

Search Models of Money

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Search Models

- ▶ Matching models have one drawback:
 - ▶ the matching function is a black box
- ▶ Search models model explicitly how matches come about.
- ▶ Their drawback: hard to take to the data.
- ▶ Applications:
 - ▶ Money - the main / original motivation for search
 - ▶ Housing
 - ▶ Labor market

Search Models of Money

- ▶ Most models of money either have no notion of **liquidity** (OLG model) or they assume liquidity (CIA).
- ▶ Search models offer a micro-foundation for liquidity.
- ▶ **Caveats:**
 - ▶ The institutional arrangement is medieval.
 - ▶ Money is literally currency, not credit.
 - ▶ Some recent work tries to relax this.

The Idea

- ▶ People produce and consume many goods.
- ▶ To consume what they want, people need to search for sellers.
- ▶ Without money: trade is hard.
 - ▶ the double coincidence of wants problem.
- ▶ One solution: designate one good to be "money."
- ▶ Money means: the good is accepted by all traders.
 - ▶ a social convention.

Kiyotaki-Wright Model

- ▶ There is a unit mass of ex ante identical, infinitely lived agents.
- ▶ There is a unit mass of goods types.
- ▶ Goods are indivisible.
 - ▶ The model gets harder when goods are divisible.

Preferences

- ▶ Each agent can consume fraction $x \in (0, 1)$ of the goods.
- ▶ Each good can be consumed by fraction x of households.
- ▶ Consumption yields utility U .
- ▶ Not consuming yields 0.
- ▶ Agents cannot consume goods they produce themselves.

Technology

- ▶ An agent can produce a good at utility cost 0.
- ▶ The type of the good is random.
- ▶ An agent can only hold one unit of the good at a time.
- ▶ This is a shortcut for a model with
 - ▶ costly production
 - ▶ costly storage of inventory

Non-monetary Equilibrium

Timing

- ▶ Agents start holding one good each.
- ▶ Each agent meets another agent with probability θ .
- ▶ If two agents meet, they can exchange goods, if both agree.
- ▶ Trade costs ε .
 - ▶ Ensures that trade only occurs if both parties can consume.

Symmetric Equilibrium

- ▶ A strategy is a decision whether or not to trade in a meeting.
- ▶ Obviously, agents trade when the opponent holds the good they can consume.
- ▶ Agents do not trade otherwise.
- ▶ There is no gain from changing the type of good held.
- ▶ There is no way to compensate the party who cannot consume.
 - ▶ This changes when goods are divisible.

Symmetric Equilibrium

- ▶ Value before meeting an agent

$$V_c^n = \theta x^2 (U - \varepsilon) + \beta V_c^n \quad (1)$$

$$= \frac{\theta x^2 (U - \varepsilon)}{1 - \beta} \quad (2)$$

- ▶ This is a measure of equilibrium welfare.
- ▶ With probability θ : meet an agent.
- ▶ With probability x^2 : both hold goods that the other can eat.
- ▶ Otherwise: get 0 this period.

Monetary Equilibria

- ▶ At the beginning of time, \bar{M} agents are offered a unit of "money."
- ▶ If they accept, they have to discard the good they carry.
- ▶ Agents can only carry 1 unit of a good or 1 unit of money.

Decision to hold money

- ▶ Money is a bubble: its value derives from the expectation that money will be valued tomorrow.
- ▶ There is always a non-monetary equilibrium.
- ▶ Π is the probability that agents will accept money tomorrow.
- ▶ The state of the economy is (Π, \bar{M}) .

Decision to hold money

Value function for an agent holding a good:

$$\begin{aligned} V_c = & ([1 - \theta] + \theta M[1 - x] + \theta [1 - M] [1 - x^2]) (0 + \beta V_c) \\ & + \theta (1 - M) x^2 (U - \varepsilon + \beta V_c) \\ & + \theta M x \max_{\pi} [\pi \beta V_m + (1 - \pi) \beta V_c] \end{aligned}$$

π : the agent can play mixed strategies

Agent holding a good

With prob $(1 - \theta)$: meet nobody and get βV_c .

With prob. θ meet somebody.

