Gender-based sorting in group contests

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April 29, 2024

Abstract

We investigate the impact of gender-based sorting coupled with communication in group contests. Our framework assumes that individuals, irrespective of gender, possess identical characteristics, yet we account for variations in competitive and cooperative tendencies among men and women. Employing a lottery rent-seeking model, we explore both balanced and unbalanced sorting, guided by the premise that men tend to exhibit higher competitiveness compared to women. Contrary to our initial hypothesis and prevailing literature consensus, our findings reveal that all-female groups demonstrate higher levels of effort investment when pitted against all-male groups.

1 Introduction

There has been a growing interest in the experimental economics literature on gender dynamics in competition in contests. Historically, men have been overrepresented in leadership positions compared to women (Bertrand & Hallock, 2001). Differences in competitive behavior may contribute to this gap, as those who exhibit more competitive tendencies may be more likely to pursue and attain leadership roles. Competitive behavior can influence individuals' willingness to advocate for themselves, negotiate for promotions, and take on challenging assignments. If men are more inclined towards competitiveness, they may be more assertive in seeking advancement opportunities, leading to differences in promotion rates between genders. Recognizing and addressing gender differences in competitive behavior is crucial for designing

effective diversity and inclusion initiatives, as well as policies aimed at promoting gender equality in the workplace.

Previous research focuses on analyzing gender dynamics in competitive behavior outside of a group contest environment (Niederle & Vesterlund, 2007). In this paper, we aim to analyze whether men are more competitive than women to investigate the impact of gender diversity on group outcomes. We experimentally study this by creating groups of different gender compositions based on a diversity rule that creates diverse and non-diverse groups that compete with each other to win a prize. We run a lab experiment that follows the lottery rent-seeking contest model by Tullock (1980) involving individuals making effort investments from endowments given to stand a chance of winning a prize with a probability that depends on individual effort investments during the game. In our framework, men and women are identical in terms of ability hence dynamics in total effort contributed between groups should purely be through competitive behavior and strong valuation of winning the prize. Our framework includes a diversity treatment and a non-diversity treatment. The diversity treatment involves groupings of males and females while the non-diversity treatment has all-male groups and all-female groups. The experiment is conducted with undergraduate students from the University of South Carolina at the University and takes place within 2 days. In our set-up we also allow participants in a group to communicate with each other to elicit coordination and strengthen the initiative for competitive behavior.

Our findings surprisingly show that all-female groups competing with all-male groups generate higher total output. When comparing diversity and non-diversity, the all-female groups perform better when competing with groups with a male and a female. On the other hand, the all-male groups initially are outperformed by the non-diverse groups but eventually outperform them in later rounds of the game. These results are the first that indicate a strong competitive behaviour of women which is contrary to what is found in the literature.

2 Literature Review

Our work draws inspiration from Brookins et. al. (2018) who study the impact of sorting and communication in group outcomes in contests. In their theoretical framework, they have individuals that are heterogeneous based on ability and provide them an environment to compete in settings with communication and settings without communication. Their results indicate that competition under a balanced sorting with communication yields higher results than under an unbalanced sorting. We draw on their unique structure of sorting and communication and focus on gender-based sorting and how that along with communication influences group performance.

Apesteguia & Iriberri (2012), similar to our objective, study the impact of gender composition on team performance. Their experiment has a more real-world setup where participants in the L'Oréal e-Strat Challenge who are assigned the role of a general manager in a beauty-industry company make investments into R&D, brand management, and corporate responsibility initiatives. The authors found that all-male significantly outperformed all-female groups and that women teams were less aggressive in their pricing strategies, invested less in research and development, and more in corporate responsibility initiatives. Our paper's contrary results suggest that women can be competitive even in settings where they compete with all-male groups.

Niederle & Vesterlund (2007) these out the dynamics in preference for competition with a laboratory experiment in which one of the treatments gives the option for participants to select into a competitive tournament incentive scheme. Their results show that 73 percent of male participants were selected for the tournament as compared to 35 percent of women. Again the result that men are more competitive than women is in direct opposition to our findings.

Our findings challenge conventional assumptions by revealing that all-female groups could exhibit high levels of competition and cooperation. Overall, our research contributes to the ongoing discourse on gender dynamics and competitiveness, empha-

sizing the sensitivity of results to factors like gender sorting, variation in ability, and the incorporation of exclusion of communication.

