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Do Females Always Generate Small Bubbles? Experimental Evidence from U.S. and China

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ABSTRACT

We report data from double-auction experiments in China and the U.S. using groups of exclusively females, exclusively males and mixed gender participants. We find that female groups in China generate price bubbles statistically identical to those produced by exclusively male groups in both China and the U.S., all of which are significantly larger than the bubbles produced by exclusively female groups in the U.S. Our results suggest that gender differences in financial markets may be sensitive to culture.

Keywords: Gender differences, Bubbles, Experimental asset markets, Culture differences

JEL Classification: G01, G11, J16, Z13

1. Introduction

Financial volatility caused by asset price bubbles blowing and bursting has occurred regularly, from Dutch tulip mania several centuries ago to the 1929 U.S. stock market bubble and to the recent 2008 U.S. house price bubble. Market crashes often create enormously detrimental economic consequences - perhaps even economic depressions. Understanding asset price volatility is surely important, and has been an active subject of theoretical and empirical research (Shiller, 2015; Fama and French, 1993).

Some evidence suggests that excess price volatility - the bubble and burst cycle - is driven by male but not female trading behavior (Eckel and Fullbrunn, 2015). The findings of that paper are that all-male markets produce the typical bubble and crashing pattern while all-female markets generate small and sometimes even negative bubbles¹. This evidence was collected in Western universities, using primarily Western participants.

Evidence suggests, however, that the economic behavior of Asian females is not always consistent with that of western females. For example, although men are found more willing to compete than women (Niederle and Vesterlund, 2007) in the west, female Han Chinese are found to be as willing to compete as males (Zhang, 2015). The author suggests that radical Communist policies promoting gender equality and female labor force participation among the Han Chinese may have helped shape a taste for competition². Similarly, Booth et al. (2016) find that Beijing females from the 1958 birth cohort are more competitive than their male counterparts and also attribute this to the change of institution and social norm during that period of China. These findings seem to suggest that the gender differences are not only innate but at least partially socially determined, while social contexts or cultures differ worldwide and could vary over time.

In view of this, it is unclear whether the gender differences in financial trading discovered in Western samples would hold in Asian countries, such as China. Our paper is a step towards addressing this. We conduct classic bubbles experiments in

¹ Some empirical evidence, such as Barber and Odean (2001), suggests that males overtrade more than females.

² In 2010, labor force participation of women aged 15 and over was 67.9% in China, higher than almost all of the OECD countries except Iceland (Zhang, 2015).

China using groups of exclusively males, exclusively females and mixed-gender participants, and compare these to new bubbles experiments run in the United States.

Our main result is that exclusively female groups in the U.S. bubble statistically significantly less than all other gender-homogenous groups we observed. Further, these other groups – exclusively male or female in China and exclusively male in the U.S. – all bubble in statistically identical ways. Further, mixed gender groups bubble significantly more in China than in the U.S. Indeed, mixed gender groups in the U.S. bubble less than any other group in our study. Consequently, our results suggest that female trading behavior is sensitive to culture, perhaps in a way that male trading is not.

The remainder of this paper is organized as follows. Section 2 reviews the related literature. Section 3 describes the experiment design and procedures. Section 4 reports the results. Section 5 concludes and discusses.

2. Literature review

Gender composition in experimental asset market

Our study is closely related to and motivated by the work of gender differences in experimental asset markets. Using the experimental asset market mechanism of Smith et al. (1988) and same-gender market design, Eckel and Fullbrunn (2015) find that all-female markets are less prone to bubbles than all-male markets, and sometimes even generate negative bubbles. Eckel and Fullbrunn (2017) find there is no significant difference between all-female and all-male markets if gender is not revealed, and hence conclude that common expectations may play a key role in asset price volatility. However, in a constant fundamental value framework, Cueva and Rustichini (2015), also focusing on Western participants, find that female-only and male-only groups generate similar bubbles but that mispricing is much lower in mixed-gender markets. Also, using a constant fundamental value market, Holt et al. (2016) do not observe gender differences in bubble behavior.

In this paper, to study whether exclusively female groups may trade differently than male groups across different cultures, we follow Eckel and Fullbrunn (2015) and

use a traditional decreasing fundamental value design. The advantage to doing this is that we are able to compare the patterns in our data directly with those found in Eckel and Fullbrunn (2015).

Gender composition in competition and risk taking

Several studies find that single-gender environments increase women's willingness to compete as well as their willingness to take risks. Gneezy et al. (2003) find that women perform better in single-sex (participants could see each other) tournament than in mixed tournament, and the gender gap decreases in the single-sex tournament. Booth and Nolen (2012) find that girls are more likely to choose risky outcomes when assigned to all-girl groups³, and girls from single-sex schools are as likely to choose the real-stakes gamble as boys from either coed or single-sex schools. Finally, in a study using the similar subject pool as ours, Chen et al. (2015) find in a Chinese sample that women bid the highest value when bidding against other women in the case where one's opponent's gender is revealed.

Gender differences in competition

Although research suggests males are more competitive than females in general⁴, recently, substantial experimental evidence has demonstrated that gender differences in willingness to compete are both culture and context dependent. For example, Gneezy et al. (2009) find that males in a patriarchal society are willing to compete at roughly twice the rate as females. In contrast, women in matrilineal society are more competitive than men. Andersen et al. (2013) reports no gender difference at any age in the matrilineal society, while girls become less competitive around puberty in patriarchal societies. Similarly, Cardenas et al. (2012) finds that gender differences in preferences for competition vary across countries differing in gender equality.

In addition to culture, gender differences in competition also vary with the type of task. For instance, Gunther et al. (2010) find that men react more strongly than

³ Participants in one group sat together in an auditorium so they could see each other.

⁴ See a literature review in Croson and Gneezy (2009).

women in male stereotyped tasks, but they react equally in neutral tasks and women react stronger than men in female-stereotyped tasks.

Gender differences in risk preference

Similar to the studies of gender differences in competition, although many studies report that females are more risk averse than males (Croson and Gneezy, 2009), some studies also report cultural differences in this. For example, Finucane et al. (2000) find that the gender difference only exists in white people and not in any another ethnic group, which, as Croson and Gneezy (2009) suggest, may imply that cultural biases cause gender differences in risk taking. Schubert et al. (1999) find that gender differences in financial risk decisions depends on the decision frame. In particular, females seem more sensitive to risk in the loss frame.

3. Experiment design

Our experiment design and procedures are nearly identical to those reported by Eckel and Fullbrunn (2015). The experiment includes asset market decisions, risk task decisions and a survey. The details of the asset market, which follows Smith et al. (1988), are as follows.

Asset market

Nine participants trade 18 assets during a sequence of 15 double-auction trading periods, each lasting four minutes. At the end of every period, each share pays a dividend of 0, 8, 28, or 60 tokens with equal probability. Since the expected dividend equals 24 tokens in every period, the expected (or fundamental) value in period t equals $24 \times (16 - t)$, i.e., 360 in period 1, 336 in period 2, and so on until it reaches a value of 24 in period 15. Traders are endowed with shares and cash before the first period. Three subjects receive three shares and 225 tokens, three subjects receive two shares and 585 tokens, and the remaining three subjects receive one share and 945 tokens. Subjects need to forecast the trading price of all the upcoming periods at the beginning of each period. The forecast is incentivized according to the forecasting

accuracy⁵. The exchange rate is \$0.01 to 1 token.

We first ran the asset market experiment. The asset market task is completed using the z-Tree (Fischbacher 2007) program that Eckel and Fullbrunn (2015) provided on the AEA website. We then ran the risk task using paper and pencil (see the appendix for detailed instructions). Following this we asked the participants to complete two surveys. The first is from Eckel and Fullbrunn (2015). The second survey is the Bem Sex Role Inventory (BSRI; Bem, 1974) which aims to test subjects' masculinity and femininity.

