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FIAT MONEY AS A STORE OF VALUE IN AN EXPERIMENTAL MARKET*

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The time path of the value of fiat money is studied in an experimental market. In this market players can achieve Pareto superior allocations by trading goods for money at fixed nominal prices. However, the finite horizon makes the value of money unstable as players learn not to hold money near the horizon. We investigate the value of money in stationary replications of the model where subjects trade off the increased value of money as a medium of exchange against the chances of holding worthless money (as the role of money as a store of value deteriorates).

1. Introduction

An important research topic among economists is the role of money in economic activity. However, trying to define the intrinsic value of money from its role as a 'medium of exchange' results in a paradox. One statement of this paradox is the following: Money is valuable because it is a 'medium of exchange'. But, people must hold money if it is to be a 'medium of exchange'. However, people will hold money only if it has value. Does money have value?[1] This paper represents a first attempt to use experimental methods in a systematic study of fiat money as both a store of value and a medium of exchange.

In the experiments reported here, three or six players traded fiat experi-

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[1]A resolution of this paradox can be found in Samuelson (1958). In his paper Samuelson investigates the time path of interest rates and ends with a caveat on the paradox of money. In particular, Samuelson argues that the paradox does not occur in a model with an infinite sequence of overlapping generations who do not repudiate earlier generations' money. In an infinite horizon, money can act as a 'store of value' and thus it can serve as a 'medium of exchange'.

mental money for nondurable goods over six trading periods. Players' preferences for goods were induced by paying U.S. currency for goods held at the end of each trading period. Players traded by offering to buy or sell units of goods at a fixed nominal price (equal to one). Goods could only be traded through the use of experimental money and transactions were completed through a clearing house which cleared the market by randomly assigning buyers to sellers. The six period design was then repeated a number of times (10, 15 or 20).

Even though the experiments are far removed from the complicated world in which money is used, and it can be argued that many interesting aspects of money are ignored, this study addresses a fundamental issue with respect to money: Will people hold money with the certain knowledge that money is worthless after some finite period of time?[2]

Nash equilibrium predicts that self-interested, noncooperative, individuals will not accept fiat money. This prediction involves backwards induction from the horizon and goes as follows: people will refuse to accept money in the last period (since money is worthless at the end of this period); anticipating that no one will accept money in the last period, people will refuse to accept money in the second to last period; and continuing with the backward induction we can conclude that money will not be accepted in any period.

From the experimental evidence we draw the following conclusions. First, immediate convergence to the no-trade solution, as predicted by Nash equilibrium, can be rejected. In two experiments trading ceased completely while in all other experiments trading continued but at a diminished level. When they did occur, monetary collapses occurred slowly indicating a reluctance by players to cease trading.

Since players are given complete information we conjecture that the assumption of common knowledge (assumed by game theory) is not satisfied in the experiments. In particular, from the data we infer that subjects entered the experiments with beliefs about the acceptability of money which they updated with experience. Since money is valuable as a medium of exchange subjects were willing to use it even though it was inherently unstable as a store of value.

2. Experimental design

The choice of market structure used in the experiments has the following

[2]Economic historians have cited many examples of money including wampum, tobacco, shells, etc.... Included in this list are the many different paper monies issued throughout history by governments and financial intermediaries. For example, it is estimated that 10,000 different kinds of paper money were afloat in the United States in 1860. See Hughes (1983). Many of these monies were discounted in monetary reforms which made them worthless. Given the historical fact that monies come and go we still observe people who accept money.

Table 1
Players characteristics.

Type	Period 1	2	3	4	5	6
Part A: Bond endowments						
A	1	0	1	1	0	1
B	1	1	0	1	1	0
C	0	1	1	0	1	1
Part B: Dividends						
A	50	0	25	50	0	25
B	25	50	0	25	50	0
C	0	25	50	0	25	50
Part C: Ticket endowments						
A	1	0	0	0	0	0
B	0	0	0	0	0	0
C	0	0	0	0	0	0

interpretation. The market institution is a clearing house where subjects are restricted to bilateral exchanges of nondurable goods for durable money at a fixed price. Thus trading is a disequilibrium process of quantity adjustment where the clearing house serves as a quantity rationing mechanism. It is this interpretation which connects these experiments to macroeconomic theory [as in Benassy (1982) and Gale (1983)].

The main advantage of this design is that it gives a well defined equilibrium prediction using a tractable extensive form game. The extensive form captures the two essential features of fiat money which are relevant to our experiment. First, the lack of a double coincidence of wants is captured through the structure of preferences and the restriction to bilateral trades. Thus money is valuable as a medium of exchange. Second, a finite trading horizon is imposed which causes an instability in the value of money by giving individuals an incentive to default on monetary debts.

