Advanced Monetary Economics

Lecture 9

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Money in a model

- Agents in a DSGE model face the question: Why hold money?
- Not an interest-bearing asset
- Bonds as investment opportunity more attractive
- Need to introduce a feature or friction for money demand

Questions we want to answer

- How to model money demand in a model?
- How does it matter for the transmission mechanism of monetary policy?

1 Money in the utility

- Holding money is positively valued – it yields direct utility.

- This assumption is rationalized by assuming: money gives utility because it provides transaction services.

- Instantaneous utility $U = U(C_t, M_t/P_t, L_t)$ depends on

  – consumption C_t,

  – the flow of services yielded by real money holdings $\frac{M_t}{P_t}$

  – leisure L_t

- Properties of the utility function: $U_c \geq 0, U_{cc} \leq 0, U_{mm} \leq 0, U_l \geq 0, U_{ll} \leq 0$

- Further assets in the model are bonds.

- Bond B pays a nominal interest rate of $1 + i_{t-1}$.

- Households' budget constraint

$$\frac{(1 + i_{t-1})B_{t-1}}{P_t} + \frac{M_{t-1}}{P_t} = C_t + \frac{B_t}{P_t} + \frac{M_t}{P_t}$$

- For the sake of time we exclude non-negativity constraints and no Ponzi-schemes conditions.

- The intertemporal first-order condition for bonds is

$$\lambda_t = \frac{\beta \lambda_{t+1}(1 + i_t)}{\pi_{t+1}}.$$

- Marginal costs of investmentment in bonds is to forego consumption today

- The marginal benefit of the investment is

  1. discounted utility of the additional resource next period

  2. plus the expected real interest rate earned on the investment

- Optimality condition for money demand: the intertemporal first-order condition w.r.t. money implies

$$\lambda_t = U_m\left(C_t, M_t/P_t, L_t\right) + \frac{\beta\lambda_{t+1}}{\pi_{t+1}}.$$

- Marginal costs of holding money is to forego investment in bonds or the marginal utility from consumption

- The marginal benefit of holding money has two parts:

    1. direct utility

    2. discounted utility of the additional resource next period

- Cost and benefits of holding money: investing in bonds yields nominal interest rate

$$\lambda_t = \frac{\beta \lambda_{t+1} i_t}{\pi_{t+1}} + \frac{\beta \lambda_{t+1}}{\pi_{t+1}}.$$

- Holding money foregoes the nominal interest rate.

- Utility from money is the compensation

$$\lambda_t = U_m \left(c_t, m_t, l_t \right) + \frac{\beta \lambda_{t+1}}{\pi_{t+1}}.$$

- How to model money demand in a model? One way is to introduce money on the utility function.

- Agents are willing to hold money because they receive utility from it.

- The costs of holding money is the foregone nominal interest rate.

- An increase in the nominal interest rate increases the cost of holding money.

- Monetary policy in the MIU model: supplies money and follows a money supply rule

$$M_t - M_{t-1} = \theta_t M_{t-1}$$

- A monetary policy shock is an unexpected temporary increase in the money growth rate

$$\theta_t = \theta + \varepsilon_t$$

- **Separability of money:** In case the marginal utility of consumption and leisure are not affected by real money holdings money is modeled separable in the utility function (see tutorial).

- A change in money supply and expected inflation only affect real money holdings

- monetary policy does not have an effect on the economy.

- Important side note: prices are flexible in the model

- **Non-separability of money:** assume marginal utility of consumption depends on money holdings and both are complements (see Gali, Ch. 2.5.2)

- an increase in money supply increases inflation

- a decrease in real money holdings decreases consumption

- the intratemporal first-order condition then requires an increase in leisure

- households work less and output declines

- How does it matter for the transmission mechanism of monetary policy?

- Monetary policy in the MIU model:

  - depends on the specification of the utility function

  - has an effect on the economy only if the real money balances affect the marginal utility of consumption or leisure

2 Cash in advance (CIA)

- Money does not yield utility.

