5. Gender differences in responses to incentives in sports: some new results from golf

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5.1 INTRODUCTION

Women and men make very different labor market decisions, which lead to different employment rates, employment patterns, and earnings. For example, women are underrepresented in many high-profile jobs, including those in academia and public administration. Research in psychology has reported that women and men gravitate toward different incentive systems; men are eager to compete, but women shy away from competition. More than men, women prefer to work under piece-rate systems in which rewards are based on absolute performance as opposed to tournament pay systems in which rewards depend on relative performance.

Some of the early literature on this issue concluded that the earnings differences were caused by gender discrimination (Goldin and Rouse, 2000). Others claimed that women self-selected into jobs that did not demand large investments in human capital because they anticipated lower returns to such investment because they would leave the labor force (at least temporarily) after having children (Polachek, 1981). Over the last decade or so, economists and other social scientists have examined other hypotheses, among them the proposition that part of the gender pay gap arises from different reactions to prize incentives. Croson and Gneezy (2009) review experimental evidence on preference differences between men and women, focusing on three factors that have been extensively studied: risk preferences, social preferences, and reaction to competition. They find that women are more risk averse and more competition averse than men.

Several papers examine why men and women respond differently. Gneezy et al. (2009) argue that cultural factors play an important role in explaining gender differences in competitiveness, while Buser (2009) focuses on biological factors. Other scholars argue that differences in incentive structures lie at the root of the gender differences in competitiveness (Manning and Saidi, 2008).

The first objective of this chapter is to survey the work that has addressed the different responses men and women have to incentive structures and

competitiveness in sports. While we focus on sports, we also selectively survey gender differences in experimental settings. Second, we use data from the 2009 men's and women's professional golf Tours to report new findings of the effects of prize money on player performance. Section 5.2 reports the outcomes of research focusing on gender differences in completing various tasks, such as solving mazes or math problems in experimental settings. Section 5.3 surveys the sports economics literature that addresses differences in men's and women's responsiveness to total prize money and prize spreads in tournaments. Section 5.4 reports our estimates of gender differences in professional golf. This work draws on a unique dataset that has several interesting features. Our data include 28 PGA (Professional Golf Association) and 16 LPGA (Ladies Professional Golf Association) tournaments in 2009, and we use objective measures of course difficulty and opponent and player performance. These features allow us to examine gender differences in response to financial incentives. Section 5.5 reports the results of our estimation. We find that larger tournament purses increase both women's and men's total scores, but the effect is slightly greater for women. Focusing on final round scores only, women improve their performance under several alternative specifications that we considered while men's scores worsen in all circumstances. Section 5.6 concludes and suggests further work on this important issue.

5.2 GENDER DIFFERENCES IN EXPERIMENTAL STUDIES

Gneezy et al. (2003) and Gneezy and Rustichini (2004) are the first experimental studies that examine the interaction of gender and competition. Gneezy et al. find that men react positively to tournament-style incentives while women react positively only when they compete against other women. Gneezy and Rustichini find essentially the same result using an experimental setting in which nine- and 10-year-old schoolchildren race against each other without any monetary rewards involved. Children ran alone and then in pairs with varying gender compositions. Boys run faster than girls when competing against someone else, regardless of the competitor's gender, but both boys and girls perform the same when they run alone.

Ivanova-Stenzel and Kubler (2005) examine the role of gender in teamwork. Their experiment looks at group incentives and productivity, focusing on the relevance of gender for the optimal composition of a team. They conclude that performance depends on both the incentive scheme and the genders of the group members. Holding the incentive scheme fixed,

they find that the gender composition of the team matters for teamwork but not for team competition. Men perform worst when the benefits are shared with other men in a cooperative environment. Men's performance increases when women are present or when the environment is competitive, or both. In contrast, women do best when competing against men but reduce their work effort when paired with men in the case of team pay. Ivanova-Stenzel and Kubler also observe that there is a significant gender difference in performance in mixed teams that is not present in single-sex teams. These findings are broadly consistent with the findings of Gneezy et al. even when the former come from teamwork and team competition and the latter from individual performance.

Niederle and Vesterlund (2005) find that there is no difference between the performances of men and women in a competitive environment, but women are less willing than men to compete in tournaments when given the opportunity to work under piece rates. Dohmen and Falk (2006) confirm this finding. Their experimental approach consists of having subjects complete a series of arithmetic computations that vary in difficulty. Before subjects start to work, they are offered a variable pay contract and a fixed-payment contract. The chosen contract determines how subjects are paid for the output they produce in the work period. There are three types of variable pay schemes: piece-rate, tournament, and revenue-sharing contracts. Their results show that women are 15 percent less likely to enter a variable pay scheme than men when the alternative is a fixed payment. Sorting, therefore, offers a channel for gender differences in occupational choice, career choice, and ultimately wages.

Datta-Gupta et al. (2005) consider whether women and men make different choices because they have different attitudes toward competition. In their experimental setting, subjects choose between a tournament and a piece-rate reward scheme *before* they perform a real task. Men choose the tournament significantly more frequently than do women. Risk matters less for men when they choose their payment scheme than for women whose choices of payment schemes are more heavily influenced by their degree of risk aversion.

In a follow-up paper, Niederle and Vesterlund (2007) examine whether men and women of the same ability differ in their selection of a competitive environment. Their experimental subjects complete a real task first under a non-competitive piece rate scheme and then under a competitive tournament scheme. Participants then select one of the two compensation schemes to apply to their next performance. They find that the majority of men select the competitive tournament, whereas the majority of women select the non-competitive piece rate. Further, low-performing men enter tournaments more frequently while high-performing women enter less

frequently than is warranted from a payoff-maximizing perspective. The gender gap in tournament theory can be explained in part by men's being more confident than women about their relative rank, and by men and women having different attitudes toward competition.

