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The Technological Role of Fiat Money

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Abstract

This article argues that fiat money's only technological role in an economy is to act as *societal memory:* money allows people to credibly record some aspects of their transactions and make that record accessible to other people. This record-keeping role is demonstrated in the three standard paradigms of fiat money: the overlapping generations, turnpike, and search models. In these models, if a new economy is created by removing the money and replacing it only with a historical record of all transactions, known to everyone in the economy, then the original monetary allocation is still achievable as an equilibrium.

This article is a less technical presentation of the ideas in the author's study, "Money is Memory," which is forthcoming in the *Journal of Economic Theory.* The article appears in the Minneapolis Fed's *Quarterly Review* with the permission of Academic Press.

Imagine that John and Paul meet. John has apples and wants bananas. Paul wants apples but doesn't have bananas. In monetary economies, this problem is solved by Paul giving John money in exchange for apples. John then uses the money to buy bananas from someone else—let's say George. If John doesn't give the apples to Paul, then John doesn't get the money and can't buy the bananas from George.

This scenario demonstrates that adding fiat money to an economy expands the set of allocations available in the economy. In this sense, money is a *technological* innovation, just as much as the train or the steam engine is.

But, of course, unlike those devices, money itself is intrinsically useless. So, what technological role does money actually play? In terms of the reallocation of intrinsically valuable resources, we can think of the scenario above as a situation in which John is considering making Paul a *gift* of apples. If John makes the gift, George will give him bananas in the future; if John doesn't make the gift, George won't give him the bananas. The money that John receives from Paul and offers to George is merely a way to let George know that John has fulfilled his societal obligations and given Paul his gift of apples.

Thus, monetary economies can be viewed as merely large interlocking networks of gifts. If agents in the economy know the history of all gifts, then any allocation of resources achievable in the economy with money is achievable without it. George, for example, can react to different histories of John's gift-giving in the same way that he reacts to John having different amounts of money.

This analysis leads to a simple conclusion: If the function performed by money can be superseded by a perfect historical record of transactions, then money's only technological role must be to provide that record. In other words, money is a form of record keeping, or *societal memory.*

I make this argument formally by considering the three standard paradigms of fiat money: the overlapping generations, turnpike, and search models. In each of these models, I create a new economy by removing the money and replacing it only with a historical record of all transactions, a history known to all agents. I do not provide agents with any additional ability to enforce contracts. I show that in each of the models the original monetary allocation is still achievable as an equilibrium in the new environment with perfect societal memory. I conclude that the only technological role of money is to provide a (possibly limited) form of societal memory of transactions.

My argument demonstrates the vacuity of the three standard explanations of the role of fiat money in an economy: money acts as a store of value, a medium of exchange, and a unit of account. From a technological point of view, we can see that none of these functions really require money. Money does not represent a new way for society to accumulate wealth. Money does not reduce the costs of transferring resources from one person to another. There is no immediate technological reason that money should be a better numeraire than other goods. The traditional explanations for the presence of money in an economy are more *descriptive* of its functions than *explanatory*. The true explanation for money's presence is that money is a record-keeping device.

I am not the first to notice that money has a record-keeping role; anyone who makes an argument along these lines has to acknowledge an enormous debt to the work of Robert Townsend (1987, 1989, 1990). Townsend has studied several environments in which the optimal arrangements feature monetary tokens that help agents remember trading histories.[1] Other researchers [among them, Joseph Ostroy (1973), Robert Lucas (1980), and Rao Aiyagari and Neil Wallace (1991)] have noted, as I emphasize here, that fiat money helps keep track of past transactions. In contrast to those researchers, though, I emphasize the *generality* and the *singularity* of money's record-keeping role. My point is a twisted version of Milton Friedman's famous dictum: *Money is always and everywhere a mnemonic phenomenon.*

The Argument in General . . .

