DIGITAL MONEY AND MONETARY POLICY

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Widespread use of digital money could affect central banks in such areas as monetary policy, banking supervision, supervision of the payment system, and the stability of the financial system. The main concern of central banks today is the security of digital money. A security breach – counterfeiting – of widely-used digital money products could severely disturb the stability of the financial system.

Digital money has been defined as an electronic substitute for banknotes and coins that is recorded on an electronic medium, either a smart card or computer hard drive, for the purpose of effecting electronic payments in limited amounts. Digital money products, designed to substitute central bank currency, could in principle replace the entire stock of central bank currency. Since central bank currency is a component in all monetary aggregates, a change in demand for this currency could affect these aggregates. The largest impact would be on the narrowly defined stock of money, M1, which in many countries consists of cash in circulation, travellers cheques held by the public and demand deposits. Other monetary aggregates, such as M2 or M3, could also be affected, but to a lesser extent given that cash in circulation carries less weight in these aggregates. The size of the stock of central bank currency in circulation, the size of demand deposit, and their relative weight represent the first indicators of the potential effect of a replacement of central bank currency on the M1 money supply.

The impact of digital money on M1 will depend on three factors: (1) the willingness of the banking sector to use its deposits, (2) the reserve requirements on digital money balances and demand deposits, and (3) the precise definition of M1. In addition, the reaction of central banks plays a crucial role since they have the means to offset any change in M1.

Substitution of central bank currency would affect all monetary aggregates. For the purposes of simplification, we shall take M1 where the money supply contains only cash in circulation, C, and demand deposits, D. Digital money balances, EM, may also be included in the definition of M1. Such a conversion would affect M1 through two channels. Obviously, a substitution of the currency would affect M1 through a reduction in the stock of central bank currency. A conversion would, however, also change the reserve position of banks and, eventually, the size of deposits, D. This second impact in the more important since it has a potentially greater affect on M1.

Banks hold reserves for two reasons. Firstly, in many countries they are required to hold a percentage of certain types of deposits as reserves. The types of deposit accounts that require the holding of reserves and the reserve ratio differ from country to country. Banks also hold reserves – excess reserves – for settlement purposes to cushion daylight and overnight overdrafts. Reserves are held either as vault cash – central bank currency in the hands of banks – or as book entries at the central bank.

The liquidity effect of a conversion of central bank currency into digital money depends on whether binding reserve requirements are in place. Banks expand their deposits by making loans. When a bank makes a loan this is automatically matched by an equal increase in deposits. Banks are willing to make loans if the marginal return on loans is larger than the marginal costs of deposits. With binding reserve requirements, this condition is met but their reserve position prevents the provision of further loans and, correspondingly, a further expansion of deposits. Thus, with binding reserve requirements, the marginal rate of return on loans is larger than the marginal costs of deposits and banks would be willing to expand their deposits at the prevailing rate of return and costs.

Zero or non-binding reserve requirements

If the central bank did not require the creation of binding reserves, the market for deposits and loans would be in equilibrium and the marginal return on loans would equal the marginal costs of deposits. Banks, however, have some market power, i.e. a bank increasing its supply of loans would reduce the rate of return on loans, which would result in a loss. Thus, at the prevailing rate of return on loans and the prevailing costs of deposits banks are not willing to increase deposits by providing additional loans.

The conversion of cash to digital money implies that the total amount of currency in circulation, C, decreases by one unit and, at the same time, that the stock of central bank currency (vault cash) increases by one unit. The bank receiving the currency unit can either hold it as vault cash or return it to the central bank thereby increasing its reserves at the central bank by one unit. It is, however,

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likely that the bank is not willing to hold the unit as vault cash because the rate of return on vault cash is zero, while the rate of return on reserves at the central bank is positive since it reduces the probability that the bank has to borrow funds for settlement purposes. Although the notion that banks hold returned currency as vault cash is simplistic, it is often used to evaluate the effect of digital money on the money supply. If issuers of digital money held 100% cash reserves for balances on stored-value cards, the money supply would not change.

