Bulletin

Vol. 81, No. 7

June 2018

RESERVE BANK
OF NEW ZEALAND
TE PŪTEA MATUA

Reserve Bank of New Zealand *Bulletin*

Subscribe online: https://www.rbnz.govt.nz/email-updates

For back issues visit: https://www.rbnz.govt.nz/research-and-publications/reserve-bank-bulletin

ISSN 1177-8644

The pros and cons of issuing a central bank digital currency

Amber Wadsworth[1]

Over the past decade the financial services industry has been disrupted by a range of new technologies. This has included the launch of new, private, digital currencies such as Bitcoin. In this environment, central banks are considering how they can take advantage of these new technologies to help deliver their core functions. This article contributes to this discussion by evaluating the pros and cons of a public digital currency issued by a central bank across four functional areas: currency distribution, payments, monetary stability and financial stability. We distinguish between two kinds of digital currency – 'conventional' digital currencies, which rely on existing payments technology to operate, and crypto-currencies which rely on distributed ledged technology (similar to Bitcoin). We find the pros and cons of a central bank issuing a digital currency are mixed across each of the central bank functions, revealing the complexity in evaluating such a currency. In particular, we find the implications for monetary policy and financial stability could be significant, both positively and negatively.

1 Introduction

Over the past decade, a number of technological innovations have disrupted the financial services industry. Consumers are demanding instant and convenient banking and payment services, new technology firms have begun providing banking services, and private companies have begun issuing digital currencies based on new crypto-technology. Central banks are not exempt from this disruption. New technologies offer both benefits and costs that can affect all four of the central banks' core functions: providing banknotes and coins (cash) to the public, operating systemically-important payments systems, setting monetary policy, and maintaining financial stability. This article discusses how each of these functional areas could be affected if the Reserve Bank of New Zealand (the Reserve Bank) took advantage of new technologies and issued a digital currency to the public.[2]

1 The author would like to thank Tom Smith, Christie Smith, Michael Thornley, David Hargreaves, Andrew Rodgers, and the late Roger Perry for their contributions.

2 This is the third article in a three-part series titled 'The central bank digital currency series'. The first article in the series, What is digital currency? Explains the different forms that digital currencies can take. The second article in the series, Decrypting the role of distributed ledger technology in payments processes considers how distributed ledger technology could change the payments process.

To investigate the pros and cons of a central bank digital currency we first need to clarify what we mean by a digital currency. To do that, we make six assumptions:

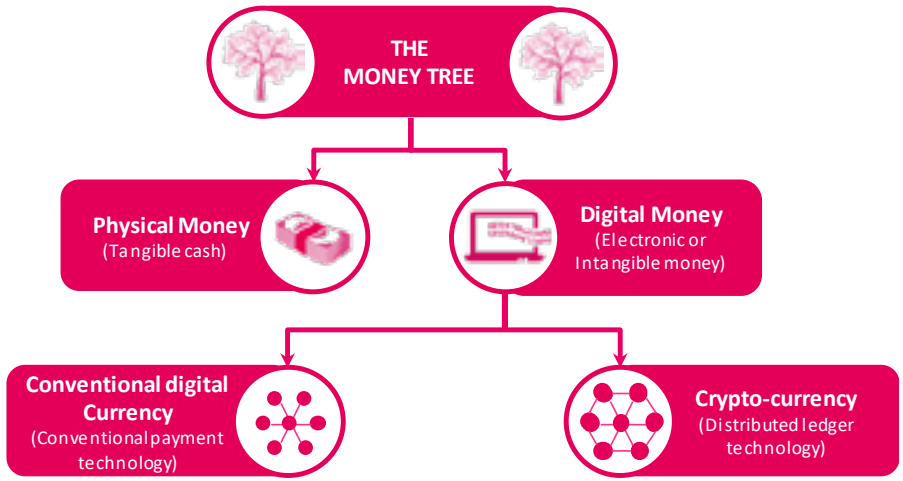
1. ***The digital currency is available to the public without restriction.***
   The Reserve Bank already operates a restricted form of digital currency via its interactions with commercial banks, which have electronic accounts at the Reserve Bank. For the purposes of this article, a central bank digital currency is defined as one that is available to the wider public without restriction, as is the case with cash.

2. ***The digital currency could take different forms based on either existing payment infrastructure technology or new crypto-technology.***
   This article defines digital currency as any form of money other than cash. As with the two previous articles in this series, this article uses the 'Money Tree' to categorise digital currencies further according to the technologies they rely on (figure 1).[3] A central bank could issue a crypto-currency, which would rely on new technology that uses cryptography to perform transactions (e.g. distributed ledger technology).[4] Alternatively, a central bank could issue a conventional digital currency which relies on existing financial market infrastructure to conduct transactions. Conventional digital currency could be account-based, which means it could involve members of the public holding bank accounts at the Reserve Bank. Or it could be token-based, which would be more like members of the public holding currency on cards or other tokens (similar to prepaid cards e.g. Visa Prezzy cards).

3 See Wadsworth (2018a) for a description of this diagram.
4 A glossary of technical terms associated with digital currencies is at the end of this article.

In general, this article will refer to a central bank digital currency as an intangible form of money. However, in the context of currency distribution and payment systems it will be useful to separate the implications arising from crypto-currencies and from conventional digital currencies.

Figure 1
The money tree



3. ***The digital currency co-circulates with cash, and other forms of digital currencies issued by the private sector.***
   Currently, central banks issue cash to the public, and private institutions issue digital currencies. This article assumes that both of these forms of currency continue to exist, and the central bank issues an official digital currency alongside them. This means households and businesses have a choice between using either cash, private digital currencies or the digital currency issued by the central bank. However, this assumption is relaxed when

considering what could happen if the use of cash declines or the use of private-sector digital currencies increases markedly.