The experiments were conducted in parallel at George Mason University (GMU) in the U.S. and at Central South University (CSU) in China. All of the instructions and surveys used in CSU were translated from English to Chinese and then translated back into English to ensure translation accuracy⁶.

We conducted 19 sessions both in GMU and CSU respectively, with each session including 9 participants. Six sessions included all females, six included all males and the remaining seven sessions each included five females and four males⁷. We ended with 171 subjects both in GMU and CSU, so 342 in total. Similar to Eckel and Fullbrunn (2015), the participants waited at the reception area prior to entering the lab, so they could see all the other participants from the same session. The average payoff is \$35.9 and ¥77.4 in GMU and CSU respectively.

4. Results

4.1. Price Patterns Across Treatments

We begin with an informal discussion of the price patterns across treatments, followed by a formal statistical comparison in the next section. Figure 1 describes the median of the median session transaction prices for each round and by treatment in

⁵ Each forecast earns the participant 5, 2 or 1 tokens, corresponding to the forecast accuracy of being within 10%, 25% and 50% of the actual price (for details, see instructions in the Appendix).

⁶ We modified or deleted a small number of survey questions that were irrelevant to Chinese students. For example, we did not query about marriage because almost no students are married at these ages. Further, in the religious options we added "no religion".

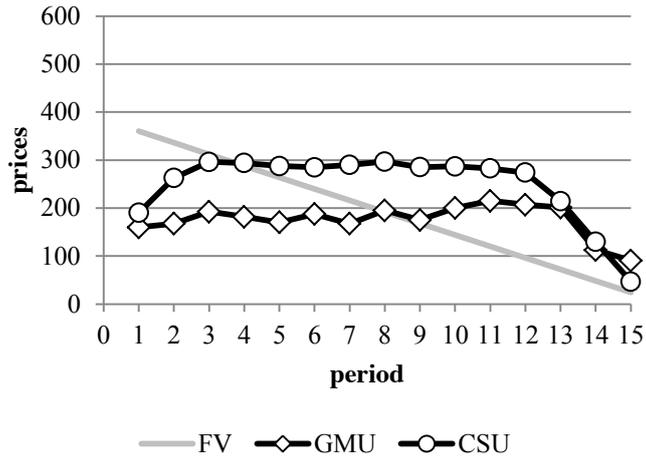
⁷ There is one exceptional session that included four females and five males in GMU in the mixed-gender markets.

GMU and CSU⁸. Figure 1A shows the comparison between U.S. and China for the all-female markets. One can observe that exclusively female groups in China generate positive bubbles in most periods, which is the typical bubble pattern in experimental asset markets. The transaction prices in CSU are higher than GMU in most periods. It is perhaps interesting to note that the pattern of transaction prices in all-female treatments in GMU is quite similar to the all-female groups reported by Eckel and Fullbrunn (2015).

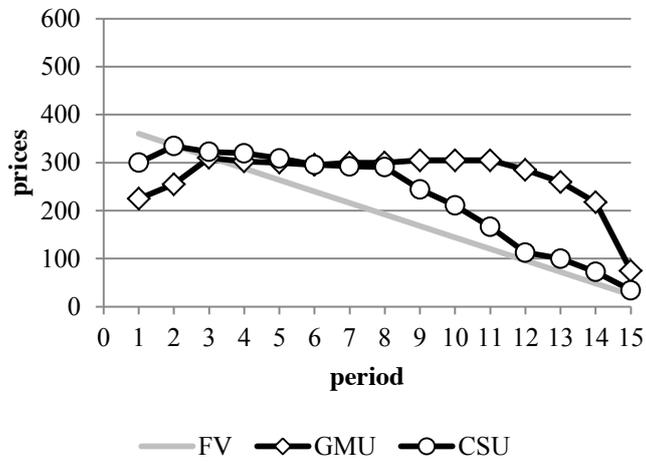
The results for all-male markets are shown in Figure 1B. Note first that both of the patterns of the transaction prices in GMU and in CSU follow the typical bubble style of booming and then bursting to fundamental value. The two lines are quite similar at the first several periods but the exclusively males in CSU converge to fundamental value earlier than in GMU. Comparing the all-female groups in CSU in Figure 1A and the all-male groups in GMU in Figure 1B, we observe that these patterns are quite similar to each other (we provide a formal statistical comparison below).

Figure 1C displays the comparison of mixed gender treatments. It is apparent that the bubbles are much smaller than exclusively males in both GMU and CSU and exclusively females in CSU. The prices in mixed-gender markets are similar to the all-female markets in GMU. The trading prices in mixed-gender markets in CSU are slightly higher than in GMU.

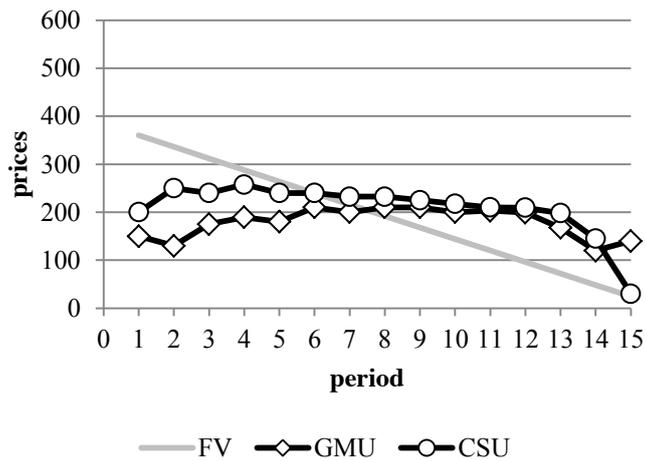
⁸ For the median transaction prices of each individual market, see Appendix A.



A. All-female



B. All-male



C. Mixed

Figure 1. Time Series of the Average of Median Transaction Prices
Average of median session prices in U.S. (diamonds) and in China (circles). Fundamental value (gray line),

4.2 Statistical Comparison of Prices Across Treatments

To compare the statistical difference between GMU and CSU across all of the three types of markets, we compute the seven bubble measures following Eckel and Fullbrunn (2015). Table 1 shows comparison of the seven bubble measures for each session and the average for each market between GMU and CSU. *Average Bias* is the average, across all 15 periods, of the deviation of the median price from the fundamental value, which serves as a measure of overpricing. A positive *Average Bias* indicates trading prices to be above fundamental value on average. *Total Dispersion* equals $\sum |P_t - FV_t|$ indicates the overall absolute difference between median prices and fundamental values which server as a mispricing measure. Note that the *Total Dispersion*, difference between prices and fundamental values, could be in both positive and negative directions. *Positive Deviation* and *Negative Deviation* indicate the absolute difference between median prices and fundamental values when prices are above and below fundamental values, respectively. The boom and bust durations are the greatest number of consecutive periods that median transaction prices are above and below fundamental values, respectively. *Turnover* reflects the trading activity which is defined as the quantity of units of the asset traded in each period.

All-female markets: GMU versus CSU

From Table 1A we observe that all-female markets in CSU generate considerable bubbles, while bubbles are on average negative in all-female markets in GMU. In all-female markets in CSU, the average of *Average Bias* is 45.86 and it is positive in five of the six sessions. The average of *Average Bias* is -11.9 in GMU and it is negative in three sessions and positive in the other three sessions. Using a two-sided Wilcoxon signed-rank test, we can reject the null hypothesis that *Average Bias* equals or is lower than zero in favor of the alternative hypothesis that *Average Bias* is higher than zero in the all-female markets ($p=0.046$) in CSU but not in GMU($p=0.916$). Moreover, average *Boom Duration* is higher than ten periods in all-female markets in CSU and prices are consistently above fundamental value for at least one-half of the

15 trading periods in all the 6 sessions except one with 7 periods. *Boom Duration* exceeds *Bust Duration* in five of the six sessions. Average *Boom Duration* in all-female markets in GMU is below seven periods and *Boom Duration* exceeds *Bust Duration* in only two sessions.

