A model of bank money creation and central bank money creation

1. Hypotheses on the money creation process

The analysis focuses on a period of time (a month, a semester, a year…) to ascertain the value of certain variables at the end of the period. For example, the volume of loans accumulated at the end of the period or the volume of deposits at the end of the period; some variables are flow variables and some others are stock variables.

The model represents how the central bank interacts with the banking private sector ('banks', for short) and the latter interacts with the non-banking private sector (NBPS = individuals + firms).

- **Hypothesis 1.** The central bank chooses the interest rate i_{BC} that banks have to pay to obtain reserves from the central bank.
- **Hypothesis 2.** Banks determine the interest rate i they charge to the NBPS for the loans that the banks grant by adding a premium m, so that $i = i_{BC} + m$.
- **Hypothesis 3.** The NBPS loan demand function decreases with the bank interest rate i, but banks only pay attention to the loan demand that they consider solvent (the demand of those who are believed to have a high enough probability of repaying loans).
- **Hypothesis 4.** No loan granted during the period is repaid during the period: it is understood that the loans of the period are repaid in subsequent periods.
- **Hypothesis 5.** The NBPS distributes the amount of money it has (cash and deposits) so that cash is a fixed proportion of deposits. The liquidity ratio $l = E/D$ is the fixed ratio between cash E and deposits D of the NBPS. The parameter l satisfies $0 \leq l < 1$. The value $l = 0$ means that the NBPS does not hold cash.
- **Hypothesis 6.** The central bank requires banks to hold a volume of reserves proportional to existing deposits; that is, the central bank requires banks to maintain a minimum balance in their reserve account at the central bank. The required reserve ratio $r = R'/D$ represents the fixed relationship between the reserves R' that banks, as a whole, must have and the net deposits D created by banks (deposits that coincide with the deposits of the NBPS). The parameter r satisfies $0 \leq r < 1$. If $r = 0$, the central bank does not require banks to maintain a minimum reserve balance. Examples of central banks setting $r = 0$: Bank of Canada, Bank of England, Reserve Bank of Australia, Reserve Bank of New Zealand, Sveriges Riksbank, Norges Bank…
- **Hypothesis 7.** In addition to mandatory reserves, banks voluntarily may accumulate a volume of reserves proportional to existing deposits. The voluntary reserve ratio $v = R''/D$ represents the fixed ratio between the reserves R'' that banks, as a whole, want to hold (in addition to the mandatory ones R') and the net deposits D they have created. The sum $v + r$ is called the reserve ratio and it is assumed that the parameters $v$and r satisfy $0 \leq v + r < 1$.

2. Money creation model I: central bank monetary policy

The central bank's monetary policy is made up of two decisions. According to Hypothesis 1, one part of monetary policy (the main part) consists of deciding the i_{CB} central bank's interest rate: the 'official interest rate'. According to Hypothesis 6, the second component of monetary policy corresponds to determining the value r of the reserve requirement ratio (this one can be considered a secondary component because some central banks have chosen the value $r = 0$).

Graphically, the model of bank money creation and central bank money creation is made up of four simultaneous graphical representations.

The first one shows the main part of monetary policy: the central bank's choice of interest rate. The simplest way to model this decision is to assume that the central bank charges the same interest rate for all volumes of reserves supplied. In graphical terms (see Fig. 1), the function relating the central bank interest rate and the supply of central bank reserves is a horizontal line: the rate i_{BC} does not depend on the volume of reserves supplied.

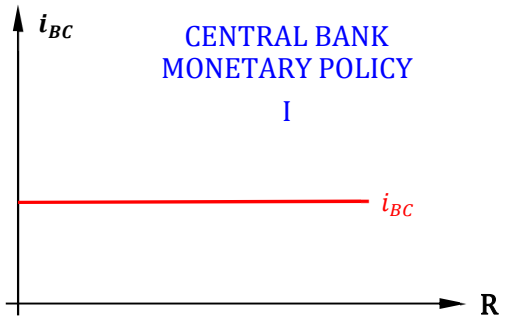

Fig. 1. Reserve supply function of the central bank

Fig. 2 shows a possible generalization of central bank decision-making: a reserve supply function defined by tranches; in this case, two tranches. The first tranche states that the central bank sets the rate i_{CB}^1 for reserves below the value R_{CB}^1 and sets the higher rate i_{CB}^2 for reserves above R_{CB}^1.

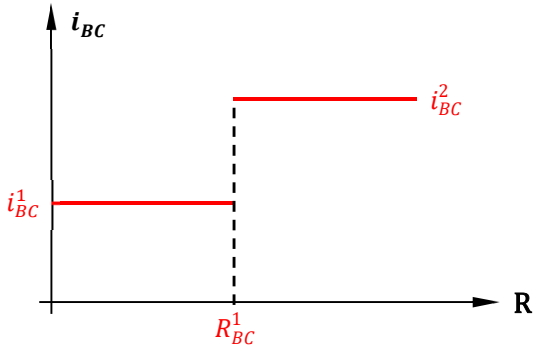

Fig. 2. Central bank reserve supply function defined by tranches

Fig. 3 presents the case where the central bank interest rate grows with the volume of reserves supplied: the price of each unit of reserves is different.

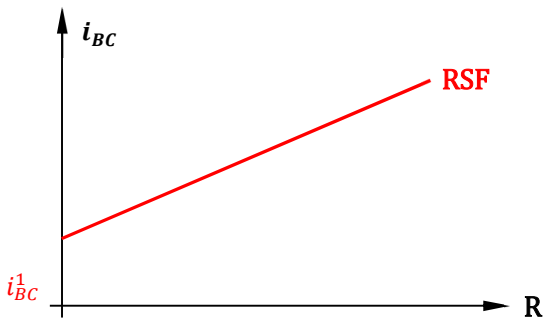

Fig. 3. Increasing central bank reserve supply function

The model is limited to the case in Fig. 1, but it can be extended to the cases in Fig. 2 (with some complications) and Fig. 3 (without any). Since the model will represent four graphs at the same time, Fig. 1 will occupy the upper left quadrant, applying a horizontal specular reflection to the graph of Fig. 1, as shown in Fig. 4.

