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LIMITED INFORMATION, MONEY, AND COMPETITIVE EQUILIBRIUM

Bruce Smith*

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ABSTRACT

In an overlapping generations model with borrowing and lending, uncertainty, and asymmetric information, fiat money may be essential to the existence of a competitive equilibrium. It may also serve to enhance the information of economic agents in a well-defined sense. In addition, the model presented provides suggestions about why the presence of valued fiat currency is essential to existence of equilibrium, even though in equilibrium perfect substitutes for money may exist.

*Federal Reserve Bank of Minneapolis

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One of the oldest questions in economics concerns the appropriate role of the government in the creation and maintenance of a means of payment, i.e., in the creation of money. Much recent work has reopened the argument that nothing in the role and use of money requires government intervention.[1/] This paper, on the other hand, suggests two new reasons why the existence of outside assets may be of importance in a competitive economy. First, it is demonstrated that there are economies where a competitive equilibrium exists in the presence of a (fixed) stock of fiat money, but where one does not exist if there is no money. Notice that, equivalently, if fiat money exists it is a necessary feature of a competitive equilibrium that it have value. Also, it is shown that there exist economies with fiat money where, in equilibrium, perfect substitutes for money are issued by the private sector; whereas if the stock of fiat money is set at zero no competitive equilibrium exists. Second, it is shown that the introduction of fiat money into some economies (where competitive equilibria do exist in its absence) can strictly enhance the amount of information available to all agents in the economy in a well-defined sense. Finally, both of these arguments are robust, in a sense to be defined below.

These results are obtained by following a suggestion of Friedman (1960) that the presence of private information provides a reason for the creation of outside assets by the government. Friedman argues[2/] that there is no role for government intervention in asset markets in the absence of bankruptcy and asymmetrically informed agents. When some agents may misrepresent their liabilities as safer than they actually are, however, Friedman suggests that "a purely fiduciary currency" is necessary, and then argues that provision of such a currency naturally entails a role for the government. Clearly, the key element in this argument is the ability of agents to misrepresent the nature of the liabilities they issue.

This paper is, in part, a formalization of this argument. A simple overlapping generations model with borrowing and lending is presented. (Some) borrowers have random future endowments, and may default on loans. Different agents have different default probabilities, with each agent's probability of default known only to himself ex ante. Hence there is some scope for agents to misrepresent the nature of the promises they issue in exactly the manner described by Friedman.

As in the adverse selection insurance literature,[3] this scope for misrepresentation creates problems for the existence of an equilibrium, competitive or otherwise. The modeling strategy adopted here is related to some strategies suggested by Prescott and Townsend (1984), so that a competitive equilibrium concept is employed. It is then demonstrated that when equilibria may or may not reveal information regarding borrowers' default probabilities, there exist economies which have competitive equilibria (with valued fiat money) in the presence of fiat money (or more generally, of an outside asset), but which have no equilibria without money. Or, put differently, if fiat money exists, for these economies it necessarily has value.[4]

The reason that money is essential to existence of equilibrium in these economies is as follows. Agents endogenously decide whether to take actions which provide signals about their default probabilities. These decisions are based on (candidate) equilibrium rates of return on various assets. In many economies there are no such rates of return consistent with agents' decisions to reveal or conceal information, and hence no equilibrium. The introduction of an outside asset, such as fiat money, alters the structure of candidate rates of return for some economies. When these are altered appropriately rates of return consistent with revelation decisions arise in equilibrium, thereby avoiding an existence problem.

In addition, the paper demonstrates a sense in which existence of an outside asset can increase the availability of information in an economy which has an equilibrium when money is not present. To see this consider the following scenario. There is one lender and two borrowers. One of the borrowers has a random future endowment and defaults on loans in some states. The other borrower has a nonrandom endowment and never defaults. If an equilibrium exists and does not reveal information about borrowers' respective default probabilities, then from the lender's point of view there are future states where borrower one defaults, where borrower two defaults, and where neither defaults. Suppose the introduction of money alters rates of returns in such a way that the equilibrium reveals information about borrowers' default probabilities. Then the introduction of money results in a finer partition of the set of states of nature for lenders, and no coarser partition for borrowers. In a well-defined sense, then, money enhances information available in the economy. We will see that money can perform exactly this function.

I. The Model

A. Description.

We consider an economy in which time is discrete, and indexed by $t = 0, 1, \ldots$. The economy consists of a sequence of two period lived, overlapping generations. At $t = 0$ there are two generations as well, a set of initial old agents, and a set of agents who appear at $t = 0$, are old at $t = 1$, etc. Within each young generation there are three types of agents, indexed by $i = 1, 2, 3$. Agents have the following characteristics. Type 1 agents may be either borrowers or savers. If they borrow, they repay their loans with probability one. The same is true for type 2 agents, except that these individuals default on loans with probability 1 - p. Type 3 agents always save. We discuss the initial old below.