Again, the general line of argument runs as follows. Take any economy in which money circulates. Remove the money, and replace it with a history of all transactions in the economy, a history known to all agents. At each point in time, allow an agent to make gifts to anyone who is a potential trading partner in the monetary economy. The monetary equilibrium allocation is, then, an equilibrium allocation in the gift-giving economy, or *game.*[2]

The logic behind this argument is that with a record of past transactions, we can construct strategies in the gift-giving game that correspond to what happens in the monetary economy. In the monetary economy, whenever an agent gives up consumption, that agent receives a sum of money which can be used to purchase consumption in the next period. Analogously, in the gift-giving game, an imaginary balance sheet is kept for each agent. When an agent gives consumption to someone else, the giver's balance rises, and so does that agent's capacity for receiving future gifts. When an agent gets consumption from someone else, the agent's balance and capacity for receiving future gifts both drop. In the monetary economy, money is merely a physical way of maintaining this balance sheet.

Note that the gift-giving game differs from the monetary economy in only two respects. One is that in the gift-giving game, money does not exist. The other is that in the gift-giving game, all agents know about all past transactions. Thus, the gift-giving game does not introduce any means of enforcement or contracting that don't exist in the monetary economy.[3] Technologically, then, money is, indeed, a form of societal memory.

. . . And in Three Standard Models

Now I will apply this general argument to three standard paradigms of fiat money: an overlapping generations model, a turnpike model, and a search model.[4] I will show that money is a perfect mnemonic device in the first two types of model, but is severely limited in this role in the third.

Overlapping Generations Models

I begin with an overlapping generations model similar to the one originally described by Paul Samuelson (1958). I show that in this type of model, any monetary equilibrium is a gift-giving equilibrium of the same economy with perfect memory of all transactions.

Let's say that in this economy, each cohort includes J agents. Agents each live two periods—in the first, they are young; in the second, old. Each period another generation of two-period lived agents is born. Agents in each generation are each endowed with one unit of a perfectly divisible consumption good when young and zero units of this good when old; the consumption good is not storable. The young agents have preferences over current consumption (c_y) and future consumption (c_o) that are represented by the utility function:

$$u(c_y, c_o)$$

where u is strictly increasing. The old agents prefer more consumption to less.

☐ *With Money*

Suppose, first, that the initial old agents each have one unit of a perfectly divisible, storable, and concealable good that gives the holder no utility; the good is intrinsically useless. I call this good *money.* Suppose further that in every period, the agents trade money for consumption in competitive markets. A *competitive equilibrium* in this environment is a sequence of prices of money in terms of consumption, $\{p_t\}_{t=1}^{\infty}$, such that the young agents in every period demand the entire stock of money. Mathematically, then, in a competitive equilibrium, it must be true that, for all t,

$$1 \in \text{argmax}_{m \geq 0}\ u(1-p_t m, p_{t+1} m)$$

where m is an individual agent's money holdings. In such an equilibrium, in period t, the young agents consume $1 - p_t$ units of the consumption good while the old agents consume p_t units.

☐ *Without Money*

Now suppose that instead of competitively exchanging money for goods, the agents play a gift-giving game. In particular, in period t, each of the J young agents simultaneously transfers some nonnegative amount of consumption to each old agent. Denote the transfer made by young agent j to old agent i in period t by τ_t^{ji}. Define a *history* in period $t + 1$ as a sequence of transfers $\{\{\tau_s^{ji}\}_{s=1}^{t}\}_{j,i=1}^{J}$. This means that the entire record of transfers is common knowledge.

A *strategy* for young agent j in period $t + 1$ is a mapping from the set of possible histories to the set of feasible transfer vectors. A *gift-giving equilibrium* is a collection of strategies for which the action prescribed by each strategy after any history of play is an optimal response, and the actions prescribed by the other strategies are taken as given.[5]

Note that in a gift-giving equilibrium, agents have no way to commit to a particular transfer scheme over time. Hence, the crucial difference between the gift-giving game and the monetary economy is that in the former, agents are endowed with knowledge of all past transactions.

The following proposition demonstrates that in this type of model, monetary equilibria are merely special instances of outcomes in the gift-giving game:

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. Consider a monetary equilibrium $\{p_t\}_{t=1}^{\infty}$. Without loss of generality, number the agents so that in a monetary equilibrium, young agent j makes a transfer p_t to old agent j in period t. The claim is that this sequence of transfers can be supported as a gift-giving equilibrium.

