Quitters Never Win: The (Adverse) Incentive Effects of Competing with Superstars

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Abstract

Managers use internal competition to motivate worker effort, yet I present a simple economic model suggesting that the benefits of competition depend critically on workers' relative abilities—large differences in skill may reduce competitors' efforts. This paper uses panel data from professional golfers and finds that the presence of a superstar in a rank-order tournament is associated with lower competitor performance. On average, higher-skill PGA golfers' tournament scores are 0.8 strokes higher when Tiger Woods participates, relative to when Woods is absent. Lower-skill players' scores appear unaffected by the superstar's presence. The adverse superstar effect increases during Woods's streaks and disappears during Woods's slumps. There is no evidence that reduced performance is due to "riskier" play.

Keywords: tournament, effort, superstar, incentives.

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1 Introduction

Proponents of internal competition systems contend that within-firm contests fuel employee efforts. They claim that, spurred by the performance of other team members and the possibility of rewards based on their relative success, workers are motivated to exert high effort (Davenport and Beck, 2000; Birkinshaw, 2001). Tournament-style competition pits workers against each other for tenure, promotion and rewards, and winners and losers emerge. GE's former CEO Jack Welch instituted a "20-70-10" system for workers, generously rewarding the top 20% of employees and "managing out" the bottom 10% each year. Indeed, it seems that Welch is not alone in his belief that effective management strategies rely on meaningful differentiation between employees; 3M, Bloomingdale's, Procter & Gamble, IBM, Digital, Johnson & Johnson, GM and Hewlett-Packard all use between- and within-team competition to provide incentives for quality and innovation (Marino and Zábojník, 2003; Eisenhardt and Gahmic, 2000).

Tournaments are important compensation structures found in many contexts: firms reward the top salesperson; contracts are awarded to firms with the best technological innovation; assistant professors compete for a limited number of tenure positions; corporate vice-presidents compete to become company president; and, professional athletes compete to clinch national titles and awards. In these situations, rewards are based only on the relative performance or rank of those vying for the prize.

Common intuition suggests that rivalries may encourage a player to exert more effort. In a high-school gymnasium, community pool or college track, one might hear a coach encouraging athletes to "step up their game" against the opposition. But, is it the case that harnessing the power of competition *always* bolsters effort? I present an economic model that suggests not. In particular, I show that the presence of a "superstar" in a competition can lead to *reduced* efforts from tournament participants.[1]

Consider two sports-inspired scenarios. In the first, you face a rival of similar skill and are motivated to work harder, relative to your normal effort, in a very "winnable" race. In the second scenario, you are matched against a highly-trained athlete and your probability of winning is very low. Competing is costly and there is always the risk of pulled muscles. In this case, you may actually reduce your effort in the contest. That is, the presence of a superstar discourages you from expending your full effort in the competition.

The "20-70-10" system and similar compensation devices are based on the notion that

[1] I use the term "superstar" in the same spirit as Sherwin Rosen in his 1981 paper, "The Economics of Superstars". He describes the Superstar phenomenon as a concentration of output among a few individuals; I use the term to describe a dominant player. That is, a superstar provides consistently superior performance relative to the field of competitors.

competition leads to greater effort, yet economic theory suggests that the opposite can occur under some circumstances—the benefits of competition depend crucially on the degree to which competitors are relatively equal in underlying ability. An adverse "superstar effect" is an intriguing theoretical possibility, but should managers worry in practice? Is there empirical validity to the theoretical claim that superstars adversely affect incentives in rank-order tournaments?

Measuring the performance and rewards of corporate executives, new lawyers, and fashion trend-setters is challenging, and rich data on sales performance in firms is largely unavailable. Moreover, the relationship between effort and observable performance is quite noisy in these contexts. Professional golf offers an excellent setting in which to examine tournament theory and superstars in rank-order events, since effort relates relatively directly to scores and performance measures are not confounded by team dynamics.

This paper uses data from Tiger Woods and the PGA Tour to examine the adverse incentive effect of a superstar in tournaments. The dataset includes round-by-round scores for all players in every PGA tournament from 1999 to 2006 and hole-by-hole data for all tournaments from 2002 to 2006. I estimate the impact of the superstar's presence on the scores of other golfers, examining first all regular and major tournaments and then the subset of courses that Woods had elected to play over his professional career. Results are robust to several specifications and are consistent with my prediction that the presence of a superstar leads other players to reduce their efforts.

The main results of the papers are:

1. The presence of a superstar in a tournament is associated with reduced performance from other competitors: On average, highly-skilled (exempt) PGA golfers' scores are almost one stroke higher in tournaments with Tiger Woods, relative to their scores when Woods is not in the field. (See Table 5)

2. Reduced performance is not attributable to "riskier" strategies: The variance of players' hole-by-hole scores in PGA tournaments is not statistically significantly higher when Woods is in the field, relative to when he does not participate. (See Table 11)

3. Superstars must be "super" to create adverse effects: The adverse superstar effect is large in streak periods when Woods is particularly successful and disappears during his slumps. (See Table 7)

In summary, there is both theory and empirical evidence that the presence of a superstar in tournament reduces the efforts of other participants. Tournaments are important compensation systems found in many business contexts. Yet, to my knowledge, this is the first paper to investigate the impact of superstars in rank-order tournaments.

Consider the implications of my results for several specific questions: When sales bonuses are based on relative performance, does introducing a superstar salesperson motivate or discourage others in the team? Does hiring a "hot-shot" vice-president lead to a reduction of effort from other executives also vying for the top corporate position? Should the law firm hire a cohort of associates with similar skill levels and avoid the superstar entirely? These questions have practical importance—they may guide firms' hiring, compensation, and management strategies. Estimating the impact of superstars on incentives is an important first step toward clear answers.

I show that a reduction in effort can be an equilibrium response when a player faces a superstar challenger. Therefore, depending on the relative outputs of the players, the presence of a superstar in a tournament may actually reduce *overall* team performance. For example, associates in law and medical firms compete to become partners. Their competition is effectively a tournament, since firms take on more associates than there are available partner positions. If the presence of a superstar undermines the efforts of other associates, and the additional gains from the star do not offset the losses from the others, then a firm might be better off hiring a cohort of similarly talented associates. That is, the overall performance of a group of non-superstar employees might be superior to the overall performance of a group with a single star.

Other features of tournaments and performance incentives have been explored empirically in several settings. Knoeber and Thurman (1994) compare tournament and linear payment schemes using data from a sample of US broiler producers. They examine the impact of prizes on performance level and variability and, in contrast with my findings, conclude that less-able producers adopt riskier strategies. Eriksson (1999) uses industry data from Denmark and suggests that wider pay dispersion leads to greater employee effort.

Tournament theory also has been examined in a laboratory setting: Bull, Schotter and Weigelt (1987) find that disadvantaged contestants provide more effort than predicted by tournament theory. While that study touches on the effect of heterogeneous contestants on tournament effort in the laboratory, my work identifies a superstar and uses data generated in a real-world context. Some aspects of political races can be framed as tournaments; Levitt (1994) uses field data in his analysis of campaign expenditure in US House elections and contends that political spending is highest in close races.

Several researchers have focused on tournaments in the world of professional golf; however, few have used a panel dataset like the one employed here, and none has examined the presence of a superstar. Ehrenberg and Bognanno (1990a) use data from a subsample of PGA tournaments in 1984 to show that larger prizes lead to lower scores, a result I do not observe in my analysis. In another paper, Ehrenberg and Bognanno (1990b) use data from the 1987 European PGA Tour and find again that higher prize levels result in lower scores. However, Orszag (1994) questions the robustness of these results and finds that tournament prizes have little impact on performance. Guryan, Kroft, and Notowidigdo (2007) use data on random partner assignments in the first two rounds of PGA events in 2002, 2003 and 2005 and find no evidence of peer effects.

The work of Lazear and Rosen (1981) provides a foundation for understanding the incentive effects of tournaments. Several studies, including Green and Stokey (1983), Nalebuff and Stiglitz (1983), Dixit (1987), and Moldovanu and Sela (2001), have extended the theoretical literature on tournaments, yet none has focused on the impact of a superstar on tournament incentives.

The paper is organized as follows: First, I present two- and n-player tournament models in section 2. In section 3, I outline some important features of professional golf and describe the PGA Tour data used in my analysis. Section 4 presents the econometric analysis and considers several alternative explanations for the observed adverse superstar effect. Section 5 reframes the results and concludes.

2 Theory

2.1 Two-Player Contest with Heterogeneous Abilities

A two-player model illustrates the impact of changes in relative ability on effort. Consider a contest where player i (for $i = 1, 2$) competes for a prize, V, by choosing his effort level, e_i.[2] The players are heterogeneous in ability—player 1 is θ times more skilled than player 2 and $\theta > 1$. Each player's contest success function is increasing in his own effort and ability, and decreasing in the effort and ability of his opponent—see Nitzan (1994) for a survey of contest modelling. Player 1's probability of winning is

$$p_1 = \frac{\theta e_1}{\theta e_1 + e_2}$$

and player 2's probability of winning is

$$p_2 = \frac{e_2}{\theta e_1 + e_2}$$

For simplicity, I assume that the cost of effort is linear and identical for both players.