Niederle et al. (2008) use experimental methods to examine how affirmative action affects entry into tournaments. They find that when women are guaranteed equal representation among winners, more women and fewer men enter competitions. Affirmative action, which affects tournament entry through changes in the probability of winning, is one of several factors that affect entry. The authors investigate a quota-like affirmative action environment in which women must be at least equally represented among those hired. They find that affirmative action encourages women to enter while discouraging men from entering. They speculate that the mere mention of affirmative action changes the decision to enter a tournament. Their experimental design allows them to characterize how the composition of the applicant pool changes with affirmative action. They find that, prior to affirmative action, only a few high-performing women chose to compete and thus rarely won tournaments.

As noted in the introduction, Gneezy et al. (2009) study the impact of nurture on attitudes toward competition by investigating two distinct societies, the patriarchal society of the Maasai tribe of Tanzania and the matriarchal society of the Khasi tribe of India. The authors conducted a field experiment in which members of each tribe were given the opportunity to compete in a contest that consisted of tossing a tennis ball into a bucket. The authors find that, in the patriarchal society, women are less competitive than men. In the matriarchal society, women are more competitive. Moreover, Khasi women are more competitive than Maasai men. The authors claim that their results provide a link between culture and behaviors that affect economic outcomes.

Booth and Nolen (2009) examine the role of nurture in explaining the stylized conclusion that women shy away from competition. They use a controlled experiment in which the subjects are students just below age 15 who attend publicly funded single-sex and coeducational schools in the UK. Their evidence suggests that a girl's environment plays an important role in explaining why she chooses not to compete: girls from single-sex schools behave more competitively and more like boys than do girls from co-educational schools.

The studies summarized use experimental settings in which subjects complete tasks such as adding up sets of numbers or solving mazes or racing relatively short distances. In these settings, men and women react differently to prize incentives depending on whether the experiments

involve single-sex or mixed gender competitions. We now turn to how tournament settings affect performance in sports.

5.3 GENDER DIFFERENCES IN SPORTS

Empirical research on the effects of financial incentives on individual performance in sports tournaments began with the seminal work on golf by Ehrenberg and Bognanno (1990a and 1990b), who studied the 1984 PGA TOUR and 1987 European PGA TOUR. They tested the predictions of tournament theory from two perspectives: (a) whether a tournament's total prize money affects a golfer's total score after four rounds, and (b) changes in marginal returns to effort in the tournament's final round affect a golfer's final-round score. Their findings in both studies found support for tournament theory predictions. A \$100,000 increase in total prize money reduces total scores by about one stroke on the PGA TOUR and three strokes on the European Tour. In the final round, a one standard deviation increase in marginal returns lowers scores by one to three strokes, with the upper end of that range reflecting performance on the European Tour. They also find that prize money differences have a larger incentive effect in the final two rounds than in the first two rounds of the tournament. Finally, they show that players perform better when participating in major tournaments and when facing a less competitive field.

In contrast, Matthews et al. (2007) find no positive incentive effects for women on the 2000 LPGA Tour. They use the top 50 money winners for that year in their sample and find that higher total prize money actually increases total scores. Their results do not change when the sample includes only the top 20 or 35 money winners. Based on their estimates, a \$100,000 increase in total prize money increases a player's golf score by 0.28 strokes. Their results also indicate that major tournaments have no effect on player scores. Finally, like Ehrenberg and Bognanno, they find that women's scores improve as the mean scoring average of the field increases, suggesting that players perform better as the opponents' ability level declines.

Matthews et al. offer several possible explanations for their results: (a) financial incentives may not affect concentration and effort levels for female golfers; (b) financial incentives affect performance but only over a long period of time; (c) LPGA prize money levels are much lower and may not change effort levels appreciably, even in lower-paying tournaments. The authors also suggest a superstar effect of Karrie Webb during the 2000 season. Webb's presence in a tournament may have adversely affected the responsiveness of other golfers to financial incentives and caused their

scores to increase. However, excluding tournaments entered by Webb also causes the opponent's ability and par variables to reverse sign, indicating that women perform better when facing superior opponents and more difficult courses.

Other research on golf provides mixed evidence regarding tournament theory. Orszag (1994) re-examines Ehrenberg and Bognanno's PGA (1990a) study by using their total score model on data from the 1992 PGA Tour. He finds that total prize money has no significant effect on total golf scores and that players' scores are higher in major tournaments, contrary to tournament theory predictions. He suggests that substantially higher purses in 1992 may have increased player nervousness and caused more people to 'choke' under greater pressure. The other possibility is simply that prize money does not significantly affect effort or concentration over four rounds in a tournament.

In the spirit of Gneezy et al. (2003), Cotton and Price (2006) study the performance of male and female golfers ages 12–17 participating in American Junior Golf Association (AJGA) tournaments. They examine the existence of a 'hot hand', that is, whether the probability that an individual succeeds in the current period depends on whether the individual succeeded in previous periods. They find that women are more prone to experiencing performance streaks than men. Further, they find that hot hands occur in the first year of AJGA tournament competition but that they virtually disappear by the third year of tournament play. Cotton and Price interpret their results as being consistent with the broader literature, which has shown that men and women respond differently to competition. However, their preferred explanation for the initial gender difference is that men are more likely to have had competitive experience prior to joining the AJGA tournament than women. When women accumulate enough tournament experience, the gender difference virtually disappears.

Ehrenberg and Bognanno's research has sparked other studies of sports tournaments, including professional bowling, car racing, foot racing, and professional tennis. Most of these studies have focused on men's rather than women's sports. As von Allmen (2006) states, evidence on gender differences in competitive environments is limited, especially in professional sports, but there are several exceptions. We focus here on the responses of men and women to incentives in foot racing and tennis.