3 Theoretical model and Hypotheses

Our theoretical framework utilizes the Tullock contest model which is a lottery rent-seeking contest model based on the theoretical paper by Tullock (1980). There are two groups indexed $j = X, Y$ competing with each other for a prize $V = 200$ by exerting efforts. In each group, there are 2 risk-neutral players, who we assume to be identical based on ability, indexed $i = 1, 2$. Each player is endowed with $A = 200$ from which they exert efforts $X_i = Y_i \in [0, 200]$. We assume homogenous linear cost of effort functions irrespective of gender which solely depends on the effort exerted; $c(X_i) = X_i$ and $c(Y_i) = Y_i$. An individual's probability of winning the contests depends on the total effort exertion in their group and the sum of effort exertion of all groups.

$$p_{ij} = \frac{E_j}{E_X + E_Y} \tag{1}$$

Where E_X and E_Y represent the total effort in group X and Y respectively. Total group effort is measured as the average of effort exertions of both individuals in the group hence $E_X = \frac{X_1+X_2}{2}$ and $E_Y = \frac{Y_1+Y_2}{2}$. The expected payoff of individual i in group j is expressed as:

$$\pi_{ij} = A + V\frac{E_j}{E_X + E_Y} - c_{ij} \tag{2}$$

This equation indicates that an individual's payoff depends on their endowment, A, the probability of winning the prize, p, and the effort they exert, c_{ij}. The equilibrium effort is found by differentiating the payoff equation with respect to E_j, assuming a symmetric equilibrium:

$$E^* = \frac{(n-1)}{n^2}V \tag{3}$$

Our hypotheses are as follows:

1. Males value winning more than females hence will compete more aggressively and will have higher total output under unbalanced sorting.

2. Between group efforts will be equalized in the balanced sorting.

4 Experimental Design

The experiment consisted of 10 rounds of a strategic game played in a computer lab via interactive software Participants worked in pairs and competed against another pair to win an additional boost to their payoffs. Once pairs were assigned, they were fixed for the experiment duration. Each pair competed against another pair, and this match also did not change from round to round. For ease of calculations in the experiment, endowments and payoffs were in experimental currency units (ECUs).

4.1 Stage 1: Pairing Procedure

At the start of the experiment, participants indicated their gender on the computer terminal. Their response was used to match them with a partner depending on the session's treatment. In balanced treatments, pairs were randomly assigned so that all pairs had one male and one female participant. As such, each pair was matched with another pair of the same makeup 1 male and 1 female participant). In the unbalanced treatment, participants were randomly partnered with another participant of the same gender. Then, pairs competed against pairs of the opposite gender; two females against two males. All pairs and matches were done randomly by the computer. Once the match was done, participants were told on the screen, "You have been matched with a (gender) participant. You are competing against a pair

with (gender) participant(s)," which was adjusted to match the session treatment: balanced or unbalanced. This message was visible on every with which screen the participants interacted, so gender was salient throughout the experiment.

4.2 Stage 2: Communication

After the pairing procedure, participants had 1 minute to chat with their partner. All chat was done via the computer. When going over the instructions, the proctor told participants not to identify themselves in the chat. The proctor also informed them that all messages were private and could not be seen by any other participants except their partners.

4.3 Stage 3: Allocation Decision and Results

Participants started each round with an endowment of 200 ECUs. In Stage 3, participants decided how many ECUs they wanted to allocate for a chance to win an additional 200 ECUs, Which were split with their partner if won (100 ECUs per winning participant). Allocation decisions were private at the decision time and revealed in the results part of this stage after all allocations were made. A pair's chance of winning the 200 ECUs prize depended on the average allocation of the pair and the average allocation of the competing pair. For instance, if person 1 in pair X allocated X_1 ECUs and person 2 in pair X allocated X_2 ECUs, then pair X 's average allocation was $X_{\text{avg}} = \frac{X_1+X_2}{2}$. The same followed for the competing pair, pair Y. For pair X and pair Y, their probabilities of winning the 200 ECU prize was $P_{\text{x}} = \frac{X_{avg}}{X_{avg}+Y_{avg}}$ and $P_{\text{y}} = \frac{Y_{avg}}{X_{avg}+Y_{avg}}$, respectively. After the submission of all allocation decisions, the computer randomly assigned a winner based on the calculated probabilities (p_x and p_y). Each participant in the winning pair received 100 additional ECUs. All ECUs allocated were subtracted from the endowment and lost. Thus, a player's payoff at the end of the round was: 200 - Allocation + 100 (if won). Along with their total payoff, participants received additional feedback, including their allocation, their partner's allocation, the average allocation of the competing pair, and whether their pair won the prize. Once all participants acknowledged receipt of the information,

the next round began with stage 2. Stage 1 only occurred in round 1 as pairs and matches stayed fixed for the duration of the experiment.

