The Institutional Nature of Price Bubbles*

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Price bubbles remain a puzzle for economic theory, particularly given their appearance in experimental markets with high efficiency and minimized uncertainty and noise. We propose that bubbles are caused by the institutionalization of social norms, when individuals observe and adopt the behavior of others. Explanations of bounded rationality or individual bias appear insufficient as we show experimentally that (1) participants' pricing skills are better ex-ante than ex-post and (2) that individual discrepancies between intrinsic values and market prices become increasingly serially correlated during trading. We also find no support for the "Greater Fool" explanation. (94 words)

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Markets sometimes develop price bubbles, i.e., they trade in high volumes at prices that are considerably at variance from intrinsic values (Ronald R. King et al., 1993). Cases such as the stock market crash of 1929 (Eugene N. White, 1990) demonstrate the enormous effect of bubbles on individuals, firms, markets and even nations, and explain the interest they draw from economists as well as the public (Charles MacKay, 1841; Charles P. Kindleberger, 1978). While important in their consequences, the causes of bubbles are not well understood. Theoreticians have suggested that bubbles may be rational (J. Bradford De Long et al., 1990; Peter M. Garber, 1990), intrinsic (Kenneth A. Froot and Maurice Obstfeld, 1991), and contagious (Richard Topol, 1991), but there is no widely accepted theory to explain their occurrence.

The existence of market bubbles seems at odds with common assumptions regarding the efficiency of financial markets. Even more puzzling is the finding that bubbles occur not only in

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real-world markets, where uncertainty and noise can lead to diverging rational expectations, but also in highly predictable experimental markets (e.g. Vernon L. Smith, Gerry L. Suchanek and Arlington W. Williams, 1988). In a typical laboratory study, participants engage in double-auction trading of assets that are defined to have a finite lifespan and a known distribution of dividends. Uncertainty is eliminated and participants should be able to calculate the *intrinsic value* of the assets simply by examining the expected stream of dividends. Nevertheless, bubbles have been observed repeatedly in experimental markets, even with sophisticated participants such as business students, managers, and professional traders. Experimental bubbles have proven robust to a variety of conditions, including short-selling, margin buying, equal portfolio endowment, brokerage fees, the presence of informed insiders, dividend certainty, constant value, and limit price change rule (Ronald R. King et al., 1993; David P. Porter and Vernon L. Smith, 2003).

A. Bounded rationality. While a complete explanation of experimental bubbles is still in the making, research findings seem to imply that the phenomena may be the result of bounded rationality, as evident in the "behavioral versus rational" debate (e.g. Colin F. Camerer, 1989; Peter M. Garber, 1990; Eugene N. White, 1990; Thomas Lux, 1995). It has been shown that bubbles abated when participants traded repeatedly within the same group (Ronald R. King et al., 1993; Mark V. van Boening, Arlington W. Williams and Shawn LaMaster, 1993). This finding can lead one to hypothesize that bounded rationality gives rise to bubbles in the short term as people may have cognitive difficulty in applying a theoretical pricing model in practice (Herbert A. Simon, 1955; Richard Cyert and James March, 1963). Arguably, initial mispricing may be decreasing due to individual learning processes, which leads to improved pricing in subsequent periods and an overall abatement of bubbles. If bubbles are indeed caused by bounded rationality and alleviated by individual learning, then we should see indications that participants improve their asset pricing skills as they trade. For instance, we would expect that average asset prices will be farther from intrinsic values ex ante and move closer to intrinsic values ex post. We would also expect that average price deviation from intrinsic value to be higher ex ante and that price amplitude will be higher ex ante.

B. Greater Fool explanation. A second possible explanation is that while market participants may be able to price correctly even initially, they tend to assume, wrongly, that they can buy overpriced assets and sell them at even more inflated prices to others. Not commonly addressed in the academic literature but prevalent among practitioners, the "Greater Fool" explanation posits that bubbles are fueled by speculators who *knowingly* purchase overpriced assets while hoping that they can sell those assets even more dearly to gullible investors, i.e. "greater fools" (e.g. David Dreman, 1993; The Economist, 2003).

