

From Commodity to Fiat and Now to Crypto: What Does History Tell Us?¹

Barry Eichengreen
University of California, Berkeley
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1. Introduction

Money makes the world go round. More concretely, it greases the wheels of commerce and finance. The adequacy of the supply of currency and coin, and of their financial derivatives, has long been a preoccupation of governments, since the stability of the economy and hence of the state itself rides upon it.

Now the monetary landscape is being turned upside down by the digital revolution: by the issuance and circulation of private-label cryptocurrencies and the prospect of central bank digital currencies. These new units, it is said, will transform the monetary world as we know it. But just saying so doesn't make it true. The challenge is separating the facts from the hype.

This paper is an effort to get my mind and those of readers around the issue by placing it in historical perspective. I start with a brief review of the relevant European and U.S. history, starting with commodity money and moving from there to bank money and fiat currency. Digital currencies can be seen as the next step in this evolution, where advances in technology, first the substitution of currency notes for metal discs and now the substitution of bits for paper, allow means of payment, store of value and unit of account services to be provided more widely at lower cost. But at another level, digital currencies run counter to the prevailing historical trend, which has been in the direction of the state assuming control of the money supply and inhabitants of a common economic space converging on a common unit. The question is: when these two trends collide, which monetary unit survives?

2. Before Digital

Once upon a time, many polities meant many currencies. Early modern polities were fragmented. Europe, for example, was divided into more than 500 polities prior to the Peace of Westphalia in 1648. It was difficult, given the technological conditions of the time, for rulers to control large swathes of territory. Medieval France, for instance, was ruled by scores of feudal lords, each of whom operated his own mint.² It was hard for those rulers even to control their borders. As a result, monies issued – that is to say, minted – in different jurisdictions circulated across borders. Since those coins varied in purity (or fineness), they traded against one another at variable rates.

¹ Revision of a paper prepared for the Digital Currency Economics and Policy Workshop of National University of Singapore, November 2018. For comments I am grateful to Nadar Al-Jaji, Randall Morck and David Wen.

² Successive French monarchs took control of these feudal mints starting in the 13th century as part of their ongoing consolidation of power.

After 1648 the modern state system emerged. Rulers were able to control larger swathes of land with the help of modern military means, what the economic historian Philip Hoffman refers to as “gunpowder technology.”³ Standing armies became more important and also more expensive. It now became imperative for these centralized states to control the mint (or to grant it a royal monopoly in return for income) in order to be able to raise extraordinary resources in an emergency. The state or monarch used its brand name (that is to say, its reputation) to signal, hopefully credibly, that coins minted under its imprint were full bodied – that they contained precious metal of the specified purity in advertised amounts. As owner of the mint, the monarch or magnate enjoyed the advantages of monopoly, notably the largest possible stream of seigniorage revenue. Entry was deterred by the fact that mints were capital and skilled-labor intensive, immobile, and required publicity in order to attract business, characteristics that rendered start-ups vulnerable to discovery and expropriation by the crown.

Under exceptional circumstances, such as an existential threat from a rival power, the monarch had the option of reducing the metallic content of the unit in order to temporarily boost seigniorage revenues when these were needed to mobilize resources for the national defense and to ensure state survival.⁴ The dilemma was that the monarch might also be tempted to debase the currency and temporarily increase seigniorage for other less legitimate reasons, abusing his monopoly power. In the absence of competition, there might be little to restrain this temptation.⁵

Limits on such practices derived from the aforementioned tendency for coins minted in different jurisdictions to circulate across borders.⁶ The state monopoly of money, in other words, was still less than complete. Gold coin was the main means of payment used in long-distance trade; it followed that gold coin migrated across borders and that different coins circulated side by side. The same could be true of silver and even copper coin, depending on circumstances. Thus, the newly independent United States established a mint in 1792 and began striking U.S. silver dollars in 1894, but Spanish silver dollars (the basis for the famous “pieces of eight”) minted in Spanish America continued to circulate until they were demonetized by an act of Congress in 1857. Gresham’s Law suggests that debased coins should have driven full-bodied coins out of circulation, but in practice traders capable of assaying and weighing coins bearing different imprints could determine what they were getting and demand an appropriate premium when accepting debased money.

The advent of bank money, first bills of exchange (promissory notes connected to a specific transactions but often guaranteed and/or discounted by a bank) and then banknotes (claims backed not by specific transactions or collateral but by the reserves of the bank itself), added an additional layer of complexity.⁷ Now the state, in its capacity as regulator, had to decide whether this note-issuing privilege should remain a state monopoly and assign it to a

³ See Hoffman (2013).

