Lecture Notes

Money Is Memory

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Abstract

Kocherlakota [1998a] argues that fiat money is a social technology for record-keeping. Any allocation achievable with money can be replicated by a perfect history of all transactions—a gift-giving economy enforced by social norms. These notes develop the argument in two settings: an overlapping generations model and a Kiyotaki–Wright search model. The search model reveals that money is only a limited form of societal memory, and that more efficient allocations exist when agents can condition on the full history.

1 Money is memory

Learning targets. After studying these notes, you should be able to:

1. Explain why fiat money is a technological innovation and identify its fourth function: memory.
2. Construct a gift-giving equilibrium that replicates a monetary equilibrium in an OLG model.
3. Construct a gift-giving equilibrium that replicates a monetary equilibrium in a search model.
4. Explain why money is only a *limited* form of societal memory, and identify what makes money essential.

1.1 Outlook

This section is inspired by Kocherlakota (1998), and follows the exposition by the same author.

Fiat money expands the set of allocations available to an economy. It is a technological innovation, like a train, yet different—useless outside the context of social interactions.

Consider the exact form of the technology under the following premise: **a monetary economy is a network of gift exchanges.** John has apples. Paul wants apples but lacks the bananas John wants. In a monetary economy, Paul gives John money, and John buys bananas from George. The final allocation (up to money holdings) is equivalent to everyone making gifts.

But nobody gives away apples for free. A **reinforcement mechanism** is needed. If an agent refuses to give a gift when asked, all agents stop giving her gifts. If agents in the economy know the full history of all gifts, then any allocation achievable with money is achievable without it.

If the function money performs in society can be achieved with a **perfect historical record of all transactions**, then the technological role of money is societal memory. We demonstrate this using monetary models, replacing money with a perfect record known to all.

This extends the **list of functions** money plays in society to a fourth:

1. Store of value
2. Unit of account
3. Medium of exchange
4. **Memory**

Kocherlakota [1998a] goes further, arguing that the first three functions are **descriptive but not explanatory**. Fiat money

1. is not a new way to store wealth,
2. is not necessarily a better denomination device than other goods, and
3. does not by itself lower the cost of transferring resources.

These functions reduce to observations about objects:

1. the medium of exchange observation is that the object frequently appears in transactions,
2. the unit of account observation is that prices are denominated in the object, and
3. the store of value observation is that the object is held as an asset.

Various authors have noted that money is a record-keeping device, but Kocherlakota emphasizes how central record keeping is.

1.2 The chronology of the argument

The argument follows a recipe:

1. Take an economy in which money circulates.

2. Remove money and replace it with the full history of all transactions, known to all agents.

3. Allow agents to make gifts instead of conducting monetary exchanges.

4. Derive strategies in the gift-giving game that yield the same allocations.

We then ask whether the monetary allocation is identical to the gift-giving allocation.

In a monetary economy, an agent gives up consumption in exchange for money, then uses that money to purchase consumption later. In a gift-giving economy with a central ledger, an agent gives up consumption and her balance rises, increasing her capacity to receive future gifts. Money is a **physical, decentralized way to keep track of everyone**.

1.3 The OLG version of the argument

1.3.1 The monetary economy

Take the standard OLG model where agents are endowed with 1 unit of the consumption good when young and zero when old. The population N_t does not grow, so $N_t = N \ \forall t$. There are M units of perfectly divisible, storable, intrinsically useless, and concealable fiat money, given to the initial old. Set $M = N = 1$ for simplicity.

In a monetary competitive equilibrium, a sequence of prices $\{\nu_t\}_{t=1}^{\infty}$ exists such that the young optimally demand the entire stock of money:

$$1 = \frac{M}{N} \in \arg\max_{m \geq 0} \{u(e - \nu_t m, \, \nu_{t+1} m)\}$$

1.3.2 The gift-giving economy

Agents now play a gift-giving game instead of trading in a centralized market.

