Predicting Outcomes: Sports and Stocks

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Many gamblers and most fans, players, and coaches offer causal explanations for long runs of good or bad performance in sports and financial analysts are quick to offer explanations for the daily performance of the stock market. The records of professional basketball and baseball teams and the Dow Jones daily closing average for a ten year period were evaluated for trends (streaks). The records of teams were also evaluated to assess whether the record against opponents, the home court or home field advantage, and—for baseball teams—the record of the winning and losing pitcher (excluding the current game) predicted the outcome of individual games. Recent performance is, at best, a very weak predictor of current performance and the three best predictors for baseball (pitching, home field, and record against opponent) together accounted for only 1.7% of the variance in the outcomes of individual games. We overestimate our ability to predict. This overconfidence is likely to play a role in maintaining gambling behaviors.

Many people believe in a just world as a way to reduce uncertainty (Lerner, 1980), have illusions of control in situations where control is not possible (Frank & Smith, 1989; Langer, 1975), attribute chance outcomes to personal skill (Gilovich, 1983), and demonstrate various biases when evaluating causal theories (Baron & Hershey,

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Thanks are due Janet Besaw, Raymond Frankmann, Neal Schmitt, and Rose Zacks. Robyn Dawes, while not making any specific comments on this manuscript, made a number of useful suggestions.

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Journal of Gambling Studies Vol. 8(2), Summer 1992

1988; Kunda, 1987). Efforts to reduce uncertainty by offering causal explanations for outcomes are common if not universal (Dawes, 1988). Investigators have also examined whether individuals have an accurate concept of randomness.

Wagenaar (1970) produced strings of 50 white and 50 black dots in which the probability of a repetition (white followed by white or black followed by black) was either .2, .3, .4, .5, .6, .7, or .8. Participants were shown slides that contained seven sequences of white and black dots and asked to select the sequence that looked most random, i.e., what they would be likely to obtain by flipping a coin. His participants were generally not able to select the sequence with the .5 probability of repetition. There was a clear bias to select strings with a repetition probability of less than .5 as the random string. Similarly, Gilovich, Vallone, and Tversky (1985) found that sequences selected as the best examples of chance had alternation probabilities of .7 and .8 rather than .5. Thus, more long runs are obtained by chance than most people expect will be obtained by chance. People believe, erroneously, that chance produces the possible outcomes with close to equal probability over the short run (Tversky & Kahneman, 1971; Wagenaar, 1988). Given this bias they are likely to believe that more than chance is operating when a long run is obtained.

The self reports and betting behaviors of gamblers reveal a tendency to use both luck and chance as explanatory concepts. Most gamblers do not realize that long runs are likely to occur in the short run so when a long run occurs players are likely to postulate a causal explanation for the run. Long runs of winning are attributed to good luck and long runs of losing are attributed to bad luck. Luck is viewed as a cause independent of chance (Wagenaar, 1988).

There is a comparable phenomenon in sports. Most fans, players, and coaches do not realize that streaks of good or poor performance are to be expected on the basis of chance alone so when these streaks occur they are "explained." If a basketball player has a streak of good shooting, he or she is said to have a hot hand. The hot hand is a causal explanation for the long string of hits. If the hot hand is a valid account for streak performance in basketball beyond what might be expected given the player's skill level, the probability of making a basket should be greater following a successful attempt than an unsuccessful one. When you're hot you're hot! However, if streak performance does not occur more often than what would be expected on the basis of chance given the player's ability level, then the hot hand would have little value as a predictor. Taking recent performance into account would not increase the accuracy of prediction.

The results of an analysis of the field goal performance of the Philadelphia 76ers for an entire season, the free throw performance of the Boston Celtics for two seasons, and studies with Cornell University basketball players all done by Gilovich et al. (1985) provide no evidence for streak performance. For example, the probability of making a basket is independent of whether the previous 1, 2, or 3 shots were made or missed. Accuracy of prediction is not improved by considering very recent performance.

