THE EFFECT OF TRADING OPTION TYPE CLAIMS ON THE EFFICIENCY OF EXPERIMENTAL SECURITY MARKETS (A PRELIMINARY REPORT)

Charles R. Plott
California Institute of Technology

Shyam Sunder
University of Chicago

Recent theories in economics claim that markets solve not only the classical allocation problem of getting buyers and sellers together efficiently but that markets can also perform another function. Namely, markets can aggregate and disseminate information. By watching the price of a stock, "outsiders" can infer what insiders know. This is a variant of the rational expectations hypothesis. If a group of insiders are competing for securities in the market, someone outside the firm can learn almost anything about the company by simply watching the economic consequences of the behavior of these people. This incredible idea is that markets themselves can serve to aggregate and disseminate information that no one in particular has an interest in allowing other people to know. Our original research was based on the assumption that this idea is bananas. In this talk I will provide you with some brief impressions of what we have observed.

Figure 1 is an experiment from some that were done several years ago. Consider an asset that has a one-period life. The return to an individual depends upon the state of nature. The state of nature can be either state x or state y. For a Type 1 individual, if x happens to occur, the security pays a return of 100. If y happens to occur, the security pays a return of 350. Type 1 people are hoping for state y. The probability of x is one-third and the probability of y is two-thirds, so the expected value of a unit for Type 1 individuals would be 266.7. For a Type 2 person, if x occurs, the security will pay a dividend of 200; state y would yield a dividend of 300, so the expected value of a unit for a Type 2 person would be 267. A Type 3 person gets 240 if x and 175 if y, with an expected value of 196. The security pays different dividends depending upon the type of holder. This is similar to differing tax brackets and/or differing risk preferences among investors.

