Hidden vs. Known Gender Effects in Experimental Asset Markets

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Eckel & Füllbrunn (2015) report a striking gender effect in experimental asset markets: Markets with only men produce substantial price bubbles while markets with only women sometimes produce negative bubbles. A possible explanation might be that common expectations about the behavior of men and women in a market drive the bubble formation. If we take away these common expectations, male/female differences might be reduced. Hence, we reran this experiment hiding the single-sex composition of the markets. We find no significant difference between all-male and all-female markets, providing evidence that common expectations play a role in bubble formation.

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Key words: Asset Market, Bubble, Experiment, Gender

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- Using the Smith, Suchaneck, and Williams (1988) asset market design, we conduct single-sex markets in which either only males ore only females participate.
- In contrast to Eckel and Füllbrunn (2015), participants were not aware of the fact that they trade in same-sex markets.
- While Eckel and Füllbrunn (2015) report a substantial gender effect, we find no difference in bubble formation comparing twelve All-male with twelve All-female markets.

1 Introduction

Eckel & Füllbrunn (2015, henceforth EF) considered whether women and men behave differently in financial markets. Using the experimental asset market design from Smith, Suchanek, & Williams (1988), they find a striking male/female difference: Markets with *only male subjects* show substantial price bubbles while markets with *only female subjects* trade do not, and sometimes even trade below fundamental value. One particular design aspect in EF is that subjects know that they are in single-sex markets. In this study, we retain single-sex markets but alter the design such that the sex composition in a market is unknown. Hence, the course of action may no longer depend on stereotype-based expectations about the behavior of females or males respectively.

Females are stereotypically less risk-taking and less competitive than men. Thus, in EF expectations about prices might be lower in the female than the male markets because of beliefs about the impact of risk-taking and competitiveness on prices. If this is the case, speculation in male markets might be justified, and rising prices become a self-fulfilling prophecy, while in female markets prices are not expected to increase. Differences in expectations thus lead to differences in prices.

Our study is related to Cheung et al. (2014), who test the effect of common knowledge of rationality. They trained some subjects to trade at the fundamental value. When it is common knowledge that all traders in a market are trained, bubbles do not occur. But when it not commonly known, bubbles do occur. We adapt their protocol to consider a situation in which the male/female composition in a market is either common knowledge (EF) or hidden. In the latter, expectation formation is no longer influenced by the single-sex market composition.

In related experiments, Cueva & Rustichini (2015) and Holt, et al.(2016) use flat fundamental value environments in comparison to the decreasing fundamental value (EF). Neither finds a male/female difference in overpricing.[1]

2 Experimental Design

Nine subjects 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 that is 0, 8, 28, or 60 francs with equal probability. Since the expected per-period dividend equals 24 francs, the fundamental value in period t equals $24\times(16-t)$, and declines from 360 in period 1 to 24 in period 15. Before period one, subjects are endowed with shares and cash. After the last dividend payment in period 15, the shares become worthless and the cash holdings–the endowment plus gains from trade plus dividends–are paid out at an exchange rate of one cent to one franc.

[1] Find also a brief section on gender/sex differences experiments in the online-appendix.

In each session, unbeknownst to the subjects, nine male subjects were grouped into the All-male market, and nine female subjects into the All-female market.[2] In contrast to EF, our subjects were not aware of the sex composition of their markets, because females and males were mixed in the session.

Twelve sessions (162 subjects) were conducted at the Economics Research Lab at Texas A&M University. Recruiting, instructions and protocol were similar to EF; details can be found in the online appendix.

3 Experimental Results

Figure 1 depicts the time series of median prices from individual markets along with the fundamental value and the treatment average. In both treatments prices exceed fundamental value in most of the periods. But in contrast to EF, the figures suggest no difference between All-female and All-male markets.

