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 economic theory suggests that the benefits of competition may 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' first-round scores are approximately 0.2 strokes higher when Tiger Woods participates, relative to when Woods is absent. The overall superstar effect for tournaments is approximately 0.8 strokes. The adverse superstar effect increases when Woods is playing well and disappears during Woods's weaker periods. There is no evidence that reduced performance is due to "riskier" play.

Keywords: tournament, effort, superstar, incentives.

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Managers use internal competition to motivate worker effort, yet economic theory suggests that the benefits of competition may 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' first-round scores are approximately 0.2 strokes higher when Tiger Woods participates, relative to when Woods is absent. The overall superstar effect for tournaments is approximately 0.8 strokes. The adverse superstar effect increases when Woods is playing well and disappears during Woods's weaker periods. There is no evidence that reduced performance is due to "riskier" play.

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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. 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, consistent with the extant literature on contests and tournaments, that suggests not.[1] In particular, these models suggest that the presence of a "superstar" in a competition can lead to *reduced* efforts from tournament participants.[2]

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

[1] Some managers have noted other potential downsides to internal competition, including perceptions of firm weakness and the duplication of effort, and employee distraction (Birkinshaw, 2001; Davenport and Beck, 2000).

[2] 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.

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 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 are 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: Players' scores are nearly 0.2 strokes higher in the first round of a tournament when Woods participates, relative to their scores when Woods is not in the field. Across all rounds of a tournament, the adverse superstar effect for highly-skilled (exempt) PGA golfers' scores is, on average, almost one stroke.

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.

3. Superstars must be "super" to create adverse effects: The adverse superstar effect is large in "hot" periods when Woods is particularly successful and disappears during his "cool" periods. Within a tournament, the adverse effect is large when the superstar is in contention and not statistically significant when he is lagging in the final round.

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.

Theory predicts 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. Sunde (2003) and Lallemand, Plasman, and Rycx (2009) examine professional tennis data to study heterogeneity in elimination tournaments. They find that the lower-ranked players tend to underperform in uneven matches.

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. While some of their specifications control for the ability of players surrounding a competitor on the final day of play, they do not discuss how competitors' skill heterogeneity affects performance. 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. Connelly and Rendleman (2008) examine the performance of 253 players from 1998 to 2001 to identify the role of luck in professional wins.

The work of Lazear and Rosen (1981) provides a foundation for understanding the incentive effects of tournaments, while Prendergast (1999) surveys the recent literature. 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, to motivate my empirical study, I present a two-player contest model 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 Contests with Heterogeneous Players

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.[3] 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

[3]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).

contest modelling. The probabilities that players 1 and 2 win the contest are

$$p_1 = \frac{\theta e_1}{\theta e_1 + e_2} \quad \text{and} \quad p_2 = \frac{e_2}{\theta e_1 + e_2}.$$

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 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

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

Similarly, the first-order condition for player 2 is

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

It is follows that $e_1 = e_2$ in any equilibrium and the common equilibrium effort is

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

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

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

The result in (2) indicates that larger differences in players' abilities will lead to lower equilibrium effort from both players and is consistent with the more general two-player results in Leininger (1993) and Baik (1994).

Stein (2002) studies an n-player asymmetric rent-seeking contest. He finds that an increase in a player's ability leads to a decrease in the effort of all other players; in his model, expenditures decrease with increased relative lobbying effectiveness. In this paper, I hypothesize that the presence of a player with *superstar* abilities will lead players to reduce their effort in the contest.

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."[4]

[4] For example, golf tournament winners may earn prize money, a luxury car, corporate sponsorship, media

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.[5] 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

attention and future career opportunities; the payoff to second position may be simply the (smaller) cash prize.

[5]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.

professional in 1996. By the end of 2006, he had collected 54 PGA wins including 12 major 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

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.[6] 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 players' 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.[7]

I also matched players' tournament scores to monthly average Official World Golf Ranking (OWGR) statistics, which measure golfers' relative quality.[8] 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.

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[6] 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).

[7] 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.

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

3.3 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.[9] 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; 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 such as Mickelson, Els and Duval earned approximately 11 points, and Woods accumulated more than 29 points.[10] 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."

[9] 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.

[10] Figure 1 captures a snapshot of the OWGR. Woods rankes first for 90% of the time between 1998 and 2006, and he never slips below 3rd place. His top rivals change over time; eleven other golfers appear in the top three spots (Duval, Els, Furyk, Goosen, Love III, Mickelson, Montgomerie, Norman, O'Meara, Singh, and Weir).

4 Results: The Presence of a Superstar

My empirical analysis examines 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).[11] 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 stroke 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.

4.1 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 score, 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 of a player

[11] Non-parametric Wilcoxon signed-rank tests yield identical results—the distribution of the scores of other golfers are statistically different when Woods participates in a tournament relative to when he does not.

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.[12] 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. In some tables, I also report the total superstar effect for exempt and non-exempt players, respectively.

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.

World Golf Championship (WGC) Dummy - I use an indicator to identify World Golf Championship events, part of a series of tournaments that attract players from the PGA, European and Japan Golf Tours.