Yet, most people are unwilling to accept the conclusion that streaks can be explained solely in terms of the player's skill level and chance fluctuations, a probabilistic notion (Dawes, 1988). Most people offer deterministic explanations. For example, gamblers and nongamblers are usually quick to offer explanations for the outcome of athletic contests and for the performance of the stock market. The unwillingness to accept probabilistic explanations (i.e., the unwillingness to attribute outcomes to chance) may be due to a biased concept of chance. If it can be shown that variables that are widely believed to influence outcomes are, at best, only very weak predictors of outcomes, this would support the conclusion that our attributions are biased or that we have inadequate knowledge (Gebotys & Claxton-Oldfield, 1989). The first two studies attempt to extend the work of Gilovich et al. (1985) by assessing "streaks" and other predictors of outcomes for professional basketball and baseball *teams*. The third study considers "streaks" in the performance of the stock market, as assessed by the Dow Jones Industrial Average.

STUDY 1—PROFESSIONAL BASKETBALL

Gamblers believe in luck (Wagenaar, 1988) and most fans, players, and coaches believe in the hot hand as an explanation for the streak performance of individual players (Gilovich et al., 1985). Most also believe in streak performance for teams, perhaps because individual streak performance is likely to influence team performance. Support for this claim was obtained by asking students to evaluate the statement that, "The probability of a team winning a game is unrelated to the team's performance for the previous game." Of the 103 students who responded, 1 strongly agreed, 11 agreed, 5 were indifferent, 71 disagreed, and 15 strongly disagreed. Although some students may have interpreted the statement as something other than an assertion about streak effects, the results suggest that most people believe in streak performance for teams.

There are plausible causal explanations for the streak performance of teams. Streak performance for teams might be expected as a result of the home court advantage, health of key players, confidence of the team, coaching, and teamwork. It is well known, for example, that professional basketball teams have a much better record for their home games than their away games. All teams in the National Basketball Association (NBA) have much better records for home games than for away games for playoff games. To illustrate, the all-time, playoff, home-versus-away records (home record given first) for the Lakers (.758 vs. .435), Celtics (.747 vs. .434), 76ers (.691 vs. .392), Pistons (.667 vs. .337), and Knicks (.686 vs. .320) reveal a clear home court advantage (Sachare & Sloan, 1989). Given the strong home court advantage and the fact that during the regular season teams typically take at least some long road trips, it is reasonable to expect that the home court advantage might help to produce streaks of wins (home team) or losses (visiting team).

Procedure

Given numerous explanations for the streak performance of teams, three analyses were made to determine whether recent performance can be used to increase the accuracy of prediction. If recent performance is not significantly related to current performance, then there is little need to offer causal explanations for "streak." Streaks are to be expected given a random model.

The 1988–89 regular season records of the 25 teams in the NBA were obtained from *The Sporting News Official 1989–90 NBA Guide* (Sachare & Sloan, 1989). For the first analysis the regular season record for each team was analyzed to assess whether the probability of winning a game was related to success or failure in the previous game. That is, performance in Game n + 1 was considered relative to performance in Game n. There are, of course, only four possibilities: win-win, win-loss, loss-win, loss-loss. A total of 81 games was considered for each team as 82 games were played in the regular season. Once performance in Game n + 1 was determined relative to performance in Game n, the relevant conditional probabilities can be computed. The critical comparison is between the probability of a win for game n + 1, given a win the previous game $P(W|W)$, and the probability of a win for game n + 1, given a loss for the previous game $P(W|L)$. If teams have streaks that are longer than what should be expected given their probability of winning, we should expect that the $P(W|W) > P(W|L)$.

For the second analysis the Wald-Wolfowitz Runs Test was performed using the pattern of wins and losses for each team for the same 81 games considered in the previous analysis. A run is defined as a succession of symbols that is followed or preceded by different symbols. A team with many long streaks will have few runs; a team with many alternations of wins and losses will have many runs. The Wald-Wolfowitz Runs Test examines the distribution of steaks of various lengths, as reflected by the number of runs, and compares it to the distribution expected if successive outcomes are independent.

