal wealth or the goods in transit [see Bodenhorn (2000) and Pennacchi (2012)].

In the twentieth century, however, encouraged by the creation of the Federal Reserve Bank in 1913, commercial banks drifted away from the real bills doctrine, started to lend for much longer maturities, established revolving lines of credit for some of their borrowers, and started to overemphasize their maturity transformation ability at the expense of prudence. The Great Depression of 1929 made banks' inability to meet their obligations successfully painfully obvious, which caused the idea of a NB to come to the fore.

In the U.K., NBs were advocated by Soddy (1926, 1933). In the U.S., a group of influential Chicago economists proposed a plan calling for the abolition of fractional reserve banks [see Knight et al. (1933), Hart (1935), Douglas et al. (1939), Fisher (1945)]. Their core proposals are summarized in Phillips (1996) as follows:

- Federal Reserve Banks should be owned by the government outright.
- Deposits of member banks should be completely guaranteed.
- Demands for payments by depositors should be satisfied by issuing Federal Reserve Notes as legal tender.
- The gold standard should be suspended.
- The assets of all member banks should be liquidated and all existing banks dissolved.
- New NBs accepting only demand deposits subject to 100% reserve requirement in cash and deposits with the Fed should be created.
- Investment trusts handling saving deposits should be created.
- Existing banking institutions should operate under Federal Reserve supervision until they are dissolved and new banks are created.

Although a practical conversion of fractional reserve banks into NBs was rejected in the forties under enormous political pressure from fractional reserve banks, the idea has always stayed close to the surface, and gained considerable momentum during and after the S&L crisis in the 1980s and 1990s [see, e.g., Friedman (1959), Tobin (1986), Litan (1987), Bryan (1991), Burnham (1991), Gorton and Pennacchi (1993), Huber and Robertson (2000), Kobayakawa and Nakamura (2000), Al-Jarhi (2004), Garcia et al. (2004)]. Not surprisingly, it became extremely popular again during and after the GFC [see, e.g., Kay (2010), Kotlikoff (2010), Phillips and Roselli (2011), Benes and Kumhof (2012), Chamley et al. (2012), Pennacchi (2012), van Dixhoorn (2013), Admati and Hellwig (2014), Cochrane (2014), Dittmer (2015), Garratt et al. (2015), McMillan (2015)].

3.2 A bank that cannot default

The main characteristic of a NB is its assets mix, which includes solely marketable low-risk securities and central bank cash in the amount exceeding its deposit base. As a result, such a bank can only be affected by operational failures, which can be minimized, but not eliminated, by using state-of-the-art technology, thus providing a maximally safe payment system. Accordingly, NB deposits would be equivalent to currency, thus abolishing the need for deposit insurance with all its perverse effects on the system as a whole, not to mention the associated moral hazards.

It is clear that the only way to keep a one-to-one parity between the fiat currency and digital tokens is to keep the exact amount of the fiat in escrow. However, you cannot put the requisite amount in a bank and expect it to be safe at all times, unless this bank is specially designed, or else you can open an account directly at the central bank. Indeed, bank depositors are junior unsecured creditors of a bank, so if the bank were to default, they cannot expect their deposits to stay intact. Even if a significant portion of these deposits can be recovered, the money will not be available until the bankruptcy issues are resolved, which can take a very long time. At the same time, a central bank, while happy to accommodate licensed banking institutions and a small selected group of trusted non-banking financial firms, such as central clearing counterparties,

cannot, and will not, allow a wider range of corporate or individual participants (particularly, if they wish to be anonymous) to have account with them. This is for a variety of reasons, including, but not limited to, being unable to solve the KYC/AML problem, not to mention potential political complications.

Thus, we need to build a bank, which cannot default, at least due to market and liquidity risks. One needs to be cognizant of the fact that, regardless of the amount of effort, it is not possible to build a bank impervious to operational risks, although proper design can minimize them to an acceptable degree.