Maloney and McCormick (2000) analyze the effect of average prize levels and prize money spreads on race times in open invitational foot races held in the southeastern United States from 1987 to 1991. They find that larger overall prize levels attract better racers, and larger prize spreads increase effort and lower individual race times, consistent with tournament theory. The authors also separate out gender effects and find

that faster women have a greater response to overall prize levels, but men respond more to larger prize spreads.

Frick and Prinz (2007) argue that Maloney and McCormick's study inappropriately combines all distance-type races and focuses only on regional races that do not attract a large number of elite racers. Instead, Frick (2011a) mentions two earlier studies that he conducted of professional marathons. Those earlier results indicate that increases in purse size and prize distribution reduce women's finishing times more than men's, but that bonus payments have no impact. Frick explains this by arguing that the distribution of ability is more homogeneous among male elite marathon runners than among female elite marathon runners. Therefore, women do not need to exert additional effort in response to bonus payments because they can win with less than maximal effort.

Frick (2011a) extends his analysis on road racing by analyzing finishing time differentials between men and women covering the 200 best finishes in races ranging from 3,000 meters to marathons. The dependent variable in his analysis is the percentage difference in finishing time between female and male runners by race type and runner rank. He argues that if women exhibit a lower degree of competitiveness, the percentage difference in finish times should increase with rank. For all race types, he finds that the percentage difference in finish times increases quickly at first and then rises at a diminishing rate.

Frick finds that gender differences have declined considerably over time, especially in races that offer greater financial rewards. He computes the coefficient of variation (variance divided by mean) for the top 200 performances by men and women in races of varying lengths and finds that the coefficients of variation for the two genders are strongly correlated. He also finds that the average ages of the men and women with the top-200 times at varying distances are correlated. He concludes that women and men respond similarly to financial incentives.

Frick (2011b) finds similar results for ultramarathons. The percentage difference between men and women's finish times increases with rank, first at a decreasing rate and then at an increasing rate, yet the difference appears to have fallen over time and to have fallen more significantly in the more lucrative 100km races. In addition, he reports that the variance in the top 100 performances of both men and women is smaller in the races with higher prizes and a larger pool of runners.

Deaner's (2006a) results for men's and women's performance in distance running are similar to those of Frick (2011a). He shows that gender differences in world-class running performances have stabilized at 10–15 percent across all races from 3,000 meters to marathons. Using gender-specific world records as a baseline for comparing performance across

sexes, Deaner finds that, among elite US runners, two to four times as many men as women run fast relative to sex-specific world-class standards. Deaner (2006b) examines whether this sex difference also holds for the non-elite participants of road races that offer equivalent prizes for men and women. For the 20 largest 5,000-meter road races and marathons held in the USA in 2003, proportionally more men run close to sex-specific world-class standards than women. Deaner concludes that the potentially elite US runners are disproportionately male.

Several studies have also examined the responsiveness of men and women to monetary incentives in tennis. However, these studies focus either on the men's or the women's professional tennis tours, making direct comparisons difficult. Lallemand et al. (2008) and Gilsdorf and Sukhatme (2008a) found that women respond to prize money incentives. Using data from the final two rounds of WTA (Women's Tennis Association) tournaments from the 2002–04 Tours, Lallemand et al. find that doubling the prize spread increases the number of games won in a match by between 0.7 and 1.

Lallemand et al. also attempt to distinguish between the incentive effect and the capability effect of differences in player abilities. According to the incentive effect, greater differences in ability reduce effort and performance of both the underdog and the favorite. The capability effect suggests that the underdog exerts less effort but the favorite plays better. Their results indicate that larger ability differences reduce the number of games won by underdogs but increase games won by the favorites beyond what one would expect from ability differences alone. In addition, the margin of victory reflected in the difference in games won also increases by about 0.55 games with a doubling of ability differences. The authors argue that these findings suggest that the capability effect dominates in professional women's tennis. In contrast, Sunde (2009) finds that the incentive effect outweighs the capability effect for professional men's tennis.

Gilsdorf and Sukhatme (2008a) use data from the 2004 WTA Tour and test whether higher prize money differentials increase the probability that the favored player wins the match. After controlling for player- and tournament-specific characteristics, their findings support Rosen's (1986) elimination tournament model. An increase in the prize differential from the 25th percentile to the mean (\$25,700 to \$161,580) increases the favorite's probability of winning the match by 1.8 percentage points. The authors also conduct a similar study of the 2001 men's professional tennis tour (Gilsdorf and Sukhatme, 2008b) and find that an increase in the prize differential from the 25th percentile (\$50,280) to the mean (\$241,960) increases the favorite's probability of winning by about 1.9 percentage points. However, given the different sample period and model

specifications, any direct comparisons of responsiveness should be made with caution.

Paserman (2010) analyzes data from the 2005–07 Grand Slam tennis tournaments to see if performance declines as pressure increases during a match. His preferred measure of performance measure is the probability of winning a point. In a match between players of equal ability, the one who can maintain performance at the most critical points of a match can increase the probability of winning from 50 to 80 percent. His results indicate that there is no significant gender difference in the probability of winning the point even while women make more unforced errors. He notes that both men and women adopt strategies that cause both the probability of making unforced errors and the probability of hitting winners to rise. Thus, he states that women, in this context, do not behave differently from men as competitive pressure rises.

5.4 A NEW MODEL OF INCENTIVES IN GOLF

Our work contributes to the literature in several ways. First, we address the contradictory findings of Orszag (1994) and Matthews et al. (2007) regarding the sensitivity of effort to prize money in professional golf. Second, we extend the literature on gender differences in economic contests to professional golf. We collect 2009 data for both the PGA and the LPGA tournaments, which allows us to test for gender differences in the effect of incentives on player performance. Third, our data are from single-sex tournaments and include individuals who voluntarily participate in a highly competitive environment, reducing the complications associated with using both mixed and single-sex groups. In their survey of differences in gender preferences, Croson and Gneezy (2009) cite numerous studies that find women respond more to the experimental setting than men do.