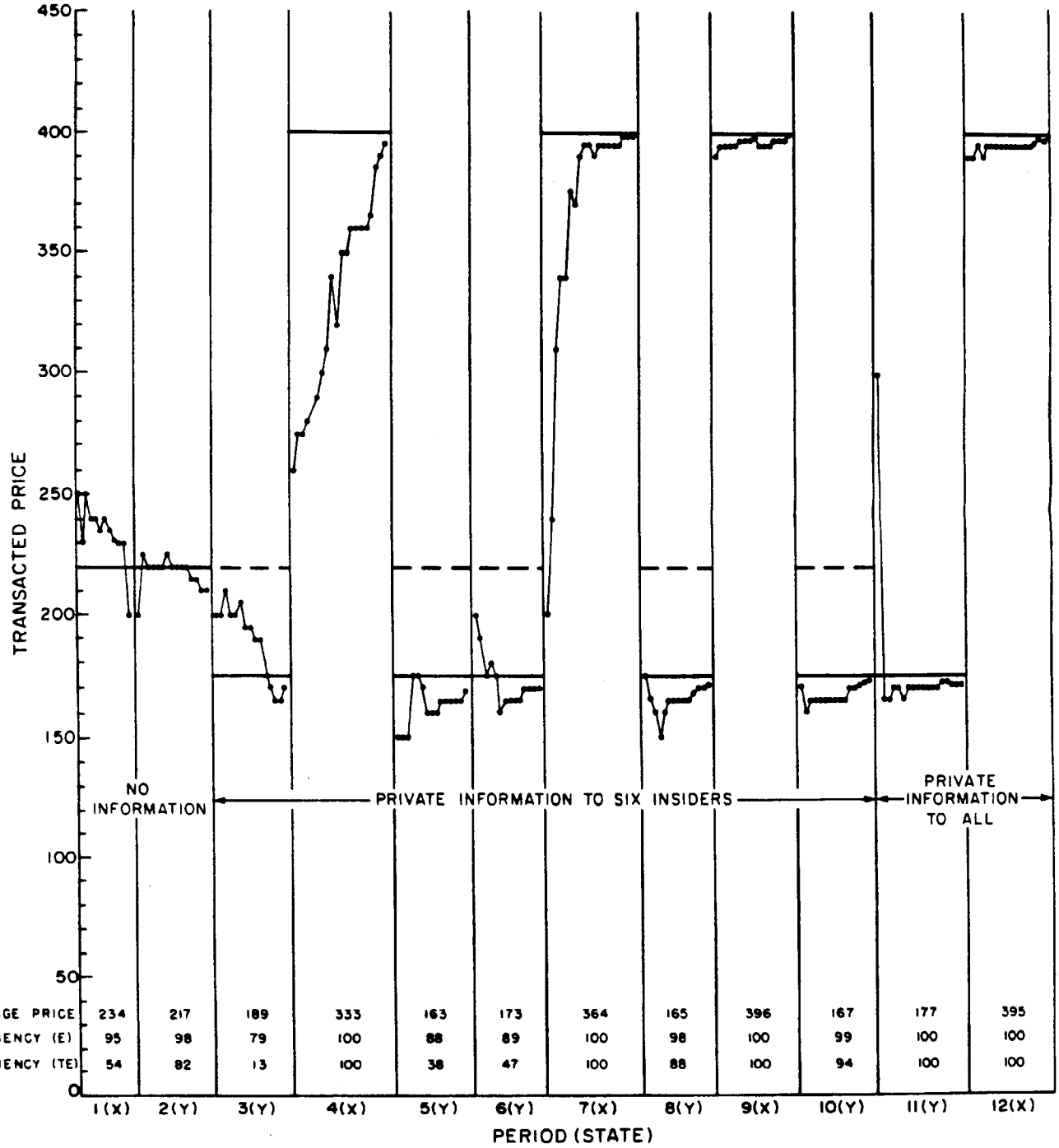

FIGURE 1 MARKET 3

TIME SERIES OF CONTRACT PRICES

Consider how this market might work. There is a fixed supply of securities initially held equally among market agents. Suppose that everyone knows the state is x. Type 1 people would sell any holdings; Type 2 people would also sell out; and Type 3 people would absorb them all and since there will be several Type 3 people they would bid the price up to 240. So, if everyone knows the state of nature is x the price of the security will be 240.

Suppose the state of nature is y and everyone knows that. Type 1 people will absorb all holdings and the price will be bid up to 350.

Suppose that no one knows anything about the state. Type 2 people have an expected value of 267, so they will compete against each other and absorb all the securities at an expected value of 267. This assumes, of course, that all agents are risk neutral, which is OK for the purposes of explanation of the model.

Consider now what the rational expectations theory adds to this. Suppose some people know the state of nature and others don't. Assume some insiders and some outsiders exist for all types of people. When the state of nature is y there is no problem because Type 1 people would just bid the price up to 350 and they would absorb the entire supply. If the state of nature is x, however, the price would fall away from 350 and if there are some uninformed Type 2's and some uninformed Type 1's who have expected values in the range of 267 these outsiders would, according to one theory, start absorbing and cause the price to settle in the 267 range. Rational expectations theory says this won't happen. From the price behavior outsiders will learn that the state is not y. If the state were y the price would be 350 so if the price is not 350 the state must be x. But if they know the state is x the price will fall to 240. So from the price behavior alone, the uninformed Type 1 and Type 2 people will know to avoid buying at prices above 240. The pattern of the prices will be as though everyone is informed. The outsiders will learn the state from the insiders just by looking at the price.

Our general disbelief in this story lead to the paper "Efficiency of Experimental Security Markets with Insider Information: An Application of Rational Expectations Models," Journal of Political Economy, vol. 9, August, 1982, pp. 663-698. The parameters were substantially as explained above. The principal result was that with replications of market conditions there is substantial evidence that the model is correct. Prices adjusted as though agents were fully informed. Insiders and outsiders made about equal profits.

The mechanism through which the state is revealed remains unknown but it probably is located in the (possibly unaccepted) bids and offers.

The moral of the story is that the expected utility hypothesis in these simple markets is a very good model. Also, the rational expectations model apparently holds. And, if we applied the fair game hypothesis the market is efficient in the sense that filter rules do not beat buy and hold.

Our current project builds on these results. The rational expectations model actually makes a much deeper assertion than simply that markets disseminate information. Suppose different insiders have a little different pass at the truth. The rational expectations model asserts that such bits of information will be aggregated by the market. In particular suppose that there are three states: x, y, and z. If the state is x, some people would be told that the state is either x or y, and other people would be told that the state is either x or z. That is, some people know that it is not y and others know that the state is not z. The market "knows with certainty" the underlying state is x but no individual knows it. The rational expectations hypothesis says that somehow this knowledge is going to become pooled and everyone, insiders and outsiders, will act as if they know the state perfectly. This is a much more complicated phenomenon. Not only must the market disseminate information from insiders to outsiders, it must actually pool the information in a statistical sense.

