

Money, inflation and interest rates

Revised: November 26, 2012

Latest version available at <http://www.fperri.net/TEACHING/20205.htm>

What is money?

A standard way to begin a discussion about money is to try to define what it is.

This is somewhat difficult to do because historically many things have been used as money - shells, beads, cigarettes, pieces of paper. What characteristics make any of these suitable as a form of money? One way to think about this is to define money in terms of the services it provides. **Money is an asset**. An asset is something that serves as a **store of value**, that is something that can transfer purchasing power from today to the future. Notice that money might not be the best way to store value (cash for example is money and does not pay interest and loses value because of inflation). But, lots of things, stocks, bonds, real estate, can and do fulfill that function. Money is really quite different from other assets because it provides another important service - it serves as a **medium of exchange**. The medium of exchange role implies that it is freely exchanged for goods and services and it has wide acceptance and (generally) well understood value; in other words money can be used to make transactions. Another service that money provides is that it serves as a **unit of account**. The role of unit of account means that when we talk about the value of other assets or consumption goods we use monetary units as a standard way of denominating them. The unit of account means also means that money is the good we use to measure prices, that is we define the concept of price of an object as the number of units of money that are required to purchase that object. This is important to recognize as when we think about inflation, that is how price level change, we have to think about how the stock of money changes. The fundamental prerequisite for functions 1,2 and 3 is that money has to have current and future value.

After outlining its functions we can then state that **money is the stock of assets that can be used to make transactions** (stock of liquid assets).

How does money come into being and why are people willing to accept some forms of money? Or in other words where does the value we attach to money come from? We know that different forms of money have evolved naturally in many societies. One example that is often cited is that cigarettes became used as a form of money in POW

camps during World War II. They are also often used as a form of money in U.S. prisons. What problems does the existence of an accepted form of money solve? The easiest way to understand this is to imagine a simple economy in which individuals all specialize in the production of a single good. Some grow wheat, some harvest wood, some raise chickens and some educate the young. Specialization, as we learned studying international trade, is efficient but how do educators and wood harvesters get to eat? how food producers get wood and educate their young?. People benefit from transacting with one another. But if this were a pure barter world, then transactions could only take place when we found someone who offered in trade something we desire and who desired that which we produce. This is called the *double coincidence of wants*. The point is that transacting in such a world would be very inefficient. Suppose, instead that there were some accepted medium of exchange. It need not be anything with intrinsic value. It could be stones of a certain size and shape, or pieces of paper embossed with a picture of long dead politicians. All that is required is that everyone agree that it is the medium of exchange and agree on its relative value. In this world, educators could now exchange education services for money and use the money to purchase wheat and wood without worrying about whether the producers of wheat and woods that he encountered had any need for education services. The acceptance of a medium of exchange thus facilitates transactions in the society because it removes an important impediment to economic activity. As money plays an important role in society it is important that its supply keeps up with the growth of the society. But who decides what is money?

There can be two main types of money: **Commodity money** and **Fiat Money**. Commodity money is a form of money that also has intrinsic value (for example gold coins or cigarettes): everything can be commodity money as long as it is accepted: for example candies sometimes are given as change: this is the case of commodity money. Fiat Money is a form of money that has no intrinsic value (for example dollar bills). Fiat money is declared money by some institution. Commodity money was the only form of money that was used on the world until fairly recent times. Now most countries use Fiat Money even though some countries are still -de facto- using commodity money systems. The main advantage of commodity money (for example gold) is that its value is guaranteed from the fact that people use gold for a variety of reasons (jewelry, industrial use etc.) and so it does not require a social convention. The main disadvantage of commodity money is that its supply cannot be controlled easily. For example when gold was the only form of money, shortages of gold or big gold discoveries affected the quantity of money. Fiat money (Let it be money) on the other hand does not have intrinsic value (it is useless) and all its value comes from social acceptance, from the diffused belief that money will be used and accepted in the future. The quantity of Fiat money can be controlled easily and cheaply, since mostly it consists of pieces of paper. The fact that Fiat money can be controlled by the issuer might be an advantage and a disadvantage. If the issuer is trustworthy (like for example the Federal Reserve Bank) having control over the money supply is a good thing because it can be used to achieve price stability. If on the other hand

the issuer is not very trustworthy (like the Argentinean Central Bank in the '80s) then control is a bad thing because it allows the government to use money creation to finance all sort of expenditures and this leads to price instability, to large unexpected wealth transfers and, in extreme cases, to the collapse of the exchange system (we will discuss more about this later).

Measures of Money Supply

The Federal Reserve has developed various measures of money and other Central Banks around the world have similar measures. A good reference for details of the various definition can be found on the wikipedia article [Money Supply](#).

The most restrictive (narrow) measure of the money supply ($M0$) counts only government-issued currency held by the non-bank public. This aggregate is included in all broader definitions of money and is called the currency component of the money supply.

A somewhat broader definition of the money supply includes the total monetary liabilities of the federal government and is known either as *high-powered money* or the *monetary base*, denoted MB . This broader definition includes currency held by the non-bank public as well as reserves held by commercial banks as backing for their deposit liabilities. Banks can hold reserves in either of two forms, *vault cash* held directly by the commercial bank and *reserve deposits* maintained by the commercial bank at one of the twelve regional Federal Reserve Banks.

An even broader definition of money is known as $M1$. It includes currency held by the non-bank public, travelers checks, and checkable deposits at commercial banks. (Note that bank reserves do not appear directly in $M1$. Instead, they back deposits at commercial banks.) A still broader definition of the money supply, known as, $M2$ includes $M1$ plus savings deposits, small time deposits (under \$100,000), money market mutual fund shares (MMMMFs) held by the public, money market deposit accounts (MMDAs), overnight Eurodollar deposits in foreign branches of U.S. banks, and overnight repurchase agreements whereby a bank sells a security overnight to a non-bank institution.

Figure 1 shows the components of the various measures of money as of March 2001.