We adopt the total score methodology employed by Ehrenberg and Bognanno (1990a and 1990b), Orszag (1994), and Matthews et al. (2007). We also follow Ehrenberg and Bognanno's final-round score approach using marginal prize variables based on the players' rank after the third round.

In our empirical model, a player's total score depends on the tournament's total purse, player ability, the ability of the opponents, and tournament-specific characteristics. Specifically, the baseline model to be estimated is:

$$\begin{aligned} TSCORE_{ij} = & \beta_0 + \beta_1 RRANKPT_{ij} + \beta_2 RCCUTSM_{ij} + \beta_3 RTOP10_i \\ & + \beta_4 FRACT20_j + \beta_5 OPPRANK_j + \beta_6 PRIZE_j \\ & + \beta_7 RDIST_j + \beta_8 PAR_j + \beta_9 MAJOR_j + u_{ij}, \end{aligned} \quad (5.1)$$

where ij represents player i in tournament j . The variables are:

$TSCORE_{ij}$	=	total score after four rounds for player i in tournament j ;
$RRANKPT_{ij}$	=	player i 's official world ranking points per event prior to tournament j divided by ranking points per event for the 150th officially ranked player prior to tournament j ;
$RCCUTSM_{ij}$	=	player i 's career cuts made through 2008 divided by the mean number of career cuts made through 2008 by the top 150 money winners in 2009;
$RTOP10_i$	=	player i 's career number of top 10 finishes through 2008 divided by the mean number of career top 10 finishes through 2008 by the top 150 money winners in 2009;
$FRACT20_j$	=	the percentage of players who made the cut in tournament j that were ranked in the top 20 of the official world rankings prior to the tournament;
$OPPRANK_j$	=	mean official world-ranking points per event prior to tournament j of players who made the cut in tournament j divided by the ranking points per event of the 150th officially ranked player prior to tournament j ;
$PRIZE_j$	=	total published prize money for tournament j measured in thousands of dollars;
$RDIST_j$	=	total course yardage of tournament j divided by the mean yardage of all four-round tournaments on the respective tour;
PAR_j	=	the par for tournament course j ; and
$MAJOR_j$	=	a dummy variable equal to 1 if tournament j is a major tournament and 0 otherwise.

Our sample includes players who ranked among the top:

1. 150 money winners for 2009;
2. 150 in scoring average for 2009; and
3. 300 in official world rankings just prior to the tournament entered.

This leaves 142 women and 132 men in the sample. By restricting our sample to the top golfers, our results might be subject to self-selection bias. Specifically, our results might not be generalizable to all golfers

on the respective Tours. For example, amateurs who receive exemptions to participate in PGA or LPGA events are not included in the samples.

Our data come from four-round tournaments with a player cut after the first two rounds. We include 28 of the 37 regular-season PGA tournaments and 16 of the LPGA's 29 regular-season tournaments, resulting in 1,204 and 1,060 observations for the PGA and the LPGA tournaments, respectively. Like Ehrenburg and Bognanno, we dropped the British Open from our sample for men, though we include it for women.

The PGA and LPGA websites provide much of the data, including player scores, career cuts made, career top 10 finishes, course yardage, par, and prize money. The websites also provide links to official world-ranking statistics for the top 300 men and women golfers during the season. Table 5.1 lists the PGA and LPGA tournaments included in the study along with their respective published prize money, par value, and course yardage. The average prize money for the PGA and LPGA tournaments is \$5,700,000 and \$1,948,785, respectively. If we include the British Open, the average PGA purse is \$5,800,000, almost three times more than the LPGA average.

Based on tournament theory, we expect performance to improve as the prize and pressure increase, that is, we expect the coefficients for *PRIZE* and *MAJOR* to be negative. We also expect the coefficients for *RRANKPT*, *RCCUTSM*, and *RTOP10* to be negative since each variable measures a player's relative ability. Higher relative ranking points earned per event, career cuts made, and career top 10 finishes all suggest higher ability levels and therefore lower total scores. *RDIST* and *PAR* measure course difficulty, so we expect their coefficients to be positive. Finally, Ehrenberg and Bognanno (1990, 1990b) suggest that *FRACT20* and *OPPRANK* have positive coefficients because facing better opponents reduces the probability of winning and therefore lowers incentives to increase effort.

5.5 EMPIRICAL RESULTS

Table 5.2 lists the means and standard deviations of our variables. Using OLS, we estimate equation (5.1) separately for PGA and LPGA data. Table 5.3 reports the coefficient estimates and *t*-statistics, as well as gender differences in the coefficient estimates and their *t*-statistics. Tests not shown here indicate the presence of heteroskedasticity, so we report *t*-statistics using White's heteroskedasticity corrected standard errors. The

Table 5.1 Sample tournaments, prize money, par, and course distance

PGA				LPGA			
Tournament	Prize money	Par	Distance (yards)	Tournament	Prize money	Par	Distance (yards)
Legends	3,000,000	72	7,451	CVS	1,100,000	72	6,185
Puerto Rico	3,500,000	72	7,569	Corona	1,300,000	73	6,539
Mayakoba	3,600,000	70	6,923	Navistar	1,300,000	72	6,460
US Bank	4,000,000	70	6,759	Jamie Farr	1,400,000	71	6,428
John Deere	4,300,000	71	7,183	J Golf	1,500,000	72	6,711
Canada Open	5,100,000	72	7,222	Corning	1,500,000	72	6,223
Buick Open	5,100,000	72	7,127	State Farm	1,700,000	72	6,746
Wyndam	5,100,000	70	7,130	Kraft Nabisco*	2,000,000	72	6,673
Buick Invitational	5,300,000	72	7,569	Sybase	2,000,000	72	6,413
Sony Open	5,400,000	70	7,044	McDonalds*	2,000,000	72	6,641
Transitions	5,400,000	71	7,295	Wegmans	2,000,000	72	6,365
Honda	5,600,000	70	7,241	British Open*	2,158,550	72	6,492
St. Jude	5,600,000	70	7,244	Michelob	2,200,000	71	6,853
Shell	5,700,000	72	7,457	Canadian Open	2,585,007	71	6,427
Verizon	5,700,000	71	6,973	US Open *	3,187,000	71	6,740
FBR Open	6,000,000	71	7,216	Evian Masters	3,250,000	72	6,344
Arnold Palmer	6,000,000	70	7,239				
Travelers	6,000,000	70	6,820				
AT&T	6,000,000	70	7,255				
National							
Valero	6,100,000	70	6,896				
Northern	6,300,000	71	7,298				
Trust							
Zurich	6,300,000	72	7,341				
Quail	6,500,000	72	7,442				
Hollow							
HP Byron	6,500,000	70	7,166				
Masters *	7,000,000	72	7,435				
US Open*	7,500,000	70	7,445				
PGA *	7,500,000	72	7,674				
Championship							
The Players	9,500,000	72	7,215				