The two-sided Mann-Whitney U-tests with six observations in each group in column three of Table 1A show that the *Average Bias* in all-female markets in CSU is significantly higher than in GMU ($p=0.055$). We find no difference in *Total Dispersion*.⁹ We find the *Positive Deviation* in CSU is higher than in GMU and the difference is economically large although it is not statistically significant ($p=0.200$). The *Negative Deviation* in CSU is significantly lower than in GMU ($p=0.037$). The two-sided Mann-Whitney U-tests also show that the *Boom Duration* is significantly higher and the *Bust Duration* is significantly lower in all-female markets in CSU than in GMU.

Consistent with Figure 1A, the statistical comparisons indicate that exclusively female groups in CSU generate considerable bubbles while the exclusively female groups at GMU generate small (even negative) bubbles.

All-male markets: GMU versus CSU

Table 1B compares all-male markets in GMU and CSU. The overpricing measure *Average Bias* indicates that the all-male markets both in GMU and CSU exhibit large bubbles. The average of *Average Bias* is 77.6 in GMU and 57.7 in CSU and is positive in all six sessions in both GMU and CSU. Using a two-sided Wilcoxon signed-rank test, we find that *Average Bias* is significantly higher than zero both in GMU ($p=0.028$) and CSU ($p=0.028$). The two-sided Mann-Whitney U-tests show there is no significant difference of *Average Bias* between GMU and CSU ($p=0.749$). The *Total Dispersion* is significantly higher in GMU than in CSU, which is consistent with Figure 1B which shows that transaction prices converge to the fundamental value more quickly in CSU than in GMU. However, the *Negative Deviation* and the *Bust*

⁹ This bi-directional measure is not of interest in our case, because data from GMU are below fundamental value about half the time.

Duration are significantly higher in GMU than in CSU. The *Boom Duration* is significantly lower in GMU.

Mixed-gender markets: GMU versus CSU

Table 1C shows the results for mixed-gender markets. The average of *Average Bias* in mixed-gender markets in GMU is -19.33 and is negative in five out of seven sessions. Using a one-sided Wilcoxon signed-rank test, we find that *Average Bias* is below zero in mixed-gender markets in GMU at a 10 percent significance level ($p=0.064$). The average of *Average Bias* in mixed-gender markets in CSU is 20.01 and is positive in six out of seven sessions. Using a one-sided Wilcoxon signed-rank test, we can reject (weakly) the null hypothesis that *Average Bias* equals or is below zero in favor of the alternative hypothesis that *Average Bias* is above zero in mixed-gender markets in CSU ($p=0.088$). The two-sided Mann-Whitney U-tests show that the *Average Bias* in mixed-gender markets in CSU is significantly higher than in GMU at 10% level ($p=0.085$). We also find the *Negative Deviation* is significantly higher and the *Boom Duration* is significantly lower in GMU than in CSU. Generally, mixed-gender markets with a majority of females (five female and four male participants) exhibit larger bubbles in CSU than in GMU.

Table 1—Observed Values of Bubble Measures between US and China

A. All-female markets								
Session ID	Country	Average Bias	Total Dispersion	Positive Deviation	Negative Deviation	Boom Duration	Bust Duration	Turnover
Average	GMU	-11.9	1604.3	712.9	891.4	6.5	7.83	17.12
1	GMU	45.63	1801.5	1243	558.5	11	4	9.78
2	GMU	-43.73	1124	234	890	5	10	23.44
3	GMU	4.37	1595.5	830.5	765	5	8	6.83
4	GMU	-90.6	1681	161	1520	4	11	26.44
5	GMU	-44.23	1573.5	455	1118.5	6	7	28.17
6	GMU	57.17	1850.5	1354	496.5	8	7	8.06
Average	CSU	45.86	1469.5	1078.7	390.8	10.17	4.17	9.24
1	CSU	57.70	1517.5	1191.5	326	13	2	8.28
2	CSU	54.10	1053.5	932.5	121	10	3	9.33
3	CSU	-21.73	1307	490.5	816.5	7	8	13.56
4	CSU	29.07	1827	1131.5	695.5	8	6	11.83
5	CSU	76.30	1534.5	1339.5	195	12	2	4.17
6	CSU	79.70	1577.5	1386.5	191	11	4	8.28
p-value		0.0547	0.2002	0.2002	0.0374	0.0364	0.0360	0.3358

B. All-male markets								
Session ID	Country	Average Bias	Total Dispersion	Positive Deviation	Negative Deviation	Boom Duration	Bust Duration	Turnover
Average	GMU	77.6	1636.8	1400.4	236.4	11.5	3.33	10.08
1	GMU	81.3	1740.5	1480	260.5	12	3	15.11
2	GMU	70.67	1766	1413	353	12	3	8.39
3	GMU	148.83	2424.5	2328.5	96	13	2	8.39
4	GMU	34.53	1233	875.5	357.5	9	6	9.5
5	GMU	65.33	1179	1079.5	99.5	12	3	11.06
6	GMU	64.93	1478	1226	252	11	3	8
Average	CSU	57.66	1011.7	938.3	73.4	12.83	1.50	6.60
1	CSU	43.43	831.5	741.5	90	14	1	5.22
2	CSU	112.27	1706	1695	11	13	2	10.72
3	CSU	82.63	1359.5	1299.5	60	14	1	5.56
4	CSU	19.40	291	291	0	15	0	5.44
5	CSU	86.53	1450	1374	76	13	2	5.17
6	CSU	1.70	432.5	229	203.5	8	3	7.50
p-value		0.7488	0.0782	0.2623	0.0104	0.0735	0.0189	0.0247

C. Mixed-gender markets

Session ID	Country	Average Bias	Total Dispersion	Positive Deviation	Negative Deviation	Boom Duration	Bust Duration	Turnover
Average	GMU	-19.33	1347.5	528.8	818.7	6.43	6.86	13.75
1	GMU	-57.03	1387.5	266.0	1121.5	5	10	22.67
2	GMU	-14.57	1667.50	724.5	943.0	7	8	21.83
3	GMU	9.00	1247.0	691.0	556.0	8	7	10.94
4	GMU	29.17	1169.5	803.5	366.0	8	7	12.06
5	GMU	-26.07	585.0	97.0	488.0	6	4	7.89
6	GMU	-38.50	1844.5	633.5	1211.0	3	5	8.22
7	GMU	-37.30	1531.5	486.0	1045.5	8	7	12.67
Average	CSU	20.01	1148.6	724.4	424.2	9.57	4.86	8.21
1	CSU	16.73	1139	695	444	8	6	6.11
2	CSU	48.10	1479.5	1100.5	379	10	5	9.56
3	CSU	5.23	879.5	479	400.5	8	7	8.00
4	CSU	-74.70	1253.5	66.5	1187	4	10	10.72
5	CSU	80.23	1523.5	1363.5	160	14	1	8.78
6	CSU	11.47	970	571	399	9	5	7.56
7	CSU	53.00	795	795	0	14	0	6.78
p-value		0.0845	0.2248	0.4822	0.0639	0.0426	0.2171	0.0253

Notes: This table reports the observed values of various measures of the magnitude of bubbles for each session. *Average Bias* = $\Sigma(P_t - FV_t)/15$ where P_t and FV_t equal median price and fundamental value in period t , respectively. *Total Dispersion* = $\Sigma |P_t - FV_t|$. *Positive Deviation* = $\Sigma |P_t - FV_t|$ where $P_t > FV_t$, and *Negative Deviation* = $\Sigma |P_t - FV_t|$ where $P_t < FV_t$. The boom and bust durations are the greatest number of consecutive periods that median transaction prices are above and below fundamental values, respectively. *Turnover* = $\Sigma Q_t / 18$ where Q_t equals the number of transactions in period t . The last row shows the p -value from a two-sided Mann-Whitney U -Test.