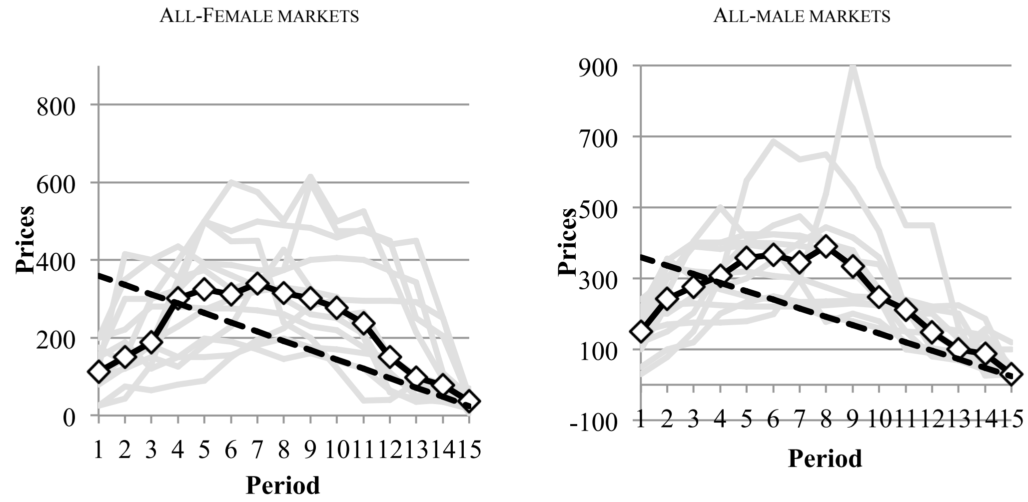

Figure 1. Time series of median transaction prices

Notes: Median prices of individual markets (grey lines), fundamental value (FV, bold line) and treatment-median of median session prices (black line with diamonds) for each period.

To measure treatment differences, we utilize established bubble measures (Haruvy & Noussair, 2006) as EF did. Table 1 shows averages of bubble measures separated for All-male markets and All-female markets (find details in the online appendix). Average Bias (AB) is the average, across all 15 periods in a session, of the per-period deviation of the median price from the fundamental value, and serves as a measure of overpricing. A positive AB indicates prices to be above fundamental value and vice versa. Total Dispersion is defined as the sum, over all 15 periods, of the absolute per-period deviation of the median price from the fundamental value, and serves as a measure of mispricing. A large value

[2] The sex of the students was self-declared when they registered for our online subject pool, and subjects were recruited for specific sessions based on that indication.

for Total Dispersion indicates a large overall distance from fundamental value. For reasons explained in EF, we also consider Positive Deviation, which is the sum of the absolute per-period deviation of the median price from the fundamental value if prices are above fundamental value. We also counted the greatest number of consecutive periods above fundamental value (Boom Duration). Finally, Turnover is the standardized measure of trading activity and defined as the sum of all transactions divided by the number of shares in the market. High Turnover is related to high trading activity and is associated with mispricing. A bubble is characterized as the positive deviation of prices from fundamental value. Thus, positive AB along with high Total Dispersion, high Positive Deviation, and long Boom Duration are indicators of a price bubble. In the following, we compare the two treatments by using the measures of interest.

Table 1. Observed Averages of Bubble Measures

Treatment	Average Bias	Total Dispersion	Positive Deviation	Boom Duration	Turnover
All-Female	**44.62**	**1984**	**1327**	**8.83**	**10.38**
All-Male	**54.57**	**1682**	**1250**	**9.58**	**9.93**
p-value MWU	0.564	0.603	0.773	0.641	0.623
p-value WSR	0.695	0.583	1.000	0.782	0.814

Notes: This table reports the observed values of various bubble measures for each session. Average Bias = $\sum (P_t - FV_t)/15$ where P_t and FV_t equal median price and fundamental value in period t, respectively. Total Dispersion = $\sum| P_t - FV_t |$. Positive Deviation = $\sum| P_t - FV_t |$ where $P_t > FV_t$. Boom = # periods with median price > FV. Turnover = Total Number of trades/18. The MWU row shows the p-value from a two-sided Mann Whitney U-Test comparing All-Male and All-Female sessions. The WSR row shows the p-value from a two-sided Wilcoxon signed rank test testing for the within-session differences. *Two periods without trade and **one period without trade. We extrapolated the missing median prices by taking the median of the observation after and before.

Observation 1: Bubbles occur in All-male markets but less so in All-female markets.

The average of the AB measure is 54.57 (SD 43.29) in the All-male market and 44.62 (SD 80.91) in the All-female markets. Using a Wilcoxon signed rank test as in EF, we can reject the Null that AB is lower or equal to zero against the alternative that the AB is greater than zero only in the All-male markets ($p_{All-Male} = 0.006,\ p_{All-Female} = 0.117$).

Observation 2: The magnitude of bubbles is not significantly lower in All-Female markets than in All-Male markets.

We find no significant difference in any of the bubble measures (p-values, see table 1). In line with a test introduced by Haruvy & Noussair (2006), we additionally compare the two treatments by considering the differences between the simultaneous All-male and All-female markets in each period and test whether these 15 differences are significantly different from zero (assuming independency across periods). We find no significant difference ($p = 0.334$).