At each date there are two types of trades which can occur here. There is a single nonstorable consumption good which can be traded for fiat currency, and trades may also take place involving consumption loans. We consider versions of the economy with and without fiat currency, and refer to these as monetary and nonmonetary economies respectively. We denote the consumption of an agent of type i born at t by $C_1(i,t)$ when young, and by $C_2(i,t,w)$ when old, where w indexes the set of second period states of nature. We require only two such states, and will call w = 0 the "nondefault state," and w = 1 the "default state." If fiat currency circulates, it circulates in fixed quantity $M \; \forall \; t > 0$. We select the consumption good as numeraire. If fiat money exists, it trades for the consumption good at rate S(t) at t. When we focus on steady states time arguments will often be omitted.

It remains to say something about consumption loans. Type i agents born at t have endowment $e_1(i,t)$ of the consumption good when young, and $e_2(i,t,w)$ when old. Our assumptions on utility functions may or may not imply demands by type 1 or 2 agents for loans. Type 1 agents never default on loans. However, state w = 1 occurs with probability 1 - p, and $e_2(2,t,1) = 0$. Thus type 2 agents may (partially) default on loans with probability 1 - p. They do not default if the state is w = 0, however (i. e., receipt of the second period endowment is verifiable by lenders). As a matter of notational convenience only, no trading in state contingent claims is permitted.

The endowments of type 3 agents will always be structured so as to imply a supply of consumption loans by these individuals in a nonmonetary economy, and preferences and endowments may imply such a supply in a monetary economy. Type 3 agents in this economy also face some uncertainty, even if $e_2(3,t,0) = e_2(3,t,1)$. First, if they lend to a type 2 agent this loan may not be repaid. Second, we assume that each agent's type is private information, ex ante. In other words, lenders can distinguish between type 1 and 2 agents (if and) only if their economic behavior differs. In the economy under consideration, economic behavior consists of quantities demanded of consumption loans (and money in a monetary economy). Therefore, type 1 and 2 agents are distinguishable when young only if their portfolio choices differ. Finally, we assume that those born at or after t = 0 receive no endowment in either period of fiat currency or consumption loans.

We denote the consumption loan demand of a type i agent born at t by $x(i,t)$; i = 1, 2. Type 3 agents, then, face two possible states of affairs. In the first $x(1,t) \neq x(2,t)$ (or $M(1,t) \neq M(2,t)$, or both), so that agents' types are revealed by their actions. In this case safe borrowers are charged the competitive (gross) rate of interest $R(1,t)$, and they repay $R(1,t)x(1,t)$ at t + 1. Risky borrowers are charged the competitive (gross) rate of interest $R(2,t)$. We denote the consumption loans of type 3 agents to agents of type i by $x_3(i,t) \geq 0$. Then if type 3 agents make loans $x_3(1,t) \neq x_3(2,t)$ at t, they receive $R(1,t)x_3(1,t)$ with certainty at t + 1, and $R(2,t)x_3(2,t)$ with probability p. In addition, if $M(2,t) > 0$, then type 2 agents must repay as much of their loan as they are able when w = 1. If, on the other hand, $x(1,t) = x(2,t)$ (and $M(1,t) = M(2,t)$ in a monetary economy), agents' types are not revealed by market outcomes. In this case type 3 agents face the informational constraint $x_3(1,t) = x_3(2,t)$ on their trades, and as a result equilibrium conditions dictate $R(1,t) = R(2,t)$ for all such t.

The preferences of agents are as follows. The initial old care only about old age consumption. Type i agents have utility function $U_i[C_1(i,t), C_2(i,t)]$ defined on R^2_+, which we take to be the consumption set for all agents. The $U_i(\quad)$ are strictly increasing in each argument everywhere in R^2_{++}, and are concave. All agents are expected utility maximizers.

The population is constant over time in both number and composition. At each date, each generation consists of equal (large) numbers of each type of agent. As regards the initial old, we need only note that they are endowed with all of the fiat currency which circulates, if any, and that they have no endowment (positive or negative) of consumption loans. All agents in the economy take prices as parametric, and have perfect foresight regarding future prices.

