

Competing Against the Opposite Sex

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May 16, 2003

Abstract

Given the tournament-style structure of many aspects of the labor market, one potentially powerful explanation for gender differences in pay and promotion is that men and women respond differently to competitive environments. We examine data from the high-stakes television game show *The Weakest Link* in order to determine whether men outperform women in competitive settings and whether the performance of men and women is affected by the gender of their opponents. The data show that in head-to-head competition men beat their female opponents over 72% of the time. Controlling for ability using past performance explains at most 27% of this differential. Our results also suggest that men's relative success arises because men perform better when they compete against women than against men, and that the higher the proportion of women among their competitors the better men perform. In contrast, we do not find strong evidence that the performance of women is affected by the gender of their opponents.

Key Words: gender, competition, performance, experiments.

JEL: C93, J16.

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§We would like to thank Nora Gordon, Patrick Dickinson and Pamela Maine.

1 Introduction

There are a wide range of important economic activities that take place in competitive group settings. Whether the interactions involve competing for promotions or working in teams, understanding how individuals respond to the decisions and characteristics of other workers can provide insights into the sources of labor market inequality.

The economic importance of behavior in these competitive settings has led to a nascent literature on how individual performance is affected by the gender mix of the group. Because adequate data on group members are rarely available, this emerging literature has primarily focused on experimental techniques.¹ Through innovative experimental designs, this literature has demonstrated that men and women respond differently to competition against the opposite sex. However, one limitation of this approach is that it is difficult in the lab to re-create the high-stakes, high-pressure environment of the workplace.

Utilizing data from the television game show *The Weakest Link*, we are able to overcome this issue. First, the prize money is much larger on the show than can be afforded in laboratory settings and may therefore more accurately reflect the benefits of competitive success. Second, beyond the monetary payments, the desire to perform well on national television may better replicate the pressure-filled environment of the workplace. Finally, the show is structured such that contestants compete in heterogenous groupings of between two and eight contestants with varying gender compositions, thus providing an excellent laboratory for studying the impact of group composition on performance.

In order to understand how we use data from the show, it is useful to first briefly outline the game's basic structure. The *The Weakest Link* is made up of a series of

¹See, for example, Gneezy et al. (2003) and Gneezy and Rustichini (2002). The analysis of the relationship between gender mix and performance has received greater attention in the psychology literature. We provide a brief discussion of this literature in section two.

rounds in which contestants take turns answering “general knowledge” questions; with each correct answer the pot prize money grows, and the longer the chain of correct answers the more quickly money accumulates. At the end of each round, contestants vote to remove one player. Since players who answer questions incorrectly prevent the pot of prize money from growing, there are strong incentives to vote off the weakest player (or “the weakest link”).² Then, at the end of the game, the two remaining players compete head-to-head to determine the sole winner of the accumulated pot of money.

The data reveal that even though roughly the same number of men and women reach the final round (103 vs. 97), men are significantly more likely to win when they face a woman than when they face a man. In fact, men win over seventy-two percent of the time in mixed-gender final rounds, and controlling for ability using past performance explains at most twenty-seven percent of this differential. Thus, the bulk of this performance differential appears to be explained by gender dynamics.

In order to determine whether men’s relative success occurs because men perform *better* against women or because women perform *worse* against men, we analyze the likelihood that contestants correctly answer questions throughout the game. We find that male performance is quite sensitive to the gender composition of the other contestants. As the ratio of women to men increases, so too does the performance of men. In contrast, female performance is unaffected by the sex ratio. Thus, our results suggest 1) that competing against women increases male performance, 2) that the higher the proportion of women among their opponents, the better men perform and 3) that the performance of women is not significantly affected by the gender of their opponents.

The remainder of this paper proceeds as follows. Section 2 discusses the related

²Indeed, in no rounds of the game is the strongest player more likely to be voted off than the weakest player. See Antonovics et al. 2003.

literature. Section 3 describes the the rules of the game and the data that we have collected. Section 4 presents our empirical methodology and our results. Section 5 concludes.

2 Related Research

Until recently, there have been very few studies within economics that have considered performance differences between men and women in competitive settings. Gneezy et al. (2003) examine male and female performance in solving computerized mazes. They find that whereas the performance of men is higher in competitive environments (relative to a piece rate pay scheme), competition only increases the performance of women when women compete against other women. Gneezy and Rustichini (2002) also examine gender differences in competitive environments but instead focus on young children (ages 9 to 10). They find that competition increases the speed at which children run and that the effect is stronger for boys than for girls. While both studies produce provocative results, neither study addresses the issue of the gender composition of groups and neither study has substantial rewards for performance. In a related paper Hoxby (2002) finds that both boys and girls perform better as the number of girls in the classroom increases.