Note: * Major tournaments on the Tours.

coefficients for *RDIST*, *PAR*, and *RRANKPT* have the expected sign for both men and women. The effect of the course difficulty is statistically different for the PGA and the LPGA tournaments. A 1 percent increase in relative distance raises scores by almost one full stroke for men but only 0.3 strokes for women. The opposite occurs for *PAR*, as a one-stroke

Table 5.2 Means and standard deviations of key variables

Variable	PGA		LPGA	
	Mean	Std dev.	Mean	Std dev.
<i>TSCORE</i>	280.34	7.35	285.57	7.95
<i>RRANKPT</i>	1.72	1.42	4.32	4.28
<i>RCCUTSM</i>	1.03	0.83	1.05	0.99
<i>RTOP10</i>	0.98	1.10	1.14	1.57
<i>FRACT20</i>	0.09	0.07	0.18	0.05
<i>OPPRANK</i>	1.62	0.49	4.56	0.70
<i>PRIZE</i>	5,894.7	1,276.2	1,920.4	610.26
<i>RDIST</i>	1.00	0.03	1.00	0.03
<i>PAR</i>	70.94	0.89	71.81	0.52
<i>MAJOR</i>	0.09	0.29	0.23	0.42

Table 5.3 OLS results for LPGA and PGA regressions

Variable	LPGA		PGA		Coefficient difference	<i>t</i> -statistic
	Coefficient	<i>t</i> -statistic	Coefficient	<i>t</i> -statistic		
<i>RRANKPT</i>	-0.54***	-9.21	-0.58***	-3.59	0.035	0.20
<i>RCCUTSM</i>	0.61	1.56	0.29	0.66		
<i>RTOP10</i>	-0.28	-1.13	-0.21	-0.55		
<i>FRACT20</i>	-55.16***	-5.16	3.84	0.57	-59***	-4.66
<i>OPPRANK</i>	3.94***	4.07	-1.36	-1.01	5.30***	3.20
<i>PRIZE</i>	0.004***	8.26	0.001***	7.39	0.003***	4.62
<i>RDIST</i>	30.84***	4.05	95.92***	11.66	-65.08***	-5.81
<i>PAR</i>	4.49***	12.10	1.57***	6.80	2.92***	6.69
<i>MAJOR</i>	6.20***	9.20	3.64***	3.79	2.56**	2.18
Constant	-82.50***	-2.79	66.97***	5.35		
Adjusted <i>R</i> ²	0.42			0.42		
Observations	1,060			1,204		

Note: *Significant at 10 percent level; **Significant at 5 percent level; ***Significant at 1 percent level.

increase raises women's scores by almost 4.5 strokes but only about 1.5 strokes for men.

The *RRANKPT* coefficients for both the PGA and the LPGA tournaments are similar and statistically indistinguishable. A 1 percent increase in rank points per event relative to the 150th-ranked player reduces the total score by about 0.005 strokes for both men and women. The average

RRANKPT is 4.32 for women and 1.72 for men. A player with this relative ranking would have a total score about 1.8 and 0.41 strokes lower than the 150th officially ranked player, respectively.¹ Neither of the ability variables, *RRCUTSM* and *RTOPI0*, is statistically significant for either the PGA or the LPGA tournament.

The coefficients for the opponent ability variables, *FRACT20* and *OPPRANK*, conflict with one another in the LPGA sample. A 1 percent increase in the number of players ranked in the top 20 reduces scores by a little over half a stroke, but a 1 percent increase in the average ranking point per event relative to the 150th-ranked player increases scores by approximately 0.04 strokes. However, the estimates are insignificant for men. *FRACT20* and *OPPRANK* are highly correlated in both samples, suggesting that multicollinearity could be an issue. In an estimation not shown here we drop *OPPRANK* from the men's equation. When we do this, *FRACT20* becomes negative but remains statistically insignificant.

Finally, the *PRIZE* and *MAJOR* coefficients are positive for men and women. A \$100,000 increase in prize money increases total scores by 0.38 strokes for women and 0.15 strokes for men. In addition, playing in a major tournament raises a player's total score by about 6.2 and 3.7 strokes for women and men. Gender differences in both *PRIZE* and *MAJOR* coefficients are also statistically significant. The *PRIZE* findings support the results found by Matthews et al. (2007) for the women's tour but conflict with Ehrenberg and Bognanno's (1990a, 1990b) earlier findings on the men's tours and, to some degree, with Orszag's since he found no significant relationship between prize money and performance. Our results for *MAJOR* are consistent with Orszag but differ from Matthews et al., as they found this variable to be insignificant.