Denote a **transfer** from young j to old i in period t by τ_t^{ji}. A transfer vector $\tau_t^j = \{\tau_t^{ji}\}_{i=1}^N$ is **feasible** if

$$\sum_{i=1}^{N} \tau_t^{ji} \leq e$$

Let T_t^{j*} denote the set of all feasible transfer vectors.

The **history in period** $t+1$ is

$$H_{t+1} = \left\{ \left\{ \left\{ \tau_s^{ji} \right\}_{s=1}^{t} \right\}_{i=1}^{N} \right\}_{j=1}^{N}$$

with $\mathbb{H}_{t+1}$ denoting the set of all possible histories. **The history H_{t+1} is known to all agents at the beginning of period t+1.**

A **strategy** σ_{t+1}^{j} of young j in period $t+1$ is a mapping from histories to feasible transfer vectors:

$$\sigma_{t+1}^{j} : \mathbb{H}_{t+1} \Rightarrow T_{t+1}^{j*}$$

For every possible history, the strategy specifies a feasible action.

A **gift-giving equilibrium** is a collection of strategies that are best responses to the history when other strategies are taken as given—**a subgame-perfect equilibrium**. Note the difference from the monetary economy: agents have complete knowledge over time, but they cannot commit to a particular transfer scheme.

Proposition 1. *In an overlapping generations model, the transfers in any stationary monetary equilibrium are an equilibrium path of transfers in a gift-giving game.*

Proof. The proposition states that any optimal transfer pattern in the monetary economy is also optimal in a gift-giving economy. It speaks about transfers, not allocations: transfers determine allocations but also include origin and path.

Consider a monetary equilibrium with price sequence $\{\nu_t\}_{t=1}^{\infty}$. Without loss of generality, assign each agent a number so that young agent j gives old agent i the amount ν_t in period t.

In period 0, all initial old are labeled G (good). Consider the following strategies for young agent j in period t: if the assigned old agent i is labeled B (bad), the young agent makes no transfer. If the assigned old agent is labeled G, the young agent transfers ν_t; failure to do so causes the young agent to be labeled B next period. Labels are functions of the history, so these are legitimate strategies.

This collection of strategies is a gift-giving equilibrium. If the old agent is labeled B, the young has no incentive to make a transfer. If the old agent is labeled G and the young refuses to transfer ν_t, then next period the young agent receives nothing. But we know from the monetary equilibrium that

$$u(1,0) \leq u\left(e - \nu_t \frac{M}{N},\ \nu_{t+1} \frac{M}{N}\right)$$

because in equilibrium, the agent optimally chose to give up $\nu_t \frac{M}{N}$ units today for $\nu_{t+1} \frac{M}{N}$ units tomorrow. The young agent therefore makes the transfer. □

Replacing money with a history-recording device does not eliminate any equilibrium allocation.

1.4 The search model version of the argument

1.4.1 The model

We use a form of the model close to the original version in Kiyotaki and Wright [1989]. An equal number of three types of agents live forever and discount utility with β. All types have different preferences and technologies over three non-durable, indivisible goods. The French produce wine but want cigarettes; the Swedish produce paper but want wine; the Greek produce cigarettes but want paper. Production costs $\epsilon < 1$ and is on-the-spot: agents can produce in a meeting. Consuming the preferred good yields $u = 1$ units of utility; all other goods yield zero. Agents are randomly matched in pairs each period.

The social planner's solution is for all agents to produce and transfer whenever the partner desires the good, since $u > \epsilon$.

1.4.2 The monetary economy

Suppose half the agents are endowed with one unit of indivisible fiat money. Agents hold at most one unit and cannot hold money and a commodity simultaneously. Money-holding inhibits production.

A stationary monetary equilibrium entails goods exchange when a French with money meets a Greek with cigarettes, a Swedish with money meets a French with wine, and a Greek with money meets a Swedish with paper. The agent obtaining the commodity consumes it and produces again.

