Statistical Analysis of PGA Tour Skill Rankings 1980-2006
USGA Research and Test Center
June 1, 2007

1. Introduction

The PGA Tour has recorded and published Tour Player performance statistics since 1980. All of this information is published for each year on the PGA Tour website (www.pgatour.com). Among a number of parameters listed on the PGA Tour website, these published statistics include four key skills. These are:

- driving distance
- driving accuracy
- greens in regulation
- putting average (data not available prior to 1986)

In addition, the PGA Tour records and publishes the amount of money each player has won during each year. The players' annual performance for money won and all measured skills are ranked from the highest to the lowest. Correlating the money won rankings to skill rankings can be used to determine the relative importance of key skills to winning and how the relative importance has changed on the PGA Tour over the period from 1980 to 2006.

2. Analysis method

The USGA has compared player rankings in the skills listed above to their ranking for money won. This was done with a Spearman Rank Correlation study, wherein the ranking for money won is correlated to the ranking for a particular skill. This study is done with only those players who have participated in enough events to qualify to be listed in the skills ranking. Every year there are a number of players who have earned money on Tour, but have not played enough Tour event rounds to be listed in the skill rankings. These players are not considered in the Spearman Rank Correlation, and are removed from the money won ranking for this analysis. The remaining players are re-ranked according to their results so that the money ranking has an equal quantity of players as each skill ranking. The ranks for tied players in a Spearman Rank Correlation are obtained by averaging the ranks that the tied players would occupy, although it was found to be immaterial to the results obtained in this study. The correlation coefficient (r) is calculated for each year's comparison of money won ranking to skill ranking. These correlation coefficients have been plotted for all years from 1980 until 2006. They are also presented in Appendix I.

3. Results

The summary of the Spearman Rank Correlation study from 1980-2006 is presented in Table 1. Plots of the year-by-year rank correlations are given in Figures 1 – 4.

	GIR	Putting Avg	Driving Distance	Driving Accuracy
1980-2006 Mean	**0.54**	**0.56**	**0.21**	**0.31**
1980-2006 Std. Dev.	**0.094**	**0.110**	**0.097**	**0.177**

Table 1: Correlation coefficients between Money winning rank and skill rank - means and standard deviations. (Putting Average 1986-2006)

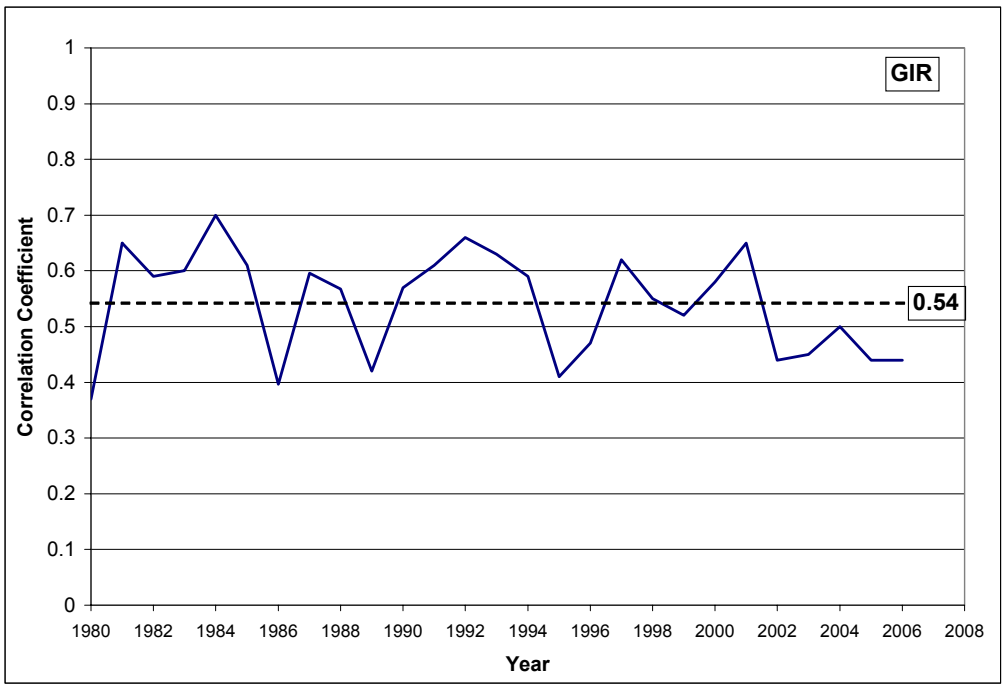

Figure 1: Correlation coefficient between money winning rank and greens-in-regulation (GIR) rank on the PGA Tour from 1980 to 2006