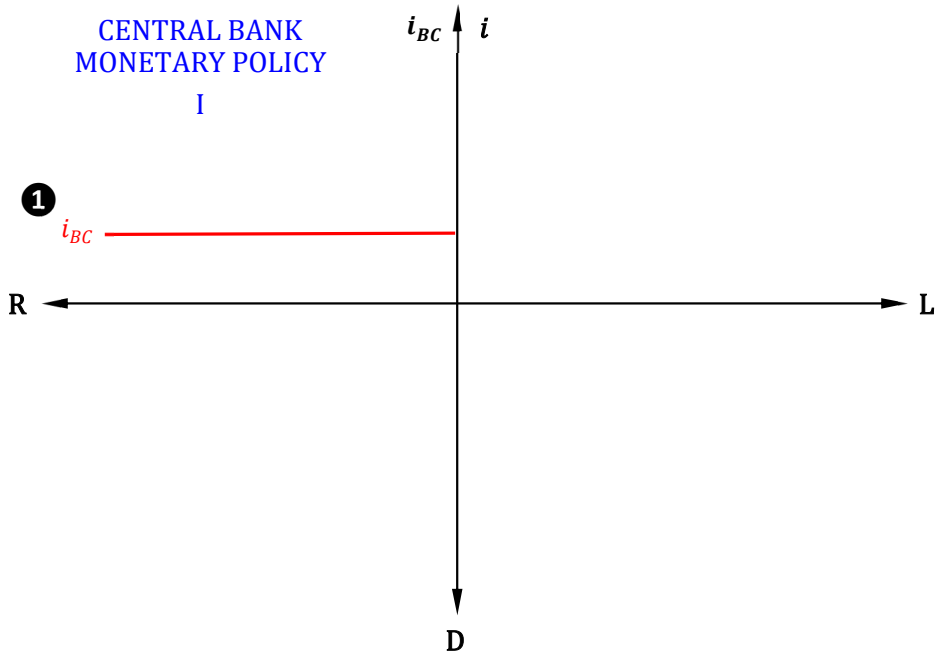

Fig. 4. First part of the money creation model

3. Money creation model II: private loan market

By Hypothesis 2, banks take the central bank rate i_{BC} and add a premium m (the bank's profit rate) to determine the interest rate i they charge NBPS borrowers.

Out of the NBPS loan demand function (function assumed to decrease with the interest rate), banks select the part of the function that they consider solvent demand.

Having identified the loan demand function presumed solvent, banks offer the volume of loans that the solvent demand function assigns at the rate $i^* = i_{BC} + m$ set by the banks.

Fig. 5 shows the result: the private loan market where banks act as a monopolist, setting the interest rate and supplying the volume of loans that, at that rate, they deem payable. Fiig. 5 is drawn under the plausible assumption that solvent demand decreases with i and is smaller than total demand.

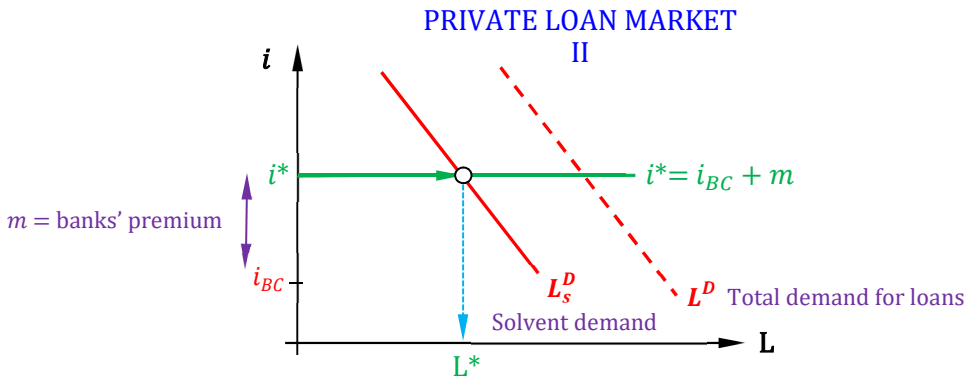

Fig. 5. Determining the volume of bank loans

Fig. 6 extends Fig. 4 by combining the interest rate choice by the central bank (Fig. 1) with the interest rate choice by banks (Fig. 5).