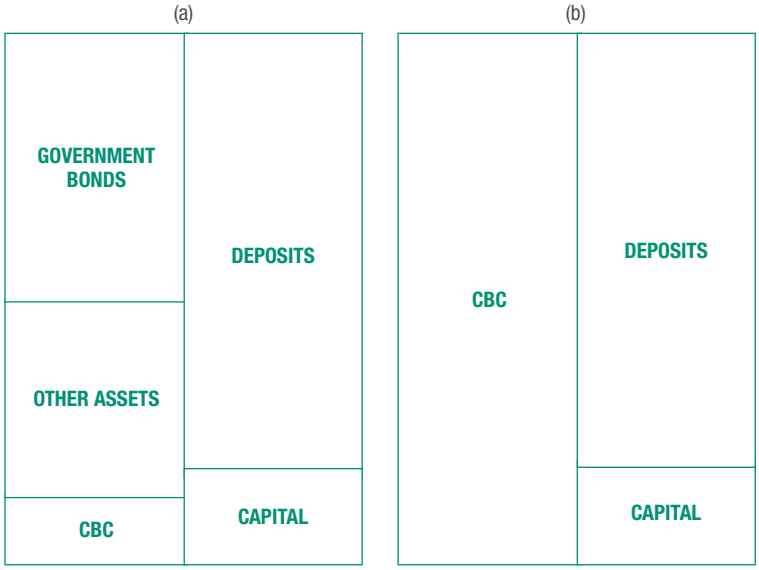
3.3 Types of NBs

Several approaches for designing a NB have been summarized in Pennacchi (2012):

- 100 percent reserve bank (C-PeRB): Assets – central bank reserves and currency; liabilities – demandable deposits and shareholder equity. Depending on the circumstances, these deposits can be either noninterest-bearing, or interest paying, or interest charging. The latter set-up might be necessary if interest rate paid by central bank is negative. C-PeRB is financed by a combination of deposits (debt) and shareholders' equity.
- Treasury money market mutual fund (TMMMF): Assets – Treasury bills or repurchase agreements collateralized by Treasury bills; liabilities – demandable equity shares having a proportional claim on the assets. TMMMF is financed solely by equity.
- Prime money market mutual fund (PMMMF): Assets – short term Federal agency securities, short-term bank certificates of deposits, bankers' acceptances, highly rated commercial paper, and repurchase agreements backed by low-risk collateral; liabilities – demandable equity shares having a proportional claim on the assets. As before, PMMMF is financed solely by equity.
- Collateralized demand deposit bank (CDDB): Assets – low-credit- and interest-rate-risk money market instruments, which are fully (over)-collateralized; liabilities – demandable deposits that have a secured claim on the collateral.
- Utility bank (UB): UB is similar to a CDDB, except for the fact that collateral can include retail loans in addition to money market instruments;

Putting aside operational risks inherent in the banking business, the reliability of a NB varies from completely stable (C-PeRB), to stable under most plausible circumstances (UB).

Figure 5: Balance sheets of a fractional reserve bank and an NB



The difference between balance sheets of a fractional reserve bank and a NB is shown in Figure 5.

3.4 The time for a NB is now

Whilst running a NB is relatively easy from a market perspective, and the required capital for doing so is comparatively small (under current Basel regulations its size is determined by leverage alone), it naturally has to possess bullet-proof security and reliability. These requirements can be met by judiciously building the corresponding ledger software and hardware. Of course, in addition to pure operational aspects, the NB has to satisfy the KYC/AML requirements. It is clear that a liberal usage of "artificial intelligence," "machine learning," and "big data analytics" is necessary to accomplish this task efficiently. In this regard, TRUST::DATA, a new framework for identity and data sharing currently being developed at MIT, is particularly promising [see Hardjono et al. (2016)].

There is a perennial question of profitability of a NB. Whilst a fractional reserve bank earns its living first and foremost via the "net interest margin" (NIM), i.e., the difference between the interest it charges its borrowers and interest it pays its depositors, a NB seemingly is deprived of this all important source income. However, this is only partially true, since at present some central banks, including the Federal Reserve, do pay substantial interest on excess deposits. Besides, NBs can earn interest on securities, charge reasonable fees

for transaction services, etc. While their operational margins are certainly low (by yesteryear standards), so are their capital requirements, operating costs (due to an efficient infrastructure), and regulatory burdens. Thus, NBs could generate competitive returns on equity, which are very favorably compared to the ones generated by their fractional reserve cousins. The quote from Friedman (1959) captures the essence of the problem: "I shall depart from the original 'Chicago Plan of Banking Reform' in only one respect, though one that I think is of great importance. I shall urge that interest be paid on the 100% reserves. This step will both improve the economic results yielded by the 100% reserve system, and, also, as a necessary consequence, render the system less subject to the difficulties of avoidance that were the bug-a-boo of the earlier proposals. ... This problem of how to set the rate of interest is another issue that I feel most uncertain about and that requires more attention than I have given to it."

