
Munich Personal RePEc Archive

Gender and the beauty contest game

Qin, Botao

Xi'an Jiaotong University

6 December 2019

Online at https://mpra.ub.uni-muenchen.de/99604/
MPRA Paper No. 99604, posted 13 Apr 2020 13:34 UTC

Gender and the beauty contest game*

Botao Qin †
Jinhe Center for Economic Research
Xi'an Jiaotong University
No. 8 West Xianning Road, Xian, Shaanxi, China, 710049

April 13, 2020

Abstract

This paper uses a beauty contest game to test the gender differences in strategic reasoning. Using both a non-monetary incentive treatment and a monetary incentives treatment in China, I find there are differences in strategic reasoning.However, the differences disappear with the increase of stakes.

Keywords: Gender; Beauty Contest Game
JEL Codes: C72, C91, J16

*I'd like to thank Yonghong Sun, Xiangyi Zhou for their help in running the experiment. All remaining errors are mine. I acknowledge financial support from China's Postdoctoral Science Fund # 2017M613089.

†Corresponding author, email: bqinecon@mail.xjtu.edu.cn; Phone: +8629 82665022

1 Introduction

In Keynes' *General Theory of Employment, Interest, and Money*, he wrote "It is not a case of choosing those which , to the best of one's judgement, are really the prettiest, nor even those which average opinion genuinely thinks the prettiest. We have reached the third degree, where we devote our intelligences anticipating what average opinion expects the average opinion to be. And there are some, I believe, who practise the fourth, fifth, and higher degrees" (1936, p.156). Keynes draws an analogy between the stock market and the newspaper guessing game about which face people think the other people think is the prettiest. The beauty contest game is first tested empirically by Nagel (1995). Ho et al. (1998) replicated Nagel's study and find most players use one to three steps of iterated reasoning. Most literature use p-beauty contest game to study strategic reasoning. However, few research studies gender and iterated reasoning. Cubel and Sanchez-Pages (2017) find males performs more iterated reasoning than females in non-monetary incentives game. When there is monetary incentives, there is no difference between male and female in strategic sophistication. They also find gender priming increases females' strategic sophistication, but decreases males' strategic sophistication. Dittrich and Leipold (2014) use both the beauty contest game and the 11-20 money request game and find males do more steps of reasoning than women. Burnham et al. (2009) find no gender difference in the beauty contest game. Östling et al. (2011) find women show lower strategic reasoning than men in the lowest unique positive integer (LUPI) game and in the Colonel Blotto games. These studies except for Cubel and Sanchez-Pages (2017) are not designed specifically to test the gender difference in strategic sophistication.

Another line of literature finds gender differences in competition. Most research find females tend to choose less competitive jobs than males (Croson and Gneezy (2009)). Gneezy et al. (2003) and Gneezy and Rustichini (2004) find women underperform than men in competitive environment. Beauty contest game creates a competitive environment and anyone outperforms others can win the game.

Given the mixed evidence in the literature about gender differences in

strategic reasoning, herein I conduct a beauty contest game with both non-monetary incentives and monetary incentives in China. My study can shed light on the gender differences and strategic reasoning as to the best of my knowledge, it is the first using participants not from west industrialized countries. My results lend support to the gender differences in strategic reasoning and males perform more steps of iterated strategic reasoning. However, the differences disappear with the increase of stakes.

2 The experiment

The basic experiment design follows Cubel and Sanchez-Pages (2017). I conducted eight sessions of experiment at Xi'an Jiaotong University, China. Six sessions include students from two sections of Principles of Economics class. The other two sessions are run in graduate courses such as environmental economics and industrial management. The distributions of gender are summarized in table 1.

I run three sessions in 2017, four sessions in June, 2019, and one session in October 2019. The experimenter reads out the instructions to the subjects and all questions are addressed before the experiment starts. The experiment has two phases. The first phase has 9 rounds with no monetary incentives. The values are $p = \{1, 2/3, 11/10, 1/3, 3/2, 1/5, 6/5, 1/2, 4/3\}$. The second phase has 4 rounds with monetary incentives. The first two rounds have a monetary incentive of 20 yuan. The second two rounds have a monetary incentive of 40 yuan. I randomly pick one round from both the first two rounds and the second two rounds to pay the subjects. Subjects fill in the chosen numbers for each p value before they submit it. There is no feedback during each round. In total, 298 students participate in the experiment, among whom 93 are female and 205 are male. There are more males than females as I run the experiment in an engineering university with more males major in engineering.