In each experiment, a number of subjects (3 or 6) are divided equally into three types (A, B or C). These subjects are put in a six period constituent game where they trade tickets (experimental fiat money) for bonds (experimental goods with induced values). The constituent game is then repeated a known number of times (10, 15 or 20). Subjects keep the same type and play against the same opponents throughout the experiment. Subjects are told this in the instructions. Table 1 shows the initial endowment of bonds (bonds last 1 period) by subject type, and the dividend values for the different subject types in different periods. The values 0, 25 and 50 cents chosen for the dividends were selected to insure saliency of the experimental design. Notice that type A subjects start with 1 ticket in period 1. Tickets last 6 periods.

2.1. The market institution

This market is defined in terms of the following extensive form game. In each period players send one of the following private messages to a central clearing house:

a. '–' (null message, i.e., do nothing),
b. 'S' (sell order, i.e., sell a bond for a ticket),
c. 'B' (buy order, i.e., buy a bond for a ticket),
d. 'B2'(buy order, i.e., buy two bonds with two tickets),

Messages are governed by the following rules. The null message may be sent at any time. A sell order can only be sent by subjects who are endowed with a bond at the beginning of the period. A buy order can be sent by subjects who own at least one ticket at the beginning of the period. In markets with one subject of each type there is one ticket in circulation while in markets with two subjects of each type there are two tickets in circulation. The 'B2' order accounts for the possibility that a single subject owns both tickets (in a 6 subject game). Thus, 'B2' can be sent by a subject who owns two tickets. The set of allowable messages places two restrictions on our market. First, goods are traded as indivisible units. Second, the ticket (nominal) price of a unit of good is fixed at one.

In each period, subjects send their messages privately to the clearing house. Once all the messages are received the clearing house matches buy and sell orders. When the number of buy and sell orders to not coincide a rationing rule is used which gives each player on the long side of the market an equal chance of getting matched with a unit on the short side of the market. Once the clearing house finishes the matching process subjects are told the number of buy and sell orders for that period and whether or not his or her buy or sell order was filled.

A strategy for each player is a choice of message in each period conditional on the history of available information, i.e., what information set the player is in. A play of the game is a realization of messages and outcomes in each trading period. In our experiments we observe plays of the game and not players' strategies. A play of the constituent game can be described as a list of players' messages, i.e., what each player offered in each of the six periods, together with a flag which indicates if their offer was accepted. The flag following a message is either an asterisk, which indicates that the offer was not accepted, or nothing, which indicates that the offer was accepted.

For example, a type A player may have the following realization of messages,

(B, –, S, B*, –, B),

which is read as follows. This player bought a unit of good in period 1, did nothing in period 2, sold a unit of good in period 3 (in order to get a ticket), made a buy offer for a unit of good in period 4 but didn't get to buy, did nothing in period 5, and bought a unit of good in period 6.

3. Experimental procedures

Subjects were recruited from the undergraduate population at the University of Arizona. Subjects were paid three dollars at the beginning of the experiment as an incentive to show up. At the end of the experiment subjects were paid their salient earnings in U.S. dollars.

After everyone showed up, subjects were given a typed set of instructions which explained the trading rules described in section 2. Upon finishing the instructions the subjects were given a brief summary of the clearing house operation. Subjects then participated in a three period dry run of the constituent game. At the end of the dry run the experiment was started.

In the instructions, subjects were given the information found in table 1. However, subjects did not know who was assigned to each type. From the viewpoint of experimental design this helps to guarantee that subjects do not play for some motive other than their own gain.

In order to keep subjects' types, messages and payoffs anonymous all messages were made in writing and collected by the experimenter. Subjects who sent invalid messages were asked to change their message to a valid one. When transaction sheets were returned subjects' record sheets were checked to make sure that correct profit information was being recorded. A strict no-talking rule was enforced during the experiment, and subjects were paid privately at the end of the experiment.

Fig. 1 reproduces a subject's worksheet. Depending on a subject's type, the initial bonds row, initial tickets for period one, and the bond value row would be filled in prior to the experiment. The initial tickets row (periods 2–6), the final bonds row, and the period earnings row are filled in by the experimenter (acting as the clearing house). Subjects enter their decisions in the buy/sell row. When the transaction sheets were collected messages were checked for validity.

The only behavior that has a high likelihood of being misinformed was a case where a player sold a 50 cent bond. In this case the subject was asked if he or she understood that he or she had to hold the bond in order to get the dividend. All subjects who sold 50 cent bonds told an experimenter they thought they had to sell a bond in order to earn a dividend. All of these types of mistakes were caught either in the dry run or in the first 2 periods of the experiment. Experienced subjects never made this mistake.