B. Behavior of Agents.

This section examines the decisions agents face in choosing their portfolios. The reasons for elaborating on portfolio choices are that, due to the informational asymmetry here, the decisions of various agents are highly interrelated, and that type 2 agents may make choices from a nonconvex budget set. Therefore, the portfolio choices of these agents should be fully described.

To begin, a young type 1 agent born at t solves the following problem in a monetary economy, taking the sequences $\{R(1,t)\}_{t=0}^{\infty}$, and $\{S(t)\}_{t=0}^{\infty}$ as given:

$$\max EU_1[C_1(1,t), C_2(1,t,w)]$$

subject to

(1) $$C_1(1,t) = e_1(1,t) + x(1,t) - S(t)M(1,t)$$

(2) $$C_2(1,t,w) = e_2(1,t,w) + S(t+1)M(1,t) - R(1,t)x(1,t); \; w = 0, 1$$

(3) $$x(1,t) > 0$$

(4) $$M(1,t) > 0,$$

by choice of $x(1,t)$, $M(1,t)$.[5/] The nonnegativity restriction (3) is imposed (on all agents) for expository convenience, and is inessential to any results.[6/] In a nonmonetary economy these agents solve the same optimization problem with (4) replaced by $M(1,t) = 0$.

Examination of this optimization problem indicates that it is quite standard. The optimization problem faced by type 2 agents is not, for the following reason. Type 2 agents have the choice, at parametric prices, of either choosing $x(2,t) = x(1,t)$, or $x(2,t) \neq x(1,t)$. If they choose to mimic type 1 agents they face the gross rate of return $R(1,t)$, whereas otherwise they face $R(2,t) > R(1,t)$. Thus, by mimicking type 1 agents, type 2 agents may be able to obtain $[C_1(2,t), C_2(2,t,w)]$ pairs which would be unaffordable to them were their type publicly known. This fact gives rise to affordable sets for type 2 agents which may consist of two disjoint subsets: a set of attainable consumption values obtained by revealing their type, and a set obtainable only by concealing their type. This nonconvex-valuedness of the affordable set correspondence, in turn, gives rise to some existence problems which the introduction of fiat money can remedy.

Formally, type 2 agents in a monetary economy solve the following problem, again taking price sequences as parametric:

$$\max EU_2[C_1(2,t), C_2(2,t,w)]$$

subject to

$$(5) \qquad C_1(2,t) = e_1(2,t) + x(2,t) - S(t)M(2,t)$$

$$(6) \qquad C_2(2,t,w) = \begin{cases} \max\,[e_2(2,t,w)-R(2,t)x(2,t)+S(t+1)M(2,t),0] \\ \text{if } x(1,t) \neq x(2,t) \text{ or } M(1,t) \neq M(2,t) \\ \\ \max\,[e_2(2,t,w)-R(1,t)x(2,t)+S(t+1)M(2,t),0] \\ \text{otherwise} \end{cases}$$

$$(7) \qquad x(2,t) \geq 0$$

$$(8) \qquad M(2,t) \geq 0.$$

For a nonmonetary economy, (8) is replaced by $M(2,t) = 0$.[7/]

For agents with $i = 3$, the choice of a portfolio depends on the actions of type 2 agents. In particular, the behavior of type 2 agents determines whether indices remain private information, and hence whether type 3 agents face an informational constraint on their portfolio choices. Formally, type 3 agents solve, in a monetary economy, the problem

$$\max EU_3[C_1(3,t), C_2(3,t,w)]$$

subject to

$$(9) \qquad C_1(3,t) = e_1(3,t) - S(t)M(3,t) - \sum_{i=1}^{2} x_3(i,t)$$

$$(10) \qquad C_2(3,t,0) = e_2(3,t,0) + S(t+1)M(3,t) + \sum_{i=1}^{2} R(i,t)x_3(i,t)$$

(11) $$C_2(3,t,1) = e_2(3,t,1) + S(t+1)M(3,t) + R(1,t)x(1,t) + \min\,[R(2,t)x(2,t), S(t+1)M(2,t)]$$

(12) $$x_3(i,t) \geq 0;\ i = 1,\ 2$$

(13) $$M(3,t) \geq 0,$$

(14) $$x_3(1,t) = x_3(2,t) \text{ if } x(1,t) = x(2,t) \text{ and } M(1,t) = M(2,t),$$

taking price sequences as given. Again, in a nonmonetary economy (13) becomes $M(3,t) = 0$. In each case, let a "~" denote the optimizing choice of a variable given sequences $\{R(i,t)\}_{t=0}^{\infty}$; $i = 1, 2$, and $\{S(t)\}_{t=0}^{\infty}$.

C. Equilibrium.

We now define a competitive equilibrium for the economy at hand when $M = (>)\ 0$.