For comparison, nominal GDP in 2001 was around \$10000 billions. It is worth noting that what you might commonly think of as money, currency, is only a small fraction of these broader measures. But it is clear that all of these other components of money are available, to some degree or other, for transactions. Note that Federal Reserve has tight short-term control over the monetary base but not over broader monetary aggregates.

Symbol	Assets Included	Amount in March 2001 (billions of dollars)
C	Currency	\$ 539
M1	Currency plus demand deposits, traveler's checks, and other checkable deposits	1,111
M2	M1 plus retail money market mutual fund balances, saving deposits (including money market deposit accounts), and small time deposits	5,100
M3	M2 plus large time deposits, repurchase agreements, Eurodollars, and institution-only money market mutual fund balances	7,326

Source: Federal Reserve.

Figure 1: MEASURES OF MONEY

Instruments of Monetary Policy

In the United States and in most countries, the supply of currency is controlled by a Central Bank. The U.S. central bank is called the Federal Reserve. It was established in 1913 by an act of congress and has responsibility for regulating banks and, most importantly, for formulating and conducting monetary policy. The Federal Reserve is an independent central bank. This means that it can formulate and implement policy independently of the government in power. This arrangement is not true of other countries. There are 12 regional Federal Reserve Banks and a Board of Governors of the Federal Reserve System that resides in Washington D.C.. Since the 1930's power over monetary policy has been concentrated in the Federal Reserve Board and a group called the Federal Open Market Committee (FOMC). The FOMC consists of the seven Governors of the Federal Reserve System, who are appointed by the president for staggered 14 year terms, the Chairman, currently Ben Bernanke, who serves for a four year term and five of the regional bank presidents who serve on a rotating basis. The FOMC meets every six weeks and is the group that sets monetary policy.

As noted above, the Federal Reserve directly controls the monetary base but through its control of the monetary base and other tools of monetary policy (like the reserve requirement that is set by the Federal Reserve), the Federal Reserve also influences broader monetary aggregates.

Open Market Operations

Open market operations (the FED buying and selling govt. bonds on the open market) affects the quantity of currency in the economy and thus will affect *M1*. Open

market operations are what the FED does to implement its policy of targeting of the Federal Funds Rate. The Federal Funds rate is the rate at which banks lend to each other balances they held at the Federal Reserve overnight. Banks need to satisfy their reserve requirement and, as we discussed, they can do so by holding balances at the Federal Reserve. If one bank needs to increase its balance it can do so by borrowing from another bank who wants to decrease its balance. The Federal Funds Rate is the rate at which this transaction take place. Clearly the total supply of these balances on the market affects this price so the FED can achieve a target level for the FFR by injecting or taking liquidity out of the open market. By selling treasury bonds the FED debits the account of the buyer so it reduces the amount of these funds and this will tend to increase the price of balances (i.e. the Federal Funds Rate). By buying bonds on the open market the FED credits the account of the buyer, increase the supply of funds and thus causes a decline in the federal funds rate.

Non Conventional Monetary Policy (QE2, QE3, operation twist)

Open market operations are the tool the FED uses to affect the federal funds rate and to inject money into the economy. There are times though in which the Federal Funds Rate is fixed at 0 so the FED cannot use monetary policy to affect it. These situations are usually referred as “liquidity traps”. In these situation the FED can use so called “non conventional instruments” to inject money into the economy. An example of this is the purchase of long term bonds. The FED has done in 2009-2010 during the so-called quantitative easing 2 (QE2) period and is doing this now during the so called “operation twist”. More extreme examples of these instruments are purchases of stocks or direct money transfers to households.

Reserve Requirement

The reserve requirement is a rule that the FED can impose on banks. It affects the ability of banks of creating loans out a given amount of currency and affect the ratio between money supply (M1) and currency. This instrument though is not used for short term changes in the money supply.

Discount Rate

Finally the discount rate, that is the rate at which commercial banks can borrow from the central bank to satisfy their reserve requirements, is another instrument that affects money supply. If the discount rate is low it is cheap for banks to borrow from the central bank (rather than from other banks through the FFR) and they will do so when in need of reserves. The discount window though, for a variety of reasons, is rarely used by commercial banks so this rate is not a very relevant instrument. For more details on monetary policy in US and in Europe see a FED article on [open market operations](#), or the ECB guidelines on [the implementation of monetary policy](#).

Now that we have defined money supply and monetary policy (changes in the money supply) we want first to discuss its effects on prices.

The Quantity Theory of Money

$M * V$ is the amount of money that can be used in a given interval of time in US, where M is the existing stock of money, V is the velocity of the current stock of money (how quickly money changes hands). This money is used to purchase output that is produced in US in that interval of time (this is not entirely correct as people might hold money for other reasons, we will come back to this point). We can write the value of output that is produced as $P * Y$ where Y is real output and P is the price of it (you can think of $P * Y$ as *GDP* deflator times real GDP). Algebraically

$$M * V = P * Y$$

Let's take logs of this identity at time t and at time $t - 1$ and we get

$$\begin{aligned}\log(M_t) + \log(V_t) &= \log(P_t) - \log(Y_t) \\ \log(M_{t-1}) + \log(V_{t-1}) &= \log(P_{t-1}) - \log(Y_{t-1})\end{aligned}$$

and subtracting the second equation from the first we get

$$\begin{aligned}\log(M_t) - \log(M_{t-1}) + \log(V_t) - \log(V_{t-1}) \\ = \log(P_t) - \log(P_{t-1}) + \log(Y_t) - \log(Y_{t-1})\end{aligned}$$

now notice that inflation is $\log(P_t) - \log(P_{t-1}) = \pi_t$ so we have

$$g_{M,t} + g_{V,t} = \pi_t + g_{Y,t} \tag{1}$$

where $g_{M,t}$, $g_{V,t}$, $g_{Y,t}$ are the growth rates of money supply, money velocity and output respectively.