Table 2 summarizes the experimental design. Treatment variables were the number of plays M, the number of players P, and player's experience level

Transaction Sheet

Date ______ Experiment ______

Player ID ______

Transaction Matrix

Period	1	2	3	4	5	6
Initial Bonds						
Initial Tickets						
Buy / Sell						
Bond Value						
Final Bonds						
Period Earnings						

Fig. 1

Table 2
Experimental design.

Experiments	N	M	P	Exp.
1a, 1b	6	10	6	0
2a, 2b	6	15	6	0
3a	6	15	6	1
3b	6	20	6	2
4a	6	10	3	0
4b, 4c	6	15	3	0

(Exp=0, 1 or 2). Exp=0 indicates that subjects were new to this design, although most subjects had participated in other economic experiments. Exp=1 indicates that subjects were chosen from previous Exp=0 experiments. In the Exp=2 experiment subjects from the Exp=1 design were brought back and randomly assigned a new player type by the experimenter. This assignment was made just prior to the start of the experiment. Initial endowments of bonds and tickets, and dividend values, were held constant across experiments (as defined by table 1).

4. Experimental results

Fig. 2 summarizes the trading data for experiments 1a and 1b. Each graph plots trading volume (y axis) for each play (x axis) of the constituent game.

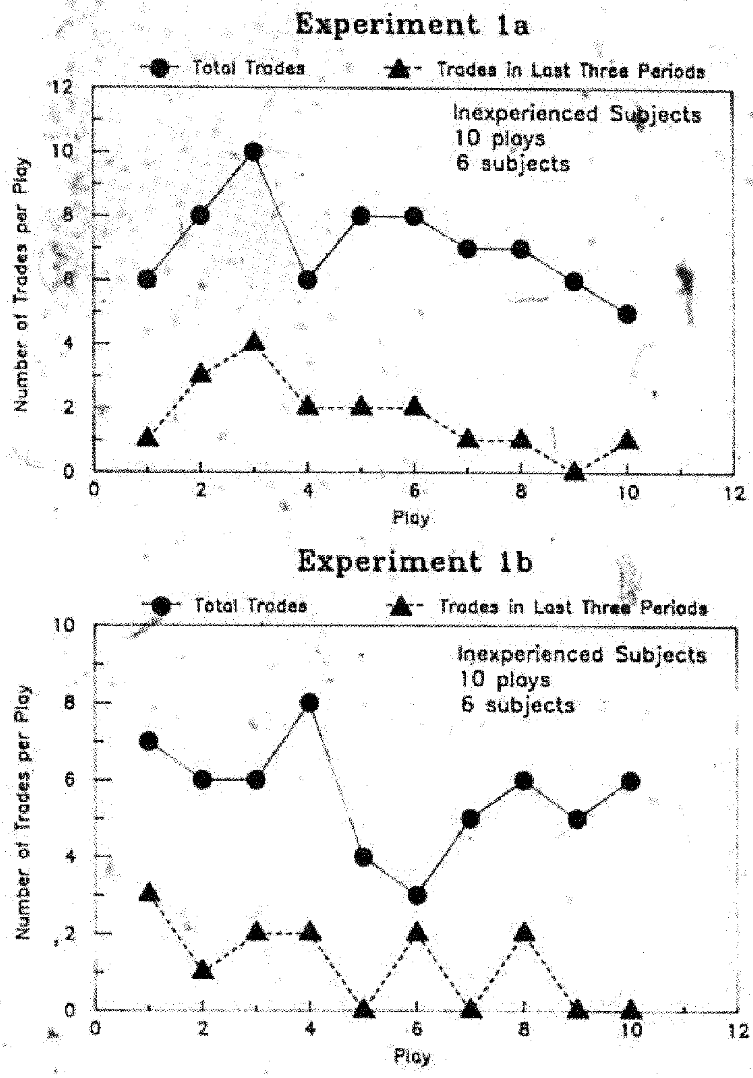

Fig. 2

Given that each constituent game is six periods long and that there are 6 players, a maximum trading volume of 12 trades can occur in any repetition. The top solid line in each graph plots total trading volume for all six periods in each play of the game while the bottom dashed line plots trading volume for the final three periods in each play of the game.

Experiments 1a and 1b were repeated 10 times. As seen in fig. 2, trading in the last three periods collapses but trading in the first three periods remains high. Since it was possible that experiments 1a and 1b were too short to see a full collapse the constituent game was repeated 15 times in experiments 2a and 2b. Fig. 3 plots trading volumes for these experiments.

