Thar "SHE" blows?
Gender, Competition, and Bubbles in Experimental Asset Markets

By CATHERINE C. ECKEL AND SASCHA C. FÜLLBRUNN *

Do women and men behave differently in financial asset markets? Our results from an asset market experiment using the Smith, Suchaneck, and Williams (1988) framework show marked gender difference in producing speculative price bubbles. Using 35 markets from different studies, a meta-analysis confirms the inverse relationship between the magnitude of price bubbles and the frequency of female traders in the market. Women's price forecasts also are much lower, even in the first period. Additional analysis shows the results are not due to differences in risk aversion, personality, or math skills. Implications for financial markets and experimental methodology are discussed.

JEL codes: C91, G02, G11, J16

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Eckel: Department of Economics, Texas A&M University, College Station, TX 77843-4228 (ceckel@tamu.edu); Füllbrunn: Radboud University Nijmegen, Department of Economics, Thomas van Aquinostraat 5.1.15, 6525 GD Nijmegen, The Netherlands (s.fullbrunn@fm.ru.nl). We thank participants at the ESA World Meeting in Chicago 2011, ESA European Conference Luxembourg 2011, Experimental Finance 2011 in Innsbruck, 6th Nordic Conference on Behavioral and Experimental Economics 2011 in Lund, and the ESA Northern Meeting in Tucson 2011 for helpful comments. Thanks also to Malcolm Kass and Ericka Scherenberg-Farrett for research assistance. Funding was provided by the Negotiations Center and the Center for Behavioral and Experimental Economic Science at the University of Texas at Dallas. Füllbrunn was supported by the National Research Fund, Luxembourg (PDR 09 044).

"*With more women on the trading floor, risk-taking would be a saner business.*"

The New York Times (Sept. 30, 2008).

The financial crisis had – and still has – tremendous consequences for economies all over the world. The housing market bubble finally burst, leading to a sharp decrease in asset value with negative externalities on the entire worldwide banking system. Reasons for the occurrence of the bubble such as excessive risk taking, new financial instruments (CDO, CDS) or lax regulations have been discussed. The New York Times article referenced above claims the more obvious culprit of the financial crises in 2008 to be men. Like the Gordon Gekko "Greed is Good" stereotype of a Wall Street trader, men in financial markets neglect the human element, to take irresponsible risks, and to compete with other 'alpha dogs' in cut-throat competition. The article suggests an influx of talented women on the trading floor could reduce aggressive risk taking and, thus, serve to calm down markets and limit the emergence of speculative price bubbles. But do women and men behave differently in financial asset markets?

Empirical studies report gender differences in financial decision making. Women investors tend to invest more often in risk-free assets (Hariharan et al. 2000), choose less risky investment portfolios (Jianakoplos and Bernasek 1998), and have a lower propensity towards financial risk than men (Barsky et al., 1997). Men trade more frequently, and earn lower portfolio returns as a result (Barber and Odean 2001). This behavior is sometimes attributed to the greater overconfidence of men (e.g. Barber and Odean 2001), but not all studies confirm this pattern (Beckman and Menkoff 2008). Differences are also found between men and women finance professionals. Women fund managers in the US are found to be more risk averse, to follow less extreme investment strategies, and to trade less often, but their performance does not differ significantly from men (Niessen and Ruenzi 2007). Atkinson et al. (2003) find that women brokers do not choose more risk-averse portfolios for their clients than their male counterparts, though the flow of investment moneys to female-managed funds is lower. Consistent with those results, Madden (2012) shows that women brokers receive lower-quality account referrals, but that performance is no different conditional on the quality of transferred accounts. Some evidence suggests that women brokers may outperform their male counterparts (Kim 1997). A recent survey by Rothstein Kass (2013) reports that women-managed hedge funds hold more conservative portfolios and outperform the industry average.

A shortcoming of empirical studies of gender differences in financial markets cannot avoid the fact that female traders reach their positions only at the end of a lengthy selection process, which is largely controlled by men. Trading is a male dominated environment and its culture involves a lot of machismo (Roth 2006). Given these women acquired male related attributes to survive in this environment, empirical results on gender differences in financial markets may be biased. Thus, we make use of experimental methods to uncover gender differences in financial markets. Our subjects are recruited from the general student body, and so avoid any biases that might affect the selection of male and female traders.