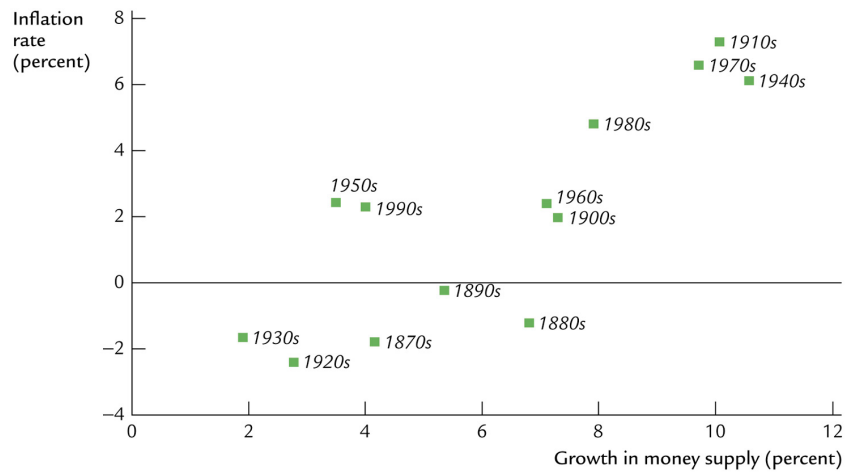


Figure 2: LONG RUN MONEY AND PRICES IN THE US

Assumptions of the Quantity theory

The quantity theory is based on two main assumptions

- 1) In the long run output is determined independently from the quantity of money present in the economy ($g_{Y,t}$ is independent from $g_{M,t}$)
- 2) Money velocity is constant ($g_V = 0$)

These assumptions imply that by controlling the growth rate of money supply the monetary authority can control inflation. Nobel prize winner Milton Friedman summarized the quantity theory with the famous, among economists, quote: “Inflation is, always and everywhere, a monetary phenomenon”.

Figure 2 plots the growth rate of money supply against the rate of inflation in several decades. You can see that in general decades characterized by high monetary growth are characterized by high inflation. One of the reason for which the points do not lie in a straight line is that different decades were also characterized also by different growth rates of output. For example the 1870s decade and 1990s decades had roughly the same monetary growth but inflation was much higher in the 1990s. One reason for that is that real income growth was much higher in 1870s and as equation 1 show, keeping $g_{M,t} + g_{V,t}$ constant, higher $g_{Y,t}$ implies lower inflation. Figure 3 plots long run monetary growth and long run inflation in a number of countries and again it shows a pretty tight connection between the two.

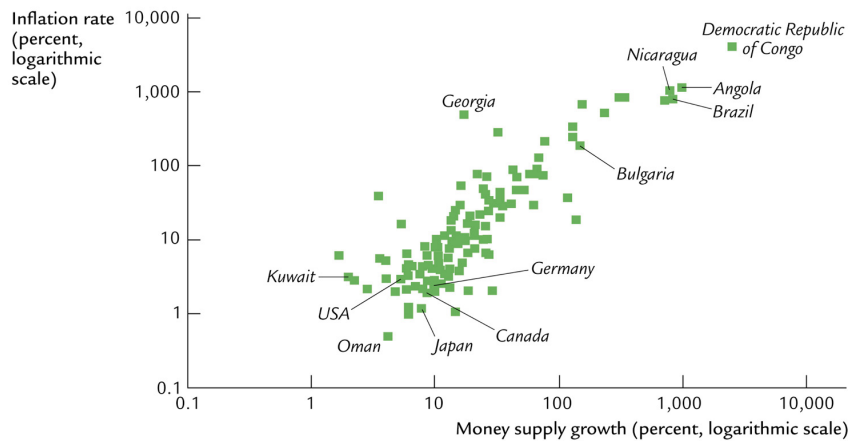


Figure 3: LONG RUN MONEY AND PRICES

Inflation tax and redistribution

The previous figures suggests that indeed inflation is a monetary phenomenon as high inflations are associated by high rates of monesy supply growth. And extreme cases in which inflation gous out of control (hyper-inflations) are clearly damaging for the economy as money loses value so fast that people stop using money and the entire system of commercial exchange, that money is supposed to facilitate, breaks down. The natural question then is why do governments/ central banks start hyperinflations or have high inflation?

The answer is simple: because inflation is a tax and it helps government to raise revenues. The agents who get taxed by inflation are the one who hold money and the tax rate on their money is exactly the inflation rate. To see this suppose I have 1000 dollar in my bank account and that the price of, say, bread is 1 dollar per loaf. This means that the purchasing power of my money is 1000 loafs of bread. Suppose that there is 100% inflation in one year so next year the price of a loaf of bread is 2\$. next year the purchasing power of my bank deposits is only 500 loafs of bread. the 500 loafs that are gone are being taxed away by the government.

This suggests that although inflation is a monetary phenomenon it is also connected to the fiscal affairs of governments. Governments in fiscal trouble are the ones who are more likely to print money to finance their expenditures and hence to raise inflation. Notice that this is the key tension underlying the Euro crisis of 2012. Some governments (Portugal, Italy, Ireland, Greece, Spain, aka PIIGS) are running in fiscal trouble and have a strong temptation of printing money to finance their needs. The problem is that they are in monetary union so they do not have the option of printing money freely. So their options are either to leave the Euro and revert to their own

currency which they could freely print (and thus generate inflation) or to convince the European Central Bank to print more money. The European Central Bank (and Germany in particular) resists that because that would be an implicitly transfer to these fiscally non-responsible countries as their debt would be financed by inflation tax levied on all members of the Euro zone.

Besides being a tax inflation has also very strong redistributive effects, as by raising price levels it reduces the real value of nominal debts and thus redistributes from debtors (young people, firms, governments) to creditors (old people, banks). In hyperinflations these effects can be very strong, as to completely wipe out the wealth of consumers who hold nominal assets (i.e. government bonds).