4. ***The digital currency is convertible into cash at a fixed rate (par value).***
The values of existing private digital currencies (such as Bitcoin) fluctuate relative to cash – they do not have a fixed rate of exchange. However, for an official digital currency that circulates alongside cash it would make more sense for the digital currency to be convertible into cash at a fixed rate. This would help develop trust in the value of the digital currency (as it would effectively be backed by cash) and would avoid complicating central bank policy by introducing a dual currency system.

   Monetary policy independence would not be compromised with a par value exchange rate on digital currency. This is because the central bank can maintain the supply of cash and its digital currency to be consistent with a par value exchange rate without involving monetary policy.[5] In addition, a central bank can promise that one unit of cash is redeemable for one unit of digital currency.

5. ***The public cannot borrow from the central bank (they cannot have negative holdings of the digital currency).***
This assumption means that the digital currency issued by the central bank would operate like cash. The central bank would not provide lending facilities for holders of the digital currency. Therefore, if the digital currency was an account-based currency, the balances on these accounts could not go negative.

6. ***The central bank does not pay interest on balances of its digital currency.***
Again, this assumption means that the digital currency issued by the central bank would operate more like cash, which does not earn interest. This assumption is relaxed in the context of monetary policy and financial stability to show its significance.

Given these six assumptions outlining a central bank digital currency, we can now assess the pros and cons of issuing such a currency. The rest of the article is structured around the implications of a central bank digital currency for the core functions of the Reserve Bank of New Zealand: Section 2 focuses on currency distribution, section 3 on the payments system, section 4 on monetary policy, and section 5 on financial stability. Section 6 concludes.

2 Currency distribution

The Reserve Bank issues banknotes and coins to the New Zealand public, as well as international visitors, that are useful, easy to read, and difficult to imitate.[6] These banknotes and coins must then be securely distributed around the country and inspected for quality when they re-circulate back to the Reserve Bank. These processes incur costs which a digital currency would not. This section explores two pros and four cons of issuing a central bank digital currency from the perspective of currency distribution.

5 Andolfatto (2015), Rogoff (2016) and Koning (2016).

6 Wright (2016).

Pro: A digital currency is likely to be safer and easier to distribute than cash.

The first benefit of issuing digital currency is that it may be easier to distribute than cash. Cash is a tangible form of money, which means it must be physically transported to and from central banks in a secure way. In New Zealand, cash typically travels from Auckland to the South Island, likely due to the movement of tourists. It must then be repatriated from the South Island back to Wellington and then sent back to the North Island.

New Zealand's geographical characteristics impose an inefficient movement of cash around the country. However, geographical characteristics do not impose any constraint on digital currency distribution. This is not to say that distributing a digital currency would be costless. To distribute a digital currency a central bank would need to either develop its own retail and customer service infrastructure, or outsource it. In either case the infrastructure would be costly to set up. Further work is required to understand whether the costs of developing and maintaining a secure digital currency network and providing a retail arm would be lower than the costs of cash distribution.[7]

In addition, a digital currency may be safer to distribute compared to cash. A significant cost of distributing and holding cash is the risk to personal safety. For example, people who work in corner dairies, petrol stations, bank branches and cash-in-transit vehicles face a risk of aggravated robbery. Offering a digital currency to the public would likely provide a form of central bank money with a lower risk to personal safety. However, digital currencies do not remove all threat of theft or injury.

- A **conventional digital currency** issued by a central bank faces a risk of theft and fraudulent payments similar to existing electronic money. In addition, if the digital currency is token-based and stored on some form of hardware (i.e. a prepaid card) then it could be physically taken.

- A **crypto-currency** could also face cyber risk depending on how the DLT is designed. Blockchain (the technology underpinning Bitcoin) is distributed, rather than centralised, which removes any potential single point of failure in the system. This makes Blockchain resilient to cyber-attacks and operational failures. When elements of centralisation are added to DLTs their resilience to cyber-attacks is reduced. A DLT that is based on closed source software and requires a central agent (e.g. the central bank) to validate payments is less resilient than Blockchain to cyber-attacks.[8]

Pro: A digital currency would ensure public access to legal tender if cash were phased out.

The second benefit is that a digital currency issued by the central bank would ensure the public continued to have access to legal tender regardless of the presence of cash. Cash is legal tender, which means it is a legally recognised form of payment and represents a claim on the central bank or government.[9] This makes it less risky than the electronic money issued by commercial banks, which carries a promise of convertibility to cash, but is not legal tender – the failure of a commercial bank would likely result in depositors losing at least some of their money. Therefore, cash is the lowest-risk form of money available to the New

7 Although this article does not describe in detail exactly how a digital currency could be issued, it does assume that the digital currency could be integrated with existing electronic point of sale technology such as mobile wallets, near field communication (NFC) and card readers.

8 Wadsworth (2018b).

9 McBride (2015).

Box A

Why might cash disappear?

Scenario 1: Cash demand falls due to costs.

Cash demand could fall to a point where it is no longer widely available for the majority of consumers. Currently, consumers in New Zealand no longer use cash for the vast majority of transactions. Instead, they use either cards or mobile payment applications. New Zealand leads other countries in terms of card transactions. In 2016, each New Zealander made 335 credit and debit card transactions on average. This is higher than the number of transactions per capita for each of the countries in the Committee on Payments and Market Infrastructures (CPMI). The CPMI reported that, on average, South Koreans each made 334 transactions, Americans each made 326, and Swedes each made 316.[1] Cash can be a burden to retailers and bank branches due to the costs of balancing end-of-day cash receipts, transporting cash to and from bank branches, and the risk of theft. Therefore, if demand for cash falls significantly, retailers and bank branches may no longer see benefits in maintaining cash infrastructure.

Scenario 2: Cash is removed due to negative externalities.

Cash could be removed due to its negative externalities. Cash is difficult to trace, which makes it attractive for tax evasion, money laundering and illegal transactions.[2] Governments might remove cash to reduce crime and improve tax receipts. However, McAndrews (2017) counters that cash protects society by preventing innocent small businesses from becoming embroiled in crime.

