1. Orthodox model of money creation

1. Monetary aggregates

Monetary aggregates are technical ways of defining money and measuring its amount. An odd feature of monetary aggregates is that they define money by examples. It is like defining what a city is by selecting a few cities and declaring the selected cities to be 'the cities', without providing the reasons or characteristics that make the chosen examples cities.

2. Monetary aggregate M0

The monetary aggregate **M0** is defined as $\mathbf{M0} = \boldsymbol{E} + \boldsymbol{R}$, where $\boldsymbol{E}$ designates the currency held by the public (cash) and $\boldsymbol{R}$ stands for the bank reserves. The bank reserves $\boldsymbol{R}$ are equal to the currency held by banks (in the banks' vaults and in ATMs) plus the banks' deposits in the central bank. Other names for **M0** are monetary base, central bank money, narrow money or high-powered money.

3. Central banks

The central bank (CB) is the monetary authority in an economy. In this course the CB will be the institution that determines and executes the monetary policy (loosely speaking, monetary policy is the set of policy measures aimed at regulating the amoung of money in an economy or its price, the interest rate of the economy). A central bank is a (typically) public institution that

- provides and regulates the monetary aggregates (at least, a central bank can control **M0**);
- issues the currency (see the letters 'ECB' in euro banknotes);
- controls (or rather pretends to control) the interest rates and/or the inflation rate;
- oversees the banking and the payment systems (the CB is the systems' supervisor);
- acts as a lender of last resort to the banking system (the CB is a banker to banks);
- establishes mininum reserve requirements and conducts the monetary policy;
- is in general independent of the government (though the CB may a banker to the government).

4. Monetary aggregate M1

The monetary aggregate **M1** is defined as $\mathbf{M1} = \boldsymbol{E} + \boldsymbol{D}$, with $\boldsymbol{D}$ being the total amount of sight bank deposits (non-interest-bearing accounts) held by the public in banks. **M1** is also called monetary mass, money stock or money supply.

5. Monetary aggregates M2 and M3

The monetary aggregate **M2** is defined as **M2** = **M1** + savings deposits. The monetary aggregate **M3** as **M3** = **M2** + time deposits + other categories.

6. Basic forms of modern money

Modern money takes three basic forms: currency, reserves and deposits. Currency plus reserves define central bank money. Deposits constitute bank money.

7. Forms of money I: currency

Currency (cash) is given by coins (metallic money) plus banknotes (paper money). Both coins and banknotes are issued by central banks. Coins are a short of residual commodity money. Paper money is the typical example of fiat money.

8. Forms of money II: central bank reserves (or, simply, reserves)

Reserves are electronic money (or computer money) created by the central bank. As a rule, reserves can only be used by banks and governments (banks use reserves for interbank payments). Reserves cannot be transferred to households or firms: the public are not allowed to receive or use reserves. Reserves do not leave the banking sector to enter the real sector.

9. Financial assets

A financial asset is a claim on someone else, an I0U ('I owe you'): an instrument by means of which someone acknowledges a debt. In essence, a financial asset is the expression of a promise to pay money in the future.

10. Financial assets as monetary time machines

Suppose someone needs money now, does not have it at present, but expects to have it in the future. Then he can bring part of this future money to the present by creating and selling a financial asset. This asset can be seen as a contract between the issuer of the asset and its purchaser in which the issuer says 'Give me money now in exchange for my promise of giving you money in the future'. A financial asset is a way of capitalizing future revenues, of taking the issuer's money back from the future to be used now. Hence, a financial asset is, essentially, a loan of money: the issuer of a financial assets is borrowing money and, by purchasing the asset (by purchasing the promise of future payment) the purchaser is actually lending money.

11. Forms of money III: bank deposits

Bank deposits (or, more appropriately, bank money) is electronic money created by banks. A bank deposit is a financial asset representing a liability: the bank's legal obligation to pay money on request to depositors. A bank deposit is a record of what the bank owes the depositor. A bank deposit is not necessarily created by depositing cash in a bank. That is why it is less confusing to use the expression 'bank money' instead of 'bank deposit'.