In period 0, all of the currently old agents are labeled G. (Think of the labels G and B as abbreviations for *good* and *bad*. Agents labeled G have never failed to make the gifts mandated by the implicit social contract in a gift-giving equilibrium; agents labeled B have broken the social contract.)

Consider the following strategies for young agent j in period t:

- If the currently old agent j is labeled B, then the young agent makes no transfer to that old agent.
- If the currently old agent j is labeled G, then the young agent does make a transfer p_t to that agent; failure to do so will cause the young agent to be labeled B next period.

Note that these are legitimate strategies, because the labels are functions of only the histories of play and the initial labels.

I claim that this collection of strategies is a gift-giving equilibrium. Suppose the old agent j is labeled B. Then the young agent has no incentive to make a transfer to the old agent, and so does not. If the old agent is labeled G, then if the young agent doesn't make a transfer p_t today, next period the currently young agent will not receive a transfer. But we know that

$$u(1,0) \leq u(1-p_t, p_{t+1})$$

because in the monetary equilibrium, the agent chose to give up p_t units of consumption today in exchange for p_{t+1} units of consumption next period. Hence, in this situation, the young agent will make a transfer to the old agent.

Q.E.D.

In an overlapping generations model, then, removing money from the economy and replacing it with a historical record does not eliminate any equilibrium allocations. Therefore, in this type of model, money is merely a particular type of mnemonic device. Indeed, here money is a good mnemonic device; monetary equilibrium allocations (in which the price level is constant) exist which are efficient among the class of all gift-giving equilibrium allocations. Society can do no better with alternative recordkeeping devices than it can with money.[6]

Turnpike Models

A defect with the overlapping generations economy is that the period of decision making (half of a lifetime) seems quite different from the frequency with which people actually make decisions about money holdings. Here I consider a similar model due to Townsend (1980) which does not suffer from that weakness. In it, I prove a proposition similar to the one above.

☐ *With Money*

Consider a world with an infinite number of trading posts located at the integer points along the real number line. Think of them as situated along a highway, or *turnpike.*

In each period, at each trading post, there are two types of agents. In period t, the *odd* agents are each endowed with one unit of consumption if t is odd and zero units of consumption if t is even; the *even* agents are each endowed with zero units of consumption if t is odd and one unit of consumption if t is even. Consumption is perishable. In period t, each type of agent has preferences over current and future consumption representable by the utility function

$$\sum_{s=0}^{\infty} \beta^s u(c_{t+s})$$

with a discount factor $0 < \beta < 1$, where u is strictly increasing, strictly concave, and bounded from above and below.

Even agents are endowed with one unit of money each in period 1. (Here, as above, money is an intrinsically useless, perfectly divisible, storable, and concealable good.) Next period, the odd agents move one trading post to the left, and the even agents move one trading post to the right. In each period, the agents at a given trading post trade consumption and money competitively among themselves.

This environment has a stationary monetary equilibrium if and only if there exists a $\delta^* > 0$ such that

$$\delta^* = \text{argmax}_\delta \; u(1-\delta) + \beta u(\delta).$$

In this type of an equilibrium, the *rich* agents (those with the larger endowment) in any period give away δ units of consumption in exchange for the money held by the *poor* agents.

□ *Without Money*

Now suppose that there is no money in the turnpike economy. Instead, agents play a gift-giving game of the sort discussed for the overlapping generations economy. In each period, every agent is free to transfer any amount of consumption to any other agent at the same trading post; the agents decide on the transfers simultaneously. In this game, as in the overlapping generations model, a *history* is a full record of all transfers made in the past, and a *gift-giving equilibrium* is a collection of strategies that prescribe optimal actions for every agent after every history, with other agents' strategies taken as given.