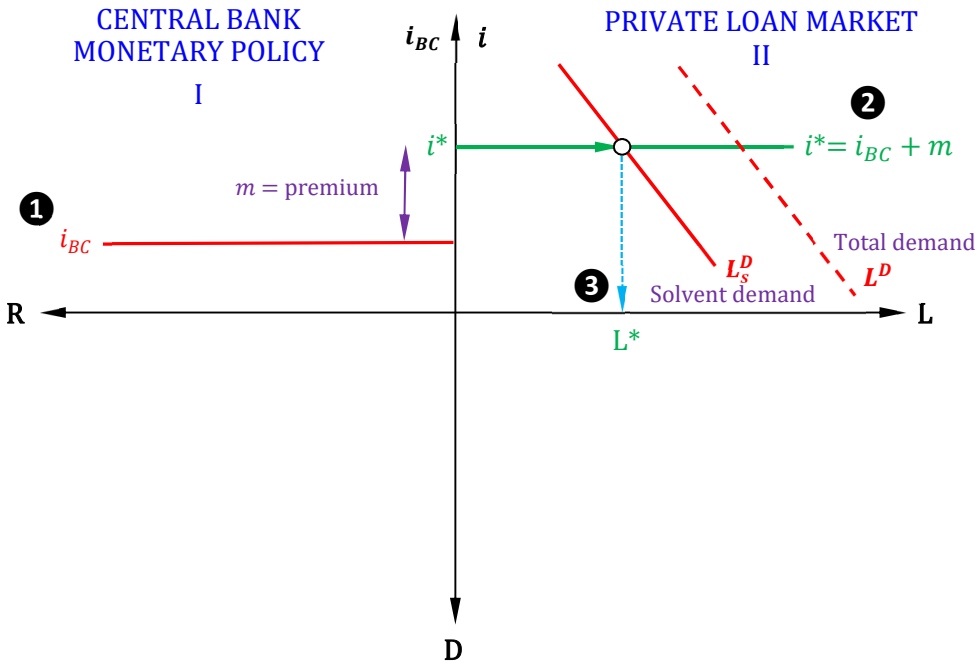

Fig. 6. First and second parts of the money creation model

In Fig. 6, the central bank initially (step ❶) determines the rate i_{BC} (the price of reserves).

Next (step ❷), banks add to the rate i_{BC} a premium m (premium that measures the profit banks obtain from granting loans) to establish the interest rate i^* on loans to the NBPS.

Finally (step ❸), banks supply the volume of loans L^* that, at the rate i^* , they consider borrowers will be able to repay (which, for banks, defines the solvent demand for loans).

4. Money creation model III: bank money creation

By Hypothesis 4, the loan volume L^* in Fig. 6 arrives intact at the end of the period.

When the volume L^* of loans was created, the same amount D' of deposits was simultaneously generated. By Hypothesis 5, the NBPS transforms a proportion of those deposits into cash (a proportion that depends on the liquidity ratio l). So, although D' is not reduced because, by Hypothesis 4, no repayment is due during the period, it is reduced because the NBPS converts a fraction of D' into cash.

Since cash conversion is the only reason for the destruction of deposits, it must be that $D' = D^* + E^*$, where D^* is the volume of deposits in existence at the end of the period.

By Hypothesis 5, the additional cash E^* obtained from the conversion of new deposits satisfies $E^* = l \cdot D^*$.

It follows from the above that $L^* = D' = D^* + E^* = D^*(1 + l)$; therefore, deposits D^* at the end of the period are

$$D^* = L^* \frac{1}{1+l} \ . \tag{1}$$

Equation (1) establishes that, at the end of the period and in net terms, the volume of deposits D^* is proportional to the total loans L^* granted during the period.

The higher the liquidity ratio l, the smaller the volume of net deposits that a given volume of loans ends up generating. The explanation is simple: the higher l, the more deposits are transformed into cash and fewer deposits arrive at the end of the period.

To the extent that $l > 0$, $\frac{1}{1+l} < 1$ and, consequently, $l > 0$ implies $D^* < L^*$.

Fig. 7 depicts equation (1), which summarizes the process of bank money creation based on the granting of loans. The inequality $D^* < L^*$ implies that the line in equation (1) lies below the main diagonal $L = D$.

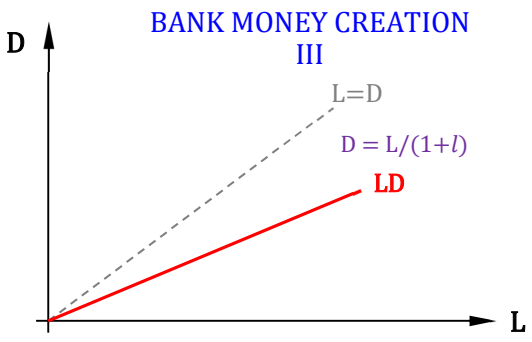

Fig. 7. Determination of the amount of bank money

Line LD in Fig. 7 establishes the volume of deposits D that are created based on the volume L of loans banks have granted.

Fig. 8 shows the result of adding Fig. 7 to Fig. 6 (where the third quadrant is the vertical specular reflection of Fig. 7).

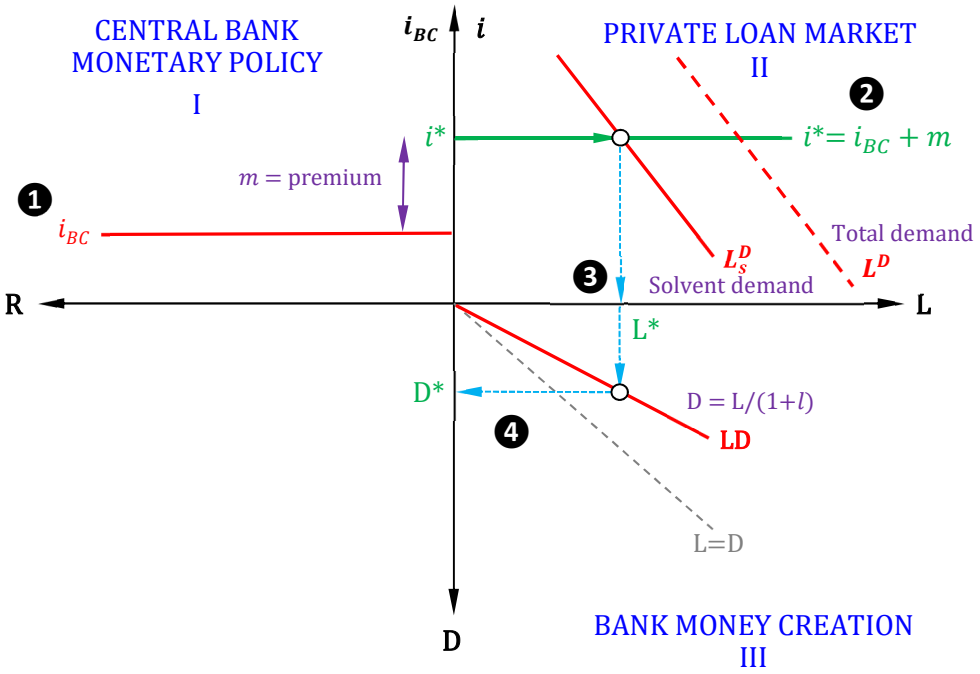

Fig. 8. First, second and third parts of the money creation model

In step ❹ of Fig. 8, the volume of loans L^* determined in step ❸ generates the volume of deposits D^*.