Merging our data ($n = 24$) with data from EF ($n = 12$), we ran OLS regressions (provided in the online appendix) with session-level AB as the dependent variable, and a known dummy (1 if EF, 0 otherwise), a female dummy (1 if female, 0 if male), and an interaction (1 if EF and female, 0 otherwise). We ran regression #1 (n=36, R2=0.244) without and regression #2 (n=36, R2=0.430) with market level averages of subjects' characteristics that we elicited as controls.3 The benchmark is thus the hidden All-male treatment. The positive known dummy (#1: 19.55, SE 29.34; #2: 36.56, SE 34.89) indicates the higher AB in EF for All-male markets, while the negative female dummy (#1: – 9.957, SE 23.96; #2: –24.76, SE 45.49) indicates a lower AB in All-female markets. However, coefficients are not significantly different from zero. The interaction term (#1: –89.87, SE 41.49; #2: –103.2, SE 45.72), however, is significantly negative at the five percent level indicating lower bubbles in the All-female/known treatment only. Note that neither the first period price forecasts (#2: -0.244, SE 0.165) nor the elicited measure of risk aversion (#2: -12.27, SE 0.341) have a significant effect on the bubble measure.

4 Discussion and Conclusion

Eckel & Füllbrunn (2015) show a striking male/female difference in price bubble formation in experimental asset markets. We ran the same experiment with 24 markets but without providing information about sex composition in a market. To our surprise, we cannot replicate the previous male/female difference.

This phenomenon may have several causes. First, common knowledge of rationality in line with Cheung, et al.(2014) drives different expectations about market behavior. Eliciting price forecasts, we see that first period price expectations are significantly higher for males than females when the sex is known (Mann-Whitney U-test, $n_i = 54$, $p < 0.001$), but not significantly different when the sex is hidden (Mann-Whitney U-test, $n_i = 108$, $p = 0.484$). Second, having common information about a market (sex in our case, training in theirs) might reduce strategic uncertainty leading market performance to be less variable within treatments. As in Cheung, et al. (2014), we observe that the treatment without public common knowledge (hidden in our case) has a higher variability in terms of price paths than the known treatments, in particular for females. Third, according to the "room effect" reported by Castillo, et al. (2013), females appear to be less risk averse if males participate in the same session. While EF ran either only male or only female sessions, we ran simultaneous all-male and all-female markets in the same sessions. Hence, the "room effect" might foster greater risk taking or competitiveness for females leading to higher bubbles in the hidden treatment.

Is seems that stereotyping plays a role when behaving in dynamic market environments. However, we need more controlled experimental considerations to understand the underlying mechanisms.

[3] We elicited the same measures as in EF: forecasts prior to each period's play in line with Haruvy, Lahav, & Noussair (2007); risk attitudes in line with Eckel & Grossman (2008); personality measures from Carver & White (1994) that assess anxiety, fun seeking, drive, and reward; and a survey measure of Type A personality, which constitutes a measure of competitiveness (Friedman, 1996).

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Online Appendix
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I. Literature on sex/gender effects in experiments

'Hawkish' strategy is played significantly more often against women than against men (Holm, 2000). Women give significantly less to other women than they do to men or to persons of unknown gender in dictator games (Ben-Ner, Kong, & Putterman, 2004). Women are perceived as being more risk averse than men (Daruvala, 2007; Eckel & Grossman, 2008). Having the same sex in bargaining games (Sutter, Bosman, Kocher, & van Winden, 2009) or tournaments (Datta Gupta, Poulsen, & Villeval, 2013; Gneezy, Niederle, & Rustichini, 2003) seems to increase competitiveness. However, there are inconclusive effects for ultimatum games (Eckel & Grossman, 2001; Solnick, 2001)and trust games (Buchan, Croson, & Solnick, 2008; Chaudhuri, Paichayontvijit, & Shen, 2013).