For such a belief to have a cumulative effect on markets, a sufficiently large part of market participant must be overconfident about their pricing acumen, believing that it is better than others'. Then, market participants will readily acquire overpriced assets, even if each individual participant realizes that the assets are overpriced. Nevertheless, each individual participant wrongly believes that enough others do not realize that those assets are overpriced and expects that the others will be willing to buy them at a premium.

It is reasonable to expect the overconfidence necessary for the Greater Fool explanation. A bias known as *self-serving belief* leads people assess themselves to be above average in various positive characteristics (Ola Svenson, 1981; Linda Babcock and George Loewenstein, 1997). People were shown to be generous in self-assessment versus the population average when asked about their driving skills, managerial acumen, ethics, productivity, and other desirable characteristics. Hence, if bubbles develop because participants subscribe collectively to a self-serving belief, then we would expect to find that on average, each participant perceives her own financial acumen to be superior to that of the others.

C. Institutionalization. It is also possible that bubbles stem not from individual biases, but from the institutionalization of social norms. Economists argued that individuals observe each other and base their decisions, at least partly, on imitation of others rather than on their own cognition (Andrei Shleifer and Lawrence H. Summers, 1990). Some have predicted, however, that such behavior would not occur in efficient markets, where sophisticated participants can counter such herd behavior (Christopher Avery and Peter Zemsky, 1998). But markets can also reward not behaviors that are intrinsically correct, but those that are correct in matching "what average opinion expects average opinion to be" (John Maynard Keynes, 1936:156), thus amplifying pressures for institutional behavior. Further, economic sociologists have shown how non-normative behavior, even if intrinsically correct, can have detrimental financial and status consequences (Joel Podolny, 2005).

Institutionalization of social norms can lead to coordinated action through the internalization of beliefs and interpretations of facts by each individual, even without formal agreement or explicit discussion of coordination (e.g., folkways). While institutions can be formal, such as the legal system, scholars have identified that institutions can also emerge to provide order endogenously: "Behavior becomes stable and patterned, or alternatively institutionalized, not because it is imposed, but because it is elicited" (Robert H. Bates et al., 1998:8). Such processes have been shown to sustain practices across individuals and over time, even when the practices were irrational. In an early laboratory experiment, Zucker (1977) demonstrated how institutionalization facilitated the transmission of a practice that would have

clearly appeared counter-factual to an outside observer but not to the agents involved. Recently, it has been shown that people learn to coordinate their price expectations without direct communication and even when such coordination leads to erroneous outcomes (Cars Hommes et al., 2005). Outside the laboratory, it was shown that US stock markets have systematically responded favorably to (costless) announcements of stock buyback, although it was publicly known that a significant proportion of the announcing firms did not act on their announcements (James D. Westphal and Edward J. Zajac, 2001; Edward J. Zajac and James D. Westphal, 2004). Economic sociologists have shown how traders of financial derivatives oscillated between institutionalizing alternative approaches to asset pricing (Donald MacKenzie and Yuval Millo, 2003).

The three explanations should differ empirically in measurements of pricing skills and self-serving bias ex ante and in the correlation of price discrepancy, i.e., the distance between the market price of an asset and the intrinsic value of that asset. Pricing discrepancies can be decomposed into *dispersion* and *common* components. If bubbles are caused by inapt pricing, then one can expect indication of inadequate pricing skills ex ante and high dispersion component, where market prices fall randomly above or below intrinsic value. If the Greater Fool explanation holds, one can expect evidence of widespread self-serving bias. If bubbles are caused by institutionalization, the common discrepancy component should be high and price discrepancies should be correlated both among individuals and serially.

I. Method

We constructed an experimental double auction market (Vernon L. Smith, 1962), which is known to possess extremely competitive characteristics (Charles A. Holt, 1995). In such markets, each participant is endowed with experimental cash and assets, and he is free to post bid and ask prices to buy and sell assets at will. The experimental market was programmed and conducted in z-Tree (Urs Fischbacher, Forthcoming), based on the seminal design of Smith, Suchanek and Williams (1988). To maintain consistency with prior work, we replicated a recently published design (Martin Dufwenberg, Tobias Lindqvist and Evan Moore, 2005).