4.4 Experiment Procedures

Participants were undergraduate economics majors from the University of South Carolina. Students were recruited from 2 Upper-level economics courses whose professors made participation in the experiment mandatory. Each session contained students from one class, so the students worked with and competed against their classmates. Four sessions were conducted with 8 participants each, for 32 participants total. Exactly 4 males and 4 females participated in each session. Sessions were designated as balanced or unbalanced treatments, and we completed 2 sessions for each treatment. One male participant participated in a balanced and unbalanced treatment session. All other participants were only in one treatment type. Because of a lack of female participants, 3 females participated in 2 unbalanced sessions.

Following check-in, participants were seated at individual computer terminals with all females on one side of the room and all males on the other side. A proctor gave a copy of the instructions to each participant and then read the instructions out loud. Including time to read instructions, each session lasted approximately 30 minutes.

5 Results

5.1 Descriptive Statistics

Table 1 presents the descriptive statistics of our sample's performance. The Balanced panel showcases outcomes for groups consisting of two individuals of the opposite sex (male, female), while the unbalanced panel displays outcomes for groups with individuals of the same sex (male-male, female-female). The average payoff for male-female groups is 189 ECUs, significantly higher than female-female groups but slightly lower than MM groups. However, the individual allocation for male-female groups averages 63 ECUs, for female-female groups it's 64 ECUs, and notably lower

for male-male groups at 30 ECUs on average, which is surprising. Additionally, the maximum individual allocation is 100 ECUs, lower than for male-female and female-female groups, suggesting male-male groups are less aggressive and more risk-averse. Moreover, the average group output for male-male groups is slightly higher than for male-female groups but considerably lower than for female-female groups. Panel A reveals that female-female groups outperformed male-male groups in terms of individual allocation and group output but performed worse in individual payoffs.

5.2 Main Results

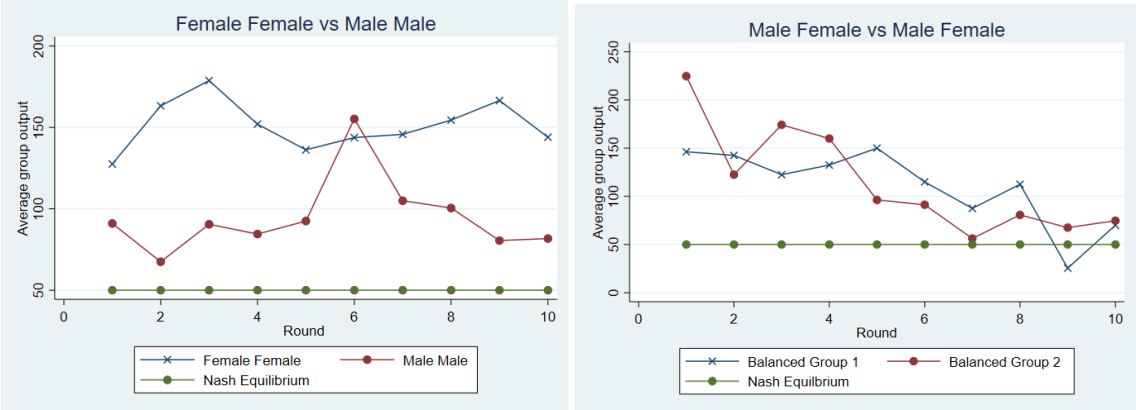
Figures 1 & 2 show our main results. Panel (a) of Figure 1 shows that female-female group output is higher than male-male groups, except for round 6 where male-male groups outperformed female-female groups, indicating females played more aggressively and strategically, and cooperated better than males. Panel (b) of Figure 1 shows similar levels of output performance between male-female and male-female (unbalanced) groups, with no significant difference observed. Panel (a) of Figure 2 compares female-female and male-female groups, indicating a consistently widening gap that persists over the entire 10 rounds. Panel (b) of Figure 2 compares the average group output for male-male and male-female. Male-female groups start with high output but decrease over rounds, ending with the lowest output while male-male groups start lower but maintain similar output throughout.

Table 2 reports OLS regression results of group output on diversity, suggesting that diverse groups performed relatively better than non-diverse groups, with an average output 58 ECUs higher. This aligns with the hypothesis that diversity in groups enhances performance.