Recent laboratory experiments consider gender differences in several decision making settings. Relevant for trading in asset markets, two main effects have been established across several environments: women are more risk averse than men, and women appear to dislike competitive environments and react negatively to competitive pressures. Comparing data across abstract gambles, contextual experiments and field studies, Eckel and Grossman (2008c) note that many studies find no gender difference in risk taking but when a significant difference is found it is nearly always that women are more risk averse. A meta-analysis of 150 studies finds a significant difference in the risk attitudes of men and women (Byrnes et al. 1999), with women preferring less risk. In general, men are greater risk takers, although the gender difference varies with the risky environment. The difference seems also greater among older participants. Croson and Gneezy (2009) also infer from their survey of risk-aversion experiments that women are more risk averse than men in most tasks and most populations.

Beginning with Gneezy, Niederle and Rustichini (2003), a number of articles confirm the differential effect of competition on the performance of women and men: while competitive situations improve effort levels and performance for men they leave the performance of women unchanged. Furthermore, given the choice, women avoid competitive environments, while men choose to compete even when they are likely to lose (Niederle and Vesterlund 2007; see Croson and Gneezy 2009 for a survey).

The reported gender differences in the experimental literature suggest that women traders in asset markets will be less willing to take risks, and that they will avoid engaging in aggressive competition with other traders. However, these conclusions are based on individual decisions or winner-take-all tournaments, but not on environments where trading takes place. Some studies on experimental asset markets infer gender differences from their data. In a study relating individual risk attitudes to market behavior, Fellner and Maciejovsky (2007) find women submit fewer offers and engage in fewer trades than men. In an asset market with short-lived assets, Deaves, Lüders, and Luo (2009) find no gender effect in trading among students in Canada, but observe that women trade less than men in Germany.[1]

To our knowledge, ours is the first study that is designed explicitly to test for gender differences in experimental markets for long-lived assets. We employ the most commonly-used experimental asset market design from Smith, Suchaneck, and Williams (1988). The key finding in studies based on this design is that prices exceed fundamental value and produce a bubble pattern. In a typical session, prices start below fundamental value, increase far above fundamental value and crash before maturity. This bubble pattern has been replicated in numerous studies. Find a discussion about the experimental design and a survey on findings in Palan (2013). We manipulate the experimental design in that we invite either only women or only men to a market session.

From the literature on gender differences in risk taking and competition we derive our main hypothesis that *all-male markets will generate higher speculative bubbles than all-female markets.* The experimental results support our hypothesis, and show that all-female markets not only generate smaller bubbles than all-male markets, but in some cases generate 'negative' bubbles – that is, prices substantially below fundamental value.

[1] The way the study is constructed may have confounded gender effects.

[2] We sent emails to all authors using the Smith et al. (1988) asset market design and made an announcement at the European Science Association discussion forum. Unfortunately, many researchers stated that data on the gender of participants was not collected in their experiments. All sessions have the same dividend process and 15 periods. In Cheung, Hedegaard, and Palan (2011) ten subjects participated in the markets, in sessions 56 and 57 of Haruvy, Noussair, and Powell (2011) eight subjects, and in session 6 of Powell (2011) seven subjects.

[3] Find bubble measures for each session implemented in the meta- analysis in the appendix.

Since these results are remarkably strong, we also conduct a meta-analysis with 35 markets from different experimental studies. We find a substantial correlation between the fraction of women in the market and the magnitude of observed price bubbles. These results support the hypothesis that increasing the number of women in the market reduces overpricing. These results suggest that the statement from The New York Times contains an element of truth.

I. Asset Market Design

Each session is a market with a parametric structure that is identical to that of "design 4" described in Smith et al. (1988). Nine traders 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 dividend equals 24 francs in every period, the fundamental value in period t equals $24*(16 - t)$, i.e. 360 in period 1, 336 in period 2, ... and 24 in period 15. Traders are endowed with shares and cash before the first period. Three subjects receive three shares and 225 francs, three subjects receive two shares and 585 francs, and the remaining three subjects receive one share and 945 francs. The exchange rate is one cent to one franc. The treatment variable is gender. In six sessions, the "all-female markets," only women were invited to participate, and in the other six sessions, the "all-male markets," only men were invited to participate.

Experiments were conducted at the Center for Behavioral and Experimental Economic Science at University of Texas at Dallas. Subjects were recruited using ORSEE (Greiner 2004). The experiments were computerized using zTree (Fischbacher 2007). Since we ran 12 sessions with 9 subjects each, 108 subjects participated. Instructions – taken basically from Haruvy and Noussair (2006) and Haruvy et al. (2007) – were read aloud and subjects practiced the double auction facility in a training phase. Instructions can be found in the Appendix.