We recruited 62 undergraduate students with no prior experience in such experiments for ten experimental sessions in what was described to them as a "study of economic decision making". Upon arrival to the experimental laboratory, participants received an instruction sheet (Appendix 1a), which described the experiment and provided sufficient information for calculation of intrinsic values. The participants then received a Price Questionnaire that probed their knowledge of a standard asset-pricing model by asking, for instance, "In the fourth period,

someone wants to sell you his stock. Write the maximum price you will be willing to pay for it". The price questionnaire included 10 questions, one for each trading session, in random order (Appendix 1b). The participants were told that they may consult the instruction sheet to answer the questions, and were given 10 minutes to complete the questionnaire. All of them finished within the time allocated.

After the Price Questionnaires were collected, the participants were asked to complete an Assessment Questionnaire, which included questions designed to assess overconfidence. Each participant was asked to provide 1) an assessment of the accuracy of his or her own responses, 2) an assessment of the accuracy of the other participants' responses, and 3) an assessment of the other participants' assessment of his or her own responses (Appendix 1c). This was followed by a brief demographics questionnaire (Appendix 1d).

After completing the pre-trade questionnaires, the participants moved to a behavioral laboratory, where they sat in separate cubicles in front of networked personal computers. Each participant was randomly assigned to receive either two shares and 600 cents or six shares and 200 cents. They knew that their earnings would be paid to them in cash at the end of the experiment. Once trading began, the participants could enter their minimum selling prices (ask) and their maximum offers to buy (bid). Conditions resembled a highly efficient stock market: bid and ask figures as well as eventual prices were visible to all of the participants and each one could initiate a transaction by accepting a buying or selling offer. All transactions were anonymous and participants could not communicate with each other.

Each experimental session consisted of six participants who traded for 10 periods lasting 120 seconds each. [1] At the end of each period, a dividend of 20 cents per share was payable with a probability of 0.5. A summary screen appeared at the end of each period and presented individualized trading and divided results. At the conclusion of the trading periods, the participants received a $5 show-up fee and earnings in cash. Excluding the fee, earnings were $13.38 on average (s.d.=2.87; range=$5.30-$18.30).

II. Results

In general, our results were similar to those obtained in prior work, i.e., we observed bubbles in most of the experimental sessions (interestingly, we find this even though the Price and Assessment Questionnaires could have affected behavior through psychological priming effect). More significantly, we found that discrepancies between market prices and intrinsic values were correlated among participants *and became even more so over time*. We found no indication

[1] With the exception of the first session, which had eight participants.

that bubbles were caused by lack of knowledge. Quite the contrary; participants had a better understanding of the theoretical pricing model ex ante, but – somewhat astonishingly -- seem to have partly abandoned that knowledge during trading. We also find no evidence of self-serving bias.

[Figure 1 about here]

A. Ex-ante pricing skills. A comparison of average prices declared in the Price Questionnaire with those obtained in actual trading revealed that, surprisingly, the prices declared *ex ante* were better fit to intrinsic values. We used Haessel R^2 (Walter Haessel, 1978) to measure fit between the responses to the Price Questionnaire and intrinsic values and between the trading prices and intrinsic values. We find better fit ex ante in nine out of 10 sessions. Figure 1 shows an illustration of the discrepancy between the prices declared ex ante and the actual trading prices. Similarly, prices in trading also had higher normalized average price deviation in nine out of 10 sessions. This statistic was calculated by summing the absolute deviation between mean trading prices and intrinsic values for each period and dividing by the number of shares outstanding. Prices in trading also had wider price amplitude in 10 out of 10 sessions. This statistic was calculated by finding the highest and the lowest discrepancies between intrinsic value and trading prices, subtracting the lowest from the highest and dividing by 100 (the initial intrinsic value). These measures have been used frequently to assess the magnitude of bubbles (Ronald R. King et al., 1993; Mark V. van Boening, Arlington W. Williams and Shawn LaMaster, 1993; David P. Porter and Vernon L. Smith, 2003; Martin Dufwenberg, Tobias Lindqvist and Evan Moore, 2005).

[Table 1 about here]

B. Self-serving bias. We found no indication of self-serving bias. Results obtained from the Assessment Questionnaire (Table 2) suggest that participants generally viewed their own price assessment to be as precise as the others'. The same is true about their assessment of others' perception of themselves – they assumed that the others had a correct assessment of their own capabilities. Measures of Cronbach's alpha (Lee J. Cronbach, 1951) show high reliability for each group of questionnaire items.

