Money Supply, Inflation, and Interest Rates

ECON 30020: Intermediate Macroeconomics

Prof. Eric Sims

University of Notre Dame

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Readings

- GLS Ch. 18

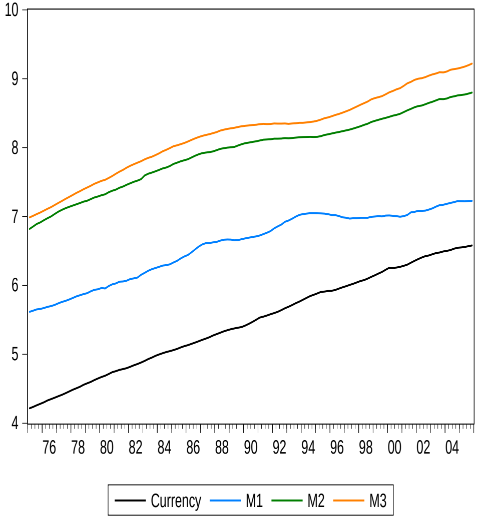
Money, Inflation, and Interest Rates

- We have now defined money, modeled money demand, and introduced money into the neoclassical business cycle model
- In that model, the classical dichotomy holds and money is neutral
- Questions we want to address:
  1. How is the money supply measured in the data?
  2. How is the money supply set in practice?
  3. What determines the average inflation rate over the medium/long run?
  4. What determines the average level of the nominal interest rate over the medium/long run?
  5. Is money really neutral in the short run?

How is the Money Supply Measured?

- Recall money serves three functions: medium of exchange, store of value, and unit of account
- In the US, unit of account is the dollar. But lots of dollar denominated assets can in principle serve as media of exchange and stores of values – e.g. currency, saving bonds, real estate, etc.
- So measuring the money supply is not so trivial
- Three different measures of the money supply, in descending order of most liquid (liquidity refers to the ease with which an asset can be used in exchange)
  1. Currency: physical dollars/coins in circulation
  2. M1: Currency plus demand deposits (electronic entries in checking accounts)
  3. M2: M1 plus money market mutual funds and savings deposits
  4. M3: M2 plus institutional money market mutual funds and short term repurchase agreements

Different Measures of the Money Supply



How the Money Supply Is Set

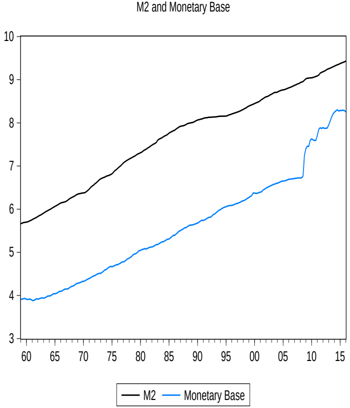
- In the model, things are much simpler – there is no ambiguity concerning the definition of money, and we simply assume that the central bank can set it
- In the data, a little more nuanced
- Central bank can directly affect currency, CU_t
- Reserves, R_t, are like demand deposits (checking accounts) which banks hold with the central bank (also includes "vault cash")
- Bank can also influence total reserves in the banking system
- In a fractional reserve banking system, the quantity of reserves influences total demand deposits (the other component of M1)
- Banks are required to hold a fraction of their deposits in reserves. If they get an increase in reserves, they can make more loans, which entails increasing deposits and therefore the money supply

The Monetary Base and the Money Supply

- Define the monetary base as currency plus reserves (both of which the central bank can directly control):

$$MB_t = CU_t + R_t$$

- Monetary Base and M2:



The Money Multiplier

- The money supply can be related to the monetary base via the equation:

$$M_t = m_t MB_t$$

- Here, m_t is the money multiplier (note: there will be a different money multiplier for different measures of M_t)
- For most of the sample, the money multiplier is reasonably stable. But it has declined considerably since 2008:

Money and Inflation

- Let's now "take the model seriously" and see what the model says about what determines the inflation rate and the nominal interest rate
- Suppose a specific functional form for money demand:

$$\frac{M_t}{P_t} = \psi i_t^{-b_1} Y_t, \quad b_1 > 0$$

- Take logs and then first difference across time. Define π_t as inflation, g_t^M the growth rate of the money supply, and g_t^Y as the growth rate of output:

$$\pi_t = g_t^M + b_1(\ln i_t - \ln i_{t-1}) - g_t^Y$$

- Inflation depends positively on money growth, positively on the growth rate of the nominal interest rate, and negatively on output growth

Money and Inflation: the Medium/Long Run

- Over sufficiently long periods of time, the nominal interest rate is roughly constant. Hence, we can write:

$$\pi_t = g_t^M - g_t^Y$$

- Hence, if the nominal rate is constant, then inflation equals the difference between money growth and output growth
- Over a sufficiently long period of time, output growth is roughly constant (one of the Solow model stylized facts)
- To the extent true, the model would therefore imply that money growth and inflation are perfectly correlated

