CAD-coin versus Fedcoin

Rod Garratt

November 15, 2016

1 Introduction

On June 15, details of Project Jasper were presented to the audience at Payments Panorama 2016. Though the session was closed to the press, pictures of a key slide with a reference to a digital unit of account called "CAD-coin" were tweeted to the press. The story was instantly picked up by Forbes, the Financial Times and other prominent media outlets. Why was this such big news? Was it a misunderstanding as to the true purpose of Project Jasper or was it an appropriate response to a historic event?

To answer these questions, it is useful to clarify what Project Jasper is and what many instantly perceived it to be: the Canadian version of Fedcoin.

2 Project Jasper

Project Jasper is an ongoing collaboration between R3 and six private Canadian banks, Payments Canada and the Bank of Canada (BoC) that began to explore the possibility of clearing and settling large value payments using distributed ledger technology (DLT). Phase one, which concluded at the conference, involved a simulation of a funds transfer that the Project team hopes will be implemented in phase two, with the goal to conduct a set of Tranche 1 payments between participants using DLT.[1] The simulation begins with participants pledging cash collateral into a special pooled account held by the BoC. This is done via Tranche 1 payments to the BoC. The BoC then issues an equal amount of a central bank issued digital asset, referred to in the presentation as CAD-coin, onto the distributed ledger and sends each bank an amount of CAD-coin equal to the amount of cash they pledged.[2] Banks can then send payments of CAD-coin to each other in real time to meet the payment obligations that they have agreed to have settled on this platform and may also send payments back to the Bank of Canada in order to "cash out" and convert CAD-coin back into Canadian dollars.

Technically, a CAD-coin is a deposit receipt; it gives the holder a transferable claim on its value in central bank money. But for all intents and purposes, this means CAD-coin is, itself, a form of central bank money. However, unlike central bank reserves, which are held in banks' master accounts at federal reserve banks, CAD-coin holdings are held in banks' "wallets" within the distributed ledger. Payments from one bank to another that are made using CAD-coin do not

---

[1]The Canadian large value payment system has two tranches. Tranche 1 is a pure real time gross settlement (RTGS) system. Tranche 2 utilizes deferred net settlement subject to risk controls intraday and then net positions are settled in central bank money at the end of day. Tranche 1 payments are equivalent to cash payments. They are funded using Tranche 1 payments already received or by drawing upon a Tranche 1 intraday line of credit granted by the Bank of Canada. Either way, such payments are immediate and irreversible, even in the event of participant default. The value that is transferred by Tranche 1 payments is backed by collateral posted at the BoC. In the event of a participant default the collateral needed to cover the cost of payments is forfeited.

[2]I use the term CAD-coin in this note, since that name was used in phase 1 of Project Jasper, however it should be understood that the BoC is unlikely to move forward with this name. The name strongly suggests a central bank digital currency, which at this point, the BoC is not promoting.

impact the central bank balance sheet. It is only during the redemption phase, when banks redeem CAD-coin for central bank money, that a redistribution of central bank reserves occurs.

CAD-coin transactions occur on a private, permissioned system. It is permissioned in that only a group of trusted users validate and maintain the integrity of the ledger. It is private in the sense that only a selected group of users can read and initiate CAD-coin transactions. In phase one, the former group was larger than the latter. All members of the R3 consortium acted to validate transactions, but only Canadian members (the participating private banks and the Bank of Canada) conducted transactions.[3] This design aspect raises some red flags as the incentives of the larger group of validators may not be exactly aligned with incentives of participants; however, there are also benefits to having a large group of validators, the most obvious being the resiliency of the network.