Within the field of psychology there exists a vast literature that examines how men and women respond to competitive settings. Much of this literature focuses on differences in emotional, attitudinal and physiological responses to competition. For example, Madden and Kirkby (1995) find that among competitive basketball players women report higher levels of stress than men in competitive settings. They also found that men were more competitive and more focused on winning than women. Similarly, Mazur et al. (1997) find that while testosterone levels increase for men during video game competitions, women's testosterone levels actually decrease.

A much smaller number of studies in the psychology literature directly examine

performance. For example, Brown et al. (1997) examine the video game performance of men and women. They find that even when men and women of similar ability compete against one another, men outperform women. Similarly, Conti et al. (2001) report that when boys and girls between the ages of six and ten compete in art contests the creativity of boys is enhanced while the creativity of girls is undermined. Finally, Edwards (2002) finds that girls in an all-girl math classroom earned higher grades than girls in a coed math classroom even though both groups were taught by the same male instructor. Explanations for disparate responses of men and women to competitive environments generally appeal to stereotype-threat, evolutionary psychology, women’s fear of success and higher levels of confidence among men than women. Indeed, a large number of studies report finding lower levels of self-confidence among women than men (See, for example, Corbin (1981), Beyer (1990), Lundberg et al. (1994), Beyer and Bowdon (1997) and Ehrlinger and Dunning (2003)).

3 Data and Rules of the Game

We use data collected from recordings of the nationally televised game show *The Weakest Link*. There are two versions of the show, an hour long weekly show and a half-hour daily show, with both versions following the same general structure. After excluding celebrity episodes where the contestants play for charity, our data consist of 28 weekly shows and 72 daily shows.³ Each show is divided into a series of timed rounds, with the number of rounds corresponding to the number of players: eight rounds in the weekly show and six rounds in the daily show. Within each round, players are sequentially asked to answer general trivia questions where correct answers translate to an increase in the prize money. Regardless of whether the question is answered correctly, the next

³Our original sample included 75 daily shows. Unfortunately, three episodes had to be dropped due to incomplete data resulting from broadcast interruptions.

contestant is asked a new question. As a result, players do not “compete” to answer individual questions. The first correct answer is worth \$1,000 in the weekly show and \$250 in the daily show. After a correct answer, a player can choose to ‘bank’ the money for the team. If the player banks, the next correct answer is again worth \$1,000 in the weekly show and \$250 in the daily show. Should the player decide not to bank, the amount of money added to the pot following a correct answer increases. However, failure to answer a question correctly leads to the loss of any unbanked money for that round. A successive chain of eight (six) correct answers with no intermittent banks leads to an \$125,000 (\$12,500) increase in the pot. Money banked from each round is accumulated into a team bank.

After each round, each player votes independently as to which player he would like to remove from the show, and the player who receives the most votes must leave the game. In the event of a tie, the ‘strongest link’ chooses which player to remove from the subset of players who received the most votes. The strongest link is the player who answers the highest percentage of his or her questions correctly.⁴ Once the field of players is reduced to two (this occurs in round 7 of the weekly show and round 5 of the daily show), these two players first accumulate prize money in the same fashion as in the earlier rounds, then the two players compete directly against each other with the winner taking all the money in the team bank. In the final round, five (three) questions are asked of each contestant in the weekly (daily) show with the winner being determined by who answers the most questions correctly. All other contestants leave with nothing. In the event of a tie in the final round, each contestant is asked an additional question until one answers correctly and the other incorrectly.

Our analysis focuses on those individuals who survive to the final round. Our primary reason for doing this is that we have much better measures of ability for this group

⁴Should there be a tie for the ‘strongest link,’ amount of money banked is used as the tie-breaker.

Table 1: Descriptive Statistics

		Women	Men
Daily	Number of Contestants	70	74
	Average Number of Questions Answered	16.1	16.2
	Overall Percent Correct	62.3%	66.6%
	Percent Correct– Final Round	47.4%	49.9%
	Percent Correct– Round 1	71.9%	75.2%
Weekly	Number of Contestants	27	29
	Average Number of Questions Answered	29.1	28.9
	Overall Percent Correct	60.8%	62.3%
	Percent Correct in the Final Round	55.3%	63.1%
	Percent Correct in Round 1	68.1%	68.4%

because they answer more questions than those voted off in earlier rounds. The basic results do not change when we use broader sample definitions.