Players choose effort simultaneously to maximize their expected payoffs, π_i. Player 1

[2] Baye and Hoppe (2003) show the strategic equivalence of contests and innovation games with similar "all-pay" features (i.e. where all players forfeit the resources they expend).

chooses e_1 to maximize

$$\pi_1 = \frac{\theta e_1}{\theta e_1 + e_2} V - e_1$$

which yields the first-order condition

$$\frac{\theta e_2}{\left(\theta e_1 + e_2\right)^2} V - 1 = 0$$

Similarly, the first-order condition for player 2 is

$$\frac{\theta e_1}{\left(\theta e_1 + e_2\right)^2} V - 1 = 0$$

It is follows that, in any equilibrium,

$$e_1 = e_2$$

Thus, I can solve for the common equilibrium effort

$$e^* = \frac{\theta}{\left(1 + \theta\right)^2} V \tag{1}$$

From (1), I derive my main testable hypothesis:

$$\frac{de^*}{d\theta} = \frac{1 - \theta}{\left(\theta + 1\right)^3} V < 0 \tag{2}$$

The result in (2) indicates that larger differences in players' abilities will lead to lower equilibrium effort from both players. Specifically, I hypothesize that the presence of a player with superstar abilities will lead both players to reduce their effort in the contest.

2.2 *n+1* Player Contest with a Superstar

Now consider the same contest with $n + 1$ players competing for a single prize, V. Let player 0 be the superstar with $\theta > 1$ and let players 1 to n be identical, regularly-skilled players. Player 0 chooses effort e_0 to maximize

$$\pi_0 = \frac{\theta e_0}{\theta e_0 + \sum_{j=1}^{n} e_j} V - e_0$$

while player i chooses e_i to maximize

$$\pi_i = \frac{e_i}{\theta e_0 + \sum_{j=1}^{n} e_j} V - e_i$$

Recall that players 1 to n are identical, so that $e_1 = e_2 = ... = e_n = e_j$, $\sum_{j=1}^{n} e_j = ne_j$ and $\sum_{i \neq j} e_j = (n-1)\, e_j$. Thus, the players' maximization problems yield the following first-order conditions:

$$\begin{aligned} \frac{\theta n e_j}{(\theta e_0 + n e_j)^2} V - 1 &= 0 \\ \frac{\theta e_0 + (n-1)\, e_j}{(\theta e_0 + n e_j)^2} V - 1 &= 0 \end{aligned}$$

From the first-order conditions, it follows that

$$e_0 = \frac{(\theta - 1)\, n + 1}{\theta} e_j$$

Substituting this expression for e_0 into the superstar's first-order condition yields the following equilibrium effort level,

$$e_j^* = \frac{n\theta}{(n\theta + 1)^2} V$$

Differentiating e_j with respect to the ability gap, θ,results in an expression analogous to (2):

$$\frac{de_j^*}{d\theta} = \frac{n - \theta n^2}{(n\theta + 1)^3} V < 0$$

That is, a larger ability difference between players leads to a greater reduction in equilibrium effort levels—introducing a superstar into the contest leads other players to reduce their effort.

These two- and n-player models represent contests with a single prize; however, the results are suggestive for other contexts. In particular, tournaments with very non-linear prize schedules may be considered approximately "winner-take-all."[3]

[3] For example, golf tournament winners may earn prize money, a luxury car, corporate sponsorship, media attention and future career opportunities; the payoff to second position may be simply the (smaller) cash prize.

3 Data

While this paper has implications beyond golf, the following section explains some important features of professional golf and describes the PGA Tour dataset used in the analysis.

3.1 The Game

The objective of golf is to complete each hole with the fewest strikes of the ball. That is, low scores are better than high scores. Each hole's par value describes how the course is designed to be played by an experienced golfer. Players are "under" and "over" par if they complete a hole in fewer or more strokes than par, respectively.

Professional golf tournaments typically consist of four rounds (Thursday through Sunday). Final positions are assigned according to players' total scores for the event. A "cut" is made after the second round. In most tournaments, only the top 70 golfers and those tied for 70^{th} position play the third and fourth rounds.[4] All players who make the cut earn prize money; players who miss the cut receive no prize. In the case of a tie for first place, additional playoff holes determine the tournament winner.

While purse size differs by tournament, the prize distribution is fixed and non-linear on the PGA Tour. The top 15 golfers earn approximately 70% of the total purse: tournament winners receive 18% of the purse, while second through fifth positions earn 10.8, 6.8 and 4.8%, respectively. The golfer in 70^{th} position receives 0.2% of the purse.

Not all PGA Tour golfers can participate in all events. "Exempt" players automatically qualify, while "non-exempt" golfers must qualify for individual tournaments. Exemptions are distributed according to a detailed list of priorities. In general, recent tour winners and golfers who finished in the top 125 positions on the money list in the previous year earn exempt status. On average, exempt players are higher skilled than non-exempt golfers.

Professional golfers are highly-trained athletes who exert effort to excel at the game. A golfer may choose to hit balls on the driving range, play practice rounds, and study the course before the tournament. During competition, he may take extra care to consider his lie, the target, the weather conditions and his club selection—activities that require considerable effort and result in improved performance. In fact, it is the close relationship between effort and performance that make golf data particularly suitable for this study.

The presence of a superstar, Tiger Woods, is a key feature of professional golf and critical for identification in my paper. Woods won his first PGA tournament within weeks of turning professional in 1996. By the end of 2006, he had collected 54 PGA wins including 12 major

[4] Some events use a 10-stroke rule to determine the cut—for example, in the US Open, the cut includes the low 60 scorers (and ties), and any player within 10 strokes of the leader.

titles. Woods has made the cut in 215 of 219 tournaments in his 10-year career. Displaying remarkable consistency, he earned top-3 finishes in 92 of those events, and top-10 finishes in 132 events. Woods was the PGA Player of the Year eight times between 1997 and 2006. He is consistent and dominant—when Woods plays, there is a high probability that Woods will play very well.

3.2 PGA Tour data (1999 to 2006)

I use a panel dataset of 363 PGA tournaments from 1999 to 2006 in my analysis. While past related work has relied on data from selected tournaments from a single season (e.g. Ehrenberg and Bognanno 1990a,b and Orszag 1994), multi-year, player-level data allows me to model between- and within-tournament variation while controlling for player-specific variation. The panel nature of the data represents a strong advantage over the data used previously—since golf courses have unique features that make cross-course comparison challenging, I can examine players' performances on the same course across many years.

Round-levels scores are available for all players in all tournaments from 1999 to 2006, while hole-by-hole scores are available from 2002 to 2006.[5] From the data, I can identify players who made the cut, did not make the cut, withdrew or were disqualified. Course information, including location, par, and yardage, was matched with tournament scores. In addition, data on course conditions and weather during play were obtained from the National Climatic Data Center of the National Oceanic and Atmospheric Administrations.[6]

I also matched players' tournament scores to monthly average Official World Golf Ranking (OWGR) statistics, which measure golfers' relative quality.[7] Players earn OWGR points based on finishing positions and field strength in PGA events in the previous two years, and the points are time-weighted. Data for the top 200 golfers are available, and unranked players were assigned a point value of zero.

[5] Tournament score data were gathered from GolfWeek magazine's website (www.golfweek.com) and The Golf Channel (www.thegolfchannel.com). Additional golf course information was collected from the Golf Course Superintendents Association of America website (www.gcsaa.org). Player data were gathered from the PGA TOUR website (www.pgatour.com).

[6] Because not all event locations are NOAA weather station sites, tournaments are matched with the closest NOAA site. The "closest" site was selected by hand to ensure geographic similarities. For example, a *coastal* golf course was matched with the closest *coastal* weather station.

[7] OWGR data were gathered from www.officialworldgolfranking.com.

4 Results

4.1 Descriptive Statistics

Table 1 presents selected descriptive statistics for golfers who made the cut in PGA Tour events from 1999 to 2006, reported by year. The number of exempt and non-exempt players participating in Tour events was relatively stable across the sample—approximately 140 exempt and 550 non-exempt golfers played each season. Score statistics are reported separately by exempt status. Since regular and major tournaments may vary in terms of difficulty and field composition, summary statistics are reported separately by event type. Tiger Woods's performance statistics are also presented separately, since he is the superstar of particular interest in this paper.

Scores exhibit a consistent and expected pattern—exempt players post lower (better) scores than non-exempt players in regular and major tournaments in every year. T-tests reject the hypotheses that exempt and non-exempt players scores are equal each year at *p-values* < 0.01. Scores in major events are also statistically-significantly higher than scores for regular events for both types of players (*p-values* < 0.01).

The superstar play of Tiger Woods is evident in Table 1; his scores in regular and major events are significantly lower than the mean scores of other exempt golfers in all years except 2004.[8] In his outstanding 2001 season, Woods averaged nearly 5 strokes better than the average exempt player. In major tournaments, Woods played more than 7 strokes better than his exempt competitors.