If NBs in different jurisdictions organize themselves as a network of sister banks, they can earn substantial (but fair) transactional fees on foreign exchange transactions.

In principle, NBs can be affiliated with lending organizations with uninsured funding, the so-called lending affiliates. In view of this fact, lending facilities can be left to their own devices and be regulated by market forces.

It is clear that the adoption of narrow banking in its entirety would require a massive transformation of the financial ecosystem and should not be undertaken until numerous and nuanced questions dealing with the pros and cons of such a transformation are answered in sufficient detail. While we list some of the pros and cons below, we are interested in a less ambitious project – that is an introduction of an NB, which would coexist with fractional reserve banks, rather than supplant them completely. An interesting analogy jumps to mind – currently electric cars (NBs), coexist with conventional gasoline cars (fractional reserve banks). While in the long run electric cars are likely to prevail over gasoline cars, in the short run they can peacefully cohabit. In order to avoid academic discussions related to the transformation of the banking system from the fractional reserve to the narrow setup, we advocate creation of a few NBs as needed for achieving our specific goals. We anticipate coexistence of fractional reserve and NBs for a long time to come.

4. PROS AND CONS OF A NB

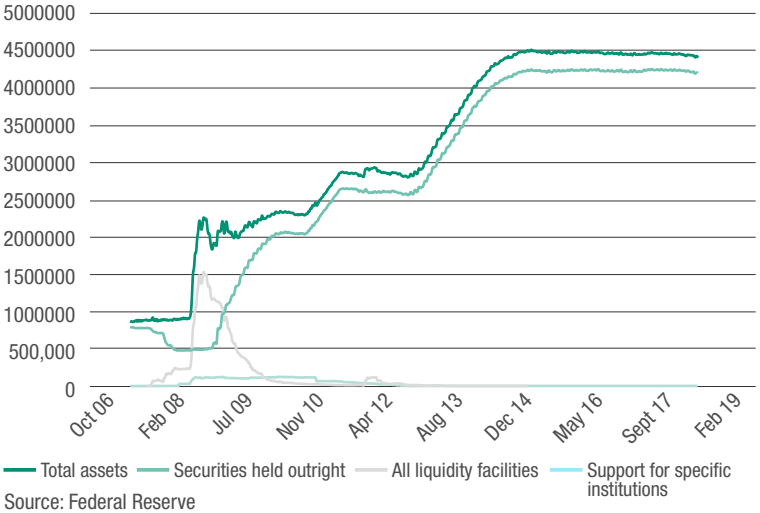
4.1 Pros

There are many leading economists who advocate narrow banking because some of its benefits are self-evident. First, by construction, and in contrast to fractional reserve banks, assets and liabilities of NBs are perfectly aligned, so that conventional stabilization mechanisms such as deposit insurance, discount window lending, rigorous regulation and control of balance sheet, without which fractional reserve banks cannot exist, are simply not necessary. We emphasize, however, that other types of regulation are certainly needed, not least because NBs, like any other organizations, are subject to operational risks, particularly from electronic attacks.

"Fortunately, remarkable technological breakthroughs – mostly related to cryptocurrencies, distributed ledgers, and related concepts – simultaneously focused attention of key decision-makers and technical experts on the glaring need for transforming the financial infrastructure, and, at the same time, indicated how such a transformation can be accomplished."

Second, since lending is performed by non-banking institutions on an uninsured basis, governmental interference in bank lending and other activities can