We can prove a version of Proposition 1 in this environment:

PROPOSITION 2. *In a turnpike model, the transfers in any stationary monetary equilibrium are an equilibrium path of transfers in a gift-giving game.*

Proof. Let δ^* be the time-invariant transfer made in a stationary monetary equilibrium. According to the model, there are groups of J agents who are always together. Index each agent in a group from 1 to J. (In effect, *name* them.) Every agent can be labeled G or B (again, *good* or *bad*); initially, all agents are labeled G. Then consider the following strategy for a currently rich agent j in a particular group (that is, an agent j who has received a high endowment):

- If either the currently rich agent j or the currently poor agent j is labeled B, then the rich agent does nothing.
- If the rich agent is labeled G, and t is an even number, then the agent does nothing.
- If the rich agent is labeled G, t is an odd number, and the poor agent is also labeled G, then the rich agent gives δ^* to the poor agent. Failure to give less than δ^* results in the rich agent being labeled B in the future.

Note that here, as in the proof of Proposition 1, the labels are functions of only the histories of play and the initial labels, so that these are legitimate strategies.

This collection of strategies is a gift-giving equilibrium. In particular, if a rich agent doesn't make a transfer when the strategies require one, then that agent is labeled B. This means the agent is forced into autarky, because an agent labeled B never receives any gifts. This is worse than staying with the pattern of transfers promised by the monetary equilibrium, because

$$u(1-\delta^*) + \beta u(\delta^*) \geq u(1) + \beta u(0). \qquad \text{Q.E.D.}$$

Again, removing money from the turnpike economy and replacing it with complete memory does not eliminate the monetary equilibrium; money is merely a special type of memory.

In the overlapping generations setting, the monetary equilibrium delivered an allocation that was efficient among the set of all gift-giving equilibrium paths. Generally, this will not be true in the turnpike model. We can easily show that in this model a time-invariant transfer δ^* can only be an efficient gift-giving equilibrium path if either $\delta^* = 1/2$ or the rich agent is pushed to the agent's autarkic level of utility:

$$u(1-\delta^*) + \{\beta[u(\delta^*) + u(1-\delta^*)]/(1-\beta)\}$$
$$= u(1) + \{\beta[u(0) + u(1)]/(1-\beta)\}.$$

(Intuitively, we know that if $\delta^* \neq 1/2$, then the rich agent needs to be pushed to an autarkic level of utility in order to generate as much consumption-smoothing as possible.) In general, neither of these conditions is met in a stationary monetary equilibrium.

This analysis suggests that money is an imperfect mnemonic device in the turnpike model. But, as Leonid Hurwicz (1980) emphasizes, we must be careful about attributing defects of particular trading arrangements to money. In this context, the failure to allocate resources efficiently is not due to some weakness in money, but rather to a defect in the procedure that individuals use to exchange goods for money.

□ *Another Exchange Procedure*

We can see this by changing the exchange procedure as follows. Suppose that within every cohort and at every trading post, agents are numbered from 1 to J. Agents with the same number are paired. In each pair, the two agents simultaneously and separately write down a proposed exchange. If the two proposals match, then the exchange occurs. The agents don't know each other's trading histories, but they can observe money holdings.

In an economy with this exchange procedure, any gift-giving equilibrium path is also an equilibrium with money but no memory. Suppose, for example, that the (1/2,1/2) split is a gift-giving equilibrium path. We can easily describe strategies in the economy with money that support this split. If the poor agent has at least one unit of money, then the rich agent proposes to give up half a unit of consumption in exchange for that unit of money. The poor agent writes down this same proposal always. If the poor agent has less than one unit of money, then the rich agent refuses to make any transfer.[7]

These strategies form an equilibrium as long as the rich agent is willing to give up half a unit of consumption today in order to gain the benefits of consumption-smoothing in the future. Put another way, these strategies support the (1/2,1/2) split as long as it delivers more utility than autarky in every period. This is true if and only if the strategies also form a gift-giving equilibrium.

The key to this exchange procedure is that the valuation of money in terms of consumption is highly nonlinear: one unit of money is worth half a unit of consumption, while any amount of money less than one unit is worth zero. The assumption that exchange at each trading post enforces a linear pricing rule is what leads to suboptimal allocations. (For a similar argument, see Townsend 1989.)

