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The macroeconomics of central-bank-issued digital currencies

The emergence of the distributed ledger technology (DLT) and of Bitcoin was a watershed moment in the history of electronic monies. It may now, for the first time, be technically feasible for central banks to offer universal electronic access to their balance sheet, to a central bank digital currency (CBDC). The only existing form of electronic access, centralized real-time gross settlement (RTGS) systems, has only been designed for a small number of participants, and would not be sufficiently robust to accommodate universal access.

We define CBDC as a monetary instrument issued by the central bank, available on a 24/7 basis, electronic and probably based on DLT, universal (meaning accessible to banks, firms and households), national-currency denominated, issued either through public spending or against eligible assets (government debt), coexisting with the existing banking system (with banks remaining the creator of the marginal unit of domestic currency), and interest-bearing, with the interest rate managed so as to equate demand and supply for CBDC at a 1:1 exchange rate with other forms of national money.

We use a state-of-the-art DSGE model to study the benefits and costs of introducing CBDC into an economy that is calibrated using U.S. macroeconomic data. The key ingredients of this model are a banking sector that creates private deposit money through the extension of loans, a government that creates CBDC, and a private sector that requires liquidity to purchase consumption goods, investment goods, and inputs into production. Liquidity in turn is produced through an imperfectly substitutable combination of bank deposits and CBDC. Government policy rules cover fiscal policy (including the use of revenue from CBDC creation), traditional monetary policy that determines the risk-free nominal policy interest rate, and CBDC policy that determines either the quantity of or the interest rate on CBDC. Countercyclical CBDC policy either withdraws CBDC from circulation in a boom, or makes CBDC less attractive to hold by paying a lower interest rate in a boom.

In this model, if liquidity becomes scarce, increases in tax-like monetary frictions increase the cost of doing business, leading to lower output. Liquidity scarcity originating in the banking sector can be partly offset through the creation of additional CBDC by the government.

Our first quantitative experiment studies the introduction of CBDC into an economy without CBDC. The magnitude equals 30% of GDP, which is introduced through buying back government debt equal to that amount. The result, which of course is calibration-dependent (but where that dependence can easily be studied), is a 3% increase in GDP, and this is shown to be due in roughly equal measure to three factors.

The first factor is lower real interest rates, due to a 30% of GDP reduction in the outstanding stock of high-interest defaultable government debt, and its replacement by 30% of GDP of low-interest non-defaultable CBDC. The

low interest rate on CBDC is explained by its non-pecuniary convenience yield due to its use in economic transactions, while its non-defaultable nature is due to the fact that holders cannot ask for repayment of sovereign money in something other than sovereign money.

The second factor is lower distortionary tax rates on labor, capital and consumption. The assumption is that the government uses the interest savings from CBDC issuance, and the revenue from its creation, to lower these taxes while leaving the deficit target unchanged.

The third factor is an increase in liquidity that lowers the cost of doing business. CBDC can be produced by the central bank without the cost of the spread and of other frictions that accompany the creation of bank deposits, leading to an overall increase in liquidity. The increase in CBDC is accompanied by a small further increase in bank deposits due to an increase in demand for liquidity in an improving economy. CBDC therefore need not crowd out but to the contrary may crowd in bank deposits.

Our remaining quantitative experiments study the use of CBDC as a monetary policy tool in a post-transition economy that is operating, on average, with CBDC balances equal to 30% of GDP.

One question concerns the comparative advantages of using a quantity rule or an interest rate rule to manage CBDC issuance over the business cycle. This choice turns out to be especially important following shocks to the supply of or demand for liquidity. Consider a sudden increase in the demand for liquidity, either in the form of bank deposits or of CBDC. We interpret this as a flight to safety, with agents preferring to hold on to their liquid and safe balances rather than spending them. This is represented in the model as an increase in the cost of doing business, and it has a contractionary effect on GDP. Going back to an argument of Poole (1970), under such money demand shocks a quantity rule is far inferior to a price rule, because holding liquidity fixed in the face of an increased demand for liquidity forces a much larger real adjustment. However, in Poole's world the central bank controlled the entire broad money supply, which is true neither in the current environment nor in a world with CBDC. Central banks only ever control narrow money, with very imperfect control over broad money due to the autonomous role of banks. The presence of CBDC does not alter this significantly, because CBDC only represents a fraction of the money supply, because its substitutability with bank deposits is unlikely to be extremely low, and because banks remain the creators of the marginal unit of currency. Our simulation finds that there is a trace of the Poole (1970) argument, in that a CBDC interest rate rule performs better than a quantity rule in buffering the effects of the shock, but it also finds that the difference is quantitatively small. The choice between a quantity rule and an interest rate rule does therefore not make a great difference.

Another question concerns the effects of using the CBDC interest rate countercyclically, in combination with the conventional policy rate for the interest rate on central bank reserves. To illustrate this, we choose a CBDC interest rate rule that, similar to the policy rate, responds to deviations of inflation from a target, and that otherwise maintains the CBDC interest rate at a fixed spread below the policy rate. Our simulations show that, in a credit boom-bust cycle, a negative response to inflation stabilizes output. In other words, during the boom/bust the spread between the policy rate and the CBDC rate widens/narrows, thereby making it less/more attractive to hold CBDC. The endogenous withdrawal and injection of CBDC liquidity during the boom and bust periods helps to stabilize GDP, over and above the effects of the policy rate. This result holds considerable promise for CBDC, but of course the subject requires further study.

There are also some arguments that advise caution with regard to CBDC. The most important of these is that the transition to such a system could be quite difficult, and getting the "plumbing" right requires very careful homework, including attention to legal and regulatory issues and to questions of computer hardware, software and protocols. But the good news is that many central banks are right now doing such homework.

Another objection to CBDC, the danger of a bank run due to the greater (electronic) ease of trading bank deposits against CBDC, seems to this author to be mostly based on a partial equilibrium fallacy. The point is that while it may become possible for an individual to quickly find a counterparty to dispose of his bank deposit in exchange for CBDC, there is no way for the economy as a whole to do so. The exchange of bank deposits between individuals does not change the aggregate stock of bank deposits, while a run from bank deposits against CBDC at the aggregate level would require that the central bank accept bank deposits in exchange for CBDC issuance. This however is ruled out as part of the assumed monetary policy operating environment. First, under a quantity rule the central bank allows the interest rate on CBDC to adjust to remove any demand in excess of the quantity target. And second, even under a CBDC interest rate rule CBDC is only issued against eligible assets such as government bills, not against bank deposits. A run scenario therefore requires extreme assumptions, such as CBDC interest rates that become too negative to be politically acceptable, together with a market that runs out of eligible assets to obtain more CBDC. It is hard to envisage such a scenario, particularly in a world where the presence of CBDC is likely to make resolution of troubled banks much easier and quicker, thereby removing part of the ex-ante incentive to run.

There are therefore many reasons to look at the possibility of CBDC issuance as a positive development, so long as the above-mentioned technical issues can be addressed. Central banks' stated reasons for considering CBDC issuance furthermore go beyond what is mentioned above, including improved wholesale securities settlement (Canada, Singapore), replacement of vanishing cash (Sweden), and greater financial inclusion (several developing countries). The future therefore promises to be very interesting, and research will have an important role to play.