3 Results

Table 1 reports the mean entries by session and gender. In the non-monetary incentive phase and p=2/3, females' mean entries are larger than males in all sessions except for one. When there is monetary incentives and the prize equals 20 yuan, three out of eight sessions have lower means for female than male in the first round. In the second round, only one out of eight sessions has a lower mean for female than male. When the prize equals 40 yuan, a half sessions have lower means for female than male in the first round. A half sessions have lower means for female than male in the second round. The results support (Cubel and Sanchez-Pages, 2017)'s findings that females have lower iterative strategic reasoning in the non-monetary incentives phase. When monetary incentives are present, females still display a lower level of iterative strategic reasoning. However, the gender gap disappears when the stakes increase.

Next, I pool data from all sessions. In Table 2 we see in the non-monetary incentives treatment and p=2/3 round, the mean bid for males is 34.2 and the mean bid for females is 37.8. The median bid for males and females are 33.0 and 33.3, respectively. Males bid lower values than females. The Mann-Whitney rank sum test rejects the null hypothesis that both males and females' bids are drawn from the same population ($z = 1.998, p = 0.046$). A median test fails to reject the null that males and females have the same median ($\chi^2 = 1.358, p = 0.244$). The cumulative distributions of males and females' guesses are drawn in Figure 1. I further classify males and females into level-k type. k belongs to $1, 2, 3, \infty$. A level 0 player chooses randomly. A level 1 player thinks other players choose randomly. She chooses 33.3 ($50 * 2/3 = 33.3$). A level 2 player thinks other players are level 1 players and choose 22.2 ($33.3 * 2/3 = 22.2$). I find the level k by minimizing the target $(bid - (50 * 2/3)^k)^2$ (Giorgio and Rosemarie (2009)). For all $p \neq 1$, if $k > 1$ for at least 5 out of the 8 rounds, I classify the subject as high type. If $k = 1$ for at least 5 out of the 8 round, I classify the subject as low type. If subjects do not meet the criteria, I drop them from the analysis. The type classification by gender is summarized in table 3. We can see in total, 53 out of 281 subjects are high type. 228 out of 281 subjects are low type. The high

type ratio is 18.9% and the low type ratio is 81.1%. The ratios are very close to Cubel and Sanchez-Pages (2017). The ratio of high types among males is 22.8% and the ratio of high types among females is 10.2%. The proportion test rejects the null hypothesis that there is no difference (p=0.013). I find there is a gender difference in the depth of reasoning in the non-monetary incentives treatment. Males play more rounds of reasoning than females.

In the monetary incentives treatment, I have four rounds with $p = 2/3$. The first two rounds have a monetary incentive of 20 rmb. The mean for males are 28.9 and 28.7. The mean for females are 34.0 and 33.3. Males choose a lower value than females. The Mann-Whitney test rejects the null that there is no significant difference in the distribution of males and females' bids (p=0.005 and 0.004, respectively). The median test also rejects the null that the medians are the same for the two distributions ($\chi^2 = 11.292, p = 0.001$ and $\chi^2 = 8.7239, p = 0.003$, respectively). The last two rounds have a monetary incentives of 40 rmb. The mean for males are 29.1 and 28.9. The mean for females are 32.9 and 32.4. Males choose a lower value than females. The Mann-Whitney test fails to reject the null that there is no difference in the distribution of males and females' bids at the 5% significance level(p = 0.052 and 0.076, respectively). The median test also fails to reject the null that the medians are equal for the two distributions at the 5% significance level(p= 0.133 and 0.051, respectively). In the low stake game, there is a gender difference and males bid lower than females. When stakes increase, the gender difference tends to decrease. The cumulative distributions for the four rounds are from Fig.2 to Fig.5. I confirm the findings using a regression model as below:

$$entry_i = \alpha + \beta_1 gender_i + \beta_2 test_i + \beta_3 grade_i + v + \xi_i \tag{1}$$

where $entry_i$ is subject i's entry in the game. $Gender_i$ is a dummy variable that equals 1 if the subject is a male. $Test_i$ is subject i's grade in the class she is enrolled in. $Grade_i$ is the grade subject i is in. v is the session fixed effect. α is the estimated intercept. ξ_i is the error term. Table 4 reports the estimates and it supports my previous findings. Males in the non-monetary incentive phase enter significantly lower values than females ($p < 0.10$). In the monetary incentives phase, males also enter significantly lower values

when the prize equals 20 yuan ($p < 0.05$). However, the entries are not significantly different when the prize increases to 40 yuan. I summarize my results in the following:

Result 1: *In experiments without monetary incentives, there is a gender gap in the depth of strategic reasoning. Males play more rounds of reasoning than females. When there are monetary incentives, the gender gap still exists. However, it disappears with the increase of stakes.*

Table 1: Summary statistics

	1		2		3		4		5		6		7		8	
	male	female	male	female	male	female	male	female	male	female	male	female	male	female	male	female
No money p=2/3	37.9	39.7	34.3	50.8	33.2	37.4	35.9	36.4	33.6	36.6	33	35.6	28.3	41.4	35.3	33.5
money=20 yuan	25.8	38.2	27	37.7	30.6	29.9	24.3	28	29.4	33.3	32.8	30.4	28.1	42.9	33.3	32.6
money=20 yuan	29	29.7	26.6	38.9	30.7	25.7	22.3	27.5	28.4	33.2	34.2	35.4	29.2	40.6	30.9	31.4
money=40 yuan	27.8	44.4	25.8	37.2	29.6	28.5	23.6	27.9	30.9	28.6	35.7	32.3	29.7	40.1	32.2	31.2
money=40 yuan	22.4	39.4	26.9	25.1	26.3	33.9	25.7	19.6	32.9	27.3	35.3	34.7	30.8	42.4	32.7	34.9
N	23	6	35	6	31	8	26	9	27	21	22	14	15	14	26	15