One concern with our specification is that par and course distance may not adequately capture course difficulty. Ehrenberg and Bognanno (1990a) use course rating as well as par to measure course difficulty. They obtain ratings measures from a representative from the Metropolitan Golf Association and various state golf associations. We do not have official course rating measures for the actual PGA and LPGA tournaments. Instead, we obtained course rating measures for all but two PGA and two LPGA tournaments from the websites of state and regional golf associations or the tournament course website. We choose the highest published course rating associated with each gender's tee box. Excluding the two PGA and LPGA tournaments for which we have no ratings from our sample reduces the number of observations to 1,134 for men and 949 for women.² Equation (5.1) thus becomes:

$$\begin{aligned}
TSCORE_{ij} = & \beta_0 + \beta_1 RRANKPT_{ij} + \beta_2 RCCUTSM_{ij} + \beta_3 RTOP10_i \\
& + \beta_4 FRACT20_j + \beta_5 OPPRANK_j + \beta_6 PRIZE_j \\
& + \beta_7 RDIST_j + \beta_8 PAR_j + \beta_9 MAJOR_j \\
& + \beta_{10} RATING_j + u_{ij},
\end{aligned} \tag{5.2}$$

where $RATING_j$ is the course rating for tournament j . We also estimate a variant of equation (5.2) in which we replace PAR_j with dummy variables representing the par values for the courses. We do this because the tournament courses in each tour have only three possible par values. The dummy variables are:

$$\begin{aligned}
PAR70 &= 1 \text{ if the course has par equal to 70 and 0 otherwise;} \\
PAR71 &= 1 \text{ if the course has par equal to 71 and 0 otherwise;} \\
PAR73 &= 1 \text{ if the course has par equal to 73 and 0 otherwise.}
\end{aligned}$$

Table 5.4(a) presents the results when using the PAR dummies and 5.4(b) reports the results for equation (5.2).

The results in Table 5.4(a and b) are very similar, with almost all coefficients being of the same sign and significance across the two specifications. $OPPRANK$ has the only coefficient that differs. It is positive and significant for women in Table 5.4(a) but insignificant in Table 5.4(b) (though, with a t -statistic of 1.47, it comes close). In addition, the results in these two tables largely mirror those of Table 5.3.

$RCCUTSM$ remains insignificant in Table 5.4(a and b) for men, but it has a positive effect for women. This is the opposite of what we expected since a higher value suggests greater ability and, thus, a lower total score. However, the change from Table 5.3 to Table 5.4(a and b) is statistically and economically insignificant. The coefficients are very similar in magnitude and are statistically indistinguishable. Moreover, the t -statistic for $RCCUTSM$ is 1.57 for women in Table 5.3.

The course rating variable has the expected signs, as a one-point increase in course rating increases total scores by about 0.4 strokes for women and 0.5 strokes for men, although the difference is not statistically significant. The omitted par value for the par dummy variables is 72, so we expect negative coefficients for PAR values below 72 and positive for those above 72. Our results match these expectations, and the coefficients are statistically significant except for $PAR73$, probably because only one tournament course had a par of 73. Interestingly, the $PAR71$ dummy for the LPGA Tour suggests that total scores would be almost seven strokes less than on a par 72 course, holding all else constant. This is much larger than any of the par dummy variables for men, so perhaps this par variable is capturing some other element unique to the

Table 5.4 LPGA and PGA regressions

(a) Course ratings and par dummies included

Variable	LPGA		PGA		Coefficient difference	<i>t</i> -statistic
	Coefficient	<i>t</i> -statistic	Coefficient	<i>t</i> -statistic		
<i>RRANKPT</i>	-0.56***	-8.87	-0.56***	-3.50	0	
<i>RCCUTSM</i>	0.88**	2.22	0.30	0.68		
<i>RTOP10</i>	-0.33	-1.25	-0.21	-0.56		
<i>FRACT20</i>	-51.82***	-4.37	-2.40	-0.33	-49.42***	-3.54
<i>OPPRANK</i>	3.61***	3.24	-1.48	-1.06	5.09***	2.85
<i>PRIZE</i>	0.005***	9.59	0.002***	7.71	0.003***	6.25
<i>RDIST</i>	28.97***	3.61	81.01***	7.00	-52.04***	-3.70
<i>PAR70</i>			-2.33***	-5.03		
<i>PAR71</i>	-6.90***	-13.36	-0.96**	-1.99		
<i>PAR73</i>	1.33	1.47				
<i>MAJOR</i>	2.81***	3.60	4.34***	4.47	-1.53	-1.23
<i>RATING</i>	0.42***	4.06	0.50**	2.21	-0.08	-0.35
Constant	211.77***	17.76	156.5***	12.67		
Adjusted <i>R</i> ²	0.41		0.42			
Observations	949		1,134			

(b) Course ratings only

Variable	LPGA		PGA		Coefficient difference	<i>t</i> -statistic
	Coefficient	<i>t</i> -statistic	Coefficient	<i>t</i> -statistic		
<i>RRANKPT</i>	-0.56***	-8.76	-0.56***	-3.50	0	
<i>RCCUTSM</i>	0.85**	2.09	0.31	0.70	0.54	0.89
<i>RTOP10</i>	-0.29	-1.11	-0.21	-0.57		
<i>FRACT20</i>	-28.49**	-2.54	-3.11	-0.43	-25.38*	-1.90
<i>OPPRANK</i>	1.53	1.47	-1.42	-1.02		
<i>PRIZE</i>	0.005***	9.84	0.002***	7.71	0.003***	6.56
<i>RDIST</i>	20.18***	2.63	80.07***	6.82	-59.89***	-4.27
<i>PAR</i>	5.18***	12.47	1.17***	5.01	4.01***	8.40
<i>MAJOR</i>	4.44***	6.20	4.33***	4.47	0.11	0.09
<i>RATING</i>	0.20**	2.12	0.52**	2.29	-0.32	-1.32
Constant	-132.29***	-4.14	71.47***	4.76		
Adjusted <i>R</i> ²	0.39		0.42			
Observations	949		1,134			

Note: *Significant at 10 percent level; **Significant at 5 percent level; ***Significant at 1 percent level.