To sum up: In a turnpike model, all stationary monetary equilibria are also gift-giving equilibria. The stationary monetary equilibria are inefficient compared to other gift-giving equilibria, but only because of the assumption of competitive exchange. An exchange procedure does exist in which using money involves no loss of memory.[8]

Search Models

Neither the overlapping generations model nor the turnpike model captures one of the traditional reasons people are thought to hold fiat money: to overcome an *absence of a double coincidence of wants.* For example, a butcher has beef to sell and wants to buy bread. Without money, the butcher has to search for a baker who isn't a vegetarian and who happens to want beef now. The time it takes the butcher to find such a baker can be a big problem since beef is perishable. The existence of money changes everything. The butcher can now sell beef to anyone who wants it in exchange for money and then use the money to buy bread from any baker who comes along.

Nobuhiro Kiyotaki and Randall Wright (1991) present a model that does capture this role for money. Here I show that in their *search* model, unlike in the other two models, money is only a limited form of societal memory. This leaves open the possibility that economies need other record-keeping devices as well—which, of course, is what actual economies have.

The Kiyotaki-Wright model works as follows. The economy has three types of agents, all of whom differ in their preferences and their technologies; three is the minimal number of types necessary to generate an absence of a double coincidence of wants. (For example, think of the types as butchers who like to eat bread, bakers who like to eat potatoes, and potato farmers who like to eat beef.) The economy has a continuum of each type of agent. The economy also has three types of nondurable and indivisible goods. In each period, a type i agent is endowed with one unit of good i. However, type i agents receive one unit of utility in a given period only from consumption of good $i + 1$.[9] These agents receive no units of utility from consuming any other good. The agents live forever and discount utility using the discount factor β.

Each period, agents are matched randomly in pairs; any particular agent is equally likely to be matched with any of the three types of agents. Matched agents can make trades or transfers of goods as they see fit. However, to make any trade or transfer, an agent must give up $\varepsilon < 1$ units of utility (say, in transportation costs).

In this environment, it is efficient ex ante for type $i + 1$ agents to give their consumption good to type i agents whenever they are paired: the ε units of utility lost when an agent is a giver is made up by the one unit gained from the consumption good. The problem with this arrangement is *enforcement:* how should a society induce the type $i + 1$ agents to endure the ε-unit cost of transferring resources to the type i agents when they are matched?

□ *With Money*

Kiyotaki and Wright (1991) demonstrate that fiat money provides a partial solution to this problem. Suppose that half the agents of each type are endowed with one unit of an indivisible, storable, and concealable good called *fiat money.* Assume that consumption of this fiat money provides no utility to any of the agents. Assume as well that the agents cannot hold more than one unit of money at one time. In a stationary monetary equilibrium, type i agents with money give their money, in exchange for goods, to type $i + 1$ agents, who have no money. The type $i + 1$ agents accept the intrinsically useless money because they can use it to acquire their desired consumption goods from half of the type $i + 2$ agents in the future.

Clearly, a stationary monetary equilibrium exists only if agents are sufficiently patient: they must be willing to pay the transportation cost ε today in exchange for the possibility of getting desirable goods in the future. Let's see what is required for a stationary monetary equilibrium.

Define the lifetime utility of agents to be V_1 for those with money and V_0 for those without money. Then, in a stationary monetary equilibrium, the values V_1 and V_0 should satisfy these equations:

$$V_1 = [(1 + \beta V_0)/6] + (5\beta V_1/6)$$

$$V_0 = [(-\varepsilon + \beta V_1)/6] + (5\beta V_0/6).$$

The V_1 equation says that agents with money will, with probability 5/6, keep their money and get zero utility today and, with probability 1/6, meet someone with a desirable good but no money and make a trade. The V_0 equation says that agents without money will, with probability 5/6, meet no one who wants to trade with them and, with probability 1/6, meet someone with money who wants their good.