The third analysis was more elaborate in that an effort was made to assess the effect of three variables on the outcome of individual games. The variables of interest were the outcome of the previous game, the record against the opponent for the entire season excluding the current game, and the home court advantage. It is well known that the home court advantage influences the outcomes of basketball games, but it is not known how much variance in individual game outcomes is accounted for by this variable. Similarly, the record against the opponent excluding the current game, might be expected to predict the outcome of individual games, but it is unclear how much variance in individual game outcomes is accounted for by this variable. By examining these variables in the same study it is possible to compare their relative strengths in predicting the outcome of individual games.

The third analysis also included 81 games for each team as the first game could not be considered. For each team the outcome of each game, starting with the second game played, was coded 1 for a win and 0 for a loss. The outcome of the previous game was also coded 1 for a win and 0 for a loss. The record for the team was computed separately for each game by determining the percentage of wins against the opponent for the entire season *excluding* the current game. The home court variable was coded as a 1 if the team being consider was the host team and a 0 if the team being considered was the visiting team. The total number of games considered was 2,025 (i.e., 25 NBA teams and 81 games each).

Results and Discussion

The results of the conditional-probability analysis and the Wald-Wolfowitz Runs Test for all the NBA teams for the 1988–89 season are presented in Table 1. The conditional probability analysis provides no overall support for the presence of streak performance beyond chance levels as the P(W|W) was virtually identical to the P(W|L). A few teams (Denver, Golden State, Washington, Dallas, Indiana, Miami) had a pattern of wins and losses that suggested the presence of streak effects greater than chance, but the performance of these teams was balanced by other teams (Detroit, Cleveland, Utah, Milwaukee, New Jersey, Charlotte) having a P(W|L) considerably greater than the P(W|W). Similarly, the results of the Wald-Wolfowitz Runs Test reveals little support for the presence of streak effects. With the exception of the Indiana Pacers ($\underline{Z} = -2.386$, $\underline{p} = .017$) the number of runs obtained was not different than what should be expected given a random model (i.e., independence between successive outcomes). Thus, both analyses suggest that present performance is independent of recent performance.

For the third analysis the important consideration is whether the outcome of the previous game, the record against the opponent excluding the current game, and the home court advantage are effective predictors of the outcome of individual games. The Pearson Product Moment Correlations between these predictors and the outcome of individual games are presented in Table 2.

An examination of Table 2 reveals a clear relationship between the home court variable and the outcome of individual games. This correlation was positive for all teams and ranged from a low of .122 for the Charlotte Hornets to a high of .632 for the Denver Nuggets. However, the other two variables (previous game and team record) show, at best, only a weak relationship to the outcome of individual games. Even though the overall correlations for these variables were slightly positive (see Table 2), they are not good predictors for the outcome of individual games.

TABLE 1
The Probability of a Win, the Conditional Probabilities of a Win, and the Wald-Wolfowitz Runs Test for the 25 NBA Teams for the 1988-89 Season

Team	*P[Win]*	*P[Win|W]*	*P[Win|L]*	*Runs*	*Z-Score*
Detroit Pistons	.765	.742	.842	33	.912
Los Angeles Lakers	.691	.679	.720	31	-1.199
Cleveland Cavaliers	.691	.661	.760	39	.901
Phoenix Suns	.679	.667	.704	36	- .079
New York Knicks	.642	.647	.633	38	- .057
Atlanta Hawks	.630	.635	.621	38	- .187
Utah Jazz	.630	.580	.710	43	1.013
Milwaukee Bucks	.593	.531	.688	45	1.133
Chicago Bulls	.580	.574	.588	40	- .105
Seattle Supersonics	.568	.596	.529	38	- .627
Houston Rockets	.556	.578	.528	39	- .453
Philadelphia 76ers	.543	.533	.556	44	.631
Denver Nuggets	.531	.568	.487	37	- .976
Golden State Warriors	.518	.581	.447	35	-1.443
Washington Bullets	.506	.525	.488	39	- 558
Boston Celtics	.506	.463	.555	44	.561
Portland Trail Blazers	.469	.500	.442	39	- .527
Dallas Mavericks	.469	.540	.409	43	.371
Indiana Pacers	.346	.518	.259	28	-2.386
Sacramento Kings	.333	.296	.352	39	.504
New Jersey Nets	.321	.192	.382	42	1.463
Los Angeles Clippers	.259	.333	.233	28	-1.201
San Antonia Spurs	.247	.286	.233	29	- .641
Charlotte Hornets	.247	.100	.295	37	1.775
Miami Heat	.185	.286	.164	22	-1.287
Mean	.500	.504	.505		