⁴ This is the explanation for the state monopoly of money advanced by Glasner (1989).

⁵ The classic analysis of the problem is Cipolla (1963). Munro (2012) argues that debasement might reflect not just national defense imperatives but also be a response to a deterioration of coins in circulation.

⁶ The modern analog to this tendency is known as “currency substitution” or “dollarization,” where residents of a country subject to high inflation, presumably reflecting the government’s financing needs, substitute dollars or another foreign currency for the local money (see Alesina and Barro 2001 and below).

⁷ The modern banknote grew out of the notes issued by early modern goldsmiths (effectively goldsmith bankers) as receipts for the gold they held on behalf of their customers circulated hand to hand. See Quinn (1997).

avored agent (the central bank, which acted as its fiscal agent), or else to permit competition subject to restrictions. Typically the state monopoly was incomplete (Selgin 2008). Scottish banks issued notes alongside the Bank of England, for example.⁸ Until 1897, Swedish commercial banks were allowed to issue notes alongside the Riksbank. But banks that competed with the government or with its privileged fiscal agent did so subject to restrictions on the volume of private money they could issue, the collateral they had to hold, and the circumstances under which issuance could occur.

With the evolution of modern financial systems, governments developed additional means, aside from debasing the coinage or printing currency, of financing expensive wars.⁹ They could issue bonds, which they serviced and then retired following the conclusion of hostilities. The three most expensive wars of the 19th century – the Napoleonic Wars, the U.S. Civil War and the Franco-Prussian War, were heavily financed in this manner.¹⁰ The argument for concentrating issuance in the hands of a central or federal government now rested not so much on national defense imperatives as on economic efficiency arguments. A uniform currency minimized transactions costs. It substituted for information in that it was not necessary to have information about the creditworthiness of each and every issuer, since there was only one. Information being costly to produce, the information insensitivity of government money minimized these costs (Dang, Gordon and Holmstrom 2015, Berentsen and Schar 2018).

U.S. experience illustrates the range of alternative arrangements and consequences. In the newly independent United States, a *mélange* of foreign monies circulated (such as the famous Spanish pieces of eight, noted above). Prior to 1836, the paper money circulation was made up of the notes issued by state-chartered banks, whose number varied across states, plus one federally chartered bank, the Bank of the United States. State regulation, notably regulations specifying the obligation of the issuer to redeem its liabilities in specie at par, determined the conditions under which state-chartered banks could emit notes, together with corresponding limits. Importantly, the Bank of the United States with its nationwide branch network acted as enforcer of those regulations, returning notes to the issuing banks and demanding specie, especially when the notes in question showed signs of circulating at a discount.

For many bankers, this discipline was less than welcome, and their objections resonated with deep-seated American suspicion of concentrated power, leading President Andrew Jackson to veto the bill re-chartering the Bank of the United States when it reached his desk in 1832. Jackson's decision opened the door to the free banking era. To ensure an adequate supply of money and credit to the local economy, state legislatures liberalized licensing requirements for banks. No longer was it necessary to obtain a legislative charter, although some bankers still proceeded in this way. Banks could enter and operate without a charter so long as they met minimum capital requirements and held specie or financial assets readily convertible into specie in amounts sufficient to redeem their notes at par. Throughout the period, which ended with the Civil War, multiple competing private currencies circulated side by side, often trading at different prices. That these currencies were multiple, private and variable in price suggests a

⁸ Under different rules before and after the adoption of Peel's Act in 1844.

⁹ As emphasized by Glasner (1989).

¹⁰ Details are in Eichengreen, El-Ganainy, Esteves and Michener (2018).

parallel with cryptocurrencies. The difference is that there was regulation of the market from the start.

Efforts to evaluate the efficiency of that regulation and of the resulting market are controversial. Classic indictments like that of Hammond (1957) dismiss regulation as inadequate and bankers as opportunistic and duplicitous. Regulators allowed bankers to value discounted state government and railway bonds at par when reporting their capital and reserves. So-called wildcat bankers purchased bonds “with their own circulating notes and disappeared in order to avoid having to redeem the notes. They had to be hunted for in the woods...their cash reserves were sometimes kegs of nails and broken glass with a layer of coin on top” (p.601). By implication, these private currencies were not reliable units of account, means of payment, and stores of value.