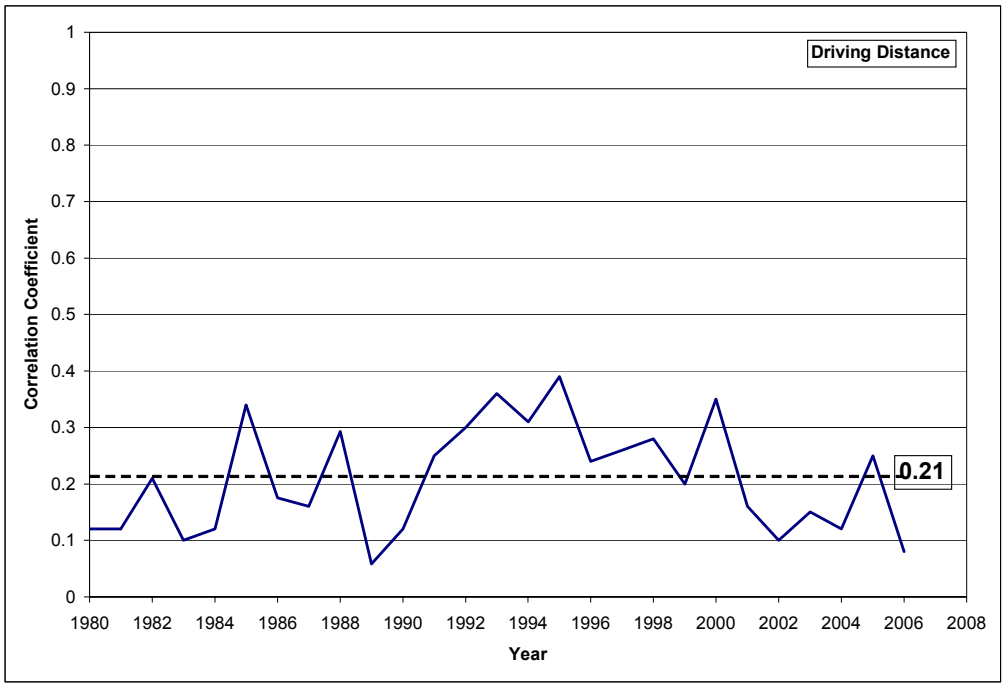

Figure 2: Correlation coefficient between money winning rank and driving distance rank on the PGA Tour from 1980 to 2006

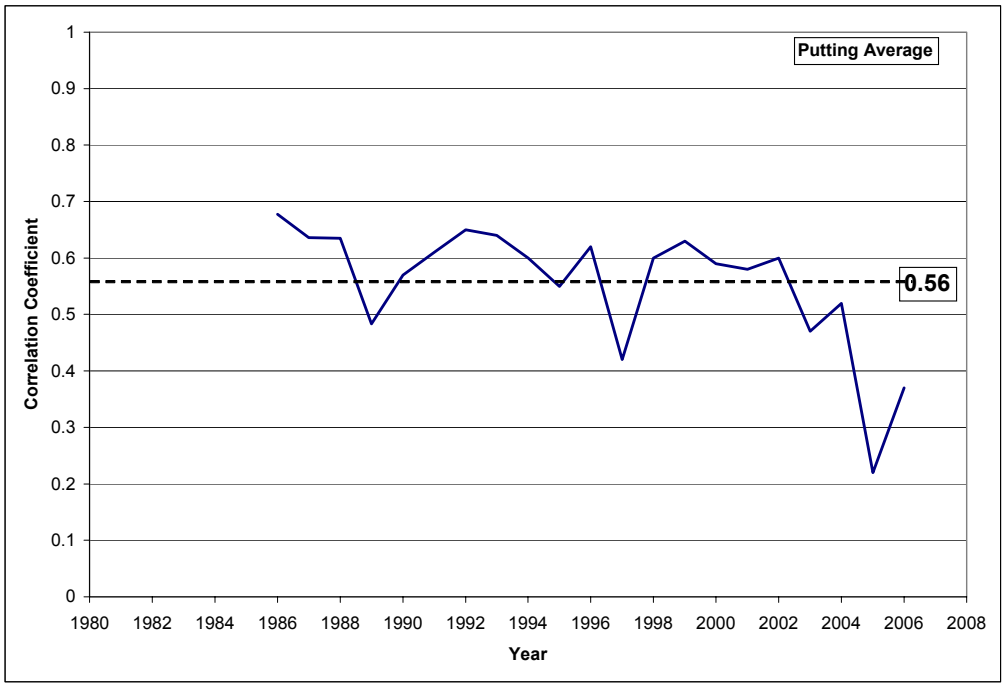

Figure 3: Correlation coefficient between money winning rank and putting average rank on the PGA Tour from 1986 to 2006. (Putting average was not published for years prior to 1986.)