1 Payments New Zealand (2016), CPMI (2017).

2 Rogoff (2016), Andolfatto (2016), Koning (2016), Bordo and Levin (2017).

Zealand public.[10] Box A describes situations in which cash may no longer be widely available to the New Zealand public.

Con: Issuing a digital currency will incur set-up costs.

One cost of issuing a digital currency is that it would require the central bank to invest in new infrastructure to create, issue and maintain a digital currency network. This set-up cost is unknown, and could be large. For example, some forms of crypto-currencies could require substantial infrastructure to mitigate the risk of operational failure and cyber-attacks. In addition, central banks would need to finance the maintenance of a digital currency network, as well as a cash distribution network. In 2017, the Reserve Bank spent $21 million on its currency operations, and earned $158 million.[11]

Con: Central bank-issued digital currencies could result in large consumer losses.

A central bank could issue a digital currency that is not easily traced to an owner in order to preserve anonymity of payments. For example, it could issue a token-based conventional digital currency or a crypto-currency. These forms of currencies would be stored on small devices and not linked to central accounts. Therefore, they could create a higher risk of consumer losses, because consumers could hold potentially very large balances on small devices which may be stolen or lost. Consumers could also lose significant sums of cash, but the risk of doing so is less because cash is relatively bulky, making it unlikely that consumers would carry large amounts on their person or store large amounts in their homes.

10 Some risks still exist with cash, since the Government could fail, or currency be significantly devalued through inflation or exchange rate changes. Furthermore, cash can still be stolen, lost or destroyed.

11 Reserve Bank of New Zealand (2017). The earnings that the Bank makes on currency operations is known as seigniorage, which is used to fund the Bank's other functions and provides a dividend to the New Zealand government.

Con: Issuing a digital currency might require additional monitoring and compliance.

A second cost of issuing a digital currency is that it could require additional monitoring and compliance under Anti-Money Laundering and Countering Financing of Terrorism (AML/CFT) laws. In New Zealand, the AML/CFT Act (2009) requires New Zealand's financial institutions to detect and deter money laundering and terrorism financing. A central bank might be required to monitor the users of its digital currency to comply with this legislation. In addition, a central bank might wish to monitor payments with its digital currency to prevent issues such as fraud. Conventional digital currencies would be theoretically easier to monitor from an AML/CFT perspective due to their centralised design, while crypto-currencies could be more difficult to monitor depending on the level of anonymity and decentralisation embedded in the distributed ledger.

It is possible that distribution of the digital currency to the public, along with its AML/CFT compliance and fraud monitoring, could be outsourced to the private sector. For example, the Reserve Bank issues cash to the public via the banking system, which means commercial banks monitor large value cash deposits and withdrawals from an AML/CFT perspective. Dyson and Hodgson (2017) suggest private banks could administer a central bank's digital currency via designated bank accounts, but the funds in these accounts would be fully held by the central bank. This would alleviate central banks from the administrative burden of issuing money to the public.

Con: A digital currency is vulnerable to electricity outages in emergencies (unlike cash).

A fourth potential con of a central bank-issued digital currency is that it is vulnerable to outages in electricity and internet connections, so is not reliable in a state of emergency. Moreover, issuing a central bank digital currency could reduce the demand and supply of cash, which is an important back-up payment method when there are electricity or internet outages. A shortage of cash could worsen the impacts of emergencies and natural disasters. Therefore, if a central bank were to issue digital currency, it might need to mitigate this risk by requiring formal back-up cash management plans. For example, in the February 2011 earthquake in Canterbury, emergency ATM machines were set up in temporary containers powered by generators to provide access to cash. Formalising back-up arrangements such as this would ensure cash is available for emergencies regardless of the demand and supply of cash in normal times.

3 Payments system

The Reserve Bank operates systemically-important payments systems. It is also responsible for the soundness and efficiency of the financial system, of which the payment system is an important component. Therefore, the Reserve Bank is interested in the pros and cons of issuing a digital currency for the soundness and efficiency of the payments system. Given the network effects associated with payment systems, the benefits of a central bank-issued digital currency depend on how many users decide to use the new currency.[12] For the purposes of this article, we assume that a central bank digital currency would attract a large network of users for the same reasons that cash has attracted a

12 Network effects refer to the benefits of being attached to a network increase as more people use the same network.

large network of users: it is a trustworthy form of money, issued by a government, and can be used to pay taxes.[13]

The underlying technology used to support a digital currency has significant implications for payment systems. Here, we distinguish between a digital currency based on conventional payment systems and one based on crypto-technology. A conventional digital currency has three potential pros for payments, while a crypto-currency could result in several pros and cons for payments depending on what form of DLT it transacts on.

Conventional digital currency

A conventional digital currency may be able to resolve inefficiencies in the current electronic payments process. Although current electronic payments have generally become simple and fast to instruct from the payer's perspective, some back-end inefficiencies remain. In particular, electronic payments are not settled at the same time as they are instructed, and they can carry expensive fees for payers and merchants. A conventional digital currency issued by the central bank could have three pros: faster settlement, reduced fees and more anonymity than existing electronic payments.

Pro: Faster settlement with conventional digital currencies.
The first pro of a conventional digital currency issued by the central bank is that it might improve settlement speed. As set out in Wadsworth (2018b), existing financial market infrastructure requires payments to be cleared before being settled. Clearing is the process of sending the transaction information to the issuing bank (payer's bank) and the acquiring bank (payee's bank) – communicating who should be paid what, and by whom. Settlement is the actual exchange of money between banks. Currently, the end-to-end payment process can take up to several hours or days to be completed depending on the payment type and when it was instructed. These delays in settlement impose a cost on the receivers of payments and represent an opportunity to improve payments efficiency. The receiver could be better off if the funds were received instantly, and this would impose no extra cost to the payer. In addition, settlement delay requires protocols to determine payment finality if a commercial bank failed.