Inflation and Interest Rates

Nominal interest rate is the cash return on an investment. Suppose a savings account pay 5%, this mean that when you deposit 100 dollars you get 105 dollars after one year. But the value of your investment (the purchasing power of your money) has to take inflation into account. We therefore define the real return, meaning the returns in term of goods, to be equal to the nominal return minus the expected inflation rate:

$$r = i - \pi^e$$

rearranging the previous equation we get

$$i = r + \pi^e$$

that is sometimes called the Fisher equation. The equation states that nominal returns have two components

- a) the real return
- b) the expected inflation rate

The Quantity theory together with the Fisher equation implies that nominal interest rate is affected by money supply. In particular whenever there is an increase in money supply, that causes an increase in inflation (and inflationary expectation) and, from the Fisher Equation, an increase in the nominal interest rate. This simply means that when inflation is high nominal assets lose more value over time and agents want to be compensated for holding them. Figure 4 plots nominal interest rates and inflation rates: in periods of high inflation nominal interest rate tend to be high.

From the analysis of open market operations we learn though that reductions in the interest rate are achieved through monetary expansions. But the quantity theory tells

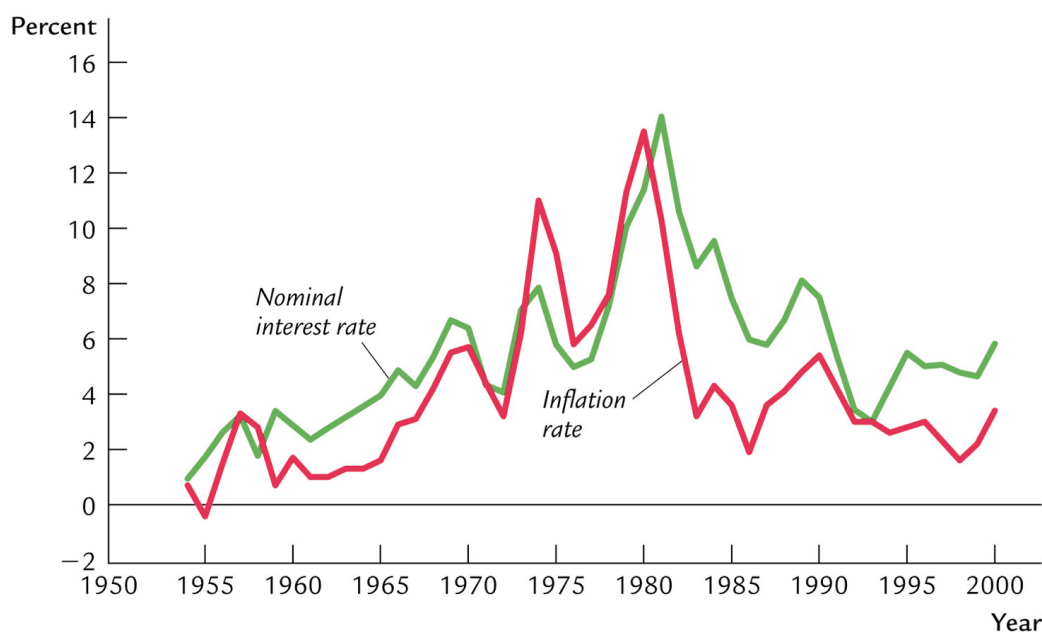


Figure 4: LONG RUN INFLATION AND NOMINAL INTEREST RATES

us that when M goes up prices go up and through the Fisher equation interest rate go up as well. What is going on?

The key distinction is between long run and short run. In the short run inflationary expectations do not change much (because in the short run prices and wages are sticky) and thus a money expansion requires a reduction in the interest rate to restore equilibrium in the money market. In the long run a monetary expansion increases inflation and inflation expectations and therefore increase the nominal interest rate through the Fisher equation. All these concepts will be clearer when we talk about the money market equilibrium. The money market is a financial market where agents trade two types of liquid assets, cash and interest bearing riskless securities, so it is our simplified model of the open market for balances with the FED.

Money Market Equilibrium

To find the nominal interest rate that clears the money market (the market for liquid funds) we need to define a demand for money and a supply for money.

Money is used to purchase output so it is reasonable to assume that the higher the value of expected nominal output growth ($\pi^e + g_y^e$) the higher the growth of demand

for money. Some people or banks might also want or need to hold money as an asset. In both cases holding money has an opportunity cost because expected real return on money is $-\pi^e$ while expected real return on bond is r (the real rate) so the interest cost of holding money is $r - (-\pi^e) = r + \pi^e$ that from the Fisher equation above is equal to the nominal interest rate i . Therefore we can write the growth of demand for money as

$$L(i, \pi^e + g_y^e)$$

Again the focus for now is on the short run in which we assume that inflationary expectations do not change. Assume now that the supply of money grows at a constant rate g_M . This can be represented in the money growth-interest rate plane as a vertical line. Consider now money demand. As we discussed previously money demand depends positively on $\pi^e + g_y^e$ (the higher the expected income and prices growth the more money we need for transactions) and negatively on i (the higher the interest rate the more costly is to hold money). In the money growth-interest rate plane money demand will be a negatively sloped curve and changes in expected income growth will shift money demand (higher income requires more money and thus will shift money demand to the right).

The money market equilibrium is represented in figure 5 as the intersection of the two lines. If the interest rate is higher than the equilibrium level then the demand for money is lower than the supply for money and therefore people will convert money into assets: this drives the prices of assets up and pushes down the interest rate restoring equilibrium. Similarly if the interest rate is below the equilibrium level demand for money exceeds the supply for money, people want to convert bonds into cash so they sell bonds, driving interest rates up.