The values V_1 and V_0 must also satisfy these two inequalities:

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

$$1 + \beta V_0 \geq \beta V_1.$$

These guarantee that agents without money find it best to exchange their good for money while those with money find it best to exchange the money for a good. Such a V_1 and a V_0 exist if and only if

$$\beta \geq 6\varepsilon/(1+5\varepsilon).$$

Thus, if individuals are sufficiently patient (β is high) or if transportation costs are sufficiently low (ε is low), fiat money provides a partial solution to the problem of how to induce agents with desirable goods to give those goods to their current trading partners.

□ *Without Money*

Here, as in the other models, fiat money is only necessary if agents do not know the economy's full history of transactions. To see this, consider the following gift-giving game.

Upon being paired, each agent chooses, simultaneously and separately, to either transfer a good to the other agent or not. A *history* in this game is a full record of an agent's past actions, the past actions of all previous partners, the past actions of those agents' past partners, and so on. As before, a *strategy* is simply a mapping from histories into choices. In a *gift-giving equilibrium*, the strategy prescribes an action after any history that is optimal, taking as given the other agents' strategies.

Having defined equilibrium in this way, we can prove the following proposition:

PROPOSITION 3. *In a search model, the transfers in any stationary monetary equilibrium are an equilibrium path of transfers in a gift-giving game.*

Proof. The stationary monetary equilibrium is an asymmetric gift-giving equilibrium. Label the agents who originally have money G (*good*), and label those without money B (*bad*). Describe a strategy in the transfer game as follows:

- In any period, if a type $i + 1$ agent labeled B meets a type i agent labeled G, then the type $i + 1$ agent gives her or his good to the type i agent. The agents' labels are then exchanged.
- There is no transfer in any other meeting.

Note that the labels G and B are functions of the history of all transactions in the economy, so that the above are legitimate strategies. Also, note that the utility associated with being labeled G equals V_1 and the utility associated with being labeled B equals V_0.

Is this collection of strategies a gift-giving equilibrium? Note first that being labeled G is better than being labeled B. Consider a type i agent who is currently labeled G. This agent will not give up a good to a type $i - 1$ agent; the type i agent sees no future compensation for the current loss of utility associated with giving up the good. (The agent already has the best possible label G.) Consider, instead, a type i agent who is currently labeled B. In the stationary monetary equilibrium, $\beta V_0 \leq -\varepsilon + \beta V_1$. Therefore, such an agent is willing to pay ε today and give up a good in exchange for receiving the better label in the future.

Q.E.D.

Thus, here, as in the previous two model economies, money is serving only as a means of keeping track of what has happened in the past. If agents can keep track on their own, then money becomes superfluous (in the sense that adding money to the economy does not help attain any Pareto superior allocations).

In the overlapping generations and turnpike contexts, we saw that the presence of a perfectly divisible, storable, and concealable good is sufficient to replace all knowledge of the historical record. This is not true in the search model: typically, this model has a gift-giving equilibrium that implements a more efficient allocation than that obtained in the stationary monetary equilibrium.

To see this, note that the worst possible gift-giving equilibrium in this environment is the equilibrium without trade. (It provides zero utility.) This can be used as a threat to support better outcomes. Hence, as long as

$$-\varepsilon(1-\beta) + [\beta(1-\varepsilon)/3] \geq 0$$

an agent will be sufficiently deterred by the prospect of no future trade to give up a consumption good today to someone who wants it. We can rewrite this restriction as

$$\beta \geq 3\varepsilon/(1+2\varepsilon).$$

Clearly,

$$3\varepsilon/(1+2\varepsilon) < 6\varepsilon/(1+5\varepsilon).$$

Thus, whenever a stationary monetary equilibrium exists, a gift-giving equilibrium implements the symmetric efficient allocation.[10]

This setting has an intrinsic limitation on money as a mnemonic device, a limitation that helps to generate the inefficiency of the monetary equilibria. In the efficient gift-giving equilibrium, type i agents who fail to make a transfer to type $i+1$ agents are punished severely. Type i agents who fail to make a transfer to type i agents are not punished at all. This distinction is crucial because the first transfer type is socially beneficial (ex ante) while the second is not.