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.[13] In all reported specifications, I use upper and lower temperature quartile dummy variables to indicate temperatures that are "hot (above 80°F) and "very cold" (below 62°F).

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

[12]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.

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

Golf Course Dummies - All versions of equation (3) include individual golf course dummies to capture unobserved course heterogeneities.[14]

Total Purse - Purse variables reflect tournaments' monetary incentives. In all reported specifications, I use the total purse in thousands of dollar, deflated by a monthly Consumer Price Index.[15]

Field Quality - The competitiveness of the field of players is proxied by the average OWGR rank points of the participants (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.

World Golf 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 monthly OWGR points average.

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.

4.1.1 First-Round Effects

Since players make critical effort-related decisions prior to the start of events, any effect of a superstar in the tournament field should be apparent in the first round. Table 4 reports results using players' first-round scores in regular and major PGA tournaments—between 140 and 170 golfers in each events. Approximately half of any tournament field fails to the make the cut. Full-tournament analysis is described in sections 4.1.2 and 4.1.3 below.

Regression 4.1 includes both major and regular tournaments, while regression 4.2 excludes major and WGC events. In both cases, the superstar effect for exempt players is positive and large. For major and regular events, exempt players' first-round scores are 0.16 strokes higher when Woods is in the field, relative to when he is not. Examining only regular events, the superstar effect is 0.18 strokes. I reject the hypothesis that $\beta_1 + \beta_3 = 0$ at *p-values*

[14] "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 slope variable are not statistical significant.

[15] Although not reported, I also estimated equation (3) using upper and lower total purse quartile dummy variables for a given year. Results were qualitatively similar.

< 0.05 and 0.01 in each regression, respectively. The magnitude of the effect is substantial, particularly when one considers that an average of 2 (and as many as 8) players share first place after the first round of tournament play. Moreover, accounting for ties, the top two first-round scores in a tournament differ by an average of only 0.8 strokes. Positions at the end of each round matter to golfers—ranks determine the following day's pairings, tee-times and media coverage.

The superstar effect for non-exempt players is positive and statistically significant for regular events—in regression 4.2, non-exempt players appear to play approximately 0.2 strokes worse when Woods participates, relative to when he does not. However, the superstar coefficient for non-exempt players is not statistically different from zero when major and regular events are considered. Relative to exempt players, for whom a significant superstar effect estimate is persistent across specifications, non-exempt golfers may be less affected by the presence of a superstar. 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.

The superstar effect is not sensitive to the specification of particular control variables. Although not reported, the estimates are robust across alternative specifications of the purse and temperature measures, including linear and quadratic terms, and multiple dummy variables.

Other coefficients in Table 4 are also reasonable and relatively stable across regressions. Scores in the first rounds of the majors tend to be significantly higher than regular events—courses played in the majors are more difficult than courses used for regular tournaments. Longer courses result in slightly higher scores. Weather also has the expected effects: cold temperatures and increased wind lead to higher scores.

Interestingly, higher purses actually appear to induce slightly higher scores—raising the purse by $100,000 is associated with 0.04 increase in first-round score. While this result is counter to the findings in Ehrenberg and Bognanno (1990a,b), Orszag (1994) concludes that changes in tournament prize money did not significantly affect golfers' scores. One plausible explanation for the current result is that the purse variable is capturing unmeasured changes in course difficulty.[16] The controls for the quality of the field are negative in regressions 4.1 and 4.2, suggesting that stronger fields may lead to lower scores. Individual quality coefficient estimates indicate that players post lower scores as their historical ranking improves.

[16] A tournament might increase its purse by more than the average change (absorbed by the year dummies) and, at the same time, adjust its course difficulty in some unmeasurable way. Recall that slope, rating and yardage measures may not reflect actual Tour event difficulty.

4.1.2 All Regular and Major Tournaments

Does the superstar effect that I identify in the first round persist and lead to worse overall tournament performance? Table 5 reports results using from players who made the cut in PGA Tour events. Golfers who make the cut play all four (or five) tournament rounds and are guaranteed a cash prize.

Regression 5.1 includes both major and regular tournaments, while regression 5.2 includes only regular events. In both cases, the superstar effect for exempt players is positive and large. Examining major and regular events, the tournament scores of exempt players are 0.9 strokes higher when Woods is present. Using only regular events, the superstar effect for exempt players is 0.6 strokes. I reject the hypothesis that $\beta_1 + \beta_3 = 0$ at *p-values* < 0.01 in both regressions. The size of the effect is substantial—on average, less than two strokes separate 1^{st} and 2^{nd} place in PGA tournaments.

The superstar effect for non-exempt players is positive and statistically significant for majors and regular tournaments—in regression 5.1, non-exempt players appear to play 0.6 strokes per tournament worse in events with the superstar (*p-value* < 0.01). When only regular events are examined in regression 5.2, however, the effect for non-exempt players is 0.5 strokes per tournament (*p-value*< 0.05). In both regressions, the magnitude of the superstar effect for non-exempt players is smaller than the estimates for exempt players. This results is not surprising given that, on average, lower skilled players are less likely to be competing with the superstar for the top prize money. Between 1999 and 2006, a non-exempt player won fewer than 5% of the regular tour events.