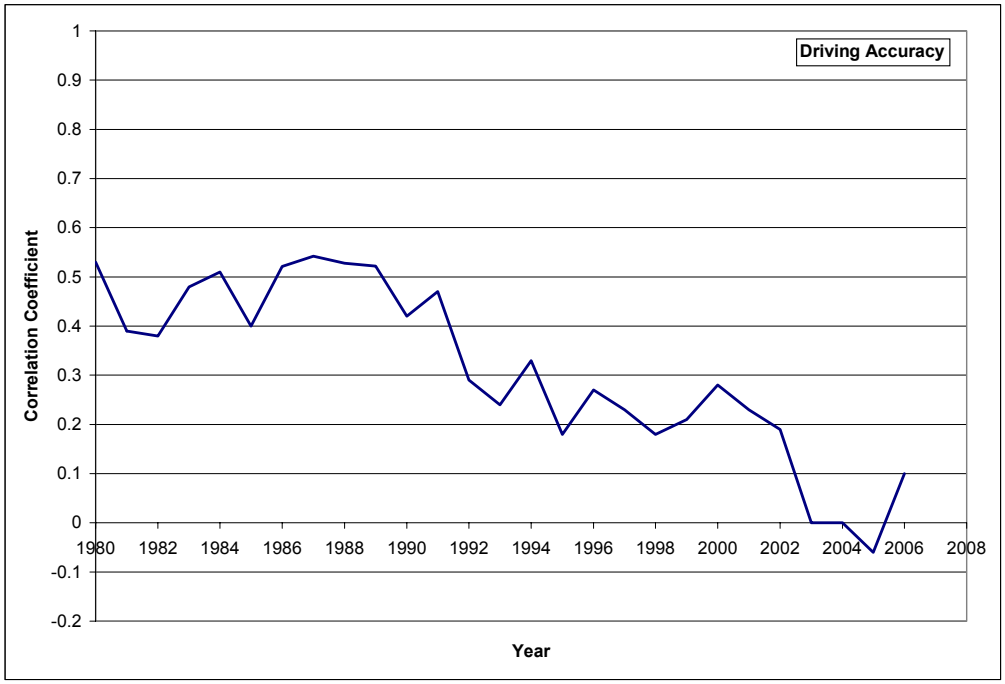

Figure 4: Correlation coefficient between money winning rank and driving accuracy rank on the PGA Tour from 1980 to 2006.

4. Analysis of Rank Correlation

4.1. Greens In Regulation and Putting Average rankings have relatively strong correlations to money won rankings. Over time, GIR has shown more stability because Putting Average correlation coefficient has decreased in the two most recent years and bears further observation to determine if this is an anomaly or an ongoing trend.

4.2 Compared to GIR and Putting Average, Driving Distance ranking has a relatively low correlation to Money ranking. It has remained fairly stable over the period studied.

4.3 Of these key skills, Driving Accuracy has changed the most over the time period studied. The overall standard deviation of the results is higher than the other skills. During the 1980's Driving Accuracy was as nearly as strongly correlated to money ranking as GIR and Putting Average. This changed in 1992 and again in 2003. Rather than a general ongoing decline, two sudden declines followed by stability have resulted in three stable eras at three distinct levels of correlation. (see Fig. 5) These changes are further evaluated in Appendix II. For the current era (2003-06), the level of correlation

between Money ranking and Driving Accuracy rank has nearly reached the lowest level absolute value it can attain.