Table 1 presents some basic descriptive statistics for those individuals who make it to the final round. As can be seen, roughly equal numbers of men and women are contestants on the weekly and daily shows and, on average, men and women answer close to the same number of questions per game.⁵ On both the daily and the weekly show, men who make it to the final round answer a slightly higher percentage of questions correctly, but these differences are small.

⁵Both Antonovics et al. (2003) and Levitt (2003) find no discrimination in voting patterns against females while the former do find that women discriminate against men in their voting behavior. However, we see no reason how this discrimination should affect our results—particularly performance in the final round—once we condition on the abilities of the contestants.

4 Results

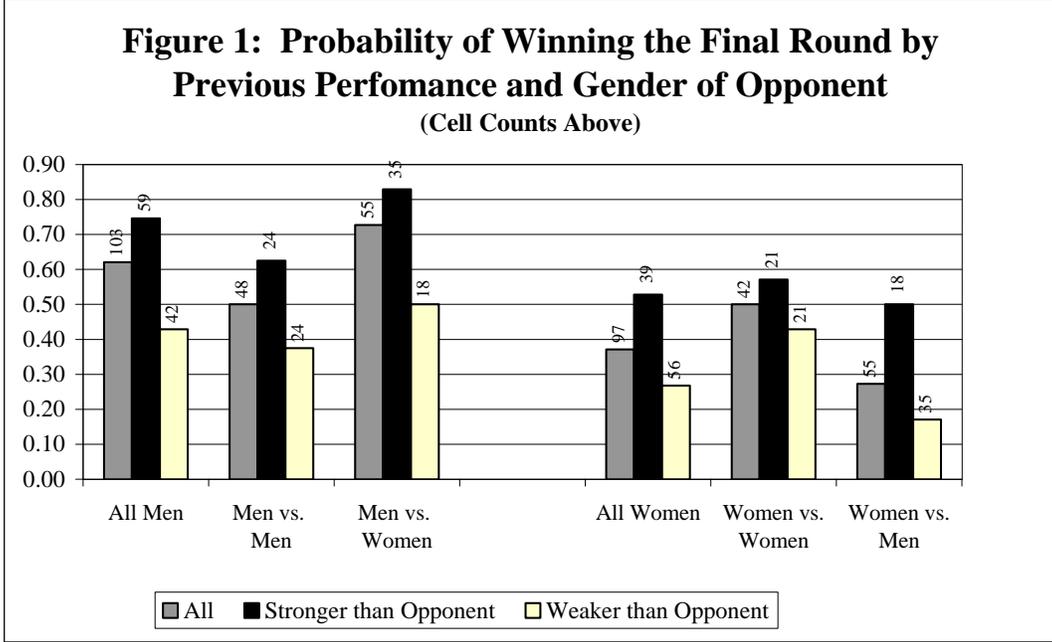
4.1 Who Wins the Game?

We begin our analysis of the data by evaluating whether men or women are more likely to win the head-to-head competition in the final round. Roughly the same number of women and men (97 and 103 respectively) survive to the final round. However, conditional on surviving to the final round, men significantly outperform women. In particular, men win over seventy-two percent of the time when they face women in the final round.

One possible explanation for this difference is that the men who survive to the final round are better at playing the game than the are women who survive to the final round. As a first cut at controlling for ability, Figure 1 breaks out the combined outcomes for the daily and the weekly shows as a function of previous performance in the game.⁶ The left half of the figure focuses on men while the right half focuses on women. The first set of bars disaggregates all male and all female contestants into three categories: All contestants; “stronger” contestants, whose percentage of questions answered correctly over all but the final round (cumulative percent correct) was greater than that of their opponent; and “weaker” contestants, whose cumulative percent correct was less than that of their opponents. As the figure shows, stronger men are are successful 75% of the time, while stronger women are only successful 53% of the time.

Figure 1 also suggests that part of the explanation for the relatively stronger showing of men stems from performance differentials associated with opponent gender. The second and third sets of bars evaluate how women and men perform when competing against contestants of same and different genders. Based on their performance in the

⁶Note that the cell counts for the number ‘stronger than opponent’ and the number ‘weaker than opponent’ do not sum to the total because a small number of pairings had identical previous performances.



earlier rounds of the game, the data reveal that stronger men win 83% of the time when they play against women but only 63% of the time when they play against men. Similarly, stronger women win 57% of the time against women but only 50% against men. Thus, even with rough controls for ability, it appears that both men and women are more likely to win when they compete against women, and this pattern is especially strong for men.