A monetary equilibrium requires sufficient patience: the producer pays $\epsilon < 1$ today but discounts future consumption $u = 1$ with $\beta < 1$ per round.

Define lifetime utility for an agent with money as V_1 and without as V_0. An agent with money meets a trading partner who has the desired good with probability $\frac{1}{6}$: she must meet the right type (probability $\frac{1}{3}$) and that agent must lack money and thus hold a commodity (probability $\frac{1}{2}$).

$$V_1 = \frac{1}{6}(u + \beta V_0) + \frac{5}{6}\beta V_1$$

$$V_0 = \frac{1}{6}(-\epsilon + \beta V_1) + \frac{5}{6}\beta V_0$$

Solving the linear system:

$$V_1 = -\frac{\beta\epsilon + 5\beta u - 6u}{12(2\beta^2 - 5\beta + 3)}, \qquad V_0 = -\frac{-5\beta\epsilon + 6\epsilon - \beta u}{12(2\beta^2 - 5\beta + 3)}$$

Two **incentive-feasibility constraints** must hold. Agents with a commodity willingly pay the trading cost and accept money if

$$-\epsilon + \beta V_1 \geq \beta V_0$$

Agents willingly give up money for their preferred consumption good if

$$u + \beta V_0 \geq \beta V_1$$

Both constraints hold when

$$\beta \geq \frac{6\epsilon}{u + 5\epsilon}$$

Agents must be sufficiently patient, or production costs sufficiently low.

1.4.3 The gift-giving economy

Upon being paired, each agent simultaneously and individually chooses to transfer a good or not. A **history** records all past actions and all past meetings.

Proposition 2. *In a search model, the transfers in any stationary monetary equilibrium are an equilibrium path of transfers in a gift-giving economy.*

Proof. Label agents who originally have money G, and those without B. The strategy in the gift-giving game: if an agent labeled B meets an agent labeled G and the former can produce what the latter desires, then the former produces and gives the output. Labels are then exchanged. This is the only form of transfer.

For example, suppose a French agent (label B) meets a Swedish agent (label G) who wants wine. The French agent produces wine and gives it to the Swede; labels flip so the French agent becomes G and the Swede becomes B. Later, when the French agent (now G) meets a Greek agent (label B) who can produce the cigarettes the French agent desires, the Greek produces and labels flip again.

Labels are functions of the transaction history, so these are legitimate strategies. The utility of label G equals V_1; the utility of label B equals V_0.

Is this collection of strategies a gift-giving equilibrium? An agent labeled G will not produce, because there is no future compensation—she already holds the most rewarding label, and there is no additional gain. An agent labeled B faces $\beta V_0 \leq -\epsilon + \beta V_1$ from the monetary equilibrium, so she willingly pays ϵ today to receive the better label. □

1.4.4 What the search model reveals beyond the OLG model

The search model shows that money is only a *limited* form of societal memory. A more efficient allocation exists.

The worst outcome is autarky, which provides zero utility. Using autarky as a threat, propose the following strategy: any agent who meets another agent whose desired product she can produce must produce. The resulting utility is

$$V = \frac{1}{3}(-\epsilon + \beta V) + \frac{1}{3}(u + \beta V) + \frac{1}{3}\beta V$$

where the agent produces in the first type of meeting, consumes in the second, and does nothing in the third. Solving:

$$V = \frac{1}{3(1-\beta)}(u - \epsilon)$$

The incentive-feasibility condition requires

$$-\epsilon + \beta V = -\epsilon + \frac{\beta}{3(1-\beta)}(u - \epsilon) \geq 0$$

so that

$$\beta \geq \frac{3\epsilon}{u + 2\epsilon}$$

Since

$$\frac{3\epsilon}{u + 2\epsilon} = \frac{6\epsilon}{2u + 4\epsilon} \leq \frac{6\epsilon}{u + 5\epsilon}$$

agents can be *less* patient in this **symmetric** gift-giving equilibrium. The utility is also higher than in the monetary equilibrium and the asymmetric gift-giving equilibrium (Exercise 1 asks you to verify that $V > V_1 > V_0$).