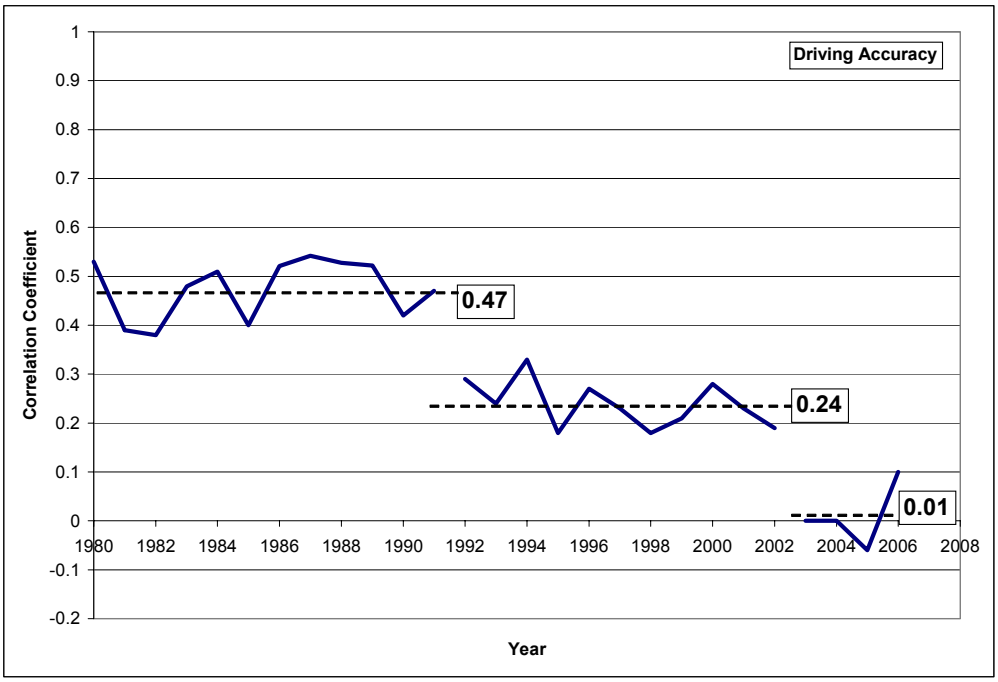

Figure 5: Correlation coefficient of money winning rank to driving accuracy rank on the PGA Tour shown as three separate eras.

5. Top 10 Money Winners Rank Analysis

In addition to the Spearman Rank Correlation Study, the top ten money winners from each year were evaluated for their rankings in the key skills of driving distance, driving accuracy, GIR, and putting average. The average ranking for each skill for the top ten money winners has been calculated. The best ranking players have the lowest numerical rank, so the lower average rank is a superior average rank.

6. Results

The summary of the top ten money winners key skills ranking from 1980-2006 is presented in Table 1. Figures 6 - 10 are the plots of the average ranking for driving distance, driving accuracy, greens in regulation, and putting average for the top ten money winners from each year since 1980. These results are also presented in Appendix III.

	GIR	Putting Avg.	Driving Distance	Driving Accuracy
Mean	**40.5**	**38.9**	**60.6**	**73**
Std. Dev.	**10.8**	**12.4**	**14.2**	**27.5**

Table 2: Average rank of the top 10 money winners 1980-2006 (putting average 1986-2006) - means and standard deviations.

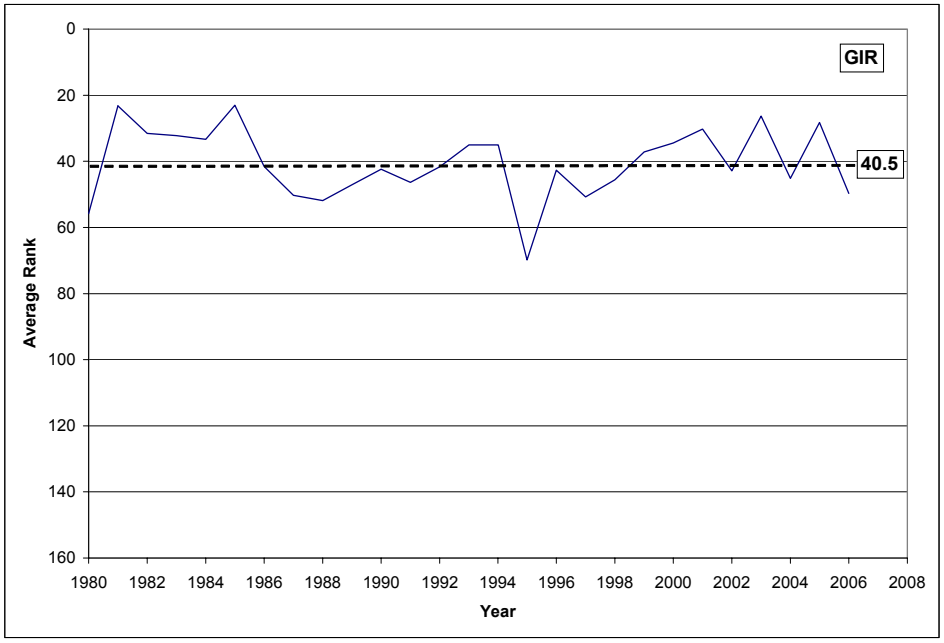

Figure 6: Average GIR rank of top ten money winners including average value 1980-2006.