[Table 2 about here]

C. **Decomposition of price discrepancy.** The average discrepancy between a given market price and the matching intrinsic value can be decomposed into two components: dispersion and common (Cars Hommes et al., 2005). The former measures the deviation from a common pricing method while the latter measures correlation between discrepancies in the market. Formally, where *t* designates the trading period (1…10) and *h* is a counter of transactions, the average price for period *t* is:

$$\bar{P}_t = \frac{1}{n}\sum_{h=1}^{n} P_{ht}$$

(1)

The average pricing discrepancy can be decomposed as:

$$\frac{1}{10n}\sum_{h=1}^{n}\sum_{t=1}^{10}(P_{ht} - P_t^i)^2 = \frac{1}{10n}\sum_{h=1}^{n}\sum_{t=1}^{10}(P_{ht} - \bar{P}_t)^2 + \frac{1}{10}\sum_{t=1}^{10}(\bar{P}_t - P_t^i)^2$$

(2)

The first term on the right-hand side of equation (2) measures the dispersion between prices in market transactions. It is the squared distance between a price in a specific transaction and the average price for that period, averaged across transactions and periods. The less similar are prices in the market, the higher this component would be. The second term on the right-hand side measures the common component. It is the squared distance between the average price in a period and the intrinsic value for that period, averaged over periods. If price discrepancies are serially uncorrelated and uncorrelated with the discrepancies of other participants, this component will be zero. The higher the common component, the higher is the similarity between the pricing discrepancies in the market.

[Table 3 about here]

Table 3 reveals that the common component plays a major role in the discrepancies between market price and intrinsic values. It accounts for most of the variance in all sessions but one. Moreover, as Figure 2 shows, the common component tends to *increase* during trading, showing that errors became more correlated as trading progressed.

[Figure 2 about here]

III. Discussion

The results suggest that price bubbles are not simply the result of individual cognitive bias. We found that participants' exhibited better understanding of intrinsic value pricing ex ante than ex post. However, this understanding was apparently abandoned during trading, resulting in worse fit to the fundamental model, higher price deviation, and higher amplitude ex post. Because we have an indication of better knowledge ex ante, individual-level bounded rationality alone cannot explain the deviations from the fundamental model. It is unlikely that time pressure is responsible for the poorer performance during the trading session, because participants spent much more time trading (20 minutes) than answering the Price Questionnaire (10 minutes).

Surveying the perception of the participants about their own pricing skills and those of the others rules out the possibility of widespread self-serving bias. Taken together with prior findings that documented bubbles even when speculation was not possible (Vivian Lei, Charles N. Noussair and Charles R. Plott, 2001), these findings suggest little validity in the Greater Fool explanation.

In contrast, a decomposition of price discrepancy shows how substantial the common component is in such discrepancies and highlights the increasing similarity in discrepancy as trading progressed. When this analysis is taken together with the evidence about better individual pricing skills ex ante and the absence of self-serving bias, it seems to indicate that bubbles originate from institutionalization of social norms about pricing.

As Douglas C. North suggested: "We form mental models to explain and interpret the environment…[which] may be continually redefined with new experiences, including *contacts with others' ideas*" (emphasis added, 1994:362-63). While prior work has acknowledged that people observe and adopt others' behavior, few have theorized or documented institutionalization in highly efficient markets, as we do here (cf. Christopher Avery and Peter Zemsky, 1998). Further, these results show that direct communication is not be necessary for institutionalization to appear; the mere posting of bid and asks can be sufficient to spread beliefs and sway markets away from intrinsic value. Hence, if institutionalization appears so rapidly and profoundly in markets designed for high efficiency, it seems reasonable to presume an even greater institutionalization in real-world markets, financial or others, with their inherent uncertainty, lower efficiency, and direct communication between market participants.

The findings reported here allow us to rule out explanations that turn on individual biases and focus on institutional processes instead. A potentially fruitful path would be to investigate how social interaction leads to the spread and formation of shared beliefs in markets,

and whether small initial differences can lead to dramatically different outcomes, as was recently shown in markets for cultural products (Matthew J. Salganik, Peter Sheridan Dodds and Duncan J. Watts, 2006).