Monetarism and the Quantity Theory of Money

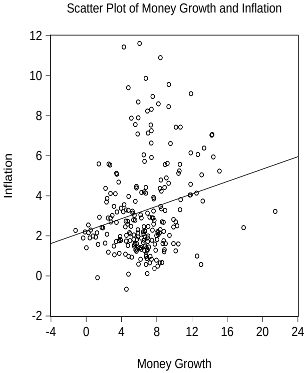
- What is presented on the previous slide is essentially the *quantity theory of money*
- The quantity equation (which is an *identity*) defines a term called "velocity" as the ratio of nominal GDP to the money supply:

$$M_t V_t = P_t Y_t \Rightarrow$$

$$V_t = \frac{P_t Y_t}{M_t}$$

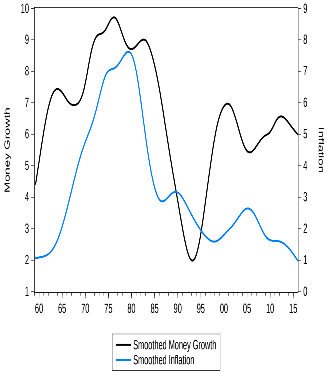
- The quantity equation is transformed into a *theory* by assuming velocity is constant: *monetarism*
- According to demand function we just used, this corresponds to (i) i_t constant and (ii) ψ (preference for holding money) constant as well (i.e. "stable" money demand)
- Then "inflation always and everywhere a monetary phenomenon" – Milton Friedman

Is Inflation Always and Everywhere a Monetary Phenomenon?



- Correlation is 0.22 – positive but not close to 1
- Caveats: output growth not literally constant and money growth may impact output (non-neutrality) in the short run

Money Growth and Inflation: Medium Run



- Correlation much higher: 0.66
- Some breakdown later in the sample
- Over long periods of time, approximately the cause of inflation is money growth

Interest Rates

- If inflation is approximately caused by money growth over sufficiently long horizons, what determines the nominal interest rate?
- First, what determines the real interest rate? Euler equation with log utility:
$$\frac{C_{t+1}}{C_t} = \beta(1 + r_t)$$
- Take logs, and suppose growth rate of consumption over long period of time is equal to the growth rate of output (true in data). Then:
$$r_t = g^Y_{t+1} - \ln \beta$$
- So real interest rate depends positively on (expected) output growth, and negatively on discount factor

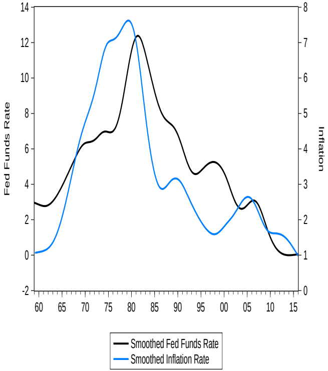
Expected Inflation and the Fisher Relationship

- Over long periods of time, the growth rate of output is (approximately) constant $\rightarrow$ the real interest rate is constant
- Call this $r = g^y - \ln \beta$
- Fisher relationship says $i_t = r_t + \pi^e_{t+1}$
- Assume that expected inflation equals actual inflation over long periods of time: $\pi^e = \pi$
- Then:

$$i = \pi + g^Y - \ln \beta$$

- To extent output growth is constant, over long periods of time – primary determinant of nominal interest rate is the inflation rate (which is in turn caused by money growth in excess of output growth)

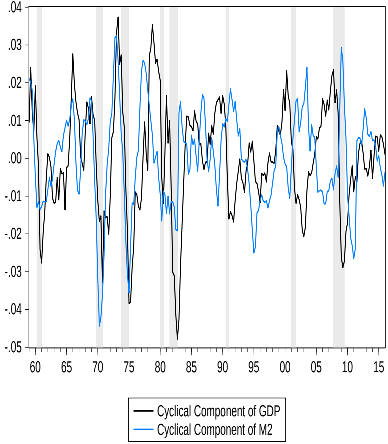
Inflation and Nominal Interest Rates over Long Periods of Time



- Correlation of 0.76
- Interest rates and inflation very positively correlated in medium run: the "Neo-Fisherian" worldview

Money and Real Variables

- Neoclassical model predicts that money is neutral with respect to output
- Is that true? Even in the short run? Correlation between cyclical components of M2 and output 0.2



Dynamic Correlations

- Positive correlations do *not* imply causality running from money to output
- What about dynamic correlations?

Variable	Correlation with $\ln M_t$
$\ln Y_t$	0.22
$\ln Y_{t+1}$	0.32
$\ln Y_{t+2}$	0.37
$\ln Y_{t+3}$	0.37
$\ln Y_{t+4}$	0.33
$\ln Y_{t+5}$	0.26
$\ln Y_{t+6}$	0.19
$\ln Y_{t+7}$	0.10
$\ln Y_{t+8}$	0.03

- Money leads output for a couple of years; suggestive that changes in money *cause* changes in output in the short run. Also emerges in more sophisticated econometric work

Conclusion

- Neoclassical model provides a reasonable account of dynamics between money, inflation, and interest rates over longer time horizons
- But maybe not in the short run – money seems to be positively correlated with output in a leading manner, suggestive that money is not neutral
- Non-neutrality is also observed in more sophisticated econometric studies, and non-neutrality seems consistent with our every day experience
- Coming task: tweak the neoclassical model to include some kind of friction that might allow monetary non-neutrality in the short run