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II. Bubble Measures

Table 1. Observed Values of Bubble Measures

Session ID	Treatment	Average Bias	Total Dispersi on	Positive Deviation	Boom Duration	Turnover
Average	**All-Female**	**44.62**	**1984**	**1327**	**8.83**	**10.38**
12	All-Female	128.33	2283	2104	13	8.00
22	All-Female	4.50	740	404	8	11.50
32*	All-Female	25.62	2002	1193	12	6.28
42	All-Female	48.07	1207	964	11	8.44
52	All-Female	19.43	1528	910	6	7.56
62	All-Female	83.33	3035	2143	9	8.11
72	All-Female	-49.13	1128	196	7	13.72
82	All-Female	-63.47	954	1	1	13.11
92	All-Female	-14.07	2461	1125	8	11.44
102	All-Female	169.87	3787	3168	12	18.56
112	All-Female	183.37	3267	3009	12	7.94
122	All-Female	-0.47	1416	705	7	9.94
Average	**All-Male**	**54.57**	**1682**	**1250**	**9.58**	**9.93**
11	All-Male	67.73	1397	1207	8	10.06
21	All-Male	67.33	1752	1381	11	14.83
31	All-Male	109.43	3190	2416	7	11.11
41	All-Male	120.17	3304	2553	12	7.56
51	All-Male	71.97	1728	1404	9	13.61
61	All-Male	-1.90	1140	556	8	16.44
71	All-Male	67.80	2088	1553	12	5.67
81	All-Male	82.53	1536	1387	13	8.33
91	All-Male	57.77	1235	1051	13	7.61
101**	All-Male	-17.17	1458	600	10	11.11
111**	All-Male	5.43	485	283	7	6.44
121	All-Male	23.77	878	617	5	6.39
p-value MWU		0.564	0.603	0.773	0.641	0.623
p-value WSR		0.695	0.583	1.000	0.782	0.814

Notes: This table reports the observed values of various bubble measures for each session. Average Bias = $\sum (P_t - FV_t)/15$ where P_t and FV_t equal median price and fundamental value in period t, respectively. Total Dispersion = $\sum| P_t - FV_t |$. Positive Deviation = $\sum| P_t - FV_t |$ where $P_t > FV_t$. Boom = # periods with median price > FV. Turnover = Total Number of trades/18. The MWU row shows the p-value from a two-sided Mann Whitney U-Test comparing All-Male and All-Female sessions. The WSR row shows the p-value from a two-sided Wilcoxon signed rank test testing for the within-session differences. *Two periods without trade and **one period without trade. We extrapolated the missing median prices by taking the median of the observation after and before.

III. Regression

Notes. Ordinary least square regression with AB being the independent variable. Treatment dummies are *Known* (1 if known, 0 if hidden) and *Female* (1 if female, 0 otherwise). Interaction effect *Known x Female*. Further controls are the forecast for period one, the personality traits according to Carver & White (1994) and Friedman (1996), a test on math ability (see section VI below), and the option chosen in the risk task (see section V below).

VARIABLES	(1) AB	(2) AB
Known	19.55	36.56
	(29.34)	(34.89)
Female	-9.957	-24.76
	(23.96)	(45.49)
Known x Female	-89.87**	-103.2**
	(41.49)	(45.72)
Forecast Period 1		-0.244
		(0.165)
Anxiety		4.199
		(4.558)
Fun seeking		-3.240
		(5.351)
Drive		9.650
		(7.553)
Reward		-2.717
		(8.601)
Type A		662.7**
		(315.7)
Math		-34.12
		(138.2)
Option (Risk)		-12.27
		(34.08)
Constant	54.57***	-47.47
	(16.94)	(167.1)
Observations	36	36
R-squared	0.244	0.430

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

IV. Asset Market Instructions

Subjects were recruited using ORSEE (Greiner, 2015). The experiments were computerized using z-Tree (Fischbacher, 2007).

Greiner, B. (2015). Subject pool recruitment procedures: organizing experiments with ORSEE. *Journal of the Economic Science Association*, *1*(1), 114–125.

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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. Share*s* 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 Share 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*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 token

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

V. Gamble Choice Task Instructions

Directions: In this game, you have a chance to earn money. Your earnings will depend on what you do, what others do, and chance, as explained below.[1] 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.**

[1] The instructions contain a small error, "what others do." This does not appear to have caused any confusion among the subjects. No subject commented or asked a question about the phrase, and no subject showed any sign of being unsure of their earnings conditional on their choices, based on interviews with the experimenters and a review of the lab logs for the sessions.

In this game, you choose **<u>One</u>** 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.

Option	Payment A	Payment B
1	$12.00	$12.00
2	$8.00	$20.00
3	$4.00	$28.00
4	$0.00	$36.00
5	-$4.00	$44.00
6	-$8.00	$48.00

<u>Examples</u>:

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.

<u>Decision</u>:

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.

VI. Math Ability Task

MATH ABILITY INSTRUCTIONS

We also considered a Math Ability Test without monetary incentives in which students had to answer the following questions

1) 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?;

2) Multiply 43 and 29;

3) Solve the equation for a: X6/X2 = Xa;

4) Complete the following statement: As X gets larger and larger, the expression 3-(1/X) gets closer and closer to…;

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

6) 80 is 20 percent of…