Subsequent revisionism (Rockoff 1975, Rolnik and Weber 1983) insists that the situation was not so bad. Regulation was not uniformly incompetent. In some jurisdictions, such as New York State, it was in fact quite rigorous. Bank notes issued in New York traded at little if any discount, and losses to noteholders were slight. Where discounts were larger and more variable, the market policed and disciplined issuers through commercial note reporters that listed prevailing discounts on the notes issued by individual banks and prevented the latter from passing these off for more than they were worth. Still, it inconvenienced a storekeeper to have to consult a note reporter each time a customer presented him with a currency note. In other words, information alone was not enough to subdue dissatisfaction with the operation of the prevailing system.

This account begs the question of why regulatory enforcement differed so dramatically across jurisdictions. The answer is that the line between monetary and fiscal policy was blurred and, consequently, motives were mixed under this regime of private competing currencies. State governments with pressing fiscal needs and few alternative sources of finance, generally states on the frontier, saw state banks as a source of demand for their bonds, and generous regulatory treatment of those bonds was a way of augmenting that demand. The relationship became clear during the Civil War, when the Congress passed the National Banking Act creating a system of nationally-chartered banks required to hold their reserves in U.S. government bonds issued to finance the war effort, and then after the war when progressively higher taxes were levied on state bank note issuance, ultimately taxing the latter out of existence.¹¹ Federally-chartered banks were required to deposit U.S. government bonds with the Treasury and permitted to issue banknotes equal to 90 per cent of the value of the bonds. The Treasury stood ready to redeem those bonds or their currency equivalent in gold in fixed amounts on demand. Banknotes bore two serial numbers, that of the Treasury and that of the issuing bank. Notes traded at fixed prices relative to one another. That the federal budget was in surplus for much of the period removed the pressure to relax regulation.

But just because the currency was now uniform did not mean that it operated to everyone’s satisfaction. Populist politicians complained of the system’s deflationary bias, due to the fact that the volume of transactions and economic activity expanded more rapidly than the supply of monetary gold (recall William Jennings Bryan’s “Cross of Gold” speech at the 1896

¹¹ The tax in question was raised from 2 per cent to 10 per cent and then ultimately to 20 per cent.

Democratic National Convention). Economic specialists warned of the destabilizing consequences of volatile spikes in interest rates (Kemmerer 1911). Following the crisis of 1907 they worried about the country's dependence for stabilizing intervention on the good offices of one exceedingly wealthy individual, J.P. Morgan, and on the emission of clearinghouse certificates, in effect multiple private monies that circulated at discounts and premia against one another (Gorton 2009). The result, to cut a long story short, was the Federal Reserve Act of 1913 to create an "elastic currency," supplies of which expanded and contracted with the seasons.

Even then, however, multiple (semi-) private currencies – national bank notes with two serial numbers – continued to circulate. This changed with passage of the Gold Reserve Act of 1934, under which remaining national banknotes were retired. This change occurred in the throes of the Great Depression, when the federal government was mobilizing resources to fight the slump and fund its budget deficit (see Jacobson, Leeper and Preston 2017), again highlighting the fuzzy line between monetary and fiscal policies. The result was to give the United States the monetary system and federal government monopoly of money it has today – or that it has had until recently.

In sum, history shows a tendency for currency and coin issuance to be increasingly concentrated in the hands of the central or federal government. The national defense rationale for this centralization has if anything weakened over time. Modern economies, unlike their predecessors, accumulate the resources needed to defend themselves and prosecute military campaigns already during peacetime. Modern financial systems give their governments means other than debasing the coinage or printing currency to finance those operations. It is sometimes argued that the Vietnam War was a source of inflation in the United States in the 1960s, because it created pressure for the Federal Reserve to help finance federal government deficits.¹² Perhaps.¹³ But the general point remains: seigniorage, whether ongoing or on an exceptional basis, is a less important source of public-sector resources than in the past.

If so, then the argument for government monopoly of money issuance must rest on the economic efficiency of a currency that is both uniform (because there is only one issuer) and stable (because it is issued in economically appropriate amounts, for example by an independent central bank with a politically-assigned mandate to pursue price stability). Such a currency minimizes transaction costs. It substitutes for information in the sense that it is not necessary to have information about the creditworthiness of each and every issuer, there being only one.

It follows that the costs of producing and obtaining information about changes in the actual and prospective value of privately-issued digital currencies is an obstacle to their wider utilization. To put the point another way, the digital payment services provided by Visa and Mastercard, albeit at a price and only vis-à-vis certain counterparties, are attractive because they are information insensitive. The credit card companies provide the end user with protection from default. And a dollar credit on one's Visa account is convertible into dollars one-to-one.