5. Money creation model IV: central bank money creation

By Hypothesis 6, the volume of deposits D^* creates the demand for required reserves $R' = r \cdot D^*$.

By Hypothesis 7, the volume of deposits D^* creates the demand for voluntary reserves $R'' = v \cdot D^*$.

Therefore, deposits D^* create the total demand for reserves $R^* = R' + R''$; that is,

$$\boxed{R^* = (r + v)D^*\,.} \qquad (2)$$

Once the deposits at the end of the period have been determined, the total reserves R demanded by banks can be calculated (using hypotheses 6 and 7): the required reserves $R' = r \cdot D$ plus the voluntary reserves $R'' = v \cdot D$. Consequently,

$$R = (r + v) \cdot D\,.$$

This equation means that, at the end of the period, the volume of reserves R that banks accumulate is proportional to the deposits existing at the end of the period. Fig. 9 represents equation (2), which summarizes the process of money creation (reserves) by the central bank.

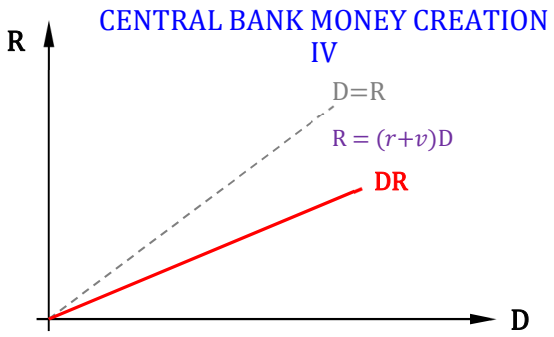

Fig. 9. Determination of the amount of centra bank money (reserves)

The line DR of Fig. 9 establishes the volume of reserves R demanded given the net volume of deposits D created by banks. The line DR is below the main diagonal $D = R$ since, by Hypothesis 7, $v + r < 1$.

Combining (1) and (2) the conclusion is that the demand for reserves derives from the volume of loans granted:

$$R^* = L^* \frac{r+v}{1+l} \ . \tag{3}$$

Fig. 10 shows the result of adding Fig. 9 to Fig. 8 (where the quadrant is obtained by rotating Fig. 8 90° to the right and then applying, from the right, a horizontal specular reflection).

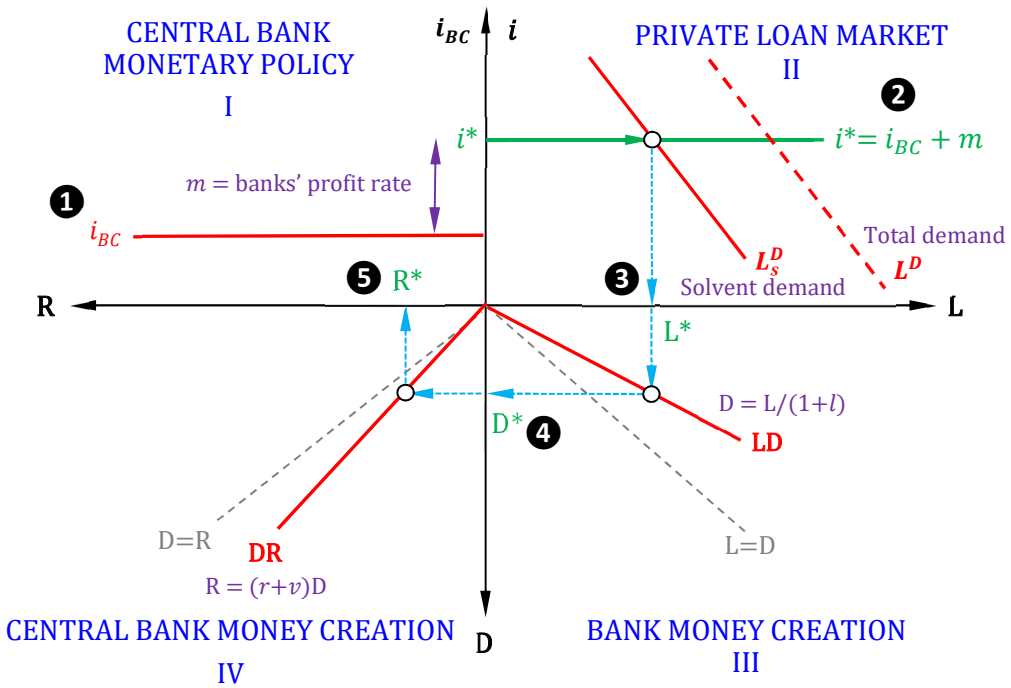

Fig. 10. The money creation model

In step ❺ of Fig. 10, the volume of deposits D^* determined in step ❹ generates the demand for reserves R^*, satisfied in full by the central bank at the initially set rate i_{BC} (hence the cost for banks to obtain reserves from the central bank is $i_{BC} \cdot R^*$).

6. Numerical example of the money creation model

• **Data.** The central bank sets an interest rate of 4%. Banks apply a 50% premium. The loan demand function that banks consider solvent is $L^d = 120 - 5i$, where the interest rate i is a percentage. The loan demand function is such that the volume of loans demanded at each interest rate is twice the volume that banks consider solvent. The required reserve ratio is $1/30$. The voluntary reserve ratio is $1/15$. The liquidity ratio is $1/8$.

• **Analysis.** The 50% premium means that banks increase the central bank's 4% rate by 50%. Consequently, the interest rate that banks set is 6%. Given the demand function banks consider solvent, the volume of loans that banks grant is $L = 120 - 5i = 120 - 5 \cdot 6 = 90$. At the 6% interest rate there is a demand for loans of twice this amount: 180. Thus $180 - 90$ represents unsatisfied demand for loans (this would be bank credit rationing).