II. Analysis of gender effects on asset market pricing

A. Gender effects in our experiment

Figure 1 depicts the time series of median prices from individual markets (grey lines) and average of median session prices (bold line with diamonds), by period, for all-female markets (left) and all-male markets (right). The bold diagonal line is the fundamental value (FV), which declines over time. The figure indicates that price levels are higher in all-male sessions than in all-female sessions, though neither tracks the fundamental value. In all-male markets, prices substantially exceed fundamental value in most of the periods, while in all-female markets, prices are below fundamental value in more than half of the periods.

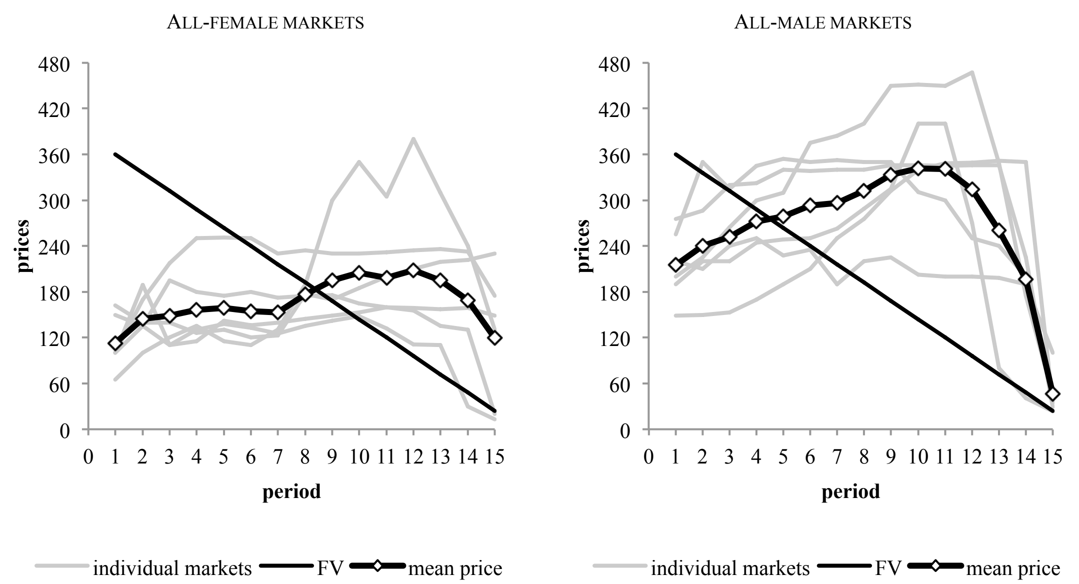

FIGURE 1. TIME SERIES OF MEDIAN TRANSACTION PRICES

Notes: Median prices of individual markets (grey lines) as a function of period, fundamental value (FV, bold line) and average of median session prices (bold line with diamonds).

To measure treatment differences, we make use of established bubble measures (see Haruvy and Noussair 2006). Table 1 shows these bubble measures for every session, as well as male and female averages. *Average Bias* is the average of the per-period deviation of the median price from the fundamental value and serves as a measure of overpricing. A positive (negative) *Average Bias* indicates prices to be above (below) fundamental value. A small magnitude of the *Average Bias* indicates prices to be close to fundamental value. *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. This measure indicates the variability of prices in comparison to the fundamental value. A small (large) magnitude of *Total Dispersion* indicates a small (large) overall distance from the fundamental value. For reasons explained below, we also introduce *Positive Deviation* and *Negative Deviation*. We define *Positive* (*Negative*) *Deviation* as the sum, over all 15 periods, of the absolute per-period deviation of the median price from the fundamental value if prices are above (below) fundamental value. We also counted the greatest number of consecutive periods above fundamental value (*Boom Duration*) and the greatest number of consecutive periods below fundamental value (*Bust Duration*). Finally, turnover is the standardized measure of the amount of trading activity and defined as the sum of all transactions divided by the number of shares in the market.

A bubble is characterized as the positive deviation of prices from fundamental value. Thus, a positive *Average Bias*, high *Total Dispersion*, a long *Boom Duration* and a short *Bust Duration* are indicators of a price bubble. In the following, we compare treatments by using several bubble measures as relevant units of interest. Since each session is an independent observation, we take six observations from each treatment to run Mann Whitney tests comparing measures between treatments and to run Wilcoxon Signed Rank tests comparing measures to benchmarks.