The phase one simulation required a use case that would validate the Project Jasper settlement platform without disrupting typical payment operations. Payments Canada identified the ACSS F Stream – Bill Payment remittances ("F" is Payments Canada coding for paper based remittances). The liquidity required to make F-stream payments is sufficiently small relative to each bank's total payment obligations that the subtraction of liquidity from the existing large value transfer system would not introduce liquidity risk to that system. This was an important consideration for the test. Like most payment systems in the developed world, the Canadian large value transfer system handles payment values that are approximately equal to the value of annual gross domestic product each week. Smooth functioning of the payment system requires that participants provide adequate liquidity to ensure that payments can be made in a timely fashion. In Canada, the vast majority of payments are made using Tranche 2 which utilizes deferred net settlement where debit positions are partially covered by a shared collateral pool. The size of the collateral pool depends upon bilateral limits banks set with each other. If the test involved payments that were significant enough in magnitude to alter the choices of these bilateral limits, then it would have implications for Tranche 2 payment flows. A decision to implement DLT as a permanent feature of the Canadian large value payment system would be based on a full and detailed assessment of the liquidity implications across all systems. Broadly speaking, Payments Canada and the BoC must have a holistic approach to payments and be mindful of how any changes in one system affect the other.

As mentioned above, the assets traded in the CAD-coin registry are deposit receipts: claims on the central bank money deposited in a segregated account at the Bank of Canada. A key operational requirement for this to work is that a legal structure is in place that will ensure that a transfer of CAD-coin is equivalent to a full and irreversible transfer of the underlying claim on central bank money. In the event that a bank defaults, it must be the case that neither that bank nor any of its creditors have any claim on the cash collateral associated with any CAD-coin spent by the bank before its default. This is needed to ensure that there is no credit risk associated with the creation, distribution, use or redemption of CAD-coin.[4] It is also key to achieving real-time settlement.

The ownership properties of CAD-coin are much like a zero-interest bearer bond. Physical possession (which in this case is requires a digital interpretation) entitles the bearer to the payment stream associated with the bond, which in this case is the cash value in the collateral pool. One obvious difference is that a key feature of bearer bonds in the United States is they were unregistered - no record was kept of the current owner. This made bearer bonds useful for certain types of transactions.[5] But the implication was that recovery of the value of a bearer bond in the event of its loss, theft, or destruction was usually impossible. While the distributed ledger does, of course, provide a record of ownership - and in fact that record is synonymous with possession of a digital asset - the idea that if possession is somehow broken, say through the loss of a private key, the

---

[3]This was done as a matter of convenience. R3 has a version of the Ethereum platform operating for the use of its members that utilizes proof of work mining built into Geth for consensus and transaction validation. This platform was utilized for the simulation, with some modifications to eliminate the costs of ether, with non-participants in the Jasper project playing a passive role. The group of Canadian banks participating in the project has grown from five to six since the simulation was conducted.

[4]The exchange of CAD-coin on the distributed ledger occurs without credit risk for participants because (i) transfers of CAD-coin are transfers of a claim on central bank money and (ii) there is no credit risk associated with claims on central bank money because the central bank is not subject to default (i.e. no concerns regarding bankruptcy remoteness of cash collateral).

[5]Bearer bonds have been associated with money laundering and tax evasion. New issuances of bearer bonds were banned in the United states in 1982. All existing U.S. Treasury bearer bonds have matured and no longer pay interest.

ownership rights cannot be exercised, remains the same.

It is worth pausing to contemplate alternative solutions to the credit risk problem that do not involve a central bank. I believe there are two ways to mitigate credit risk without central bank involvement. One is to create a 100% reserve bank that does nothing but hold the funds.[6] Since the bank has no other operations there should be no risk of default. However, the potential for fraud would still exist, an aspect that seems unavoidable in any private solution.

The second approach would be for the funds to be held in a segregated account of a private bank that is separate from the bank's master account. The Federal Reserve Bank of New York (FRBNY) floated the idea of segregated balance accounts (SBAs) as a monetary policy tool and others have asked for the creation of segregated accounts to hold collateral for systemically important financial market infrastructures.[7] At present, while it is technically allowed for banks to have multiple master accounts at their federal reserve bank, the legal structure that would protect these funds and make them immediately available to system participants in the event that the holding bank defaults is not in place, nor is it likely to be in place soon. At present, even funds deposited in a segregated account would be subject to an automatic stay in the event of default.