We did not see a collapse in any of our first four experiments. But inexperienced subjects are likely to have very diffuse expectations about the

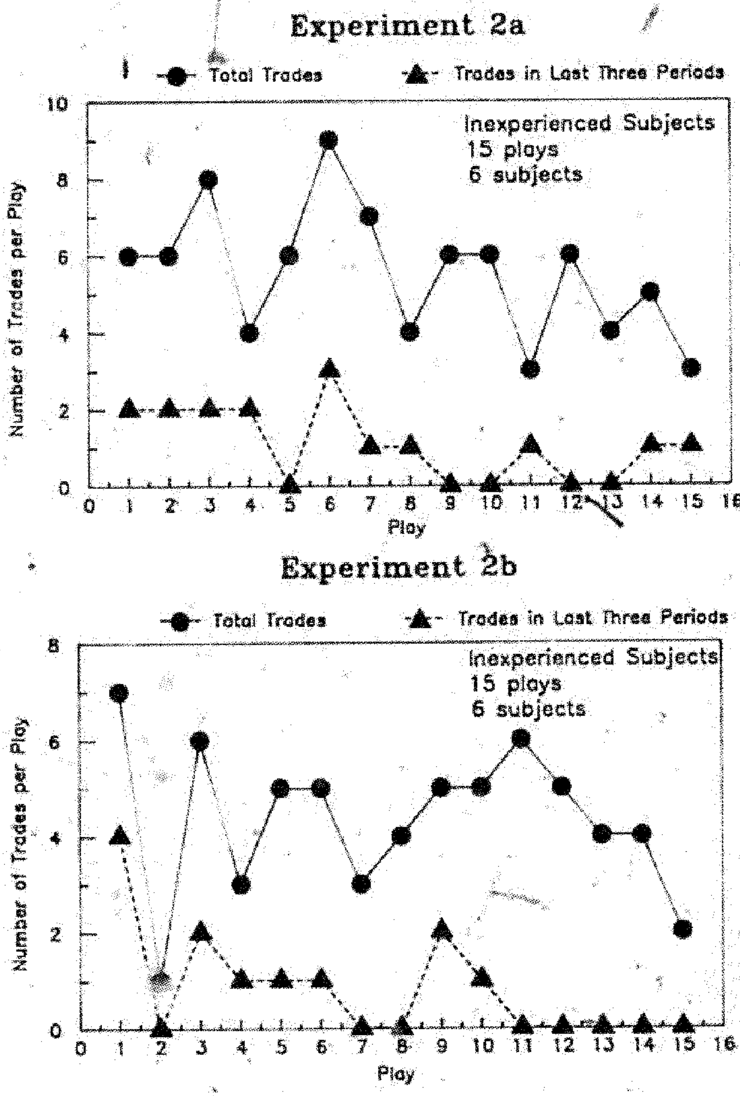

Fig. 3

'best' way to play the game and thus be less predictable to the other subjects. For this reason we ran experiments 3a and 3b to see if experience changed subjects' behavior.

In experiment 3a six subjects from the first series of experiments were brought back a second time and ask to play the same constituent game as the first series. From fig. 4 we see that trade looks very similar to the earlier experiments. At this point we decided to bring the same subjects back (a week later) to play in experiment 3b.

Highly experienced subjects who played the constituent game at least 45 times (35 times with the same group) finally cause a full collapse in the use of money as predicted by Nash equilibrium. In experiment 3b we get the autarky outcome (i.e. no trade) on the 15th play. With the exception of