Players' skill measure, OWGR points, are reported at the bottom of Table 1. On average, exempt players earned approximately 2 points, while Woods often earned 10 times more points than other exempt golfers. Figure 1 presents the distribution of OWGR points for exempt players in 2000 and shows Woods's position as the top-ranked player—other exempt players averaged 2.46 points, excellent players like Mickelson, Els and Duval earned approximately 11 points, and Woods accumulated more than 29 points. According to Table 1, even in his "slump" 2004 season, Woods accumulated six times more points than an average exempt golfer. While the values in Table 1 do not address Woods's effect on other golfers, the descriptive statistics provide further evidence of his "superstardom."

[8] T-tests reject the hypothesis of equal mean scores in 1999, 2000, 2002, 2005 and 2006 at *p-values* < 0.001, and *p-values* < 0.10 in 2001 and 2003.

4.2 Presence of a Superstar

I begin my empirical analysis by examining Woods's impact on the performance of other golfers on the PGA tour. The dataset, described in section 3, consists of players' identities, hole-by-hole and final scores, prize money, and other individual and tournament attributes from 363 tournaments on the PGA Tour between 1999 and 2006.

Simple comparisons of mean scores of other golfers in the presence and absence of a superstar provide a suggestive start and motivate the analysis. Table 2 provides a summary of average scores relative to par for exempt and non-exempt players by year, separating tournaments in which Woods did and did not participate. T-tests reject the equality of means for exempt players overall and for all eight years individually (*p-values* < 0.01).[9] Similar tests reject the equality of means for non-exempt players in all years except 2005, where I cannot reject the null hypothesis of equal means at conventional significance levels.

Table 3 presents summary statistics for different hole-level scores in rounds from 2002 to 2006. On average, golfers have slightly fewer eagles (2 strokes under par) per round in tournaments with Woods, relative to when they are not competing with the superstar; a t-test rejects the equality of means at a *p-value* of 0.06. However, players post more bogeys (1 strokes over par) and double-bogeys (2 strokes over par) when the superstar is present—the differences are small, but statistically significantly different from zero at *p-values* of 0.07 and 0.04, respectively. These figures suggest that more high scores and fewer low scores are posted in tournaments with Woods, relative to when he does not compete.

The summary statistics in Tables 2 and 3 are consistent with the hypothesis that players reduce their effort when they face the superstar. The regression analysis reported in the following sections parse the "superstar effect" from other tournament-, course- and condition-specific effects.

4.3 Econometric Specification

The hypothesis outlined in section 2 suggests the following initial econometric specification:

$$strokes_{ij} = \beta_0 + \beta_1 star_j + \beta_2 exempt_i + \beta_3 star_j \times exempt_i + \beta_4 X_j + \beta_5 Y_i + \varepsilon_{ij} \qquad (3)$$

where $strokes_{ij}$ is the final scores, in terms of strokes above or below par, for player i in tournament j, $star_j$ is a dummy variable that equals 1 when the superstar is present in the tournament, and $exempt_i$ is a dummy variable indicating the exempt or non-exempt status

[9] Non-parametric Wilcoxon signed-rank tests yield identical results—the distribution of the scores of other golfers are statistically different when Tiger Woods participates in a tournament relative to when he is absent.

of a player in a given year. In addition, I include X_j, a matrix of tournament- and course-specific controls, and Y_i, a matrix of variables representing player attributes. Finally, ε_{ij} is the error term. I estimate the equation using OLS with a robust variance estimator that is clustered by player-year to allow for correlation across an individual golfer's tournaments in a given year.[10] Because the variable of particular interest is the presence of the superstar, Woods's scores are omitted from the regressions.

The coefficient on the superstar dummy (β_1) captures the effect of Woods's presence on the scores of non-exempt (lower-skill) players. The sum of the superstar and superstar-exempt interaction ($\beta_1 + \beta_3$) captures Woods's impact on exempt (higher-skill) players.

The matrix of tournament controls, X_j, may include the following variables:

Year Dummies - Fixed effects for 1999 to 2006 are included to control for annual differences in scores.

Major Dummy - I use an indicator for the four major tournaments (US Open, British Open, PGA Championship and the Masters) which are prestigious, attract a strong field of players and are notoriously challenging.

Yardage - The total length of the course in yards may impact the difficulty of play. Average yardage is included when the tournament was played on several courses.

Number of Rounds - More rounds give players more opportunities to accumulate strokes over and under par (e.g. while a golfer may be 12 under for four rounds, he is unlikely to be 12 under for a single round). Nearly 95% of PGA tournaments consist of four rounds.

Temperature and Wind Speed - I use the average daily temperature (°F) and resultant wind speed (tenths of mile/hour) to control for the weather conditions during tournaments.[11] In all reported specifications, I use temperature threshold dummy variables to indicate temperatures that are "very hot" (above 80°F) and "very cold" (below 60°F).

Lagged Rainfall - Inches of rain accumulated over the four days before the event also controls for playing conditions. Rain may make the course easier, since moist greens are soft, slow and forgiving.

Golf Course Dummies - All versions of equation (3) include individual golf course dummies to capture unobserved course heterogeneities.[12]

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[10] Since golfers' performances may be correlated within a tournament, I also consider clustering by event. The results are qualitatively similar to those presented in the tables and are not reported separately.

[11] Resultant wind speed reflects the net speed of movement by the wind over a defined period of time.

[12] "Slope" is another measure of course difficulty, assigned by the USGA and bounded between 55 and 155. The slope ratings of many Tour courses are censored at the maximum. For example, several US Open courses have slopes of 155, but are widely considered to be more difficult than the rating suggests. While the USGA slope rating may represent course quality during non-professional play, the rating is not indicative of Tour event difficulty and is omitted from the reported regressions. When included, the coefficients on the

Total Purse - Purse variables reflect tournaments' monetary incentives. Since the prize distribution is fixed for almost all tour events, the total purse statistic is sufficient. When entered linearly, purse values are deflated by a monthly Consumer Price Index. I also use total purse size dummy variables; large and small purses are above the 75^{th} percentile and below the 25^{th} percentile for all tournament purses in a given year, respectively.

Field Quality - The competitiveness of the field of players is proxied by the average OWGR rank points of the players who made the cut (excluding Woods). Section 3 provides OWGR details.

The matrix of player attributes, Y_i, may include the following variables:

Golfer Dummies - All versions of the equation (3) include dummy variables for individual golfers to capture unobserved heterogeneity in skill level.

Official World Ranking Points - While player dummies capture much of the golfer-level variation, players' skills may develop or degenerate over time. Changes in a player's skill is proxied by his year-end OWGR points average.

4.3.1 All Regular and Major Tournaments

Table 4 report results from regressions using only data from players who made the cut in regular and major PGA Tour events. Observations from alternate (e.g., Air Canada Championship, Reno-Tahoe and B.C. Opens) and small-field tournaments (e.g., Mercedes and Tour Championships) are omitted. Alternate and small-field events select only lower or higher skills players, respectively, and are not typical tournaments.

Regression 4.1 in Table 4 includes the final tournament scores for all players who made the cut, along with several event and player controls. The superstar effect is positive and large—the tournament scores of exempt and non-exempt players are 0.8 and 0.6 strokes higher when Woods is present, respectively. I reject the hypotheses that $\beta_1 = 0$ and $\beta_1 + \beta_3 = 0$ at *p-values* < 0.01. The magnitude of the effect is substantial, particularly when one considers that, on average, only two strokes separate 1^{st} and 2^{nd} place in PGA tournaments.

Additional controls are included in the other regressions reported in Table 4: regression 4.2 includes purse-size dummy variables, regression 4.3 controls for the average quality of the field of competitors, and regression 4.4 allows individual golfers' quality to vary across years. The superstar effect for non-exempt players decreases to approximately 0.4 strokes with the additional controls. However, the superstar effect for exempt players is similar across the alternative specifications. Exempt players' tournament scores are, on average, 0.8 strokes higher when Woods participates, relative to when he does not.

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slope variable are not statistical significant.

Other coefficients in Table 4 are also reasonable and relatively stable across the regressions. Scores in major events tend to be significantly higher than regular events—courses played in the majors are more difficult than the courses for regular events. Longer courses result in higher scores, although the effect is small. Weather also has the expected effects: cold conditions and increased wind lead to higher scores, while recent precipitation leads to lower scores.

Interestingly, and counter to the results found in Ehrenberg and Bognanno (1990a,b), higher purses actually appear to induce slightly higher scores. However, the effect is small—when total purse is included linearly, raising the purse by $100,000 is associated with less than one-tenth of a stroke difference in final score.[13] While controls for the quality of the field are not statistically significant, the estimated coefficient for player quality suggests that historically better players post lower scores.

4.3.2 "Tiger-Played" Tournaments

Results in Table 4 suggest an adverse superstar effect, but one might ask: Is the estimated superstar effect simply capturing unobserved heterogeneity in the tournaments that Woods enters and those that he avoids? Does Woods, who typically plays less than 20 of the 45 PGA events each year, select only courses that are more challenging for average professional golfers?