The liquidity ratio $l = 1/8$ implies that the relation LD between loans and deposits is $D = \frac{L}{1+l} = \frac{8L}{9}$ and so, given $L = 90$, the volume of deposits is $D = 80$.

With required reserve ratio $r = 1/30$ and voluntary reserve ratio $v = 1/15$, the reserve ratio is $r + v = \frac{1}{30} + \frac{1}{15} = \frac{3}{30} = \frac{1}{10}$.

The DR relation between deposits and reserves is $R = (r + v)D = \frac{D}{10}$. As a result, the amount of deposits $D = 80$ generates a demand for reserves $R = \frac{D}{10} = 8$. The cost to banks of obtaining these reserves is $i_{BC} \cdot R = 4 \cdot 8 = 32$.

7. Reflections on the money creation model

The combination of relations (1) and (2) produces the connection (3) between loans L and reserves R. In the model, the causal order is $L \to D \to R$: loans determine bank money (deposits) and bank money determines central bank money (reserves).

This sequence contrasts with the conventional (textbook) view $R \to D \to L$ according to which the provision of reserves by the central bank allows the creation of deposits and this allows the granting of loans.

Big remark. The mainstream textbook model of bank money creation (known as 'the money multiplier model') relies on the hypothesis that cash is needed to create bank money. The bank money creation mechanism is the cycle

… → cash loan → expenditure → revenue → deposit → cash loan → …

Specifically, banks lend in cash; borrowers use the borrowed cash to purchase goods or services; the sellers of the goods or services receive a cash payment; part of the payment is held in cash and the rest is deposited in a bank; next the bank sets aside part of the cash desposit as reserves and lends the remaining cash…

Each time a cycle is completed, there is less cash in circulation: a fraction is kept by sellers and another fraction kept by banks in their vaults. This property guarantees that the creation of deposits eventually converges and the multiplication process comes to an end. In addition, each cycle increases the amount of deposits (which is the money being multiplied).

The mechanism is conceptually interesting because it links the financial with the real sector: participants in the cycle are

… → banks → buyers of goods → sellers of goods → buyers of financial assets → banks → …

Heterodox economists, and even reports by some central banks, have debunked this modelization of bank money creation; see, for instance, Michael McLeay, Amar Radia and Ryland Thomas (2014): "Money creation in the modern economy", Bank of England Quarterly Bulletin 2014 Q1, https://www.bankofengland.co.uk/quarterly-bulletin/2014/q1/money-creation-in-the-modern-economy.

The money multiplier model is simple, plausible and appealing, but wrong: it does not correspond to the reality of actual bank money creation (and wrongly assigns a fundamental role to cash in the process). Yet mainstream textbooks keep telling the fairy tale.

> "The 'money multiplier' has been shown many times to be an inadequate and misleading explanation of how banks work, yet it still features in many undergraduate economic courses. No university would teach the Ptolemaic system to young astrophysicists, so why are they still teaching its financial equivalent to young economists? (...) If people don't understand how banks work, they won't understand how money is created in our economy – and how banks need to be regulated to ensure that they don't blow the world up again. "
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> Frances Coppola (2019): "If You Don't Understand Banks, Don't Write About Them" https://www.forbes.com/sites/francescoppola/2019/09/17/if-you-dont-understand-banks-dont-write-about-them/?sh=28e316292e69

The mechanism of bank money creation as described in §1-6 is based on the following ideas.

1. Banks do not need cash to make a loan, contrary to what the conventional model of the money multiplier based on the circulation of cash assumes.

2. Banks can (and do) create bank money ex nihilo.

3. Bank loans and bank money (deposits) are created simultaneously (the loan as the bank's asset and the deposit as the equivalent liability).

4. Both reserves and deposits are expressions of a debit (or, equivalently, credit) relationship: reserves are a debit (obligation) created by the central bank and a credit (right) in favour of banks; and deposits are a debit (obligation) created by banks and a credit (right) in favour of depositors.

5. Both reserves and deposits are created as accounting entries (numbers in the central bank and banks' computers).

6. The central bank does not control reserves (or, by extension, the monetary base M0) but rather chooses the price of reserves (the interest rate that determines the rest of the interest rates in the economy).

7. Consequently, the amount of money in the economy is endogenous, that is, determined by the decisions of the private sector of the economy (the traditional view postulates that the amount of money is exogenous, that is, controlled by the central bank through both the money multiplier process and its presumed control of the monetary base).

8. The central bank is not the protagonist in the creation of money, but the banks.

9. The power of the central bank lies in guiding the dynamics of interest rates in the economy, based on the central bank's power to establish the price at which it supplies or acquires reserves.

10. The decision of banks to lend (based on how profitable they consider lending to be) is the source of deposits and any subsequent reserve needs of banks are met by the central bank (through open market operations and standing facilities).

11. If the central bank did not allow the automatic (endogenous) adjustment of the volume of reserves, the interest rates of the economy would move away from the central bank's target interest rate: if there were an excess of reserves that the central bank did not want to absorb, the price of reserves would fall to zero; if there were a shortage of reserves that the central bank did not want to supply, the price of reserves would climb and would do so even more, and continuously, if the banks believed that the central bank would not supply the reserves necessary for the banks' daily operations.

12. All forms of money are destroyed when they return to their creator/issuer. Cash that enters the central bank ceases to count as cash (which, by definition, is 'cash in circulation', that is, cash outside the central bank). The payment of reserves to the central bank removes them from the central bank's balance sheet (they represent an obligation of the central bank to the central bank itself, which is not an effective obligation). The cancellation of a loan granted by a bank by means of a deposit causes both the loan and the deposit to disappear from the bank's balance sheet (the taking of the deposit cancels the obligation represented by the loan).