4.3 Within country comparison

Table 2 shows the comparison between treatments within the same country and the comparison across country and gender. Consistent with Eckel and Fullbrunn (2015), we find that exclusively male groups generate larger bubbles than exclusively female groups in U.S. samples. The average of *Average Bias* in GMU is -11.9 in all-female markets and 77.6 in all-male markets. The two-sided Mann-Whitney U -tests show that the *Average Bias* in all-female markets is significantly lower than in all-male markets ($p=0.010$). The *Positive Deviation* and *Boom Duration* are significantly lower and the *Negative Deviation* and *Bust Duration* are significantly higher in all-females markets than in all-male markets, all of which are consistent

with Eckel and Fullbrunn (2015).

In contrast, we find there is no significant difference in the *Average Bias* in CSU between all-female and all-male markets ($p=0.522$). However, *Negative Deviation* and *Bust Duration* are significantly lower, and *Boom Duration* is significantly higher, in all-male than all-female markets.

We also compared the difference between all-female markets in GMU and all-male markets in CSU as well as all-male markets in GMU and all-females markets in CSU (last two rows in Table 2). The results show that nearly all bubbles measures except *Positive Deviation* are significantly different between exclusively female groups in GMU and exclusively male groups in CSU. However, none of the measures is significant between exclusively male groups in GMU and exclusively female groups in CSU.

Turn now to the mixed-gender markets. In contrast to Eckel and Fullbrunn (2015), who found market outcomes with mixed-gender groups to lie between the single-gender market outcomes, we find in both GMU and CSU that mixed-gender markets exhibit less bubbles than both the exclusively male and exclusively females markets. For example, the average of *Average Bias* in CSU in mixed-gender markets is 20.01, lower than in all-female markets and in all-male markets, though the difference is not statistically significant. This finding is consistent with Cueva and Rustichini (2015) who report more price stability with mixed-gender markets than single gender markets.

Table 2—Bubble Measures between Treatments within and between Countries

Country	Treatment	Average Bias	Total Dispersion	Positive Deviation	Negative Deviation	Boom Duration	Bust Duration	Turnover
GMU	①All-female	-11.9	1604.3	712.9	891.4	6.5	7.83	17.12
	②All-male	77.6	1636.8	1400.4	236.4	11.5	3.33	10.08
	③Mixed	-19.33	1347.5	528.8	818.7	6.43	6.86	13.75
p-value	① versus ②	0.0104	0.8728	0.0547	0.0039	0.0076	0.0055	0.4225
p-value	① versus ③	1.0000	0.1985	0.5677	0.7751	0.7704	0.4169	0.6682
p-value	② versus ③	0.0027	0.3914	0.0027	0.0027	0.0024	0.0056	0.3907
CSU	④All-female	45.86	1469.5	1078.7	390.8	10.17	4.17	9.24
	⑤All-male	57.66	1011.7	938.3	73.4	12.83	1.50	6.60
	⑥Mixed	20.01	1148.6	724.4	424.2	9.57	4.86	8.21
p-value	④ versus ⑤	0.5218	0.1495	0.7488	0.0163	0.0431	0.0272	0.1488
p-value	④ versus ⑥	0.2531	0.0455	0.1161	0.7751	0.8289	0.7199	0.3907
p-value	⑤ versus ⑥	0.1985	0.6682	0.4751	0.0381	0.1446	0.0971	0.0737
p-value	① versus ⑤	0.0782	0.0547	0.4233	0.0039	0.0078	0.0038	0.0250
p-value	② versus ④	0.2002	0.7488	0.2623	0.5218	0.5218	0.6752	0.6298

Notes: This table reports the comparison of observed values of various measures of the magnitude of bubbles between the three treatments within GMU and CSU. The computing method is the same as Table 1. The p -value is from a two-sided Mann-Whitney U -Test.

Summary of the comparison of *Average Bias* between all-female and all-male markets

Combining the information from Table 1 and Table 2, we draw a graph to demonstrate the comparison of *Average Bias* (the key measure of bubbles) between exclusively female groups and exclusively male groups within and between countries. As shown in Figure 2, all-females markets in U.S. is significantly different from all the other three groups, i.e. all-male markets in U.S. and all-female and all-male markets in China. However, each two of all the other three groups are not significantly different from each other.

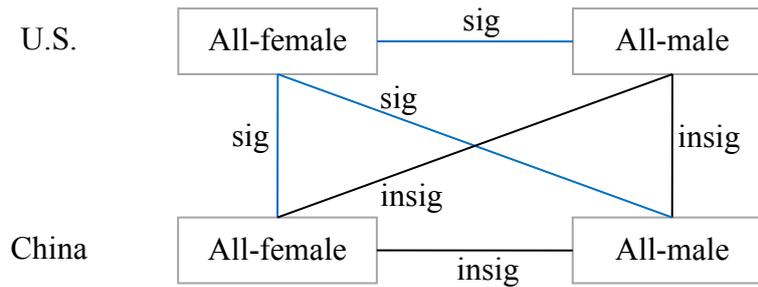


Figure 2. Summary of the comparison of *Average Bias* across treatment and country

Price forecasts

Prior to each trading period, we asked participants to predict prices for all subsequent trading periods (e.g., prior to period 3 they would be asked to predict prices for periods 3 to 15). Forecast accuracy was incentivized (see the instructions in the Appendix). Note that forecasts prior to period one cannot be affected by trading activity. Consequently, we use those forecasts as a measure of prior beliefs and compare these priors across countries within the same gender.

Table 3 compares forecast prices and forecast errors. Here, forecast errors are the absolute difference between the forecasted price and the actual trading price. Females' forecasted prices and forecast errors in GMU are both greater than in CSU. In all-female markets, the forecast price for the first period is 259.91 in GMU and 213.33 in CSU. The forecast error is 88.97 in GMU, which is significantly higher than the 21.28 observed in CSU ($p < 0.10$). The average initial forecast price for all future periods is 336.56 in GMU in all females markets, which is significantly higher than 222.39 observed in CSU ($p < 0.05$). The forecast bias is 154.18 in GMU and the forecast prices are significantly above actual trading price ($p = 0.002$, two-sided Wilcoxon signed-rank test). It is -13.61 in CSU and is insignificantly different from zero ($p = 0.288$, two-sided Wilcoxon signed-rank test). Using both two-sided Mann-Whitney U-test and T-test, we find that the forecast bias is significantly higher in GMU than in CSU in all-female markets ($p = 0.002$, U-test, $p = 0.002$, T-test).

Both of the forecast bias (for all the future periods) in all-male markets in GMU and CSU is insignificantly different from zero ($p = 0.562$ and $p = 0.401$, two-sided Wilcoxon signed-rank test). There is also no significant difference between these two

groups ($p=0.789$, U-test, $p=0.142$, T-test).

We also find that there is significant difference of the forecast bias for all future periods between all-female and all-male markets in GMU ($p=0.010$, two-sided Mann-Whitney U-Test).

Overall, we find significant forecast bias only in all-female markets in GMU in all of the four exclusively gender groups.

Table 3 Forecast over Gender and Culture In all-female and all-male markets

Gender	Culture	N.	Forecast			Forecast Bias
			Forecast1	Bias1	Forecast	
Female	GMU	54	259.91	88.97	336.56	154.18
	CSU	54	213.33	21.28	222.39	-13.61
	p-value (U-Test)		0.931	0.839	0.113	0.002
	p-value (T-Test)		0.186	0.053	0.022	0.002
	GMU	53	300.09	74.74	328.83	59.74
	CSU	54	284.96	-5.06	244.98	-5.18
Male	p-value (U-Test)		0.482	0.079	0.194	0.789
	p-value (T-Test)		0.617	0.010	0.054	0.142

Notes: All of the forecast in this table are forecasts before the first period, i.e. the forecast before trading takes place. Forecast bias = forecast price – average trading price. Forecast1 and forecast bias1 are the forecast for period1. Forecast and forecast bias are the forecast for all the future period including period 1. We exclude one outlier in all-male markets in GMU which is 6600 for the forecast of the first period. The p-value is from a two-sided Mann-Whitney U-Test and a two-sided T-Test.