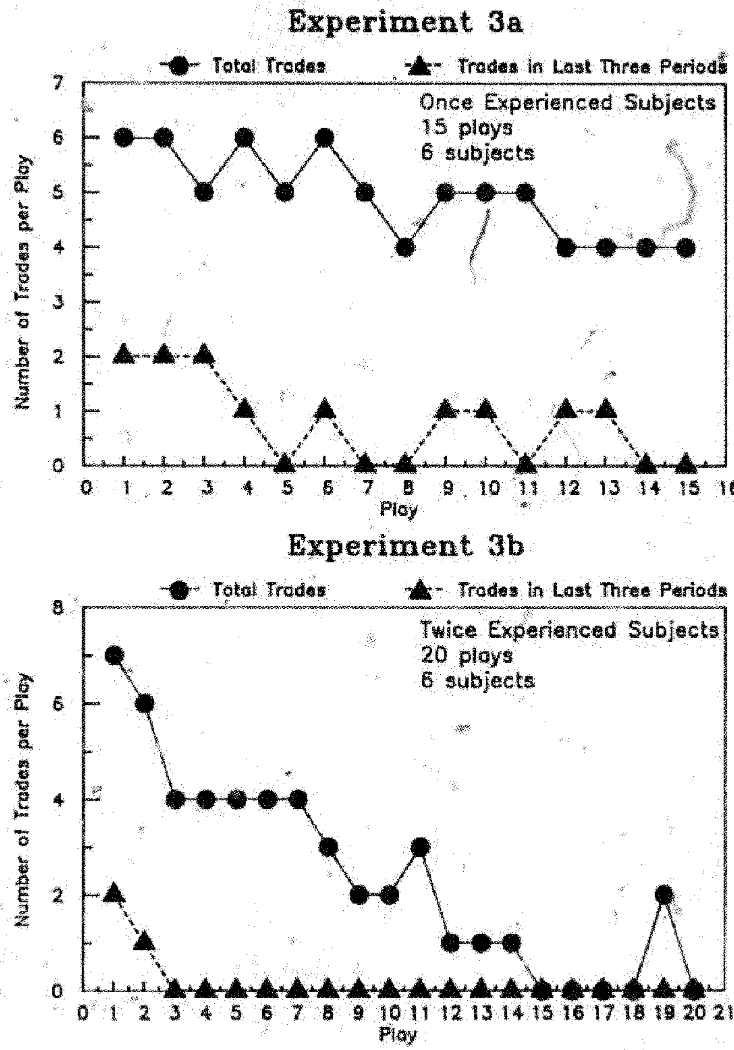

Fig. 4

period 19 subjects refused to accept money from play 15 to the end of the experiment. In period 19, a type B and a type C subject reacted to a costless sell decision by a type A subject in period three of repetition 18, i.e., player A2 offered to sell knowing no one could take him up on this offer. The players quickly went back to no trade when they realized player A2 has no intention of selling in period 3.

Since messages are private subjects don't know who is responsible for a partial collapse in experiments 1a, 1b, 2a, 2b, 3a and 3b, i.e., a situation where one of the two subjects who are supposed to sell in a period decide not to. When there is only one subject of each type it is easy to deduce when a particular subject fails to cooperate and thus relatively easier to punish that subject. The three subject experiments in series three (one subject of each type) allows us to see if improved information about defections changes behavior.

Fig. 5 summarizes the trading data. With only three subjects there is a maximum of 6 trades (3 trades in each cycle). In experiment 4c inexperienced subjects traded in a six period constituent game which was played 10 times. Notice that there was no trade in periods 4, 5 and 6 for repetitions 7, 8 and 9. Furthermore, trading in the first cycle (periods 1, 2 and 3) starts collapsing from full trade, i.e., three trades, in repetition 7 to one trade in repetition 9. However, in repetition 10, full trade is restored for the first cycle. Examination of the individual data reveals what happened.

Subject A experienced the realization (B,–,S,B*,–,S) in play 7. In response player A played and realized (B,–,–,–,–,–) in play 8. In play 9 subject A sends a sell message at $t=3$ and realized the outcome (B,–,S*,–,–,–). Even though this signal to support trade was costless for player A, it results in renewed trade in play 10 with a realization of (B,–,S,B,–,–) for player A.

In experiment 4a we again observe sustained trade in periods 1, 2 and 3. In this experiment no-trade in periods 4, 5 and 6 is reached in repetition 12. At this point subject A continues to play (B,–,S,B*,–,–) and sustains trading in the first cycle.

In experiment 4b we see convergence to the no-trade solution in repetitions 14 and 15. However, the pattern of realizations from repetition 11 (when no-trade is reached for periods 4, 5 and 6) to repetition 15 is similar in many ways to repetition 7 through 10 in experiment 4c. In experiment 4b, subject A plays (B,–,–,–,–,–) in repetition 12. As was the case in experiment 4a subject A then sends costless sell signals in repetitions 13 and 14 in an attempt to restore trading. However, this time players B and C do not renew cooperation and trading collapses.

5. Why subjects trade

Consider the following thought experiment. If tickets have a redemption value strictly between 25 and 50 cents (U.S.), then the unique subgame perfect Nash equilibrium requires that everyone offer to sell bonds worth 25 cents and buy bonds worth 50 cents. This behavior results in the flow of tickets shown with arrows in table 3, and generates the following realization of messages for the different types of subjects.

Type	Message
A	(B,–,S,B,–,S)
B	(S,B,–,S,B,–)
C	(–,S,B,–,S,B)

We call this outcome full cooperation. It results in payoffs of ($2.00 + r, $2.00,