A conventional digital currency could improve settlement because payments could be settled quickly by the central bank updating account balances. The central bank is both the acquirer and the issuer of funds, removing the need for any interbank co-ordination. This is similar to when the payment sender and receiver are using accounts within the same commercial bank. However, transactions between a central bank-issued digital currency and commercial bank accounts would require interbank settlement and thus would be susceptible to the same delays that affect current electronic payments.

Cross-border transaction processing could also be improved with a central bank digital currency. Currently, cross-border transactions require the co-ordination of a network of banks and payments systems to instruct and settle payments across countries. This can take up to five days to settle.[14] A central bank digital currency could improve settlement times by reducing the number of service providers required on at least one side of the transaction. If the transaction was between two central bank-issued

13 Wadsworth (2018a).

14 He. *et al* (2017).

digital currencies then the settlement might only require a currency exchange market.[15]

Pro: Potentially lower transaction fees with conventional digital currencies.

The second pro of a conventional digital currency would arise if a central bank charged lower fees for payments processing than existing electronic payment providers. Currently in New Zealand, domestic electronic domestic card transactions (excluding EFTPOS) incur a fee to the merchant (payee) of between 1.2 to 1.6 percent. This fee is charged by banks and can be passed onto the consumer (payer) via higher goods prices or surcharges.[16] A central bank is not profit motivated, and so might be able to charge a lower fee for electronic transactions with the digital currency compared to current payment providers. However, it would still need to cover the costs of providing the digital currency and its payment network (depending on its form).

Pro: A conventional digital currency could offer more anonymity than existing commercial bank card payments.

A third potential pro of a conventional digital currency is that it could enable more payment anonymity than existing card payments, and less anonymity than cash. This anonymity would depend on the design of the conventional digital currency. As mentioned earlier, an account-based currency would be similar to electronic money in transaction accounts offered by commercial banks. Therefore, this form of central bank digital currency would offer little anonymity.

However, a token-based currency could offer some anonymity. This is because the central bank would not necessarily be able to identify who is holding each token, and attribute payments to individuals. For example, payment settlement for a token-based central bank digital currency would likely involve a central bank moving funds from one token to another token (or to another account if an external payment) without identifying who holds each token.[17] To the extent that tokens are swapped regularly between people, it could be difficult to identify who initiated certain payments. But as mentioned, token-based currencies would not be truly anonymous. All transactions with digital currencies leave an electronic record. Therefore, even payments with a token–based currency would be less anonymous than cash payments (of which there is no record).

Partial anonymity may be a pro for a central bank digital currency as it strikes a balance between a means of payment that can deter crime (as electronic records of transactions would exist) but which also satisfies public demand for anonymity (particularly if cash was not widely available or used). Rogoff (2016) suggests a central bank could issue a digital currency that was anonymous up to a certain limit if it wanted to preserve anonymity while also deterring tax evasion, money laundering, and illegal transactions.

Crypto-currency

Evaluating the pros and cons of a crypto-currency on payments efficiency is more complex. In general, crypto-currencies rely on DLT to transact. How crypto-currencies impact the payment process depends on how the underlying DLT is designed. Not all technologies with the name ‘DLT’

15 Another way to improve cross-border payments is to reduce inefficiencies in the existing systems. One improvement of this nature is the SWIFT, Global Payments Initiative (GPI) that attaches a unique reference number to payments amongst participating banks. This initiative encourages faster payments by revealing the source of delays. There is also an emerging sector of global currency exchanges (that use conventional digital currencies) that can circumvent the correspondent banking system to provide cross-border settlement.

16 Retail NZ (2018). In addition, banks charge annual fees to cardholders.

17 Settlement of a token-based digital currency would be similar to settlement with prepaid payment cards that are not registered to a specific person (e.g. an unregistered Visa Prezzy card). The balances of these cards are usually linked to a single pooled account at a bank, and the value associated with a card is tracked separately by card number. Furletti (2004).

are the same. Wadsworth (2018b) finds that some forms of DLT can substantially change the payments process from the existing system, while other forms of DLT appear similar to existing payments systems.

A DLT enables faster settlement by combining clearing and settlement into one step called 'validation'. This contrasts with a conventional central bank-issued digital currency which enables fast settlement because the central bank performs clearing and settlement quickly. In DLT, there is no separation of sending the financial transaction information and the final interchange of money.

Pros and cons of a crypto-currency with distributed and transparent validation.

To get a sense of the pros and cons of crypto-currency it is useful to begin by evaluating a crypto-currency that is similar to Bitcoin. Bitcoin relies on Bitcoin-blockchain (Blockchain) technology, which substantially changes the payments process compared to that generated by conventional systems. These changes can be attributed to the distributed and transparent nature of Blockchain validation.[18] Crypto-currencies based on Blockchain benefit from several pros:

- The increased transparency of balances and transactions on Blockchain provides a 'single source of truth' and is useful for record keeping.
- There is no single point of failure, making the Blockchain more resilient to cyber-attacks and operational failures compared to existing payment systems.
- Settlement and clearing are combined into one step, removing the delay between clearing and settlement that can exist with current electronic payments. This means once a payment is validated the payee immediately receives the payment, which is beneficial for individual liquidity management.
- Payments are anonymous in the same way as payments with token-based conventional digital currencies. On the Blockchain, payments are authorised when the owner provides their digital signature. Digital signatures are encrypted code that verify someone's unique identity and are used to validate ownership of crypto-currency for transactions, but do not reveal the identity of the owner. However, the electronic record of transactions means that if a digital signature is traced to a person, then all of their transactions are easily identified.
- Payments are borderless. This means that transactions between currency holders are not complicated by their physical location.

Crypto-currencies based on Blockchain also come with several cons:

- Transaction validation on the Blockchain requires high energy inputs, which can result in higher transaction fees compared to current domestic transaction fees. These fees can be relatively high because individual validators (who could be anyone with a computer) must be compensated to incentivise validation and to cover the cost of electricity.