Figure 6: Assets of the Federal Reserve Bank



Source: Federal Reserve

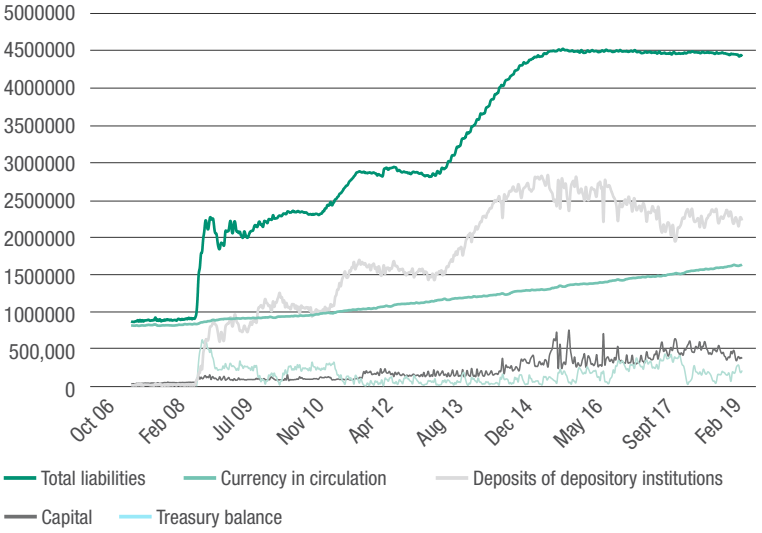
be dramatically reduced, if not completely eliminated. Third, deposit insurance can be reduced in size and eventually phased out.

4.2 Cons

Needless to say, narrow banking is not without its detractors. Some economists argue that NB will not be a silver bullet needed to kill financial instability, particularly because lending affiliates would suffer from the same issues as fractional reserve banks. Although it is true to some extent, it is clear that narrow banking can serve as a cornerstone of a stable and reliable payment system, capable of operating on its own even under the most extreme conditions, so that the pressure on the financial ecosystem as a whole would be significantly less compared to fractional reserve banking. To attract investors, lending affiliates would have to maintain their own strong capital cushion and look for long-term financing opportunities. Still, these measures in and by themselves might not be sufficient to ensure the financial stability under all circumstances, so that the "lender of last resort" in the form of a central bank would still have to be present in the system. Such a bank will provide required liquidity to uninsured lenders including affiliates of NBs against illiquid, but sound, collateral, thus avoiding a systemic credit collapse. This is to be compared with the current setup, where financial authorities support private banks through deposit insurance, access to the discount window, and implicit government guarantees.

Specifically, Miles (2001) argues that separation of deposit taking and lending would result in elevated agency costs and reduce stability of the supply of lending. In all likelihood, this is not going to happen since lenders would become much more efficient to survive without a cushion provided by depositors. Bossone (2002) emphasizes that benefits of NB in terms of financial stability are much smaller than its drawbacks associated with cutting the link between bank money and economic activity and creating "market incompleteness." He thinks that this void will be filled by financial firms, whose operations will be as risky as the ones conducted by fractional reserve banks, so that overall stability of the financial ecosystem will not improve. Most interestingly from our standpoint, Bossone (2002) is not opposed to voluntary creation of NBs, or segregated NB subsidiaries within existing bank holding companies.

Figure 7: Liabilities of the Federal Reserve Bank



Source: Federal Reserve
Notes: Excess reserves kept by commercial banks increased enormously since 2008

The other danger is the risk of flight to quality from fractional reserve banks to NBs during the times of financial instability, i.e., precisely when the former can least afford to lose their liquidity. This danger is not as acute as it might sound, because the actual amount of liquidity NBs can absorb is limited by their capital size.

5. NBS AS PART OF THE FINANCIAL ECOSYSTEM

5.1 Current trends in banks' behavior

In the build-up to the GFC, banks tried to stay as leveraged as possible, by simultaneously reducing their capital ratio and choosing progressively riskier asset mix. However, after 2008, their group behavior changed dramatically. The balance sheet of the Federal Reserve is shown in Figures 6 and 7. Comparison of these figures shows that the asset and liability mix of the banking sector underwent a dramatic transformation after the GFC. One of the most striking aspects of this change is the precipitous increase in excess reserves depositary institutions keep with the Federal Reserve. We are observing interesting and somewhat perplexing developments: until the onset of the GFC, central banks were run as NBs, and commercial banks were run as fractional reserve banks, while after the crisis the situation flipped, although not completely. This fact shows that banks prefer to keep a considerable cash cushion, partly because they put an extra premium

on maintaining high liquidity, and partly due to lack of demand for loans. Besides, attractive interest rate paid by the Federal Reserve on the excess deposits is clearly an additional motivation.

In view of the above, it is clear that building a NB cannot and should not upend the overall balance of the banking ecosystem, since it is pretty much aligned with prevailing trends anyway.