Other coefficients in Table 5 are also relatively stable across the regressions. As in Table 4, scores in major and international events tend to be significantly higher than regular events. Longer courses result in higher scores, although the effect is small. Weather also has the expected effects: cold temperatures and increased wind leads to higher scores, while recent precipitation leads to lower scores. Purse-related coefficients are positive, small and statistically significant. Improved quality of the individual player and the field result in lower tournament scores.

4.1.3 "Tiger-Played" Courses

Results in Tables 4 and 5 suggest an adverse superstar effect, but one might ask: Is this effect simply capturing unobserved heterogeneity in the tournaments that Woods enters and those that he avoids? Woods typically plays less than 20 of the 45 PGA events year and notoriously selects challenging courses. In theory, if other players were responding differently to purse, course, and weather conditions on those "Tiger-played" courses, relative to their behavior on other courses, then the observed superstar effect could be driven by Woods's course preferences. In practice, however, my results suggest that the superstar effect remains strong, even after accounting for Woods's course selection.

I narrow the sample to golf courses on which Woods has sometimes competed.[17] Because this smaller dataset is robust to potential bias caused by Woods's selection criteria, I often use this subsample in the remainder of my analysis.

Table 6 presents results from replicating regressions 6.1 and 6.2 using the subsample of tournaments.[18] As above, the results in Table 6 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' tournament scores are approximately 0.85 strokes higher when Woods competes (I reject $\beta_1 + \beta_3 = 0$ at *p-values* < 0.01).

The superstar effect can also be estimated by individual player. Figure 2 presents a histogram of the statistically significant superstar effects for all exempt players in regular events on "Tiger-Played" courses. The shape of the distribution suggests that the results in Tables 4, 5 and 6 are capturing a mean effect—that is, the superstar effect is not being driven by a small number of particularly susceptible players.

In regressions 6.1 and 6.2, the superstar effect for non-exempt players is not statistically different from zero at conventional levels. Unlike their more experienced or skilled tour counterparts, the average non-exempt player appears unaffected by the presence of the superstar—perhaps because non-exempt players are less frequently in contention.

Coefficient estimates for the control variables in Table 6 imply the expected relationships. On average, scores from major tournaments are approximately 6 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 very small and statistically significant in major tournaments, and not statistically significant in regular events alone.

4.1.4 "Hot" and "Cool"

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."[19] Results

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

[18] The "Major" dummy remains because Woods has played Pebble Beach, which hosts the US Open about once a decade and hosts the AT&T National Pro-Am annually.

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

in Tables 4, 5 and 6 included a single indicator for the presence of the superstar, the empirical analogy of fixing relative skill, θ, in Section 2. If, instead, I allowed θ to take on high and low values, then I would expect players' effort to respond accordingly. When the superstar was relative "hot" (large θ), effort would be low and the superstar effect should be large. When the superstar was relatively "cool" (small θ), effort would be high and the superstar effect should be small. To operationalize these predictions, I estimate equation (3) with "hot" and "cool" indicators for Woods's more and less successful periods, respectively. Estimates of the variables of interest are reported in Table 7.

I identify hot and cool periods 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 cool period. When Woods's scores are remarkably lower than his competitors—score differences in the top quintile—he is in a hot period. Score differences in the second to fourth quintiles represent Woods's typical performance.[20] To conserve space, I do not report the full results since they are similar to those in Table 5.

Regression 7.1 and 7.2 examine overall tournament scores, while regressions 7.3 and 7.4 use first-round data. Similar to the results holding "superstardom" fixed, the superstar effect during Woods's typical play (i.e. neither hot nor cool periods) is approximately 0.8 strokes per tournament for exempt players (p-*values* < 0.01). During Woods's hot periods, the superstar effect for exempt players more than doubles to between 1.5 and 1.8 strokes per tournament (p-*values* < 0.01). Cool periods have the opposite effect on the superstar coefficients: golfers may actually play better when Woods is perceived to be weaker (and beatable). The *adverse* superstar effect disappears for exempt players—coefficients are negative and statistically significant (p-*values* < 0.05). Similarly, the superstar effect for non-exempt players is significantly larger when Woods is hot, relative to when he is a "typical superstar," and negative when Woods is cool.

A similar pattern emerges from first round scores. The superstar effect during Woods's typical periods is small and not statistically different from zero for both exempt and non-exempt players. However, when Woods is playing particularly well, the superstar effect is between 0.58 and 0.71 strokes per round for exempt players and between 0.48 and 0.64 strokes per round for non-exempt players (p-*values* < 0.01). In contrast, when the superstar is weak, the effects are negative and, in most cases, statistically significant.

The tournament and first-round hot and cool effects are consistent with predictions from simple theory model in section 2. The superstar effect is large when the Woods is particularly

[20] Results are similar when I use quartiles of score differences and hot/cool years as reported by the media; these estimates are not reported.