Both private alternatives to eliminating credit risk have potential, but neither exactly duplicates the benefits of a central bank digital currency. One additional issue to consider is the cost of maintaining the collateral pool in a private bank. Under either proposal there would be set-up and operational costs. Moreover, the holding bank would be assessed FDIC fees on the account, even though the funds are never at risk. Finally, it may be that under Regulation D, the holding bank may be required to post additional reserves associated with the collateral accounts, if these were interpreted as deposits. This is something the Board could overrule.

The CAD-coin experiment was designed to have a beginning and an end. Banks purchase CAD-coin at the beginning of the day. At the end of the day, participants redeem CAD-coin for Tranche 1 cash collateral and the central bank destroys the redeemed CAD-coin. This means that CAD-coin only exists intraday, an aspect that is important because it means that CAD-coin is monetary policy neutral.

What does the CAD-coin experiment achieve? This is an important question and I begin to answer it by saying what CAD-coin is not. CAD-coin, as implemented in phase 1, is not an improvement in payments processing. In fact, it is actually a step backwards on that dimension. The Tranche 1 payments that are used to fund CAD-coin could have been used to clear the F-stream obligations of the participating banks. So buying CAD-coin and then using CAD-coin to make the payment and then converting CAD-coin back into cash might seem like the technology is taking us in the wrong direction, making things harder instead of easier. But that would be missing the point.

The CAD-coin experiment is a proof of concept. It demonstrates that central bank money can be transferred using DLT. This may seem simple, but it is crucial for one reason: it enables settlement.

Settlement is the final part of the holy trinity of finance: trading, clearing and settlement. Trading has typically been thought to be outside the scope of DLT, although this could change with the development of smart contracts that could act as market makers, but there are currently high expectations for the use of DLT in clearing and settlement. Clearing is easy - the implementation of DLT would be most useful in terms of updating accounts and keeping track of who owns what. Settlement, however, is difficult. We can record that I paid you $10 (that is, we can debit my account by $10 and credit yours by $10), but how do we move the money? How do we reach a state where the numbers in my account represent legitimate purchasing power? To do this we need to move something of value. In the physical word, the updating of accounts mentioned above would be accompanied by my handing you a 10-dollar bill. In the virtual world I simply send you the equivalent value in CAD-coin. The CAD-coin shared ledger reflects real-time, accurate account balances for each participant and these balances are also synonymous with the ownership of funds. Hence, the CAD-coin shared ledger simultaneously achieves clearing and settlement.[8]

---

[6]Green Dot Bank is an example of this business model in the prepaid card industry.

[7]In fact, the idea can be traced back to Tobin (1985) who argued for narrow bank accounts. This is discussed in Garratt et all (2015) and credit is also given to Tobin in a recent speech at the London School of Economics by Deputy Governor Ben Broadbent. http://www.bankofengland.co.uk/publications/Pages/speeches/2016/886.aspx

[8]The CAD-coin experiment focused on payment processing, but its real value could come as the missing piece in other clearing and settlement scenarios. The application of DLT that seems to have the most traction in central banking circles at the moment is securities exchange. This sentiment was strongly articulated in the previously mentioned speech by Deputy Governor Ben Broadbent. Alternative solutions to the settlement problem in securities

There is also another outcome that would be achieved by the transfer of central bank money over a distributed ledger in future phases of Project Jasper: it would set a precedent that other central banks could follow. My experience in central banking leads me to believe that policy makers are receptive to new ideas and new approaches. However, they are also necessarily and understandably cautious. A compelling argument for getting a central bank to at least consider a new technology is that it has been adopted successfully elsewhere.