- ▶ With prob. θM he holds money
 - ▶ With prob θMx he likes my good.
 - ▶ Then trade with prob. π and get βV_m .
 - ▶ If he does not like my good: βV_c .
- ▶ With prob. $\theta (1 - M)$ he holds a good.
 - ▶ With prob $\theta (1 - M)x^2$: trade and get $U - \varepsilon + \beta V_c$.
 - ▶ Otherwise, no trade and get βV_c .

Simplify

$$\begin{aligned} V_c = & \theta (1-M)x^2 (U - \varepsilon + \beta V_c) \\ & + \theta M x \max_{\pi} [\pi \beta V_m + (1-\pi) \beta V_c] \\ & + [1 - \theta [1-M]x^2 - \theta Mx] \beta V_c \end{aligned}$$

Agent holding money

$$V_m = [(1 - \theta) + \theta M + \theta (1 - M) (1 - x)] (0 + \beta V_m) + \theta (1 - M) x \Pi (U - \varepsilon + \beta V_c)$$

With prob $(1 - \theta)$: meet nobody and get βV_m .

With prob θ meet someone.

- ▶ With prob θM he holds money. No trade. Get βV_m .
- ▶ With prob $\theta (1 - M)$ he holds a good.
 - ▶ With prob $\theta (1 - M) x$ I like the good. Trade with prob. Π .
 - ▶ With prob $\theta (1 - M) (1 - x)$ I don't like the good. No trade and get βV_m .

Decision to hold money

- ▶ Benefits of money:
 - ▶ Trade with person holding a good I like who does not like my good.
- ▶ Drawback of money:
 - ▶ Trade with person who likes my good only with prob. Π .
- ▶ No change when:
 - ▶ meet somebody who holds money or a good I don't like.

Decision to hold money

- ▶ If $\Pi < x$:
 - ▶ Money is less liquid than goods.
 - ▶ $V_m < V_c$.
 - ▶ Set $\pi = 0$ and never accept money.
- ▶ If $\Pi > x$:
 - ▶ Money is liquid.
 - ▶ $V_m > V_c$.
 - ▶ Set $\pi = 1$ and always accept money.
- ▶ If $\Pi = x$:
 - ▶ Indifferent between money and goods.
 - ▶ Any π is optimal.

Equilibrium

- ▶ Equilibrium requires $\pi = \Pi$.
- ▶ Three equilibria:
 1. $\Pi = 0$. Back to the non-monetary equilibrium.
 2. $\Pi = 1$ and $M = \bar{M}$.
 3. Mixed strategy equilibrium: $\Pi = x$ and any $M \in [0, \bar{M}]$.
 - ▶ Now M is indeterminate because agents are indifferent between money and goods.

Remarks

- ▶ Money is purely a way of **breaking a symmetric equilibrium**.
- ▶ Any good could take the role of money.
- ▶ The question is: how to coordinate agents' expectations about the future acceptability of "money"?

Welfare

- ▶ To find welfare, impose $\pi = \Pi$ on the value functions and solve.
- ▶ Result: The mixed monetary equilibrium ($\Pi = x$) has lower welfare than the non-monetary equilibrium.
- ▶ Intuition: Money does not facilitate transactions.
- ▶ The welfare cost stems from the fact that some goods were lost in order to hold money.
- ▶ Equivalent to an economy in which some goods can no longer be consumed.

Monetary equilibrium

- ▶ Result: The monetary equilibrium raises welfare iff $x < 0.5$.
- ▶ Intuition: Trading is always easier.
- ▶ But some "goods" cannot be consumed (those held by monetary traders).
- ▶ For the liquidity benefit to win, barter trade must be sufficiently hard.

Extensions

- ▶ Goods are divisible:
 - ▶ Alberto Trejos and Randall Wright. "Search, Bargaining, Money, and Prices." The Journal of Political Economy Vol. 103, No. 1 (Feb., 1995), pp. 118-141.
- ▶ Money and goods are divisible / policy analysis:
 - ▶ Ricardo Lagos and Randall Wright. "A Unified Framework for Monetary Theory and Policy Analysis." The Journal of Political Economy Vol. 113, No. 3 (Jun., 2005), pp. 463-484.

How Useful Is This?

- ▶ People disagree...
- ▶ The big question:
 - ▶ How does it fit a modern economy where most money is credit?

Reading

- ▶ Ljungqvist & Sargent, "Recursive Methods," ch. 26.8.