The outcome of a step-wise multiple regression in which the alpha-to-enter was .05 and the alpha-to-remove was .05 is also presented in Table 2. The outcome of each game was the dependent variable and the outcome of the previous game, team record, and the home court variable were the predictors. The letter a immediately following the correlation coefficient in Table 2 means that the step-wise

TABLE 2
The Pearson Correlations Between the Outcome of each Game and the Outcome of the Previous Game, the Record against the Opponent, and the Home Court Advantage for the 25 NBA Teams for the 1988-89 Season

Team	*Previous*	*Record*	*Home*
Detroit Pistons	−.100	.316a	.327a
Los Angeles Lakers	−.082	−.109	.372a
Cleveland Cavaliers	−.099	.068a	.463a
Phoenix Suns	−.037	−.106	.379a
New York Knicks	.014	−.134	.447a
Atlanta Hawks	.014	−.220	.367a
Utah Jazz	−.131a	−.195	.451a
Milwaukee Bucks	−.156	.195a	.337a
Chicago Bulls	−.014	.355a	.261a
Seattle Supersonics	.066	−.053	.385a
Houston Rockets	.050	.068a	.409a
Philadelphia 76ers	−.045	−.099	.360a
Denver Nuggets	.082	−.275	.632a
Golden State Warriors	.134	−.107	.359a
Washington Bullets	.062	.131a	.506a
Boston Celtics	−.087	.035a	.531a
Portland Trail Blazers	.082	.264a	.384a
Dallas Mavericks	.131	.101	.259a
Indiana Pacers	.257a	−.163	.321a
Sacramento Kings	−.093	−.047	.419a
New Jersey Nets	−.190	−.050	.184a
Los Angeles Clippers	.100	−.184	.359a
San Antonio Spurs	.053	−.091	.408a
Charlotte Hornets	−.195	.158	.122
Miami Heat	.118	.025	.292a
Overall	.100	.133	.358

a = significant step-wise multiple regression with alpha = .05

multiple regression for that predictor was significant. Home court is the only variable with a consistent, significant relationship to the outcome of individual games.

A similar step-wise multiple regression analysis was performed for all teams combined (i.e., for all 2025 games) with the alpha to enter and alpha to remove equal to .01. This analysis yielded an R of .358 for the home variable for the first step. This increased to .420 with the addition of the record predictor in the second step and to .426 (18.2% of the variance) with the addition of the outcome of the previous game as a predictor in the third step. The home court predictor accounts for considerably more variance than the other predictors. A regression analysis using the outcome of the previous game as the only predictor, accounts for 1% of the variance in the outcome of individual games.

The results of the previous work by Gilovich et al. (1985) and the results reported in Tables 1 and 2 indicate that a consideration of recent performance is not a useful way to increase the accuracy of prediction. Knowing the outcome of Game n provides, at best, only a slight increase in the predictability of Game n + 1.

Given the strong influence of the home court advantage it is reasonable to expect stronger evidence for streaks. Teams should be more likely to win at home and lose on the road. However, in order for the home court advantage to "produce" streaks it is necessary for teams to play consecutive games at home or away from home. Wald-Wolfowitz Runs Tests were performed on each team's schedule to assess whether the schedule contained "streaks" of home games and away games. Although 16 of the 25 teams had negative Z-scores—a tendency towards consecutive home games or away games—the Wald-Wolfowitz Runs Test was significant for only two teams. The Los Angeles Lakers had fewer runs that expected on the basis of chance ($Z = -2.339$, $p = .019$); the Detroit Pistons had more runs than expected by chance ($Z = 2.126$, $p = .033$). Thus, the home court advantage may not have produced streak because teams did not play enough consecutive games at home or on the road.