To further control for any possible ability differences, we estimate conditional logits of the probability of winning the game. In particular, we assume that the probability of contestant i beating contestant j in the final round follows is given by:

$$Pr(w_i = 1) = \frac{\exp(\beta_1 A_i + \beta_2 S_j)}{\exp(\beta_1 A_i + \beta_2 S_j) + \exp(\beta_1 A_j + \beta_2 S_i)}. \quad (1)$$

where $w_i = 1$ if contestant i beats contestant j , A_i is contestant i 's ability and $S_i = 1$ if contestant i is a woman. Since we do not actually observe the contestants' true

Table 2: Conditional Logit Estimates of the Probability of Winning the Game[†]

	Model A		Model B	
	Coefficient	Std. Error	Coefficient	Std. Error
Cumulative Pct. Correct	4.789*	(1.480)		
Pct. Correct in Round 1			0.688	(0.546)
Female	-0.819*	(0.320)	-0.941*	(0.305)
Observations	200		200	

[†] Weekly and daily shows are pooled. Results are conditional on surviving to the final round.

* statistically significant at 95% level.

underlying abilities, we proxy for ability two different ways. First, we use the cumulative percent correct in all of the previous rounds. That is, suppose contestant i answered N_i questions before the final round. The ability measure used is given by:

$$A_i = \frac{\sum_{n=1}^{N_i} c_{in}}{N_i} \quad (2)$$

where c_{in} equals one if contestant i answered the n th question correctly and equals 0 otherwise. We estimate the conditional logit on pooled data from the weekly and daily shows.⁷ Estimates of the conditional logit are presented under model A in Table 2.

As expected, the probability of winning is positively correlated with the percentage of questions that the contestant answered correctly in the previous rounds. Further, the negative coefficient on the female indicator suggests that men perform better than women even after controlling for ability, and the magnitude of this effect is quite large.⁸

⁷Show specific models were also estimated. While pooling increases precision, it has no qualitative effect on the point estimates.

⁸Note that given the structure of the conditional logit model, it is not possible to distinguish between the effect of a contestant's gender and that of their opponent's gender.

To see this, note that the average cumulative percent correct for men and women who reach the final round is 69.5% and 63.3%, respectively. The model predicts that if a man and a woman with these ability levels compete against one another in the final round, then the man will win 75.2% of the time. It is possible to decompose this performance differential into an ability component and a gender component. First, consider the impact of the difference in mean ability measures. The model predicts that if two final round contestants with the performance levels mentioned above are of the same sex, the contestant with the higher ability measure will win 57.3% of the time. If, on the other hand, a man is competing against a woman of identical ability, the model predicts that the man will win 69.4% of the time. (If chance alone determined the outcome, then this number would be 50%.) Thus, roughly speaking, gender appears to explain 73% of the difference in the probability that men and women win the game, while differential ability explains only 27%.

These estimates of the gender gap in performance are actually lower bounds. To see this, note that men who face women in the final round are likely to have faced more women in the other rounds of the show than men who faced men in the final round. If male performance is positively affected by having more females in the contestant pool, then our measure of cumulative percent correct will be biased upward for men who face women, lowering our estimate of the effect that gender has in the final round.⁹

We therefore use a second proxy for ability, the percentage of questions answered correctly in the first round of the game. This measure is not contaminated by changes in the sex ratio over the course of the game, and there are almost always equal numbers of male and female contestants in the first round. Model B replicates the conditional logit estimation using this alternative ability measure. As would be expected, the noisiness

⁹This logic holds if women perform better (worse) when there are more women (men) as the cumulative percent correct measure will be biased downward for women who faced men.

of this measure leads to a much smaller ability coefficient relative to the initial specification. The implications for the gender effect are now even larger. Performing a similar calculation to the one above shows that without gender effects the model predicts men will win 51.3% of the time given the differences in abilities between men facing women. Turning off the difference in abilities and examining just the gender effect yields a prediction that men would win 71.9% of the time; implying that over 94% of the difference in the probability of winning the show is due to gender.