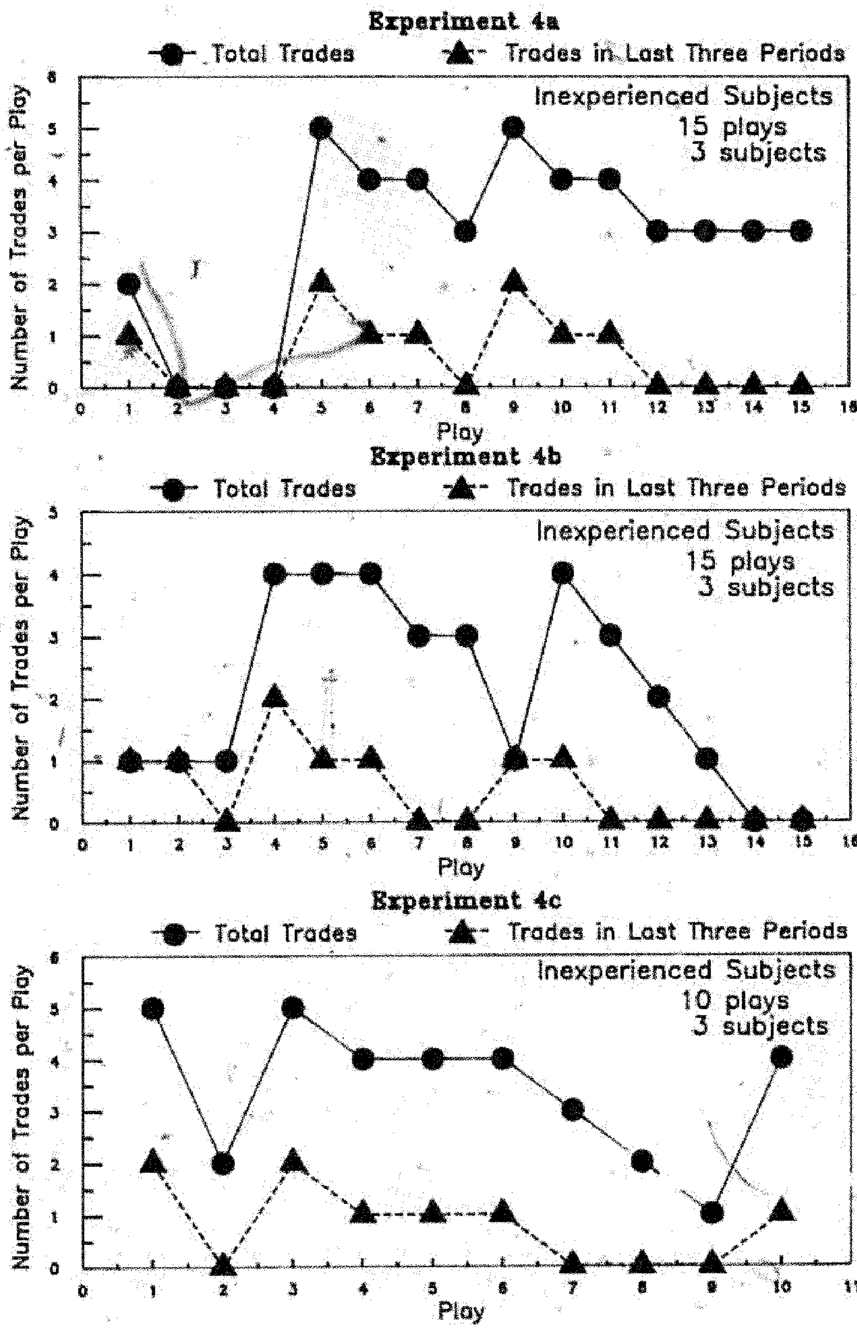
Experiment 4a
Total Trades
Trades in Last Three Periods
Inexperienced Subjects
15 plays
3 subjects
Number of Trades per Play
Play
Experiment 4b
Total Trades
Trades in Last Three Periods
Inexperienced Subjects
15 plays
3 subjects
Number of Trades per Play
Play
Experiment 4c
Total Trades
Trades in Last Three Periods
Inexperienced Subjects
10 plays
3 subjects
Number of Trades per Play
Play

Fig. 5

Table 3
Full cooperation.

	Period					
Type	1	2	3	4	5	6
Bond endowments (arrows indicate flow of tickets)						
A	1	0	1	1	0	1
B	1	1	0	1	1	0
C	0	1	1	0	1	1
Final allocation of bonds						
A	2	0	0	2	0	0
B	0	2	0	0	2	0
C	0	0	2	0	0	2

\$2.00) to type A, B and C subjects, respectively (where r is the redemption value of a ticket).

Alternatively, if the rules were changed to allow enforceable contracts and $r=0$, type B and type C subjects would be willing to pay a type A subject at least 25 cents to agree (prior to the start of the constituent game) to sell his or her 25 cent bond in period 6.

However, in the experiments reported in this paper money is unbacked, i.e., $r=0$, and only the current spot trades are enforceable. Thus, tickets (i.e. money) will be accepted only if a subject accepting a ticket gives it an implicit value greater than 25 cents. This is true when subject believes that by selling a 25 cent bond there is at least a 50% chance that their ticket, which is either received in payment in the current game or part of an endowment for a later game, will buy a 50 cent bond.