Monetary tightening and interest rates

The previous analysis is focused on the short run. One prediction is that in the short run monetary contractions will raise nominal and real interest rates or monetary expansion reduce real and nominal interest rates. This can be seen from figure 5: the reduction of money supply from M_1 to M_2 increase the interest rate rate from i_1 to i_2 . Remember though that so far we have assumed inflationary expectations are constant. The quantity theory tells us that in the long run inflation (and inflationary expectation) should decrease in response to a decline in money growth. A reduction in prices will also induce a reduction in PY and therefore a downward shift in money demand. As you can see in figure 5 a downward shift in money demand will tend to lower equilibrium interest rate to i_3 .¹ Summarizing we have learned that in

¹The exact position of the new interest rate i_3 relative to the initial interest rate i_1 depends on a number of factors and in particular on what happens to the real interest rate (i.e. the returns to capital). If the long run real rate is unaffected then after the monetary contraction nominal rates will be lower

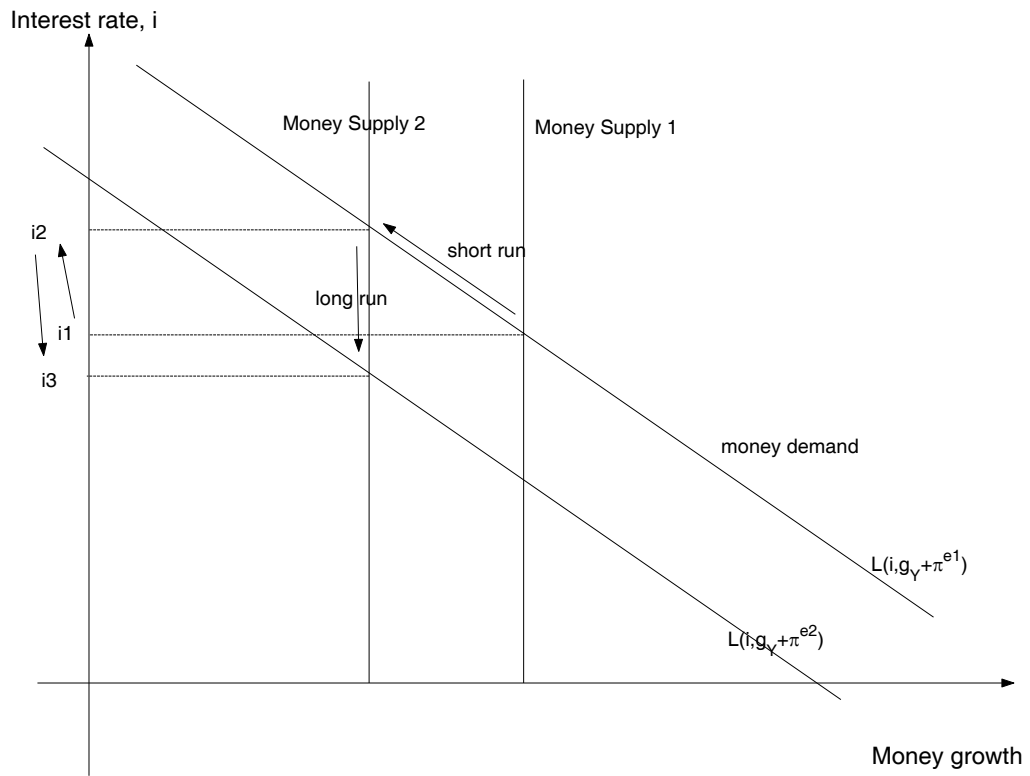


Figure 5: MONEY MARKET EQUILIBRIUM

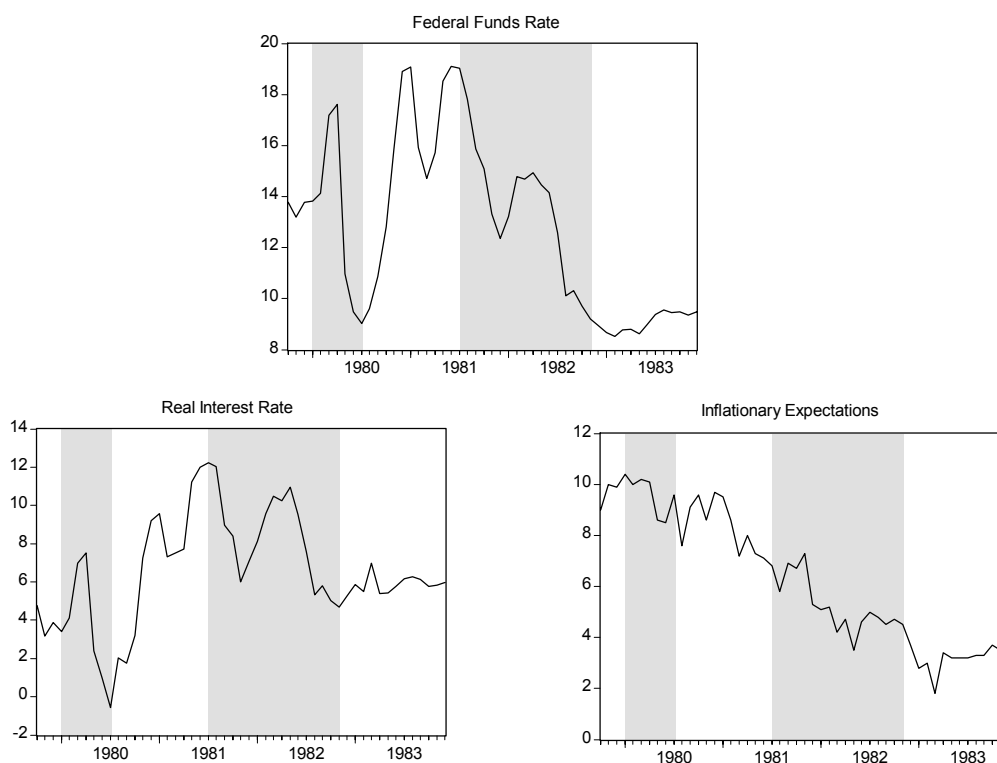


Figure 6: THE VOLCKER TIGHTENING

the short run (when prices and inflation are fixed) monetary contraction will tend to increase nominal interest rate but in the long run (when price move in response to monetary changes) a decline in the nominal interest rate will follow. Similarly monetary expansions cause an initial reduction in the nominal interest rate, followed by an increase.