To compare golfers' performances on the same course with and without the superstar, I narrow the sample to golf courses on which Woods has sometimes competed.[14] Because this smaller dataset is robust to bias caused by Woods's selection criteria, I primarily use this subsample in the remainder of my analysis.

Table 5 presents results from replicating regressions 4.1 to 4.4 using the subsample of tournaments.[15] All regressions in Table 5 suggest that Woods's presence affects differently the performance of exempt and non-exempt players. The performance of higher-skilled competitors is adversely affected by the presence of the superstar—exempt players' scores are 0.9 strokes higher when Woods competes (I reject $\beta_1 + \beta_3 = 0$ at *p-values* < 0.01).

In contrast to Table 4, the superstar effect for non-exempt players in Table 5 is not statistically different from zero at conventional levels. The change is due to differences in the quality of tournaments in the full dataset and subsample. Smaller, lower-scoring

[13] This regression is not reported, as the results are similar to those in Table 3.

[14] I restrict the sample by course and not tournament because some event names change across years and several tournaments change locations annually.

[15] I examine courses Woods has played, not tournaments in which he has competed. Pebble Beach hosts the major US Open about once a decade and hosts the AT&T National Pro-Am annually. Results in Table 4 are qualitatively unaffected by the exclusion of scores from major events.

tournaments in which non-exempt players excel and Woods never participates are excluded from the subsample. When all tournaments are examined, non-exempt players average 0.85 strokes over par and 2.68 strokes under par when Woods does and does not participate, respectively. Regressions in Table 4 capture this statistically significant difference between non-exempt players' scores with and without the superstar, while controlling for other factors. When the lower-scoring events are excluded from the sample, the difference between non-exempt players' average scores disappears—on these "Tiger-played" courses, non-exempt players average 1.68 and 1.72 strokes under par with and without Woods, respectively. Small, low-scoring tournaments exaggerate the superstar effect for non-exempt players in Table 4. Thus, when I correct for this bias in Table 5, the superstar effect for non-exempt players becomes indistinguishable from zero. This change is not surprising—lower-skilled players are likely not in "real" competition with top golfers, and the marginal value of improved play is small for players lower in the prize distribution.

Coefficient estimates for the control variables in Table 5 imply the expected relationships. On average, scores from major tournaments are approximately 17 strokes higher than those from regular events. Wind and cold temperatures result in worse play, while rain and hot conditions improve scores. Purse-related effects are small and not statistically significant.

4.3.3 Tournament Entry and Making the Cut

Tables 4 and 5 present an analysis of the performance of golfers who entered and made the cut in tournaments. That is, I have examined only a certain type and quality of player. Anecdotal evidence suggests that golfers may amend their playing commitments to accommodate Woods's schedule—when Woods withdrew only a week before the 2007 Nissan Open, Phil Mickelson announced his participation.[16] Could it be that better players avoid tournaments with Woods, and selection bias is driving the superstar effects in Table 4 and 5?

To identify Woods's effect on tournament selection, I use a probit model and examine players' decisions to enter PGA events. Marginal effects from the estimation are presented in Table 6; regressions 6.1 and 6.2 include all tournaments and the subsample of Tiger-played courses, respectively. Again, I estimate robust standard errors clustered by player-year to allow for correlation within individuals' years. In addition to exempt status, player quality and tournament purse size, I expect past performance and earnings to influence entry decisions—variables representing the number of years on tour and cumulative career earnings prior to the tournament are included for all players.

Exempt players appear 0 to 2% more likely to enter a tournament if Woods participates, while non-exempt players are 1 to 2% less likely to play with the superstar (I reject both

[16] ESPN.com, February 8, 2007

$\beta_1 = 0$ and $\beta_1 + \beta_3 = 0$ at *p-values* < 0.01). These marginal effects are not surprising, given that Woods participates in the more challenging and prestigious tour events. These probit results are inconsistent with the claim that selection bias drives the superstar effect—Woods's presence does not result in higher scores because better players avoid him.

My analysis in Tables 4 and 5 examines only players who made the cut. But, are better golfers being weeded out by the cut in tournaments with Woods, leaving lower-ability players to face the superstar? I estimate two additional probit models to examine the impact of the superstar on other golfers' probability of making the cut, given their participation in a tournament. Regressions 6.3 and 6.4 include all tournaments and the subsample of Tiger-played courses, respectively. Results suggest that exempt players are 12 to 15% more likely to advance in a tournament, relative to non-exempt players. However, the presence of the superstar has little statistical impact on either types' likelihood of making the cut.

The probit results suggest that my estimates of the superstar effect do not suffer from selection bias caused by players' participation choices—that better players are more likely to play against Woods actually strengthens claims of a superstar effect. I also estimated the original equations using Heckman's selection model approach; coefficients are virtually identical to those in Table 5, and are not reported.

4.3.4 Streaks and Slumps

Although his career has been extraordinary, Tiger Woods has not always been perceived as unbeatable. In 2003 and 2004, Woods failed to win a major event, and the media reported that "Tiger slump gives rivals hope" and "Woods' year a major disappointment."[17]

To examine differences in the superstar effect over Woods's more and less successful periods, I re-estimate equation (3) with streak and slump indicators. Estimates of the variables of interest are reported in Table 7. I identify slumps and streaks by calculating the difference between Woods's average score and other exempt players' average score in the previous month. When Woods's performance is not remarkably better than other golfers—score differences in the bottom quintile—he is in a slump. When Woods's scores are remarkably lower than his competitors—score differences in the top quintile—he is in a streak period. Score differences in the second to fourth quintiles represent Woods's typical performance.[18] To conserve space, I do not report results for other variables; they are similar to the results in Table 5.

[17] Headlines by Majendie of BBC.co.uk (April 14, 2003) and Potter of USAtoday.com (August 17, 2003), respectively.

[18] Results are similar when I use quartiles of score differences and slump/streak years as reported by the media; estimates are not reported.

Similar to previous estimations, the superstar effect during typical play (i.e. neither slump nor streak) is approximately 0.7 strokes for non-exempt players and 1 stroke for exempt players (*p-values* < 0.01). During Woods's streaks, the superstar effect for non-exempt players decreases to approximately 0.6 (*p-value* $= 0.09$). Exempt players' superstar effect increases by approximately 0.85 strokes during Woods's streaks; the total superstar effect is 1.8 strokes. Slump periods have the opposite effect on the superstar coefficients. Instead of posting higher scores in the presence of a superstar, golfers appear to play better against Woods during his slumps. The adverse superstar effect disappears for exempt players—the sum of the coefficients suggests a 0.4 stroke improvement, but is not statistically significant at conventional levels. Similarly, non-exempt players' scores are 0.4 strokes lower when Woods participates during a slump relative to when he does not participate (*p-value* $= 0.06$).

The streak and slump superstar effects are consistent with predictions from simple theory model presented in section 2. The original model, and the analysis in Tables 4 and 5, held the superstar's relative ability (θ) fixed. However, during streak and slump periods, players' relative abilities change. When the superstar is playing particularly well, θ is large and the model predicts lower effort. When the superstar is performing poorly relative to his typical play, θ is small and I predict higher effort from the competitors. In fact, Table 7 reports this pattern in the data—the superstar effect is large when the superstar is particularly "super", and the effect is small when the superstar is struggling.

4.3.5 Tiger "In the Hunt"

A similar streak and slump pattern is evident *within* tournaments. From 1999 to 2006, Woods won every tournament in which he held the lead going into the final round. Woods's limitation are sometimes evident, however—he has never overcome more than a five-stroke deficit after Saturday to win a PGA event. I assert that Woods is "in contention" when he is within five strokes of the lead after Saturday or 10 strokes of the lead after Friday, and present regression results in Table 8.

Regression 8.1 reports a statistically significant difference in the superstar effect when Woods is in and out of contention (*p-value* < 0.01). When Woods is in the hunt in the final round, exempt players' Sunday scores are 0.32 strokes higher than when Woods is not in the field (*p-value* < 0.01). When Woods falls behind, the superstar effect is only 0.06 strokes for exempt players and is not statistically significant at conventional levels. The superstar effect for non-exempt players is 0.16 strokes when Woods has a strong position in the field and 0.44 strokes when he is lagging. However, these values are not statistically different from each other.

Saturday scores are analyzed in regression 8.2. Again, the overall superstar effect for exempt players is large and statistically significant. On Saturday, however, Woods's position in the field does not have a differential impact on his competitors' scores—the superstar effects when Woods is in and out contention are not statistically different at conventional levels. Whether Woods is leading or not, exempt and non-exempt players' scores are, respectively, 0.5 and 0.25 strokes higher with a superstar in the competition, relative to when he does not participate.

4.3.6 The "Distraction Factor"

Fan and media attention may be distracting for professional golfers—John Daly withdrew from the 2007 Honda Classic after being distracted by a photographer and Tiger Woods complained when fans broke his concentration at the 2006 British Open. Of all players on the Tour, Woods attracts the largest following. Thus, one might ask: Can the superstar effect be attributed to increased media distraction when Woods participates in an event?

