Chapter 30

PRICE BUBBLES

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1. Introduction

Smith, Suchanek, and Williams (1988) report the results of laboratory asset markets in which each trader receives an initial portfolio of cash and shares of a security with an earnings life of 15 trading periods. Before the tth trading period, the expected dividend value of a share, e.g., $\$0.24(15-t+1)$, is computed and reported to all subjects to guard against any possibility of misunderstanding. Each trader is free to trade shares of the security using double auction trading rules. At the end of the experiment, a sum equal to all dividends received on shares, plus initial cash plus capital gains minus capital losses is paid in U.S. currency to the trader.

The data in Figure 1 shows a typical result from a laboratory asset market. With inexperienced traders, bubbles and crashes are standard fare. However, these phenomena disappear as traders become experienced. That is, traders who have experienced trading twice in a laboratory asset market will trade at prices that reflect fundamental value.

2. Empirical Results from Laboratory Asset Markets

Figure 1 supplies the structure of the baseline experiment of Smith, Suchanek, and Williams (1988) where the theory would predict prices that track the fundamental value line (see Tirole, 1982). In this environment, inexperienced traders produced high amplitude[1] bubbles that are 2 to 3 times intrinsic value. In addition, the span of a boom tends to be of long duration (10 to 11 periods) with a large turnover of shares (5 to 6 times the outstanding stock of shares over the 15-period experiment). In nearly all cases, prices crash to fundamental value by period 15.

The baseline market developed by Smith, Suchanek, and Williams (1988) omits many institutional features that are present in the field. Since some of these factors may very well dampen bubbles, they have provided the impetus for several new experiments reported in two recent studies: (1) King et al. (1993) report experiments that introduce short selling, margin buying, brokerage fees, informed "specialists," equal portfolio endowments, and limit price change rules; (2) Porter and Smith (1995) report new experiments examining the effect of a futures market and the effect of dividend certainty.

[1] We calculate amplitude as the difference between the highest deviation of mean contract price from its fundamental value and the lowest deviation of mean contract from its fundamental value. This value is then normalized by 360, the expected dividend value over 15 periods.

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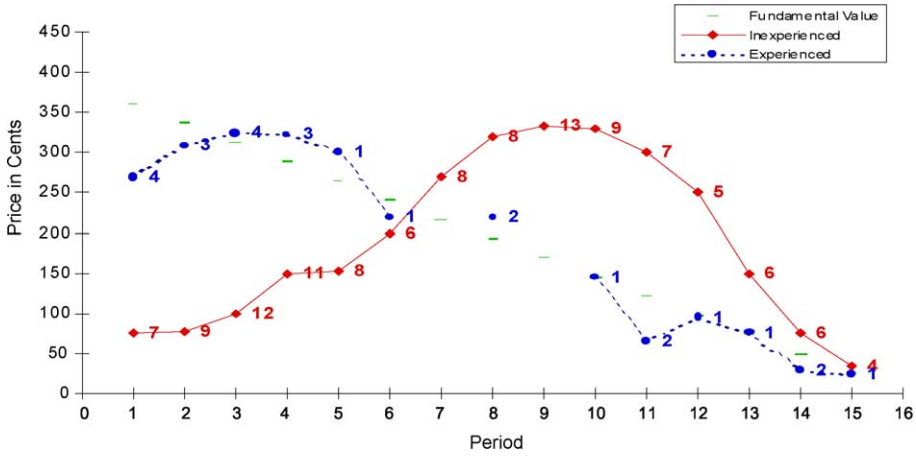

Figure 1. Mean contract price and total volume. The experiments graphed have nine subjects who can both buy and sell a security using the double auction trading rules. Each subject is endowed with cash and shares of the security (a third of the subjects had $9.45 in cash and one share; another third had $5.85 and two shares; one third had $2.25 and three shares) that pays a dividend at the end of each of 15 trading periods (the dividend is either $.00, $.08, $.28, $.60 with equal probability which is drawn at the end of each trading period). Thus the security has an expected dividend of $.24 for each period. If held for all fifteen periods it would pay $3.60 in dividends on average. The security's dividend or fundamental value decreases $.24 each trading period. This declining fundamental value is shown by the green dashed values in the graph. The red data points and red numbers next to them are the mean contract prices and volume, respectively, for an experiment in which subjects participated for the first time. The blue data points and associated number are the mean contract prices and volume, respectively, for an experiment in which these same subjects participated in the market for a second time.