Comparison to Eckel and Fullbrunn (2015)

We compared bubble measures in all-female markets between Eckel and Fullbrunn (2015) and our CSU data, and found convergent evidence for the results reported above in Table 4. In particular, the *Average Bias* and *Boom Duration* are significantly higher and the *Negative Deviation* and *Bust Duration* are significantly lower in China than in U.S. female-only markets. In comparison to the female-only data from GMU,

the significance of the difference in *Average Bias* is greater ($p=0.016$)¹⁰.

Further, we also compared bubble measures in all-female markets in Eckel and Fullbrunn (2015) with our CSU and GMU all-male markets, respectively. Both of the all-male markets in CSU and GMU are distinct from the all-female markets in Eckel and Fullbrunn (2015).

Table 4 Observed Values of Bubble Measures between Eckel and Fullbrunn (2015) and CSU in all-females markets

Session ID	Treatment	Average Bias	Total Dispersion	Positive Deviation	Negative Deviation	Boom Duration	Bust Duration	Turnover
Average	EF	-25.71	1668.17	641.33	1027.17	6.67	7.83	14.28
1	EF	-47.77	1583.0	433.0	1150.0	6	9	11.28
2	EF	26.20	1536.0	965.0	572.0	10	5	12.89
3	EF	-75.90	1277.0	69.0	1208.0	4	9	9.94
4	EF	6.67	2586.0	1343.0	1243.0	7	8	20.72
5	EF	-21.70	1854.0	764.0	1090.0	7	8	19.72
6	EF	-41.73	1173.0	274.0	900.0	6	8	11.11
Average	CSU	45.86	1469.50	1078.67	390.83	10.17	4.17	9.24
1	CSU	57.70	1517.5	1191.5	326	13	2	8.28
2	CSU	54.10	1053.5	932.5	121	10	3	9.33
3	CSU	-21.73	1307	490.5	816.5	7	8	13.56
4	CSU	29.07	1827	1131.5	695.5	8	6	11.83
5	CSU	76.30	1534.5	1339.5	195	12	2	4.17
6	CSU	79.70	1577.5	1386.5	191	11	4	8.28
p-value		0.0163	0.4233	0.1093	0.0104	0.0189	0.0177	0.0776

Notes: This table reports the observed values of various measures of the magnitude of bubbles for each session. *Average Bias* = $\Sigma (Pt - FVt) / 15$ where Pt and FVt equal median price and fundamental value in period t , respectively. *Total Dispersion* = $\Sigma |Pt - FVt|$. *Positive Deviation* = $\Sigma |Pt - FVt|$ where $Pt > FVt$, and *Negative Deviation* = $\Sigma |Pt - FVt|$ where $Pt < FVt$. The boom and bust durations are the greatest number of consecutive periods that median transaction prices are above and below fundamental values, respectively. *Turnover* = $\Sigma Qt / 18$ where Qt equals the number of transactions in period t . The last row shows the p -value from a two-sided Mann-Whitney U -Test comparing all-male and all-female sessions.

¹⁰ Additionally, we also compared the difference between Eckel and Fullbrunn (2015) and our GMU data (both from Western Universities) in all-female markets and all-male markets respectively. None of the seven bubble measures is significant in all of the above comparisons.

5. Conclusion and discussion

Gender difference in experimental asset markets and the real financial markets have received substantial discussion in both academia and in industry, especially since the 2008 financial crisis. Males, who comprise the majority of financial markets traders, are argued to be the source of excessive and risky trading, a potential contributor to the financial crisis. Academic evidence from the West suggests that females generate smaller bubbles than males (Eckel and Fullbrunn, 2015). We investigated whether this result holds also in the East, and in particular China. We ran exclusively females, exclusively males and mixed-gender experimental asset markets both in U.S. and China. We found that, unlike the all-female's pricing style in U.S., exclusively female trading groups in China display the same and typical bubble producing and crashing patterns as males. We find no significant difference in all-male markets between U.S. and China.

An explanation for the difference in trading behavior between Eastern and Western women could be radical Communist policies that promoted gender equality and female labor force participation. The labor force participation of women aged 15 and over was 67.9% in China in 2010, much higher than most of the OECD countries including the U.S. (Zhang, 2015)¹¹. These policies and social norms may have increased females' willingness to compete. If so this suggests that gender differences are at least partially socially determined. Since social contexts and cultures differ worldwide and may change over time, we should perhaps recognize that culture can impact the effectiveness of gender-based policies meant to increase price-stability in financial markets.

Gender differences in economic behavior are also impacted by stereotype (Coffman, 2014), and may be one reason females are less willing to compete (Iriberry and Rey-Biel, 2013). Stereotype, however, is a social construct (Bian et al. (2017) Bordalo et al., 2016; Gneezy et al. 2009; Rosin, 2010), which like culture may vary across time and place.

¹¹ In fact, East Asia has a much higher female labor force participation rate than Developed Economies and European Union. For example, According to Elder and Rosas(2015), the female youth labor force participation rate in 1991 is 76.6% in East Asia, 24.2% higher than Developed Economies and European Union (52.4%).

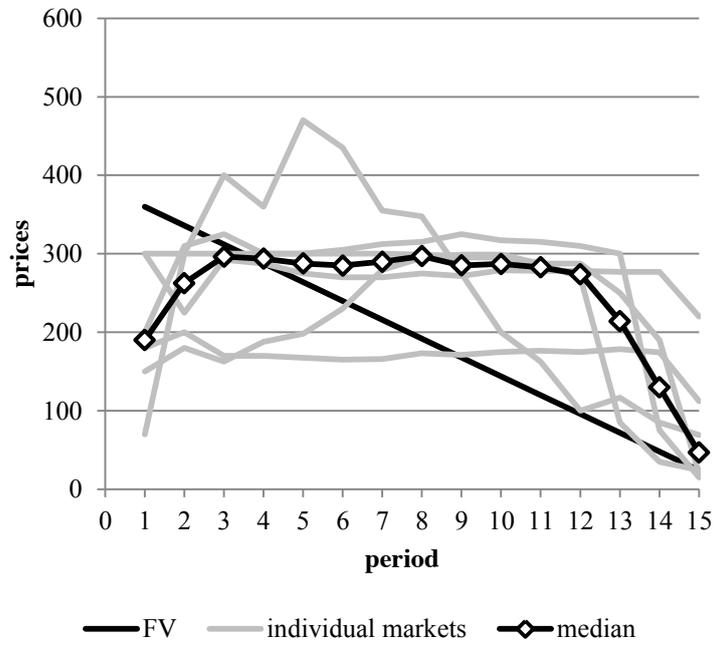
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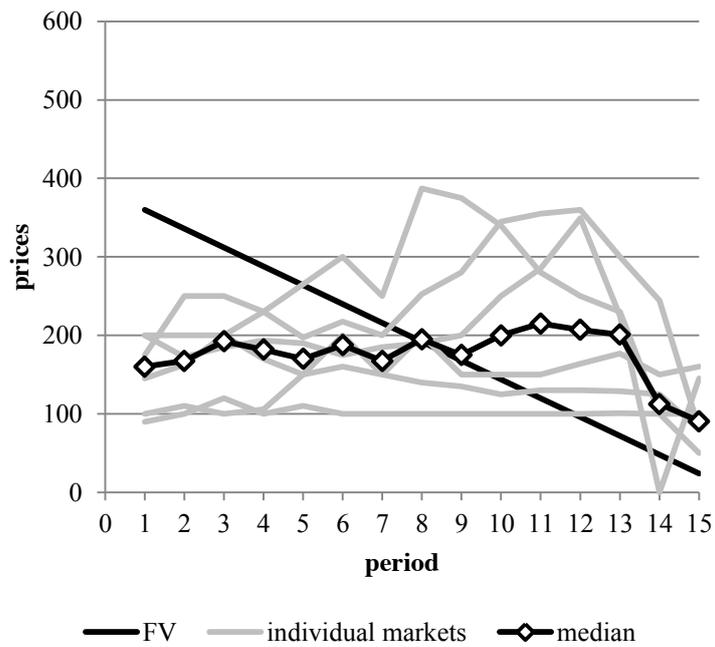
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Appendix A.