¹² As argued for example by Riddell (1989).

¹³ For a skeptical view see Walker and Vatter (1982)

Stable Coins

From this flows the appeal of so-called stable coins, which are designed to maintain a peg (typically one to one) to an official numeraire (typically the U.S. dollar), and therefore should be information insensitive (assuming the viability of the model).¹⁴ Four types of stable coins can be distinguished, with different implications for the future of money and the future of digital money.¹⁵ Type 1 is the fiat fully collateralized stable coin, which is pegged one-to-one to the U.S. dollar or another existing numeraire. Tether is a leading example of a fully collateralized cryptocurrency pegged one-to-one to the dollar.¹⁶

More specifically, Tether is a U.S. dollar-linked fiat fully collateralized stable coin.¹⁷ Each coin is collateralized by an equal amount of U.S. dollar deposits held on deposit in commercial bank accounts in Taiwan. Like conventional cash transactions, Tether offers its users the advantage of anonymity, since those transactions can be verified using the Bitcoin blockchain. It displayed the promised degree of stability, with the exception of a brief period in April 2017, for several years.¹⁸

But this type of stable coin is expensive to operate. The issuer and its investors must commit substantial amounts of collateral in low-yielding liquid form. This makes the resulting “currency” more like the “money” created by commercial banks (see inter alia Tobin 1963 – quotation marks in original), which has to be funded by inter alia deposits, than the currency created by governments and central banks, which doesn’t have to be financed in this way. The contract gives reasons for doubting that the model is scalable, since large amounts of additional funding would be required. Assuming that the costs are passed along to the end user, there is no difference between holding a certain number of dollars in one’s commercial bank account and using that account to pay bills and receive wire transfers from one’s customers, on the one hand, and using Tether for transactions, on the other – aside from the fact that a conventional bank account may permit one to engage in a larger volume of transactions at lower cost, given the current state of blockchain technology.¹⁹ Tether’s market capitalization is just a small fraction of

¹⁴ Thus, my focus on whether it may be possible for the private or public sectors to issue a digital coin that is *stable* and *uniform* is why I consciously do not discuss other developments in the crypto space (Bitcoin and its rivals) that do not purport to display this stability and uniformity relative to the established numeraire.

¹⁵ I build on Pauw (2018), who lists three of the four categories I distinguish here.

¹⁶ Saga is an example of a collateralized currency pegged to an alternative numeraire, the IMF’s Special Drawing Rights (more on this below). Just like pegged exchange rates none of these coins are actually pegged one-to-one to their numeraire; rather they fluctuate within narrow bands as determined by bid-ask spreads and transactions costs. Saga’s is the only white paper I have seen that makes this explicit.

¹⁷ Other examples include Digix, which is supposed to be fully collateralized in gold, and Venezuela’s Petro, which purports to be fully collateralized by oil.

¹⁸ One conjecture about the April 2017 episode is that the Taiwanese banks cut off the international wire transfer privileges of Bitfinex, the digital coin trading platform that is Tether’s parent, causing Bitfinex to resort to Tether for liquidity. In the second half of 2018 there was then another period when the value of Tether dropped precipitously against the dollar. A full explanation for the unit’s behavior in this period is not available at the time of writing.

¹⁹ And there is also the fact that bank accounts may be insured by the Federal Deposit Insurance Corporation or another government agency. Working in the other direction, of course, is the fact that the anonymity that fiat collateralized currencies provide will be attractive for entities engaged in money laundering, tax evasion and terrorist finance.

that of Bitcoin, which suggests that the means of payment function – as opposed to speculation – is not the principal motive of investors active in the cryptocurrency currency space.²⁰

In addition, the search for profitability may encourage issuers to cut corners. Questions have been raised about whether Tether in fact holds all the dollars it claims. It has issued hundreds of millions of additional tokens without allowing its reserves to be audited.²¹ One is reminded of Bray Hammond’s “kegs of nails and broken glass with a layer of coin on top.”²²

A second category is made up of crypto collateralized stable coins. In this case another cryptocurrency is held as collateral to back the stable coin. This variant frees the issuer from having to deal with, *inter alia*, Taiwanese banks, which may have qualms about providing services to a platform that can be used for illicit purposes.

The problem in this case is that the value of the collateral will fluctuate, since the collateral is not in the form of a stable coin. Because the value of the collateral can fall, crypto collateralized stable coins, to be credible, must be overcapitalized, potentially making them even more expensive to operate than fiat collateralized stable coins. Dai, the leading crypto collateralized stable coin, has an announced collateralization ratio of 300 per cent. In addition, because nothing in principle prevents the value of the collateral from falling below the par value of the coin issuance, over-collateralization notwithstanding, these coins are vulnerable to bank-run-like problems.