18 Validation ensures that money is not double-spent on the Blockchain. It relies on proof of work and consensus. A third party on the Blockchain validates a group of transactions by using brute computing power to find a proof-of-work hash (a mathematical proof that solves a cryptographic problem). The proof of work is shown to the Blockchain network and validation is completed if, and when, the majority of the network agree that the transactions can be added to the Blockchain—this is called consensus. See Wadsworth (2018b) for more details.

- Payment finality occurs after the transaction is validated, which can delay the release of goods and services. For example, payments initiated over the Blockchain typically have a delay of around 10 minutes. This means buyers and sellers might wait about 10 minutes before goods and services could reasonably be released. Currently, most domestic electronic payments are legally finalised after the payment is authorised (which occurs relatively quickly).

- The Blockchain is not scalable to relatively high volumes of payments due to the computing power and time delay required to validate transactions.

- Payment finality is one-way (there are no refunds) and probabilistic (based on a high probability payments cannot be changed). The proof-of-work validation and the length of Blockchain make it difficult, but not impossible, for a malicious agent to change historical transactions on the Blockchain (and fraudulently spend money that have been already spent).

Pros and cons of crypto-currencies with centralised validation.

The Bank of Canada and Monetary Authority of Singapore have experimented with DLT by attempting to capture the benefits of blockchain while avoiding the cons outlined above.[19] In particular, these experiments improve end-to-end payment speed and reduced the cost and scalability concerns of crypto-currencies by introducing a central validator of transactions. However, Wadsworth (2018b) finds the resulting ledgers became more similar to a conventional digital currency, such as a token-based currency. This results in three pros which are similar to the pros of conventional digital currency:

- Faster settlement compared to existing payments.

- Reduced cost (depending on the central bank fees).

- A degree of anonymity.

Con: Crypto-currencies issued by central banks are not borderless.

A crypto-currency issued by a central bank is not likely to be borderless as it would generally only be accepted within the country that issued it. As with a conventional digital currency, cross-border transactions with a crypto-currency could circumvent the existing network of international payments services. These transactions would require a currency exchange. Provided an exchange existed, a cross-border transaction with a central bank-issued crypto-currency could reduce payment settlement time from days to hours.

Private crypto-currencies like Bitcoin are considered to be borderless because they are not affiliated with any country, but they do depend on crypto-currency exchanges to be converted into domestic currencies.[20] Reliance on private crypto-currency exchanges carries risk as these exchanges are centralised and typically opaque. This has led to a number of high-profile cyber-attacks on privately owned exchanges, such as the cyber-attack on the Mt. Gox exchange.

19 These experiments were conducted in two phases. This section focuses on the phase two experiments.

20 Crypto-currency exchanges are reasonably common and large but tend to serve only specific currency pairs (i.e BIT/USD etc). Bitfinex is the largest crypto-currency exchange and processes USD 5.7 billion transactions each day. Bitfinex exchanges 10 major crypto-currencies into US dollars and other currencies. Cryptopia is a New Zealand-based exchange and processes about USD 63 million a day.

4 Monetary policy

The Reserve Bank has an objective to use monetary policy to ensure price stability by targeting an inflation rate between 1 and 3 percent, as well as supporting maximum sustainable employment. To do this the Reserve Bank uses a tool called the Official Cash Rate (OCR). This section considers whether a central bank digital currency would be useful as an additional monetary policy tool.

The Reserve Bank influences short-term interest rates in the economy by changing the OCR. Commercial bank interest rates are based on the OCR.

- Banks would be unwilling to lend money for less than what they can earn from deposits with the Reserve Bank (a rate of OCR).*
- Banks would also be unwilling to borrow money for more than what they pay the Reserve Bank (a rate of OCR plus 50 basis points).*

Hence the Reserve Bank can move the OCR to either lower interest rates and stimulate inflation, or increase interest rates and contain inflation.

However, the OCR as a monetary policy tool has two limitations. Firstly, it relies on commercial banks to pass through interest rate changes to deposit and lending rates. This leaves a risk that banks may not pass on the full changes in interest rates if they need to retain margins. Secondly, cash imposes a lower bound on monetary policy, which means that interest rates on bank deposits cannot be lowered below a certain level. This is because deposits can always be converted into cash which has a zero interest rate. Depositors may be willing to accept negative interest rates up to the point at which the costs of storing, insuring and transporting cash are equal to the negative interest rate charged on bank deposits. This is referred to as the effective lower bound.[21]

This section considers whether a central bank-issued digital currency, as an additional monetary policy tool, could improve these constraints on monetary policy implementation.

Pro: Central bank digital currency could be used as a direct monetary policy tool if it was interest bearing.

The first pro for monetary policy is that a digital currency issued by a central bank could be used as a monetary policy tool. This requires relaxing our baseline assumption that the central bank digital currency is not interest bearing. A central bank might want to relax this assumption because a digital currency issued with no interest would increase the lower bound on monetary policy to zero percent, therefore further limiting the effectiveness of monetary policy. In this scenario, depositors would have no tolerance for negative interest rates because there would be no cost of converting their deposits into the zero interest central bank-issued digital currency.

It is possible for a central bank to issue an interest bearing digital currency. Bordo and Levin (2017) suggest a central bank could directly pay interest on a digital currency at the same rate that is paid on other funds held by the central bank.[22] This suggests a single monetary policy interest rate. To stimulate inflation the policy rate would be lowered, and to lower inflation the policy rate would be increased. The policy rate

* This corrects an original number used in error.

21 Drought, Perry & Richardson (2018).

22 The forms of crypto-currencies that could have interest earning abilities would need to be explored further. This is currently outside of the scope of this article.

would be directly transmitted to households and businesses that hold the digital currency, as well as indirectly transmitted to the wider economy via the banking system.[23]

However, an interest-bearing digital currency issued by the central bank would not remove the effective lower bound because consumers could still transfer deposits into cash. To remove the effective lower bound, other methods need to be implemented. Rogoff (2016) argues a central bank should remove high denomination notes, Gesell (1916) suggests a tax on cash notes, and Agarwal and Kimball (2015) suggest a managed non-par exchange rate between cash and digital currency.