While the results in Table 7 suggest a diminished superstar effect during his slumps, Woods remained a fan and media favorite. If competitors' higher scores were due to distractions, then reduced performance should have been evident across all streaks and slumps.

Distractions have also increased over Woods's career. In 1996, PGA tournaments attracted an average of 107,000 spectators; by 1999, average attendance was 148,800. Attendance figures have continued to grow—the 2006 FBR Open attracted nearly 540,000 fans. Table 9 reports the superstar effect by year. If crowd distraction were driving the result, then the superstar effect should increase over time. However, the coefficients for the superstar effect show no such pattern of increase and provide further evidence that distraction is not driving the superstar results.[19]

4.3.7 Scaring the Competition

With an impressive collection of titles, Woods is a formidable opponent on the golf course. Is it possible that he is so intimidating that he scares his competition? Could the superstar effect be a result of intimidation and not reduced effort?[20] If intimidation is leading to higher scores, then players paired with the superstar should be particularly affected—golfers teeing-off with Woods should be more "scared" than those who teed-off hours before.

[19] Assuming a one-year lag on the effect of Woods' slumps and streaks, results in Table 8 are consistent with the discussion in section (4.3.4); the superstar effect is particularly large after his excellent 2001 and 2002 seasons, and small after his disappointing performance in 2003 and 2004.

[20] I draw a subtle distinction between "distraction" and "intimidation." I define distraction as an external force that disturbs a golfer's game (e.g. loud fans). In contrast, "intimidation" is an internal, psychological force that leads to relatively poor play (e.g. doubt of one's ability to perform).

I address this issue using round-level data. Tournaments pairings are determined by players' performance on the previous day; players with high scores start early, while leaders take the final spots. From Thursday and Friday scores, I can determine Saturday's couples.[21] To examine on-course intimidation, I estimate equation (3) separately for Saturday and Sunday and include additional indicators for being paired ahead, behind or with Woods. Selected coefficients are presented in Table 10. Regressions 10.1 and 10.3 include all players in the subsample of Tiger-played courses, while regressions 10.2 and 10.4 include only players paired ahead, behind or with Woods in all regular and major tournaments.

Saturday, often called "moving day", is reputed to be the day on which players jockey for tournament position. Indeed, reported in regression 10.3, Saturday's superstar effect for exempt players is 0.4 strokes (*p-value* < 0.01). If intimidation were driving the superstar effect, I would expect players playing closer to Woods to be more adversely affected by his presence. In fact, coefficients on the pairing indicators are not statistically different from zero at conventional levels—there is no statistical evidence of a greater superstar effect for players paired near Woods. Guryan, Kroft and Notowidigdo (2007) examine only the first two rounds of tournaments in 2002, 2005 and 2006 and also find that being paired with Woods has no statistically significant effect on golfers' performance.

4.3.8 Risky Strategies (i.e. Going for the Green)

Do golfers employ riskier strategies when they face the superstar relative to their play in more "winnable" tournaments? For example, does a golfer shoot over a corner of trees when competing against the superstar, but select a more conservative approach against a non-superstar rival? I use hole-by-hole data to try to identify differences in players' strategies in the presence or absence of the superstar.[22]

Risky shots sometimes succeed and, other times, fail—uncertainty widens the distribution of scores relative to more conservative play. I calculate the variance of individual's hole-by-hole scores within each round of a tournament and use this measure of "riskiness" to identify differences in the distribution of scores in tournaments with and without Woods. Using within-round variance as the dependent variable, I estimate equation (3) for Tiger-played courses and include tournament, condition and player controls. Table 11 reports the results.

The presence of the superstar appears to have little impact on score variance for both exempt and non-exempt players; the superstar-related coefficients are not statistically significantly different from zero at conventional levels. There is little evidence that Woods's

[21] Groups on Thursdays and Fridays are typically threesomes, while groups after the cut are couples.

[22] Ideally, I would observe players' shots and options to evaluate their on-course decision-making. Unfortunately, shot-by-shot data were not available.

presence induces players riskier strategies that result in higher scores and the estimated superstar effect.

To summarize:

1. A superstar leads to reduced performance from other competitors in a tournament: On average, exempt PGA players' scores are 0.8 strokes higher in tournaments where Woods is in the field, relative to when he does not participate.

2. Higher scores are not due to the adoption of "riskier" strategies by competitors: Golfers' within-round score variance is not statistically significantly higher when Woods is in the field, relative to when he does not participate.

3. Superstars must be "super" to create adverse effects: The adverse superstar effect is large during Woods's streak periods and disappears during his slumps.

5 Conclusion

While there are many situations in which tournament-style internal competition improves worker performance, I present theory that suggests that large inherent skill differences between competitors can have the perverse effect of reducing effort incentives under competition. The main contribution of this paper is to investigate whether this theoretical possibility matters in practice. Using a rich panel dataset of the performance of PGA Tour golfers, I present evidence that a "superstar effect" is in fact present in professional golf tournaments.

It is useful to know not only that incentives are adversely affected by the presence of a superstar, but also the economic magnitude of the effect. Consider the following counterfactual: How much would Tiger Woods's earnings have been reduced if his competitors played as well as they did when he was not in the field? In my main results, I identify a superstar effect of nearly one stroke for exempt players. To answer this question, I simulate the distribution of prizes if all exempt players' scores had been one stroke lower when they competed against Woods—that is, I removed the estimated superstar effect from exempt players' scores. My calculations suggest that Woods's PGA Tour earnings would have fallen from $48.1 million to $43.2 million between 1999 and 2006 had his competitors' performance not suffered the superstar effect. Woods has pocketed an estimated $4.9 million in additional earnings because of the reduced effort of other golfers—prize money that would otherwise have been distributed to other players in the field. Viewed in this light, the superstar effect is economically substantial.

The implications of the superstar effect extend beyond the PGA Tour and, in principle, require firms to be cautious in using "best athlete" hiring policies in organizations where internal competition is a key driver of incentives. For example, sale managers should be aware of the consequences of introducing a superstar team member, and law firms should consider the impact of a superstar associate on the cohort's overall performance. Understanding the superstar effect is a first step towards learning how to best structure situations where competition exists between players of heterogeneous abilities.

Outside of the firm context, the superstar effect identified in this paper is an example of how peer effects interact with individual incentives to affect decision-making. A key finding of peer effect research, particularly in the school-performance literature, is that individuals are influenced by the abilities and behaviors of other members of their cohort (cf. Zimmerman, 2003). Classrooms are increasingly competitive environments in which students' abilities are judged against the performance of their peers. While there are substantial gaps in translating professional golfers' tournament performances to children's school behavior, my results suggest that there is a potential downside to introducing tournament-style incentives into a classroom setting with a "superstar" pupil. Indeed, my research suggests that one possible outcome of such an introduction is a reduction in the effort of other students who are unlikely to win the status or rewards associated with being a top class performer.

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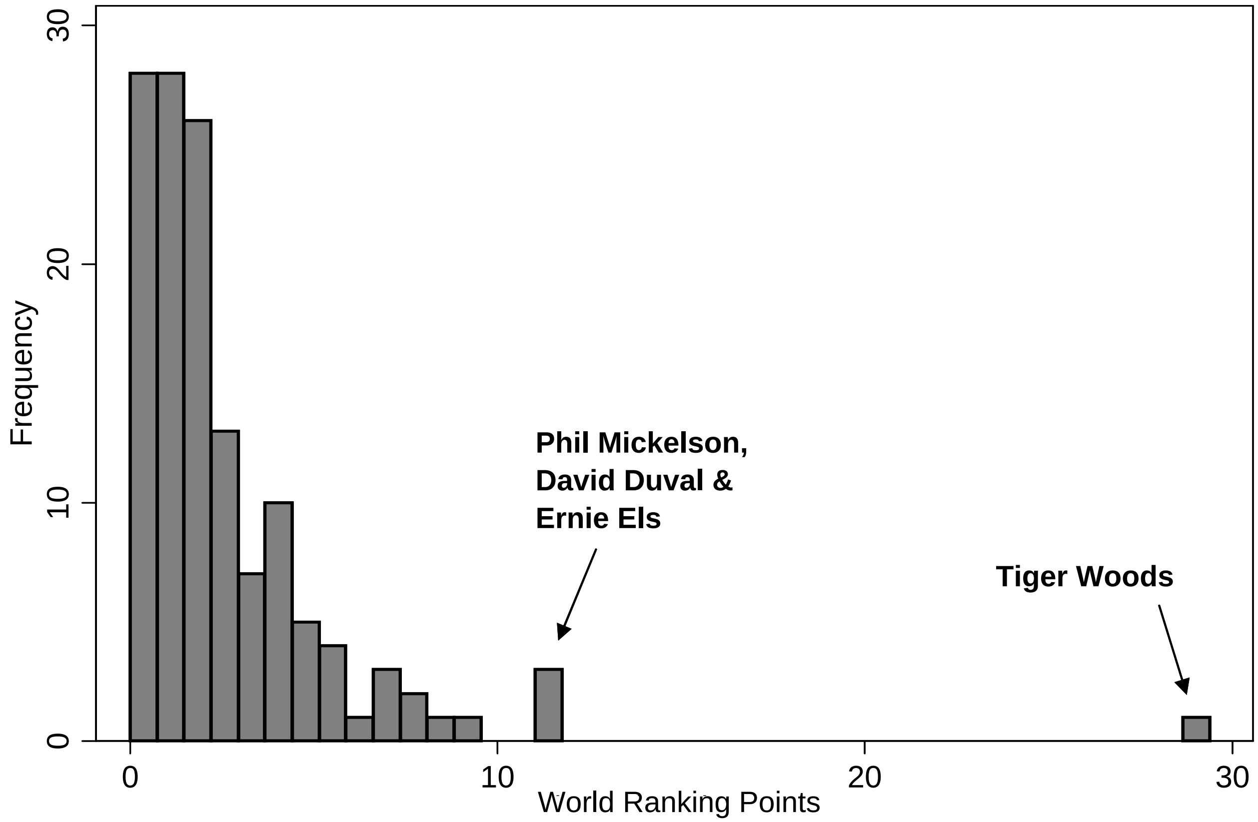
Figure 1: Distribution of Official World Golf Rankings Points for Exempt PGA Tour players in 2000