We can use the previous analysis to understand the effects of the most dramatic monetary tightening in US history, that is the monetary contraction engineered by Paul Volcker in October 1979. Figure 6 shows that the monetary contraction (the increase in federal funds rate) has initially caused an increase in nominal and real rates that lasted for more than one year but after inflationary expectations have started to decline, real rates declined to their pre tightening level and nominal rates fell below the pre-tightening level, due to the decline in inflation.

The effects of money on output

The previous discussion showed us that there when we look at the effects of a monetary expansions/contractions on the interest rates it makes a difference whether we consider short or long run. In the short run inflationary expectations are fixed so, for example, monetary expansions reduce nominal and the real interest rates. In the long run inflation should respond to money creation (quantity theory) so monetary expansions leave the real interest rate unchanged and increase nominal interest rates. A main takeaway from this is that monetary policy can, in the short run, affect the real interest rate, i.e. the price of goods today v/s goods tomorrow. In particular lowering real interest rates makes today's goods cheaper relative to future goods and can shift demand of consumers and firms from tomorrow to today, possibly increasing economic activity today. But demand alone is not enough to increase economic activity, you also need to increase supply, and the main instrument through which the FED can increase supply (production) is by changing another relative price, i.e. the real wage, which is the price of labor relative to goods.

The main theoretical tool we will use is the AS (Aggregate supply) and AD (Aggregate demand) diagram (see figure 7) On the y-axis of the diagram we have prices and in the x-axis we have real output (GDP). In the long run we assume aggregate supply is independent from prices (reflecting the assumption of the quantity theory were that in the long run money growth has no effect on output growth) so we represent the long run supply curve as a vertical line. To understand the short run effect of prices on aggregate supply and demand is convenient to think that nominal wages (i.e. price of labor in terms of money) are fixed in the short run and think of an effect of changes in prices. If wages are fixed when prices increase real income available to consumers w/p is declining in prices and thus aggregate demand is declining in prices: so we represent short run aggregate demand as a downward sloping line. Also when wages are fixed real profits of firms $p-w$ are increasing in prices. If firms make higher profits they would like to expand production so short run aggregate supply is represented as a positively sloped line.

Now let's think of the effect of an increase in money supply. Remember that monetary policy is, in the short run, de-facto an adjustment of the nominal interest rates. In the short run inflationary expectations do not move much so adjusting the nominal interest rates affects the real interest rates. But changes in real interest rate affect aggregate demand through investment and purchases of consumer durables, for each price level. In particular lower interest rates lowers the cost of financing and thus increases investment by firms and purchases of houses and durables by consumers. So monetary expansions lead, for every level of prices, to a higher demand. When demand shifts to the right because of a monetary expansion (since we assumed that short run aggregate supply is elastic) the economy also expands. Figure 7 considers the case of a demand driven recession. Suppose (as it happens in many recessions) that there is a fall in investment demand (represented as a shift in aggregate demand)