Another point to note is that an interest bearing digital currency could impact the assumption of par value between the digital currency and cash. If households and businesses valued the anonymous and physical attributes of cash highly then they could view cash as on par with a positive interest bearing digital currency. However, Barrdear and Kumhof (2016) suggest that an interest bearing digital currency issued by the central bank would be an imperfect substitute for cash and other financial assets. Therefore, further work is needed to understand the dynamics of an interest bearing digital currency and its exchange rate with cash.

Pro: A central bank digital currency could ensure monetary policy effectiveness if there was an extensive take-up of private crypto-currencies.

The second potential benefit to monetary policy is that it provides a way for a central bank to compete with private crypto-currencies if necessary.

Central banks are maintaining a watching brief on the uptake of private crypto-currencies by the general public. Private crypto-currencies do not interact with the existing banking system and so are not influenced by the policy rate. Therefore, if crypto-currencies grow in popularity it is possible a large number of deposits could move outside of the influence of monetary policy. To maintain monetary policy effectiveness, a central bank could either regulate the use of private crypto-currencies or issue its own crypto-currency to compete with the privately issued crypto-currency.[24]

However, because private crypto-currencies are not a stable form of money they do not pose a risk to monetary policy effectiveness in New Zealand.[25] In addition, private crypto-currencies are based on DLT, which is not designed to facilitate lending. While lending could occur on a peer-to-peer basis, there would not be a central agent to collect large volumes of short term deposits and transform them into long term loans.[26] Further, introducing a central agent to a DLT to conduct lending operations would introduce a single point of failure and create a target for cyber-theft.[27]

Globally, the current demand for private crypto-currencies has been too small to pose any threat to the transmission of monetary policy.[28] Work by the Bank of England has indicated that its monetary policy would remain effective in influencing the level of interest rates in the economy provided that the majority of payments were made using traditional currencies

23 Barrdear and Kumhof (2016) propose a more complex monetary policy mechanism. They indicate that a central bank could use a digital currency as a second monetary policy instrument in addition to the official policy rate. Their argument relies on a specific set of assumptions including regarding the digital currency as an imperfect substitute to other forms of money and financial assets. Central banks could have a digital currency interest rate as well as an official policy rate. The price rule involves changing the spread between the policy rate and the interest on the digital currency in a countercyclical way.

24 Alternatively, Davoodalhosseini and Rivadeneyra (2018) argue that in theory, a central bank could use open market operations (OMO) to influence the supply of these private crypto-currencies. But these operations would likely be limited depending on a central bank's holdings of all private crypto-currencies. Further, a central bank could not control the response from the issuers of private currencies.

25 Wadsworth (2018a).

26 Existing peer-to-peer lending platforms provide centralisation of deposits using bank accounts, enabling lenders to diversify their lending across a range of borrowers. Therefore, these platforms are different to the peer-to-peer lending that would occur on a distributed ledger.

27 Wadsworth (2018b).

28 Committee on Payments and Markets Infrastructures (2015), Barrdear *et al*. (2014), Aaron, Rivadeneyra and Sohal (2017).

and payment systems.[29] If a private crypto-currency was developed that overcame the current challenges of present crypto-currencies while retaining the benefits of a distributed DLT crypto-currency, then it could become more widely used.

5 Financial stability

The Reserve Bank is responsible for the soundness and efficiency of the financial system. Therefore, we must consider the potential implications for financial stability that could arise from issuing a central bank digital currency.

A digital currency issued by a central bank would provide a safer currency for transactions and deposits. Deposits in commercial banks are relatively risky because they are not fully backed by reserves and because commercial banks take on greater risks through their lending and market operations. For example, commercial bank deposits are at risk of being lost if the bank becomes insolvent due to risks materialising. A central bank digital currency would have a lower credit risk compared with commercial bank deposits. This might be attractive for risk averse households and businesses and would be more efficient than privately storing cash. However, this could result in three cons to the stability of the current financial system.

Con: Increased reliance on wholesale funding markets.

A central bank-issued currency introduces some costs to financial stability. The first cost would be increased reliance on wholesale funding markets. The core business of commercial banks is to provide savings accounts, facilitate payments and provide lending. A digital currency issued by a central bank would compete with transaction accounts, even more so if it was interest bearing. Commercial banks might find they lose some deposits as households put money into central bank digital currency.

In New Zealand, commercial banks would likely increase their reliance on overseas wholesale funding, accentuating our banking system's susceptibility to downturns in overseas markets. For example, if there was an international shock in the European or US markets, this could have more severe flow through to New Zealand via increased bank funding costs (risk spreads) or reduced availability of funding.

Con: Reduction in bank resiliency.

A second and related risk to financial stability is that a central bank digital currency could reduce commercial bank resiliency to economic downturns due to increased competition and lower profitability. If large sums of deposits move from commercial bank accounts to central bank digital currency, then commercial banks would have to compete for deposits by offering higher interest rates. Further, commercial banks earn significant revenues on payment fees that could be diminished if a central bank digital currency offers cheaper domestic and cross-border transaction fees. Competition with banking activities resulting in a reduction in bank profitability might imply that bank activities are being conducted more efficiently (assuming the central bank services were priced appropriately). But there may be adverse consequences for financial stability if less profitable banks become less resilient to shocks, or if they look to replace lost profitability by searching for higher yielding (more risky) assets.

29 Ali, Barrdear, Clews and Southgate (2014).

However, additional competition from a central bank digital currency might not result in lower bank resiliency. Commercial banks are already competing in the deposit accounts and payments part of their business.[30] For example, electronic wallets and non-banks such as PayPal, Google Wallet and TransferWise provide alternatives to transaction accounts in commercial banks. Further, history suggests that commercial banks have been able to compete with central bank-issued currency in the past. Fung, Hendry and Weber (2017) and Weber (2015) documented the co-circulation of central bank-issued notes and commercial bank-issued notes in Canada and the US. They found that the existence of government issued currency did not wipe out the use of commercial bank notes, despite commercial bank notes being inherently more risky than central bank notes. Therefore, there is evidence to suggest that commercial banks can compete with other private competitors and central bank digital currencies, for example by providing attractive services or higher interest on deposits.

