Central Bank Digital Currency and the Future of Monetary Policy

Michael Bordo and Andrew Levin

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A number of major central banks are actively exploring the initiation of sovereign digital currencies. In this analysis, we consider how a central bank digital currency (CBDC) can transform all aspects of the monetary system and facilitate the systematic and transparent conduct of monetary policy. Building on a long strand of the literature in monetary economics, we formulate a set of overarching design principles. In particular, we find a compelling rationale for establishing a CBDC that serves as a stable unit of account, a practically costless medium of exchange, and a secure store of value. In particular, the CBDC should be interest-bearing, and the central bank should adjust that interest rate to foster true price stability.

I. Background

Digital currency is an asset stored in electronic form that can serve essentially the same function as physical currency, namely, facilitating payments transactions; cf. BIS (2015). At present, the only forms of digital currency in wide circulation are *virtual currencies* created by private individuals or entities. Bitcoin is the most prevalent example, with an outstanding value of about $15 billion as of early 2017.[1] Nonetheless, bitcoin has a number of intrinsic limitations. First, the total supply of bitcoin follows a predetermined path with a fixed limit; consequently, the value of bitcoin can vary markedly over time in response to fluctuations in demand or speculative motives, similar to the price of gold and other physical commodities. Second, bitcoin creation and verification involves "mining" activities that consume substantial electric power at nontrivial cost.[2]

In contrast, a number of central banks are actively exploring the initiation of sovereign digital currencies that would serve as legal tender and could be used by anyone.[3] In contrast to bitcoin, the value of the central bank's digital currency would be fixed in nominal terms. Moreover, the central bank's digital currency could be implemented using an account-based system, thereby avoiding the resource-consuming "mining" operations involved in generating virtual currencies like bitcoin.[4] Allowing private individuals and firms to hold accounts directly at the central bank is by no means unprecedented; indeed, a number of major central banks have had these sorts of arrangements in the past.

As discussed in Goodfriend (2016), the launching of a central bank digital currency can be accompanied by an accelerated obsolescence of paper currency. Indeed, once the central bank's digital currency is widely used as a form of electronic payment, the demand for holding paper currency and coins would quickly diminish, especially if deposits and withdrawals of cash are associated with substantial fees by the central bank and private financial institutions. Of course, those individuals who preferred to engage in relatively anonymous transactions would remain free to use virtual currencies or other forms of payment.

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[1] See McCallum (2015) for further background and discussion.

[2] One recent estimate indicates that bitcoin mining consumes more than 1.5 terawatt-hours of electricity per year—roughly equivalent to the electric power usage of about 135,000 average American homes; cf. *Economist* (2015).

[3] For example, the Sveriges Riksbank has announced an accelerated timeframe for reaching a decision on launching a digital currency, and the Bank of England is conducting a multiyear investigation. The Bank of Canada, Deutsche Bundesbank, Dutch National Bank, and the People's Bank of China are experimenting with alternative designs.

[4] An alternative possibility might involve the use of "permissioned blockchain" technologies; see Hayes (2016).

II. Design Principles

A. Medium of Exchange

Any individual, firm, or organization may hold funds electronically in a digital currency account at the central bank. This digital currency will be legal tender for all payment transactions, public and private. The central bank will process such payments by debiting the payer's account and crediting the payee's account; consequently, such payments can be practically instantaneous and costless as well as completely secure. Moreover, the central bank will strictly protect the privacy of all such transactions.

-- Facilitating universal access to digital currency is the natural parallel to this property of physical currency (i.e., bills and coins), which can be held by anyone and used in any financial transaction. Moreover, there is historical precedent for individuals and nonfinancial firms having accounts at central banks such as the Bank of England and Sveriges Riksbank; such private accounts were discontinued for practical reasons in an age of paper-based bookkeeping.

-- Establishing a digital currency will practically eliminate payment transactions costs for small businesses and consumers, with accompanying productivity benefits similar to those of a tax cut; cf. Barrdear & Kumhof (2016).

Central bank digital currency will be complementary to other payment methods; cf. Selgin (2008). In particular, individuals and businesses will be free to hold funds in accounts at private financial institutions and to make payments using such funds, and such financial institutions will be free to transmit and receive payments via private networks rather than the central bank's digital currency.

-- Large financial institutions are currently engaged in developing new payment networks using blockchain technology; cf. Brainard (2016a,b). However, such networks will likely exhibit increasing returns to scale and hence be imperfectly competitive. Consequently, in the absence of a digital currency, the imposition of complex, opaque and cumbersome government regulations might become inevitable in order to ensure that such networks did not discriminate against small banks, small businesses or consumers.