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Appendix 1a: Participant Instructions

This is an experiment in economic decision making. The instructions are simple. If you follow the instructions carefully and make good decisions, you will earn a considerable amount of money. It will be paid to you in cash at the end of the experiment.

In this experiment, you will assume the role of a stock trader. During each period of the experiment, you will be able to buy shares from the other participants or sell to them shares that you own. You also might earn dividends on shares that you own. You will decide at which prices you are willing to buy and sell, and how many shares to hold.

You will not know the identities of the other participants or how much money they earn or lose during the experiment. Similarly, they will not know who you are or how much money you earn or lose. Please do not speak with any other participants during this experiment.

The experiment will last for approximately an hour, including time for instructions and practice.

The Market

Six participants will trade in the experiment. Selected randomly at the beginning of the experiment, half will receive 6 shares and 200 cents. The other half will receive 2 shares and 600 cents.

The experiment has 10 periods. In each period, you may buy or sell shares. The shares have a lifespan of 10 periods, and your inventory of shares carries over from one trading period to the next. Each period lasts for 120 seconds.

At the end of each trading period, each share may or may not pay a dividend. The dividend will be randomly decided as 0 or 20 cents, with 50 percent chance for either outcome. That is, the chance of receiving nothing is equal to the chance of receiving 20 cents. Thus, the average dividend per period is 10 cents.

Your profits in the market will be equal to the total of the dividends that you receive on the shares in your inventory at the end of each market period plus the cash you have at the end of the experiment. Section 3 describes how to calculate your earning.

Earnings from Dividends

You can use the table to help you make decisions. There are five columns in the table. The first column, labeled Ending Period, indicates the last trading period of the market. The second column, labeled Current Period, indicates the period during which the average holding value is being calculated. The third column gives the number of holding periods from the period in the second column until the end of the market. The fourth column, labeled Average Dividend Value per Period, gives the average amount that the dividend will be in each period for each unit held in your inventory. The fifth column, labeled Average Holding Value per Unit of Inventory, gives the expected total dividend for the remainder of the experiment for each unit held in your inventory for the rest of the market. That is, for each unit you hold for the remainder of the experiment, you can expect to receive, on average, the amount listed in column 5. The amount in column 5 is calculated by multiplying the numbers in columns 3 and 4.

For example, suppose that there are 4 periods remaining. Since there is an equal chance of receiving nothing or 20 cents, the dividend is on average 10 cents per share in each period. If you hold a share for 4 periods, the total dividend paid on the share (over the 4 periods) can be expected to be $4 \times 10 = 40$.

Ending Period	Current Period	Number of Holding Periods	Average Dividend Value per Period	Average Earnings per Share
10	1	10	10	100
10	2	9	10	90
10	3	8	10	80
10	4	7	10	70
10	5	6	10	60
10	6	5	10	50
10	7	4	10	40
10	8	3	10	30
10	9	2	10	20
10	10	1	10	10

Calculate Your Earnings

Your earnings in each period equal the value of the dividends you receive each period for the shares you hold at the end of the period. That is,

Your earnings for a period = Dividend per share × number of shares held at the end of period

When you buy shares, the cost of purchase is deduced from your cash. When you sell shares, the income is added to your cash. Your total earnings are the earnings in each one of the periods, plus the amount of cash that you have at the end of period 10. That is

Your total earnings in the market =

Earnings for period 1 + Earnings for period 2 + Earnings for period 3 + Earnings for period 4 + Earnings for period 5 + Earnings for period 6 + Earnings for period 7 + Earnings for period 8 + Earnings for period 9 + Earnings for period 10 + cash at the end of period 10.

The computer will display your earnings after each period.

There will also be a show up fee of $5 to all participants

5. The Trading Screen

Top

Remaining time (sec): number of seconds remaining until the current period ends.
Period…out of...: The number of the current period out of the total number of periods in the experiment.
Cash: Your current cash amount (in cents)
Shares: The current number of shares that you hold.

Bottom

Make an Offer to Sell (in cents): Enter the amount that you demand for selling a single share. Click the button to publish the offer. It will immediately appear in the Offers to Sell column and will be visible to the other participants. The offer is not visible until you publish it by pressing the button.