Table 1 lists these structural changes, the associated data, and the predictions of the effect of these treatments on the market. Such structural changes have been suggested by others as an explanation of the bubbles reported in Smith, Suchanek, and Williams (1988). Table 1 lists the treatments discussed herein along with their hypothesized effect on the bubble's characteristics. Table 2 lists the mean values of amplitude, duration and turnover for each treatment.

The baseline experiments have individual traders endowed with different initial portfolios. A common characteristic of first-period trading is that buyers tend to be those with low share endowments, while sellers are those with relatively high share endowments. This suggests that risk-averse traders might be using the market to acquire more balanced portfolios. If liquidity preference accounts for the low initial prices, which in turn lead to expectations of price increases, then making the initial trader endowments equal across subjects would tend to dampen bubbles.

RESULT 1. Observations from four experiments with inexperienced traders show no significant effect of equal endowments on bubble characteristics.

Table 1
Treatments and hypothesis

Treatment	Description	Hypothesis
Baseline	Declining dividend value (see Figure 2)	Rational expectations equilibrium has trading at fundamental values
Short-selling	Traders are given the capacity to sell units to be covered by last period	Traders can leverage sales and counter ebullient expectations
Margin buying	Traders are given interest free loan to be paid back at last period	Purchases can be leveraged to raise prices that are below dividend value
Equal portfolios	Each traders is given the identical initial amounts of cash and shares	Traders do not need to use the market to balance portfolios
Brokerage fees	Buy and seller in a transactions pay 10 cents each for the trade	Should reduce trading based on boredom or playing
Informed insiders	Specially trained traders who are given bid ask adjustment model	Expert traders aware of bubble characteristics engage in arbitrage
Dividend certainty	Security pays a fixed and known amount each period	Trading based on expectations/risk preference is virtually eliminated
Futures contracting	Traders are given a mid-horizon (period 8) security	Futures contracts should give read on traders price expectations
Limit price change rule	Asset price can only change a fixed percentage amount based on previous period prices	This rule has been recommended by expert advisory groups to reduce price volatility and crashes

If risk aversion about price expectations due to dividend uncertainty causes a divergence of common expectations, then the elimination of such uncertainty should reduce the severity of bubbles. The Porter and Smith (1995) experiments demonstrate otherwise (see Figure 2 for an example).

RESULT 2. When the dividend draw each period is set equal to the one period expected dividend value, so that the asset dividend stream is certain, bubbles still occur and are not significantly different from the case with dividend uncertainty.

Results 1 and 2 are directed at changing the underlying induced value parameters of the baseline experiments but not the basic structure of the market. Stock markets in the field provide margin rules that allow traders to take a position on either side of the market and leverage their sales by taking a short position or leverage their purchases by buying with borrowed funds. Consequently, a small number of traders who have counter cyclical expectations would be able to offset the ebullient expectations of others.

RESULT 3. Short-selling does not significantly diminish the amplitude and duration of bubbles, but the volume of trade is increased significantly; Figure 3 provides an example.

Table 2
Mean values by treatment

Treatment	Inexperienced			Once-experienced			Twice-experienced		
	Amplitude	Duration	Turnover	Amplitude	Duration	Turnover	Amplitude	Duration	Turnover
Baseline	1.21 $n = 19$	9.23	5.79	.75 $n = 4$	5.51	3.00	.10 $n = 3$	3.00	1.60
Short-sell	1.61 $n = 4$	9.50	6.67	.76 $n = 5$	5.80	4.19	.40 $n = 3$	3.67	1.74
Margin buy	3.64 $n = 2$	8.00	5.48	1.15 $n = 1$	2.00	2.33			
Equal portfolios	1.87 $n = 4$	10.00	6.29						
Broker fees	.73 $n = 2$	10.00	5.56	.63 $n = 3$	4.00	4.92			
Informed insiders	.63 $n = 2$	13.00	2.68	.25 $n = 3$	6.00	4.05			
Dividend certain	1.10 $n = 3$	11.00	8.84	.52 $n = 3$	9.67	2.71			
Futures contract	.92 $n = 3$	10.00	6.85	.60 $n = 2$	5.50	2.63			
Limit price change	2.51 $n = 2$	10.50	4.84	1.77 $n = 2$	5.50	2.22	.70 $n = 2$	1.50	1.89

RESULT 4. Margin buying opportunities cause a significant increase in the amplitude of bubbles for inexperienced ($p < 0.01$), but not for experienced subjects.