The lower costs of reserves decrease the costs of making deposits. Banks could therefore increase lending and deposit taking. Demand deposits would then increase unambiguously. The overall effect on M1, however, is not determined because central bank currency would be reduced by one unit. However, because the effect of a conversion on deposits is equivalent to the effect of an open market operation, it is more likely that an increase in current account deposits would offset the decrease in central bank currency and, consequently, M1 would increase.

The mechanism changes slightly if digital money balances are included in the definition of M1. In this case, M1 would increase unambiguously because the reduction in cash in circulation, C, would be matched by an increase in digital money, EM, and demand deposits, *D*, would likewise increase. Thus, if digital money balances are not included in the definition of M1, the change of the stock of money depends on whether the increase in *D* offsets the decrease in *C*.

Binding reserve requirements

Conversion of currency in circulation to digital money directly affects M1 through a reduction in C and indirectly through a change in the reserve position of banks. To see how banks' reserve position is affected, consider the following example:

When a customer hands in a banknote, say one hundred crowns, and at the same time increases the digital money balances on his smart card or computer by one hundred crowns, the bank's balance sheet and reserves change as follows. First, it increases the bank's total amount of vault cash by one hundred crowns and it increases the bank's liability (the outstanding balance of digital money) by the same amount. Second, the increase in vault cash amounts to a one hundred- crowns increase in the bank's reserves whereas the increase of the outstanding amount of digital money requires either no additional reserves or – if there is a 2% reserve requirement on digital money – a 98-crown increase in reserves. In either case, the bank has excess reserves, and, if the reserve ratio on deposits is 2%, it has gained the ability to expand its deposits, in the first case by SKK 1,000 and in the second case by SKK 980.

The following analysis, based on the notion of a money multiplier, relies on a simple model of money creation. The money multiplier describes the relation between the various monetary aggregates and the monetary base. The monetary base consists of central bank currency in the hands of the public plus reserves of deposit institutions, i.e., banks. The relation between the monetary base and M1 is described by the following equation:

$$M = m \, . \, H$$

M is the stock of narrowly defined money, *H* is the monetary base, and m is the money multiplier. In its simplest form, the money multiplier is derived as follows:

$$M = C + D + (EM)$$

$$H = R + C + E$$

$$R = r_D \, D + r_{EM} EM$$

C is currency in the hands of the public, EM are digital money balances, *D* are demand deposits, *R* are required reserves, and *E* are excess reserves; r_D is the required reserve ratio on demand deposits and r_{EM} is the required reserve ratio on digital money balances.

The stock of money *M* consists of currency holdings, demand deposit and, if included, digital money balances. The monetary base *H* consists of required reserves, currency and excess reserves, while required reserves *R* are the sum of reserves on demand deposits and reserves on digital money balances.

Banks are willing to provide loans if the marginal return on loans is larger than the marginal cost of deposits. An assumption of the money creation process is that this condition is met. In this case, banks find it profitable to make loans whenever they have excess reserves. The size of deposit expansion depends on the reserve ratio on demand deposits, r_D, and on the reserve ratio on digital money balances, r_{EM}.

Monetary policy

The previous section suggests that a conversion of central bank currency into digital money balances would increase bank reserves and, consequently, also the stock of money. If banks were to use the additional reserves to expand demand deposits, it is likely that central banks would not remain passive. Rather, they would take measures to control the stock of money. Central bank activity is likely because, in relation to binding reserve requirements, the potential increase of the stock of money is non-trivial.

To see this, consider the potential change in M1 when digital money balances are not included in the definition of M1 and when there are no reserve requirements on digital money balances.