"super" and the effect is small when Woods is struggling.

4.1.5 Tiger "In the Hunt"

A similar hot and cool 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 the hunt" when he is within five strokes of the lead after Saturday, 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—the in and out of the hunt superstar coefficients for exempt players are statistically different from each other at *p-value* of 0.02. When Woods is in the hunt in the final round, exempt players' Sunday scores are 0.19 strokes higher than when Woods is not in the field (*p-value* < 0.01). When Woods falls behind, the superstar effect for exempt players is negative and not statistically significant at conventional levels. The superstar effect for non-exempt players is 0.02 strokes when Woods has a strong position in the field and negative when he is lagging. However, these values are not statistically different from zero or each other.

4.1.6 "Toughening Up" the Course

While the basic geography of a course is fixed, tournament organizers can vary the challenges faced by golfers over years and within tournaments. For example, over time, courses can add bunkers or move tee boxes. Within tournaments, organizers can select pin placements to adjust hole difficulty.[21] It is possible that organizers set tough pin placements when Woods participates; yet, this alone does not rationalize the pattern of results.

Since pins are set for the round, exempt and non-exempt competitors face the same terrain. If physical course changes were driving the superstar effect, then we would expect the performance of both types of players to suffer. Indeed, we might even expect the lower-skilled golfers to be *more* affected. The results in Tables 4 to 8 suggest the opposite—except for the estimate in regression 4.2, the adverse superstar effect for non-exempt player is smaller than the effect for exempt players. While tournament directors may adjust course difficulty for fields of players, the observed adverse superstar effect cannot be explained by pin placement alone.

[21] Some golfers believe that pin placement becomes increasingly challenging over the weekend; some tournament directors argue the opposite (e.g. see "Hiding Pins Can Level Buick Field" by Clifton Brown in the New York Times, June 9, 2004).

4.1.7 Composition of the Field

Table 4 presents an analysis of the performance of golfers who entered tournaments. Tables 5 and 6 refine that further to examine only players who made the cut in those events. That is, I have studied 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.[22] Could it be that better players avoid tournaments with Woods? And, in turn, that the differences in the composition of the field in these events is driving the superstar effect? The answer is no.

On average, 60% of the field in regular and major tournaments with the superstar is exempt, while only 53% of the field is exempt in tournaments where Woods does not participate. Approximately 70% of the field after the cut is exempt when the superstar is present, compared to 63% of the field without Woods. These field composition measures are statistically significantly different from each other at *p-values* < 0.01. On "Tiger-played" courses, there are slightly more exempt players in the field with Woods, relative to when Woods is not in attendance. However, these differences are not statistically significant from each other at conventional levels.

If anything, the direction of the differences suggest that tournaments with Woods have more competitive fields of closely-matched participants (except the superstar) that could lead to better play.[23] Indeed, this field effect could offset, at least in part, the adverse effects of the superstar. Note the I include an index of the quality of the field, the average OWGR points of the participants, in all reported specifications.

4.1.8 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. 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. 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 (or positive) superstar effect during his

[22] ESPN.com, February 8, 2007

[23] This is consistent with Ehrenberg and Bognanno's (1990a) finding that exempt players were more likely to enter major tournaments than non-exempt players—events in which Woods always participates.

"cooler" periods, Woods remained a fan and media favorite. If competitors' higher scores were due to distractions, then reduced performance should have been evident across all typical, hot and cool periods.

4.1.9 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? If intimidation is leading to higher scores, then golfers playing near the superstar should be particularly affected—golfers teeing-off with Woods should be more "scared" than those who teed-off hours before. Yet, this does not appear to be the case. 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.

With data from 1999 to 2006, I address this issue using data from the final round. 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, Friday and Saturday scores, I can determine Sunday's couples.[24] To examine on-course intimidation, I estimate equation (3) for Sunday and include additional indicators for being paired ahead, behind or with Woods. Since Woods's position in the field may also matter—results discussed in section 4.1.4 suggest that a lagging superstar may not affect his competitors' play—I interact the pair indicators with whether Woods is "in the hunt" or not. Table 9 reports the total effect for exempt and non-exempt players and additional effects for players grouped near Woods on the course. Regressions 9.1 examines all major and regular events, while regression 9.2 restricts the analysis to only "Tiger-Played" tournaments.

The estimated superstar effects for exempt and non-exempt are similar to those reported in Table 8—exempt players suffer a large and statistically significant superstar effect when Woods is in contention (*p-values* < 0.05), while the effect for non-exempt players is smaller and not statistically different from zero.

If intimidation were driving the superstar effect, I would expect golfers playing closer to Woods to be more adversely affected by his presence. Results are mixed: Examining all major and regular events, the scores of exempt players are higher when they are grouped with Woods, regardless of whether he is in contention or not. Yet, when I restrict the sample to "Tiger-Played" courses, these differential impacts are much smaller and are not statistically significant. Playing ahead of or behind Woods's group appears to have no additional statistical impact on players' performance.