RESULT 5. A brokerage fee of 20 cents on each trade (10 cents each on the buyer and seller) had no significant effect on the amplitude, duration, or share turnover.

These results suggest that bubbles are robust against significant structural and environmental changes. The endogenous process by which expectations are being formed has no difficulty surviving these first-order changes. The observation that individuals do not form common expectations, given common information on asset value, raises the question of whether these bubbles are sensitive to the subject pool. Most of the experiments have been conducted at the University of Arizona and Indiana University, using volunteers from the student population.[2] Could the use of professional traders

[2] Bubbles have been observed with inexperienced student traders in two experiments at the California Institute of Technology and three experiments at the Wharton School.

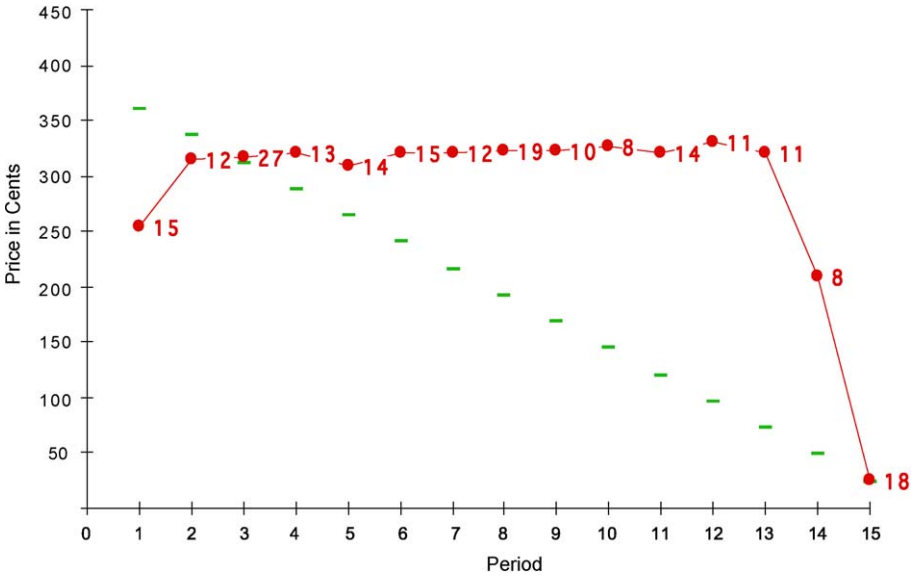

Figure 2. Mean contract price and total volume: Certain dividend. This experiment had nine subjects endowed with cash and shares of the security (a third of the subjects had \$9.45 in cash and one share; another third had \$5.85 and two shares; one third had \$2.25 and three shares) that pays a certain \$.24 dividend at the end of each of 15 trading periods. If held for all fifteen periods it would pay exactly \$3.60 in dividends. The security's dividend or fundamental value decreases \$.24 each trading period since the security has only a fifteen period life. This declining fundamental value is shown by the green dashed values in the graph. The red data points and red numbers next to them are the mean contract prices and volume, respectively for each trading period.

and business executives eliminate this uncertainty concerning the rationality of other's behavior?

RESULT 6. The use of subject pools of small business persons, mid-level corporate executives, and over-the-counter market dealers has no significant effect on the characteristics of bubbles with first time subjects.

Rational expectations theory predicts that if irrational trading patterns create profitable arbitrage, then knowledgeable traders will take advantage of these opportunities and this will eliminate such trading patterns. This hypothesis was tested by having three graduate students read the Smith, Suchanek, and Williams (1988) paper. In addition to seeing past data on laboratory bubbles, these "experts" were given information on the bid and offer count each period. As discovered in Smith, Suchanek, and Williams (1988), the excess of bids over offers was found to be a leading indicator of average price changes. These informed subjects then participated in a market with 6 or 9 uninformed traders recruited in the usual way.