12. Electronic money (e-money) and digital money (digital currencies)

E-money (PayPal, Google Wallet) is a substitute or a way of using bank money. Digital money is a form of money not backed by a public authority and its value comes from its limited supply (as occurs with assets). Digital money is like a modern form of gold. Examples include Bitcoin, Litecoin and Ripple.

13. The basic forms of money represent I0Us between sectors

Currency can be seen as I0Us from the public sector to (mostly) the non-banking private sector (households and firms). Reserves, as I0Us from the public sector to the banking private sector

(banks). And bank money, as IOUs from the banking private sector to the non-banking private sector; see Figs. 1 and 2 below.

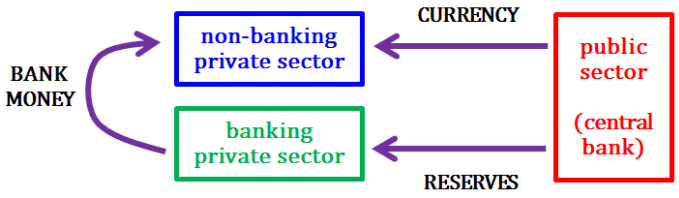


Fig. 1. The forms of money as IOUs between sectors

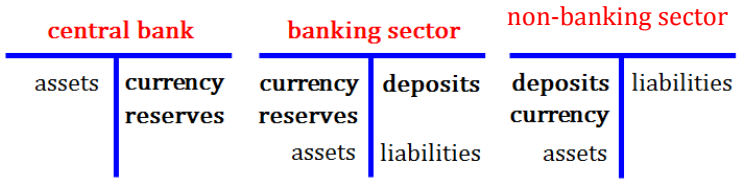


Fig. 2. The forms of money in the sectoral balance sheets

14. The textbook (inaccurate) story of how banks create M1.

Suppose the central bank buys some asset, worth 100, from Bank 1 and pays the purchase with new banknotes. Fig. 3 represents (as T-accounts) the changes that take place in the balance sheets of the central bank and Bank 1 (assets are represented on the left-hand side of a balance sheet and liabilities on the right-hand side).

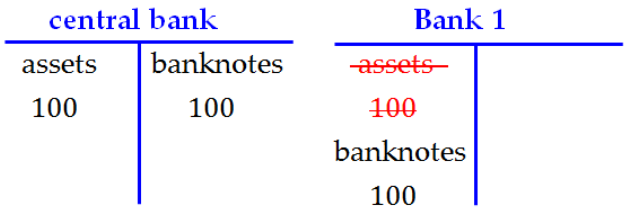


Fig. 3. The central bank buys assets from Bank 1

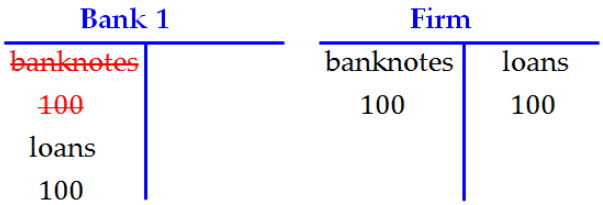


Fig. 4. Bank 1 lends the banknotes to a firm

As banks dislike having banknotes sitting idle in their vaults, Bank 1 satisfies a loan request of 100 by a firm. The firm receives the banknotes from Bank 1. Fig. 4 depicts the impact of this operation on the respective balance sheets. The firm uses the banknotes to pay the wage of one of its workers. The worker gets the banknotes and deposits them in Bank 2. Fig. 5 displays the changes in Bank 2's balance sheet after the worker deposits the banknotes.