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

4.1.10 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.[25]

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 all major and regular tournaments and Tiger-played courses. The specification includes the controls used in Tables 4, 5 and 6, in addition to round-level fixed effects.

Results in Table 10 suggest that the presence of the superstar does not lead to increased variance in players' scores. In regression 10.1, both superstar related coefficients are negative and statistically significant (*p-values* < 0.01 and < 0.05 for exempt and non-exempt players, respectively). Examining only "Tiger-Played" courses, 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.

In both regressions, the variance of scores in rounds 3 and 4 tends to be higher than variance in the first two rounds of play. This finding is not surprising given that golfers may play relatively cautiously before the cut, then adopt riskier strategies once they are guaranteed a cash prize—Saturday, when players often jockey for position, is sometimes called "moving day" on the tour.

Overall, this hole-level analysis provides little evidence that Woods's presence induces players riskier strategies that result in higher scores and the observed superstar effect.

To summarize:

1. A superstar leads to reduced performance from other competitors in a tournament: Players' first round scores are nearly 0.2 strokes higher when Woods participates, relative to when Woods is not in the field. Across all rounds of a tournament, the adverse superstar effect for exempt PGA golfers' scores is, on average, almost one stroke.

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

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 "hot" periods and disappears during his "cool" periods. Within a tournament, the adverse effect is large when the superstar is "in the hunt" and not statistically significant when he lags in the final round.

5 Conclusion

While there are many situations in which tournament-style internal competition improves worker performance, tournament and contest theory 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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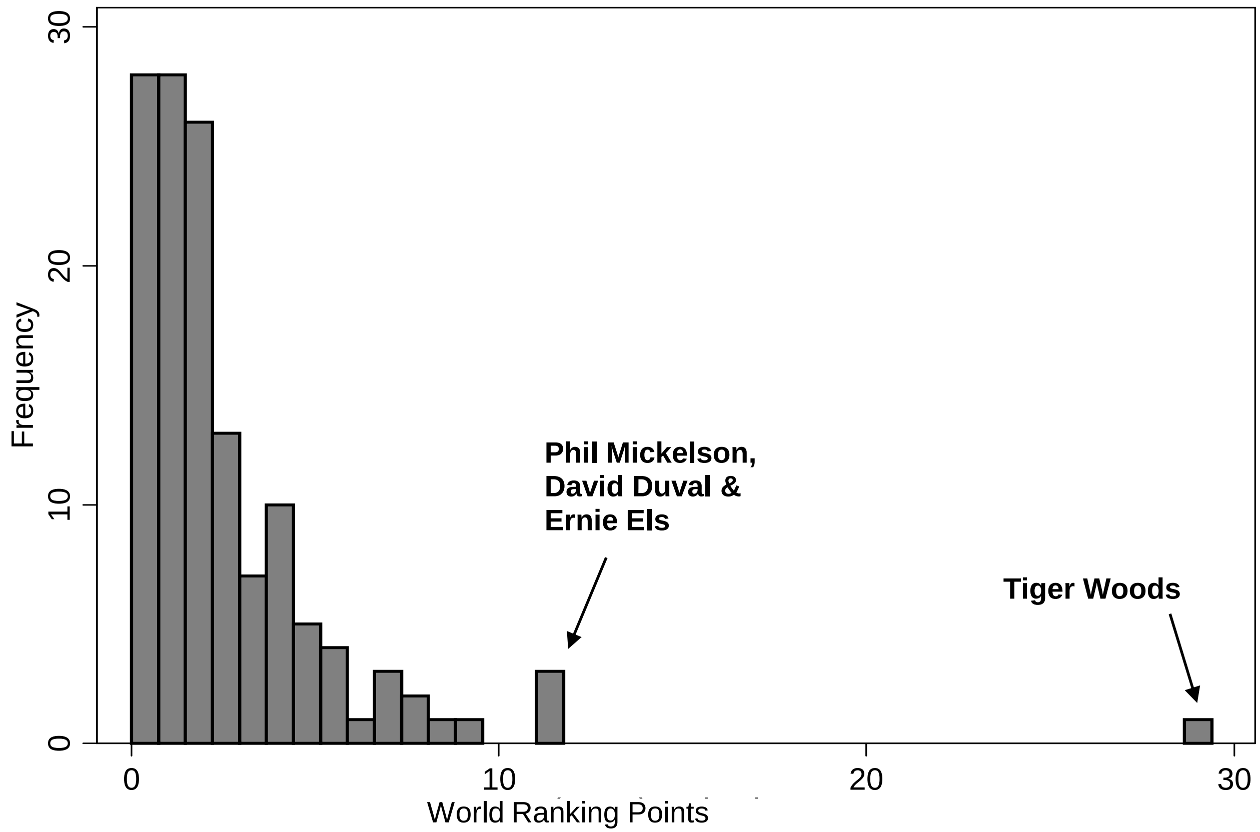
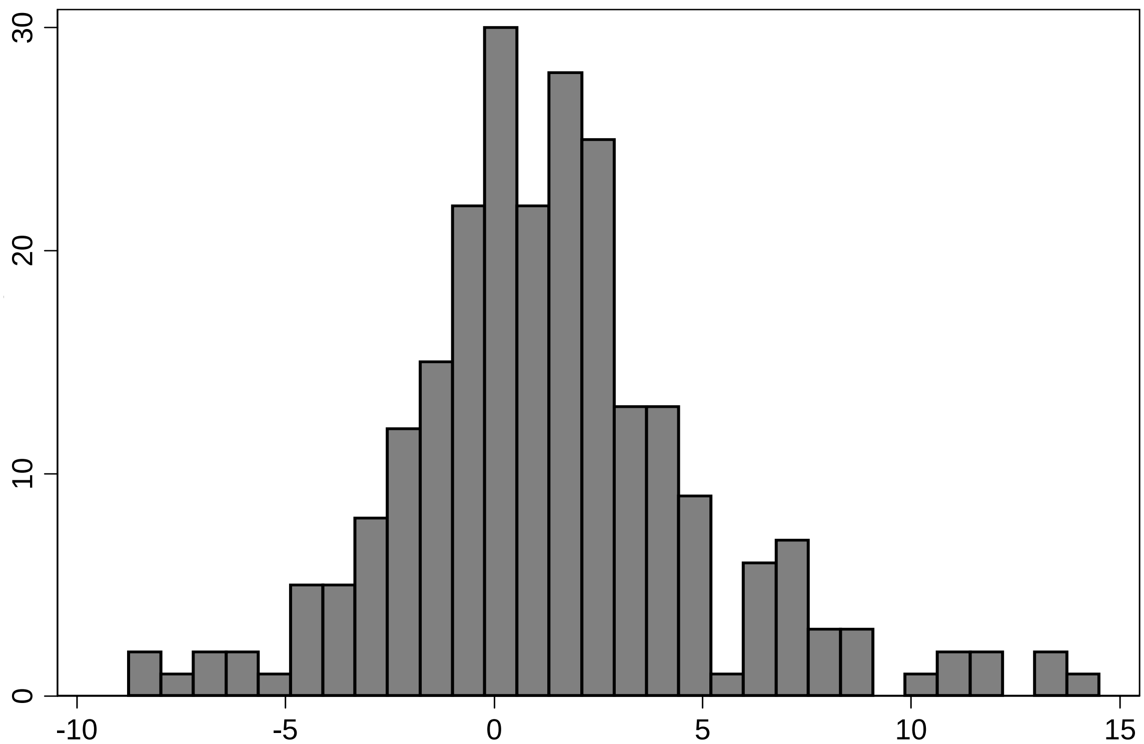
Figure 1: Distribution of Official World Golf Rankings Points for Exempt PGA Tour players in 2000