Source: PGA Tour Official World Golf Rankings are available online at http://www.pgatour.com/r/stats/2000/186.html
Note: Official World Golf Ranking points are based on players' finishing positions and the strength of the field in PGA Tour events. Values reflect the average number of points earned in each tournament in the previous two years. Points are time-weighted, declining by 25 percent of their value after each 13-week period since the event.

Table 1: Score and Skill Summary Statistics for the PGA Tour 1999-2006

		1999	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**
# of Players	Exempt Players	132	133	140	140	140	148	147	141
	Non-Exempt Players	511	599	545	549	538	524	519	513
Performance: Average strokes relative to par for a tournament									
Regular Events	Exempt Players	-3.93	-5.16	-6.33	-5.94	-5.53	-4.59	-4.17	-3.75
		(6.42)	(7.41)	(7.08)	(7.51)	(8.10)	(7.00)	(7.00)	(6.94)
	Non-Exempt Players	-1.01	-2.55	-3.84	-4.10	-2.60	-2.33	-2.32	-1.94
		(6.31)	(7.21)	(6.46)	(7.10)	(7.91)	(6.77)	(6.73)	(6.78)
	Tiger Woods	-9.91	-14.31	-11.08	-13.60	-12.64	-9.55	-11.00	-13.57
		(7.62)	(6.02)	(5.04)	(6.50)	(6.19)	(5.20)	(7.33)	(6.83)
Major Tournaments	Exempt Players	6.86	-0.89	3.81	5.59	7.20	4.18	4.92	2.15
		(7.54)	(6.12)	(7.57)	(6.87)	(5.82)	(8.15)	(6.84)	(7.99)
	Non-Exempt Players	11.01	0.47	6.59	1.45	8.59	7.67	5.68	4.33
		(7.27)	(7.25)	(7.66)	(6.44)	(5.59)	(7.34)	(7.96)	(8.96)
	Tiger Woods	-0.75	-13.67	-3.75	-6.00	4.50	1.75	-6.50	-13.33
		(7.23)	(8.39)	(8.38)	(5.48)	(5.07)	(5.91)	(7.72)	(8.08)
Skill: Official World Golf Rankings									
OWGR Average Points	Exempt Players	2.54	2.46	1.72	1.68	1.80	1.82	1.86	1.87
		(2.40)	(2.44)	(1.80)	(1.56)	(1.80)	(1.81)	(1.67)	(1.53)
	Non-Exempt Players	0.45	0.50	0.39	0.46	0.40	0.51	0.53	0.56
		(0.98)	(1.12)	(0.86)	(0.88)	(0.79)	(0.68)	(0.79)	(0.75)
	Tiger Woods	19.98	29.40	15.67	15.72	15.09	11.11	17.16	20.41

Note: Values in parentheses are standard deviations. Only players who made the cut are included. "Exempt" players automatically qualify for PGA Tour event. "Non-Exempt" players must qualify for individual tournaments. Values for small-field and alternate events are not presented. Scores from "Regular" events exclude values for the four "Majors" (PGA Championship, British Open, US Open and the Masters). Values for Tiger Woods are presented separately and, therefore, are omitted from the statistics for exempt players.

Table 2: Average Strokes Relative to Par for Tournaments With and Without Tiger Woods

		1999	2000	2001	2002	2003	2004	2005	2006
Exempt Players	With Tiger Woods	-1.87	-3.35	-4.84	-4.14	-1.66	-2.03	-3.46	-2.73
		(6.04)	(7.24)	(6.43)	(6.91)	(8.01)	(6.24)	(7.35)	(6.96)
	Without Tiger Woods	-5.21	-6.36	-7.37	-6.88	-7.63	-6.08	-4.65	-4.16
		(6.32)	(7.28)	(7.33)	(7.65)	(7.34)	(6.99)	(6.71)	(6.90)
Non-Exempt Players	With Tiger Woods	0.85	-1.19	-2.47	-1.83	0.21	0.51	-2.20	-0.50
		(6.52)	(7.58)	(5.94)	(6.69)	(8.27)	(6.22)	(7.75)	(7.12)
	Without Tiger Woods	-1.83	-3.28	-4.59	-5.05	-3.90	-3.45	-2.39	-2.33
		(6.04)	(6.90)	(6.61)	(7.06)	(7.39)	(6.66)	(6.11)	(6.64)

Note: Values in parentheses are standard deviations. Only scores from players who made the cut are included. Regular and major events are included; small-field and alternate events are excluded. "With Tiger Woods" indicates that Woods played in the tournament, while "Without Tiger Woods" includes only tournament in which Woods did not participate. "Exempt" players automatically qualify for PGA Tour event. "Non-Exempt" players must qualify for individual tournaments. Scores for Tiger Woods are excluded.

Table 3: Average Number of Eagles, Birdies, Pars, Bogeys and Double Bogeys in Tournaments With and Without Tiger Woods on "Tiger-Played" Courses from 2002 to 2006

		Average # Per Round in Tournaments With Tiger	Average # Per Round in Tournaments Without Tiger Woods	H_0: Equal number with and without Tiger (Unpaired t-test)
2 Strokes under par	*"Eagle"*	0.080	0.093	p-value=0.065
		(0.004)	(0.006)	
1 Stroke under par	*"Birdie"*	3.815	3.866	p-value=0.194
		(0.021)	(0.033)	
Equal to par	*"Par"*	11.323	11.354	p-value=0.515
		(0.026)	(0.038)	
1 Stroke over par	*"Bogey"*	2.510	2.448	p-value=0.069
		(0.020)	(0.028)	
2 Strokes over par	*"Double Bogeys*	0.242	0.218	p-value=0.035
		(0.006)	(0.009)	

Note: Values in parentheses are standard deviations. Only scores from players who "made the cut" are included. Regular and major events are included; small-field and alternate events are excluded. "With Tiger Woods" indicates that Woods played in the tournament, while "Without Tiger Woods" includes only tournament in which Woods did not participate. Scores for Tiger Woods are excluded.

Table 4: Regression Results for Score in All Regular and Major Tournaments 1999-2006

Dependent Variable: *Strokes Relative to Par for a Tournament*

	4.1	4.2	4.3	4.4
# of Rounds	-0.1772	-0.1949	-0.2003	-0.2169
	(0.1926)	(0.1946)	(0.1949)	(0.1981)
Major Event Dummy	16.3328 ***	16.1158 ***	16.1593 ***	16.5754 ***
	(0.7747)	(0.7741)	(0.7729)	(0.7503)
Course Length in Yards	0.0090 ***	0.0095 ***	0.0094 ***	0.0090 ***
	(0.0007)	(0.0007)	(0.0007)	(0.0007)
Superstar Dummy	0.6040 ***	0.4354 **	0.4327 **	0.3689 *
	(0.2015)	(0.2043)	(0.2043)	(0.2024)
Exempt Dummy	-0.9170 ***	-1.0877 ***	-1.0841 ***	-0.5370 ***
	(0.1325)	(0.1534)	(0.1533)	(0.1402)
Superstar x Exempt	0.2854 *	0.3242 *	0.3238 *	0.3941 **
	(0.1705)	(0.1787)	(0.1787)	(0.1768)
Very Hot Dummy (Mean Temp>80F)	-0.1414	-0.1488	-0.1599	-0.1398
	(0.2014)	(0.2005)	(0.2009)	(0.1986)
Very Cold Dummy (Mean Temp<60F)	1.8339 ***	1.8843 ***	1.8848 ***	1.8990 ***
	(0.1781)	(0.1791)	(0.1793)	(0.1782)
Average Tournament Wind Speed	0.0489 ***	0.0484 ***	0.0485 ***	0.0486 ***
	(0.0028)	(0.0027)	(0.0027)	(0.0027)
Recent Rainfall (4 days prior)	-0.0038 ***	-0.0034 ***	-0.0034 ***	-0.0034 ***
	(0.0007)	(0.0007)	(0.0007)	(0.0007)
Large Purse Dummy (>75th percentile)		0.6521 ***	0.6529 ***	0.6261 ***
		(0.2106)	(0.2106)	(0.2082)
Large Purse x Exempt		0.2706	0.2663	0.2879
		(0.1998)	(0.1999)	(0.1970)
Small Purse Dummy (<25th percentile)		-0.8719 ***	-0.9053 ***	-0.9059 ***
		(0.2208)	(0.2224)	(0.2222)
Small Purse x Exempt		0.3701 *	0.3738 *	0.3746 *
		(0.1992)	(0.1993)	(0.1980)
Player Quality (World Ranking Points)				-0.9516 ***
				(0.0477)
Quality of Field			-0.2823	0.0248
			(0.1852)	(0.1842)
Year dummies	Yes	Yes	Yes	Yes
Golf course dummies	Yes	Yes	Yes	Yes
Player dummies	Yes	Yes	Yes	Yes
# of obs	20539	20539	20539	20539
R-squared	0.51	0.51	0.51	0.51