Definition. A competitive nonmonetary equilibrium is a pair of sequences $\{\hat{R}(i,t)\}_{t=0}^{\infty}$; $i = 1, 2$, such that

(15) $$\hat{x}(1,t) = \hat{x}_3(1,t) \ \forall\ t \geq 0$$

(16) $$\hat{x}(2,t) = \hat{x}_3(2,t) \ \forall\ t \geq 0.$$

for the nonmonetary economy.

Definition. A competitive monetary equilibrium is a pair of sequences $\{\hat{R}(i,t)\}_{t=0}^{\infty}$; $i = 1, 2$, and a sequence $\{\hat{S}(t)\}_{t=0}^{\infty}$ (with $S(t)$ possibly zero at any date) such that

(17) $$\hat{x}(1,t) = \hat{x}_3(1,t) \ \forall\ t \geq 0$$

(18) $\tilde{x}(2,t) = \tilde{x}_3(2,t) \;\forall\; t \geq 0$

(19) $\sum_{i=1}^{3} \tilde{M}(i,t) = M \;\forall\; t \geq 0.$

These are simply standard definitions of a competitive equilibrium. However, note that money is not treated symmetrically with other assets. In particular, the descriptions of agents' behavior imply that fiat money is always recognizable as a liability of the government. More specifically, no agent is permitted to misrepresent his liabilities as government liabilities, which amounts to a "no counterfeiting" assumption.

Finally, two additional pieces of terminology will be useful. First, if $\tilde{x}(1,t) \neq \tilde{x}(2,t)$ and/or $\tilde{M}(1,t) \neq \tilde{M}(2,t)$ for some t, we say that revelation of type occurs for that t. If type 2 agents mimic type 1 agents at some date, we refer to this as nonrevelation. Second, if revelation occurs at some date t we say that some agents have more information than if nonrevelation occurs at t. With these conventions in mind, we may now present our results.

II. Money and the Existence of Equilibrium

In this section we wish to show that (i) the presence of privately informed agents creates an existence problem, and (ii) that for some economies this problem is remedied by the introduction of fiat money. We also wish to argue (iii) that examples illustrating the above are robust with respect to changes in underlying parameters of the economy, and with respect to changes in assumptions about what is publicly observable. Finally, we argue that (iv) introducing an outside asset, such as money, is not the same as "opening additional markets" in inside assets, and relatedly, that (v) the introduction of fiat money never leads to an existence problem. We begin with (i) and (ii).

Example 1. Preferences are given by $U_1(C_1,C_2) = \ln C_1 + \ln C_2$, $U_2(C_1,C_2) = 2 \ln C_1 + C_2$, $U_3(C_1,C_2) = \ln C_1 + C_2$, with an obvious abbreviation of notation. In addition, $e_1(1,t) = e_2(1,t) = 2 \ \forall \ t > 0$, $e_1(2,t) = 2$, $e_2(2,t,0) = 20$, $e_1(3,t) = 9/5$, $e_2(3,t) = 0 \ \forall \ t > 0$, and $p = 1/9$. Notice in particular that $e_1(1,t) = e_1(2,t)$, so that even if first period endowments are observable they do not provide any information. Hence for this example it is irrelevant whether first period endowments are observable (point (iii) above).

We begin by showing that this economy has no nonmonetary equilibrium. Suppose the contrary. Then there are two possibilities.

Case 1. Suppose there exists a nonmonetary equilibrium with $\hat{x}(1,t) \neq \hat{x}(2,t)$ for some t. Then market clearing implies that $\hat{R}(1,t) = 5/6$, $\hat{R}(2,t) = 15/2$ for that t. Also, $\hat{x}(1,t) = 1/5$, $\hat{x}(2,t) = 2/5$ at t. However, if these are, in fact, equilibrium values, $x(2,t) = 2/5$ must be maximal for type 2 agents in their budget sets. But $x(2,t) = 1/5$ can be obtained at the (gross) rate of interest 5/6 by mimicking type 1 agents, and $2\ln(2+1/5) + (1/9)[20-(5/6)(1/5)] = 3.78 > 3.64 = 2\ln(2+2/5) + (1/9)[20-(15/2)(2/5)]$. This contradicts the assumption that $x(2,t) \neq \hat{x}(1,t)$ for any t is maximal for type 2 agents. Thus revelation of type cannot occur at any date.