A third category is the partially collateralized stable coin, of which Saga is an example. Saga is interesting in that it is issued by a nonprofit foundation and requires compliance checks so as to avoid facilitating money laundering and similar abuses, while also using blockchain to ensure the anonymity of transactions among approved parties.²³ It promises its users low transactions costs and scalability (time will tell).

Different from the first two categories of stable coins, Saga is only partially collateralized. The platform sells and buys Saga tokens in return for Ethereum (another cryptocurrency) and invests the proceeds, aside from an Ethereum liquidity buffer, in the fiat currencies making up the SDR basket. Initially the protocol holds 100 per cent reserves in these currencies, essentially replicating what Tether purports to do (in Tether’s case in dollars). Over time, however, Saga’s reserve ratio will be reduced. At what rate is not specified in the Saga white paper, which states only that the reserve ratio will decline “as inherent value becomes less volatile.” An unpublished paper on Saga’s “monetary policy” indicates that the reserve ratio will decline asymptotically to ten per cent (Saga 2018).

²⁰ There are now plenty of other fully-collateralized stable coins, such as TrueUSD, which is similarly pegged one-to-one to the U.S. dollar. But it maintains a \$10,000 minimum on redemptions and charges 10 basis points on transactions as of the time of writing.

²¹ It is sometimes argued that there is a fundamental tension between the need for credible auditing and cryptocurrency holders’ desire for anonymity. With effective auditing it becomes easier for governments to locate and freeze assets, which cryptocurrency holders are anxious to avoid, but the worse the auditing the less credible the backing.

²² A separate allegation is that additional units of Tether have been created to finance purchases of Bitcoin and artificially inflate the market in that unit (see Griffin and Shams 2018). I do not explore that avenue here.

²³ It will be interesting to see how background checks and anonymity fit together in practice.

Herein lies the problem. As the relevant footnote to the white paper notes, “...inherent value is derived from a combination of factors: market confidence, usefulness as means of exchange, sentiment, and future prospects.” Confidence, as any central banker with experience in operating a currency peg can tell you, is fragile. Just because volatility has been declining in the past, whether because of the existence of a larger installed base of users or for other reasons, is no guarantee against it rising in the future. And questions about confidence can become self-fulfilling when the reserves are fractional. If some holders of Saga tokens develop doubts, whether for reasons good or bad, about the convertibility of their tokens into fixed numbers of SDRs (more precisely, into units of Ethereum currently valued at those fixed numbers of SDRs), they will seek to cash out. Other holders, not wishing to be at the end of the queue, will scramble to do likewise before the reserve cupboard is bare. The platform’s fractional reserves could be exhausted by the resulting run.

Central banks faced with this situation generally respond in two ways. First, they devalue the currency, which reduces their ratio of liabilities to reserves. In the present context, this would not be consistent with the stable-coin rationale; it would not be good for confidence and market share. Second, they impose capital controls, effectively limiting the access of investors to their reserves. Limiting the convertibility of the crypto token into fiat currency in this way would again be inconsistent with the rationale for creating a stable coin and therefore for with future prospects.

The fourth variant is the uncollateralized stable coin. Smart contracts are used to manage the supply of the digital coin with the goal of maintaining its value against, inter alia, the dollar. The platform issues both digital coins and digital bonds, and the smart contract sells bonds for coin (coin for bonds) when the price of the latter dips (rises) in terms of dollars. In some variants, bonds are automatically redeemed by the blockchain in the same order in which they were issued, as opposed to being purchased on the open market, when it is necessary to expand the coin supply.

Bonds are less liquid than coin, come in larger denominations, and are less useful for transactions, but investors have an incentive to hold them because bondholders are promised “dividends” in the form of digital coin when additional quantities of the latter are issued (that is, when the price of the token threatens to exceed \$1). Dividends are funded out of the commission, or seigniorage, taken by the platform when selling additional coins. In addition, some uncollateralized stable coins issue a third unit, known as shares, whose recipients automatically receive additional coins when additional issuance is required and all bonds have been redeemed.²⁴

The viability of such schemes depends on success at growing the platform, since without additional stable coin holders/users, there will be no additional issuance with which to pay bondholders.²⁵ To be sure, when additional bonds are sold to prevent the value of the coin from

²⁴ Some uncollateralized cryptocurrencies, such as Carbon, foresee doing away with the bonds, issuing only tokens and “credits” – essentially equities – which, since they are not senior to other claims, are likely to be even more volatile than bonds.