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.

Figure 2: Distribution of "Superstar Effects" for Exempt Players



strokes over par
(Exempt players in regular tournaments on "Tiger-Played" courses)

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 Scores in Regular and Major Tournaments 1999-2006

	4.1	4.2
Dependent Variable		
Strokes Relative to Par for	first round	first round
Tournament types:	regulars & majors	regulars
Total Superstar Effect for Exempt Players	0.1595 **	0.1787 ***
	(0.0673)	(0.0736)
Total Superstar Effect for Non-Exempt Players	0.1195	0.2037 **
	(0.0729)	(0.0791)
estimated coefficients		
Exempt Dummy	-0.1581	-0.0393
	(0.1780)	(0.2049)
Superstar Dummy	0.1195	0.2037 **
	(0.0729)	(0.0791)
Superstar x Exempt	0.0400	-0.0250
	(0.0694)	(0.0748)
Major Event Dummy	1.3268 ***	
	(0.2356)	
World Golf Championship Event	0.9367 *	
	(0.5121)	
Course Length in Yards	0.0014 ***	0.0008 ***
	(0.0002)	(0.0003)
Hot Dummy (Mean Temp>80F)	-0.0725	-0.1711 *
	(0.0904)	(0.0962)
Cold Dummy (Mean Temp<62F)	0.6162 ***	0.5571 ***
	(0.0768)	(0.0806)
Average Tournament Wind Speed	0.0146 ***	0.0147 ***
	(0.0012)	(0.0013)
Recent Rainfall (4 days prior)	-0.0004	-0.0003
	(0.0003)	(0.0003)
Purse (in thousands of $)	0.0004 ***	0.0005 ***
	(0.0001)	(0.0001)
Purse x Exempt	-0.0001	-0.0001 *
	(0.0000)	(0.0000)
Player Quality (World Ranking Points)	-0.1785 ***	-0.1856 ***
	(0.0209)	(0.0220)
Quality of Field	-0.7770 ***	-0.7770 ***
	(0.1022)	(0.1022)
# of obs	37172	31353
R-squared	0.25	0.21

Note: All specifications include year, golf course and individual player fixed effects.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 entered the tournament. Scores for Tiger Woods are excluded.