Case 2. Then suppose there is a nonmonetary equilibrium with $\hat{x}(1,t) = \hat{x}(2,t)$ $\forall$ t. Market clearing implies $\hat{R}(1,t) = \hat{R}(2,t) = 1 \ \forall \ t > 0$. Moreover, $\hat{x}(1,t) = \hat{x}(2,t) = 0 \ \forall \ t > 0$. But at the interest rate $\hat{R}(2,t) = 1$, type 2 agents prefer the choice $\hat{x}(2,t) = 16$ to $\hat{x}(2,t) = 0 \ \forall$ t, contradicting the assumption that $\hat{x}(2,t) = \hat{x}(1,t)$ is optimal at prevailing prices. Thus, this economy has no nonmonetary equilibrium.

We now show that the introduction of an outside asset (fiat money) results in existence of a steady state equilibrium in which revelation of type occurs. To see this, note that in such an equilibrium, $S(t) = \frac{4}{5M} \; \forall \; t > 0$, $\hat{R}(1,t) = 1 \; \forall \; t$ and $\hat{R}(2,t) = 9 \; \forall \; t$. At these values of $R(1)$ and $R(2)$, $\hat{x}(1,t) = \hat{x}(2,t) = 0$ (i.e., these are the notional demands of both sets of agents). Thus type 2 agents trivially have no incentive to misrepresent type, and it is straightforward to verify that the above are equilibrium values. In short, then, we have demonstrated the existence of an economy which has no competitive equilibrium when $M = 0$, but which does have one when $M > 0 \; \forall \; t$.

Why is this result important? The answer is that in a wide class of models it has been claimed that if an economy has an equilibrium with a strictly positive $\{\hat{S}(t)\}$ sequence, it also has an equilibrium with $\hat{S}(t) = 0 \; \forall \; t$. In other words, the valuation of money is in some sense an accidental outcome. Example 1 shows that there exist economies where the only outcome is for fiat money to be valued. Thus the introduction of private information is a strategy for reducing (for some economies) the set of equilibria in a way which eliminates some undesirable (i.e., nonmonetary) equilibria.

One possible reaction to this is as follows. It is well known (Hart (1975)) that the addition or deletion of certain sets of markets can have profound implications for the existence and optimality of competitive equilibria in settings with market incompleteness. This is easy to see if the following modification of example 1 is considered. Take the economy of example 1, but suppose no borrowing or lending is permitted. Then an autarkic competitive equilibrium exists trivially. However, if $M = 0$ and a loan market is opened, then existence is destroyed (as shown). Thus the addition of markets can be detrimental to existence of equilibrium. It may also be helpful in this regard. Then it is natural to ask if the introduction of money functions in the same way as the opening of an additional market here?

The answer to this is no, for the following reason. In the steady state monetary equilibrium of example 1, markets exist in safe loans and in money. One unit of the good lent to a type 1 agent pays off $R(1,t)$ units of the good in both future states of nature. So does money. Hence money and safe loans are linearly dependent assets, i.e., there is no distinct "market" for money in example 1. Of course the fact that $\hat{x}(1,t) = 0$ in that example tends to obscure the above argument. Hence we present the following example, which has money and safe loans (in positive quantities) traded in equilibrium. For purposes of this example (and subsequently) we assume that the value of the first period endowment is private information.

Example 2. Preferences are (abbreviating notation) $U_1(C_1,C_2) = \ln C_1 + \ln C_2$, $U_2(C_1,C_2) = (C_1C_2)^{1/2}$, $U_3(C_1,C_2) = \ln C_1 + C_2$. Parameter values are $p = 1/9$, $e_1(1) = 3/25$, $e_2(1) = 3/20$, $e_2(2) = 9/10$, $e_1(2) = 0$, $e_1(3) = 72/50$, and $e_2(3) = 0$, where time arguments have been suppressed. We begin by showing that this economy has no nonmonetary equilibrium, and then show that it has a monetary equilibrium with $\hat{x}(1,t) > 0 \;\forall\; t$.

Suppose first that a nonmonetary equilibrium exists in which revelation of type occurs for some t. For this t, then, $\hat{R}(1,t) = 3/4$, $\hat{R}(2,t) = 27/4$, and the associated values of loan demand are $\hat{x}(1,t) = 1/25$, $\hat{x}(2,t) = 1/15$. However, if type 2 agents opt not to reveal their indices, i.e., select $x(2, t) = 1/25$, they receive expected utility $(1/9)(1/25)^{1/2}\,[e_2(2,t,0)-(3/4)(1/25)]^{1/2} > (1/9)(1/15)^{1/2}[e_2(2,t,0)-(27/4)(1/15)]^{1/2}$. This contradicts the assumption that a nonmonetary equilibrium can have $\hat{x}(1,t) \neq \hat{x}(2,t)$ for any t.