Table 1: Summary Statistics

Balanced				
		Male, Female		
	Mean	Standard Deviation	Minimum	Maximum
Individual payoff	189.13	64.14	50	295
Individual allocation	63.375	48.97	0	200
Group Output	225.25	127.77	0	529
Total output (Pair 1)	128.53	97.23	0	400
Total output (Pair 2)	96.73	73.58	0	200
Win probability	0.53	0.51	0	1
Pair output	40			
Observations				
Unbalanced				
		Female, Female		
	Mean	Standard Deviation	Minimum	Maximum
Individual payoff	160.70	53.42	75	250
Individual allocation	64.30	39.88	0	125
Group Output	255.25	130.88	40	432
Total output (Pair 1)	130.75	81.60	0	250
Total output (Pair 2)	124.50	62.13	40	182
Win probability	0.25	0.44	0	1
Observations	20			
		Male, Male		
	Mean	Standard Deviation	Minimum	Maximum
Individual payoff	194.75	32.71	101	250
Individual allocation	30.25	34.32	0	100
Group Output	237.00	73.72	140.00	373
Total output (Pair 1)	65.30	67.16	0.00	201
Total output (Pair 2)	171.70	46.62	40.00	260
Win probability	0.25	0.44	0	1
Observations	20			

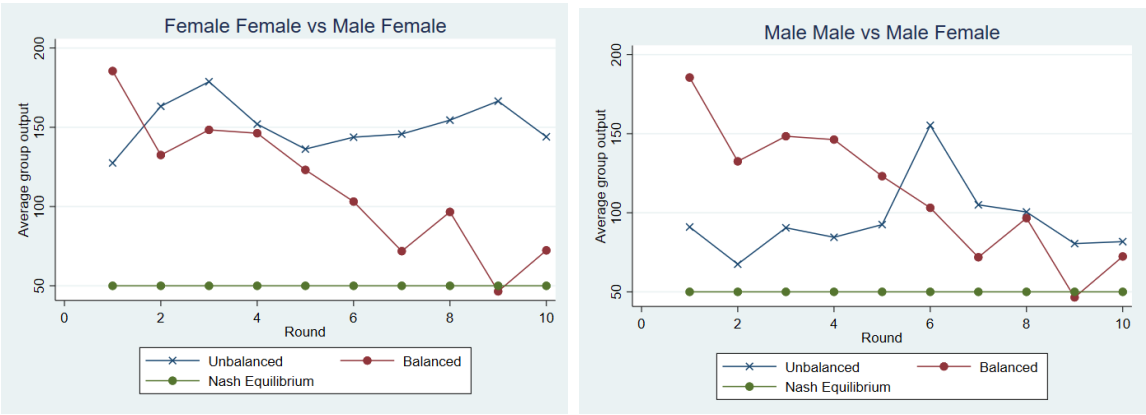
Table 1 shows summary statistics for both sessions and all ten rounds of the experiment. Group output represents the total output of two group pairs under the balanced or unbalanced treatment.



(a) Unbalanced sorting

(b) Balanced sorting

Figure 1: Average group output by sorting type. Balanced group 1 and 2 are two separate male-female groups competing with each other.



(a) Unbalanced vs Balanced (Female comparison)

(b) Unbalanced vs Balanced (Male comparison)

Figure 2: Average group output by sorting type.