Table 1 — Observed Value of Bubble Measures

Session ID	Treatment	Average Bias	Total Dispersion	Positive Deviation	Negative Deviation	Boom Duration	Bust Duration	Turnover
average	all-female	-25.71	1668	641	1027	6.67	7.83	14.28
1	all-female	-47.77	1583	433	1150	6	9	11.28
2	all-female	26.20	1536	965	572	10	5	12.89
3	all-female	-75.90	1277	69	1208	4	9	9.94
4	all-female	6.67	2586	1343	1243	7	8	20.72
5	all-female	-21.70	1854	764	1090	7	8	19.72
6	all-female	-41.73	1173	274	900	6	8	11.11
average	all-male	74.12	1854	1483	371	10.67	4.00	9.77
1	all-male	99.17	1698	1593	105	14	1	10.78
2	all-male	131.00	2602	2284	319	12	3	8.39
3	all-male	15.20	1115	672	444	8	7	11.56
4	all-male	50.27	2310	1532	778	9	6	9.83
5	all-male	110.83	1933	1798	135	13	2	8.11
6	all-male	38.27	1464	1019	445	8	5	9.94
Two-sided Mann-Whitney	p-value	0.007	0.522	0.025	0.007	0.016	0.012	0.030

Notes: This table reports the observed values of various measures of the magnitude of bubbles 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 $P_t > FV_t$ and Negative Deviation = $\sum| P_t - FV_t |$ 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 = $\sum Q_t$ /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 comparing all-male and all-female sessions.

Observation 1: In all-male markets, bubbles occur. In all-female markets, bubbles do not occur.

Support: The treatment average of *Average Bias* equals 74.12 in all-male markets and is positive in each session, and equals -25.71 in all-female markets and is positive in two and negative in four sessions. Using a one-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* exceeds zero in the all-male markets (p = 0.014) but not in the all-female markets (p = 0.915). Average *Boom Duration* in all-male markets exceeds 10 periods, and in all sessions prices are consistently above fundamental value in at least half of the share's lifetime. *Boom Duration* exceeds *Bust Duration* in all sessions. Average *Boom Duration* in all-female markets is below 7 periods and in only one session are prices consistently above fundamental value more than half of the share's lifetime. Here, *Boom Duration* exceeds *Bust Duration* in only one session.

Observation 2: Bubbles in all-female markets are smaller than in all-male markets.

Support: To illustrate the differences consider figure 2. The figure depicts *Average Bias* and *Total Dispersion* for each session. Going from left to right, *Total Dispersion* (mispricing) increases, and going from bottom to top, *Average Bias* (overpricing) increases. A session with a very large bubble would be located at the top right; trading at fundamental value would be located in the middle left. The figure shows that treatments do not differ so much in mispricing but rather in overpricing. Most of the diamonds, representing all-male sessions are above and to the right of the triangles, representing all-female sessions. Thus, the figure indicates a treatment effect in *Average Bias* rather than in *Total Dispersion*.

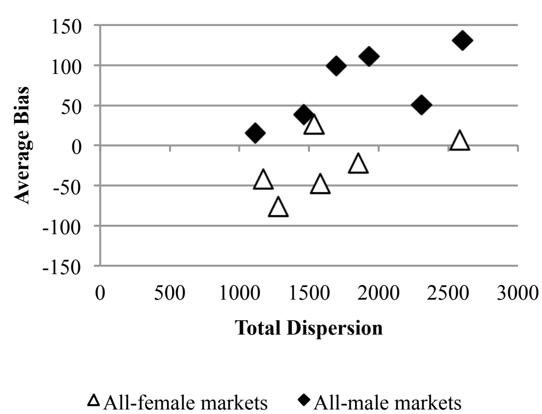

FIGURE 2. BUBBLE MEASURES ACROSS TREATMENTS

Notes: Each diamond/triangle indicates the Average Bias – Total Dispersion combination of a session. A session with a very large bubble would be located at the top right.