Any nonmonetary equilibrium must have $\hat{x}(1,t) = \hat{x}(2,t) \; \forall \; t$ then. In this case market clearing implies that $\hat{R}(1,t) = \hat{R}(2,t) = 5/4 \; \forall \; t > 0$, and the associated values of loan demand are $\hat{x}(1,t) = 0$ (= $\hat{x}(2,t)$ by assumption). But examination of $U_2(\;\;)$ indicates that this gives $EU_2 = 0$, a global minimum over these agents' consumption sets. This contradicts the maximality of $\hat{x}(2,t) = \hat{x}(1,t)$ at prevailing prices, so that no nonmonetary equilibrium exists.

This economy has a monetary equilibrium with $\hat{x}(1,t) \neq \hat{x}(2,t) \; \forall \; t$, however, where $S(t) = \frac{3}{8M} \; \forall \; t > 0$. To see this, note that constancy of $S(t)$ implies that $\hat{R}(1,t) = 1$, and $\hat{R}(2,t) = 9$ for all t. At these prices, agents select $\hat{x}(1,t) = 3/200$, and $\hat{x}(2,t) = 1/20$. It is readily verified that at these prices, type 2 agents prefer $\hat{x}(2,t) = 1/20$ to concealing their type. Thus a monetary equilibrium exists with $\hat{x}(1,t) > 0 \; \forall \; t$.

Note that in this example the steady state equilibrium has safe inside assets which are <u>perfect</u> substitutes for money in the portfolios of all lenders. Nevertheless, absent fiat currency there is no equilibrium. While this may at first seem paradoxical, there is straightforward intuition for the result. For instance, it is easily verified that so long as $x(i,t) > 0$ is not a binding constraint, the effect of introducing money and focusing on steady states is identical to the effect on the equilibrium outcome of introducing an appropriate number of additional safe borrowers. It is well known that for economies with underlying nonconvexities, equilibria can be caused to exist by replicating certain subsets of agents. Thus the introduction of money, which is equivalent to such a replication for this example, may result in existence here. Moreover, the example suggests why money <u>should</u> coexist with perfectly safe liabilities, and thus provides an explanation of why currency is not superseded by "close substitutes" for it in practice. It also indicates why empirically motivated definitions of money are inadequate. In this example, from the viewpoint of all lenders, loans to type 1 agents are "as good as" money. However, if the two assets are identified as one composite asset this precludes an understanding of the role played by money. Finally, it will be noted that money and safe consumption loans (traded in positive quantities in equilibrium) are linearly dependent assets, so there is no "independent market" in money here.

A second point to be made regarding why introducing money is not the same as opening additional asset markets is as follows. It has already been seen that creating additional markets in inside assets may destroy the existence of a competitive equilibrium for the economies under consideration here. However, the introduction of fiat money never leads to nonexistence for an economy which has a competitive equilibrium with $M = 0$. This is straightforward, since $\tilde{S}(t) = 0 \; \forall \; t$ is possible as an equilibrium outcome.

Lastly, it remains to discuss whether money can remedy existence problems for a robust class of examples. It is easy to work out[8/] versions of example 1 where (a) no nonmonetary equilibrium exists, and (b) a revealing steady state equilibrium exists in which type 2 agents strictly prefer their equilibrium allocation to that which they could obtain by mimicking type 1 agents. Then, fixing agents' preferences to be in the class given in example 1, it is easy to check that the economy is regular in the sense of Hildenbrand (1972), i.e., candidate values for equilibrium prices are obtainable as locally continuous functions of underlying economic parameters (endowments, probabilities, population proportions of agent types, and preference parameters). Thus there will exist open neighborhoods of the example economies such that no nonmonetary equilibrium exists, but such that a revealing steady state monetary equilibrium does exist. The details of this argument are tedious, however, and hence omitted here.[9/]

III. Money and Information

The idea that money can act to reduce costs of information acquisition has been previously advanced (Brunner and Meltzer (1971)), but it appears not to have been argued that the mere introduction of fiat money could play an information enhancing role. Moreover, the alleged informational roles for money have not been worked out in a general equilibrium setting. In this section we show that there exist economies where agents have (strictly) more information when fiat money is valued than when it is not.