5.2 What can an NB do for you?

A properly designed NB is a natural repository of funds for those who highly value their funds' stability (either by inclination, such as wealthy individuals and organizations, or by necessity, such as central clearing counterparties). It is also a natural emitter of FBDC. In addition, such a bank can do many other things. For instance, it can be used to hold non-operational deposits, which conventional commercial banks do not want and cannot hold at a profit. Besides, it is a custodian for initial margins (IM) supplied by investment banks as part of their regular over-the-counter derivatives business. These funds are naturally paid via FBDC and are kept safe by construction. Moreover, if so desired, the NB, being a neutral custodian, can provide value-added services, such as calculating the size of the required collateral and administering its allocation. Besides, a NB can be a very useful source of digital identity.

5.3 Lending affiliates – credit money creators of the future

If banking institutions all become narrow, then credit creation will be performed by lending affiliates and other lenders, for instance, mutual funds or hedge funds. In fact, after the GFC, a considerable portion of credit is issued by non-banks, while many banks keep massive excess reserves with central banks, thus becoming de-facto more narrow. By reorganizing themselves into transaction-oriented NBs and lending affiliates, fractional reserve banks can become much more cost-efficient, nimble, and stable.

By construction, NBs offer their depositors a high level of safety, handle regulatory burden with relative ease, require a low capital cushion, derive a stable and considerable flow of income from their transactional activities, and benefit from the interest paid on bank reserves by central banks. Transactional cash flow can be increased manifold if foreign exchange and, especially, cryptocurrency issuance are included into the mix. At the same time, since NBs require very limited capital cushion, which is needed to satisfy leverage ratio constraints and cover operational risks, they can offer very attractive return on equity (ROE) to their investors. Recall that a non-risk-based leverage ratio is calculated by dividing Tier-1 capital by the bank's average total consolidated assets, which, for NBs, boil down to central banks reserves and short-term government paper. Under Basel III rules, banks have to maintain a leverage ratio in excess of 3%.

Given the simplicity of their balance sheet and efficiency of the state-of-the-art IT systems, NBs can use technological advancements, such as distributed ledgers and blockchain, to provide excellent transactional banking services and successfully complete with transactionally-oriented fintech startups [see Lipton (2016a), Lipton et al. (2016), He et al. (2017), Powell (2017), among others].

At the same time, uninsured lending affiliates of NBs, unencumbered by the requirement to provide utility-like transactional services, can better serve the needs of the real economy, by offering traditional as well as innovative credit financial products. Given that lending affiliates would not have cheap sources of funding in the form of deposits, they would have to maintain healthy capital cushions and choose the quality of assets aligned with their risk appetite, in order to attract savings and other forms of funding from investors. Lending affiliates would be stratified depending on the level of their speculative activities. Denuded of all amenities related to deposit insurance, lending affiliates will have their own skin in the game, and be open to scrutiny by their investors.

Thus, splitting fractional reserve banks into NBs and lending affiliates would increase investment value of both, much like nuclear fission releases enormous energy in nature.

5.4 Limited impact of narrow banks on the ecosystem at large

Even though an NB by construction is impervious to market and liquidity shocks, it can suffer from operational risks. Hence, it requires capital cushion. The size of this cushion is determined by the leverage ratio, and is of the order 3%-4% of its assets.

Thus, the size of the available capital effectively limits the amount of central bank money a NB can attract from fractional reserve banks. As a result, potential systemic impact of such an institution on the financial system as a whole is limited. Besides, since a NB does not lend its funds, it is unable to create money “out of thin air,” so from this angle, its impact is limited too.

Yet, such a bank would have a great impact in other ways. First and foremost, it will create an honest competition in the banking ecosystem and will force conventional banks to pay a fair interest to their depositors. Second, it would make FBDC expansion above and beyond its original narrow base a reality. Finally, for the first time in recent history, such a bank would provide a venue for both retail and institutional depositors who are particularly concerned about availability and stability of their deposits even under the most extreme conditions. Among the institutional depositors, central clearing counterparties are the primary candidates, given that they have all kind of negative externalities including the fact that some of their largest clearing members are, at the same time, their bankers. Thus, a potential default of a clearing member can cause a double loss for such a CCP.

NB, being a radical departure from the familiar financial setup, naturally raises numerous questions of monetary policy, particularly regarding the manner of money creation and who should be responsible for it. The main issue is that to a large extend money will be created or destroyed by central banks, which would have to exercise preternatural abilities to do so properly. Money creation along these lines would be a de facto tool of central planning. Given that central planning is next to impossible to execute efficiently, the dangers can outweigh the benefits. The behavior of credit markets would be affected in a very profound way, since banks will no longer be natural sources of credit. All these effects have to be analyzed in detail before narrow banking is implemented in its entirety.