3   The Birth of Fedcoin

In a blog that was posted on April 14, 2013, JP Koning innocently gave birth to the notion of Fedcoin (although not yet by that name) when he argued that transferring the United States large value payment system, Fedwire Funds©, to a distributed ledger would eliminate its dependence on centralized processors and increase its resiliency.[9] Interestingly, and much to his credit, Koning separated Bitcoin, the medium of exchange, from the platform on which it is transacted, the distributed ledger, and touted the potential of the latter independently of its role in facilitating the former. A year later this would become the mantra of virtually everyone in the financial services industry.

Fedcoin, as it is currently known, came to light in a later blog (October 19, 2014).[10] While the principles of Fedcoin had been articulated in another post by Sina Motamedi a couple of months earlier, Fedcoin is the notion that captured the attention of pundits, practitioners and policy makers.[11] The reason for this is that Fedcoin was endorsed by David Andolfatto of the Federal Reserve Bank of St. Louis at the International Workshop on P2P Financial Systems 2015.[12] As the saying goes, the opinions Andolfatto expressed were his own and did not reflect policy of the Federal Reserve Board or the Federal Reserve System.[13] Nonetheless, people took his remarks as a signal of the Fed's interest in this concept.

As Koning describes it, the Fedcoin proposal emphasizes *bitcoin-as-product* over *bitcoin-as-philosophy*. In other words, the goal is to create a stable (less price volatility) and dependable cryptocurrency that delivers the practical advantages of bitcoin even if this means involving the central government and abandoning the Libertarian principles that many believe underlay Bitcoin's creation. Price stability is achieved by tying the value of Fedcoin to the US dollar. In particular, under Koning's proposal, Fedcoin would have a fixed one-to-one exchange rate with the US dollar.[14] The Fedcoin proposal involves two-way convertibility, but the Federal Reserve would control both the creation and destruction of Fedcoin. This aspect is crucial. As Benjamin Klein (1974) points out, if a competing currency were issued by a private supplier, then, under a fixed exchange rate, the private supplier would have incentives to continually increase supply leading to an infinite price level.[15] As put forth in the Fedcoin proposal, each dollar of cash surrendered for Fedcoin would be removed from the monetary base and each dollar of Fedcoin surrendered for sovereign currency would be removed from the distributed ledger for Fedcoin transactions. So, in fact, and this point does not seem to be well understood, the Fedcoin proposal is really more about having more alternative "forms" of sovereign currency than what monetary economists would call a competing, private outside money (see Lagos (2006) for a definition of outside money).

The primary role of Fedcoin would be as a substitute for cash. Were the central bank to agree to the creation of Fedcoin it would stand ready and willing to convert paper money into Fedcoin and/or bank deposits into Fedcoin. Cash submitted for Fedcoin would be destroyed and the surrendering of consumer deposits would be done through transfers of reserves of the issuing

---

exchange involving digital tokens that represent claims to central bank money are being proposed elsewhere. The most notable is the Utility Settlement Coin.

[9]http://jpkoning.blogspot.ca/2013/04/why-fed-is-more-likely-to-adopt-bitcoin.html

[10]http://jpkoning.blogspot.com/2014/10/fedcoin.html

[11]http://tannutuva.org/blog/2014/7/21/will-bitcoins-ever-become-money-a-path-to-decentralized-central-banking

[12]I also think it was because Fedcoin is a catchier name than BitDollar, proposed by Motamedi.

[13]I was the co-Chair of the Virtual Currency Working Group at the time of Andolfatto's remarks. At this time the Federal Reserve System was studying all developments in this space, but had not formulated an official policy stance (Janet Yellen made it clear that there was no immediate need for the Fed to do so) and certainly was not entertaining the idea of launching its own virtual currency.

[14]This was also true in Motamedi's proposal although he also entertained the possibility of setting alternative exchange rates as a monetary policy tool.

[15]The idea is the same as Milton Friedman's (1959) contention that indistinguishable competing currencies lead to an infinite price level, since indistinguishability implies a fixed-exchange rate.

bank to the central bank, which would also lead to their destruction. So, Fedcoin would be a third component of the monetary base, which would then equal cash plus reserves plus Fedcoin.