LPGA courses. The coefficients for *PAR* rise by over a half a stroke when course rating is added.

Finally, the tournament theory variables, *PRIZE* and *MAJOR*, continue to be positive with high *t*-statistics in both specifications, contrary to

Ehrenberg and Bognanno's (1990a, 1990b) results and tournament theory predictions. Moreover, the difference between *PRIZE* coefficients for men and women increases and remains significant. Based on the par-dummy model's estimates, a \$100,000 increase in prize money raises women's scores by about 0.5 strokes while men's scores rise by approximately 0.16 strokes, roughly the same as in the previous estimation.

One other addition to our PGA model involves recognizing that some players receive an exemption for qualifying in the following season's tournaments. Nonexempt players, on the other hand, face the added pressure of performing well enough to qualify for tournaments in the following year. Therefore, nonexempt players do not necessarily respond as much to prize differentials as exempt players do. Nonexempt players must maintain high effort to enhance their chances to gain exempt status, and Ehrenberg and Bognanno's (1990a, 1990b) results support this view. Therefore, we added a dummy variable for exempt PGA players (*EXEMPT*) and an interaction term between prize money and exempt players (*PREXEMP*) to the par-dummy model. The results, not presented here, show little change in coefficient magnitudes and no change in their statistical significance. In addition, the *EXEMPT* dummy is negative, perhaps indicating greater ability levels for exempt players not fully captured by ranking point differences. However, the interaction between *PREXEMP* and *PRIZE* is positive, contrary to Ehrenberg and Bognanno's (1990a, 1990b) findings.

In sum, our results using total prize money as a proxy for the marginal returns to effort consistently show that prize money raises total scores for both men and women golfers, with a slightly greater increase for women. These findings contradict Ehrenberg and Bognanno (1990a and 1990b) and agree with results from Matthews et al. (2007) and Brown (2011). Brown investigates superstar effects on the PGA TOUR and finds that higher prize money raises first-round scores and total scores, although the effect is small. She argues that the total prize money variable may capture unmeasured differences in course difficulty because course rating and distance may not fully reflect the degree of course difficulty on the Tour.

We now investigate whether larger marginal prize money levels affect the players' final round scores. Utilizing Ehrenberg and Bognanno's approach, we specify an equation in which the final-round score is a function of the player's scores in the first three rounds (*RD1*, *RD2*, *RD3*) and a marginal prize money variable. Like Ehrenberg and Bognanno, we include several alternative marginal return measures in the regression. *UPIPOS* represents the estimated increase in prize money if the player's final rank improves by one step relative to the third-round rank. *DNIPPOS*, in a similar way, measures the estimated decrease in prize money if the final rank falls one spot below the third-round rank. *UP1STROKE* and *UP2STROKE* are the

Table 5.5 Means and standard deviations of marginal prize variables

Variable	PGA		LPGA	
	Mean(000's)	Std dev.	Mean(000's)	Std dev.
<i>UPIPOS</i>	35.693	153.22	5.720	25.18
<i>DNIPPOS</i>	39.645	152.42	6.929	30.56
<i>UPISTROKE</i>	52.737	148.19	7.621	23.65
<i>UP2STROKE</i>	125.050	259.23	19.049	43.28

estimated increases in prize money if the player's final score improves relative to the field by one stroke and two strokes, respectively.

The first step in obtaining these alternative measures involves estimating the share of a tournament's total purse that would be paid to players at their final rank. Using data from all players who received prize money in the tournaments included in our sample, the following equations were estimated for the PGA and the LPGA tournaments:

$$\ln PGAPCT = -1.1558 - 1.2989 \ln \text{Rank} \quad (5.3)$$

(0.004) (0.014) Adjusted $R^2 = 0.975$

$$\ln LPGAPCT = 1.054 - 1.5389 \ln \text{Rank} \quad (5.4)$$

(0.006) (0.019) Adjusted $R^2 = 0.967$.

PGAPCT and *LPGAPCT* measure the share of the purse a player receives, given the final rank. Standard errors appear in parentheses. We use these estimates to calculate the predicted prize money that would have been paid to players at the end of the third round. The difference between the payments to players in adjacent ranks is the marginal return. Table 5.5 shows the means and standard deviations of the marginal prize variables for both tours.

Ehrenberg and Bognanno (1990a, 1990b) also argue that endogeneity is a concern in the model because a player's performance in each round (*RD1*, *RD2*, *RD3*) depends on player ability, opponent ability, prize money incentives, and tournament characteristics. In addition, the marginal prize money in the final round depends on the player's performance in the first three rounds. Hausman specification tests showed that the null hypothesis of exogeneity was rejected in both samples for all specifications. Therefore we use two-stage least squares (2SLS) to estimate the final round equations. The exogenous variables used to derive instruments for the endogenous variables include those listed in Table 5.4(a) (excluding *PRIZE*) as well as the following:

- *RD1AVG* and *RD2AVG* = a player's scoring average in rounds 1 and 2, respectively, during the 2009 Tour;
- Moneyrank = a player's official prize money rank at the end of 2009 Tour;
- Age = the player's age;
- Underpar = the player's percentage of rounds finished under par in 2009; and
- Girpet = the player's percentage of greens made in regulation for 2009.