The respective derivative is: $\frac{\partial M}{\partial C} = -\frac{1 - r_D}{r_D}$

The elasticity of M1 is given by:

$$\varepsilon = \frac{\partial M}{\partial C} \cdot \frac{C}{M} = -\frac{1 - r_D}{r_D} \cdot \frac{c}{1 + c},$$

where c is the currency-to-deposit ratio. The smaller the reserve requirements on demand deposits rD, and the larger the currency-to-deposit ratio is, the larger is the elasticity of M1.

Elasticity ∂ is given as the percentage change in M1 when the stock of central bank currency changes by 1%. In Slovakia, for example, where the reserve requirements stand at 2% and the currency-to-deposit ratio came to 0.34 for 2004, the elasticity of M1 is 12.74. Thus, with binding reserve requirements, a substitution of 1% of central bank currency would increase the stock of money by 12.74%.

The larger the currency-to-deposit ratio, c, and the smaller the reserve ratio on demand deposits, r_D, the larger is the potential expansion of M1. Recall that these results are derived under the assumption that the reserve requirements are binding. The small reserve ratios in most countries indicate that the reserve requirements are not binding and, therefore, the expected increase in M1 is smaller.

Next we will consider the measures that central banks can take to prevent potential changes in M1. There are four:

- They can limit the proliferation of digital money to prevent the replacement of central bank currency.
- They can issue digital money products and treat digital money balances in the same way as they do central bank currency.
- They can apply high reserve requirements on digital money balances.
- They can absorb – sterilize – the excess liquidity created by appropriate monetary operations.

Legal restrictions to prevent the proliferation of digital money will be difficult to justify, especially in light of efforts to deregulate and improve the efficiency of the financial sector. It is well known that central bank currency is an expensive medium of exchange (for example, the costs of processing money).

Digital money products also offer substantial cost savings compared with paper cheques. The cost of an electronic payment ranges between one third to one half of a cheque or paper giro payment. Moreover, measures that prevent development of digital money products will result in a competitive disadvantage. Countries that develop these products will thereby take a lead in a crucial technological sector. In addition, digital money easily crosses international borders and it will be difficult to control foreign digital money products that could eventually emerge as a medium of exchange in the home country.

Central banks could provide digital money in the same way as they provide paper currency right now. The Bank of Finland, for example, is developing a cash-card system through its branches. Most central banks, however, remain passive in this respect. There is concern that central banks issuing digital money products could limit competition and reduce incentives in the private sector to innovate further digital money products.

Central banks could require reserves on digital money balances. High reserve requirements can make digital money products neutral with respect to changes in the stock of money. However, since the main incentive to issue digital money products is the interest-free debt financing that digital money balances provide, high reserve requirements will make it less profitable to issue digital money and will hold back its development.

The drawback of the first three measures is that they reduce the private sector's incentive to invest in the development of digital money products. It is, therefore, likely that central banks will hold the money supply constant by appropriate monetary operations. If digital money balances were included in the definition of M1, then for every crown of central bank currency replaced by digital money, the central bank would have to sell one crown's worth of assets. For example, the central bank would be required to sell one crown government securities for each crown of currency converted into digital money balances. If digital money balances were not included in M1, then – assuming a reserve ratio on demand deposits of 2% – it would have to sell 0.98 crown of assets.

Summary

These reserve-absorbing open market operations would come at the cost of a steadily shrinking monetary base. There is concern that replacement of central bank currency would reduce the monetary base to the extent that it could adversely affect monetary policy implementation. Since cash is a large or the largest component of central bank liabilities in many countries, an extensive spread of digital money could shrink central bank balance sheets significantly. The issue is at what point this shrinkage might begin to adversely affect monetary policy implementation. The relatively modest size of everyday open market operations suggests that a relatively small balance sheet might be sufficient. However, special circumstances could arise in which the central bank might not be able to implement reserve-absorbing operations on a large enough scale (for example, to sterilize the effects of large purchases in the foreign exchange markets) because it lacked sufficient assets on its balance sheet.

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