The failure to find clear evidence for streak performance for teams is limited to basketball. A second study was conducted to evaluate the regular season records of professional baseball teams in order to test the generality of the above findings and to assess the value of other variables for predicting the outcome of individual games. Given that most people consider pitching to be an extremely important variable determining the outcome of baseball games, the records of the winning and losing pitcher were added as predictors.

STUDY 2—PROFESSIONAL BASEBALL

Streak effects may be obtained in baseball even though there is little evidence for these effects in basketball. Baseball teams typically have better home records than away records (see Tables 3 and 4) and baseball teams typically play the same opponent for three or four games before moving on to new opponents. Thus, if two teams are mismatched in terms of talent, it is reasonable to expect more long runs of wins and losses in baseball than in basketball. A professional basketball team rarely plays the same opponent in consecutive games during the regular season.

The effect of five variables on the outcome of individual games was assessed. The variables evaluated were the outcome of the previous game, the record against the opponent excluding the current game, the home field advantage, the record of the winning pitcher (excluding the current game), and the record of the losing pitcher (excluding the current game). Given that these variables are widely believed to influence outcomes, an assessment of their relative strength should be of interest.

Procedure

The 1988 regular season records of the 14 teams in the American League and the 12 teams in the National League were obtained from *The Sporting News Official Baseball Guide* (Sloan & Zesch, 1989). The regular season record for each team was analyzed to assess whether the probability of winning a game was related to success or failure in the previous game. That is, performance in Game n + 1 was considered relative to performance in Game n. There was a maximum of 161 games to consider for each team because each team played at most 162 games and the analysis began with the second game played. The critical comparison is between the $P(W|W)$ and the $P(W|L)$. If teams have streaks that are greater than what should be expected given their probability of winning, we should expect the $P(W|W)$ to be greater than the $P(W|L)$.

For the second analysis the Wald-Wolfowitz Runs Test was performed using the pattern of wins and losses for each team for the same 161 games considered in the first analysis. This test examines the distribution of streaks of various lengths, as reflected by the number of runs, and compares it to the distribution expected if successive outcomes are independent. The Wald-Wolfowitz Runs Test was also performed on the home field variable to assess whether the schedule was conducive to obtaining streak effects through a home field advantage.

For the third analysis the outcome of each game, beginning with the second game, was coded 1 for a win and 0 for a loss, and the outcome of the previous game was also coded 1 for a win and 0 for a loss. The record for the team was calculated by determining the percentage of wins against the current opponent for the entire season *excluding* the current game. The home field variable was coded as a 1 if the team being considered was the host team and a 0 if the team being considered was the visiting team. The records for the pitchers of record were calculated by determining their winning percentage for the *entire* regular season excluding the current game.

Results and Discussion

The results of the conditional probability analysis and the Wald-Wolfowitz Runs Test for all the American League teams for the 1988 season are presented in Table 3 and the results for the National League teams are presented in Table 4. An examination of the results indicates

TABLE 3
The Probability of a Win, the Conditional Probabilities of a Win, and the Wald-Wolfowitz Runs Test for the 14 American League Teams for the 1988 Season