Table 5.6 presents both OLS and 2SLS final-round score results for the PGA and LPGA samples, respectively, using the marginal prize money

Table 5.6 Final-round score results for both PGA and LPGA tournaments (t-statistics in parentheses)

Variable	PGA OLS	PGA 2SLS	LPGA OLS	LPGA 2SLS
<i>RD1</i>	0.23 (5.70)	0.04 (.22)	0.23 (5.99)	0.06 (0.30)
<i>RD2</i>	0.25 (6.50)	0.54 (2.61)	0.14 (4.19)	0.12 (0.59)
<i>RD3</i>	0.17 (5.16)	0.51 (2.88)	0.12 (3.78)	0.31 (1.38)
<i>UPIPOS</i>	0.002 (2.87)	0.001 (.35)	0.002 (0.60)	-0.14 (-4.31)
Constant	25.60 (6.36)	-5.23 (-0.61)	36.36 (10.13)	37.38 (4.24)
Adjusted R^2	0.10		0.09	
<i>RD1</i>	0.25 (6.32)	-0.01 (-0.03)	0.24 (6.19)	-0.04 (-0.23)
<i>RD2</i>	0.28 (7.18)	0.57 (2.81)	0.15 (4.34)	0.03 (0.15)
<i>RD3</i>	0.18 (5.60)	0.54 (3.04)	0.13 (4.00)	0.44 (2.27)
<i>DNIPPOS</i>	0.003 (5.14)	0.01 (2.45)	0.01 (1.83)	-0.08 (-4.11)
Constant	20.84 (5.03)	-6.49 (-0.75)	34.65 (9.41)	41.77 (5.07)
Adjusted R^2	0.12		0.10	
<i>RD1</i>	0.23 (5.70)	0.05 (0.22)	0.23 (5.91)	0.15 (0.91)
<i>RD2</i>	0.26 (6.65)	0.42 (1.61)	0.14 (4.09)	0.06 (0.36)
<i>RD3</i>	0.18 (5.51)	0.73 (3.05)	0.12 (3.67)	0.28 (1.37)
<i>UP1STROKE</i>	0.002 (3.29)	0.02 (2.92)	-0.001 (-0.19)	-0.11 (-4.34)
Constant	24.30 (5.94)	-15.19 (-1.31)	37.05 (10.29)	37.729 (5.03)
Adjusted R^2	0.11		0.09	
<i>RD1</i>	0.24 (6.12)	0.14 (.68)	0.22 (5.74)	0.11 (0.73)
<i>RD2</i>	0.27 (7.02)	0.35 (1.53)	0.13 (3.81)	-0.09 (-0.61)
<i>RD3</i>	0.19 (5.91)	0.68 (3.46)	0.11 (3.36)	0.53 (3.13)
<i>UP2STROKE</i>	0.002 (4.86)	0.01 (3.42)	-0.004 (-1.57)	-0.04 (-4.47)
Constant	21.00 (5.04)	-11.87 (-1.25)	38.83 (10.51)	33.28 (4.88)
Adjusted R^2	0.12		0.10	

variables calculated using equations (5.3) and (5.4). For men, coefficients for all four marginal return variables are positive and significant in all but one case.

Like the previous findings in this chapter, these results conflict with Ehrenberg and Bognanno (1990a, 1990b). However, our results for women offer some support for tournament theory. All the 2SLS estimates of the marginal prize money coefficients are negative, suggesting that female golfers respond to financial incentives and improve their performance. Ehrenberg and Bognanno (1990b) point out that one can calculate the effect of a change in the marginal prize variable on player performance. If the marginal prize variable is one standard deviation above the mean, the effect is found by multiplying the marginal prize variable's standard deviation by the estimated regression coefficient for that marginal prize variable. For example, if a player faced an *UP2STROKE* one standard deviation above its mean, a player's score may be about 1.7 ($= 43.28 * (-0.04)$) strokes lower on the final round. This is less than the 3.4 to 4.5 stroke estimates found in Ehrenberg and Bognanno (*ibid.*).

Several words of caution are in order. First, the explanatory power of the final-round score equations is much lower than that of the total score approach. Additional work on model specification would improve the model's predictive performance. Second, as noted above, we restrict our dataset to the best players on the two tours. Using a broader sample might yield different results.

5.6 CONCLUSION

Many economic studies have examined the impact of incentives on player performance in sports, but most of these studies have considered only men. The results of experimental work on differences in gender preferences suggest that female athletes might respond differently to prize structures than male athletes do. We analyze the impact of incentives on the performance of men on the PGA TOUR and women on the LPGA Tour. We find mixed evidence regarding the predictions of tournament theory in general and for gender differences in particular.

Using the total score approach, our results do not support tournament theory's predictions for either gender. Larger purses increase a player's total score for both men and women, slightly more for women. Final-round score equations bring a different perspective. Using alternative marginal return measures, we find that women improve their performance as prize money differentials increase while the men's scores worsen to some extent. When one accounts for endogeneity, women react to

marginal prizes in the manner predicted by tournament theory, while men do not.

There are also significant gender differences in responsiveness to opponent ability. The tournament field had no significant effect on men's performance while, for women, it has a mixed effect. Women perform better when elite competition joins the field, as reflected by the *FRACT20* coefficient, but they do less well if the general field quality improves, as measured by *OPPRANK*.

Future work can extend and refine our work by considering alternative specifications of final round score equations and accounting for sample selection bias. Further, considering the potential for superstar effects and weather, such as in Brown (2011), may well be fruitful. Also, expanding the dataset to include several years and employing a fixed-effects model will better account for differences in ability between players and tournament-specific characteristics that are not being completely captured by course rating, par, and distance.

NOTES

- * The authors thank the editors of this volume, Jagre Walley (Augsburg College) and participants at the 2011 Western Economic Association meetings, especially Ross Booth and Michael Leeds, for many helpful comments on earlier versions of this chapter.
- 1. Tiger Woods and Lorena Ochoa had the highest *RRANKPT* in the sample, with 11.6 and 28.94 in the PGA Championship and Sybase tournaments, respectively. Our estimates imply that Woods' score would be about six strokes less than the 150th-ranked player while Ochoa's score would be about 15 strokes less, holding all else constant.
- 2. The tournaments for which we could not find course ratings were Legends and Wyndam on the PGA TOUR and the British Open and Evian Masters on the LPGA Tour. In addition, for the Masters course in Augusta, we used a course rating estimate published in the April 2010 issue of *Golf Digest*.

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