Numerical illustration. Set $\epsilon = 0.2$ and $u = 1$. The monetary equilibrium requires $\beta \geq \frac{6\times 0.2}{1+5\times 0.2} = 0.6$. The symmetric gift-giving equilibrium requires only $\beta \geq \frac{3\times 0.2}{1+2\times 0.2} = \frac{3}{7} \approx 0.43$. For any $\beta \in [0.43, 0.6)$, the efficient allocation is achievable with a perfect record of transactions but not with money.

Setting $\beta = 0.7$ (both equilibria exist), the symmetric gift-giving equilibrium yields $V = \frac{0.8}{3\times 0.3} = \frac{8}{9} \approx 0.89$. Solving the monetary value functions gives $V_1 = \frac{59}{144} \approx 0.41$ and $V_0 = \frac{5}{144} \approx 0.03$. The ranking $V > V_1 > V_0$ confirms that the symmetric gift-giving equilibrium Pareto-dominates the monetary equilibrium. Money is a limited form of memory.

Money's limitations as a mnemonic device are twofold: only past actions can be rewarded, and the constraint of holding only one unit limits wealth accumulation. The latter limitation stems from modeling simplifications, not from money itself.

1.5 Bonds

If money is a record of gift-giving, can we think of all paper assets this way? A bond is, after all, a promise put on paper.

The propositions above do not apply to bonds for two reasons. First, in a finite horizon, monetary equilibria are not sustained because the last holder cannot realize any value from money. Since this destroys the chain of future acceptances, money becomes useless—and gift-giving does too. Bonds, however, support exchange in finite horizons because the last holder can realize value from the bond's promise. Second, bonds require either commitment or an external enforcement mechanism to prevent the issuer from defaulting. Therefore, asset market equilibria cannot generally be obtained as gift-giving equilibria.

1.6 Stablecoins

Stablecoins are a hybrid instrument: they circulate like fiat money—as bearer instruments requiring no identity at the point of transfer—but carry a redemption promise like bonds, pegging one token to one unit of a reference currency.

The blockchain ledger on which stablecoins operate makes the "money is memory" metaphor almost literal. The public transaction history maintained by network participants *is* the record Kocherlakota envisioned, sustained without a trusted central authority.

Yet stablecoins inherit the intrinsic uselessness of the fiat currency they are pegged to. Their value ultimately rests on the same chain of future acceptance that sustains fiat money. In a finite horizon, the last holder of a stablecoin holds a claim to fiat money—which itself has no terminal value. The finite-horizon unraveling that destroys monetary equilibria therefore propagates through the peg: if fiat money is worthless at the terminal date, so is a promise to redeem one unit of it. Stablecoins do not escape this problem; they import it.

Like bonds, stablecoins require trust in the issuer—for redemption at par and for maintaining adequate reserves. Their circulation value depends on the issuer's reputation and perceived solvency, making the commitment problem central. Stablecoins therefore combine the fragilities of both fiat money and bonds: they need the chain of future acceptance that sustains fiat money *and* the trust in the issuer that sustains bonds.

In the gift-giving equilibria of the preceding sections, no external enforcement is needed: the punishment strategy—labeling a deviating agent B and withholding future transfers—is self-enforcing. The redemption promise of a stablecoin, however, is not self-enforcing. An issuer who absconds with reserves faces no in-game punishment that restores holders. This is precisely the role regulation plays: MiCAR's reserve, segregation, and disclosure requirements provide the external enforcement mechanism that substitutes for the issuer's inability to commit.

Algorithmic stablecoins—which hold no reserves and maintain their peg through protocol rules alone—attempt to function as pure memory: no external asset, only a record and a mechanism. Their fragility (cf. Terra/Luna in 2022) illustrates what happens when the historical record becomes unreliable. Like the free banking era, in which note holders could not distinguish sound banks from insolvent ones, participants can no longer tell whether labels in the record reflect genuine past production or hollow promises. The gift-giving equilibrium unravels not because memory disappears, but because it becomes murky.