²⁵ A less charitable way of putting it would be that this approach smells suspiciously like a Ponzi scheme..

slipping below par, the platform will then acquire the coin balances taken out of circulation. But those balances have to be retired, or frozen, to maintain the coin's value; they can't be injected back into circulation in order to pay dividends to bondholders without threatening the peg.

And even if the platform is growing, doubts about its future may undermine stability now. Doubts about whether the platform will be able to generate sufficient seigniorage in the future to pay the bondholders may cause investors to reduce their bids for new bonds, making it even more expensive for the platform to take excess coin out of circulation (increasing the value of claims on dividends relative to remaining circulating coin), which will only heighten preexisting doubts – with good reason. It's not hard to imagine a self-reinforcing spiral in which investors are unwilling to purchase additional bonds at any price and the platform is therefore unable to prevent the price of the stable coin from collapsing. Again, the problem will be familiar to anyone conversant in the literature on speculative attacks on pegged exchange rates.

It is not clear whether the architects of uncollateralized stable coins are conversant in that literature. The white paper for Basis (Al-Naji, Chen and Diao 2018), until recently the leading stablecoin, cites the existence of a five-year expiration date on its bonds as protection against the danger that the bondholder queue will grow too long to be serviced.²⁶ This reads like a non sequitur. As the authors write “We elected a 5-year bond expiration after rigorous simulation showed that this produced a robust system with sufficiently high bond prices even in the face of wild price swings. We save the details for later discussion.” Say no more.

Later in their white paper the authors argue that their system would be robust even if bond prices hit zero because bonds are automatically extinguished on reaching maturity at five years, reducing the dividend liabilities of the platform. Extinguishing old bonds without repaying the principal is akin to a debt default or restructuring, where the sustainability of a sovereign's debt is restored and bond prices rise after the bondholders receive a haircut. But as any student of sovereign debt will know, the promise of a haircut in the future will only make investors demand a larger risk premium ex ante and bring forward the crisis of sustainability ultimately requiring the haircut.²⁷

3. Central Bank Digital Currency

It follows that the only reliable way of creating a stable-value digital currency is for the central bank to issue it. The central bank can issue digital currency by fiat, as it were. It can

²⁶ In December Basis announced that it was returning its remaining capital to its funders, having concluded that its bonds would be treated as securities by the Securities and Exchange Commission and thus be subject to regulation.

²⁷ A final issue is whether private-label stable coins would in fact be able to efficiently execute the means-of-payment function offered by conventional currency – or, for that matter, by credit card companies like Visa and electronic-payment platforms like Paypal but at a significantly lower price. One problem is the cost, in electricity and computing power, of verifying blockchain-based transactions. Some technologists claim that the efficiency of this process can be significantly enhanced; time will tell. Another problem is simple fraud: googling “Paypal fraud” or “stolen Bitcoin” reveals that this can be a serious problem for electronic payments problems and unstable cryptocurrencies. Why it should not also be a problem for stable coins is, to put it mildly, unclear. Visa and Mastercard have massive internal divisions whose sole purpose is to detect and deter fraud. Would a stable coin that relied on the digital wallet services of private providers be equally fraud proof and secure?

inject it into circulation by purchasing other financial assets. It can retire it by selling those assets. It can ensure parity between its digital and non-digital liabilities by standing ready to exchange them for one another in unlimited amounts, much as it exchanges nickels for dimes. 90 plus central banks are currently studying the possibility (Roland Berger 2016).

A central bank digital currency could be implemented in a number of different ways. The most straightforward is allowing individuals, and not just member banks, to maintain electronic accounts with the central bank. The central bank would be providing the same services as Visa, Paypal or a debit-card issuing commercial bank, with the advantage that access would be universal (Bjerg 2018). Everyone could have an account, just as everyone can carry currency notes in his or her wallet. This might result in social savings if universal coverage translates into additional economies of scale.

Alternatively, the central bank could issue a digital unit that circulates in a distributed fashion – that is held in mobile wallets or on electronic smart cards, between which payments could take place directly. This model would presumably be useful mainly for smaller transactions. It is also conceivable that access to central bank digital currency could be limited to businesses and usable only for wholesale payments (Bech and Garratt 2018).