8. Hyman Minsky's financial instability hypothesis

The orthodox (conventional) view argues that the financial sector functions well without any public intervention or regulation: that left to its own devices, the financial sector is inherently stable. The heterodox view considers that the financial sector tends by its very nature towards instability[1].

Hyman Minsky proposed an explanation for the tendency towards instability, based on three forms of debt. Hedge finance means that the borrower's income stream allows him to pay the loan amount and the corresponding interest. In speculative finance the income stream only allows to pay the interest. In Ponzi finance the income stream does not even allow to pay the interest.

Minsky's financial instability hypothesis postulates that financial stability cannot be durable: the longer the stability lasts, the more likely it is that speculative and Ponzi finance will dominate financial activity. The loss of weight in hedge finance makes the financial sector more vulnerable, since a continuous increase in debt is needed (debt refinancing). A setback, however small, can cause lenders to be unwilling to refinance enough debt, so that agents who have engaged in speculative or Ponzi finance are forced to sell (liquidate) financial assets. The sale of these assets lowers their price. This causes everyone who holds these assets to experience accounting losses (since they have assets that have lost some value). These agents may find themselves in need of selling other assets to obtain income or eliminate losses, thus contributing to a snowball effect where more and more financial assets lose value. The result is a financial crisis where many are in need to borrow and few risk lending. In Minsky's own words (1992):

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[1] The mechanism behind the conventional money creation model carries with it the seed of instability. Arguing by example: suppose person A deposits 100 units of cash in bank X. This means that A has the right to call the cash back at any time. Most depositors will not ask for a convertion of their deposits into cash. Thus a bank may need to keep in cash a proportion of deposits, to satisfy withdrawal requests. Assume 10% is enough. So bank X retains 10 cash units and lends the remaining 90. The model presumes that there is always someone willing to borrow whatever banks would like to lend. Then someone borrows 90, and this is used to make payments. Some B receives the 90 cash units, pockets a fraction (assume 10%) and deposits the rest in (for simplicity) bank X. Bank X receives now 81 cash units, keeps 8.1 and lends 72.9. At this point, the initial 100 cash units have generated deposits worth 100 + 81 (the bank money creation). Here lies the potential instability: what if A and B simultaneously request bank X the convertion of all their deposits in cash? The bank has only at hand 10 + 8.1. In sum, the conventional money creation mechanism is not immune to a bank run: a sufficiently high demand for cash withdrawal that banks cannot meet by their own means.

The model presented here is also prone to instability, at least due to an asymmetry. Someone not solvent now may turn solvent in the future; and someone solvent now may become insolvent later. But banks, in the first place, will not lend to an not-solvent-now; rather, the only possibility left is lending now to someone that will not be able to repay the debt in due time. If a significant amount of borrowers become insolvent, the bank may run into trouble: assets (loans) will become worthless. That loss increases the chances of bankruptcy.

All financial activity (that is, lending) is essentially unstable for the simple reason that it is a bet. What makes a financial transaction different from a real transaction is that the latter can be settled in a moment of time (creates no future right or obligation), whereas the former is a two-fold transaction connecting different points of time. Lending now is done presuming repayment later; and repayment later can never be guaranteed. So what if there is no repayment later? Though default implies that someone is better off (the borrower) and someone worse off (the lender), rarely the net result (beyond certain scale of default) is a gain: the stylized fact is that, when enough agents are involved, the loss caused to the lender by no getting the loan back is bigger than the benefit enjoyed by the borrower who defaulted (at least because lenders tend to be a few, so losses are concentrated in a few agents). Financial crises testify to that.

"The first theorem of the financial instability hypothesis is that the economy has financing regimes under which it is stable, and financing regimes in which it is unstable . The second theorem of the financial instability hypothesis is that over periods of prolonged prosperity, the economy transits from financial relations that make for a stable system to financial relations that make for an unstable system .

In particular, over a prolonged period of good times, capitalist economies tend to move from a financial structure dominated by hedge finance units to a structure in which there is large weight to units engaged in speculative and Ponzi finance . Furthermore, if an economy with a sizeable body of speculative financial units is in an inflationary state, and the authorities attempt to exorcise inflation by monetary constraint, then speculative units will become Ponzi units and the net worth of previously Ponzi units will quickly evaporate. Consequently, units with cash flow shortfalls will be forced to try to make position by selling out position. This is likely to lead to a collapse of asset values ."

Minsky, Hyman P. (1992): "The Financial Instability Hypothesis", The Jerome Levy Economics Institute of Bard College, Working Paper No. 74.

The table in Fig. 11 roughly summarizes the orthodox and heterodox views on debt. Orthodoxy questions public debt (which is problematic, because it is interpreted that the public sector always borrows at the expense of the private sector) and sees no problem with private debt (which is considered virtuous, like everything that arises from the private sector when it is allowed to do so).

	orthodox opinion about	**heterodox opinion about**
private debt	**favourable**	**unfavourable when 'excessive'**
public debt	**unfavourable**	**favourable**

Fig. 11. Views on public debt and private debt

The heterodox view regards public borrowing favourably, to the extent that borrowing finances socially desirable activities.

The concept of functional finance captures this vision: public deficit and debt are not a problem per se; they are instruments for achieving economic policy objectives (such as increasing employment, promoting structural transformations of the economy, providing essential public services, etc.).

From the heterodox perspective, private debt has the potential to be problematic, inasmuch as the financial sector easily disconnects from the real sector. When this disconnection occurs, lenders' income does not come so much from the profits of productive activity in the real sector as from speculative purchases with which to obtain income from sales at a price higher than the one at which it was purchased. In order for the expectation of an increase in the price of financial assets to materialize, an increasing flow of buyers is necessary, which requires an increasing flow of debt. Since debt cannot grow without limit, at some point the brakes will be put on debt and the

expectations of an increase in the price of financial assets cannot be realized. The result is a financial crisis, which initially manifests itself in the loss of value of certain financial assets. The stoppage of debt not only affects the financial sector, but is transferred to the real sector, which ends up paying for the financial sector's party with a contraction of GDP and an increase in unemployment.