Example 3. Preferences are given by (abbreviating notation) $U_1(C_1,C_2) = \ln C_1 + C_2$, $U_2(C_1,C_2) = \ln C_1 + 30C_2$, $U_3(C_1,C_2) = C_2$, and parameter values are $p = \frac{1}{10}$, $e_1(1) = 1 = e_3(1)$, $e_1(2) = 0$, $e_2(1) = 2$, $e_2(2,0) = 5$, and $e_2(3) = 0$. We proceed by showing that if $M = 0$, the only equilibrium for this economy has $\hat{x}(1,t) = \hat{x}(2,t) \;\forall\; t$. We then show that if $M > 0$ a steady state equilibrium with valued fiat money and with $\hat{x}(1,t) \neq \hat{x}(2,t) \;\forall\; t$ exists. Moreover, we show that in *any* equilibrium with valued fiat money revelation of type occurs for some t. Hence no agent possesses less information than in the nonmonetary equilibrium, and some agents are strictly better informed than in the nonmonetary equilibrium.

To begin, then, suppose $M = 0$ and $\hat{x}(1,t) \neq \hat{x}(2,t)$ some t. The unique market clearing values of the $R(i,t)$ for this t are $\hat{R}(1,t) = .517$ and $\hat{R}(2,t) = 5.17$, with associated market quantities $\hat{x}(1,t) = .935$ and $\hat{x}(2,t) = .064$. However, for $\hat{x}(1,t) \neq \hat{x}(2,t)$ to hold in equilibrium, we require that $\ln(.064) + 30p[e_2(2,0)-(5.17)(.064)] > \ln(.935) + 30p[e_2(2,0)-(.517)(.935)]$. This condition is false, so that revelation of type cannot be optimal for type

2 agents at any date. Thus no nonmonetary equilibrium exists with $\hat{x}(1,t) \neq \hat{x}(2,t)$ for any t.

This economy does have an equilibrium with $\hat{x}(1,t) = \hat{x}(2,t) \; \forall \; t$, however. To see this, note that if $\hat{R}(1,t) = \hat{R}(2,t) = 2/3 \; \forall \; t$, and if $\hat{x}(1,t) = \hat{x}(2,t) = 1/2 \; \forall \; t$, then the loan market clears. It is also easy to check that $\hat{x}(1,t)$ and $\hat{x}(2,t)$ are both maximal choices for type i agents, i = 1, 2, in their budget sets, and that setting $\hat{x}_3(1,t) + \hat{x}_3(2,t) = 1$ is maximal for type 3 agents in their budget set. Hence a steady state (nonrevealing) nonmonetary equilibrium exists for this economy.

Now let $M > 0$ hold. It is easy to verify that this economy has a steady state equilibrium with $S(t) > 0$ and $\hat{x}(1,t) \neq \hat{x}(2,t) \; \forall \; t$. To see this, notice that if $\hat{S}(t+1) = \hat{S}(t) > 0 \; \forall \; t$, $\hat{R}(1,t) = 1$ and $\hat{R}(2,t) = 10 \; \forall \; t$ must hold. For $\hat{R}(1) = 1$, $\hat{x}(1,t) = \hat{S}\hat{M}(1,t) = 0 \; \forall \; t$. If type 2 agents were to mimic type 1 agents, then, they would not consume when young. This results in global minimization of their utility, so that setting $\hat{x}(2,t) \neq \hat{x}(1,t)$ is maximal for type 2 agents. In fact, for $\hat{R}(2) = 10$, $\hat{x}(2) = \frac{1}{30}$. Then it is easy to check that setting $\hat{x}_3(1,t) = 0$, $\hat{x}_3(2,t) = \frac{1}{30}$, and $\hat{S}(t)M = \frac{29}{30} \; \forall$ t is an equilibrium portfolio choice for type 3 agents. Hence there is a revealing steady state equilibrium for this economy when $M > 0$.

We now show that if $\hat{S}(t) > 0 \; \forall \; t$, it must be the case that any equilibrium has $\hat{x}(1,t) \neq \hat{x}(2,t)$ for some t. In order to do so, we begin by noting that

$$S(t) = S(0) \prod_{j=1}^{t} [S(j)/S(j-1)]; \; t \geq 1.$$

Since $\lim_{t\to\infty} S(t) > 0$ by hypothesis, it must be the case that $S(t+1)/S(t) \geq 1$ for some t. Suppose $\hat{x}(1,t) = \hat{x}(2,t) \; \forall \; t$, and in particular, for any t such that

$S(t+1)/S(t) > 1$. Then market clearing requires $\hat{R}(1,t) = \hat{R}(2,t) > 2/(1+p) > 1$ for such t. However, for any value $R(1,t) > 1$, $x(1,t) < 0$, which we know implies that type 2 agents will wish to choose $x(2,t) \neq x(1,t)$. This contradicts the assumption that an equilibrium with $\hat{x}(1,t) = \hat{x}(2,t)\ \forall\ t$ exists with valued fiat money, implying that $\hat{x}(1,t) \neq \hat{x}(2,t)$ for some t, thereby establishing the desired result.