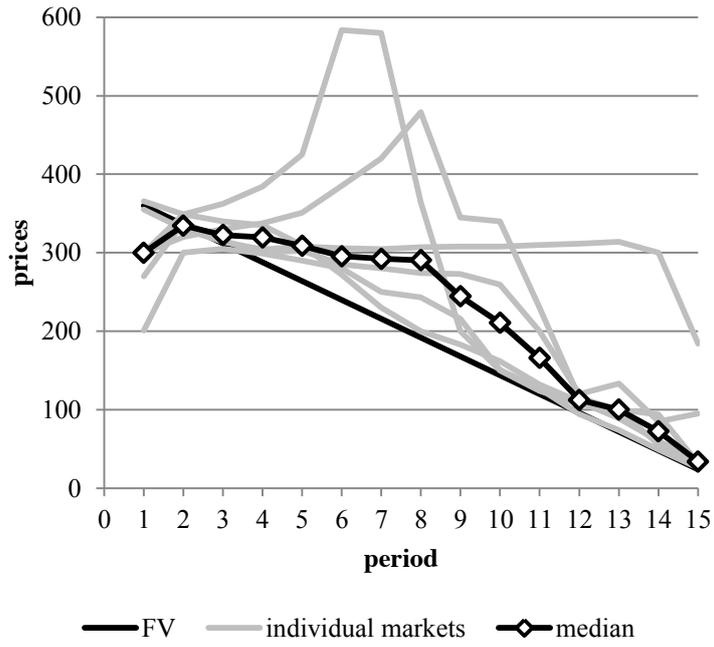
Time series of the median transaction prices for individual market in each treatment



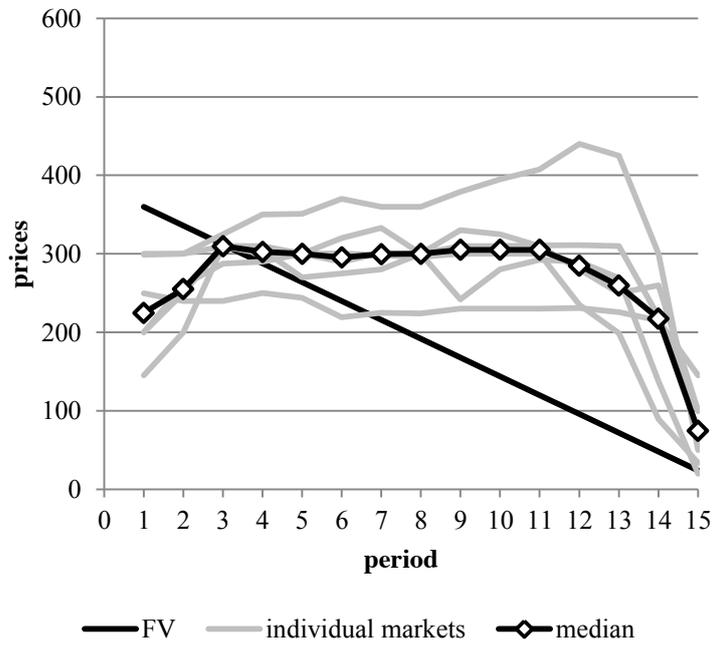
All-female(China)



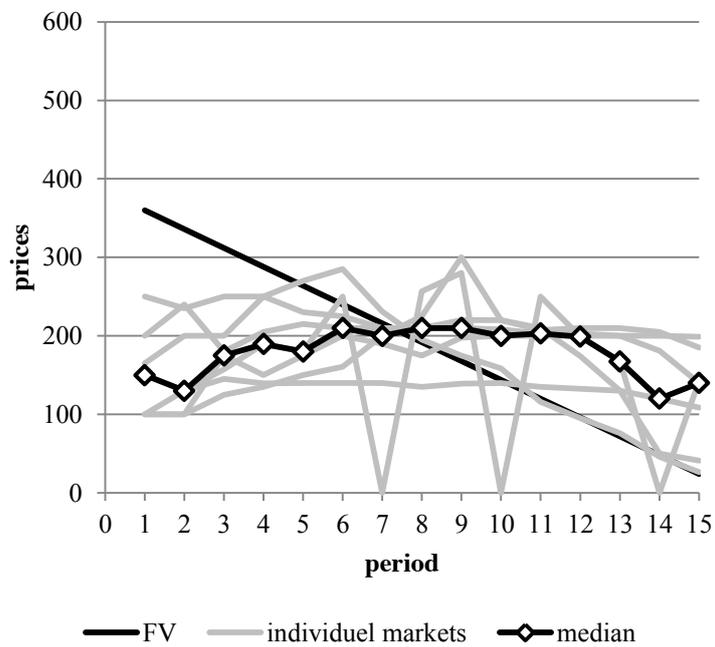
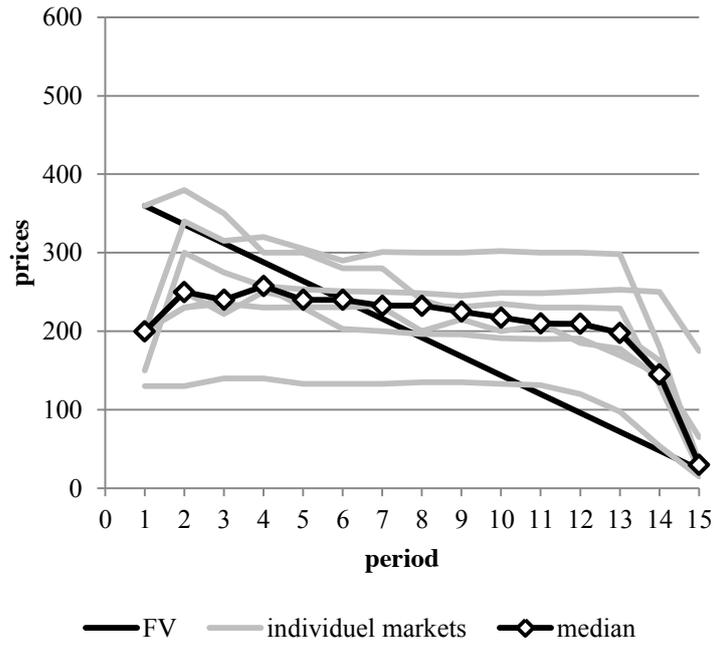
All-female(U.S.)



All-male(China)



All-male(U.S.)



Appendix B.

Asset market instructions

1. General Instructions

This is an experiment in the economics of market decision making. If you follow the instructions and make good decisions, you might earn a considerable amount of money, which will be paid to you in cash at the end of the experiment. The experiment will consist of a sequence of trading periods in which you will have the opportunity to buy and sell shares. Money in this experiment is expressed in tokens (100 tokens = 1 Dollar).

2. How To Use The Computerized Market.

The goods that can be bought and sold in the market are called *Shares*. On the top panel of your computer screen you can see the *Money* you have available to buy shares and the number of shares you currently have.

If you would like to **offer to sell a share**, use the text area entitled “Enter Ask price”. In that text area you can enter the price at which you are offering to sell a share, and then select “Submit Ask Price”. Please do so now. You will notice that 9 numbers, one submitted by each participant, now appear in the column entitled “Ask Price”. The lowest ask price will always be on the top of that list and will be highlighted. If you press “BUY”, you will buy one share for the lowest current ask price. You can also highlight one of the other prices if you wish to buy at a price other than the lowest.

