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PRICE-CONVEYED INFORMATION VS. OBSERVED INSIDER BEHAVIOR  
A NOTE ON RATIONAL EXPECTATIONS CONVERGENCE

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#### ABSTRACT

The recent experimental results of Plott and Sunder (1982) and Friedman, Harrison and Salmon (1983) on the ability of single commodity markets to "reveal" the underlying state to initially uninformed traders were potentially influenced by a design in which the set of informed traders was held constant throughout the life of the market. Hence the performance of uninformed traders in the market might have been predicated on their knowledge of, and the observed behavior of, the informed traders. The experiment discussed below is a replication of one market in Plott and Sunder (1982), with the added feature that the traders who were to be informed of the state differed from period to period. The results are equivalent to those of Plott and Sunder (1982) in the price dynamics, while less conclusive regarding the acquisition and use of the state-price correspondence by uninformed traders.

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## PRICE-CONVEYED INFORMATION VS. OBSERVED INSIDER BEHAVIOR:

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## 1. INTRODUCTION

In a recent paper on behavior in experimental securities markets, Plott and Sunder (1982) concluded that the rational expectations (RE) model was superior to the traditional prior information (PI) model in predicting equilibrium prices and holdings. In particular, given a market with one commodity, three possible states of the world, and three groups of trader "types" each with differing valuations on the commodity per state, initially uninformed traders were able to infer the underlying state from the current market price and act accordingly. In a related paper, Friedman, Harrison and Salmon (1983) observed that, given the existence of a futures market, the RE model outperformed the PI model in multiperiod single commodity markets as well. One source of potential misinterpretation, however, comes from the fact that, although one half of the traders of each type were informed of the true state at the beginning of each period in Plott and Sunder (1982) and one third of the traders of each type in Friedman, Harrison and Salmon (1983), the same traders were informed in every period. In a more recent paper, Plott and Sunder (1983) constructed markets where all traders received partial information (i.e. given possible states X, Y, and Z, a

trader's private information would be either "not X" or "not Y" if the state were Z), yet the combinations of traders receiving a certain message in any period was determined randomly. Hence no trader could be identified as having some constant bit of information. In the single commodity markets, Plott and Sunder (1983) concluded that the RE model did not perform as well as the PI model in their respective predictions. Thus, given the fixed information structure of Plott and Sunder (1982) and Friedman, Harrison and Salmon (1983), one cannot ignore the possibility that, in these experiments, initially uninformed traders guessed the identities of the informed traders and then used their observed behavior to gain knowledge of the state, as opposed to gaining knowledge from the market bids, offers, and prices.

In the experiment discussed below, an attempt was made to overcome this problem. The experiment consisted of replicating market 5 of Plott and Sunder (1982), altering only the information structure so that each trader was informed of the state in at least two periods (out of a possible ten) and then randomizing over which periods a trader was informed. This structure was designed to limit the ability of uninformed traders to infer the identities of the informed traders, since in each period different combinations of traders were informed. Note that a single replication, with equivalent empirical results, will be sufficient to conclude that holding the informed traders constant did not generate the results reported in Plott and Sunder (1982) and Friedman, Harrison and Salmon (1983).

## 2. EXPERIMENTAL DESIGN

The market consisted of three possible states, labeled X, Y, and Z, and three trader types, I, II, and III. Each type consisted of four traders, for a total of twelve. The parameters, as shown in Table 1, were chosen to conform to those of Plott and Sunder (1982), with the exception that the probability of any state occurring was simplified to one third for each state. Each trader had a number of information and record sheets, one for each period, which consisted of possible valuations (one per state), his/her initial endowments (held constant for all traders and for all periods at 2 securities and 10,000 francs), and room to keep running totals of his/her securities and currency. At the end of each period, profits were calculated and recorded on a separate profit sheet. [Examples of these and a complete description of the design can be found in Plott and Sunder (1982).]

Traders were told that the true state for a period was determined randomly by choosing one ball out of a bingo cage containing thirty balls, numbered one thru thirty. If the ball chosen was numbered one to ten, the state was X; if the ball was numbered eleven to twenty, the state was Y; etc. Traders were told that, in the interest of time, the sequence of actual states had been determined using this method prior to the experiment.