Note: Values in parentheses are standard errors, clustered by player-year (e.g. Mickelson in 1999). *,**, and *** represent statistical significance at p-values of 90, 95 and 99 percent, respectively. "Major" events are the PGA Championship, US Open, British Open and Masters. "Exempt"=1 for players who automatically qualify for PGA Tour event, and =0 for non-exempt players who must qualify for individual tournaments. "Superstar"=1 if Tiger Woods participated in the tournament, and =0 otherwise. "Quality of Field" is the average OWGR points of all players who made the tournament cut. Only scores from players who made the cut are included. Only regular and major events are included, and scores for Tiger Woods are excluded.

Table 5: Regression Results for Score in "Tiger-Played" Regular and Major Tournaments 1999-2006

Dependent Variable: *Strokes Relative to Par for a Tournament*

	5.1	5.2	5.3	5.4
Major Event Dummy	17.8824 ***	17.6323 ***	17.7464 ***	18.2485 ***
	(0.9047)	(0.9046)	(0.9051)	(0.8813)
Course Length in Yards	-0.0023	-0.0013	-0.0010	-0.0011
	(0.0016)	(0.0017)	(0.0017)	(0.0017)
Superstar Dummy	0.3095	0.3426	0.3348	0.2934
	(0.2805)	(0.2861)	(0.2857)	(0.2833)
Exempt Dummy	-1.3119 ***	-1.3984 ***	-1.3950 ***	-0.8296 ***
	(0.2466)	(0.2932)	(0.2928)	(0.2848)
Superstar x Exempt	0.6095 **	0.5468 *	0.5613 *	0.5848 **
	(0.2999)	(0.3004)	(0.3001)	(0.2961)
Very Hot Dummy (Mean Temp>80F)	-1.3370 ***	-1.5111 ***	-1.7220 ***	-1.6153 ***
	(0.4174)	(0.4347)	(0.4430)	(0.4374)
Very Cold Dummy (Mean Temp<60F)	3.7694 ***	3.8559 ***	3.9873 ***	4.0244 ***
	(0.4046)	(0.4198)	(0.4254)	(0.4206)
Average Tournament Wind Speed	0.0169 ***	0.0205 ***	0.0192 ***	0.0191 ***
	(0.0055)	(0.0059)	(0.0059)	(0.0059)
Recent Rainfall (4 days prior)	-0.0068 ***	-0.0062 ***	-0.0064 ***	-0.0063 ***
	(0.0013)	(0.0013)	(0.0013)	(0.0013)
Large Purse Dummy (>75th percentile)		0.1183	0.1234	0.1625
		(0.3361)	(0.3360)	(0.3335)
Large Purse x Exempt		0.4796	0.4779	0.4403
		(0.3214)	(0.3208)	(0.3183)
Small Purse Dummy (<25th percentile)		0.4490	0.5107	0.3936
		(0.5194)	(0.5219)	(0.5165)
Small Purse x Exempt		-0.5780	-0.5849	-0.5180
		(0.4854)	(0.4870)	(0.4803)
Player Quality (World Ranking Points)				-0.9572 ***
				(0.0712)
Quality of Field			-0.8567 **	-0.6206 *
			(0.3596)	(0.3559)
Year dummies	Yes	Yes	Yes	Yes
Golf course dummies	Yes	Yes	Yes	Yes
Player dummies	Yes	Yes	Yes	Yes
# of obs	6075	6075	6075	6075
R-squared	0.34	0.36	0.36	0.42

Note: Values in parentheses are standard errors, clustered by player-year (e.g. Mickelson in 1999). *,**, and *** represent statistical significance at p-values of 90, 95 and 99 percent, respectively. "Tiger-Played" courses are those on which Woods has played occasionally, but not always; variation in the superstar's participation permits identification of key variables. "Major" events are the PGA Championship, US Open, British Open and Masters. "Exempt"=1 for players who automatically qualify for Tour events; =0 for non-exempt players who must qualify for individual tournaments. "Superstar"=1 if Tiger Woods participated in the tournament; =0 otherwise. "Quality of Field" is the average OWGR points of all players who made the tournament cut. Only scores from players who made the cut are included. Only regular and major events are included, and scores for Tiger Woods are excluded.

Table 6: Probit Marginal Effects for the Tournament Entry Decision & Making The Cut

Dependent Variable: *Participate=1, Do Not Participate=0; Made the Cut=1, Did Not Make the Cut=0*

	Participation **6.1**	Participation **6.2**	Making the Cut **6.3**	Making the Cut **6.4**
Major Event Dummy	-0.0199	-0.0592	-0.0113	-0.2635
	(0.0236)	(0.0553)	(0.0668)	(0.1663)
Superstar Dummy	-0.0152 ***	-0.0096 **	0.0016	-0.0001
	(0.0039)	(0.0043)	(0.0133)	(0.0168)
Exempt Dummy	0.4075 ***	0.4931 ***	0.1104 ***	0.1490 ***
	(0.0113)	(0.0142)	(0.0147)	(0.0263)
Superstar x Exempt	0.0338 ***	0.0128	-0.0151	-0.0119
	(0.0062)	(0.0085)	(0.0118)	(0.0203)
Large Purse Dummy (>75th percentile)	0.0062	0.0065	-0.0001	0.0363
	(0.0046)	(0.0070)	(0.0141)	(0.0315)
Large Purse x Exempt	-0.0037	-0.0149 *	0.0050	-0.0459
	(0.0071)	(0.0087)	(0.0141)	(0.0320)
Small Purse Dummy (<25th percentile)	2.13E-02 ***	9.34E-03	7.37E-03	0.0203
	(3.87E-03)	(8.89E-03)	(1.47E-02)	(2.26E-02)
Small Purse x Exempt	-5.12E-02 ***	-2.57E-02 **	1.17E-02	-0.0188
	(4.02E-03)	(1.09E-02)	(1.41E-02)	(2.30E-02)
Player Quality (World Ranking Points)	0.0036 *	-0.0042	0.0879 ***	0.0822 ***
	(0.0020)	(0.0027)	(0.0042)	(0.0071)
# Years on Tour	0.0024 ***	0.0015 ***	0.0011 *	0.0020 **
	(0.0004)	(0.0005)	(0.0007)	(0.0010)
Current Career Earnings (in US$)	0.0031 **	6.97E-03 ***	5.47E-04	-0.0001
	(0.0013)	(1.79E-03)	(1.68E-03)	(2.68E-03)
Tournament Order in the Year	-3.84E-04	0.0021	0.0007	0.0156
	(7.65E-04)	(0.0035)	(0.0024)	(0.0105)
Tournament Order x Exempt	-1.15E-03 ***	-0.0017 ***	4.05E-05	0.0006
	(1.71E-04)	(0.0004)	(0.0005)	(0.0011)
Year dummies	Yes	Yes	Yes	Yes
Golf course dummies	Yes	Yes	Yes	Yes
Tournaments	All	"Tiger-Played"	All	"Tiger-Played"
# Participation=1	39082	12186	20668	6290
# Participation=0	153128	45460	18414	5896
Pseudo R-squared	0.17	0.22	0.09	0.09

Note: Marginal values have been computed from the estimated coefficient of the probit model. Values in parentheses are standard errors, clustered by player-year (e.g. Mickelson in 1999). *,**, and *** represent statistical significance at p-values of 90, 95 and 99 percent, respectively. "Tiger-Played" courses are those on which Woods has played occasionally, but not always; variation in the superstar's participation permits identification of key variables. "Major" events are the PGA Championship, US Open, British Open and Masters. "Exempt"=1 for players who automatically qualify for PGA Tour event, and =0 for non-exempt players who must qualify for individual tournaments. "Superstar"=1 if Tiger Woods participated in the tournament, and =0 otherwise. "Quality of Field" is the average OWGR points of all players who made the tournament cut. Only regular and major events are included, and Tiger Woods is excluded.