Table 5: Regression Results for Scores in Regular and Major Tournaments 1999-2006

	5.2	**5.2**
Dependent Variable		
Strokes Relative to Par for	tournament	tournament
Tournament types:	regulars & majors	regulars
Total Superstar Effect for Exempt Players	0.9171 ***	0.6259 ***
	(0.1663)	(0.1736)
Total Superstar Effect for Non-Exempt Players	0.6563 ***	0.4901 **
	(0.1999)	(0.2120)
estimated coefficients		
Exempt Dummy	-1.0526 **	-1.0759 **
	(0.4519)	(0.5165)
Superstar Dummy	0.6563 ***	0.4901 **
	(0.1999)	(0.2120)
Superstar x Exempt	0.2608	0.1358
	(0.1810)	(0.1935)
Number of Tournament Rounds	-4.2873 ***	-4.1033 ***
	(0.5448)	(0.5641)
Major Event Dummy	7.6637 ***	
	(0.7662)	
World Golf Championship Event	10.0059 ***	
	(1.2731)	
Course Length in Yards	0.0092 ***	0.0088 ***
	(0.0006)	(0.0007)
Hot Dummy (Mean Temp>80F)	-0.0491	-0.3154
	(0.2178)	(0.2411)
Cold Dummy (Mean Temp<62F)	2.0325 ***	1.8941 ***
	(0.1896)	(0.2017)
Average Tournament Wind Speed	0.0534 ***	0.0601 ***
	(0.0029)	(0.0030)
Recent Rainfall (4 days prior)	-0.0036 ***	-0.0040 ***
	(0.0007)	(0.0008)
Purse (in thousands of $)	0.0008 ***	0.0007 ***
	(0.0002)	(0.0002)
Purse x Exempt	0.0001	0.0001 *
	(0.0001)	(0.0001)
Player Quality (World Ranking Points)	-0.4093 ***	-0.4530 ***
	(0.0415)	(0.0464)
Quality of Field	-0.5798 ***	-0.2540
	(0.1865)	(0.2278)
# of obs	19685	16531
R-squared	0.52	0.44

Note: All specifications include year, golf course and individual player fixed effects.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. Scores for Tiger Woods are excluded.

Table 6: Regression Results for Scores in Regular and Major Tournaments 1999-2006

	6.1	6.2
Dependent Variable		
Strokes Relative to Par for	tournament	tournament
Tournament types:	"Tiger-played" regulars & majors	"Tiger-played" regulars
Total Superstar Effect for Exempt Players	0.8601 ***	0.8485 ***
	(0.1802)	(0.1941)
Total Superstar Effect for Non-Exempt Players	0.0995	-0.0059
	(0.2621)	(0.2760)
estimated coefficients		
Exempt Dummy	-3.5389 ***	-3.6436 ***
	(0.9159)	(0.9655)
Superstar Dummy	0.0995	-0.0059
	(0.2621)	(0.2760)
Superstar x Exempt	0.7606 ***	0.8544 ***
	(0.2906)	(0.3056)
Major Event	6.0502 ***	
	(0.9974)	
World Golf Championship Event	-9.8368 ***	
	(0.7059)	
Course Length in Yards	0.0058 ***	0.0034 **
	(0.0014)	(0.0014)
Hot Dummy (Mean Temp>80F)	-1.9830 ***	-3.3430 ***
	(0.4361)	(0.6658)
Cold Dummy (Mean Temp<62F)	4.2917 ***	4.8921 ***
	(0.4750)	(0.4966)
Average Tournament Wind Speed	0.0151 ***	0.0440 ***
	(0.0060)	(0.0074)
Recent Rainfall (4 days prior)	-0.0050 ***	-0.0081 ***
	(0.0013)	(0.0014)
Purse (in thousands of $)	0.0015 ***	0.0004
	(0.0003)	(0.0004)
Purse x Exempt	0.0005 ***	0.0005 ***
	(0.0002)	(0.0002)
Player Quality (World Ranking Points)	-(0.3782) ***	-(0.3719) ***
	(0.0698)	(0.0740)
Quality of Field	-1.3392 ***	-1.1017 ***
	(0.3426)	(0.3822)
# of obs	6465	5689
R-squared	0.43	0.42

Note: All specifications include year, golf course and individual player fixed effects.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. "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. "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. Scores for Tiger Woods are excluded.