The fact that the introduction of fiat money can induce agents to reveal their type when they would not do so if $M = 0$ has some important implications. As an example, "credit rationing" is often cited as a mechanism through which monetary policy has real effects.[10] Models which generate credit rationing are often based on the kind of informational asymmetry modeled here, as in Jaffee and Russell (1976), who do not allow for the presence of money. Our argument shows that the absence of money is not innocuous in these settings.

It is, however, possible to construct economies which have only nonrevealing equilibria regardless of whether money is present (and valued) or not. While such economies are quite special, they do have the feature that equilibria exist and that revelation of type cannot occur at any date. An example of such an economy is presented in Smith (1983a), so it is not necessary to produce a new example here. The existence of such examples does suggest that it is inappropriate to assert, as some have done, that money can always play an information enhancing role in economies with asymmetrically informed agents.

Footnotes

1/ See, e.g., Bilson (1981), Hall (1981, 1983), Greenfield and Yeager (1983), Fama (1983), and Black (1970).

2/ See Friedman (1960), p. 4-9.

3/ See Rothschild and Stiglitz (1976) or Prescott and Townsend (1984).

4/ Contrast this with the economies discussed by Kurz (1974) and Wallace (1980) where all information is public.

5/ It is also worth stating that we assume type 1 agents face the additional constraint $R(1,t)x(1,t) < \min_{w} e_2(1,t,w)$.

6/ In particular, the constraint (3) (as well as constraints (7) and (12) below) do not bind in any of the subsequent analysis. However, imposing these constraints permits some economy of notation in the context of this discussion.

7/ As above, if $x(2,t) \neq x(1,t)$ (or $M(2,t) \neq M(1,t)$, or both), then type 2 agents face the additional constraint $R(2,t)x(2,t) < e_2(1,t,0)$.

8/ See Smith (1983b), examples 1 and 2.

9/ See Smith (1983b) for a formal presentation.

10/ See, e.g., Blinder and Stiglitz (1983).

References

Bilson, J. F. O., "A Proposal for Monetary Reform," unpublished, 1981.

Black, F., "Banking and Interest Rates in a World Without Money," Journal of Bank Research, 1970.

Blinder, A., and J. Stiglitz, "Money, Credit Constraints, and Economic Activity, AEA Papers and Proceedings, 1983.

Brunner, K., and Meltzer, A., "The Uses of Money: Money in the Theory of an Exchange Economy," American Economic Review, 1971.

Fama, E., "Financial Intermediation and Price Level Control," Journal of Monetary Economics, 1983.

Friedman, M., A Program For Monetary Stability, Fordham Univ. Press, New York, 1960.

Greenfield, R., and L. Yeager, "A Laissez-Faire Approach to Monetary Stability," Journal of Money, Credit, and Banking, 1983.

Hall, R., "The Role of Government in Stabilizing Prices and Regulating Money," unpublished, 1981.

__________, "Optimal Fiduciary Monetary Systems," Journal of Monetary Economics, 1983.

Hart, O., "On the Optimality of Equilibrium when the Market Structure is Incomplete," Journal of Economic Theory, 1975.

Hildenbrand, K., "Continuity of the Equilibrium Set Correspondence," Journal of Economic Theory, 1972.

Jaffee, D., and Russell, T., "Imperfect Information, Uncertainty, and Credit Rationing," Quarterly Journal of Economics, 1976.

Kurz, M., "Equilibrium with Transaction Cost and Money in a Single Market Exchange Economy," Journal of Economic Theory, 1974.

Prescott, E., and R. Townsend, "Pareto Optima and Competitive Equilibria with Adverse Selection and Moral Hazard," Econometrica, 1984.

Rothschild, M., and Stiglitz, J., "Equilibrium in Competitive Insurance Markets: The Economics of Imperfect Information," Quarterly Journal of Economics, 1976.

Smith, B., "Limited Information, Credit Rationing, and Optimal Government Lending Policy," American Economic Review, 1983a.

__________, "Limited Information, Money, and Competitive Equilibrium," Federal Reserve Bank of Minneapolis Working Paper 204, 1983b.

Wallace, N., "The Overlapping Generations Model of Fiat Money," in Kareken and Wallace (eds.), Models of Monetary Economies, Federal Reserve Bank of Minneapolis, 1980.

Wilson, C., "A Model of Insurance Markets with Incomplete Information," Journal of Economic Theory, 1977.