4.2 Why Do Men Win?

While the analysis in the previous section shows that men are more likely to beat women in the final round even after controlling for ability, it does not tell us whether this is because men perform better against women or women perform worse against men. To further distinguish between these two hypotheses and explore the role of gender mix when the competitive environment includes more than two actors, we examine the factors that influence the likelihood that men and women answer questions correctly in all rounds of both shows. In particular, if women perform poorly in the presence of men, they should be less likely to answer questions correctly when the sex ratio tilts towards more men. A similar feature will hold for men if they perform better in the presence of women.

We assume that the probability of answering the j th question correctly, $c_j = 1$, depends upon individual i 's ability, A_i , and the sex ratio (percentage of women),¹⁰ SR , in the particular round. In order to account for the possibility that the difficulty of the

¹⁰We calculate this as the percentage of women in the round *including* the contestant whose performance we are analyzing. This allows the effect that two women have on one man when there are three contestants left to be stronger than the effect of one woman on one man with two contestants left. We also experimented with calculating the sex ratio omitting the contestant's own sex. There were no changes in the qualitative results and the results were still significant at conventional levels.

questions varies by show and by round, we include separate round dummies for both the weekly and the daily shows. These probabilities are assumed to follow a logit form:

$$P(c_j = 1) = \frac{\exp(\beta_3 A_i + \beta_4 S R_{rs} + \beta_5 r_s)}{1 + \exp(\beta_3 A_i + \beta_4 S R_{rs} + \beta_5 r_s)}. \quad (3)$$

As with the probability of winning the game, we do not actually observe the abilities of the contestants. As a proxy for the abilities of the individuals, we use the cumulative percent of past and future questions answered correctly. That is, we use information on all questions answered by the contestant besides the one we are modelling to form a cumulative percent correct. Given that an individual answered N_i questions, the ability measure used in modelling the probability of answering the j th question is given by:

$$A_{ij} = \frac{\sum_{n=1}^{N_i} c_{in} - c_{ij}}{N_i - 1} \quad (4)$$

We estimate these probabilities using a balanced panel consisting of all contestants who survive to the final round. These logit probabilities are estimated separately for men and women with the results displayed in Table 3. Although we pool the daily and weekly shows in all specifications, the qualitative results do not change if we estimate the probabilities separately for the two shows.

Results for men are presented in the first two columns of Table 3. As expected, the ability to answer other questions correctly is positively correlated with the probability of answering the current question correctly. More notably, the greater the percentage of the other contestants who are women, the higher the probability is that a male will answer correctly.

The second two columns of Table 3 display the results for women. As with men, the ability to answer other questions correctly is positively correlated with the probability of answering the current question correctly. However, unlike the case for men and in contrast to the findings of Gneezy et al. (2003), we find no evidence that women compete less successfully against men. The coefficient on sex ratio is always small and

insignificant. We have experimented with a number of other specifications, for example allowing the coefficient on sex ratio to vary with the round, and never do we see changes in the sex ratio affecting female performance. Hence, these results suggest that men are more likely to win the final round because men perform better against women rather than because women perform worse against men.

The marginal effects of a higher sex ratio on the probability of an individual correct answer, however, are much smaller here than on the probability of winning the game. Consider a man in round 4 of the daily show who, in all his other questions, has answered two-thirds correctly. Changing the pool of contestants he faces from two men to two women increases his probability of answering correctly from 65.6% to 71.9% — an increase of slightly over six percentage points. These small differences in the probability of a correct answer, however, translate into large differences in the probability of winning the game.

As discussed above, there is a potential concern about selection effects associated with using the cumulative percent correct over all other questions as a proxy for ability. In particular, if contestant i competes in a round with a high sex ratio (a high proportion of women) when answering question j they will on average have faced a high sex ratio when answering the questions upon which their percent correct measure is calculated. If high sex ratios increase performance, their ability measure will be biased upward and the coefficient on sex ratio in the logit model will then suffer a downward bias. As with our analysis of who wins the game, our results represent a lower bound on the effect of sex ratio on performance.

To mitigate the contamination of the ability measure by the sex ratio, we estimate a second version of the model using the percent correct in round 1 as an ability proxy and excluding round 1 questions from the estimation. Because there is a much lower variance in the sex ratio for this round than for later rounds, if a downward bias exists

in the initial model, it should be much less pronounced in this second specification. The results for this model are presented in Table 4. Using percent correct from only a single round leads yields a higher variance ability measure resulting in a much smaller (although still significant) coefficient on the ability proxy. We still see virtually no effect of sex ratio on female performance. However, consistent with the downward bias story, the alternative model yields a larger coefficient on sex ratio in the male-only model. The marginal effects on sex ratio under the alternative specification are much larger. Again, using the example of round 4 from the daily show, we find that a man who answered two-thirds of his round 1 questions correctly would see his probability of answering the current question correctly increase from 64.2% to 72.0% if he faced two women rather than two men.