From the model's perspective, a fully backed and transparently regulated stablecoin approximates fiat money, and the propositions above apply. An under-collateralized or opaque stablecoin behaves more like a bond, and the propositions fail because enforcement becomes load-bearing.

The patience-threshold result from the search model has an analogue: stablecoins lower the effective "patience" required for exchange through instant settlement, continuous availability, and programmability, compared to traditional payment rails—potentially expanding the set of sustainable equilibria.

This reveals a tension at the heart of stablecoin design. The open ledger technology provides the transparent, shared record of transactions that Kocherlakota's framework calls for. Yet the redemption promise requires commitment that no record, however perfect, can enforce on its own. Stablecoins therefore occupy the gap between the limited memory that cash provides and the full memory that sustains efficient allocations—closer to the theoretical ideal in record keeping, but no closer in commitment.

1.7 Conclusion

Money is a social technology that allows members of a society to record past transactions credibly. We can therefore call money a societal memory device. Conversely, if agents could keep track of everyone's actions, we would not need money.

This insight points to a pattern: cash is popular in societies where record keeping is impossible or unattractive—where criminal activity, tax evasion, or sheer size makes tracking identities and histories impractical. In large, mobile societies, monetary exchange replaces personal relationships. Child rearing, once shared among extended families, is now paid for through professional child care services.

Distributed-ledger technologies—blockchain-based currencies in particular—can be understood through this lens. A blockchain is a decentralized record of all transactions, maintained collectively by participants without a trusted central authority. It is a partial implementation of the "perfect history" in Kocherlakota's framework: perfect enough to sustain exchange, yet decentralized enough to operate without an omniscient record keeper. The theoretical question becomes whether the technology can close the gap between the limited memory that money provides and the full memory that sustains efficient allocations.

For money to be essential, we need limited commitment and imperfect

information [see Wallace, 2001, for a broader perspective on the essentiality program].

Key takeaways.

- Money is a physical, decentralized record of past transactions—a societal memory device.
- Any stationary monetary equilibrium can be replicated by a gift-giving game with a perfect history of actions.
- In the search model, a symmetric gift-giving equilibrium achieves higher welfare than the monetary equilibrium and requires less patience.
- Money is a *limited* form of memory: it can only reward past actions, and indivisibility constrains wealth accumulation.
- For money to be essential, two frictions are needed: limited commitment and imperfect record keeping.

1.8 Exercises

1. Show that the symmetric gift-giving equilibrium Pareto-dominates the monetary equilibrium. That is, show $V > V_1 > V_0$.
2. In the OLG gift-giving economy, what happens if an agent labeled G deviates by *not* making a transfer? Trace the consequences through the labeling strategy and verify that the deviation is not profitable.
3. Why do the propositions above not extend to bonds? Give an economic argument, not just a technical one.
4. Suppose a stablecoin issuer holds reserves equal to a fraction $\alpha \in [0, 1]$ of outstanding tokens. At the terminal date of a finite-horizon economy, each token is redeemed at α units of the consumption good. For what values of α does a monetary equilibrium exist? What happens as $\alpha \to 0$?
5. Compare the free banking era to algorithmic stablecoins using the search model. Suppose that upon meeting a trading partner, an agent observes the partner's label (G or B) only with probability $\pi \in [0, 1]$. With probability $1 - \pi$, the label is not observed. Derive the patience threshold $\beta(\pi)$ required to sustain the gift-giving equilibrium and show that it is decreasing in π. Interpret π as the transparency of the ledger.

6. In the stablecoin section, we argued that regulation substitutes for the issuer's inability to commit. Suppose instead that the issuer can be punished by the community: if the issuer fails to redeem at par, all agents refuse to accept the stablecoin in future periods. Under what conditions is this self-enforcing punishment sufficient to sustain the peg without external regulation? When does it fail?

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