Table 7: Regression Results for Score in "Tiger-Played" Tournaments during Streaks and Slumps

Dependent Variable: *Strokes Relative to Par for a Tournament*

	7.1		**F-tests for Total Effect** (e.g. 'superstar'+'superstar x Exempt'+'streak' + 'streak x Exempt' = 0)
Exempt	-1.3966	***	
	(0.2923)		
Superstar	0.7303	**	
	(0.3501)		
Superstar x Exempt	0.2427		
	(0.3683)		
Superstar Streak	-0.0343		p-value=0.09
	(0.4610)		
Superstar Streak x Exempt	0.8474	*	p-value<0.001
	(0.4943)		
Superstar Slump	-1.4814	***	p-value=0.06
	(0.4323)		
Superstar Slump x Exempt	0.1425		p-value=0.22
	(0.4954)		
Other variable coefficients suppressed			
# of obs	6075		
R-squared	0.36		

Note: Values in parentheses are standard errors, clustered by player-year (e.g. Mickelson in 1999). *,**, and *** represent statistical significance at p-values of 90, 95 and 99 percent, respectively. The difference between the average score posted by exempt players and the score posted by Tiger Woods was calculated for all months. "Slump" and "Streak" periods represent the first and fifth quintile of these values, respectively. Missing percentile values were replaced with data from the previous available month. "Superstar"=1 if Tiger Woods participated in the tournament, and =0 otherwise. "Tiger-Played" courses are those on which Woods has played occasionally, but not always; variation in the superstar's participation permits identification of key variables. Only scores from players who made the cut are included. Only regular and major events are included, and scores for Tiger Woods are excluded.

Table 8: Regression Results with Superstar "In" or "Out" of contention 1999-2006

Dependent Variable: *(Daily) Strokes Relative to Par*

	Sunday	Saturday
	"In Contention" going into Sunday's round	"In Contention" going into Saturday's round
	8.1	**8.2**
Strokes Round 1	0.0754 ***	-0.0086
	(0.0128)	(0.0178)
Strokes Round 2	0.0523 ***	-0.0271
	(0.0172)	(0.0176)
Strokes Round 3	0.0146	
	(0.0171)	
Exempt Dummy	-0.8276 *	-0.4087
	(0.4598)	(0.4566)
Superstar "In Contention" Dummy	0.1649	0.2912 *
	(0.1820)	(0.1635)
Superstar "In Contention" x Exempt	0.1602	0.2104
	(0.1948)	(0.1794)
Superstar "Lagging"	0.4448 *	0.1820
	(0.2451)	(0.4051)
Superstar "Lagging" x Exempt	-0.3885	0.2550
	(0.2658)	(0.4411)
Other variable coefficients suppressed		
Year dummies	Yes	Yes
Golf course dummies	Yes	Yes
Player dummies	Yes	Yes
# of obs	6004	6004
R-squared	0.21	0.2

Note: Values in parentheses are robust standard errors, clustered by player-year (e.g. Mickelson in 1999) . *,**, and *** represent statistical significance at p-values of 90, 95 and 99 percent, respectively. The superstar is "in contention" if he is within five (for reg 8.1) and nine (for reg 8.2) strokes of the leader after the previous round. "Tiger-Played" courses are those on which Woods has played occasionally, but not always; variation in the superstar's participation permits identification of key variables. Only scores from players who made the cut are included. Only regular and major events are included, and scores for Tiger Woods are excluded.

Table 9: Regression Results for Score in "Tiger-Played" Tournaments by Year

Dependent Variable: *Strokes Relative to Par for a Tournament*

	9.1	F-tests for Total Effect (i.e. 'year x superstar'+ year x superstar x Exempt'= 0)
Year 1999 x Superstar	-0.9935	
	(0.7369)	
Year 2000 x Superstar	0.6282	
	(0.5265)	
Year 2001 x Superstar	-0.4589	
	(0.4853)	
Year 2002 x Superstar	-0.8226	
	(0.5477)	
Year 2003 x Superstar	0.2440	
	(0.5762)	
Year 2004 x Superstar	-1.2639 **	
	(0.5755)	
Year 2005 x Superstar	0.0699	
	(0.5992)	
Year 2006 x Superstar	-0.3535	
	(0.7214)	
Year 1999 x Superstar x Exempt	-0.0406	p-value = 0.95
	(0.7389)	
Year 2000 x Superstar x Exempt	0.7168	p-value<0.01
	(0.6125)	
Year 2001 x Superstar x Exempt	-0.2692	p-value = 0.11
	(0.5518)	
Year 2002 x Superstar x Exempt	5.0385 ***	p-value < 0.01
	(0.5510)	
Year 2003 x Superstar x Exempt	1.8048 ***	p-value <0.01
	(0.5801)	
Year 2004 x Superstar x Exempt	1.8808 ***	p-value = 0.15
	(0.6044)	
Year 2005 x Superstar x Exempt	-0.6696	p-value = 0.22
	(0.6811)	
Year 2006 x Superstar x Exempt	-1.8350 ***	p-value <0.01
	(0.6962)	
Other variable coefficients suppressed		
# of obs	6075	
R-squared	0.36	

Note: Values in parentheses are standard errors, clustered by player-year (e.g. Mickelson in 1999). *,**, and *** represent statistical significance at p-values of 90, 95 and 99 percent, respectively. "Superstar"=1 if Tiger Woods participated in the tournament, and =0 otherwise. "Tiger-Played" courses are those on which Woods has played occasionally, but not always; variation in the superstar's participation permits identification of key variables. Only scores from players who made the cut are included. Only regular and major events are included, and scores for Tiger Woods are excluded.

Table 10: Regression Results for Tournament Pairings 1999-2006

Dependent Variable: *(Daily) Strokes Relative to Par*

	Sunday		Saturday	
	All Players on Tiger-Played Courses	Players Paired Ahead, Behind or With Tiger	All Players on Tiger-Played Courses	Players Paired Ahead, Behind or With Tiger
	10.1	**10.2**	**10.3**	**10.4**
Strokes Round 1	0.0758 ***	0.0207	-0.0074	-0.0967
	(0.0129)	(0.0838)	(0.0179)	(0.0681)
Strokes Round 2	0.0506 ***	-0.1136	-0.0222	-0.1346 **
	(0.0174)	(0.0936)	(0.0177)	(0.0672)
Strokes Round 3	0.0150	-0.1181		
	(0.0172)	(0.0919)		
Superstar Dummy	0.0963		0.1896	
	(0.1688)		(0.1603)	
Exempt Dummy	-0.7403	1.6360	-0.42189	
	(0.4534)	(2.2068)	(0.4509)	
Superstar x Exempt	0.0057		0.2388	
	(0.1796)		(0.1726)	
Paired with Superstar	-0.3414	-0.0714	0.4930	0.054726
	(0.3822)	(0.4448)	(0.5283)	(0.3632)
Pair Ahead of Superstar	0.0684		0.1818	
	(0.3386)		(0.3011)	
Pair Behind Superstar	0.3961	0.1877	0.2689	-0.6587 **
	(0.3250)	(0.4215)	(0.4305)	(0.3329)
Other variable coefficients suppressed				
Year dummies	Yes	Yes	Yes	Yes
Golf course dummies	Yes	Yes	Yes	Yes
Player dummies	Yes	Yes	Yes	Yes
# of obs	6004	472	6004	472
R-squared	0.38	0.31	0.35	0.49

Note: Values in parentheses are robust standard errors, clustered by player-year (e.g. Mickelson in 1999) . *,**, and *** represent statistical significance at p-values of 90, 95 and 99 percent, respectively. "Superstar"=1 if Tiger Woods participated in the tournament, and =0 otherwise. "Tiger-Played" courses are those on which Woods has played occasionally, but not always; variation in the superstar's participation permits identification of key variables. Only scores from players who made the cut are included. Only regular and major events are included, and scores for Tiger Woods are excluded.

Table 11: Regression Results for Score Variance in "Tiger-Played" Regular and Major Tournaments 2002-2006

Dependent Variable: *Variance of Hole-By-Hole Strokes Relative to Par*

	11.1
Round 2	0.0058
	(0.0049)
Round 3	0.0449 ***
	(0.0051)
Round 4	0.0480 ***
	(0.0051)
Superstar Dummy	0.0071
	(0.0096)
Exempt Dummy	-0.0092
	(0.0119)
Superstar x Exempt	-0.0002
	(0.0107)
Other variable coefficients suppressed	
# of obs	10724
R-squared	0.10

Note: Values in parentheses are robust standard errors, clustered by player-year (e.g. Mickelson in 1999). *,**, and *** represent statistical significance at p-values of 90, 95 and 99 percent, respectively. "Tiger-Played" courses are those one which Woods has played occasionally, but not always; variation in the presence or absence of a superstar allows for identification of key variables. "Exempt"=1 for players who automatically qualify for PGA Tour event, and =0 for non-exempt players who must qualify for individual tournaments. "Superstar"=1 if Tiger Woods participated in the tournament, and =0 otherwise. Only scores from players who made the cut are included. Only regular and major events are included, and values for Tiger Woods are excluded.