Please purchase a share now by highlighting a price and selecting “BUY”. Since each of you had put a share for sale and attempted to buy a share, if all were successful, you all have the same number of shares you started out with. This is because you bought one share and sold one share. When you buy a share, your *Money* decreases by the price of the purchase, but your shares increase by one. When you sell a share, your *Money* increases by the price of the sale, but your shares decrease by one. Purchase prices are displayed in a table and in the graph on the top right part of the screen.

If you would like to **offer to buy a share**, use the text area entitled “Enter Bid price”. In that text area you can enter the price at which you are offering to buy a share, and then select “Submit Bid Price”. Please do so now. You will notice that 9 numbers, one submitted by each participant, now appear in the column entitled “Bid Price”. The highest price will always be on the top of that list and will be highlighted. If you press “SELL”, you will sell one share for the highest current bid price. You can also highlight one of the other prices if you wish to sell at a price other than the highest.

Please sell a share now by highlighting a price and selecting “SELL”. Since each of you had put a share for purchase and attempted to sell a share, if all were successful, you all have the same number of shares you started out with. This is because you sold one share and bought one share. You will now have a practice period. Your actions in the practice period do not count toward your earnings and do not influence your position later in the experiment. The goal of the practice period is only to master the use of the interface. Please be sure that you have successfully submitted bid prices and ask prices. Also be sure that you have accepted both bid and ask prices. You are free to

ask questions, by raising your hand, during the practice period.

On the right hand side you have one price diagram showing this period's recent purchase prices (the same in the "Purchase Price" list). On the horizontal axis will be the number of shares traded, and on the vertical axis is the price paid for that particular share. You will also see a graph on the historical performance of the experiment, where the blue dots indicate the maximum price a share was traded in that period, the black dots indicate the average price, and the red dots indicate the minimum price.

3. Specific Instructions for this experiment

The experiment will consist of 15 trading periods. In each period, there will be a market open for 240 seconds, in which you may buy and sell shares. Shares are assets with a life of 15 periods, and your inventory of shares carries over from one trading period to the next. You may receive dividends for each share in your inventory at the end of each of the 15 trading periods.

At the end of each trading period, including period 15 the computer randomly draws a dividend for the period. Each period, each share you hold at the end of the period:

- earns you a dividend of 0 tokens with a probability of 25%
- earns you a dividend of 8 tokens with a probability of 25%
- earns you a dividend of 28 tokens with a probability of 25%
- earns you a dividend of 60 tokens with a probability of 25%

Each of the four numbers is equally likely. The average dividend in each period is 24. The dividend is added to your cash balance automatically. After the dividend is paid at the end of period 15, there will be no further earnings possible from shares.

4. Average Holding Value Table

You can use the following table to help you make decisions.

Ending Period	Current Period	Number of Holding periods	×	Average Dividend per Period	=	Average Holding value per Shares in Inventory
15	1	15	×	24	=	360
15	2	14	×	24	=	336
15	3	13	×	24	=	312
15	4	12	×	24	=	288
15	5	11	×	24	=	264
15	6	10	×	24	=	240
15	7	9	×	24	=	216
15	8	8	×	24	=	192
15	9	7	×	24	=	168
15	10	6	×	24	=	144
15	11	5	×	24	=	120
15	12	4	×	24	=	96
15	13	3	×	24	=	72
15	14	2	×	24	=	48
15	15	1	×	24	=	24

There are 5 columns in the table. The first column, labeled Ending Period, indicates the last trading period of the experiment. 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 experiment. The fourth column, labeled Average Dividend 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 average value for each unit held in your inventory from now until the end of the experiment. That is, for each unit you hold in your inventory for the remainder of the experiment, you will earn on average the amount listed in column 5.

Suppose for example that there are 7 periods remaining. Since the dividend on a Share has a 25% chance of being 0, a 25% chance of being 8, a 25% chance of being 28 and a 25% chance of being 60 in any period, the dividend is on average 24 per period for each Share. If you hold a Share for 7 periods, the total dividend for the Share over the 7 periods is on average $7 \times 24 = 168$. Therefore, the total value of holding a Share over the 7 periods is on average 168.

6. Making Predictions

In addition to the money you earn from dividends and trading, you can make money by accurately forecasting the trading prices of all future periods. You will indicate your forecasts before each period begins on the computer screen.

The cells correspond to the periods for which you have to make a forecast. Each input box is labeled with a period number representing a period for which you need to make a forecast. The money you receive from your forecasts will be calculated in the following manner

Accuracy	Your earnings
Within 10% of actual price	5 tokens
Within 25% of actual price	2 tokens
Within 50% of actual price	1 tokens

You may earn money on each and every forecast. The accuracy of each forecast will be evaluated separately. For example, for period 2, your forecast of the period 2 trading price that you made prior to period 1 and your forecast of period 2 trading price that you made prior to period 2 will be evaluated separately from each other. For example, if both fall within 10% of the actual price in period 2, you will earn 2×5 tokens = 10 tokens. If exactly one of the two predictions falls within 10% of the actual price and the other falls within 25% but not 10% you will earn 5 tokens + 2 tokens = 7 tokens.

7. Your Earnings

Your earnings for the entire experiment will equal the amount of cash that you have at the end of period 15, after the last dividend has been paid, plus the \$5 you receive for participating. The amount of cash you will have is equal to:

Money you have at the beginning of the experiment
 + *Dividends you receive*
 + *Money received from sales of shares*
 - *Money spent on purchases of shares*
 + *Earnings from all forecasts*

Appendix C.

Gamble choice task instructions

Directions: In this game, you have a chance to earn money. Your earnings will depend on what you do and chance, as explained below. When this game is completed, you will be paid the amount you earn in this game. **Note: the dollar values in the experiment are measured in US dollars.**

In this game, you choose **One** from six possible options. Once you choose an option, a six-sided die will be rolled to determine whether you receive payment A or payment B. If a 1, 2, or 3 is rolled you receive payment A; if a 4, 5, or 6 is rolled you receive payment B. You only play the game once.

Options	Payoff A	Payoff B
1	\$ 12	\$ 12
2	\$ 8	\$ 20
3	\$ 4	\$ 28
4	\$ 0	\$ 36
5	-\$ 4	\$ 44
6	-\$ 8	\$ 48

Examples:

If you choose option 1: If you roll 1, 2, or 3 you earn \$12.00; if you roll 4, 5, or 6, you earn \$12.00.

If you choose option 2: If you roll 1, 2, or 3 you earn \$8.00; if you roll 4, 5, or 6, you earn \$20.00.

If you choose option 3: If you roll 1, 2, or 3 you earn \$4.00; if you roll 4, 5, or 6, you earn \$28.00.

If you choose option 4: If you roll 1, 2, or 3 you earn \$0.00; if you roll 4, 5, or 6, you earn \$36.00.

If you choose option 5: If you roll 1, 2, or 3 you **lose** \$4.00 (taken from your show up fee); if you roll 4, 5, or 6, you earn \$44.00.

If you choose option 6: If you roll 1, 2, or 3 you **lose** \$8.00 (taken from your show up fee); if you roll 4, 5, or 6, you earn \$48.00.

Decision:

When you are ready please circle the option (1, 2, 3, 4, 5, or 6) that you prefer. Remember, there are no right or wrong answers, you should just choose the option that you like best.

Appendix D.

Survey 1

Please answer with your response to the following: I...

Choose from the following scale:

Strongly Agree 1 2 3 4 5 **Strongly Disagree**

1. Am easily hurt.
2. Get stressed out easily.
3. Am always worried about something.
4. Am not embarrassed easily.
5. Rarely worry.
6. Am afraid that I will do the wrong thing.
7. Begin to panic when there is danger.
8. Often worry about things that turn out to be unimportant.
9. Worry about what people think of me.
10. Become overwhelmed by events.

11. Like to behave spontaneously.
12. Like to act on a whim.
13. Rarely enjoy behaving in a silly manner.
14. Have persuaded others to do something really adventurous or crazy.
15. Enjoy being reckless.
16. Am willing to try anything once.
17. Do crazy things.
18. Prefer friends who are excitingly unpredictable.
19. Avoid dangerous situations.
20. Would never go hang gliding or bungee jumping.