6. CBDC VERSUS FBDC

In principle, distributed ledgers can potentially become a truly transformative force by making central bank digital currency (CBDC) a reality, in a dramatic departure from the past. A variety of viewpoints on this subject, some of which are mutually exclusive and contradictory, can be found in Ali et al. (2014), Andalfatto (2015), Barrdear and Kumhof (2016), Broadbent (2016), Danezis and Meiklejohn (2015), Fung and Halaburda (2016), Koning (2016), Lipton (2016b), Bordo and Levin (2017), Dyson and Hodgson (2016), Mersch (2017), Scorer (2017), among many others.

If central banks start to issue CBDC, they can not only abandon physical cash in favor of its electronic equivalent, as is advocated in Rogoff (2016), but, eventually, retire a substantial portion of the government debt in its favor. This would be a very impactful development for society at large. Taken to its logical limit, CBDC can eliminate fractional banking raison d’être and dramatically improve financial ecosystem resilience, by allowing economic agents to have accounts at the central bank directly. As a result, these

will dramatically reduce the ability of the banking sector to create money "out of thin air" and transfer this all-important function to central banks. However, central banks are not equipped to address the large-scale KYC/AML problem, which they would have to solve if they open their balance sheets to a large portion of economic agents, rather than licensed banks and selected financial institutions alone. While developments in this direction are inevitable, their timing and magnitude cannot be ascertained at present.

Realistically, we do not expect central banks' balance sheet to be open to all economic agents. Accordingly, we think that FBDC, being a private coin, is a much more convenient solution to digitization of the fiat currency than CBDC. Issued by a purpose-built NB, FBDC will be as reliable as fiat. At the same time, the corresponding bank can satisfactorily solve the KYC/AML problem and navigate the complicated political landscape. Moreover, NBs, organized as a network of sister banks incorporated in different jurisdictions, can simplify and cheapen foreign exchange transactions.

7. DIGITAL IDENTITY AND KYC/AML

With the emergence of blockchain and DLT, and their usage for cryptocurrencies, the question of digital identity in the context of KYC/AML has come to the foreground. A major shortcoming in current identity systems on the internet is the lack of privacy with respect to transactions performed using these identities. This deficiency is also true in the context of blockchain-based currencies, such as Bitcoin, namely the disclosure of identities through the reverse engineering and analytics of the public-keys used in transactions recorded on the blockchain.

We believe a new breed to "crypto-identities" may need to be devised that not only provides transaction confidentiality, but more importantly exhibit the features necessary to make it compliant to KYC/AML regulations. These crypto-identities must be based on and derive from the appropriate combination of highly private and accurate personal data, and must yield truthful assertions or claims regarding the owner relevant to the KYC/AML requirements. Additionally, for transaction confidentiality, these identities must be conditionally anonymous-verifiable, meaning that the identities must seemingly be anonymous to non-participants and be reversible by KYC/AML processes. In this way, a chain of provenance (or chain of verifiability) can be established for a given digital identity from the transaction on the blockchain to the legal owners of the digital identity.

The area blockchain and DLT is currently still nascent, and additional infrastructure technologies will be needed in order for the full benefits of blockchains to be realized in a transformative manner in connection to digital identities. The report by Hardjono and Maler (2018) provides a broad industry review of identity technology and the relevance of blockchain to identity management.

8. MORAL HAZARD

One of the greatest hazards of a widely used digital currency is enabling a repressive surveillance state. If the government can track all of its citizens' payments, then they can exert unprecedented control over their lives. Nor is this situation just some science fiction fantasy; in parts of Northern China virtually all payments – for transportation, food, entertainment, communication, everything – are logged by just two companies, both of whom collaborate closely and share data with the government.

To avoid this situation, small financial transactions, such as currently performed with cash, must be anonymous. Exceptions to this anonymity should be few and far between. For instance, in serious criminal investigations or similar situations, where there is an overriding social imperative, society may decide that it should be possible to override this anonymity using carefully vetted and expensive methods such as legal court orders.