Before trading commenced in a period, the traders were handed

a 3"x5" card containing one of the following:

- i) X
- ii) Y
- iii) Z
- iv) a blank

If a trader was handed a card with an X showing, the value of the security to him/her was the X value, which would be paid to him/her for any securities held at the end of the trading period; if the card showed a Y, the Y value would be paid; etc. This information was private, and two traders of each type were informed of the state in every period, though the identities of the informed traders varied. Traders were told that the means by which a trader's private information was chosen was random, though in reality the information structure was predetermined, as discussed in Section 1.

The market was organized as an oral double auction, and traders were free to buy and sell securities as they wished, one security at a time, subject only to the "improvement" rule on bids (to buy) and offers (to sell): any bid by a trader must be higher than the bid outstanding in the market, and any offer must be lower than any offer outstanding. After a transaction was closed, the bidding process began anew. Each period lasted 7 minutes, with warnings at 5 minutes, 6 minutes, 6 minutes 30 seconds, and 6 minutes 50 seconds.

## 3. MODELS

The traditional PI equilibrium hypothesis assumes that traders

will condition their behavior only on their private information, ignoring any information gained from observing the market price. Thus, for instance, if we assume risk-neutrality on the part of the traders, when the state X occurs, in the PI equilibrium uninformed type I traders should be holding all the securities at the end of the trading period, with a market price of 203. In contrast, the RE equilibrium hypothesis suggests that traders will condition their behavior on both their private information and the market price; if the state-price correspondence is known with certainty and is one-to-one, uninformed traders can infer the state from the market price and thus can become informed. Hence the RE prediction, given the X state, is that the informed and uninformed type III traders should be holding all securities at the end of the period, with a market price of 180. The reasoning is that the type I uninformed traders "learn" that the state is X, and thus are only willing to pay 120 (as opposed to 203), while type III uninformed traders also "learn" and thus are willing to pay 180 (as opposed to 147). Thus, when the state is X, the PI and RE predictions are disjoint.

Note that, given the parameters in Table 1, the PI and RE predictions for states Y and Z differ only in the holdings of uninformed traders: in the Y state, PI predicts type II informed traders will hold the final securities at a market price of 245, while RE predicts both informed and uninformed type II traders will hold at a market price of 245; in the Z state, PI predicts type I informed traders will hold final securities at a market price of 320, while RE

predicts that both informed and uninformed type I traders should hold at a market price of 320. Hence the separation of predictions in states Y and Z is quite sensitive to the assumptions of risk-neutrality and learning the state with certainty from the price.

#### 4. RESULTS

The time series of prices for the ten periods is shown in Figure 1. The sequence of states was the same as in Plott and Sunder (1982) except that we ran only one period with no information (as opposed to three), which was the first period, and we did not replicate the final period. As can be seen, prices converged to the RE predicted price in the X states, and to the price-equivalent PI and RE predictions in the Y and Z states. When compared to the Plott and Sunder (1982) results, prices actually converged faster (and closer to the predicted values) in three of the periods, while converging slower (and farther from predicted values) in three periods, and were roughly equal in the remaining four periods. Thus we can conclude that the fixed information structure of Plott and Sunder (1982) had little to do with price convergence.

Table 2 lists the number of securities in the "wrong" hands at the end of each period, given the PI and RE predictions, for both Plott and Sunder (1982) and the current experiment. Recall that the predictions for states Y and Z differ only in final holdings, so that the results in Table 2 are important in discriminating between the two models. As can be seen, the RE model outperforms the PI model in all but one period (interestingly, PI does better in the same period as in

Plott and Sunder). Any conclusions drawn from Table 2 must be viewed with caution, however, for by the nature of the predictions, it is technically impossible for the PI model to do strictly better than the RE model in states Y and Z, since the set of traders holding in the PI prediction is a proper subset of the traders holding in the RE prediction. Notice that the PI model does extremely well in periods 6, 8, and 10 of the current experiment, yet still cannot (and could not) overcome the RE prediction.

Figures 2a and 2b provide data on the ability of traders to learn the state-price correspondence. Figure 2a shows the ratio of average profits for buyers to average profits for sellers under the RE model. As Plott and Sunder claim: "The ratio of profits of agents predicted by the RE model to be buyers to those of the predicted sellers reflects the degree of knowledge about the state-price correspondence...therefore, profits of buyers and sellers might reasonably be expected to be equal if the equilibrium-price correspondence has been revealed and understood". The Plott and Sunder (1982) data was used to conclude that the agents did become informed of this correspondence. The current data suggest that changing the information structure lessens the variability of the ratio, and more importantly gives consistently higher values in the final periods relative to the Plott and Sunder results. Notice that the large jumps in periods 4 and 5 come after a change in the state from the previous period, and that this jump occurs in both sets of data.