-- In effect, digital currency is an instance in which the public sector has a natural role in fostering competition and facilitating access to a practically free resource that has significant externalities. The conceptual underpinnings of this rationale trace back to Adam Smith (1776), who concluded that currency is a "natural monopoly" that should be regulated by the government.

-- Moreover, establishing a digital currency is likely to be particularly beneficial to smaller banks and other financial institutions that engage in customer-focused "relationship banking." In many communities, such institutions play a crucial role in providing financial services to small businesses, entrepreneurs, and households.

B. Unit of Account

The central bank's digital currency should serve as a stable unit of account that facilitates the economic and financial decisions of individuals and businesses, including the determination of wages and prices, the spending and saving decisions of consumers, and the specification of financial contracts. Thus, the monetary policy framework should ensure that the value of the central bank's digital currency remains stable over time in terms of a general index of consumer prices. (The specific characteristics of the monetary policy framework and the price target will be discussed in greater detail below.)

-- This design would embed the most appealing features of the classical gold standard while avoiding its disadvantages and pitfalls. Indeed, under the gold standard, the general price level was subject to substantial fluctuations and persistent drift due to shifts in the relative supply and demand for gold. Consequently, the problem of establishing a more robust unit of account was a recurring theme in monetary economics; cf. Jevons (1875), Marshall (1877), Wicksell (1898), Fisher (1913a,b), Buchanan (1962), Hayek (1978), Black (1981), Bordo (1984), Cagan (1987), and Patinkin (1993).

-- Stabilizing the value of currency in terms of a broad price index (rather than a single commodity) must be accomplished via monetary policy and cannot be achieved merely by issuing a legal edict. Indeed, in a market economy, it is logically impossible to define the value of the currency in terms of the general price level, because the prices of individual goods and services are set by businesses operating in specific markets rather than determined by a central planner.

-- Although government spending and taxes can have an influence on wages and prices, it would be a grave mistake to task fiscal policy with stabilizing the price level over time. Rather, the central bank should have primary responsibility for this mission, and fiscal policy should only become involved under extraordinary circumstances (as discussed further below). Indeed, these priorities echo the conclusions reached by Henry Simons (1936 ff.).

C. Store of Value

The digital currency should provide a secure store of value for individuals or businesses who wish to hold such funds at the central bank. One key question is whether such digital currency accounts should be interest-bearing and/or indexed to fluctuations in the general price level. Here we briefly consider each of these approaches in terms of the direct benefits to account holders as well as potential indirect effects on the broader financial system:

1. Constant Nominal Value. Funds in central bank digital currency accounts could have a constant nominal value, just like paper currency. Indeed, the Sveriges Riksbank is actively considering this approach; cf. Boel (2016).

-- In effect, the digital currency accounts of the general public would be treated distinctly from the reserves of commercial banks held at the central bank, which are typically interest-bearing.

-- During periods of positive nominal interest rates, households and businesses would be incentivized to keep most of their funds in interest-bearing accounts of financial institutions, and hence the stock of digital currency might remain fairly modest.

-- As in current practice, the central bank could conduct monetary policy by adjusting short-term nominal interest rates. However, this form of digital currency might severely constrain the central bank's ability to push nominal interest rates below zero, because depositors could readily move their funds into digital currency paying zero interest. Consequently, in a protracted period of weak aggregate demand and deflation, the central bank would likely need to rely on other tools such as quantitive easing; alternatively, the government would need to engage in fiscal stimulus to boost aggregate demand and thereby push the price level back up to its target.

-- Given those constraints on monetary policy, it might well be reasonable to maintain a positive "inflation buffer" to mitigate the severity of the effective lower bound on nominal interest rates. In particular, rather than having a fixed target for the general price level, it might be preferable for the target to trend upwards over time, i.e., the trajectory of prices would be stabilized around an upward-sloping path rather than a constant target.

2. Stable Real Value. The real value of funds in digital currency accounts could be preserved by indexing these funds to past changes in the general price level.

-- Such an approach would essentially encapsulate the "tabular standard" proposed by Jevons (1875) and Marshall (1877) and the "compensated dollar" of Fisher (1913). The rationale for indexing currency and other financial contracts was compelling under the gold standard, because the general price level was subject to large and persistent fluctuations; however, the practical obstacles at that time proved to be daunting. See also Bordo (1984), Bordo et al. (2007).

-- By contrast, indexing digital currency would be quite straightforward from a technical perspective but the rationale would be less compelling than under the gold standard, because our proposed monetary regime would ensure the stationarity of the price level over time. For example, under the indexation scheme, the nominal value of funds would increase temporarily during periods when the price level was rising above target and then diminish as the price level subsided back to target. Indeed, some households might prefer the funds in their digital currency accounts to remain constant in nominal terms, matching the nominal nature of their liabilities such as mortgages and auto loans.