In a monetary economy without a historical record, this distinction is impossible. Because no record is kept of the past trading partners of particular agents, those who fail to make a transfer because they are poorly matched must be treated the same by future agents as those who fail to make a transfer because they are defecting from the optimal social arrangement. Money only induces transfers by promising future benefits to those who make them. Therefore, in any equilibrium, a type i agent is better off meeting a type $i + 1$ agent than meeting another type i agent. This fluctuation in utility along the equilibrium path is suboptimal relative to what occurs in the efficient gift-giving equilibrium.

The imperfections of money as a mnemonic device in search models do not undercut my general argument that money is a mnemonic device. Rather, the search model allows us to contemplate the quite realistic possibility that there are other mnemonic devices that are as good as or perhaps better than money. In the search model, alternate record-keeping technologies such as electronic debit cards and transaction records might well offer a welfare improvement over money; they do not in the overlapping generations and turnpike models.

The Role of Bonds?

So, money is merely a way to keep track of promises of future benefits in exchange for past gifts. Can we think of all paper assets in this way? A bond, for example, is an intrinsically useless piece of paper that promises the holder consumption in the future for having given up consumption in the past. Do the above propositions also apply to bonds? No. Asset market equilibria cannot generally be obtained as gift-giving equilibria.

Here is a trivial example of that fact. In any finite-horizon setting, there is only one gift-giving equilibrium: autarky. (Similarly, autarky is the only monetary equilibrium.) Yet, finite-horizon settings may well have nonautarkic asset market allocations. The phenomenon is less obvious in infinite-horizon settings, but is nonetheless still true: those settings have asset market equilibria that are not gift-giving equilibria.

Bonds are able to achieve additional allocations because bonds are used in settings in which agents can be forced to violate ex post individual rationality constraints. In a two-period setting, that is, a rational borrower has an incentive to default on a loan in the second period. Some threat of external force is necessary to make the borrower abide by the terms of the contract. This threat of external force is not present in gift-giving games.

In sum: Both money and bonds are intrinsically useless pieces of paper that help keep track of past transactions. The distinction between the two is contextual. Money serves as a type of memory in environments or relationships without enforcement or commitment. (So when money is involved, all transfers of resources can legitimately be described as *gifts.*) Bonds serve as a type of memory in environments or relationships with enforcement or commitment. (Some transfers of resources occur because of the threat of external force.)[11]

Conclusion

Money's technological role in an economy is to allow people to credibly record some aspects of their past transactions and make that record accessible to other people. In short, money acts as *societal memory*. The ability of money to perform this role depends on specifics of the environment: Money is a perfect memory device in some overlapping generations and turnpike models, but is of only limited use in some search models. The main difference between the roles of money and bonds has to do with the type of environment or relationship involved. Both money and bonds are used as record-keeping devices, but with bonds, commitment to abide by the terms of the contract is possible, and with money, it is not.

In his work, Townsend (1980 especially) emphasizes the importance of spatial arrangements in determining the relative use of currency and credit. According to my reasoning here, the crucial attribute of a particular spatial arrangement is not the geography itself, but rather the technological limitations to memory and commitment that the geography suggests. Thus, in the turnpike model, it seems natural for even and odd agents who meet at a trading post to be unaware of each other's pasts; this lack of memory generates a need for money. Nonetheless, the lack of memory is not intrinsic to the geographical specification, but rather reflects a particular technological deficiency.

Similarly, in the turnpike model, it seems unnatural for an odd agent j to give up consumption today for a piece of paper that reads "Agent j in the even cohort at the next trading post to the left owes the bearer one unit of consumption." The absence of such contracts is what makes money valued. Again, however, nothing intrinsic in the geography rules out such contracts; rather, the absence of such contracts reflects the absence of a particular type of enforcement technology.

As my analysis of the search model makes clear, money is, in general, only a limited form of memory. This suggests at least two challenges for future research. One is to find a more precise qualifier than *limited* to describe money's record-keeping function. We must remember, though, that any such qualifiers are uninteresting unless they apply to a wide class of economic environments.