Figure 2b depicts the ratio of profits of informed traders to profits of uninformed traders for both the Plott and Sunder (1982) and the current experiment. Plott and Sunder claim that this is a measure of the ability of uninformed traders to learn the state from the price; i.e. their ability to use the inverse of the state-price correspondence. Plott and Sunder concluded that, over time, uninformed traders were able to learn the state, hence the values near 100 in the last four periods. The current data suggest that, by changing the information structure, we again have lessened the variability of the ratio over time, and again we see the values for the final periods remaining above those for Plott and Sunder.

## 5. CONCLUSION

The results of the new experiment confirm the conclusions of Plott and Sunder (1982) regarding the price dynamics of the market; however, they also weaken their claim that uninformed traders learn the state from the market price. Figures 2a and 2b show that, although the markets become in a sense "more revealing" over time, the fixed information structure of Plott and Sunder overstated this revelation. Thus the conclusions drawn from their late-period data should not be made without regard to the bias introduced by their information structure. Similarly, the Friedman, Harrison and Salmon results on informational efficiency in the presence of futures markets could have been driven, to some extent, by this same phenomena. As for Plott and Sunder (1983), we can conclude that their results are derived mainly from the incomplete nature of the private information

and the inability of the market (or the traders) to aggregate the diverse information into a state-revealing signal.

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TABLE 1  
parameters

Trader Type	# of Traders	Initial Endowment		Dividends			Prior Probability			Expected Dividend
		Security	Francs	X	Y	Z	X	Y	Z	
I	4	2	10,000	120	170	320	.33	.33	.33	203.3
II	4	2	10,000	155	245	135				178.3
III	4	2	10,000	180	100	160				146.7

TABLE 2

number of securities in the wrong hands:

RE vs. PI models

Period		1	2	3	4	5	6	7	8	9	10
State		Y	X	X	Y	Z	Z	Y	Y	X	Y
P/S	RE	11	13	4	10	0	0	0	0	0	0
	PI	11	11	20	13	5	0	7	9	24	11
B	RE	13	18	13	2	0	0	7	0	2	0
	PI	13	17	21	9	10	4	10	1	22	0