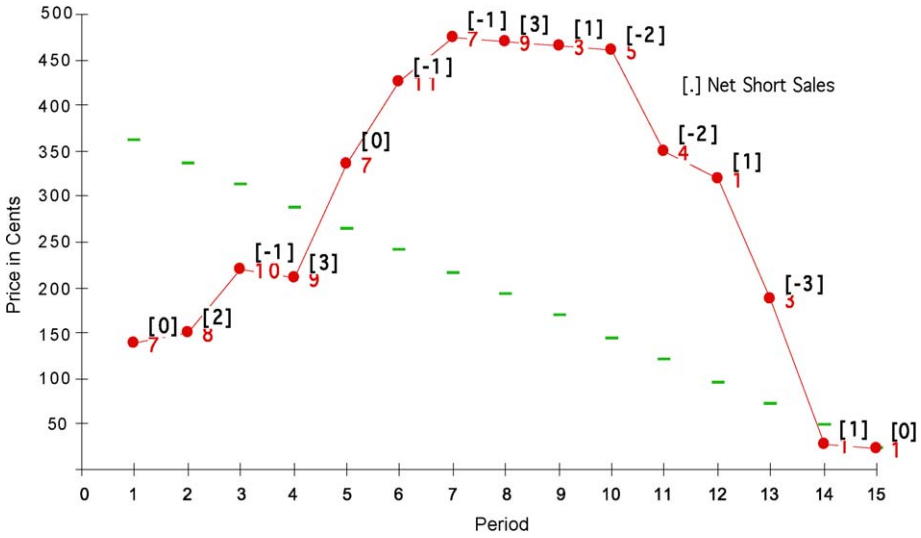

Figure 3. Mean contract price, volume and short sales. This experiment had nine subjects with endowments and dividend distribution the same as in Figure 1, but in addition, each subject was also given the capacity to short sell up to two shares. These shares had to be covered or a penalty of $4.00 would be paid for uncovered shares at the end of the experiment. The red data points and red numbers next to them are the mean contract prices and volume, respectively for each trading period. The black numbers in brackets are the net short sales of the all the subjects. Thus, a positive number implies that units in the short sale inventory have been used in that trading period; a negative number indicates net units have been bought to cover short positions.

RESULT 7. The results support the rational expectations prediction provided that the informed traders are endowed with a capacity to sell short and the uninformed traders are once experienced. When the uninformed traders are inexperienced, the bubble forces are so strong that the expert traders are swamped by the buying wave; by period 11 they reach their maximum selling capacity, including short sales.

The failure of the informed traders to eliminate the bubble when the uninformed traders are inexperienced is illustrated by the experiment in Figure 4.

It should be noted in Figure 4 that since short sales had to be covered by purchases to avoid penalties, when facing inexperienced traders short covering by expert traders prevented the market from crashing to dividend value in period 15. Thus, short selling against the bubble prevented convergence to the rational expectations value at the end.

A futures contract provides a mechanism by which each trader can get a reading on all traders' expectations concerning a future event. In effect, one runs a future spot market in advance. If a price bubble arises because of the failure of common information to induce common expectations, but the latter are achieved through repeat experience, then a futures contract should have the effect of speeding up this expectations homogenizing process. To test this hypothesis, Porter and Smith (1995) ran two sequences of two