Using a Mann Whitney U-test, we find *Average Bias* in all-male markets to significantly exceed *Average Bias* in all-female markets (p = 0.007). Recent experimental studies use *Total Dispersion* as a (positive) bubble measure. This is a good measure only when mispricing is due to prices that are above fundamental value in both treatments. Thus we find no significant treatment difference in *Total Dispersion,* which indicates that the overall mispricing is not different across gender (p-value = 0.522). Figure 1, however, suggests that prices negatively deviate from fundamental value in the all-female sessions, disqualifying *Total Dispersion* as a relevant bubble measure to compare treatments. Thus, we introduce the *Positive Deviation* from fundamental value as the relevant unit of interest. The treatment average is 1483 in all-male markets and 641 in all-female markets. Using a two-tailed Mann Whitney U-Test, we can reject the hypothesis of equal *Positive Deviation* (p = 0.025) indicating that all-male markets have higher *Positive Deviation* than all-female markets. Also the duration measures support observation 2. Using a two-tailed Mann Whitney U-Test, we can reject the hypothesis of equal *Boom Duration* (p = 0.016) and we can reject the hypothesis of equal *Bust Duration* (p-value = 0.012). All-male markets exhibit a significantly higher *Boom Duration* and a significantly lower *Bust Duration*.

Observation 3: Bubbles in some all-female markets are "negative".

Support: *Average Bias* is negative in four out of six all-female markets. Using a one-sided Wilcoxon-signed rank test, we can reject the null hypothesis that *Average Bias* equals or is above zero in favor of the alternative hypothesis that *Average Bias* is below zero in all-female markets at a 10% significance level (p = 0.084). Average *Bust Duration* in all-female markets equals about 8 periods, and prices are consistently below fundamental value in at least half of the share's lifetime in all but one session. *Bust Duration* exceeds *Boom Duration* in all but one session.

To consider trading effects, we calculate the *Turnover* for every session, which is a normalized measure of trading activity defined as *Turnover* = (number of trades)/(number of shares available). A high turnover supposed to be positively related to price bubbles – that is, more trading occurs in sessions with bubbles. However, this relationship seems to be due to mispricing in general rather than to positive price deviations only. We find the spearman rank correlation coefficient to be positive for *Average Bias* and *Positive Deviation* in the all-males markets (0.771, 0.943) and a negative in the all-female markets (-0.771, -0.771). Thus, the higher the deviation from the fundamental value, the higher the turnover. Table 1 shows that the median *Turnover* in the all-female markets equals 14 while it equals 10 in the all-male markets. Using a two-tailed Mann Whitney U-Test, we can reject the hypothesis of equal Turnover (p = 0.030). These results are different from observational studies: Field data show that men trade more than women in financial markets (e.g. Barber and Odean 2001), but recent experimental data show either no gender differences in trading (Deaves et al. 2009) or that the frequency of women in the market is positively correlated with turnover (Robin, Strážnická, and Villeval 2010). We can conclude that positive price bubbles are not the result of "excessive" trading on the part of men, since turnover is even higher for women. However, it turns out that the gender difference in turnover is based on early trading periods. Running the Mann Whitney U-test in every period using volume as the relevant unit of observation, we find a significant difference only in period 1 (p = 0.007), but in neither period thereafter. Thus, women tend to trade more in early periods at prices well below fundamental value. Perhaps the high trading turnover for the early periods of the all-female sessions is the result of women desiring to lower the proportion of risky assets in their portfolios in favor of cash, and after an initial flurry of trades in which the assets are heavily discounted relative to fundamental value, further trades are unnecessary.

B. A meta-analysis of gender and price bubbles

Our results suggest a gender effect on pricing financial assets. However, same-gender groups may lead to results qualitatively different from what is seen in the aggregate with mixed-gender pairings or groups (e.g., Charness and Rustichini 2011;

Eckel and Grossman 2008a survey gender composition in cooperation games). To see whether the gender effect persists in mixed-markets we consider the following hypothesis

HYPOTHESIS: In experimental asset markets a higher frequency of female participants in the market decreases the bubble magnitude.

We run a meta-analysis with 35 markets from labs in Magdeburg, Bonn, Tilburg and Copenhagen, using the same parameterization as in Smith et al. (1988).[2] We were able to obtain data on gender composition (fraction of women in market) and median period prices from these 35 sessions.[3] We apply a spearman rank correlation between the fraction of women in the market and bubble measures. Spearman's rho equals -0.477 (p = 0.004) for *Average Bias*, -0.351 (p = 0.039) for *Positive Deviation*, -0.390 (p = 0.021) for *Boom Duration* and 0.529 (p = 0.001) for *Bust Duration*. Since the p-values reject the hypothesis that variables are independent, the correlations show a significant effect that supports hypothesis 1.[4] We also see that the bubble measures of the 35 markets fall between the values for our all-female and all-male markets. Using a Jonckheere-Terpstra-Test and defining classes to be 1 for all-female markets, 2 for the 35 mixed gender markets and 3 for the all-male markets, we test the null hypothesis that the distribution of the bubble measure of interest does not differ among classes. We can reject the null hypothesis in favor of an increasing trend for *Average Bias* (p = 0.004), *Positive Deviation* (p = 0.051), *Boom Duration* (p = 0.039) and a decreasing trend for *Bust Duration* (p = 0.027). The analysis provides some evidence that gender composition has an impact on price bubbles in the Smith et al. (1988) asset market design.