Nash equilibria predicts that the implicit value of tickets is zero in every period. But the autarky solution, i.e., no trade, is note in the Core. From previous studies of finitely repeated Prisoner Dilemma games we could have predicted that the Nash equilibrium prediction would fail. The more important question is how to model this failure.

In the study of cooperation in finitely repeated Prisoner Dilemma game incomplete information is used to weaken the assumption of common knowledge and thus explain cooperation. The literature includes Kreps and Wilson (1982), Kreps, Milgrom, Roberts and Wilson (1982) and Fudenberg and Maskin (1986). Each of these papers show that cooperation is possible in repeated game with incomplete information where players use reciprocity type strategies. In fact, Fudenberg and Maskin prove that many outcomes (including outcomes not in the Core), can be supported by Nash equilibrium strategies.

However, for two reasons we suspect that reciprocity strategies were not used in the money experiments. First, the very fact that money is used to restore a double coincidence of wants makes the coordination of punishment strategies very difficult. For example, suppose the different types of players have the following realizations:

Type	Realization
A	(B, –, S, B*, –, –)
B	(S, B, –, –, –, –)
C	(–, S, B, –, –, –)

and the A players play (B, –, –, –, –, –), then all of the B and C players should play (–, –, –, –, –, –) in order to punish the A player. Suppose instead that only the C players punish (since they are the ones directly affected by the defection) by playing (–, –, –, –, –, –). Notice that this hurts the B players. The B players would then have to decide if the C players are defecting or punishing the A player. Since players are unable to communicate it is hard to believe that they will coordinate the mutual defection that would punish the A player.

A second problem with the use of reciprocity occurs when there is more than one type A subject. For example, suppose A1 is playing (B, –, S, B*, –, –) and making $1.75, then A2 can free ride by playing (B, –, –, –, –, –) and make $2.00. Note that the B and C types would like to punish A2 but given our information conditions they do not know which type A subject defected. Even if subjects know which type A subject defected the random matching mechanism makes it impossible to punish only one. Thus, type B and C subjects face their own dilemma. They would like to punish the free rider but they run the risk of causing the cooperative A subject to defect.

5.1. *Subjective beliefs*

A type A subject, herein called A, will experience the following realizations as cooperation deteriorates:

	Realization						Payoff
1a	B	–	S	B	–	S	200
2a	B	–	S	B	–	–	225
3a	B	–	S	B*	–	B*	175
4a	B	–	–	–	–	–	200
5a	–	–	–	–	–	–	150

If A is an expected profit maximizer and knows that full cooperation can be sustained as long as he or she is willing to play (B, –, S, B, –, S) then the minimum profit A should expect is $200 \times M$ (where M is the number of plays). However, type A's only played this strategy twice in 170 plays. We can explain this with the following subjective beliefs,

Let F_{it} be the expected number of times A believes that realization i will occur on or after play t. If,

$$150F_{5t}+200F_{4t}+175F_{3t}+225F_{2t}>200(F_{2t}+F_{3t}+F_{4t}+F_{5t}),$$

then A is better off not maintaining cooperation. But this is true when,

$$F_{2t}-F_{3t}-2F_{5t}>0.$$

If A is inexperienced he or she is likely to hold the following beliefs. First, F_{3t} can be made small relative to F_{4t} since A can always eliminate realization 3a in favor of 4a. Second, the possibility of autarky, i.e., 5a, is very small relative to realization 2a. Looking at experiments 1a–1d we find that actual frequencies are $F_{21}=30$, $F_{31}=28$ and $F_{51}=0$ which substantiate these beliefs.

A type B subject, herein called B, will experience the following realizations as trade unravels from full cooperation.

	Realization						Payoff
1b	S	B	–	S	B	–	200
2b	S	B	–	S	B*	–	150
3b	S	B	–	–	–	–	175
4b	S	B*	–	–	–	–	125
5b	–	–	–	–	–	–	150 (autarky)

Let G_{it} be the expected number of times B believes that realization i will occur on or after play t then B will prefer trading to autraky as long as,

$$200G_{1t}+150G_{2t}+175G_{3t}+125G_{4t}>150(G_{1t}+G_{2t}+G_{3t}+G_{4t}).$$

But this condition holds as long as,

$$2G_{1t}+G_{3t}-G_{4t}>0.$$

If B is inexperienced he or she is likely to believe that G_{4t} can always be made small since B can always eliminate realization 4b in favor of 5b. Looking at the inexperienced subject experiments 1a–1d, we find that actual frequencies are $G_{31}=69$, $G_{41}=7$ which substantiates these beliefs.

A type C subject, herein called C, will experience the following realizations as trade unravels from full cooperation.