Buy: To buy a share, click on one of the offers in the Offers to Sell column, and click the "Buy" button. Unless someone else was quicker in responding, you will receive one share and the cost will be deducted from your cash.

Sell: To sell a share, click on one of the requests in the Requests to Buy column, and click the "Sell" button. Unless someone else was quicker in responding, you will receive the amount specified in the request and one share will be deducted from your holdings.

Make a Request to Buy (in cents): Enter the amount that you are willing to pay for a single share. Click the button to publish the request. It will immediately appear in the Requests to Buy column and will be visible to the other participants. The request is not visible until you publish it by pressing the button.

Center

Offers to Sell Shows the available offers in descending price order, so that the lowest price is at the bottom.
Transaction price column Shows all of the prices at which a share has been bought or sold in the current period.
Requests to Buy Shows the available requests in ascending order, so that the highest price is at the bottom.

Earnings Report

The earnings report appears at the end of each period. After seeing your earnings, press the "Next" button to go to the next period. The next period will begin after all of the participants press the "Next" button.

Appendix 1b: Price Questionnaire

Please write your **participant number**

Please take about 10 minutes to fill in this questionnaire. You may use the instruction sheet to assist you.

1. In the 4th period, someone wants to sell you his stock. Write the maximum price you will be willing to pay for it

2. In the 8th period, someone wants to sell you her stock. Write the maximum price you will be willing to pay for it.

3. In the 1st period, write the minimum price you will be willing to sell a single stock for.

4. In the 3rd period, write the minimum price you will be willing to sell a single stock for.

5. In the 6th period, you are offered a single stock. Write the maximum price you will be willing to pay for it.

6. In the 7th period, write the minimum price you will be willing to sell a single stock for.

7. In the 2nd period, you are offered a single stock. Write the maximum price you will be willing to pay for it.

8. In the 5th period, someone offers to buy your stock. Write the minimum price you will be willing to sell the stock for.

9. In the 9th period, someone offers to buy your stock. Write the minimum price you will be willing to sell the stock for.

10. In the 10th period, write the maximum price you will be willing to buy a stock.

Appendix 1c: Self Assessment Questionnaire

Please write your **participant number** Please take about 5 minutes to fill in this questionnaire

1.	How confident are you in your answers to these questions?	1 I am not confident at all	2	3	4	5 I am very confident
2.	How sure are you that you wrote the right answers?	1 I am not sure at all	2	3	4	5 I am very sure
3.	In your assessment, how well do you normally answer questions such as the ones on the previous page?	1 I normally do not answer well at all	2	3	4	5 I normally answer very well
4.	Compared to the other people in the room, how precise are your answers?	1 My answers are much less precise	2	3	4	5 My answers are much more precise
5.	If we were to rank the answers of the people in this room, where do you think your answers would rank?	1 Worse than all other answers	2	3	4	5 Better than all other answers
6.	In your opinion, how confident are the other people in the room in their answers to these questions?	1 The others are not confident at all	2	3	4	5 The others are very confident
7.	In your opinion, how sure are the other people in the room that they wrote the right answers?	1 The others are not sure at all	2	3	4	5 The others are very sure
8.	In your assessment, how well did the other people in the room in answering the questions on the previous page?	1 The others did not answer well at all	2	3	4	5 The others answered very well
9.	In your assessment, how skillful are the other people in the room in answering questions such as the ones on the previous page?	1 The others are not skilful at all	2	3	4	5 The others are very skilful

10.	Try to imagine what the other people in the room think of you. In their opinion, how precise are <u>your</u> answers?	1 They think that my answers are not precise at all	2	3	4	5 They think that my answers are very precise
11.	Try to imagine what the other people in the room think of you. In their opinion, how skillful are <u>you</u> in answering questions such as the ones on the previous page?	1 They think that my answers are not precise at all	2	3	4	5 They think that my answers are very precise
12.	In your opinion, how confident are the <u>others</u> in the room about their impression of <u>you</u>?	1 They are not confident at all in their impression of me	2	3	4	5 They are very confident in their impression of me