[2] We sent emails to all authors using the Smith et al. (1988) asset market design and made an announcement at the European Science Association discussion forum. Unfortunately, many researchers stated that data on the gender of participants was not collected in their experiments. All sessions have the same dividend process and 15 periods. In Cheung, Hedegaard, and Palan (2011) ten subjects participated in the markets, in sessions 56 and 57 of Haruvy, Noussair, and Powell (2011) eight subjects, and in session 6 of Powell (2011) seven subjects.

[3] Find bubble measures for each session implemented in the meta- analysis in the appendix.

[4] Note we do not include markets from our study in the Meta-Analysis.

III. Elicitation of individual measures and forecasts

We now turn to an analysis of individual differences in subjects across sessions. We consider price forecasts, risk-aversion measured by an incentivized task, math ability, and survey measures of personality in an attempt to better understand gender differences in these markets. Cross-session heterogeneity in the characteristics of the participants can help us to understand the sources of gender differences.

The data show considerable gender differences in price forecasts. Before each period, subjects were asked to forecast average period prices for all remaining periods, using the rules and the incentive scheme of Haruvy, Lahav, and Noussair (2007). For example, before period 1 each subject was required to submit 15 predictions, one prediction for each of the prices in periods 1 to period 15. Each participant received a payment for accuracy. The closer the prediction was to the actual average market price, the higher the payment. We implemented this element of the design to see whether price predictions can account for the differences in behavior between genders.

To compare treatments, we calculate the *Average Bias* with predicted prices instead of median prices for all remaining periods for each subject.[5] The average measure is lower for women than for men in every period. Using a simple t-Test with 108 observations, we find no significant difference in *Average Bias* in early periods (Period 1-3) or in late periods (Period 14, 15), but in all periods in between at a significance level of 5%. Note, however, that the all-male sessions generate higher prices from the initial period, and so men observe higher prices, which then influence their predictions of future prices. In the forecast preceding the first trading period in which no price anchor disturbs the prediction, women on average predict period-one-prices to be about 105 francs while men predict them to be at about 205 francs. This difference is significant using a t-Test with 108 observations (p = 0.010). Men's predictions for period two prices also exceed women's predictions (p = 0.020). Prediction for later periods, however, put in perspective the gender differences in price predictions. Overall, we conclude that women tend to expect lower prices than men from the beginning. However, none of the participants

[5] This is the average of predicted period prices minus fundamental value in all remaining periods.

expect prices to have a bubble pattern and only one subject expected prices to track fundamental value.[6]

To measure the subject's attitude toward risk, each subject participated in an incentivized gamble-choice task (Eckel and Grossman 2008b). Prior to the asset market, subjects were asked to choose their most-preferred lottery from six ranked lottery options. Each 50/50 lottery involved a high and low possible outcome, as follows: option 1 = {$12.00, $12.00}; option 2 {$8.00, $20.00}; option 3 {$ 4.00, $28.00}; option 4 {$0.00, $36.00}; option 5 {$-4.00, $ 44.00}; option 6 {-$8.00, $ 48.00}. The lottery was played out, using a six-sided die, after the asset market was completed. Therefore subjects did not receive any feedback on the outcome of the lottery until the end of the session.

Note that these lotteries range from a certain outcome of $12, and increase in expected value and variance through option 5; option 6 consists of an increase in variance from option 5, with the same expected value. Thus choosing option 1 indicates extremely high risk aversion, and only subjects who are risk-lovers should prefer option 6. We code the decisions as the option number, 1 – 6, reflecting the lottery selected, and this provides an index of risk aversion.[7] While the women's average lottery choice equals 3.05, the men's average equals 3.94.[8] Using a two-sided Mann Whitney U-test with 54 observations in each treatment, we find men to choose lotteries indicating less risk aversion than women (p = 0.003). Comparing on session level, the highest session average in the all-female markets is lower than the lowest session average in the all-male markets.

[6] This is in line with observations form Haruvy et al. (2007) in which subjects start to predict bubbles after gaining experience.

[7] Under the assumption of a CRRA utility function, each possible choice defines a range of coefficients of relative risk aversion. Using the midpoint of the ranges, substituting the average of these coefficients for the average gamble number for each session does not alter results. See Eckel and Grossman 2008b for further details. Note the measure used in the present paper adds one additional gamble, Gamble 6, to the protocol used in Eckel and Grossman 2008b.

[8] On average the results do not substantially vary from Eckel and Grossman (2008b), where the average of 138 males is 3.79 and the average of 120 females is 3.08.

Subjects also completed a simple math test, which was not incentivized.[9] The average frequency of correct answers in all-female markets was 74% and in all-male market was 85%. Using a t-Test with 54 observations in each treatment, we find that women solve fewer tasks on average than men (p = 0.010).

Running a OLS regression using *Average Bias* as dependent variable and a dummy variable to indicate gender (male = 1), the average of chosen lottery options (*Lottery Option*) and the frequency of solved math tasks (*Math*) as independent variables, we find the male dummy to remain significantly different, indicating a persistent gender effect on the bubble magnitude.[10]

TABLE 2. OLS REGRESSION ON AVERAGE BIAS

Male Dummy	155.1***	96.04**	145.9***
	(36.62)	(35.85)	(41.31)
Lottery Option	62.16*		66.53*
	(33.24)		(35.39)
Math		-34.09	-117.6
		(227.1)	(205.5)
Constant	-270.9*	3.334	-188.0
	(132.0)	(194.3)	(199.6)
Observations	12	12	12
R-squared	0.734	0.631	0.744

Notes: Dependent Variable is Average Bias. Independent variables are *Male Dummy* = 1 if all-male market, *Lottery Option* = average gamble choice with 1 = riskless choice and 6 = high risk choice (see Eckel and Grossmann 2008b), and *Math* = Frequency of solved math tasks. Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Finally, to see whether personality traits play a role we make use of personality measures from Carver and White (1994) to see whether behavior in markets is related to

[9] Subjects solved the following tasks: 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…

[10] Using tobit regressions with Boom Duration and Bust Duration as dependent variables leads qualitatively to the same results. Running similar regressions but with individual data (n=108) also yields the same qualitative results.

BIS and BAS.[11] Therefore, we elicited the following measures; anxiety (BIS), and fun seeking (BAS), drive (BAS), and reward-responsiveness (BAS). Subjects also complete a survey measure of Type A personality (see Friedman 1996). However, we find no differences in BIS/BAS or Type A personality between genders using a Mann Whitney U-test (all p-values > 0.2) comparing all subjects (n = 54 in each treatment) or session averages (n = 6 in all treatments), and including them in the regression analysis above does not change the results.

We conclude from this analysis that, while risk aversion plays a relatively weak role in the price differences across sessions, other individual differences seem not to be responsible for gender differences in the production of bubbles in asset market experiments.

IV. Conclusion and Discussion

This is the first study that systematically tests for gender effects in experimental asset markets with long-lived assets. Comparing all-male and all-female markets, we find a significant gender effect in that all-male markets show significant price bubbles while all-female markets produce prices that are below fundamental value. Women's price expectations are consistent with this pattern of behavior: from the very first period, women's expectations are substantially below that of men. Risk attitudes seem to have some impact on forming bubbles. Using a Meta-Analysis on 35 markets from different studies using the Smith, Suchaneck, and Williams (1988) asset market design, we find a relationship between gender composition and price bubbles, in that a higher frequency of women in the market reduces the magnitude of a price bubble. This may explain part of the large heterogeneity of price bubbles within treatments in experimental studies.

These results imply that financial markets might indeed operate differently if they were run by women. It became a popular mantra in the wake of the collapse of the

[11] Gray's behavioral inhibition and activation system postulates two dimension of personality, anxiety proneness and impulsivity (see Carver and White 1994). The first regulates aversive motivation (behavioral inhabitation system, BIS) and the latter regulates appetitive motivation (behavioral activation system, BAS). Activation of BIS causes inhabitation of movement towards goals and is correlated with feelings such as fear, anxiety, frustration, and sadness. Activation of BAS, however, causes the person to begin movement toward goals and is correlated with feelings such as hope, elation, and happiness. The questions for these measures can be received upon request.

housing bubble in 2008, that men's competitive nature and overconfidence were responsible for the crash. Indeed women are relatively scarce in the fields of investment and corporate finance, representing only about 10% of Wall Street traders. Our data suggest that increasing the proportion of women traders might have a dampening effect on the likelihood and magnitude of bubbles.