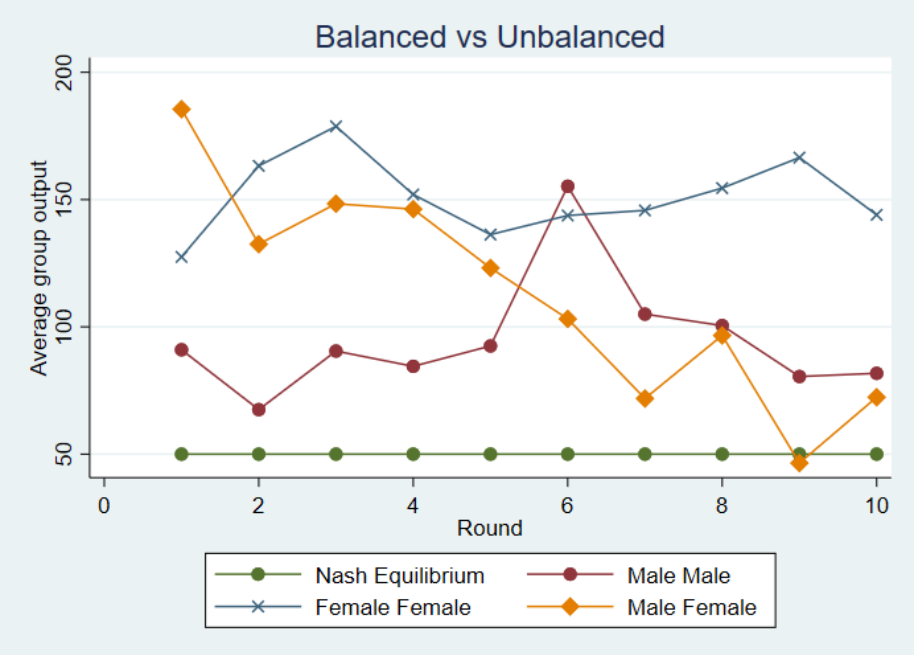


Figure 3: Average group output by sorting type. Male, male and female, female groups belong to the unbalanced sorting while male, female belong to the unbalanced sorting.

Table 2: Effect of diversity sorting and group output

Balanced	58*
Standard error	(30)
Observations	80
R-squared	0.32

Notes: Dependent variable is an indicator that equals 1 when the treatment is balanced and 0 otherwise. Asterisks indicate statistical significance at the *10 percent level.

5.3 Chat Analysis

We conducted chat analysis on 80 conversations between group members, categorizing them into various categories reflecting competitive and cooperative behavior. Each conversation could fall into multiple categories, counted once per round. The results are detailed in Table 3. The category "Agreed on effort level" shows that under the balanced and unbalanced sorting men and women were willing to cooperate with each other. 23.8% conversations indicated that females in the balanced sorting agreed with the effort level proposed by male teammates. Interesting to note that is that in 35% of the conversations, the effort proposal was made by a female. For the unbalanced groups, there is a higher number of conversations by males where they are "strategically thinking about the other group", "discussing changing strategy" and "making decisions by discussing the previous round". These categories reflect competitive behavior in men. However, we noticed that although men sounded competitive in their conversations, the male-male groupings invested low amounts of effort as compared to women. We noticed that males were more willing to give up and invest less effort in response to the progression of the game with women. This is reflected in the chat categories "Appeal to give up" and "Decide to bid lower after losing". These results could provide suggestive evidence that men were less willing to compete aggressively with female groups.

Table 3: Average frequencies of chat categories of the most frequently occurring categories

	Percent observed		Percent observed	
	Balanced		Unbalanced	
Chat category	Males	Females	(F, F)	(M,M)
Agreed on effort level	23.75	28.75	26.25	30
First proposal by Male	31.25	-	-	-
First proposal by Female	-	35	-	-
Strategically thinking about other group	18.75	11.25	18.75	27.5
Appeal to beat other group	3.75	0	8.75	7.5
Discussed coordinating on same effort level	30	36.25	15	32.5
Discuss changing strategy	11.25	11.25	15	17.5
First proposal accepted	26.25	26.25	11.25	28.75
Decided to focus on individual payoffs rather than winning	6.25	3.75	2.5	5
Decide on bidding higher	7.5	5	3.75	13.75
Make decision by discussing previous round	5	6.25	17.5	22.5
Appeal to give up	0	0	0	5
First proposal declined	5	6.25	0	3.75
Decide to bid lower after losing	7.5	6.25	0	5
Conversational Leader: Male	8.75	1.25	-	-
Conversational leader: Female	2.5	3.75	-	-

6 Conclusion and Discussion

Our experiment delved into the dynamics of gender-based sorting and communication within group contests. Contrary to our initial hypothesis and prevailing literature consensus, our findings shed light on a surprising discovery: all-female groups displayed greater levels of effort investment when competing against all-male groups. We also found that all-female groups did significantly better than male-female groups in all rounds throughout the experiment. All-male groups however initially were outperformed by male-female groups in the first half of the experiment and eventually surpassed them in the 6th round. These results are striking and indicate the poten-

tial for women to compete in settings that involve compensation with moderate risk levels. What is even more surprising is the perceived inability of men to compete aggressively was expected in a setting with very minimum levels of risk.

There are a few limitations to our research, however. For one, given the number of participants and the period of time in which the experiment was conducted, our sample size is quite modest therefore lacking strong statistical power in our estimates. It would be worthwhile to replicate this experiment on a larger scale to investigate whether the results we found persist. We could also increase the amount of variation created by including treatments with no communication to estimate the difference in total output between that and treatments with communication. Furthermore, borrowing from Niederle & Vesterlund (2007) it could be helpful to create an optional tournament with higher payoffs to see the percentage of women who select to this and if that in any differs from their findings.

7 References

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