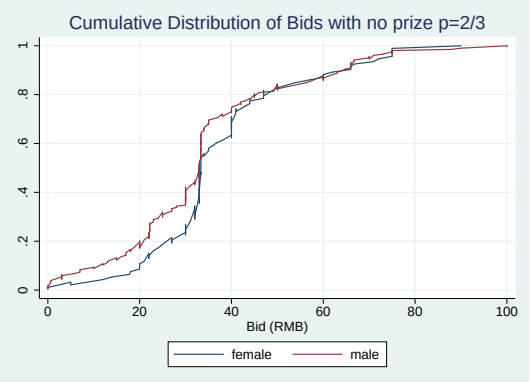

Figure 1: Cumulative Distribution of Bids with no prize p=2/3

Table 2: Results by gender without monetary incentives and p=2/3

	mean	median	S.D
males	34.2	33.0	19.2
females	37.8	33.3	16.7

Table 3: Type classification by gender

	High	Low	TOTAL
Males	44	149	193
Females	9	79	88
TOTAL	53	228	281

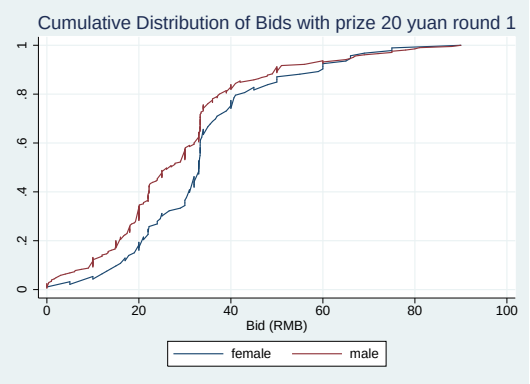

Figure 2: Cumulative Distribution of Bids with prize 20 yuan round 1

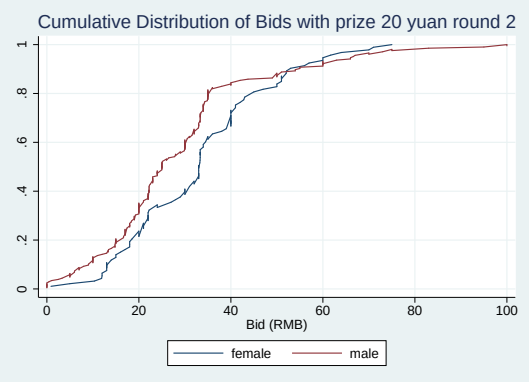

Figure 3: Cumulative Distribution of Bids with prize 20 yuan round 2

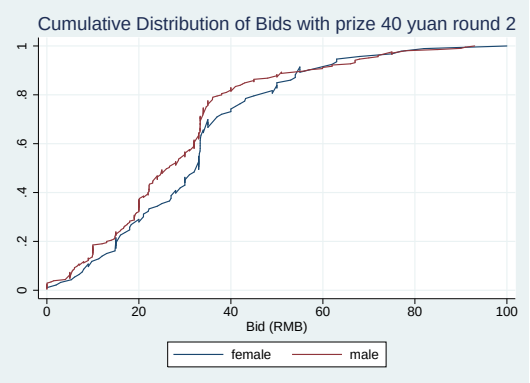

Figure 4: Cumulative Distribution of Bids with prize 40 yuan round 1

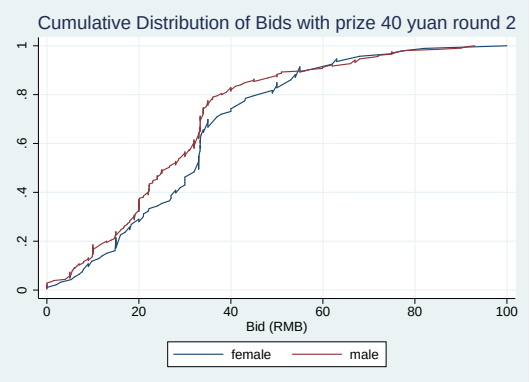

Figure 5: Cumulative Distribution of Bids with prize 40 yuan round 2

Next I compare the mean entries among the non-monetary incentive phase, the monetary phase and prize equals 20 yuan, and prize equals 40 yuan. From table 1, I find when there are monetary incentives, subjects choose lower entries on average. The average entry in the non-monetary incentive phase is 35.3 yuan. The average entries are 30.4 yuan and 30.2 yuan when prize equals 20 yuan. The average entries are 30.3 and 30.0 when prize equals 40 yuan. The Wilcoxon matched-pairs signed-ranks test rejects the null the distributions are equal between the non-monetary incentive and the monetary incentive when prize equals 20 yuan ($p = 0.000$ and 0.000). However, we fail to reject the null that the distributions are the same when prize equals 20 yuan or 40 yuan ($p = 0.1634, 0.0932, 0.9297, 0.8074$). Subjects respond to the monetary incentives by exerting more efforts.

Studies find subjects with higher cognitive abilities play dominant strategies and choose smaller values in p-beauty contest game (Burnham et al. (2009);Branasgarza et al. (2012)). To test the relationship between cognitive ability and the level of strategic reasoning, I collect subjects' grades in the courses they are enrolled in as a proxy for cognitive ability. The estimates in table 4 show that in the four rounds with monetary incentives, subjects with higher grade in the course they are enrolled in have a significantly smaller entry ($p < 0.01$). When there is no monetary incentives, grades do not have a significant effect at the 5% significance level. I summarize the results as follows:

Table 4: Estimates of gender effect

	no money	money=20 yuan		money=40 yuan	
		round1	round2	round1	round2
gender	-4.477*	-4.762**	-4.498**	-3.586	-2.941
	(2.366)	(2.223)	(2.096)	(2.498)	(2.495)
grade	-3.136	-1.534	0.361	-0.854	0.409
	(2.602)	(1.616)	(1.946)	(1.993)	(2.010)
test	-0.213*	-0.297***	-0.463***	-0.320***	-0.475***
	(0.111)	(0.111)	(0.111)	(0.120)	(0.121)
Constant	67.87***	62.16***	73.70***	64.99***	70.26***
	(11.88)	(10.96)	(10.78)	(12.41)	(11.81)
group effect	controlled	controlled	controlled	controlled	controlled
N	293	294	294	294	294
R-squared	0.033	0.065	0.099	0.062	0.102

Notes: Dependent variable is the entry in p-beauty contest game with p=2/3.

Robust standard errors in parentheses.

$***p < 0.01, **p < 0.05, *p < 0.1$.

Result 2: *When there are monetary incentives, subjects with higher test grades have significantly smaller entries in the beauty contest game.*

I also use the classification such as high type and low type as the dependent variable for robustness check. The high and low type for the zero stake rounds are defined the same as before. In both the 20 yuan and 40 yuan stake rounds, if both rounds have a k equal to 1, he/she is classified as low type. If both rounds have k larger than 1, they are classified as high type. Otherwise, they are dropped from analysis. The results are qualitatively the same for gender. Males are more likely to be high type in the zero stake and 20 yuan stake game. We fail to reject the null hypothesis that males and females have the same type at the 5 % significance level in the 40 yuan round. Moreover, the regression coefficients are not jointly significant ($p = 0.23$). The test score is not significant for the strategic type.

4 Conclusion

Herein I use a beauty contest game both without and with monetary incentives to test gender differences in the depth of strategic reasoning in China. I confirm the gender gap. Males play more rounds of strategic reasoning. However, the gender gap disappears with the increase of stakes. My results are consistent with previous findings such as Dittrich and Leipold (2014). My results are also the same as Cubel and Sanchez-Pages (2017) in the zero-stake game. However, I find gender differences also in the monetary incentives game, which is different from Cubel and Sanchez-Pages (2017). There is evidence that stakes matter in the ultimatum game. Andersen et al. (2011) find respondents' rejection rates decrease to zero with the increase of stakes.