Presently the Federal Reserve does not impose any limits on how much cash consumers can choose to hold. Although many banks impose limits on the amount that can be withdrawn at each visit without prior notification. This is, of course, true at ATMs, but there are also limits on unannounced cash withdrawals from tellers. These limitations are important to the Fed's ability to control higher level monetary aggregates. Money creation through banks depends upon the level of deposits, which vary inversely with cash holdings. However, fluctuations in cash holdings are typically too small to undermine the Fed's ability to control higher money aggregates (M2 etc.). In addition, there are practical limits in terms of how much cash money people can physically store. This ensures fluctuations in cash holdings are not likely to be too extreme, even in stress scenarios.[16]

The creation of Fedcoin could change this. Unless the central bank put limits on peoples' ability to convert money into Fedcoin there could be significant swings in the composition of the monetary base which could have serious implications for liquidity, bank funding, and the ability of banks to meet reserve requirements.

Recent crises have been marked by flights to quality in financial markets. In 2008, large dollar values shifted into Treasury securities, especially bills, but there was also a huge flow of funds into U.S. commercial bank deposits. The removal of liquidity from key markets is problematic as many borrowers have difficulties rolling over their liabilities and finding new funding sources, but there can be a silver lining. When big banks become flush with deposits, this allows their customers to more easily draw down lines of credit.[17]

This silver lining dissipates if cash holders find an alternative place for their funds that they perceive to be safer than deposits at large banks. This concern was expressed by market observers and policy makers when the FRBNY tested is Overnight Reverse Repo (ON RRP) Facility in the Fall of 2013. People were concerned uncapped ON RRPs would exacerbate flight-to-quality flows, by providing a risk-free alternative to bank deposits, thereby causing a removal of much needed liquidity from the financial system. For these reasons, an aggregate cap on the amount that can be invested at the ON RRP facility was imposed and an auction pricing mechanism was introduced to ration ON RRPs in the event that bids exceed the aggregate cap.[18]

A similar concern was raised in response to the FRBNY's proposal for SBAs, mentioned earlier. During a crisis, SBAs might be seen by lenders as an attractive near risk-free investment. Since reserves held in SBAs would not be accessible to the holding banks this would result in a decline in "usable reserves" by banks, potentially causing them to restrict lending and/or have trouble meeting reserve requirements.

Flight to quality flows into treasuries, SBAs and other safe assets sometimes have natural counterbalancing effects. For instance, a fight into Treasury securities depresses their yields, thus reducing the incentives to buy them. Likewise, Garratt et al. (2015) argue that an increased supply of funds by lenders for SBA collateral arrangements would be accompanied by counterbalancing price movements: there would be an increase in the federal funds rate and deposit rates as banks compete to attract funds, but no increase in the rate paid on balances in SBAs since that rate would be competitively tied to the IOER rate. The predicted result would be an increase in the spread between both the deposit and the federal funds rates and the rate paid on SBA balances, which would help to arrest a surge and mitigate potential dislocations in funding markets.

The likelihood of a flight into Fedcoin would depend on several factors, some of which have not been pinned down in the Fedcoin proposal. An important detail missing from early descriptions of the Fedcoin proposal is the way in which people convert cash or deposits into Fedcoin. We could imagine several possibilities: in person cash transfer, through the creation of direct consumer accounts at federal reserve banks or, perhaps most likely, the exchange could be done by private banks as a simple online transfer.[19] We could imagine people would transfer money from savings

---

[16]A caveat would be significant outflow of deposits and increase in cash holdings that occurred during the banking panics of 1930-33. Though the monetary base remained relatively constant there was a sharp decrease in M1 due to the fall in the money multiplier. That was, of course, before deposit insurance. See Friedman and Schwartz (1963).

[17]See Gatev and Strahan (2006).

[18]A discussion of the ONRRP facility and the policy concerns is found in Frost et al. (2015).

[19]At present there is no authorization for Reserve Banks to serve as depositories to the general population. A direct consumer account at a Federal Reserve bank, therefore, would require an amendment to the Federal Reserve Act (Section 13(1)). However, the act is less precise on the form deposit relations can take. Therefore, third-party facilitation of Fedcoin accounts might be easier to establish within the current legal framework.

and checking accounts into Fedcoin much like they currently transfer funds across these accounts, using current electronic banking features.

However, too much convenience might not be a good thing. Ease of transfer in and out of Fedcoin could increase the likelihood of a virtual bank run. Since the seminal paper by Diamond and Dybvig (1984) we have understood that the likelihood of a bank run depends not only on balance sheet conditions, but also on people's beliefs regarding the withdrawal intentions of others. Bank runs can occur, even for completely solvent banks, if enough people believe others will run. The reduction of transaction costs and storage costs associated with a Fedcoin-like technology could make such runs more likely.

That said, Fedcoin might have a natural braking system. As in the case of SBAs discussed above, movements out of deposits into Fedcoin represent a removal of reserves from the banking system and would likely be accompanied by an increase in the federal funds rate and in deposit rates. It is unlikely that the Federal Reserve System would depend wholly on these market forces, however. It seems more likely that any future implementation of a Fedcoin concept would involve individual and aggregate caps.

4   Differing Objectives

The best way to draw a clear distinction between CAD-coin and Fedcoin is to focus on the differences in their objectives. Fedcoin is intended as a substitute for cash and, as such, it should preserve the privacy attributes of cash (and possibly improve upon them). This actually presents some challenges which the Fedcoin proposal, as it has been articulated so far, does not seem to address. The primary issue is that, since the Fed acts as the gateway in and out of Fedcoin, it will have to know the public address of a Fedcoin recipient. Cash conversions could be done anonymously, but conversions of bank deposits would imply the Fed would know the owner of the public address (assuming she is the same as the owner of the deposit account). This identity-link could be broken via a third party funds distributor which accepts Fedcoin on a recipient's behalf and distributes them to the recipient anonymously. Of course, this would have to be trusted third-party and the Fed would have to agree to this. This would be another reason why the Fed would place limitations on the amounts exchanged into Fedcoin (to meet AML requirements). Similar third-party entities already exist for the purposes of ensuring anonymity in the Bitcoin blockchain, but this is outside the realm of the Fed.

With CAD-coin, the central bank again acts as the gateway to conversion from central bank money to CAD-coin, but privacy at conversion is not required. In fact, it is quite the opposite. Central banks typically have the authority to monitor payments transactions in their role as overseer of a systemically important financial market infrastructure, so complete privacy is not a reasonable objective.[20] This means the identity link associated with conversion from a bank's central bank account to its public address in the distributed ledger is fine. The privacy requirements with CAD-coin instead relate to the needs of the non-central bank participants. That is each private bank does not wish to have its complete transaction record be public to the whole system. In CAD-coin, banks are still identified by a public address, but in order to complete payments requests generated from the real system, which are in terms of a bank's legal name, a bank must know the complete list mapping of bank names to public addresses in the distributed ledger. Therefore, the only way to ensure privacy of the complete transaction record of a bank is to limit each individual bank's access to the distributed ledger itself and to either (i) not involve all parties in transaction validation or (ii) find a way of validating the trades without seeing them, a so called "zero-knowledge validation".

Mainelli and Milne (2016) conducted a survey of industry professionals in which they questioned participants about the need for a distributed ledger settlement system for securities in which only a limited number of proposed network participants can propose updates and validate the ledger. Their results indicated that market participants believe that in a future version of permissioned ledgers the major banks that currently act as established intermediaries will be the only ones allowed to record and verify transactions. However, it is possible that protocols will be developed in which only transacting parties participate in the validation process (see the recent announcement of Corda).[21] In short, a future version of the DLT that meets privacy requirements of participants

---

[20]There are also laws surrounding "regulated data" that impact who can touch financial transactions as they cross borders. See the EU General Data Protection Regulation.