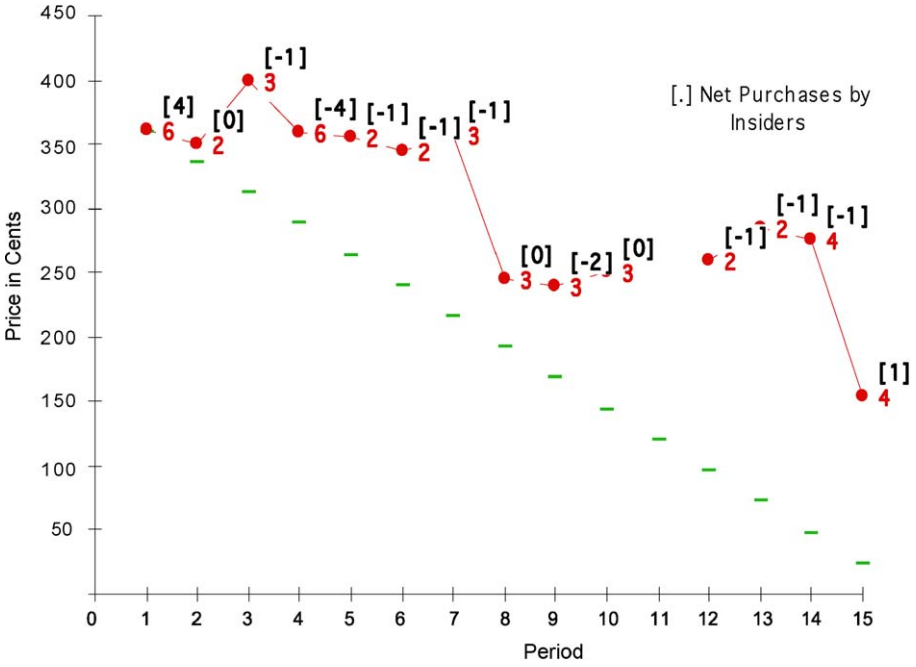

Figure 4. Mean contract price, volume and insider purchases (inexperienced uninformed traders). This experiment had 12 subjects (9 subjects had not participated in this type of market previously and 3 subjects were informed of this market and its characteristics). The nine inexperienced subjects were endowed with cash and shares of the security (a third of the subjects had \$9.45 in cash and one share; another third had \$5.85 and two shares; one third had \$2.25 and three shares) that pays a dividend at the end of each of 15 trading periods. The three informed subjects, who were given information on the number of bids and asks tendered each market period, were endowed with \$5.85 and two shares along with the ability to short sale up to 4 shares. These shares had to be covered or a penalty of \$4.00 would be paid for uncovered shares at the end of the experiment. The red data points and red numbers next to them are the mean contract prices and volume, respectively for each trading period. The black numbers in brackets are the net short sales of the insiders. Thus, a positive number implies that units in the short sale inventory have been used in that trading period; a negative number indicates net units have been bought to cover short positions.

experiments with the same subjects trained in the mechanics of a futures market. In the new experiments, a futures contract due in period 8 was utilized, where agents could trade both the spot and futures contracts in periods 1–8; after period 8, only the spot market was active. Figure 5 shows the results of one these futures market experiments.

RESULT 8. Futures markets dampen, but do not eliminate, bubbles by speeding up the process by which traders form common expectations.

In the wake of the worldwide stock market crash of October 19, 1987, it was widely recommended by various investigatory groups that limit price change rules be imple-