I use the subjects' grades as a proxy for cognitive ability. I find subjects with higher grades have significantly smaller entries in all rounds with monetary incentives. This is consistent with previous findings such as Burnham et al. (2009) and Branasgarza et al. (2012).

My study contributes to the literature on gender and strategy reasoning. It also contributes to cognitive ability and strategic reasoning. The limitation of the research is I didn't ask participants to state their reasons for their choices of entry. Studies find elicited belief may have different results than

actual choices (Lahav (2015)). Future research can explore whether higher stakes can eliminate the gender gap in strategic reasoning in the beauty contest game.

References

Andersen, S., Ertaç, S., Gneezy, U., Hoffman, M., and List, J. A. (2011). Stakes matter in ultimatum games. *American Economic Review*, 101(7):3427–39.

Branasgarza, P., Garciamunoz, T. M., and Gonzalez, R. H. (2012). Cognitive effort in the beauty contest game. *Journal of Economic Behavior and Organization*, 83(2):254–260.

Burnham, T. C., Cesarini, D., Johannesson, M., Lichtenstein, P., and Wallace, B. (2009). Higher cognitive ability is associated with lower entries in a p -beauty contest. *Journal of Economic Behavior & Organization*, 72(1):171–175.

Croson, R. and Gneezy, U. (2009). Gender differences in preferences. *Journal of Economic Literature*, 47(2):448–474.

Cubel, M. and Sanchez-Pages, S. (2017). Gender differences and stereotypes in strategic reasoning. *The Economic Journal*, 127(601):728–756.

Dittrich, M. and Leipold, K. (2014). Gender differences in strategic reasoning. *Social Science Electronic Publishing*.

Giorgio, C. and Rosemarie, N. (2009). Neural correlates of depth of strategic reasoning in medial prefrontal cortex. *Proceedings of the National Academy of Sciences of the United States of America*, 106(23):9163–9168.

Gneezy and Rustichini (2004). Gender and competition at a young age. *American Economic Review*, 94(2):377–381.

Gneezy, U., Niederle, M., and Rustichini, A. (2003). Performance in competitive environments: Gender differences. *Quarterly Journal of Economics*, 118(3):1049–1074.

Ho, T.-H., Camerer, C., and Weigelt, K. (1998). Iterated dominance and iterated best response in experimental" p-beauty contests". *The American Economic Review*, 88(4):947–969.

Lahav, Y. (2015). Eliciting beliefs in beauty contest experiments. *Economics Letters*, 137:45–49.

Nagel, R. (1995). Unraveling in guessing games: An experimental study. *American Economic Review*, 85(5):1313–1326.

Östling, R., Wang, J. T.-y., Chou, E. Y., and Camerer, C. F. (2011). Testing game theory in the field: Swedish lupi lottery games. *American Economic Journal: Microeconomics*, 3(3):1–33.

A Experimental Instructions

The instruction is adapted from Cubel and Sanchez-Pages (2017).

The purpose of this experiment is to study how people make decisions. There are two phases in the experiment. The first phase is to help you get familiar with the experiment. In the second phase, you are going to compete with other students to win monetary awards. The participant who picks the number closest to the target wins the awards. If two participants win, they will split the award. Please keep silent and do not communicate with others as this is very important to the experiment.

A.1 Part I No monetary award

Please pick a number from $[0, 100]$.

$$Target = P * \frac{\sum_{i=1}^{N} x_i}{N} = P * average$$

Anyone who picks the number closet to the target wins the award.

round	P	the number you choose (x_i)
1	1	
2	2/3	
3	11/16	
4	1/3	
5	3/2	
6	1/5	
7	6/5	
8	1/2	
9	4/3	

A.2 Part II Monetary award

Now we will have four rounds of game with monetary incentives. The first two rounds (1, 2) have a monetary award of 20 yuan. The second two round (3, 4) have a monetary award of 40 yuan. At last we will randomly pick one round from (1,2) to pay the winner. We will randomly pick another round from (3, 4) to pay the winner.

round	award	x_i
1	20 yuan	
2	20 yuan	
3	40 yuan	
4	40 yuan	

$p = 2/3$ for each round in the phase. The winner is anyone who chooses a number closet to the 2/3 of the average.

Is there any question?

B Survey

Please tick with the corresponding answer.

1. What's your gender? Male Female

2. What's your major? Science and Engineering Business and Management Pharmacy

3. Do you have any course in game theory besides Principles of Economics? Yes NO

4. Your grade: