

Dynamic Model with Money

ECO 305: Intermediate Macroeconomics

Goals

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- Introduce, money, price level, and inflation to the dynamic general equilibrium model
- Describe the relationship between inflation, real interest rates, and nominal interest rates
- Construct a microfounded model of money demand
- Make predictions for changes in quantity of money and price level in the dynamic general equilibrium model

Reading and Exercises

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- Dynamic model of money supply and demand Williamson, Chapter 12, pp. 442-457
- Complete dynamic macroeconomic model with money Williamson, Chapter 12, pp. 457-459
- Money neutrality Williamson, Chapter 12, pp. 460-464
- Shifts in Money Demand Williamson, Chapter 12, pp. 464-467
- **Canvas Quiz due Wed 11:59 PM.**
Multiple-choice, 10 questions, unlimited attempts allowed, only best score counts
- **Homework/Exercise due Fri 11:59 PM.** We will work together in class on Thursday

Notation

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- **Fisher equation:** Relationship between real interest rate, nominal interest rate, and inflation rate
- **Price level notation:** P : price level today, P' : price level in future period
- **Inflation rate:** Denoted by π , growth rate of aggregate price level. $1 + \pi = \frac{P'}{P}$
- **Nominal interest rate (i):** Unadjusted rate of interest, not adjusted for changes in price level
- **Real interest rate (r):** Real rate, adjusted for inflation, paid for borrowed funds or earned from saving
- **Nominal bond:** Purchased in current period for \$1 by a lender. Seller/borrower pays $\$(1+i)$ in future period.

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Fisher Equation

Nominal bond: Purchased in current period for \$1 by a lender. Seller/borrower pays $\$(1+i)$ in future period.

$$\text{Real opportunity cost of buying bond} = \frac{\$1}{P}$$

$$\text{Real benefit to buying bond} = \frac{\$(1+i)}{P'}$$

$$\text{Gross rate of return to buying bond} = 1 + r = \frac{\text{Real benefit}}{\text{Real opportunity cost}}$$

$$1 + r = \frac{\frac{1+i}{P'}}{\frac{1}{P}} = \frac{1+i}{1+\pi}$$

Fisher Equation

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$$\text{Exact: } 1 + r = \frac{1+i}{1+\pi}$$

$$\text{Approximate: } r \approx i - \pi$$

- Real interest rate depends positively on nominal interest rate
- Inflation rate and real interest rates are negatively related
- An increase in expected inflation reduces the expected real return on a bond

Credit vs Cash Goods

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Bank Function

- Bank function: Facilitating transactions using credit services
- **Credit service** used here implies not needing cash at time of purchase

Cash vs. Credit Goods

- Two types of goods: **cash goods** and **credit goods**
- Can think of as literally different goods (cash goods require cash or check)
- Normal goods, imperfectly substitutable
- Can think of as a choice to use credit services versus cash
- Real, per unit cost of using credit services: $q \in (0, 1)$
- Opportunity cost of cash good = nominal interest rate = $i \in (0, 1)$

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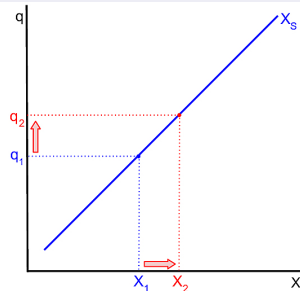
Supply of Credit Goods

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Supply of Credit Services

- Banks provide credit services; quantity = X
- Price received for credit services = q
- Assume diminishing returns / increasing marginal costs
- Operating costs: technology and communication networks, research customers' credit histories, customer assistance, etc.
- Upward sloping supply curve

Supply Curve



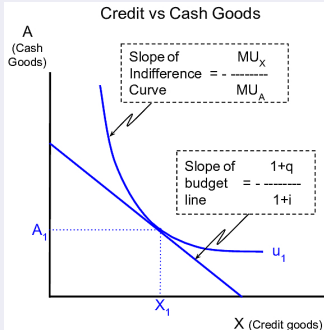
Utility Maximization for Credit vs Cash Goods

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Utility Max Framework

- Two goods: Cash goods = A , Credit goods = X
- Nominal price of cash good (including opportunity cost) = $P(1+i)$
- Nominal price of credit good = $P(1+q)$

Utility Maximization

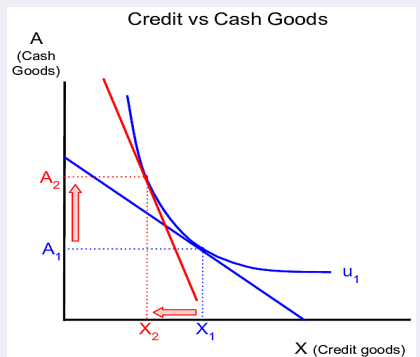


Demand for Credit Goods

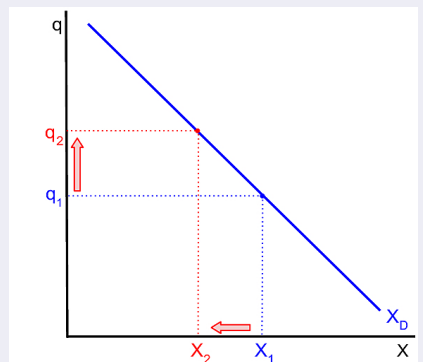
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Suppose there is an **increase in price of credit services (q)**
 (Focusing on substitution effects)

Utility Maximization



Utility Maximization



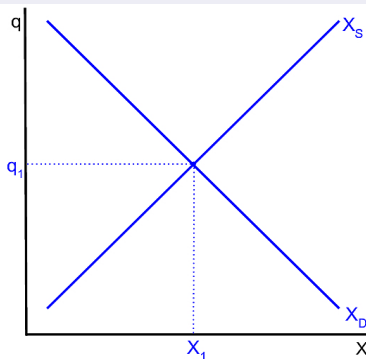
Equilibrium In Credit Services Market

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Demand and Supply

- Demand depends on utility maximization
- Demand shifts with changes in interest rate and income
- Supply depends on profit maximization of banking sector
- Supply shifts with cost of providing credit services

Equilibrium

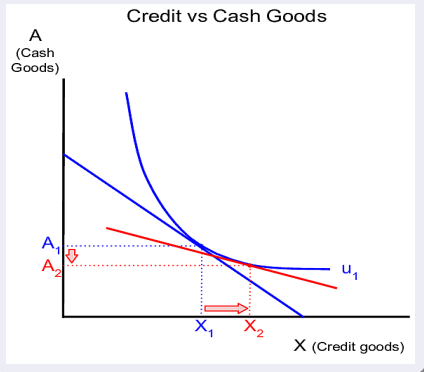


Shift in Demand for Credit Goods: Interest Rate

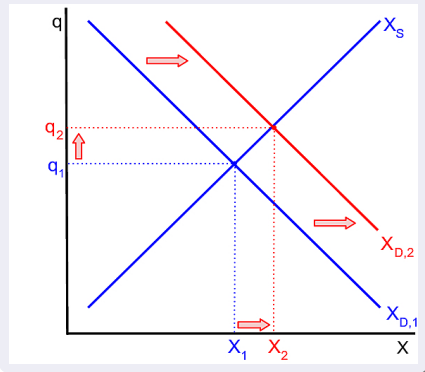
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Suppose there is an **increase in the interest rate (i)**
 (Focusing on substitution effects)

Utility Maximization



Utility Maximization

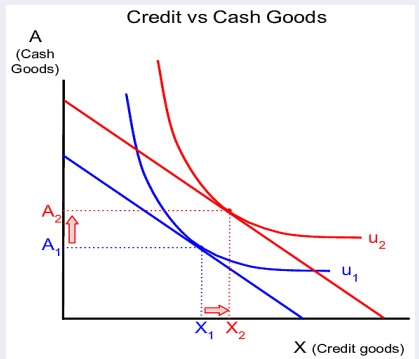


Shift in Demand for Credit Goods: Income

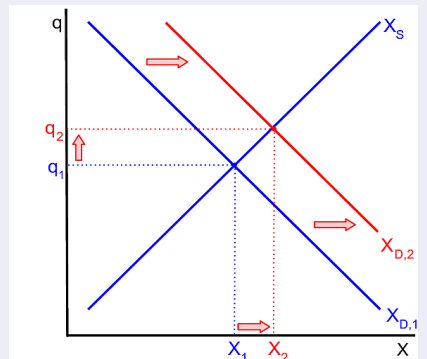
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Suppose there is an **increase in income**

Utility Maximization



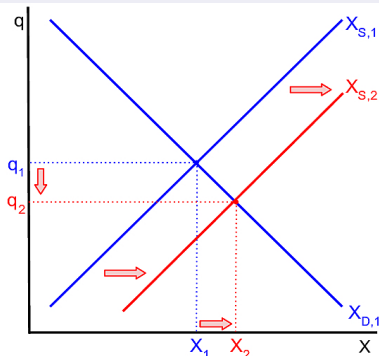
Utility Maximization



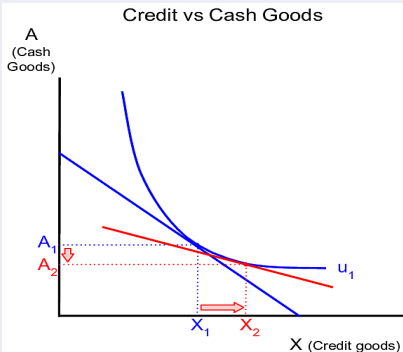
Shift in Supply of Credit Services

Suppose there is an improvement in financial technology, lowering the costs for banks to provide financial services

Utility Maximization



Utility Maximization

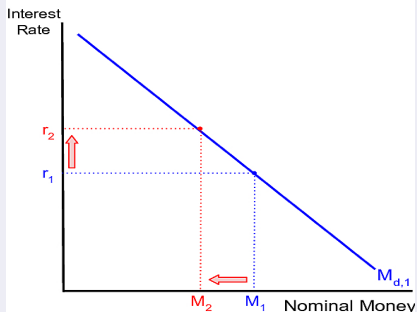


Money Demand

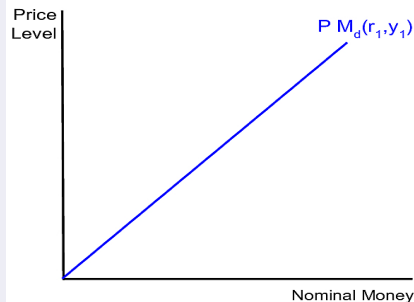
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Real money demand is the equilibrium outcome for cash goods, A .

Typical Approach:
Qty Money \times Interest rate



Our Approach:
Qty Money \times Price Level



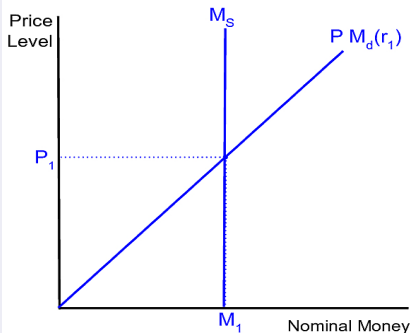
Money Market Equilibrium

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Money Supply & Equilibrium

- Money supply is vertical where the central bank decides it should be
- Equilibrium price level is where money demand equals money supply

Equilibrium

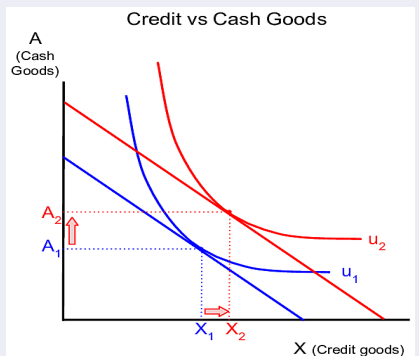


Shift in Demand for Money: Income

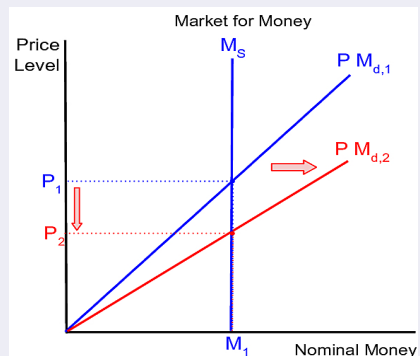
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Suppose there is an **increase in income**

Utility Maximization



Market for Money

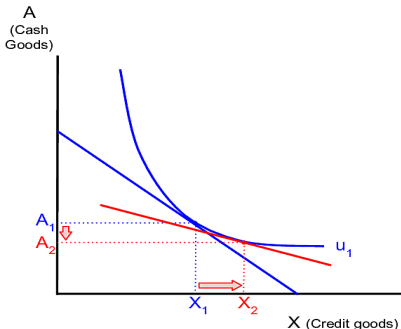


Shift in Demand for Money: Interest Rate

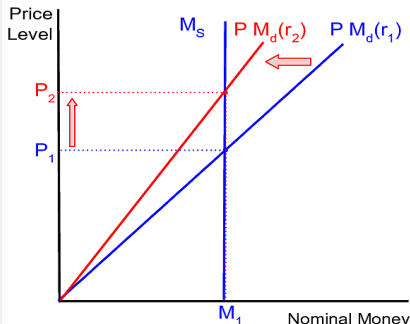
Suppose there is an **increase in interest rates**

Utility Maximization

Credit vs Cash Goods



Market for Money



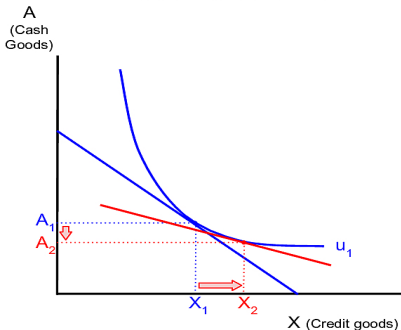
Shift in Demand for Money: Financial Innovation

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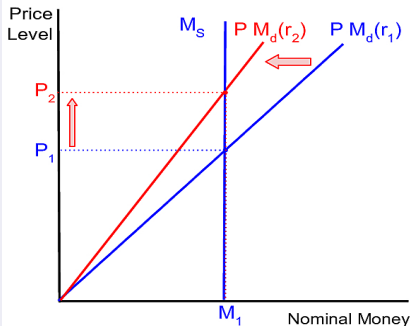
A financial innovation **decreases eqm price of credit services**

Market for Credit Services

Credit vs Cash Goods



Market for Money



Combine with Dynamic General Equilibrium Model

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Dynamic General Equilibrium

- Solve the model: Improvement in productivity
- Solve the model: Consumer confidence falls (expectation of lower wages in future)
- Money neutrality: Federal Reserve increases money supply

Strategy

- Start on outsides (supply side and demand side)
- Bring findings inward to output supply/demand
- Take results outward *and downward to money market*

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Money Surprises

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- Suppose Fed increases money supply
- Price rises + real wage stays same \rightarrow nominal wage increased
- Suppose consumers were perceived increase in nominal wage was an increase in real wage
- Monetary policy has real effects, but is welfare reducing

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