- Instead it is modeled as a medium of exchange - it is used to purchase goods.

- The household faces an additional constraint: it needs as much money as it wants to consume goods.

- This constraint is called the cash-in-advance constraint.
- **Assumption 1:** What exactly denotes "goods"?
- Consumption goods only or investment goods too?
- Mostly, only consumption will be cash-in-advance constrained.
- Are all consumption goods constrained or only a part of them?
- The possibility of credit goods exist.
- Today, all consumption will be constrained.

- **Assumption 2:** The timing

- Lucas - timing: Agents can allocate their resources after the shocks have been observed. Asset markets open first - followed by the goods market (see tutorial).

- Svensson - timing: Goods market opens first - followed by the asset market:

$$P_t C_t \leq M_{t-1}.$$

- **Simple CIA model setup:** utility function $u(C_t)$.

- Endowment: M_{t-1}, T_t, B_{t-1}

- T_t are transfers in form of money (helicopter money)

- Svensson - timing. Cash-in-advance constraint in nominal terms given by:

$$P_t C_t \leq M_{t-1} + T_t.$$

- CIA in real terms

$$C_t \leq \frac{m_{t-1}}{\pi_t} + \tau_t.$$

- Maximization problem (no uncertainty)

$$\begin{aligned}\mathcal{L} \;&=\; \sum_{t=0}^{\infty} \beta^t \left\{ u(C_t) + \lambda_t \left[(1 + i_{t-1}) \frac{b_{t-1}}{\pi_t} + \frac{m_{t-1}}{\pi_t} - C_t - m_t - b_t \right] \right. \\ &\quad \left. + \mu_t \left[\frac{m_{t-1}}{\pi_t} + \tau_t - C_t \right] \right\}\end{aligned}$$

plus non-negativity constraints and a no-Ponzi condition.

- First-order condition in the CIA model

$$\lambda_t = \beta \frac{\lambda_{t+1} + \mu_{t+1}}{\pi_{t+1}}$$

- Marginal costs of holding money is to forego investment in bonds or consumption

- The marginal benefit of holding money has two parts:

  1. discounted utility of the additional resource next period

  2. discounted easing of the CIA-constraint next period

- Comparison CIA and MIU:

  – CIA

$$\lambda_t = \beta \frac{\mu_{t+1}}{\pi_{t+1}} + \beta \frac{\lambda_{t+1}}{\pi_{t+1}}$$

– MIU

$$\lambda_t = U_m\left(C_t, m_t, L_t\right) + \beta \frac{\lambda_{t+1}}{\pi_{t+1}}.$$

- The cost of holding money is in both cases the foregone nominal interest rate:

$$\lambda_t = \beta \frac{\lambda_{t+1} i_t}{\pi_{t+1}} + \beta \frac{\lambda_{t+1}}{\pi_{t+1}}.$$

- Both models add a feature that motivates the agent to hold money.

- How to introduce money demand in a model?

- One way is to introduce money in the utility function.

- Another one is to model money necessary to obtain consumption goods. Agents are willing to hold money because they need it to obtain consumption goods.

- **Interest rates as a tax:** in a standard CIA model: $i_t = \frac{\mu_{t+1}}{\lambda_{t+1}}$.

- First-order condition w.r.t. consumption can be re-written as

$$U_c = \lambda_t (1 + i_{t-1})$$

- Marginal utility exceeds marginal utility of income

- Nominal interest rates, and therefore expected inflation, can be thought of as a tax on consumption.

- What about the effects of monetary policy in the CIA model?

  1. A persistent increase the money supply increases expected inflation and thus nominal interest rates

2. Marginal utility of consumption increases

3. Agents substitute towards leisure

4. Labor and output fall

- How does it matter for the transmission mechanism of monetary policy?

  – Monetary policy in the CIA model works trough nominal interest rates as a tax on the constrained good

  – depends on the definition of the constrained good

  – depends on the availability of credit

- Questions we have answered

  1. How to model money demand in a model?

2. How does it matter for the transmission mechanism of monetary policy?