Appendix 1d: Demographics Questionnaire

Please write your **participant number**
Please take about 3 minutes to fill in this questionnaire

a. Gender (circle): Male Female

b. Year of Birth:

c. Race:

d. Nationality:

e. Highest Level of Education:

If you have academic education or currently a university student, please answer the following:

a. Currently a student: (circle): Yes No

b. Year in School (circle): 1 2 3 4 Graduate Student

c. What was (is) your academic major (if undecided, write "undecided"):

d. Have you taken any classes in *Finance* or *Economics*? Please write their full titles below:

	Session									
	1a	2a	3a	4a	5a	6a	7a	8a	9a	10a
Haessel R^2										
Declared (D)	0.927	0.903	0.859	0.916	0.888	0.906	0.969	0.004	0.927	0.758
Trading (T)	0.552	0.962	0.691	0.698	0.069	0.747	0.896	0.000	0.810	0.525
T>D	No	Yes	No	No	No	No	No	No	No	No
Normalized Absolute Price Deviation										
Declared (D)	0.356	0.279	0.779	0.675	0.454	0.392	0.288	0.793	0.452	0.456
Trading (T)	0.594	0.176	0.567	0.757	1.342	0.394	0.167	1.289	0.203	1.856
T>D	Yes	No	No	Yes	Yes	Yes	No	Yes	No	Yes
Normalized Average Price Deviation										
Declared (D)	0.016	0.036	0.083	0.067	0.044	0.041	0.083	0.113	0.057	0.052
Trading (T)	0.142	0.040	0.120	0.131	0.162	0.092	0.034	0.204	0.039	0.295
T>D	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	No	Yes
Price Amplitude										
Declared (D)	0.119	0.123	0.317	0.367	0.195	0.133	0.142	0.602	0.200	0.398
Trading (T)	0.678	0.149	0.560	0.443	0.786	0.479	0.186	0.785	0.395	1.329
T>D	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Table 1: Measures of Goodness of Fit, Price Deviation, and Price Amplitude for Average Declared versus Trading Prices

Construct	No. of Items	Mean	Standard Deviation	Cronbach's Alpha
Participant's self-assessment	3	2.90	1.04	0.79
Participant's assessment of the other participants	6	3.00	0.79	0.69
Participant's assessment of the other participants' perception of him/her	3	2.95	0.77	0.83

Table 2: Items measured in Assessment Questionnaire

Session	Average Individual Error	Average Dispersion Error	Average Common Error
	$\frac{1}{10h}\sum_{h=1}^{n}\sum_{t=1}^{10}(P_{ht}-P_t^i)^2$	$\frac{1}{10h}\sum_{h=1}^{n}\sum_{t=1}^{10}(P_{ht}-\bar{P}_t)^2$	$\frac{1}{10}\sum_{t=1}^{10}(\bar{P}_t-P_t^i)^2$
A1	1809.811	30.990 (2%)	1778.821(98%)
A2	128.689	17.068 (13%)	111.620 (87%)
A3	1324.818	129.751 (10%)	1195.067 (90%)
A4	1231.000	155.975 (13%)	1075.025 (87%)
A5	3160.076	981.072 (31%)	2179.003 (69%)
A6	590.917	19.452 (3%)	571.464 (97%)
A7	254.326	164.033 (64.5%)	90.292 (35.5%)
A8	3358.302	143.153 (4%)	3215.148 (96%)
A9	281.455	59.723 (21%)	221.731 (79%)
A10	11839.706	2569.031 (22%)	9270.669 (78%)

Table 3: Decomposition of the average individual pricing discrepancy into dispersion and common components