-- During periods of weak aggregate demand and real interest rates dropping below zero, investors would be incentivized to shift their assets into digital currency bearing a zero real interest rate. In effect, the indexation of digital currency accounts would induce a zero lower bound on ***real*** *interest rates, which would pose a much more severe constraint on monetary policy than a zero lower bound on nominal rates. Consequently, the central bank would need to rely very heavily on other tools such as quantitative easing, or conceivably fiscal policy might end up bearing primary responsibility for restoring price stability under such circumstances.*

-- A variation of this approach would be to provide asymmetric indexation analogous to that of U.S. Treasury Inflation-Protected Securities (TIPS), i.e., the nominal value of digital currency funds would be increased if the price level exceeded its target but not reduced if the price level dropped below target. Such a scheme would impose a milder constraint on the conduct of monetary policy (namely, a zero lower bound on nominal rates rather than real rates).

3. Interest-Bearing Currency. From a technical perspective, the central bank could easily pay interest on digital currency accounts. In effect, all funds held at the central bank would bear the same nominal interest rate, regardless of whether those funds belonged to an individual, firm, or financial institution.

-- This approach would encapsulate the analysis of Friedman (1960), who argued that in an efficient monetary system, government-issued money should bear the same return as other risk-free assets. Indeed, that reasoning underpins the arrangements of many central banks around the world, which pay interest on the reserves of commercial banks held electronically at the central bank. In fact, the Federal Reserve now pays interest to an even wider range of financial counterparties through its reverse repo facility.

-- Paying interest on digital currency might well enhance the competitiveness of the banking system. Depository institutions that engage in customer-focused "relationship banking" would not be affected, whereas depositors in other less-competitive institutions would have the option of shifting funds into digital currency accounts at the central bank.

-- In a growing economy with a stable price level, the interest rate paid on digital currency would typically be positive. However, if the economy encountered a severe adverse disturbance that exerted downward pressure on the general price level, then the central bank would be able to cut interest

rates as appropriate. Indeed, a number of major central banks (including the ECB and the BOJ) are currently paying negative rates on bank reserves,but their ability to cut rates further remains constrained by the zero interest rate on paper currency (which would likely fall into disuse following the introduction of a digital currency).

-- In effect, monetary policy would no longer be constrained by an effective lower bound on nominal interest rates; cf. Agarwal and Kimball (2015). Consequently, the interest rate on digital currency could serve as the primary tool of monetary policy, thereby avoiding the need to deploy alternative tools such as quantitative easing or to rely on fiscal interventions to maintain price stability over time. In effect, as discussed below, the monetary policy framework could be focused on a rules-based approach for making adjustments to the digital currency rate.

-- The lower bound on nominal interest rates has been a primary motivation for maintaining a positive inflation buffer. Indeed, major central banks generally have inflation targets of 2 percent, and in the wake of the global financial crisis some economists have advocated raising such targets. With interest-bearing digital currency, there would no longer be any need to maintain an inflation buffer, and hence the price level target could be fixed and constant over time.

III. The Monetary Policy Framework

The conduct of monetary policy should be systematic and transparent, thereby facilitating the effectiveness of the monetary transmission mechanism as well as the central bank's accountability to elected officials and the general public. These considerations provide a compelling rationale for the central bank to frame its policy deliberations and communications in terms of a simple benchmark like that of the Taylor Rule. As emphasized by Taylor (1993, 1999), such a benchmark should not be followed in a purely mechanistic fashion but rather used to clarify the central bank's overarching strategy and in explaining any specific policy decisions which depart from that benchmark.

Here we assume that the central bank digital currency is interest-bearing, and hence the benchmark policy rule can be framed in terms of adjustments to that interest rate. Moreover, we assume that the price level target is specified as a fixed constant; i.e., the long-run average inflation rate will be zero under this policy framework. Thus, our benchmark rule is analogous to the Taylor Rule but oriented towards stabilizing the price level rather than the inflation rate, and hence can be expressed as follows:

$$i_t \;=\; \tilde{\pi}_t \;+\; r_t^* \;+\; \alpha(\tilde{p}_t - p^*) \;+\; \beta(p_t - p^*) \;+\; \delta(y_t - y_t^*)$$

where i_t denotes the interest rate on digital currency, p_t denotes the price level, p^*denotes the target price level, $\tilde{p}_t$ denotes a "core" measure of the price level (i.e., smoothed to remove transitory fluctuations in volatile components), $\tilde{\pi}_t$ denotes the core inflation rate, r_t^* denotes the equilibrium real interest rate, and $(y_t - y_t^*)$ denotes the output gap (that is, the deviation of real GDP from its potential level). The interest rate should respond more strongly to the core measure of prices than to fluctuations in the overall price index ($\alpha >> \beta > 0$) and should also respond appropriately to movements in the output gap ($\delta > 0$).