Fortunately, there are a range of cryptographic methods to enforce levels of anonymity ranging from technologies that allow complete unbreakable anonymity, to methods that provide anonymity for payers but not for sellers, to frameworks that provide anonymity except for court orders. For instance, a narrow bank can follow the Chaumian scheme and issue numbered and blind signed currency units onto a distributed ledger, whose trust is maintained either by designated notaries or by the bank itself. KYC/AML requirements could be limited to large deposits or withdrawals, much as cash transactions are today.

9. CONCLUSION

In this document, we have outlined an efficient framework, which can be used in order to extend the domain of applicability of the FBDC from an initial group of bank sponsors to a much wider group of potential users including SMEs. We have argued that a purpose-built NB is necessary (and, hopefully, sufficient) to achieve this goal. Not only can it be used to securely hold collateral, but also to solve the all-important KYC/AML problem. The FBDC, being a stable cryptocurrency, can facilitate both domestic and foreign trade and offer numerous possibilities for streamlining and facilitating commercial and retail transactions.

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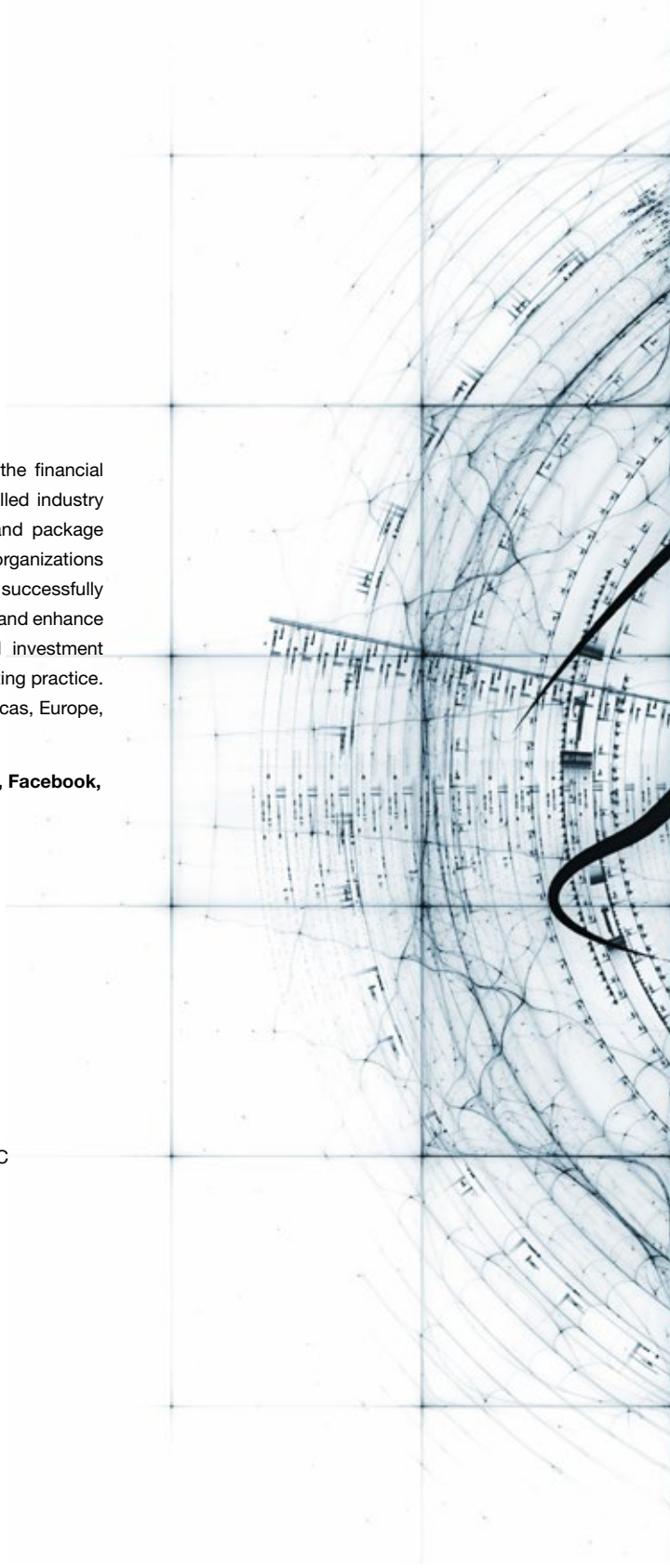

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