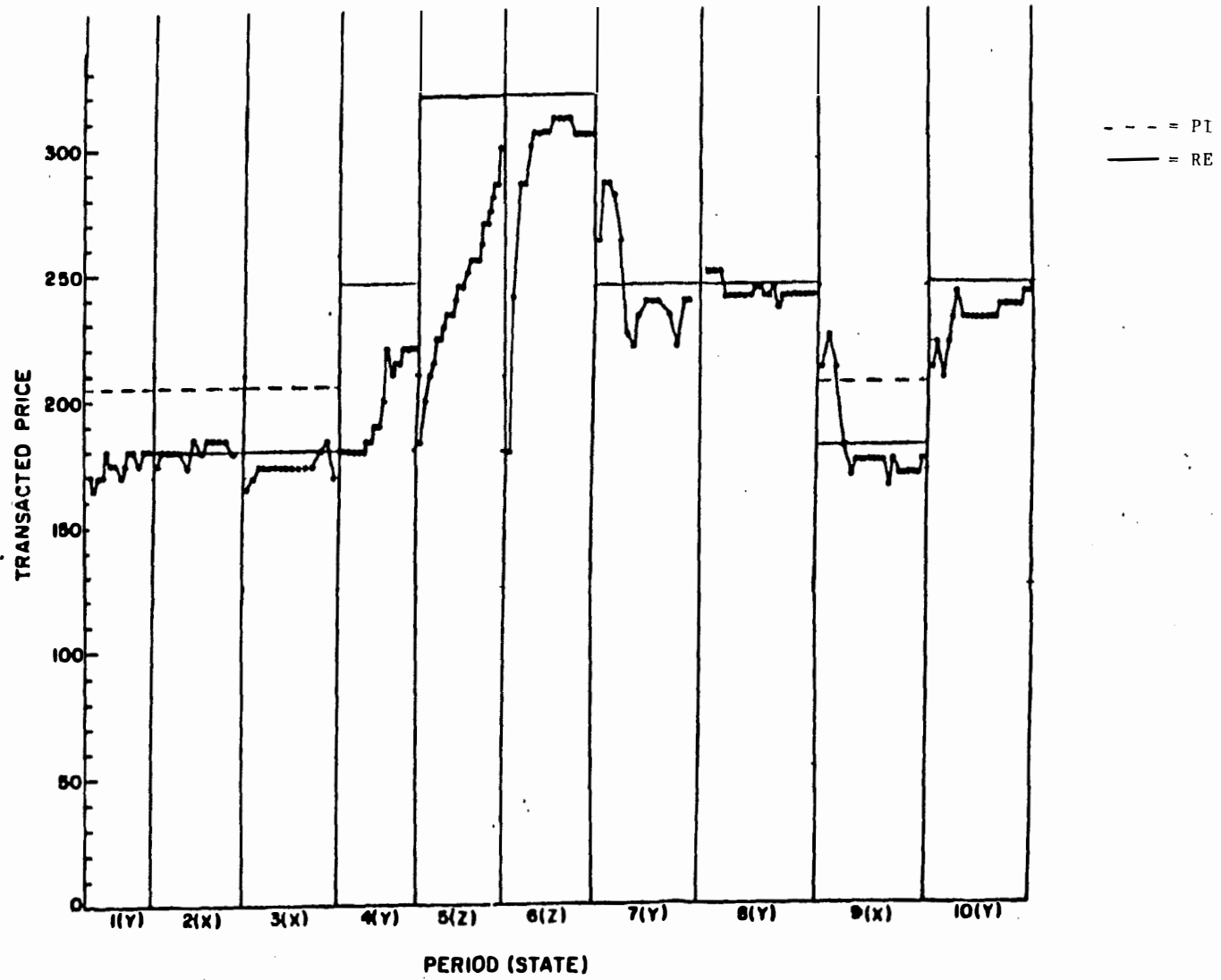
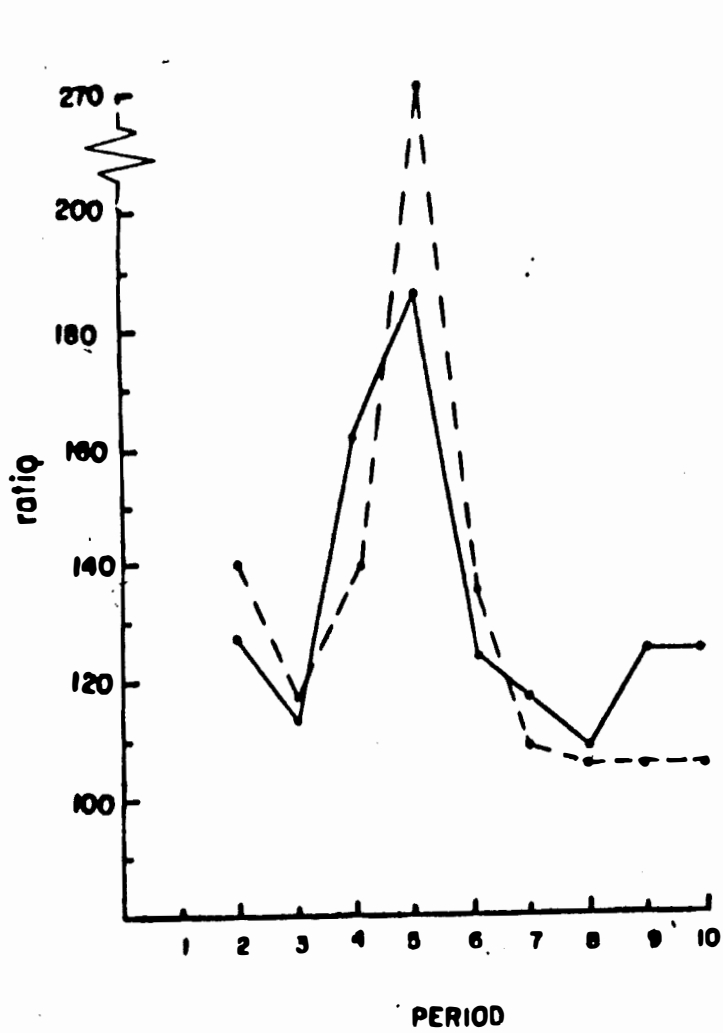


FIGURE I



a. ratio of average profits for RE buyers to RE sellers



b. ratio of informed trader profits to uninformed trader profits

FIGURE 2