-- As in the Taylor Rule, this specification can be interpreted as a benchmark for adjusting the real interest rate in response to fluctuations in economic activity and prices. In particular, when the price level is at its target and output is at potential, then the ex post real interest rate $i_t - \tilde{\pi}_t$ equals its equilibrium value r_t^*. That value could reflect historical average real rates, as in the Taylor Rule, or could be specified as the median estimate of professional forecasters, as in Levin (2014).

-- In this framework, the price index p_t serves a fundamental role in providing a stable unit of account. Thus, the specification of this index should be determined when the digital currency is established and henceforth not modified except for compelling technical reasons. To facilitate transparency, the index should be constructed from publicly-posted prices of final goods, using a published methodology that can be reproduced by private-sector analysts. Moreover, to ensure continuity over time, the index should incorporate chain-weighting rather than relying on a specific base year. For example, the appropriate U.S. price index might be the chain-weighted CPI or the market-based PCE price index.

-- A large body of literature has analyzed the merits and pitfalls of targeting the price level rather than the inflation rate. These studies have generally concluded that price-level targeting can provide substantial benefits to macroeconomic stability if the framework is transparent and the commitment to price stability is credible. Moreover, the stance of monetary policy should respond to real economic activity as well as prices; hence, such frameworks are often characterized in the literature as "flexible price-level targeting." (We avoid that terminology here because the word "flexible" could easily be misunderstood as referring to a relatively opaque and discretionary approach.)

-- This policy framework also echoes various proposals to target the level of nominal GDP. Indeed, our benchmark rule would be equivalent to that approach if p_t were specified as the GDP price index and the coefficients β and δ were constrained to be equal. Nonetheless, our analysis indicates that such an approach would be inferior to the framework proposed here. In particular, the GDP price index is a value-added deflator, not an index of final goods prices, and hence not appropriate for anchoring the unit of account. Indeed, the GDP price index exhibits some counterintuitive properties, e.g., a fall in the price of imported fuel induces an increase in the GDP price index.

-- The coefficient values in this benchmark rule (α, β, and δ) should be chosen to generate robust macroeconomic stabilization outcomes based on evaluations of a wide array of alternative macroeconometric models; cf. Taylor (1999), Levin et al. (1999, 2003), and Levin et al. (2006).

-- An abrupt shift from a positive inflation target to a stable price level could be very disruptive to the economy and the financial system. Consequently, the transition process would need to be carefully planned and managed, so that this transition would be well understood and fully incorporated into the planning of households and firms.

IV. The Central Bank's Balance Sheet

To facilitate public accountability, the central bank's management of its balance sheet should also be systematic and transparent. In a monetary policy framework with an interest-bearing digital currency and obsolescence of paper currency, policymakers would be able to push market interest rates below zero in response to a severe adverse shock. In effect, the central bank would be able to provide an appropriate degree of monetary accommodation without resorting to measures aimed at modifying the size or composition of its balance sheet—often referred to as quantitative easing or credit easing.

Thus, the central bank's balance sheet could become very transparent. In particular, the central bank would generally hold short-term government securities in the same quantity as its liabilities of digital currency. The central bank's operating procedures would be correspondingly transparent: It would engage in purchases and sales of short-term government securities so that the supply of digital currency would simply move in line with changes in demand for digital currency.

The interest rate spread between digital currency and short-term government securities would generally be negligible, given the practically costless arbitrage between these two assets. Consequently, shifts in the size of the central bank's balance sheet would have no direct fiscal consequences. Indeed, with the obsolescence of paper currency, the government would no longer receive any substantial seignorage revenue, and the central bank would simply cover its own expenses by imposing miniscule fees on payment transactions. Moreover, the maturity composition of the stock of government securities held by the public would be determined by the fiscal authorities, *not* the central bank; cf. Greenwood et al. (2014).

Finally, the central bank would still need to retain its capacity to serve as the lender of last resort. In particular, during a financial crisis the central bank would have the ability to expand the quantity of digital currency to provide emergency liquidity to supervised financial institutions. Alternatively, the central bank could provide those funds to another public agency, such as the deposit insurance fund, as long as the appropriate legal safeguards were firmly in place.

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