Many new experiments have been conducted. The initial periods of several markets were cases in which no individual had information about the state. Generally the markets converged to the maximum expected value. These periods served as controls on the experiments. The primary focus was on markets with diverse information and diverse preferences as described above. The results show some variation across experiments. There is some evidence of bubbles, for example, but the general and important conclusion is unambiguous. The markets do not behave in accord with rational expectations theory. The information is not aggregated and the markets are not efficient. However, the markets are efficient according to the efficient market hypothesis. They are fair games. Buy and hold cannot be beat by filters in any of the markets. But, the markets are not efficient markets in the rational expectations sense. The data demonstrate that the efficient markets hypothesis is not a sufficient test for efficiency of the underlying market. It doesn't work, and we have studied many experimental markets that demonstrate the point.

When the insiders know bits and pieces of information the market just doesn't necessarily aggregate all of it. Of course with more time, replications, experience, etc. the market might do it but that is not obvious now. In fact, our attempts to control time and experience suggest that more of each will not be enough to get the markets to work as theoretically anticipated.

The next thing we studied was state contingent securities. The compound security was divided into three state contingent securities. The x security paid the x state dividend if x occurred and zero otherwise. Another security, the y security, paid if y occurred and zero otherwise, and a third security paid the z dividend if z occurred and zero otherwise. The three securities together collectively make the compound security of the previous markets. These markets had more instruments in the market than the previous single compound security markets but collectively the instruments look like the compound security.

In terms of the previous two state example, if the state is x the price of the x security should be 240 and all of the x security should be held by Type 3 people. The y security should be worth zero since y has not occurred. And, generally if a third state exists, the z security should also be worth zero since z has not occurred. If z occurs then the z security should be priced at the maximum dividend and the other two securities should be worth zero.

Figure 2 contains the results of one experiment. The market opened with state contingent securities. The first period state was x. With these parameters the price of x should be 460 and the other two securities should be priced at zero. As can be seen the contract prices represented by the dots are above zero in all three security markets. The next period the state is z. One trade occurs in the x market before the price plunges to near zero. A few trades occur in the y market but volume and prices in the z market are climbing toward the 600 predicted. In the next period the state is y. Notice the price of the x security drops to zero immediately. The z market has only one trade. Everyone really knows from the behavior of the markets that the state is y and the value of the y security is near the competitive price of 320.

The central conclusion is unambiguous. When the markets are complete the information is completely and unambiguously aggregated. The rational