Con: Increased risk of a system-wide bank run.

The third risk to financial stability is that a digital currency issued by a central bank could increase the risk of a system-wide bank run in a financial crisis. This is because depositors can more easily withdraw their money and transfer it to central bank digital money, compared to cash withdrawals. Cash withdrawals in bank runs typically require queuing at ATMs or bank branches and so reduce the speed of withdrawals, giving bank managers and regulators more time to react to the bank run. Electronic transfers of balances from a commercial bank to a digital currency could occur quickly as the physical location of depositors and number of physical withdrawal points are not a limiting factor. Therefore, a central bank-issued digital currency could increase the probability and severity of a run on banks. This is potentially more of a risk during periods of widespread instability, such as a financial crisis similar to that experienced in 2007/08. However, the risk of an individual or system-wide bank run can be mitigated by tools such as deposit insurance.[31]

30 Watson (2016).

6 Conclusion

The emergence of new financial technologies, including crypto-currencies and distributed ledger technology, have put the spotlight on central bank money issuance. Central banks are investigating whether they should take advantage of these new technologies, by issuing a digital currency of their own to the public. This article contributes to this discussion by evaluating the pros and cons of issuing a digital currency for currency distribution, payments, monetary policy, and financial stability. On balance, this article finds that there are a mix of pros and cons, as summarised in table 1, and leads us to three high-level conclusions.

First, a central bank digital currency could have significant impacts on monetary policy and financial stability, both positively and negatively. These are less dependent on the technology used for the currency and more sensitive to the how the digital currency is used and what constraints, if any, are placed on it. These could include, whether a bank digital currency is interest bearing, how easy it is to move between central bank digital currency and bank deposits, and whether it has a par value with cash.

31 It is worth noting that the risk of a run on an individual bank is not changed by the presence of a central bank-issued digital currency. Depositors can already electronically move deposits from one bank to another at short notice unless banks freeze these payments.

Table 1
Pros and cons of a central bank digital currency[1]

	Pros	Cons
Currency distribution	Safer and cheaper to transport than cash. Provides public access to an electronic form of legal tender.	Requires significant investment to issue. Transactions over a certain size would need to comply with AML/CFT legislation. Consumers could accidentally lose large sums of token-based conventional digital currency or crypto-currency. Reduces cash demand and supply which could reduce the availability of cash in an electricity outage.
Payments	Conventional digital currency and centralised crypto-currency: • Improve settlement speed. • Potentially lower fees. • Single point of failure. • Less anonymity than cash, but more than existing card payments. Blockchain-like crypto-currency: • Improves settlement speed, operational resilience, and cyber resilience. • All transactions are recorded on one ledger. • Cheaper for cross-border payments. • Less anonymity than cash, but more than existing card payments.	Blockchain-like crypto-currency: • Slow payment authorisation. • Inefficient use of electricity, and higher transaction fees for low value payments. • Not scalable. • Probabilistic finality. Cross-border transactions in any digital currency would require an exchange.
Monetary policy	Interest bearing digital currency: • Provides a direct transmission of monetary policy to households and firms. • Competes with private crypto-currencies to improve monetary policy effectiveness, in event of large take-up of private crypto-currencies.	Non-interest bearing digital currency: • Creates a zero lower bound on monetary policy.
Financial stability		Reduce bank resilience to economic downturns and incentivise search-for-yield behaviour. Increase commercial bank reliance on overseas wholesale funding, accentuating susceptibility to down turns in overseas markets. Increase the probability and severity of bank runs during periods of system-wide instability.

1 Blue text refers to pros and cons when one of the six assumptions listed in the introduction are relaxed.

Second, a central bank digital currency will result in a mix of pros and cons for payments efficiency and resiliency. These depend on whether the central bank issues a conventional digital currency or a crypto-currency. These pros and cons can be altered with the design of the central bank digital currency so do not appear to drive the debate of whether or not such a currency should be issued.

Third, a central bank digital currency could lead to cost savings for currency distribution, but it would also create new costs. It would also provide an electronic form of legal tender which could be more valuable than cost savings.

In conclusion, more research is required to weigh the pros and cons identified in this article. In particular, policy makers should investigate the implications of central bank digital currencies for monetary policy and the financial system by examining whether a central bank digital currency could be issued to the public while mitigating the cons that could arise. If a central bank digital currency posed large and significant costs on financial stability and monetary policy, then it could be impractical to issue one.

References

Aaron, M, F Rivadeneyra and S Sohal (2017) 'Fintech: Is this time different? A framework for assessing risks and opportunities for central banks', *Bank of Canada Staff Discussion Paper 2017-10.*

Ali, R, Barrdear, J, Clews, R and J Southgate (2014) 'The economics of digital currencies', Bank of England *Quarterly Bulletin,* 54(3), 276-286.

Andolfatto, D (2015) 'Fedcoin: On the desirability of a government cryptocurrency', *MacroMania*.http://andolfatto.blogspot.co.nz/2015/02/fedcoin-on-desirability-of-government.html .

Agarwall, R and M Kimball (2015) 'Breaking though the zero lower bound', IMF *Working Paper,* WP/15/224.

Barrdear, J and M Kumhof (2016) 'The macroeconomics of central bank issued digital currencies', *Bank of England Staff Working Paper 605.*

Barrdear, J, A Robleh, R Clews, and J Southgate (2014) 'The economics of digital currencies', *Bank of England Quarterly Bulletin.*

Bjerg, O (2017) 'Designing new money – The policy trilemma of central bank digital currency', *Copenhagen Business School Working Paper.*

Bordo, M and A Levin (2017) 'Central bank digital currency and the future of monetary policy', *Hoover Institution Economics Working Paper 17104.*

Committee on Payments and Markets Infrastructures (2015) Digital currencies. *Bank for International Settlements.*

Committee on Payments and Markets Infrastructures (2016) 'Statistics on payment, clearing and settlement systems in the CPMI countries', *Bank for International Settlements.*

Davoodalhosseini, M and F Rivadeneyra ' A policy framework for E-money: A report on Bank of Canada research', *Bank of Canada Staff Discussion Paper* 2018-5.