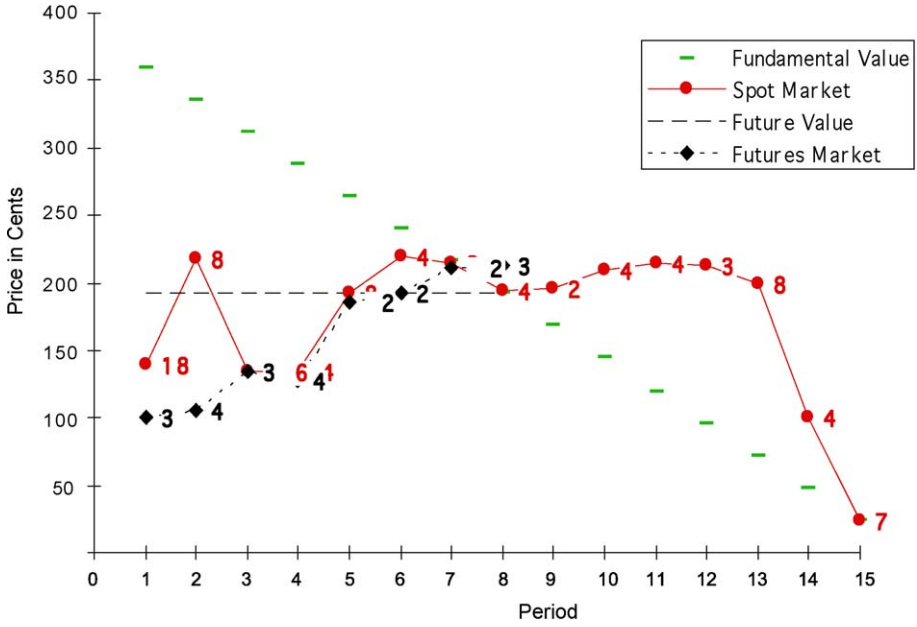

Figure 5. Mean spot and futures contract prices and total volume. This experiment had 9 subjects with endowments and dividends as in Figure 1. The fundamental value is shown by the green dashed values in the graph. In addition, each subject could sell up to 3 futures contracts. The futures contracts came due in period 8. That is, any futures contracts purchased beyond the 3 shares in inventory would becomes spot shares and begin earning dividends from period 9 and beyond. Thus, the fundamental value of the a futures contract is \$1.92 (\$.24 times 8 periods) and is the dashed black line in the figure. Any short futures at period 8 would pay a penalty of \$4.00. Subjects were also given an interest-fee loan (margin account) to buy shares beyond their initial cash endowment. Any margin funds used had to be repaid at the end of the experiment. The red data points and red numbers next to them are the mean spot contract prices and volume, respectively for each trading period. The black data points and numbers are the mean futures prices and volume.

mented on U.S. stock market exchanges. King et al. (1993) report six experiments in which ceiling and floor limits were placed at plus (or minus) twice the expected one period dividend value.

RESULT 9. Price limit change rules do not prevent bubbles.

King et al. (1993) conjecture that bubbles are more severe with limit price change rules because traders perceive a reduced down-side risk inducing them to ride the bubble higher and longer. But, of course, when the market breaks, it moves down by the limit and finds no buyers. Trading volume is zero in each period of the crash as the market declines by the limit each period (see Figure 6 for example).

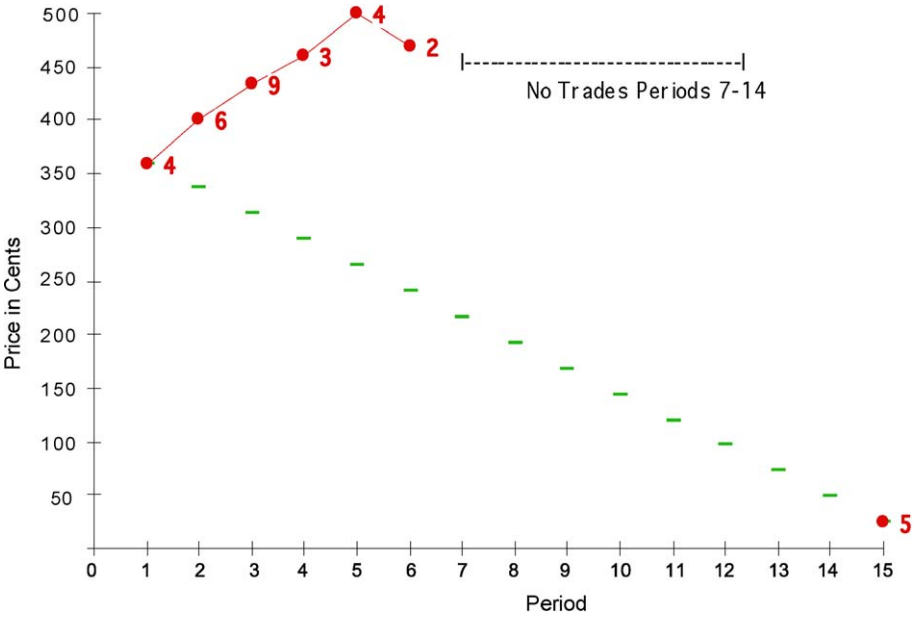

Figure 6. Mean contract price and total volume: Limit price change rule. This experiment had nine subjects endowed with cash and shares of the security (a third of the subjects had \$9.45 in cash and one share; another third had \$5.85 and two shares; one third had \$2.25 and three shares) that pays a dividend at the end of each of 15 trading periods. If held for all fifteen periods it would pay exactly \$3.60 in dividends. The security's dividend or fundamental value decreases \$.24 each trading period since the security has only a fifteen period life. This declining fundamental value is shown by the green dashed values in the graph. In this experiment, prices could move up or down from the previous period mean contract price by only twice the expected one-period dividend value, i.e., \$.48. The red data points and red numbers next to them are the mean contract prices and volume, respectively for each trading period.

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