Minsky's instability hypothesis is based on the perception that private debt tends to be excessive and, as a consequence, unsustainable and unpayable . All the most severe crises of the last century have begun in the financial sector, when excessive private debt became apparent.

Another heterodox economist, Wynne Godley, based his macroeconomic analysis on the premise that a growing private debt is eventually unsustainable and that it eventually translates into a contraction in private aggregate demand (from which an economic recession ensues). Godley anticipated the global financial crisis of 2008 that the orthodox myth says 'no one predicted'.

The experience of the US should be illustrative enough: both periods where maximum levels of private debt were reached (the 1920s and the period 1996-2007) culminated in a major economic crisis. On the one hand, the Great Depression that began in 1929 followed the private debt boom of the 1920s, and the Great Recession that began around 2008 was the continuation of the longest period of continuous growth of the US economy, growth built on massive private debt.

Often the public debt that the orthodox analyst judges excessive or unsustainable comes from the bailout of the financial sector: the public sector ends up assuming the losses generated by the private financial sector and thus the financial sector is once again in a position to generate another debt bubble. An apparent historical regularity of the financial sector is that every decade or so produces some financial crisis (some big, some small, some gigantic). If we are lucky, the financial crisis only causes a loss to the real sector of less than 5% of GDP.

9. Accounting illustration of bank money creation

The following example aims to offer a more detailed view of the aggregate summary of the money creation process in Fig. 10. There is a bank, with the following balance sheet:

ASSETS	**Private loans (L)**	**Public loans and other assets/rights (L^G)**	**Reserves (R)**
LIABILITIES	**Deposits (D)**	**Net worth (NW)**	

The bank grants a loan of 100 at 5%. The loan amount and interest are paid in the following period. The granting of the loan changes the bank's balance sheet as follows:

ASSETS	**L** +100	**Interest** (receivable)	+5
LIABILITIES	**D** +100	**NW**	+5

The borrower requests the conversion of 1% of the loan into cash. Since the bank has neither cash nor reserves, it sells assets to obtain the reserves and then requests the central bank an exchange of reserves for cash. The bank obtains the reserves from the central bank through the marginal lending facility (the interest rate on which is assumed to be zero).

- Acquisition of reserves:

  ASSETS L^G −1 **R** +1

- Cash acquisition:

  ASSETS **E** +1 **R** −1

- Converting part of the deposit in cash:

  ASSETS **E** −1
  LIABILITIES **D** −1

These operations demonstrate that the creation of bank money may require having liquid assets (that can be sold quickly and easily on the interbank market in exchange for reserves) or assets of sufficient quality (with minimal risk, issued by solvent or prestigious entities, and of high liquidity) to be acceptable to the central bank to obtain central bank reserves.

Deposit creation leads the bank to accumulate reserves (mandatory and voluntary). Specifically, the bank must obtain reserves worth 2. The operation is identical to that carried out to get cash: the bank must sell assets to obtain reserves (it is assumed that private loans are not assets liquid enough or of sufficient quality to be sold: central banks are very strict on what they are willing to accept in exchange for reserves).

ASSETS L^G −2 **R** +2

Summarizing all the operations, following the granting of the loan, the bank's balance sheet has undergone the following changes:

ASSETS **L** +100 **Interests** +5 **R** +2 L^G −3
LIABILITIES **D** +99 **NP** +5

Over the period, the borrower uses the deposit to make payments to customers at other banks. This requires the bank to obtain more reserves again (it already had two units of reserves).

ASSETS L^G −97 **R** +97

and transfer deposits and reserves to other banks:

ASSETS **R** −99
LIABILITIES **D** −99

Since the loan was granted, the net result has been:

ASSETS **L** +100 **Interests** +5 L^G −100 (4)
LIABILITIES **NP** +5

From the above it is deduced (not surprisingly) that interest is the source of the bank's equity increase and the need to have liquid or quality assets prior to granting the loan is confirmed. The loan can be seen as an exchange of assets: the increase in private loans has been made at the expense of getting rid of other assets, predictably public debt securities. In this case, a third message would

be inferred: that the existence of a sufficient volume of public debt (assets generally very liquid and with sufficient quality according to recognized rating agencies) helps to grant private loans.

The next period arrives and the bank receives the interest payment (5) and the amount borrowed (100). The natural hypothesis is that the borrower makes the payment by means of a deposit obtained from another bank (for example, as a salary or as the price for selling goods or assets). It is understood that the other bank that remits the deposit also transfers reserves in the same amount.

ASSETS	**R**	+105
LIABILITIES	**D**	+105

The above notation may seem strange: the borrower again has a deposit in the bank to which he has to pay a debt. The practical effect is that the deposit received is cancelled with the loan (and the interest to be received), in a manner analogous to how the deposit was created together with the loan:

ASSETS	**L**	−100	**Interest**	−5
LIABILITIES	**D**	−105		

Considering only the recorded transactions related to the loan, the net result for the bank's balance sheet is

ASSETS	**R**	+105	$\mathbf{L^G}$	−100
LIABILITIES	**NW**	+5		

Some conclusions can be drawn from all the above.

1. To increase equity, the bank must previously have sufficient equity: in the extreme case analyzed, the bank needed to have liquid or quality assets of the same value (100) as the loan made.

2. The equity increase associated with successful lending activity initially manifests itself in the form of an accumulation of reserves.

3. The bank accumulates reserves amounting to 105, but has no obligation or desire to maintain them, since they are reserves that do not correspond to deposits. For this reason, the reserves of 105 represent excess reserves.