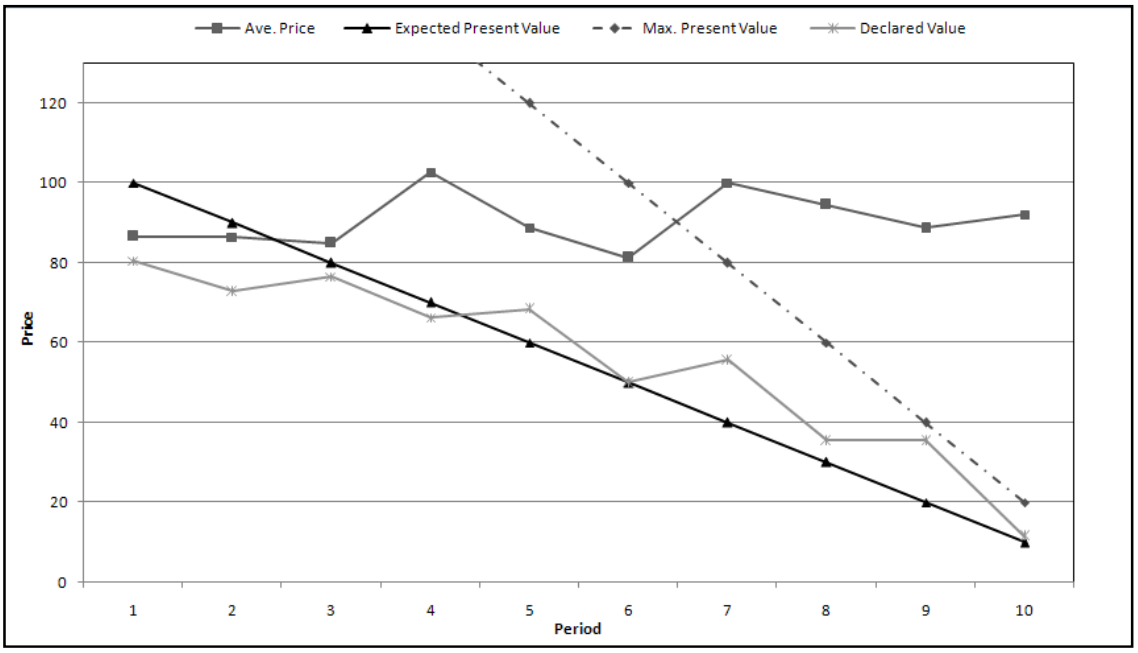

Figure 1**: Illustration of declared, intrinsic, and actual prices over trading periods**

Legend (left to right): average trading price; average present value (intrinsic value); maximum present value possible (intrinsic value); average declared value in Pricing Questionnaire.

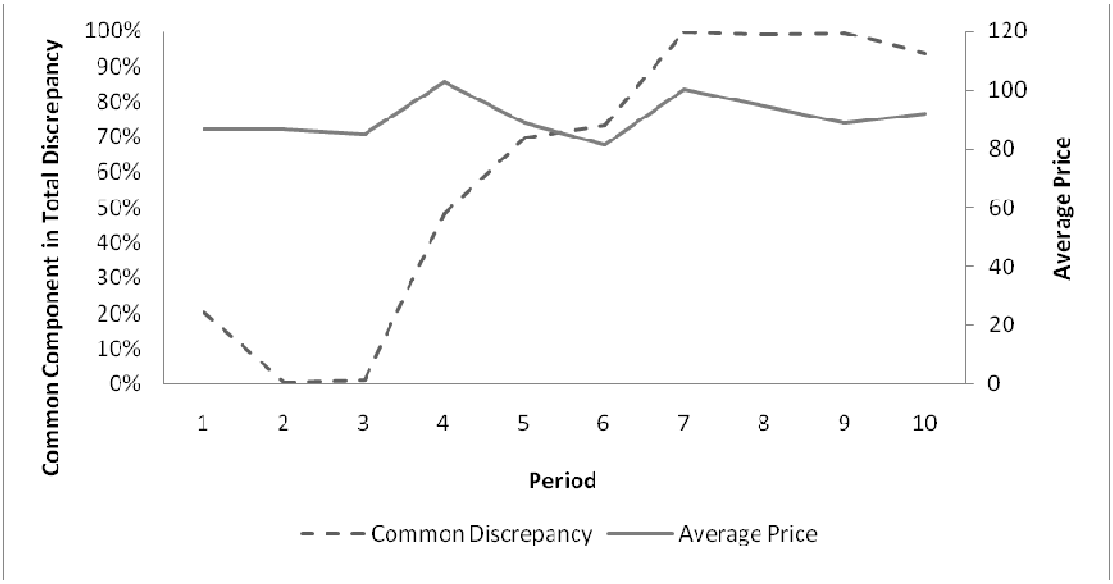

Figure 2**: Illustration of common component in price discrepancy over trading periods**