The other challenge for researchers is essentially that posed by Hurwicz (1980). He argues that we might want to think of money as being an efficient way to solve some type of problem in institutional design. With my analysis, we can tighten Hurwicz's point a bit. Societies have access to a wide variety of record-keeping technologies. Why is money, with all of its mnemonic limitations, such a widespread institution? My recent work with Wallace (Kocherlakota and Wallace 1997) is a first step toward answering that question.

Finally, a word about the real-world implications of this view of money. Monetary economics has traditionally been dominated by the question of how the quantity of money, or the growth rate of that quantity, affects prices and quantities of goods. My reasoning here suggests that this focus is misplaced. Money is a record-keeping device; hence, monetary policy should be designed so that record-keeping is performed in the most efficient way possible. How do we do that? Currently, we do not know. But searching for the answers should lead to a more satisfactory (and robust) understanding of optimal monetary policy.

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[1]Townsend (1987) terms money a *communication* technology because it lets individuals credibly communicate aspects of their trading and production histories to other agents. I prefer the more specific term *societal memory,* but we are referring to the same function. The most precise term is probably *public access database:* money is essentially an informational storage device that allows all individuals access to records of certain aspects of trading histories.

[2]Throughout, I restrict attention to model economies in which preferences and technology are common knowledge. The main result can easily be extended to economic environments in which an agent has private information about some random variable (like income or productivity or preference type) that is independently and identically distributed over time. However, as Ed Green and Ned Prescott have emphasized to me, in the presence of private information about fixed attributes, some monetary equilibria may not be achievable as gift-giving equilibria when agents know the full history of trades.

For example, suppose I have a genetic predisposition to heart disease, and my trading partner is a health insurance provider. If my partner knows my full history of medical purchases, it might be able to infer that I have this genetic predisposition and be unwilling to provide insurance. From an ex ante point of view, this failure to provide insurance is suboptimal. Money holdings, in contrast, typically cannot convey enough information to destroy insurance possibilities.

[3]I assume that monetary economies have no external enforcement of societal allocations of resources (technically, that agents have to satisfy sequential, individual rationality constraints). I have two reasons for making this assumption. In the environments I study, the existence of this external enforcement would imply that neither money nor memory allows society to obtain any Pareto improvements in the allocations of resources. [For elaboration, see the work of Mark Huggett and Stefan Krasa (1996) and my forthcoming article in the *Journal of Economic Theory,* on which this *Quarterly Review* article is based.] The other reason for my assumption is that when intrinsically useless tokens are used for record-keeping purposes in environments with external enforcement, those tokens resemble bonds rather than money. I will discuss that situation in the last section.

[4]For more complete descriptions of the overlapping generations and turnpike models, see Thomas Sargent's 1987 textbook.

[5]I am describing here what is formally termed a *perfect public equilibrium* by Drew Fudenberg and Jean Tirole (1991, pp. 187ff). See also my forthcoming article in the *Journal of Economic Theory*.

[6]Consider the following allocation coordination mechanism in the overlapping generations economy with money. Old agent j writes down a division of money and consumption between old agent j and young agent j; simultaneously, young agent j does the same. If they write down the same allocation, then that division of money and consumption is implemented; otherwise, it is not. We can easily show, then, that any gift-giving equilibrium in the overlapping generations economy with societal memory is a monetary equilibrium of this allocation coordination mechanism (even if money is indivisible and concealable).

[7]In this description of equilibrium behavior, I treat money holdings as if they are perfectly observable. However, the strategies still form an equilibrium if money holdings are concealable.

[8]What kinds of auxiliary frictions are needed to make competition a good way to allocate resources in this environment? And when the environment has those auxiliary frictions, is money a perfect or imperfect mnemonic device? These are good questions, but answering them is beyond my scope here.

[9]In my discussion of search models, all types are understood to be modulo 3.

[10]It can also be shown that the utilities in the symmetric efficient allocation are larger than V_1, so agents both with and without money are worse off in the stationary monetary equilibrium.

[11]According to this view, checking accounts are a form of bonds, not money.

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