There is also the issue of the efficiency of public enterprise. Whether private-label digital currencies, and for that matter private mobile-payment platforms like Paypal or Visa, could successfully compete with a central bank offering digital payment services to retail customers is far from clear. Conversely, absent the chill winds of competition, the efficiency of the dominant state-sector producer can be questioned. Granting a monopoly to a public-sector enterprise or positioning it to be the dominant player results in social savings only if that public enterprise is efficient in delivering services. In practice the efficiency record of public enterprises is far from spotless.

Having the central bank issue the digital currency, much less giving it a monopoly in this space, would not appeal to libertarians who oppose all government involvement, though this would be less bothersome to the rest of us. One can imagine different systems in different countries that attach varying degrees of anonymity to transactions conducted using the central bank digital currency. One can imagine a blockchain-based approach in where all transactions are anonymous, although this might create concerns about tax evasion, money laundering and other criminal activity.²⁸ Alternatively one can imagine a system in which the central bank sees every resident's balance but not the counterparty in each and every transaction, just as different countries apply and enforce rules on cash transactions of various degrees of severity (Rogoff 2016).

But concentrating all digital currency transactions at the central bank would also concentrate risk, in much the manner that concentrating the clearing of trades in derivative securities in central clearinghouses concentrates failure risk.²⁹ If the central bank's digital currency network goes down, cash transactions may be halted (all of them if digital currency

²⁸ These concerns would be all the greater insofar as it would be easier to engage in large-value surreptitious transactions using digital as opposed to paper currency (Claeys, Demertzis and Efastathiou 2018).

²⁹ See the discussions in Roe (2013), Yadav (2013) and Peirce (2016).

replaces paper currency *in toto*).³⁰ For terrorists and hackers, the central bank's digital currency network would be a rich target.³¹ Then there are the related problems of counterfeiting digital currency and preventing its theft (stories of private cryptocurrencies being stolen from digital wallets and platforms by hackers exploiting software glitches being legion).³²

Companies like eCurrency seek to provide central banks with hardware, software and advanced cryptography protecting them against counterfeiting, theft and security threats.³³ Blockchain may be part of the solution, although eCurrency also refers to additional layers of hardware and software encryption (Yanqing and Xintong 2018). Others (e.g. Grym, Heikkinen, Kauto and Takala 2017) argue that blockchain is not suitable for central bank digital currencies and advocate other solutions entirely. Whatever the solution, regulators have an old saying about their relationship with the regulated – regulators are like bloodhounds, always on the trail, but the regulated are greyhounds; they run very fast – which would also seem to be applicable here.

Another financial-stability concern is the danger of facilitating runs on conventional banks (Tolle 2016). Claims on the central bank, including currency claims, are presumably free of default risk, where this is not necessarily true of claims on commercial banks. Historically, when doubts develop about the stability and solvency of the commercial banking system, depositors have shifted into currency (see e.g. Boughton and Wicker 1979). The danger is that this kind of behavior will become more frequent, it being easier to shift one's digital balances from a commercial bank to the central bank with a mere swipe of the phone – with destabilizing consequences.³⁴

Some observers (National Bank of Denmark 2016, Coats 2018) have suggested that this risk could be mitigated by limiting the volume of such transfers or limiting the overall size of central bank digital accounts. But this would presumably give rise to the situation where central bank money traded at a premium relative to accounts held at commercial banks, reintroducing all the complications of a non-uniform currency.

³⁰ Recall the brouhaha that resulted on June 1, 2018 when some of Visa's systems went down, preventing its European customers from making purchases. And recall that those were only some systems of one of several competing commercial networks affecting only one part of the world.

³¹ It can be argued that a blockchain-based central bank digital currency, because it is distributed, removes this single point of failure and should therefore be more resilient, but it has other costs, such as high energy inputs, and would still be vulnerable to internet and electricity outages (Wadsworth 2018)

³² Some central banks, the Danish National Bank for example, have provisionally concluded that the benefits are outweighed by the risks (National Bank of Denmark 2017).

³³ It is sometimes said that the costs of issuing a digital currency would be less than those of printing paper currency. Given the costs of ensuring security, the accuracy of this assertion is uncertain.

³⁴ Berentsen and Schar (2018) argue that a central-bank-issued digital currency would be stabilizing because commercial banks would respond to this increased danger of runs by de-risking their operations and upgrading their business models. Claeys, Demertzis and Efstathiou (2018) conjecture that they could move to full reserve banking. My own reading is that the connection between run risk and de-risking is tenuous and that the unintended consequences of the former can be costly. For elaboration see Admati and Hellwig (2013). Then there are the implications for commercial bank funding. Wadsworth (2018) conjectures that commercial banks would respond to the availability of retail accounts at the central bank by increasing their reliance on wholesale funding. As demonstrated in the 2008 financial crisis, such reliance could weaken the stabilizing function of deposit insurance. It could also amplify destabilizing cross-border spillovers insofar as that wholesale funding is from abroad.