5 Conclusion

Gender differences in pay and promotion are substantial. Even after controlling for a broad range of demographic and background characteristics women earn significantly less than men, and women are less likely to be promoted to top-ranking positions. One potentially powerful explanation for these differences is that men and women respond differently to competitive environments. This paper explores how the performance of men and women is affected by the gender of their opponents by examining data from the high-stakes television game show *The Weakest Link*. These data are uniquely well-suited to this task for two reasons. First, performance in previous rounds of the game provide strong measures of individual ability. Second, the high-stakes tournament nature of the game helps to overcome problems that traditional laboratory experiments face in replicating the high-pressure environment of the workplace.

We find that even after controlling for ability, in competitions between men and women, men are more likely to win. In addition, our results suggest that men's advantage

Table 3: Logit Estimates of the Probability of Answering a Question Correctly

	Males Only		Females Only	
	Coefficient	Stand. Error	Coefficient	Stand. Error
Percent Correct [†]	1.453*	(0.452)	1.792*	(0.412)
Sex Ratio [‡]	0.437*	(0.207)	0.097	(0.269)
Round 2	-0.148	(0.247)	-0.204	(0.231)
Round 3	-0.522*	(0.180)	-0.206	(0.246)
Round 4	-0.288	(0.231)	-0.573*	(0.198)
Round 5	-0.221	(0.208)	-0.421*	(0.205)
Round 6	-1.020*	(0.203)	-1.088*	(0.234)
Weekly Show X Round 1	-0.294	(0.290)	-0.178	(0.296)
Weekly Show X Round 2	-0.237	(0.309)	-0.076	(0.301)
Weekly Show X Round 3	0.178	(0.245)	0.014	(0.281)
Weekly Show X Round 4	-0.132	(0.261)	0.263	(0.268)
Weekly Show X Round 5	-0.097	(0.239)	-0.230	(0.247)
Weekly Show X Round 6	-0.027	(0.201)	0.510	(0.270)
Weekly Show X Round 7	-0.607*	(0.209)	-0.631*	(0.230)
Weekly Show X Round 8	-0.465*	(0.211)	-0.735*	(0.249)
Constant	-0.033	(0.351)	-0.201	(0.331)
Observations	2109		1977	

[†]Calculated as the number of other questions answered correctly divided by the total number of other questions answered by the contestant.

[‡]Calculated as the fraction of the contestants in the round who were female.

* statistically significant at 95% level.

Table 4: Logit Estimates of the Probability of Answering a Question Correctly (Excluding Round 1 & Using Round 1 Performance as Ability Proxy)

	Males Only		Females Only	
	Coefficient	Stand. Error	Coefficient	Stand. Error
Percent Correct Round 1 [†]	0.350	(0.190)	0.442*	(0.211)
Sex Ratio [‡]	0.540*	(0.247)	0.098	(0.336)
Round 3	-0.367	(0.223)	0.004	(0.233)
Round 4	-0.118	(0.219)	-0.336	(0.211)
Round 5	-0.039	(0.213)	-0.192	(0.247)
Round 6	-0.813*	(0.196)	-0.836*	(0.192)
Weekly Show X Round 2	-0.265	(0.323)	-0.066	(0.301)
Weekly Show X Round 3	0.136	(0.254)	0.014	(0.292)
Weekly Show X Round 4	-0.188	(0.279)	0.239	(0.274)
Weekly Show X Round 5	-0.154	(0.245)	-0.236	(0.261)
Weekly Show X Round 6	-0.099	(0.217)	0.475	(0.286)
Weekly Show X Round 7	-0.465*	(0.223)	-0.411	(0.251)
Weekly Show X Round 8	-0.328	(0.221)	-0.515	(0.264)
Constant	0.468	(0.260)	0.374	(0.291)
Observations	1840		1727	

[†]Calculated as the number of other questions answered correctly in round 1 divided by the total number of questions answered by the contestant in round 1.

[‡]Calculated as the fraction of the contestants in the round who were female.

* statistically significant at 95% level.

over women occurs because men perform better when they compete against women. Further, the higher the proportion of women among their opponents, the better men perform. We find no evidence that the performance of women is affected by the gender of their opponents.

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