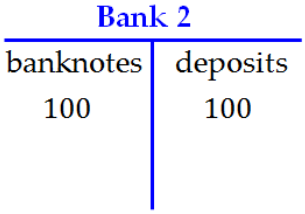


Fig. 5. Bank 2 receives deposits

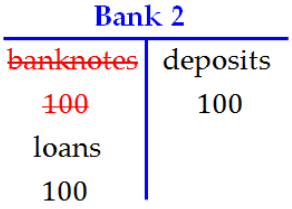


Fig. 6. Bank 2 lends the banknotes

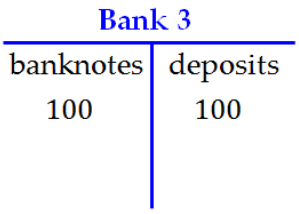


Fig. 7. Bank 3 receives deposits

Just like Bank 1, Bank 2 grants a loan to some consumer. Fig. 6 shows the change in Bank 2's balance sheet. The consumer spends the banknotes purchasing goods. The seller of the goods is given the banknotes in exchange for the goods and deposits them in Bank 3. Fig. 7 indicates the effect on Bank 3's balance sheet of the seller's deposit. Now it is Bank 3 that lends the banknotes and the process goes on… To recap, the central bank has 'injected' 100 units of currency (in the form of banknotes) in the economy through Bank 1. Yet, the increase in **M1** is larger than the

value 100 of the new banknotes. The reason is that, up to the point at which Bank 3 receives the deposit (Fig. 7), new deposits worth $100 + 100 = 200$ have been created. Hence,

$$\Delta \mathbf{M1} \geq \Delta \text{ banknotes} + \Delta \text{ deposits} = 100 + 200 = 300\,.$$

Moreover, economagically, three agents can make use of the same money: Bank 3 can lend the banknotes; the seller of the goods can use his deposits in Bank 3 to make payments; and the worker can also make use of his deposits in Bank 2 to make payments. The new deposits in Bank 2 and Bank 3 (which add up to 200) are backed by the same banknotes (whose value is only 100). To see why this fact is relevant, imagine that seller and worker would simultaneously like to withdraw their deposits. If Bank 3 has not yet lent the banknotes, the seller's request can be satisfied. But Bank 2 would have a problem to pay back the banknotes to the worker because the banknotes the worker deposited have been lent. This means that, if Bank 2 has no funds to attend the client's request, Bank 2 would need to borrow money. In normal circumstances this could be easily done in the interbank money market. Yet, during financial crises, interbank markets freeze: banks are less willing to lend money because all banks lack funds (they all face liquidity constraints).

15. The textbook model of M1 creation

The model aims to ascertain the final outcome of the process described in §14. To this end, two behavioural rules are assumed. First, banks hold as reserves a fixed fraction r of the deposits by clients. Second, the public keep in cash a fixed proportion l of their deposits.

• The cash reserve ratio $r = \boldsymbol{R}/\boldsymbol{D}$ is the amount of reserves banks hold per unit of deposits. It is the percent of deposits that banks choose (or are required) not to lend.

• The liquidity ratio $l = \boldsymbol{E}/\boldsymbol{D}$ is the amount of currency that people hold per unit of deposits.

With the above definitions, it is possible to express **M1** as a fixed multiple of **M0**. If the two ratios $r = \boldsymbol{R}/\boldsymbol{D}$ and $l = \boldsymbol{E}/\boldsymbol{D}$ are held constant, then

$$\boxed{\mathbf{M1} = \frac{1+l}{r+l} \cdot \mathbf{M0}\,.} \qquad (1)$$

To prove (1), it follows from $l = \boldsymbol{E}/\boldsymbol{D}$ that $\boldsymbol{E} = l \cdot \boldsymbol{D}$. It follows from $r = \boldsymbol{R}/\boldsymbol{D}$ that $\boldsymbol{R} = r \cdot \boldsymbol{D}$. Therefore, $\mathbf{M0} = \boldsymbol{E} + \boldsymbol{R} = l \cdot \boldsymbol{D} + r \cdot \boldsymbol{D} = (l + r) \cdot \boldsymbol{D}$. Solving for $\boldsymbol{D}$, it turns out that

$$\boldsymbol{D} = \mathbf{M0}/(l + r). \qquad (2)$$

On the other hand, $\mathbf{M1} = \boldsymbol{E} + \boldsymbol{D} = l \cdot \boldsymbol{D} + \boldsymbol{D} = (1 + l) \cdot \boldsymbol{D}$. Solving for $\boldsymbol{D}$, now $\boldsymbol{D} = \mathbf{M1}/(1+ l)$. The combination of this equation with (2) yields (1).

16. The money multiplier

Assuming r and l constant, the money multiplier mm is defined as the ratio $\dfrac{1+l}{r+l}$.

Suppose banks choose $\boldsymbol{R}$ so that, for a fixed proportion $0 < r < 1$ and any given $\boldsymbol{D}$, $\boldsymbol{R} = r \cdot \boldsymbol{D}$. Suppose as well that people choose $\boldsymbol{E}$ so that, for a fixed proportion $0 < l < 1$ and any given $\boldsymbol{D}$, $\boldsymbol{E} = l \cdot \boldsymbol{D}$. Then $\mathbf{M1} = mm \cdot \mathbf{M0}$; that is, the money stock **M1** is a fixed multiple (mm) of the monetary base **M0**. Equivalently,

$$mm = \frac{\mathbf{M1}}{\mathbf{M0}}.$$

The money multiplier mm indicates how many units of money stock **M1** are generated by one unit of monetary base **M0**. If mm remains constant, then $\Delta\mathbf{M1} = mm \cdot \Delta\mathbf{M0}$. Accordingly, with a fixed money multiplier, a change in **M0** causes a fixed proportional change in **M1**.

17. **A dynamic numerical version of the textbook model of M1 creation.** Suppose **M0** is increased by €600 million. For instance, the central bank buys financial assets from the banks and pays that purchase with new banknotes worth €600 million. Assume that

- $l = \frac{1}{5} = 0.2$, which means that people hold 0.2 euros in cash for each euro deposited in banks;
- $r = \frac{1}{10} = 0.1$, so banks need to keep 10% of new deposits as reserves and can lend the rest.

Since the deposits $\boldsymbol{D}$ in banks have not changed, banks have an excess of cash reserves equal to €600 million. They can then lend the €600 million to consumers and firms. Denote loans by $\boldsymbol{L}$. The change $\Delta\boldsymbol{L}$ in the volume of loans is equal to the change $\Delta\boldsymbol{D}$ in deposits minus the change $\Delta\boldsymbol{R}$ in reserves. Let consumers and firms be always willing to borrow any amount offered by banks.

The people that borrow the €600 million will spend them buying goods or financial assets. The sellers of the goods or the financial assets receive €600 million. This amount must be allocated between cash and deposits to make the increase in cash $\Delta\boldsymbol{E}$ divided by the increase in deposits $\Delta\boldsymbol{D}$ equal to 0.2. The following two equations provide the solution.

- Distribution of 600 between two uses $\quad \Delta\boldsymbol{E} + \Delta\boldsymbol{D} = 600$
- Fulfillment of the liquidity ratio $\quad \Delta\boldsymbol{E}/\Delta\boldsymbol{D} = 1/5$ (or, equivalently, $\Delta\boldsymbol{D} = 5 \cdot \Delta\boldsymbol{E}$)

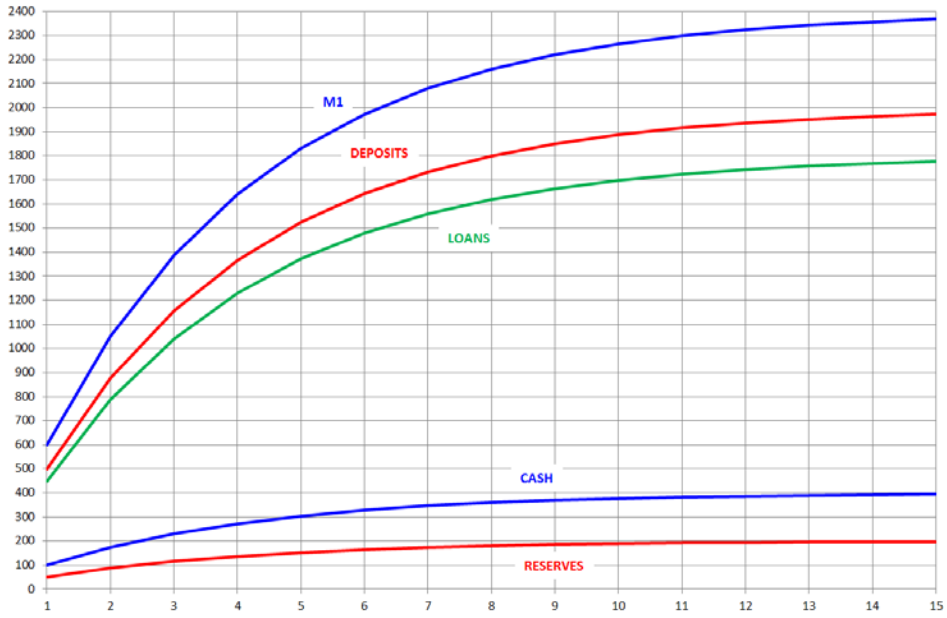
Consequently, $\Delta\boldsymbol{D} = 500$ and $\Delta\boldsymbol{E} = 100$. This means that people deposit €500 million in banks and hold €100 million in cash. With reserve ratio $r = 0.1$, banks retain 10% of the new deposits as reserves ($\Delta\boldsymbol{R} = \Delta\boldsymbol{D}/10 = 500/10 = 50$) and lend the rest ($\Delta\boldsymbol{L} = \Delta\boldsymbol{D} - \Delta\boldsymbol{R} = 500 - 50 = 450$). The table below summarizes the process so far.

round	$\Delta\mathbf{M0}$	$\Delta\boldsymbol{D}$	$\Delta\boldsymbol{E}$	$\Delta\boldsymbol{R}$	$\Delta\boldsymbol{L} = \Delta\boldsymbol{D} - \Delta\boldsymbol{R}$	$\Delta\mathbf{M1} = \Delta\boldsymbol{E} + \Delta\boldsymbol{D}$
1	600				600	
2		500	100	50	450	600

At this point the process recommences: people borrow and spend 450, and those receiving the 450 keep a part in cash (75) and deposit the rest (375) on banks. The same process is repeated round after round, as shown in Table 8 next.

round	Δ**M0**	ΔD	ΔE	ΔR	$\Delta L = \Delta D - \Delta R$	Δ**M1** $= \Delta E + \Delta D$
1	600				600	
2		500	100	50	450	600
3		375	75	37.5	337.5	450
4		281.25	56.25	28.125	253.125	337.5
5		210.9..	42.1...	210.9...	189.84...	253.125
...		...	...	...	...	...
TOTAL	600	2,000	400	200	1,800	2,400

Table 8. The deposits (money) multiplier process and the limit of the process



Deposits grow continuously: 500 + 375 + 281.25 + 210.9 + … = 2,000. **M0** initially increased by 600. The fraction held in cash is the sum 100 + 75 + 56.25 + 42.18 + … = 400. Since **M0** = $\boldsymbol{E} + \boldsymbol{R}$, Δ**M0** = $\Delta\boldsymbol{E} + \Delta\boldsymbol{R}$. That is, 600 = 400 + $\Delta\boldsymbol{R}$. Thus, $\Delta\boldsymbol{R}$ = 200 = 50 + 37.5 + 28.125 + 21.09 + …

Fig. 9. Chart of Table 8 (15 first periods)