Drought, A, Perry, R and A Richardson (2018) 'Aspects of implementing monetary policy in New Zealand', Reserve Bank of New Zealand *Bulletin*, Vol. 81. No. 4.

Fung, B and H Halaburda (2016) 'Central bank digital currencies: A framework for assessing why and how', *Bank of Canada Staff Discussion Paper 2016-22.*

Fung, B, Hendry, S and W Weber (2017) 'Canadian Bank Notes and Dominion Notes: lessons for digital currencies', *Bank of Canada Staff Working Paper 2017-5*.

Furletti, M (2004) 'Prepaid cards: How do they function? How are they regulated?' Federal Reserve Bank of Philadelphia *Conference Summary*.

Gesell, S (1916), 'Die Naturliche Wirtschaftsordnung', available in English as 'The natural economic order', 1958, *Peter Owen Ltd,* London.

He, D, R Leckow, V Haksar, T Mancini-Griffoli, N Jenkinson, M Kashima, T Khianonarong, C Rochon and H Tourpe (2017) 'Fintech and financial services: initial considerations', IMF *Staff Discussion Note,* SDN/17/05.

Kay, J (2009) 'Narrow banking: the reform of banking regulation', *Centre for the study of financial innovation*, 88.

Koning, J (2016) 'Fedcoin: A central bank-issued cryptocurrency' https://static1.squarespace.com/static/.../t/.../R3+Report-+Fedcoin.pdf

Kumar, A and C Smith (2017) Crypto-currencies – An introduction to not-so-funny moneys. Reserve Bank of New Zealand *Analytical Note Series*. AN2017/07.

McAndrews, J (2017) 'The case for cash', ADBI *Working Paper 679. Tokyo: Asian Development Bank Institute.*

Reserve Bank of New Zealand (2017) *Annual Report.*

Rogoff, K (2016) '*The curse of cash'*, Princeton University Press, Princeton.

Sveriges Riksbank (2017) 'The Riksbank's e-krona project', *Svierges Riksbank Report 1*.

Wadsworth, A (2018a) 'What is digital currency?' Reserve Bank of New Zealand *Bulletin,* Vol 81. No. 3.

Wadsworth, A (2018b) 'Decrypting the role of distributed ledger technology in payments processes' Reserve Bank of New Zealand *Bulletin,* Vol 81. No. 5.

Weber, W (2015) 'Government and private e-money-like systems: Federal Reserve notes and National Bank notes, Bank of Canada Staff Working Paper 2015-18.

Wright, M (2016) 'The imagery and themes of the Series 7 "Brighter Money" banknotes', Reserve Bank of New Zealand *Bulletin*, Vol. 79, No. 15.

Glossary

Authorisation: The process of requesting approval for the transaction from the issuer and routeing the decision back to the merchant. The issuer will give authorisation if the payer has sufficient funds or credit to effect the payment.

Bitcoin: A crypto-currency that uses Blockchain and proof-of-work validation. Several competing crypto-currencies have Bitcoin in their name.

Blockchain: A distributed, open source, public and permissionless ledger. Titled the Blockchain as the ledger consists of a chain of completed blocks of transactions.

Clearing: The process of sending the financial transaction information to the acquirer and issuer and determining settlement obligations.

Closed source: Computer software that is owned by a private entity and where its source code is not published or shared to the public for alterations. The opposite of open source.

Conventional payment technology: Payment systems that use a more typical hierarchical and centralised structure to ensure trust and security.

Crypto-currency: A digital currency that requires distributed ledger technology and encryption techniques to be transferred.

Crypto-currency exchange: An online exchange market that enables crypto-currencies to be changed for other crypto-currencies or domestic currencies.

Cryptography (digital): Converting data into a code for transmission over a network. Typically the data text will be turned into a coded text using an encryption algorithm.

Cyber-attack: An attack by malicious hackers to steal information from or destroy a computer network system.

Digital (electronic) currency: A broad term that captures all forms of money that are not physical or tangible.

Effective lower bound: A limit on how low interest rates (and therefore monetary policy) can be due to the ability of households and businesses to convert deposits into cash which has a zero interest rate.

Fiat currency: Physical forms of money that a) a government issues and declares to be legal tender, and b) is not backed by a promise of convertibility into a tangible asset, such as gold.

Fixed conventional digital currency: Digital currency with a fixed exchange rate to national currency that relies on existing financial market infrastructure to transact.

Fixed crypto-currency: Crypto-currency that has a fixed exchange rate to fiat currency.

Fixed exchange rate: When the exchange rate between two currencies is held constant, often because the supply and demand dynamics are controlled.

International switches: A payment switch is transaction processing software that routes payment instructions and payment authorisations to and from issuing and acquiring banks.

Ledger: A record of account balances and transaction history.

Par value: Where the exchange rate between two currencies is one for one.

Payment instruction: The instruction between issuing and acquirer banks enabling a transaction to take place.

Point of sale (POS): Place where the transaction is initiated, i.e., at the shop till, or online checkout page.

Privately issued: [Currency that is] issued by a private entity or not a central bank or government.

Settlement: Settlement involves fulfilling the obligations between payer and payee. This might involve several different obligations such as payer to issuer; issuer to acquirer; and acquirer to merchant.

Validation: In a DLT transaction validation is the process of ensuring that the funds are not being double-spent and that ledger balances are accurate and true.

Variable conventional digital currency: Conventional digital currency with a flexible exchange rate to other currencies, including fiat currency.

Variable crypto-currency: Crypto-currency that has a flexible exchange rate to other currencies, including fiat currency.