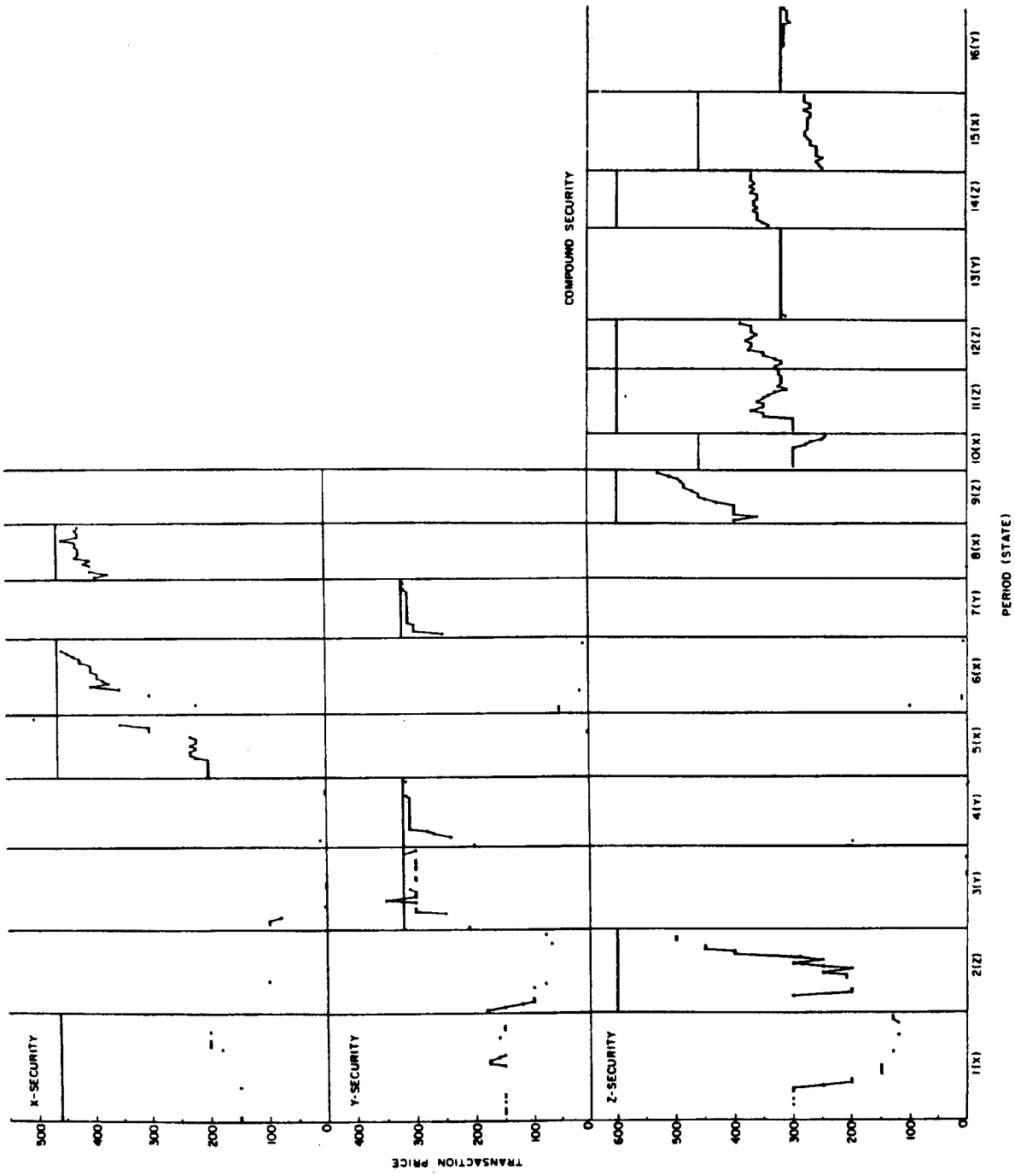
X-SECURITY
Y-SECURITY
Z-SECURITY
COMPOUND SECURITY
TRANSACTION PRICE
PERIOD (STATE)
1(X)
2(Z)
3(Y)
4(Y)
5(X)
6(X)
7(Y)
8(X)
9(Z)
10(X)
11(Z)
12(Z)
13(Y)
14(Z)
15(X)
16(Y)

FIGURE 2

expectatons model works.

Before the beginning of period 10 the complete securities were collapsed into a single security. The setting is the same as first studied. The prices just meander as they did in other compound security markets. The market looks like an efficient market according to the efficient market (fair game) hypothesis but it is not. Again, even after the experience of the complete markets, the markets failed to attain rational expectations prices.

We did this type of experiment several times to confirm our findings.

Finally we studied a market in which everyone had the same dividend. In the two markets we conducted with uniform dividends the results were the same as those in complete markets. Information aggregation was outstanding. The rational expectations model works. People have different information initially so gains from trade exist. After the market has operated for awhile, however, the market almost dries up. If everyone has the same payoff and if everyone knows the state of nature there is no one to trade with. Trade only occurs if there is a difference of opinion.

To summarize: We know first that demand-supply laws work as advertised in simple situations--markets are efficient, very little centralized information is needed for them to work. Alternative ideas like labor theory of value are wrong. Secondly we know that institutional details are very important to the working of the laws. In the markets we have studied we suspect that bids in the trading pit itself are a vehicle through which much of the information is transferred. We have studied posted price, sealed bid, one-sided auctions and futures markets. The expected utility hypothesis is pretty good. We use it all the time. It's not perfect, but it's not bad. We know that the markets can disseminate information from outsiders to insiders. The rational expectations model holds on both prices and profits tests when some people know the state with certainty. The fair game test of efficiency holds in this case. And we know that price is not the only means that transfers information. Finally, in terms of information aggregation, which is more complicated, we know that the rational expectations model is not reliable in a single security market. The information does not necessarily get aggregated. We know also that the fair game tests that are applied so frequently are unreliable as indicators about when an underlying market is operating inefficiently. Fair game tests can indicate efficiency when in fact the market is not efficient. If markets are complete in the sense of a

complete set of state contingent securities or if preferences are sufficiently similar in the single security market case, the rational expectations model works substantially as advertised. In these cases the information becomes aggregated and all agents behave as if they were perfectly informed.