On the other hand, **M1** = $\boldsymbol{E} + \boldsymbol{D}$ yields Δ**M1** = $\Delta\boldsymbol{E} + \Delta\boldsymbol{D}$. As $\Delta\boldsymbol{E}$ = 400 and $\Delta\boldsymbol{D}$ = 2,000, it follows that Δ**M1** = 2,400: an increase of 600 in **M0** is transformed into an increase of 2,400 in **M1**. Given Δ**M1** = $\Delta\boldsymbol{E} + \Delta\boldsymbol{D}$ and Δ**M0** = $\Delta\boldsymbol{E} + \Delta\boldsymbol{R}$, it turns out that Δ**M1** – Δ**M0** = ($\Delta\boldsymbol{E} + \Delta\boldsymbol{D}$) – ($\Delta\boldsymbol{E} + \Delta\boldsymbol{R}$) = $\Delta\boldsymbol{D} - \Delta\boldsymbol{R} = \Delta\boldsymbol{L}$. In words, the multiplier effect (the increase in **M1** over **M0**) is generated by loans (in the example, $\Delta\boldsymbol{L}$ = Δ**M1** – Δ**M0** = 2,400 – 600 = 1,800).

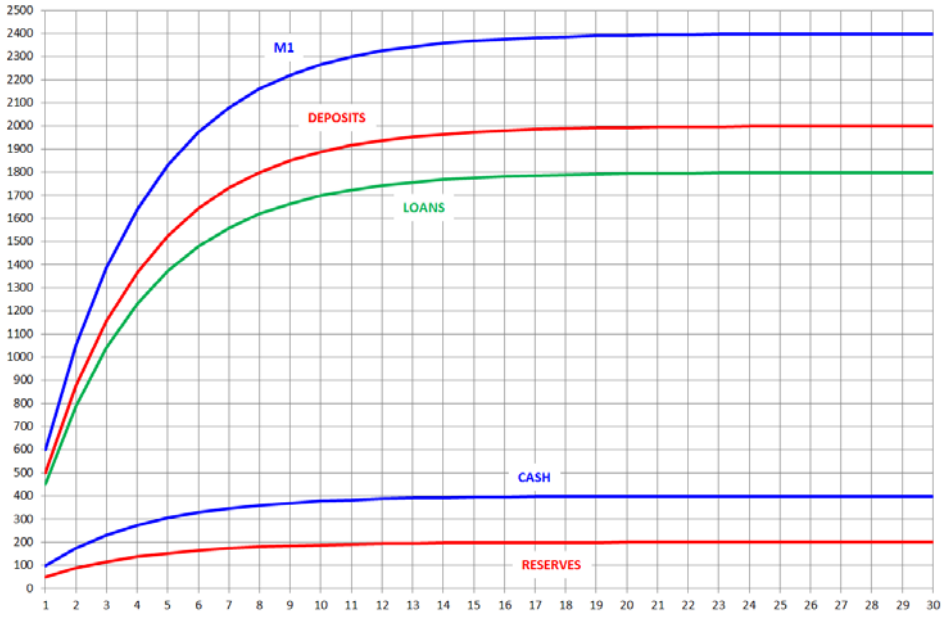


Fig. 10. Chart of Table 8 (30 first periods)

This analysis suggests that the money multiplier *mm* has to be 4: $\Delta\mathbf{M0} = 600$ generates $\Delta\mathbf{M1} = 2{,}400$. In fact,

$$mm = \frac{1+l}{r+l} = \frac{1+0.2}{0.1+0.2} = \frac{1.2}{0.3} = \frac{12}{3} = 4\,.$$

Value *mm* is the total effect on the cash held by the people and on deposits created by the process

$$\ldots \Rightarrow \uparrow \textbf{deposits} \Rightarrow \uparrow \textbf{loans} \Rightarrow \uparrow \textbf{expenditures} \Rightarrow \uparrow \textbf{revenues} \Rightarrow \uparrow \textbf{deposits} \Rightarrow \uparrow \textbf{loans} \Rightarrow \ldots$$

18. Interaction between real and financial activity

The above sequence illustrates the interaction between the financial sector (deposits and loans) and the real sector (purchases of goods) of the economy. Fig. 11 on the right sketches the process underlying the results in Table 8. The values in the example illustrate the fact that most money (80-90%) is bank money, that is, just a digital record in the banks' computer databases.