4. What will the bank do with excess reserves? The central bank offers a way out with the deposit facility, but the profitability of this option is, predictably, the worst existing (for more than five years, from 11 June 2014 to 18 September 2019, the European Central Bank set a negative interest rate for the deposit facility: reserves had to be paid to deposit them with the central bank). Consequently, the bank will seek to exchange the reserves for other more profitable assets. A typical option here is public debt, so the bank's balance sheet is most likely to be modified as follows:

ASSETS	**R**	−105	$\mathbf{L^G}$	+105

5. What if the government does not issue enough public debt for banks to transform the excess reserves obtained from private loans? Is public debt not allowing the continued granting of private loans? In fact, the new public debt acquired would allow future loans to increase by 105, instead of the initial 100. With insufficient public debt, it appears that:

   (i) the granting of private loans would be restricted;

   (ii) a source (if not the main source) of investment in banks' reserves would be eliminated;

   (iii) the effectiveness of monetary policy would be put at risk (given that a permanent excess of reserves would bring their price to zero and make it impossible for the central bank to raise interest rates in the economy).

6. The final message of the example is that fiscal austerity policies (or, specifically, arbitrary limitations on the level of public debt) can be detrimental in multiple ways.

   (i) Directly, by reducing the public sector's contribution to economic activity (causing or aggravating recessions and unemployment).

   (ii) Indirectly, the adverse effect on the economy would be double.

   - On the one hand, reinforcing the contraction of economic activity (and the increase in unemployment) by making it difficult for banks to grant private loans (which would not have sufficient liquid or quality assets to finance the acquisition of reserves).

   - On the other, by reducing the profitability of banking activity: the banks' credit activity generates surplus reserves that, by themselves, do not provide profitability or not a substantial one or, in any case, not one comparable to that of public debt. Consequently, the reduction of public debt would eliminate investment options with relatively high profitability and would contribute to reducing the profitability of banks (in turn threatening their solvency or viability and, by extension, the stability of the banking sector and the entire financial sector of the economy).

The following are questions of interest that will not be answered.

1. Where did the bank's net equity gain come from?

2. With what additional money did the borrower pay the interest?

3. Are the five units of additional reserves that the bank has obtained, and which express the profit that the bank derives from loans, also additional reserves for the entire banking sector or is there another bank that has lost them?

4. If the banking sector has also gained five units of reserves, does this mean that granting loans requires an expansionary monetary policy (in the sense that the central bank provides all the reserves demanded by the banking sector as a whole)?

If there is default, the changes following the situation described in (4) would be

ASSETS	L	−100	Interest −5
LIABILITIES	NW	−105	

so that the loss of value associated with the default would be recorded. With respect to the initial situation, the bank has lost assets: $\mathbf{L^G}$ −100. Based on the analysis of the example, the loss of assets limits the potential for new loans and, by extension, the creation of bank money.

To sum up some lessons from the example:

- private loans are not independent of public loans;
- public loans underpin the creation of private loans (they are an instrument to fulfill the obligations —specified in the transfer of reserves— associated with the creation of private loans);
- without public debt there would probably not be a type of asset in sufficient volume and with equivalent characteristics to replace it;
- public debt is very liquid and safe, and the counterpart is a relatively low return (in any case, higher than that of reserves, so banks have an incentive to convert reserves into public debt);
- private lending will have a higher return than public debt, so banks will convert public debt into private debt;
- public debt can be understood as a transitory investment platform for banks, which await an opportunity to convert public debt into a more profitable asset;
- when the private loan is repaid, the entire operation is reduced to a swap of public debt for reserves (the reserves will have a value greater than the public debt sacrificed; the difference in value will be the interest on the loan);
- but this is not the end of the story, insofar as banks have little interest in maintaining a substantial volume of excess reserves and will prefer to convert the reserves into a more profitable asset, with public debt being the basic alternative to reserves.
- What would happen if sufficient new public debt were not created? Reserves would have a harder time being exchanged for a more profitable asset (and then what would be the point of lending to households and firms if what you get in the end are reserves that cannot easily be invested in more profitable assets?).
- All of the above suggests that public debt plays a decisive role in the creation of private debt and in the creation of profits for banks (mainstream macroeconomics instructs governments to minimize public debt and attributes monetary policy most of the responsibility for stabilizing economies or boosting economic growth).

Addendum: the money multiplier formula

The mainstream textbook model of money creation is based on the following equations (where R is interpreted as cash held by banks and the ratios are presumed constant).

- Monetary base: $\mathrm{M0} = \mathrm{E} + \mathrm{R}$
- Monetary mass: $\mathrm{M1} = \mathrm{E} + \mathrm{D}$
- Liquidity ratio: $l = \mathrm{E}/\mathrm{D}$
- Reserve ratio: $r = \mathrm{R}/\mathrm{D}$

It then follows that

$$\frac{\mathrm{M1}}{\mathrm{M0}} = \frac{\mathrm{E}+\mathrm{D}}{\mathrm{E}+\mathrm{R}} = \frac{\frac{\mathrm{E}+\mathrm{D}}{\mathrm{D}}}{\frac{\mathrm{E}+\mathrm{R}}{\mathrm{D}}} = \frac{\frac{\mathrm{E}}{\mathrm{D}}+\frac{\mathrm{D}}{\mathrm{D}}}{\frac{\mathrm{E}}{\mathrm{D}}+\frac{\mathrm{R}}{\mathrm{D}}} = \frac{l+1}{l+r}.$$

The assumption that the two ratios are constant implies that the so-called 'money multiplier'

$$mm = \frac{l+1}{l+r}$$

is constant and, in consequence,

$$\mathrm{M1} = mm \cdot \mathrm{M0}.$$

This is the mainstream conclusion that the monetary mass M1 is a multiple of the monetary base M0. As the central bank determines M0, the final conclusion is that, through the money multiplier, the central bank also determines M1 (which justifies the assumption behind the LM relation that the 'money supply' is constant).