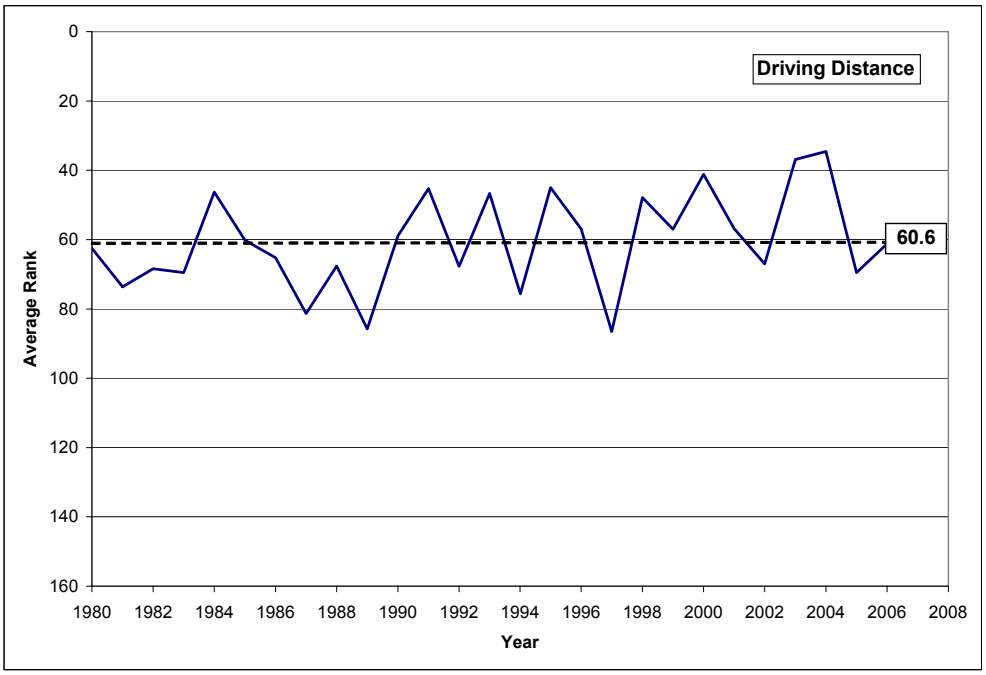

Figure 7: Average driving distance rank of top ten money winners 1980-2006.

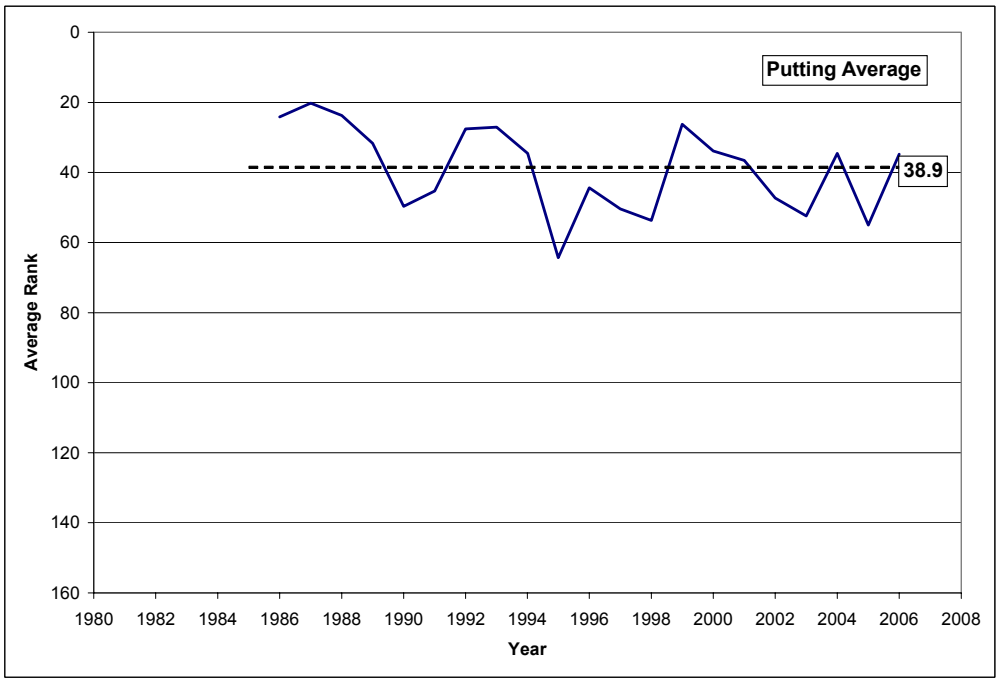

Figure 8: Average putting average rank of top ten money winners 1986-2006.