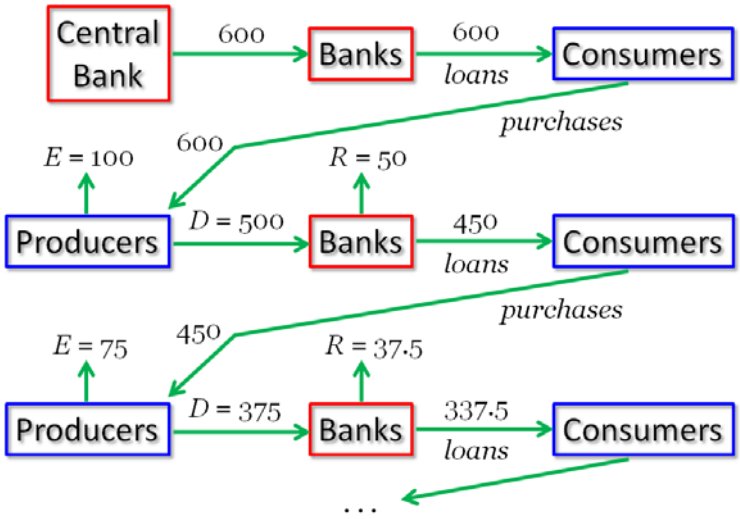


Fig. 11. The sequence of events behind the **M1** creation process

19. Implications of the orthodox multiplier model

- Deposits come first and loans are created afterwards. Hence, banks cannot lend until they receive deposits: the money creation process cannot start unless deposits are previously created. This result expresses the view of banks as money intermediaries: banks transfer existing purchasing power from lenders to borrowers.
- The amount of loans (credit issued) can be controlled by the central bank changing the reserve ratio or the monetary base. Accordingly, banks have no control over the money stock **M1**.
- Without a continuous exogenous increase in the monetary base, **M1** cannot grow indefinitely and get out of control.

(see Josh Ryan-Collins et al. (2012): *Where does money come from?*)

20. The reality of bank money creation

- A bank can make a loan without previously having to receive cash or accept a deposit. Loans do not need to wait for the arrival of money to the bank. A bank can, simultaneously and at will, create a loan and a bank deposit, the latter representing the extension of credit by the bank. When a bank makes a loan, the money lent is not taken from anyone's account nor from the bank's funds: it is created out of thin air.

- As deposits are accounting entries in a computer, a bank creates the money by crediting its customer's account with the amount of the loan and balancing this liability by registering the amount of the loan as an asset. The bank is not actually providing cash but the promise to provide cash. But that promise, the account at the bank, counts as cash.
- Banks establish the amount of central bank money that the central bank must provide to banks.
- The extent to which banks create bank money depends on the probability that banks attribute to the repayment of the loans: bank money is the product of the bank's confidence. This confidence may be volatile. Excessive confindence of banks in the ability of borrowers to replay loans may fuel a credit bubble. A credit crunch may ensue when banks realize the unsustainability of the credit boom. The credit crunch may persist no matter how much central bank money (monetary base) the central bank lends, or makes available, to banks.

21. Bank runs

A bank run is a sudden and simultaneous request by customers to withdraw a sufficiently high volume of deposits. The deposit creation process shows that the banking system is exposed to bank runs: as there are more deposits than currency, it is impossible for banks to satisfy a sufficiently large demand by clients to withdraw deposits. The banking system is then unstable: its stability depends on the belief that the banking system is stable, which amounts to holding the (false) belief that banks have enough cash to transform most of the deposits into cash.

22. 'Our' central bank: the European Central Bank (ECB)

Visit the ECB's website: http://www.ecb.europa.eu/home/html/index.en.html. For statistics, see http://sdw.ecb.europa.eu/. The chart below illustrates the magnitude of the multiplier in the euro area.