21. Push myself very hard to succeed.
22. Know how to get around the rules.
23. Want to be in charge.
24. Take charge.
25. Am not highly motivated to succeed.
26. Have a strong need for power.
27. Try to surpass others' accomplishments.
28. Hate being the center of attention.
29. Like to show off my body.
30. Am not an extraordinary person.

31. Get so happy or energetic that I am almost giddy.

- 32. Feel excited or happy for no apparent reason.
- 33. Get caught up in the excitement when others are celebrating.
- 34. Am eager to soothe hurt feelings.
- 35. Rarely get caught up in the excitement.
- 36. Don't get excited about things.

Imagine yourself in the following situations, and chose the answer that best describes what you would do

37. You get an exam back. You

- compare it to the top scores in the class
- compare it to the average scores in the class
- compare it to the lowest scores in the class

38. Your mother's birthday is coming up. Your sister tells you that she has a killer gift for her but won't tell you what it is

- hit the mall in a frenzied effort to find something better
- forget about your sister's gift and get your mom something that you feel she would like
- figure your mom will like anything you give her and get the first thing that comes to your mind

39. You do well on a paper, according to your classmates and teachers. You

- are happy and proud of yourself
- put it aside without analyzing and forget about it
- keep thinking about all those who have done better than you

40. You need to talk to your friend about your newest crush. You call her/him but the line is busy and you get the voice mail. You leave a message asking her/him to call you back. Half an hour goes by and s/he has not called back. You

- keep calling every 5 min
- wait an hour or so and then call her/him again
- find something else to do

41. You are playing Monopoly with your younger cousins (ages 8 and 12). You

- play as well as you can and try to beat them
- loosen up your regular strategy and give them some opportunities to score
- play well but let them win in the end

42. Your goal is to

- be the best at everything
- be as good as you can get
- enjoy life and forget about achievements

43. You are writing an exam. You know you have 2 hours to finish the 100 multiple-choice

questions. After an hour (when you still have 30 questions to go), someone gets up, hands in their exam booklet, and walks out. Ten minutes later, another student leaves. You

check the time to make sure you still have enough time and keep working at the same pace as before

get really nervous, thinking you might not have enough time, and start working faster

get angry or start feeling like a loser because someone has beaten you--you speed up considerably, trying to be the next one to walk out

44. You take an acting class with your best friend. When the casting of roles for a school play are announced, you realize that you got a small role of the main character's visiting cousin, while your friend was cast as the lead. You

get angry and/or bitter

are happy for her/him - s/he definitely deserved the role

don't care either way.

45. Your friend asks you to help her out with a math problem (assume you understand the topic very well). You explain to her/him how you understand it - s/he still does not get it. You

go ahead and explain it again - in a different way

tell her/him that you don't understand very well either - and its no big deal anyways

get angry with her/him - and silently wonder how come you are friends with such a dummy

46. When you face a very challenging task, how do you prefer to proceed? You would rather

work in a group and actively participate

work in a group and let others do most of the work

work alone

47. What do you prefer to do with your free time?

Mostly just hang out, doing nothing in particular

Various things - sometimes just hang out, sometimes work on hobbies, do some sports etc.

What free time?

48. When you are tired, what do you do?

I take it easy and slow down, taking the time to recover

I get plenty of rest so I never get tired

I don't have time for fatigue - I just keep going

49. How old are you in years?

50. What is your gender?

Male Female

51. What is your marital status?

Single, Never Married

Married, Civil Union, Domestic Partner

Separated
Divorced
Widowed

52. Are you a full time or part time student?

Full-time Student
Part-time Student
Not a Student

53. What is your current student classification?

Freshmen
Sophomore
Junior
Senior
Graduate Student
Not a Student

54. What is your ethnicity? Please check ALL categories that apply

American Indian or Native Alaskan
Black or African American
East Asian (Chinese, Japanese, Korean, etc.
Hispanic or Latino
Middle Eastern
Pacifier Islander or Hawaiian
South Asian (India, Pakistan, Bangladesh, etc.
White
Other

55. Where were you born?

United States
Another Country

56. Do you speak a language other than English at home?

Yes No

57. What is your employment status?

Not Working
Temporary Job
Permanent Job less than 30 hours per week
Permanent Job more than 30 hours per week

58. What is your own yearly income?

Less than \$13,999
\$14,000 - \$27,999

\$28,000 - \$43,999

\$44,000 - \$65,999

\$66,000 - \$89,000

\$90,000 or above

Not Applicable

59. What is your religious affiliation?

Agnostic or Atheist

Buddhist

Catholic

Hindu

Jewish

Muslim

Protestant, Denominational

Protestant, Non-denominational

Other

Do not wish to reveal

60. How often do you attend religious services?

More than once a week

Once a week

At least once a month

Less than once a month

Never

61. Are you a member of a sorority or fraternity?

Yes No

For the following questions, 1 means Strongly Disagree while 10 means Strongly Agree.

62. Do you think that most people would try to take advantage of you if they got a chance, or would they try to be fair?

63. Generally speaking, would you say that most people can be trusted, or that you need to be very careful in dealing with people?

64. Some people believe that individuals can decide their own destiny, while other think that it is impossible to escape a predetermined fate. What comes closest to your view on the scale below?

65. How much of the time do people get what they deserve in life?

Always

Most of the time

About half the time
Once in while
Never

For the following questions, 1 means Strongly Disagree while 10 means Strongly Agree.

66. Some people feel they have completely free choice and control over their lives, while other people feel that what they do has no real effect on what happens to them. Please use this scale to indicate how much freedom of choice and control you feel you have over the way your life turns out.

67. Are you, generally speaking, a person who is fully prepared to take risks, or do you try to avoid taking risks?

68. In general, your health is:

Excellent
Very good
Good
Fair
Poor

69. How many people in this session do you recognize?

70. How many would you consider friends?

71. Phone plan A costs \$30 per month and 10 cents per minute.

Phone plan B costs \$20 per month and 15 cents per minute.

How many minutes makes plan A cost the same as plan B?

72. Multiply 43 and 29:

73. Solve the equation for a: $X^6/X^2 = X^a$, a=?

74. Complete the following statement: As X gets larger and larger, the expression $3-(1/X)$ gets closer and closer to:

75. Suppose 20,000 people live in a city. If six percent of them are sick, how many people are sick?

76. 80 is 20 percent of...

Survey 2

Rate yourself on each item, on a scale from 1 (never or almost never true) to 7 (almost always true)

1. Self-reliant.
2. Yielding.
3. Helpful.
4. Defends own beliefs.
5. Cheerful.
6. Moody.
7. Independent.
8. Shy.
9. Conscientious.
10. Athletic.
11. Affectionate.
12. Theatrical.
13. Assertive.
14. Not susceptible to flattery.
15. Happy.
16. Strong personality.
17. Loyal.
18. Unpredictable.
19. Forceful.
20. Feminine.
21. Reliable.
22. Analytical.
23. Sympathetic.
24. Jealous.
25. Leadership ability.
26. Sensitive to others' needs.
27. Truthful.
28. Willing to take risks.
29. Understanding.
30. Secretive.
31. Makes decisions easily.
32. Compassionate.
33. Sincere.
34. Self-sufficient.
35. Eager to soothe hurt feelings.
36. Conceited.
37. Dominant.
38. Soft-spoken.
39. Likeable.

40. Masculine.
41. Warm.
42. Solemn.
43. Willing to take a stand.
44. Tender.
45. Friendly.
46. Aggressive.
47. Gullible.
48. Inefficient.
49. Acts as a leader.
50. Childlike.
51. Adaptable.
52. Individualistic.
53. Does not use harsh language.
54. Unsystematic.
55. Competitive.
56. Loves children.
57. Tactful.
58. Ambitious.
59. Gentle.
60. Conventional