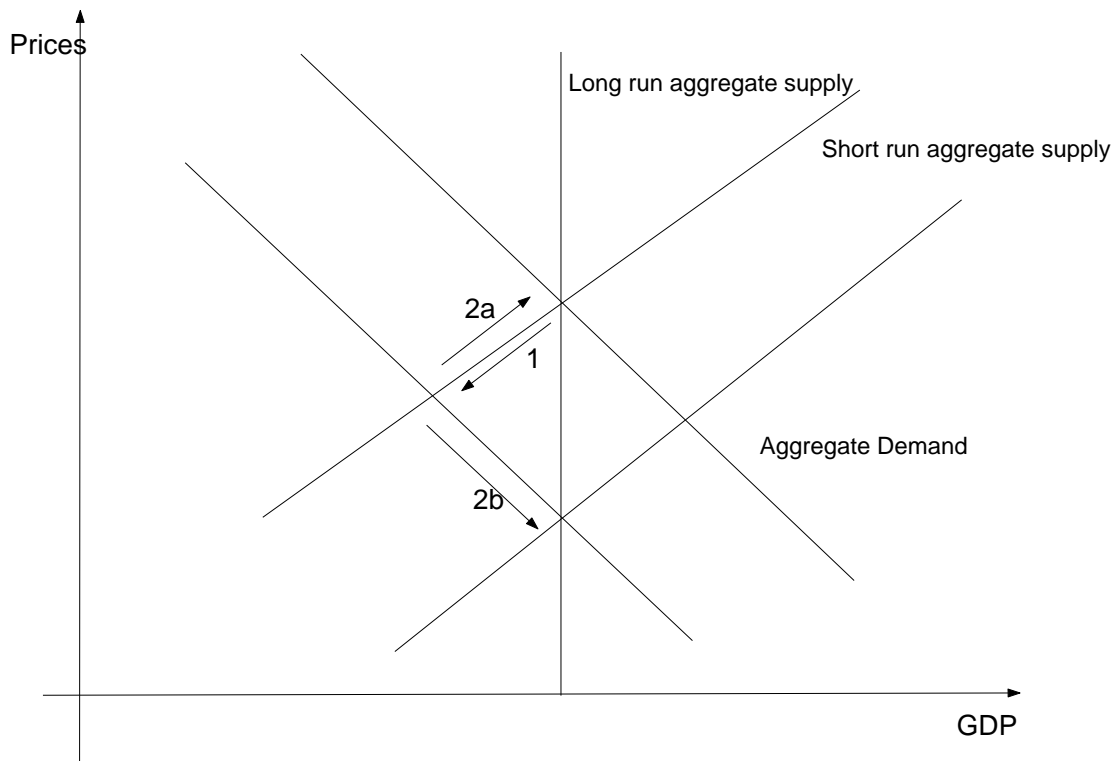


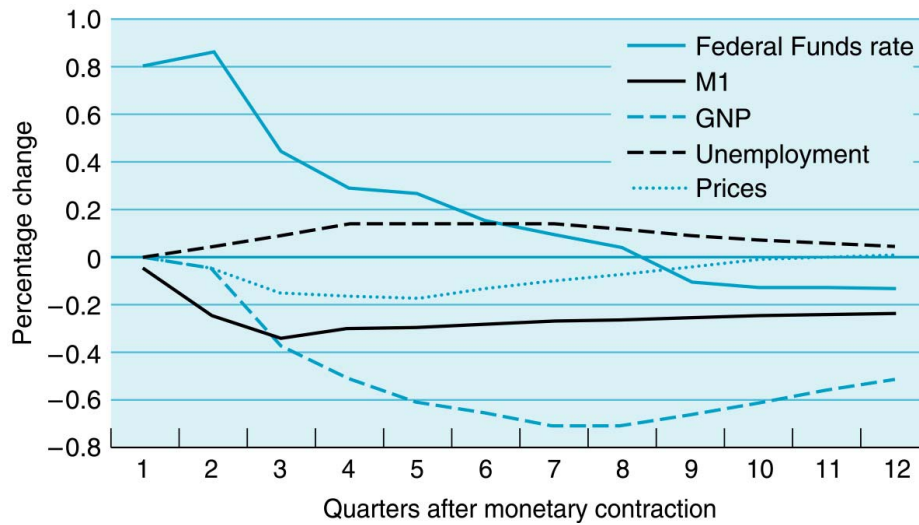
Figure 7: RESPONSES TO A MONETARY SHOCK

that lowers GDP (arrow 1) below its potential, which is given by the vertical long run aggregate supply. At this point the monetary authority has two options:

1) Do nothing and let the economy adjust through deflation. Since at that point the economy is producing below potential (the long run aggregate supply) wages should have a tendency to fall, shifting the aggregate supply to the right (arrow 2b) until the new equilibrium is reached. This process though might be slow and most importantly note that through the process prices are falling. If prices are falling deflationary expectations set in, and in response to that demand might shrink even more and it might take a very long time and this exactly the main fear that the FED has.

2) Reduce interest rates through monetary expansion. This will shift the aggregate demand back up and the economy will quickly move back to full potential (arrow 2a).

Notice that the effects of monetary policy on output are thus linked to the effects that demand management policy have on output. If (as supply-siders do) you believe the even the short run supply curve is vertical then attempts to stimulate demand only result in higher prices and monetary policy is ineffective in stimulating output (and



Source: Miles and Scott, from Christiano, Eichenbaum, and Evans

Figure 8: ESTIMATED EFFECTS OF A MONETARY TIGHTENING

the quantity theory hold also in the short run). If you believe that the supply curve is positively sloped in the short run then monetary policy can, by stimulating aggregate demand, affect output. Policy makers are obviously very interested in quantifying the importance of the effects of monetary policy (in particular of changes in interest rates) on output. Estimating these effects is difficult because there are multiple links between interest rates and output and these links have opposite sign. On one hand output should increase when interest rates are reduced (negative relation between output and interest rates). On the other hand monetary policy responds to output (for example when output goes down monetary interest rates are lowered by the FED) and this in the data produces a positive relation between interest rates and output. Using a special econometric technique called Vector Autoregression (VAR) economists have come up with ballpark estimate is that a 100bp increase in the federal funds rate causes, on average, a peak reduction of GDP of 0.8% that lasts a maximum of 3/4 years, so overall quite small and delayed effect but not negligible. Figure 8 summarizes the estimated effect of given path of increases of Federal Funds Rates on several economic variables.

What do central banks do? The Taylor rule, liquidity traps and non conventional monetary policy

So far we have established that the monetary policy can control inflation in the long run but that it can affect output growth in the short run. Monetary policy is then the result of these two objectives as central banks try to use monetary policy (i.e. the target short term rate) to keep inflation under control and to stimulate output. The exact way in which a central bank does this is often described using a rule which has been first introduced by economist John Taylor. The Taylor rule is as follows

$$i = 0.5(\pi - \pi^*) + 0.5(y - y^*) + \pi + r$$

where π is the current inflation rate, π^* is the target inflation rate (i.e. the inflation rate which the Central Bank is comfortable with in the long run which is around 2%), y is the log of real GDP, y^* is the log of potential (long run) GDP r is the real interest rate. The rule basically says that a Central Bank should increase the target short term rate when inflation is higher than they would like (and lower it when inflation is lower) and lower interest rates when output is below its long run potential. Note that when, for example, inflation is where the Central Banks wants it to be (i.e. $\pi = \pi^*$) and output is at its potential (i.e. the economy is not in a recession , $y = y^*$) then

$$i = r + \pi^*$$

i.e. the nominal interest rate is equal to the real interest rate plus the desired inflation rate. Figure 9 shows the actual US Federal Funds rate (the blue line) and the rate prescribed by the Taylor rule.

Note that although the actual rate chosen by the FED does not track the Taylor rule precisely (the Taylor rule is not an official rule nor it constraints in any way the actions of the FED) the rule describes the behavior of FED pretty well. Notice also that in 2010 the Taylor rule prescribes a rate of 0 and that the actual rate is close to 0. Why is it the case? In 2010 unemployment is still high so GDP is well below potential ($y < y^*$) and inflation is below target level ($\pi < \pi^* = 2\%$) hence the rule prescribes lowering federal funds rate: since the nominal interest rate cannot go below 0, the rate stays at its minimum possible. The problem is that even after an extended time of Federal Funds Rate being at 0 the economy is still below potential and inflation is still below the desired one. This why the FED is now implementing non conventional monetary policies described above. The objective is the same i.e. to lower interests rates to stimulate aggregate demand, but the focus is not on the short term Federal Funds rate but rather on long terms rates.