[21]http://www.coindesk.com/r3cev-blockchain-regulated-businesses

must go beyond existing notions of permissioned and private which apply equally to a group.

5   Concluding Remarks

Whatever its future manifestation could or might be, Fedcoin is a very different animal than the digital asset labeled CAD-coin in Project Jasper. Fedcoin is intended as a retail payment solution, while CAD-coin is intended as a wholesale payments solution: it does not trade on a public network, nor is it consumer facing. Fedcoin would be issued onto a public ledger by the central bank and would be convertible one-to-one for USD. CAD-coin are also issued by the central bank, but they represent deposit receipts that are backed by central bank money.

It is worth mentioning that CAD-coin could be implemented without the use of a segregated account. The BoC could simply exchange incoming funds for CAD-coin, delete the liability of the incoming funds from its books, and promise conversion at a fixed exchange rate. In fact, this would bring the CAD-coin proposal much closer to the Fedcoin proposal, with the nontrivial exception that CAD-coin would still circulate on a private and permissioned network that was only accessible to Canadian large value transfer system participants. While operationally very similar, this would be a much bigger step for a central bank, with broader legal and monetary policy implications.

Validations of transactions in both the Fedcoin proposal and the phase 1 implementation of CAD-coin utilize proof-of-work. Proof-of-work eliminates the need for trust between participants and is censorship resistant. However, perhaps in both cases, the need for this is unclear. Certainly in the case of Project Jasper there is no desire to create a system that is protected from the actions of the central bank. The case for adopting DLT, which is still evolving as improvements in the technology develop, must be based on improved operational efficiencies, increased resilience and cost reductions. It is important to recognize that distributed data systems have been around for quite some time and these systems do not require blockchain and proof of work. Cofounder of Nootrobox, Geoffrey Woo, summarized these ideas in a blog post: "From a technical standpoint, the blockchain doesn't open up any new 'technical' attributes. The blockchain does not enable any new sensors, nor does it enable an order of magnitude increase in bandwidth, storage, affordability, that doesn't also apply to any other types of distributed stores of data. In fact, performance will most likely be worse and at best cannot be better than existing trustful distributed datastores."[22] It is therefore incumbent upon us to evaluate whether the benefits of proof-of-work style protocols warrant the reduction in efficiency and to consider alternatives.

Acknowledgements

---

[22]http://geoffreywoo.com/the-blockchain-story-part-2

References

Diamond, D.W. and P. Dybvig (1984). Bank Runs, Deposit Insurance and Liquidity, Journal of Political Economy, 91(3): 401-419.

Friedman, M. (1959): A Program for Monetary Stability. New York: Fordam University Press.

Friedman M. and A.J. Schwartz, A Monetary History of the United States, 1867–1960 (Princeton, NJ: Princeton University Press, 1963).

Frost, J., L. Logan, A. Martin, P. McCabe, F. Natalucci, and J. Remache (2015). Overnight RRP Operations as a Monetary Policy Tool: Some Design Considerations. Finance and Economics Discussion Series 2015-010. Washington: Board of Governors of the Federal Reserve System.

Gatev, E. and P. Strahan (2006). Banks' Advantage in Hedging Liquidity Risk: Theory and Evidence from the Commercial Paper Market. The Journal of Finance, 61(2): 867-92.

Garratt, R., A. Martin, J. McAndrews and E. Nosal (2015) Segregated Balance Accounts, Federal Reserve Bank of New York Staff Report no. 730.

Klein, B. (1974) The Competitive Supply of Money, Journal of Money, Credit and Banking, 6(4): 423-53.

Lagos, R. (2006). Inside and Outside Money. Federal Reserve Bank of Minneapolis Research Department Staff Report 374.

Mainelli, M. and A. Milne (2016). The Impact and Potential of Blockchain on Securities Transaction Lifecycle. SWIFT Institute Working Paper No. 2015-007.

Tobin, J. (1985). Financial Innovation and Deregulation in Perspective. Cowles Foundation Paper #635.