Why are women so scarce in these fields, anecdotally known for machismo and hyper-competitive work cultures? This characterization is supported by a history of spectacular employment discrimination lawsuits, including the $150 million settlement of the so-called "boom boom room" lawsuit in the 1990s. The 'bonus system' of compensation in Wall Street firms, where workers earn large bonuses based on their relative performance, also fosters competition. Experimental research clearly establishes women's preference for non-competitive environments (see survey in Croson and Gneezy 2009). In addition, Wall Street culture has led to a lack of family-friendly policies that women tend to value – or an unwillingness to use such policies even if they are in place. Since workers are expected to put the job first and work extremely long hours, taking family leave or negotiating for fewer work hours has negative effects on perceptions of a worker's quality, and therefore on their bonus (Roth 2006). The cultural setting no doubt plays an important role in discouraging women from employment in these sectors, apart from any possible direct discrimination in hiring by employers.

Finally, our results suggest a cautionary note with respect to financial market experiments. We urge researchers studying financial markets to take gender composition into consideration before running experiments to avoid undesired variance. This is especially relevant when using laboratory asset markets as test beds for exploring market institutions

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Appendix I

BUBBLE MEASURES FOR META-ANALYSIS

Treatment	Session	Fraction Women	Average Bias	Positive Deviation	Boom Duration	Bust Duration
Füllbrunn/Neugebauer 2012	Equity MD 1	0.67	19.27	745	11	4
Füllbrunn/Neugebauer 2012	Equity MD 2	0.33	-2.30	396	10	5
Füllbrunn/Neugebauer 2012	Equity MD 3	0.56	6.77	338	9	2
Füllbrunn/Neugebauer 2012	Equity BN 1	0.33	104.80	1685	13	1
Füllbrunn/Neugebauer 2012	Equity BN 2	0.33	4.93	267	7	3
Füllbrunn/Neugebauer 2012	Equity BN 3	0.33	82.97	1345	12	2
Füllbrunn/Neugebauer 2012	Equity BN 4	0.22	92.50	1508	11	3
Füllbrunn/Neugebauer/Nicklisch 2012	Pilot SSW 1	0.44	34.40	1176	8	6
Füllbrunn/Neugebauer/Nicklisch 2012	Pilot SSW 2	0.00	142.00	2130	15	0
Füllbrunn/Neugebauer/Nicklisch 2012	Pilot SSW 3	0.44	67.77	1087	13	2
Cheung/Palan 2011	1 - Individuals	0.33	105.00	2316	11	4
Cheung/Palan 2011	5 - Individuals	0.44	47.27	967	12	3
Cheung/Palan 2011	6 - Individuals	0.78	-41.20	900	8	7
Cheung/Palan 2011	7 - Individuals	0.22	29.87	608	12	3
Cheung/Hedegaard/Palan 2011	36-USB	0.70	-59.50	0	0	15
Cheung/Hedegaard/Palan 2011	37-USB	0.70	78.77	1384	11	4
Cheung/Hedegaard/Palan 2011	38-USB	0.70	-12.53	128	9	6
Cheung/Hedegaard/Palan 2011	39-USB	0.70	18.30	522	9	4
Cheung/Hedegaard/Palan 2011	40-USB	0.60	-100.80	225	4	11
Cheung/Hedegaard/Palan 2011	41-USB	0.40	-21.03	117	4	5
Haruvy/Noussair/Powell 2011	57	0.38	153.13	3263	11	4
Haruvy/Noussair/Powell 2011	58	0.56	-125.23	13	2	13
Haruvy/Noussair/Powell 2011	62	0.56	33.80	886	11	4
Haruvy/Noussair/Powell 2011	63	0.56	19.57	1426	6	6
Haruvy/Noussair/Powell 2011	64	0.44	57.50	1087	11	4
Haruvy/Noussair/Powell 2011	56	0.63	-60.47	8	1	10
Powell 2011	1	0.56	-12.30	79	6	5
Powell 2011	2	0.56	-3.17	751	11	4
Powell 2011	3	0.25	175.73	2636	15	0
Powell 2011	4	0.22	4.63	156	4	3
Powell 2011	5	0.89	26.60	606	10	3
Powell 2011	6	0.29	-87.40	0	0	15
Powell 2011	7	0.33	69.67	1108	11	2
Powell 2011	8	0.67	-29.50	9	2	7
Powell 2011	9	0.33	29.17	557	10	2

Appendix II: Instructions for market experiment

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

Appendix III: Instructions for Gamble Choice Task

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. 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.

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

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.