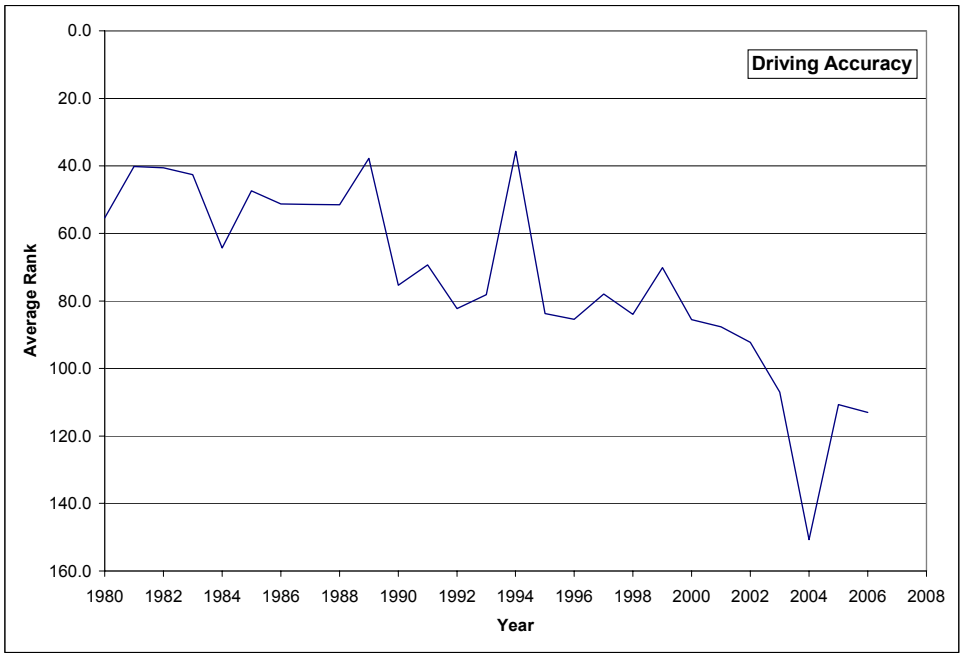

Figure 9: Average driving accuracy rank of top ten money winners 1980-2006.

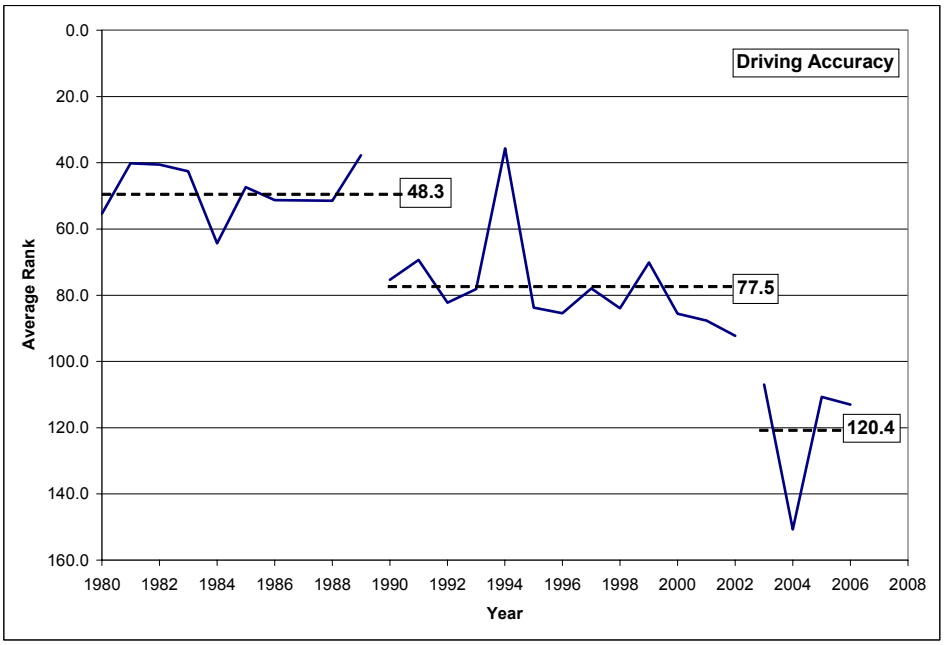

Figure 10: Three eras of average driving accuracy rank of top ten money winners 1980-2006