Finally there are the implications of central bank-issued digital currency for the conduct of monetary policy. Monetary policy operates first and foremost by influencing the deposit and lending interest rates of commercial banks. By altering the policy rate, the monetary authority changes the incentive for commercial banks to maintain reserves at or borrow from the central bank, and thereby the volume and price of deposits and loans. Were a central bank-issued digital currency available, it would become easier for individuals as well as banks to shift their balances to the central bank, (as just noted. And if interest was paid on those central bank balances, individuals would have an incentive to do so in response to changes in the policy interest rate. Commercial banks would more quickly see the impact of the change in the policy rate on their funding costs, increasing the speed of pass-through from the policy rate to other interest rates (Meaning, Dyson, Barker and Clayton 2018). If a given change in the policy rate elicited a larger shift away from commercial bank retail deposits, the size of the induced change in lending rates might be accentuated. If banks respond to the greater flightiness of demand deposits by increasing their reliance on time deposits and other forms of long-term funding, however, these effects could be eliminated or reversed.

Introduction of a central bank digital currency could also eliminate the zero lower bound on interest rates, since nothing would prevent the central bank from paying negative interest on the balances of retail customers (just as some central banks have paid negative interest rates on reserves). This would represent an increase in the transparency of policy in periods when interest rates are around zero, since at present the central bank is forced to resort to quantitative easing and credit easing, operations that are relatively opaque (Bordo and Levin 2017). This would, however, require the abolition of cash, which individuals can hold to avoid negative rates.³⁵

The maintenance of universal digital accounts at the central bank would also be a way of facilitating the use of “helicopter money.” The central bank, in lieu of quantitative easing, could simply drop additional currency into everyone’s digital account. This assumes, of course, that account holding is universal. It assumes a distribution rule (does everyone get the same absolute amount? Does everyone get an amount proportional to their existing holdings?). One suspects that even with a central bank digital currency, helicopter money remains in the realm of social science fiction.

Overall, it would appear that the implications for the conduct of monetary policy are consequential but not revolutionary.

4. Conclusion

History is not a linear process. There is no straight line from commodity money to fiat money and from there to crypto, nor from metallic currency to paper currency and from there to digital. Still, some broad trends are evident in the historical record. There has been a tendency over time for political jurisdictions and inhabitants of common economic spaces to converge on a single currency. Political leaders like it this way, since their monopoly of seigniorage is a source

³⁵ Alternatively, the central bank could impose a time-varying paper currency deposit fee on commercial banks at its cash window (Agarwal and Kimball 2015). But this would represent a loss in the policy transparency and simplicity otherwise gained.

of power and a valuable lifeline when sovereignty is threatened. Economic agents like it, since the existence of a uniform currency that is information insensitive (that is free of counterparty and liquidity risk) facilitates transactions and economic activity generally. Followers of Hayek (1976) might prefer otherwise, but history is against them.

To every rule there are exceptions. Early modern Europe was, to some extent, an exception, where different coined monies circulated side by side, trading at different prices vis-à-vis one another owing to clipping, debasement and related practices. The United States from the 1830s to the 1860s was an exception, where competing currency notes circulated side by side, at varying discounts, owing to hostility to the idea of a powerful federal government empowered to regulate the currency supply. Episodes of high inflation are another exception, where agents have an incentive to substitute foreign currencies for the unstable domestic unit. But the broad tendency, it is fair to say, has been in the direction of one currency for each political jurisdiction and common economic space, where in practice those political and economic spheres coincide.³⁶

The question is whether digital currencies will now reverse this trend, given the apparent ease with which they can be created. At the moment such digital units are proliferating. But the information sensitivity of those units, as evident in the fact that they trade at varying prices against one another and the established numeraire, suggests that they fail to provide the core functions of money. So-called stable coins are intended to bridge this gap by providing a reliable store of value, means of payment and unit of account, but whether they can be scaled up at reasonable cost (when fully collateralized) or maintain their stability (when not) is doubtful.

The one unit that can clearly meet these dual challenges of scale and stability is central bank digital currency. But there would be both costs and benefits of such a currency. The case is not a slam dunk.

³⁶ The Euro Area is of course an interesting exception where the political and economic spheres do not coincide, but it is subject to its own problems (that are properly the subject of another paper).

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