	Realization						Payoff
1c	–	S	B	–	S	B	200
2c	–	S	B	–	S	B*	150
3c	–	S	B	–	–	–	175
4c	–	S	B*	–	–	–	125
5c	–	–	–	–	–	–	150 (autarky)

Let H_{it} be the expected number of times C believes that realization i will occur on or after play t then C will prefer trading to autarky as long as,

$$200H_{1t}+150H_{2t}+175H_{3t}+125H_{4t}>150(H_{1t}+H_{2t}+H_{3t}+H_{4t}).$$

But this condition holds as long as,

$$2H_{1t}+H_{3t}-H_{4t}>0.$$

If C is inexperienced he or she is likely to believe that H_{4t} can be made small since C can always eliminate realization 4 in favor of 5. Looking at the inexperienced subject experiments 1a–1d, we find that actual frequencies are $H_{31}=54$, $H_{41}=12$ which substantiates these beliefs.

5.2. *Relationship to asset market experiments*

In a number of experiments in double auction asset market (i.e., a durable good trades over time) environments Forsythe, Palfrey and Plott (1982) and Friedman, Harrison and Salmon (1984) find a similar result. They refer to this behavior as the 'swing back' hypothesis. This conjecture is motivated by the idea that rational players, with incomplete information about other players, will use their experience in earlier replications of the game to form expectations about behavior in the current game.

In the asset market experiments players first learn the equilibrium price of the asset in the last period and, given that they know the equilibrium price in the last period, their behavior then leads to an equilibrium price in both the second to last period and the last period. This process continues until equilibrium prices are found for every period.

In all nine experiments reported in this paper trade unravels from the last period forwards. From the plots one can verify that trading stops in the last three periods before it stops in the first three periods. Closer examination of the data reveals that collapses start in period six, move to period five, and then to period four, etc. Within a constituent game the failure to trade in some period meant no more trading for the rest of that game (97% of the time). This is easy to explain since the trading rules make it difficult to restore trading after it stops in some period since the flow of tickets needs to be correctly coordinated. The next time the constituent game was played subjects would often (20% of the time) trade past the period in which trade stopped in the previous play.

Assuming that subjects update their expectations against realizations can explain this intertemporal trading pattern as follows. Since type A subjects decide not to sell in period 6, type C subjects experience realization 2c immediately. After a few periods they are led to believe that $H_{1t}=0$ and stop selling bonds in period 5. At this point type B subjects, who have experienced a few realizations of 1b now begin to experience 2b. After a while they believe that $G_{11}=0$ and stop selling bonds in period 4. As this process continues it takes subjects longer to conclude that they should stop selling bonds since they have been successful at selling and buying for a greater number of periods. Thus the deterioration in trade slows down over time. Experienced subjects update more quickly since they are more familiar with the pattern of trade.

In the asset market experiments subjects values are private information while in our experiments values are common information. Thus our experiments extend the domain of games in which swing back is observed.

6. Conclusions and extensions

In this paper we examine trading behavior over a finite time horizon in a market with an outside fiat money. The experiments are designed to make the use of money Pareto improving. However, as is the case with all outside, unbacked, fiat monies, the value individuals placed on experimental money is inherently unstable.

We found that subjects accepted money even though the Nash equilibrium prediction was for no trade. We suspect that lack of common knowledge is the cause for trading in our experiments. Since money is valuable as a medium of exchange subjects enter the experiments with subjective beliefs about the value of money (i.e., tickets) which they update with experience. In the long run, with enough subject experience, Nash equilibrium can be a relevant model of behavior. Thus, in experiment 3b, behavior did converge to the no trade prediction.

In retrospect there are several changes to the experiment which will improve future experimentation. First, given the importance of experience, subjects should initially be rotated through all three types in a training run. This will give each subject more direct experience with the decision problem faced by the other types. Second, the experiments should be run on a computer (such as the Plato system or a PC network). Using the computer to manage the experiments will result in higher repetitions and better control of privacy. Third, and finally, the message to do nothing '–' may be interpreted as a bad action by players. An alternative interpretation is to tell subjects that '–' means sell to the clearing house for dollars instead of tickets. We would still need '–' for those cases where a player had neither bonds or money.

There are several extensions to this research which are currently being investigated. First, the value of money when the trading horizon is uncertain can be studied. It is important in studying the effects of uncertainty to first cause a collapse of money for the certain horizon and only then introduce uncertainty. Second, proposals for a private money system claim that competition among the different suppliers of money will insure that money has value. Properties of private money systems can be studied in this design. Third, the use of a fixed price for bonds can be dropped in favor of a market determined price. By doing this, the value of money will be reflected in the price of bonds. In particular, money is likely to collapse more quickly when there are price signals to that effect.

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