Table 7: Regression Results for "Typical", "Hot" and "Cool" Periods

	7.1	**7.2**	**7.3**	**7.4**
Dependent Variable				
Strokes Relative to Par for	tournament	tournament	first round	first round
Tournament types:	regulars & majors	regulars	regulars & majors	regulars
Total Typical Superstar Effect for Exempt Players	0.8340 ***	0.8119 ***	-0.0420	0.0457
	(0.1904)	(0.2130)	(0.0754)	(0.0828)
Total Hot Superstar Effect for Exempt Players	1.5779 ***	1.7516 ***	0.5800 ***	0.7144 ***
	(0.2006)	(0.2408)	(0.0824)	(0.0942)
Total Cool Superstar Effect for Exempt Players	-0.6893 ***	-1.1741 ***	-0.2554 **	-0.3660 ***
	(0.2638)	(0.3736)	(0.1053)	(0.1157)
Total Typical Superstar Effect for Non-Exempt Players	0.8115 ***	0.41536	0.0369353	0.140279
	(0.2532)	(0.3266)	(0.0878)	(0.0962)
Total Hot Superstar Effect for Non-Exempt Players	1.3176 ***	0.7747 **	0.4785 ***	0.6386 ***
	(0.2469)	(0.3448)	(0.0917)	(0.1032)
Total Cool Superstar Effect for Non-Exempt Players	-1.2484 ***	-1.9141 ***	-0.2835 **	-0.1944
	(0.3167)	(0.4839)	(0.1201)	(0.1325)
Other variable coefficients suppressed				
# of obs	19685	16531	37172	31353
R-squared	0.50	0.39	0.21	0.15

Note: All specifications include year, golf course and individual player fixed effects. 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. "Cool" and "Hot" periods represent the first and fifth quintile of these values, respectively, lagged by one month. Missing percentile values were replaced with data from the previous available month. "Superstar"=1 if Tiger Woods participated in the tournament, and =0 otherwise. Scores for Tiger Woods are excluded.

Table 8: Regression Results with Superstar "In the Hunt" After Saturday 1999-2006

	8.1	**8.2**
Dependent Variable Strokes Relative to Par for	Sunday Round	Sunday Round
Tournament types:	regulars & majors	"Tiger-Played" regulars & majors
Total "In the Hunt" Superstar Effect for Exempt Players	0.1932 **	0.3157 ***
	(0.1030)	(0.1175)
Total "In the Hunt" Superstar Effect for Non-Exempt Players	0.0186	0.1552
	(0.1325)	(0.1866)
Total "Not In the Hunt" Superstar Effect for Exempt Players	-0.0243	0.0601
	(0.1079)	(0.1311)
Total "Not In the Hunt" Superstar Effect for Non-Exempt Players	-0.1002	0.1063
	(0.1354)	(0.1879)
Other variable coefficients suppressed, including scores from previous rounds		
# of obs	18800	6465
R-squared	0.21	0.2

Note: All specifications include year, golf course and individual player fixed effects. 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 the hunt" if he is within five 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. Scores for Tiger Woods are excluded.

Table 9: Regression Results for Tournament Pairings 1999-2006

	9.1	9.2
Dependent Variable Strokes Relative to Par for	Sunday Round	Sunday Round
Tournament types:	regulars & majors	"Tiger-Played" regulars & majors
Total "In the Hunt" Superstar Effect for Exempt Players	0.2306 **	0.3432 **
	(0.1020)	(0.1146)
Total "In the Hunt" Superstar Effect for Non-Exempt Players	0.0720	0.1877
	(0.1320)	(0.1841)
Total "Not In the Hunt" Superstar Effect for Exempt Players	-0.0098	0.0967
	(0.1076)	(0.1268)
Total "Not In the Hunt" Superstar Effect for Non-Exempt Players	-0.0801	0.1492
	(0.1346)	(0.1849)
Additional Superstar effect for:		
Players in Superstar's Group when he is "In The Hunt"	0.6418 *	0.1062
	(0.3393)	(0.5551)
Players ahead of Superstar's Group when he is "In The Hunt"	0.2980	0.4463
	(0.2575)	(0.3925)
Players behind Superstar's Group when he is "In The Hunt"	0.0180	0.0057
	(0.3815)	(0.6629)
Players in Superstar's Group when he is "Not In The Hunt"	1.0300 **	0.2347
	(0.5085)	(0.5165)
Players ahead of Superstar's Group when he is "Not In The Hunt"	0.4015	0.1990
	(0.3264)	(0.4056)
Players behind Superstar's Group when he is "Not In The Hunt"	-0.2715	0.4265
	(0.3228)	(0.4626)
Other variable coefficients suppressed, including scores from previous rounds		
# of obs	18800	6465
R-squared	0.21	0.17

Note: All specifications include year, golf course and individual player fixed effects. 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. The superstar is "in the hunt" if he is within five strokes of the leader after the previous round. Scores for Tiger Woods are excluded.

Table 10: Regression Results for Score Variance in Regular and Major Tournaments 2001-2006

	10.1	**10.1**
Dependent Variable		
Variance of Strokes Relative to Par	tournament	tournament
Tournament types:	regulars & majors	"Tiger-played" regulars & majors
Total Superstar Effect for Exempt Players	-0.0225 ***	0.0033
	(0.0070)	(0.0075)
Total Superstar Effect for Non-Exempt Players	-0.0263 **	0.0088
	(0.0115)	(0.0154)
Round 2	0.0014	0.0000
	(0.0036)	(0.0058)
Round 3	0.0188 ***	0.0331 ***
	(0.0038)	(0.0060)
Round 4	0.0315 ***	0.0318 ***
	(0.0038)	(0.0058)
# of obs	25050	8464
R-squared	0.25	0.11

Note: All specifications include round, year, golf course and individual player fixed effects.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. "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. "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. Scores for Tiger Woods are excluded.