7. Analysis of Top Ten Rank

7.1 The Putting Average of the top ten money winners has the lowest average rank over the period studied.

7.2 GIR is the most stable of all the skills for average rank of the top ten money winners.

7.3 Driving accuracy has changed the most over the period studied in a similar fashion to the change shown in the Spearman Rank Correlation Study. Three separate, relatively stable eras have occurred with the changes taking place at a similar time that the driving accuracy correlation changed (top ten: 1990 / 2003; correlation: 1992 / 2003). These changes are further evaluated in Appendix IV. The current level (2003-2006) demonstrates a numerically high average ranking that is different from the other skills. This difference from the other skills is similar to the results obtained in the rank correlation studies.

Appendix I

Correlation Annual Coefficient between PGA Tour Money Winning Rank and Skill Rank

	Driving Distance	Accuracy	GIR	Putting Average
1980	0.12	0.53	0.37	
1981	0.12	0.39	0.65	
1982	0.21	0.38	0.59	
1983	0.10	0.48	0.60	
1984	0.12	0.51	0.70	
1985	0.34	0.4	0.61	
1986	0.18	0.52	0.40	0.68
1987	0.16	0.54	0.60	0.64
1988	0.29	0.53	0.57	0.63
1989	0.06	0.52	0.42	0.48
1990	0.12	0.42	0.57	0.57
1991	0.25	0.47	0.61	0.61
1992	0.30	0.29	0.66	0.65
1993	0.36	0.24	0.63	0.64
1994	0.31	0.33	0.59	0.60
1995	0.39	0.18	0.41	0.55
1996	0.24	0.27	0.47	0.62
1997	0.26	0.23	0.62	0.42
1998	0.28	0.18	0.55	0.60
1999	0.20	0.21	0.52	0.63
2000	0.35	0.28	0.58	0.59
2001	0.16	0.23	0.65	0.58
2002	0.10	0.19	0.44	0.60
2003	0.15	0.00	0.45	0.47
2004	0.12	0.00	0.50	0.52
2005	0.25	-0.06	0.44	0.22
2006	0.08	0.10	0.44	0.37

Appendix II

An examination of the data that appear in Figure 5 indicates that the correlation coefficient between accuracy and money earned in 1992 decreases by more than three standard deviations from its mean value over the time period from 1980 to 1991. The coefficient maintains this decrease of more than three standard deviations until 2002. In 2003 the coefficient decreases again by more than three standard deviations from its average value over the period from 1992 to 2002. It continues this same decrease for another 2 years with a smaller decrease in 2006.

This behavior suggests that one can pool the data into three separate time spans: 1980 to 1991, 1992 to 2002, and 2003 to 2006, and test whether the correlation coefficient varies over these three time periods. An ANOVA is applied to the data to test the hypothesis of a uniform value of the correlation coefficient. If the hypothesis is rejected, a Tukey Multiple Comparison Test can be made to determine confidence intervals for the difference associated with each of the correlation coefficients over each time span.

If one lets mu(1), mu(2), and mu(3) be the value of the correlation between money and accuracy over the time intervals 1980 to 1991, 1992 to 2002, and 2003 to 2006, respectively, and tests the null hypothesis that mu(1)=mu(2)=mu(3) against the alternative that some are not equal, one finds from the analysis below that one must reject the null hypothesis. In addition one obtains the following 95% simultaneous confidence intervals for the difference between these mu's:

$$0.17 < mu(1) - mu(2) < 0.30$$
$$0.14 < mu(2) - mu(3) < 0.32;$$

i.e., the decreases are somewhere between 0.17 and 0.30 for the first jump and 0.14 and 0.32 for the second jump simultaneously at the 95% level of confidence.
The MINITAB output of the analysis that leads to the above conclusion appears below.