One important question you might ask is why inflation in US, Europe and Japan has not increased after 2007, even though the FED, the Bank of Japan and the ECB have all pursued policies of injecting large amounts of money in the economy (as you can

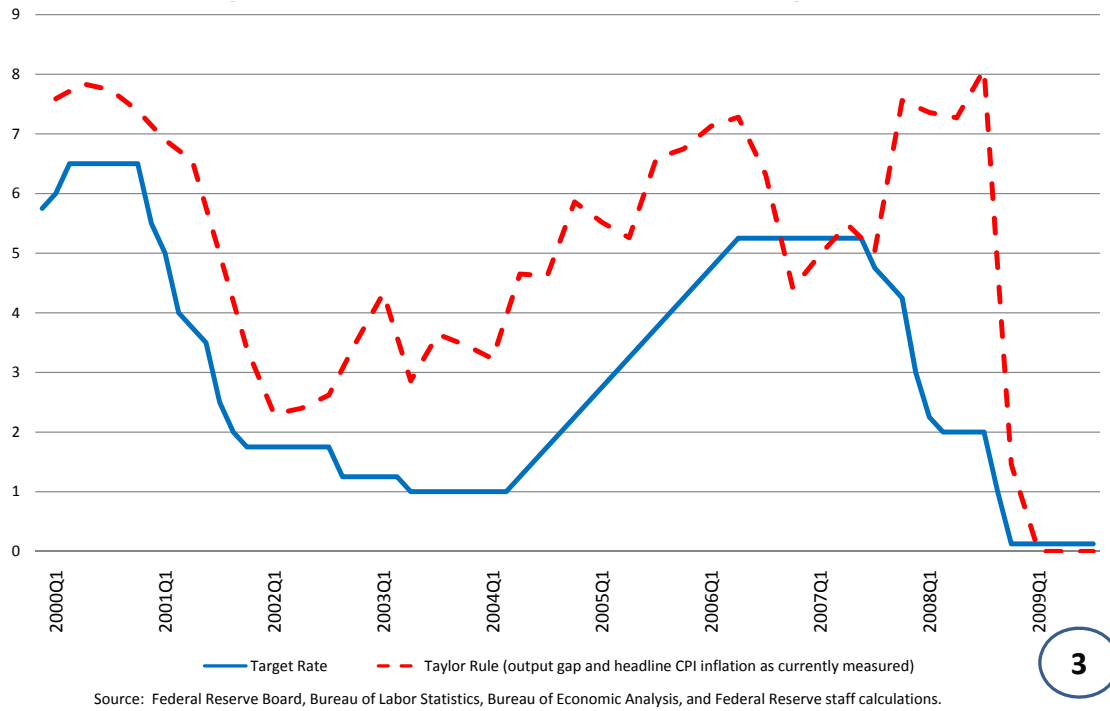


Figure 9: THE TAYLOR RULE AND ACTUAL FEDERAL FUNDS RATE, 2000-2010

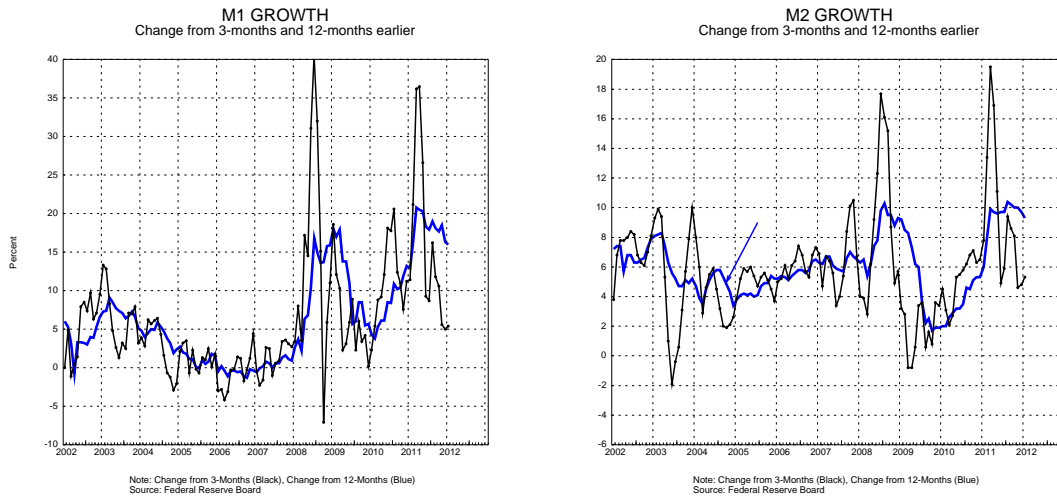


Figure 10: M1 AND M2 GROWTH, 2000-2012

easily check by looking at the growth rates of M1 or M2 in these economies, see for example figure 10),

or why are we in a so called "liquidity trap". The reason is that the link between inflation and money holds only when consumers actually use money to purchase goods. A liquidity trap is a situation in which interest rates are so low (actually close to 0) that consumers and firms are happy to hold money as an asset and do not spend it. So even though the FED is printing money, money gets accumulated as reserve by firms and consumers, so inflation and aggregate demand do not increase.

Concepts you should know

1. Functions of Money
2. Open Markets Operations
3. Quantity Theory
4. Fisher Equation
5. Money Market Equilibrium
6. Long run and short run effect of monetary policy on interest rates and output
7. Taylor rule
8. Liquidity trap

Review question

- Suppose that at a time when inflation is 3% and the Federal Funds rate is 5% the FED unexpectedly lowers the federal funds rate 100 basis points. What is the effect of this policy on money supply? How do you expect this policy to affect output and real interest rates in the short run? How about the long run?
- Answer. The policy will be implemented through increasing purchases of bonds in the Federal Funds market and this will increase the supply of money in the economy. In the short run inflation will not move much so the real rate will fall and there will be a positive stimulus on demand and output. In the long run though inflation should grow, increasing money demand and pushing back up the nominal and real rate.