One-way ANOVA: Correlation between Money and Accuracy versus Time Span

```
Analysis of Variance for Correlation between Money and Accuracy
Source     DF        SS        MS        F        P
Time Span   2   0.73971   0.36985   113.92    0.000
Error      24   0.07792   0.00325
Total      26   0.81763
                                  Individual 95% CIs For Mean
                                  Based on Pooled StDev
Level       N      Mean     StDev  ----+---------+---------+---------+--
mu(1)      12   0.47442   0.06092                                (-*-)
mu(2)      11   0.23909   0.04888                   (-*-)
mu(3)       4   0.01000   0.06633   (---*--)
                                  ----+---------+---------+---------+--
Pooled StDev =  0.05698              0.00      0.16      0.32      0.48

Tukey's pairwise comparisons

Family error rate = 0.05; Individual error rate = 0.02; Critical value = 3.53

0.17595 < mu(1) - mu(2) < 0.29470
0.38230 < mu(1) - mu(3) < 0.54653
0.14605 < mu(2) - mu(3) < 0.31213
```

Appendix III

Average Annual Skill Rank of Top 10 PGA Tour Money Winners

	Driving Distance	Accuracy	GIR	Putting Average
1980	62.5	55.4	55.8	
1981	73.6	40.2	23.2	
1982	68.4	40.6	31.6	
1983	69.5	42.6	32.3	
1984	46.3	64.3	33.4	
1985	60.2	47.4	23.0	
1986	65.2	51.3	41.6	24.1
1987	81.4	51.4	50.3	20.2
1988	67.6	51.5	51.9	23.7
1989	85.8	37.8	47.1	31.7
1990	58.9	75.3	42.4	49.7
1991	45.3	69.3	46.4	45.3
1992	67.7	82.3	41.7	27.6
1993	46.7	78.1	35.1	27.1
1994	75.6	35.7	35.1	34.6
1995	45.0	83.8	69.8	64.3
1996	56.9	85.5	42.7	44.4
1997	86.6	77.9	50.8	50.4
1998	47.9	84.0	45.6	53.7
1999	57.0	70.1	37.2	26.2
2000	41.2	85.6	34.5	33.9
2001	56.8	87.7	30.3	36.6
2002	67.0	92.3	42.9	47.3
2003	36.9	107.0	26.3	52.4
2004	34.6	150.7	45.2	34.6
2005	69.5	110.7	28.3	55.0
2006	61.2	113.0	49.7	34.8

Appendix IV

In an analysis similar to the one that appears in Appendix 1, it is possible to show that the data of the mean driving accuracy rank of the top 10 money winners in Figure 13 can be partitioned into three time spans: 1980 to 1989, 1990 to 2002, and 2003 to 2006.

This behavior suggests that one can pool the data into these three separate time spans, and test whether the mean rank varies over these three periods. An ANOVA is applied to the data to test the hypothesis of a uniform value of the mean rank. If the hypothesis is rejected, a Tukey Multiple Comparison Test can be made to determine confidence intervals for the difference associated with each of the mean ranks over each time span.

If one lets mu(1), mu(2), and mu(3) be the value of the mean rank of the top 10 money winners' driving accuracy over the time intervals 1980 to 1989, 1990 to 2002, and 2003 to 2006, respectively, and tests the null hypothesis that mu(1)=mu(2)=mu(3) against the alternative that some are not equal, one finds from the analysis below that one must reject the null hypothesis. In addition one obtains the following 95% simultaneous confidence intervals for the difference between these mu's:

$$15 < mu(2) - mu(1) < 44$$
$$23 < mu(3) - mu(2) < 62;$$

i.e., the decreases are somewhere between 15 and 44 for the first jump and 23 and 62 for the second jump simultaneously at the 95% level of confidence.

The MINITAB output of the analysis that leads to the above conclusion appears below.

One-way ANOVA: Top 10 Driving Accuracy Rank versus Time Span

```
Analysis of Variance for Top 10 Money Winners' Driving Accuracy Rank
Source     DF        SS        MS        F        P
Time Span   2     15358      7679    43.03    0.000
Error      24      4282       178
Total      26     19640
                                  Individual 95% CIs For Mean
                                  Based on Pooled StDev
Level       N      Mean     StDev  -------+---------+---------+---------
mu(1)      10     48.25      8.19  (--*--)
mu(2)      13     77.51     14.24            (--*-)
mu(3)       4    120.35     20.38                        (---*----)
                                  -------+---------+---------+---------
Pooled StDev =    13.36                 60        90       120

Tukey's pairwise comparisons

Family error rate = 0.0500; Individual error rate = 0.02; Critical value = 3.53

15.23 < mu(2) - mu(1) < 43.28
52.37 < mu(3) - mu(1) < 91.83
23.78 < mu(3) - mu(2) < 61.91
```