Team	*P[Win]*	*P[Win|W]*	*P[Win|L]*	*P[W|H]*	*P[W|A]*	*Runs*	*Z-Score*
Oakland	.634	.651	.600	.667	.617	69	– 1.066
Minnesota	.565	.600	.521	.580	.543	74	– .986
Boston	.553	.539	.569	.654	.444	82	.223
Detroit	.540	.506	.581	.617	.469	88	1.092
Milwaukee	.534	.598	.459	.580	.494	70	– 1.767
Toronto	.534	.581	.480	.556	.519	73	– 1.291
New York	.525	.518	.533	.575	.481	86	.827
Kansas City	.519	.536	.500	.550	.494	79	– .286
Cleveland	.484	.532	.440	.543	.420	73	– 1.333
California	.466	.520	.419	.432	.494	72	– 1.450
Chicago	.438	.357	.500	.494	.388	86	1.007
Texas	.431	.348	.495	.469	.400	91	1.861
Seattle	.412	.348	.462	.457	.388	91	1.915
Baltimore	.338	.296	.358	.425	.247	77	.790
Mean	.498	.495	.494	.543	.457		

Note: P[W|Home] and P[W|Away] are from Sloan & Zesch page 161.

no overall support for the presence of streak performance beyond chance levels. The P(W|W) was either identical or virtually identical to the P(W|L). Four teams in the American League (Milwaukee, Toronto, Cleveland, California) had a pattern of wins and losses that suggested the presence of streak effects greater than chance, but the performance of these teams was balanced by other teams (Chicago, Texas, Seattle) having a P(W|L) considerably greater than the P(W|W). Only one team in the National League (New York Mets) had a pattern of wins and losses that suggested the presence of streak effects greater than chance, but the performance of this team was balanced by two other teams (Cincinnati Reds, Chicago Cubs) having a P(W|L) considerably greater than the P(W|W). Thus, the conditional probability analyses are consistent with what should be expected if current performance is unrelated to recent performance.

The results for the Wald-Wolfowitz Runs Test also failed to provide any evidence for significant streak effects. No team had fewer runs than what would be expected given independence between successive outcomes. The Wald-Wolfowitz Runs Test was significant for the Cincinnati Reds ($Z = 2.624$, $\underline{p} = .009$), but this result is in the wrong

TABLE 4
The Probability of a Win, the Conditional Probabilities of a Win, and the Wald-Wolfowitz Runs Test for the 12 National League Teams for the 1988 Season

Team	*P[Win]*	*P[Win|W]*	*P[Win|L]*	*P[W|H]*	*P[W|A]*	*Runs*	*Z-Score*
New York	.598	.657	.508	.700	.550	74	- .291
Los Angeles	.588	.585	.591	.556	.613	78	- .090
Cincinnati	.538	.442	.649	.563	.519	97	2.624
Pittsburgh	.528	.541	.514	.531	.532	77	- .518
San Diego	.516	.512	.519	.580	.450	89	1.289
San Francisco	.509	.512	.506	.556	.469	78	- .542
Montreal	.503	.525	.482	.531	.469	77	- .711
Houston	.503	.524	.481	.543	.469	84	.396
Chicago	.475	.427	.518	.481	.469	89	1.230
St. Louis	.472	.474	.471	.506	.432	81	- .039
Philadelphia	.406	.431	.389	.475	.333	74	- .689
Atlanta	.333	.333	.333	.354	.321	73	.121
Mean	.497	.497	.497	.531	.469		

Note: P[W|Home] and P[W|Away] are from Sloan & Zesch page 75.

direction (i.e., more alternations than one might expect given a random model).

For the third analysis the important consideration is whether the home field advantage, the record against the opponent excluding the current game, the outcome of the previous game, and the records of the pitchers are effective predictors of the outcome of individual games. The Pearson Product Moment Correlations between these predictors and the outcome of individual games are presented in Tables 5 and 6.

An examination of the tables reveals only low correlations between each of the predictor variables and the outcome of individual games. If all 4,170 games (i.e., both leagues) are considered, the highest correlation obtained is .08 for the record of the team's pitcher, indicating that none of the variables is an effective predictor of the outcome of

TABLE 5

The Pearson Correlations Between the Outcome of each Game and the Outcome of the Previous Game, the Team's Record against the Opponent, the Home Court Advantage, the Pitcher's Winning Percentage, and the Opposing Pitcher's Winning Percentage for the 14 American League Teams for the 1988 Season

Team	*Previous*	*Record*	*Home*	*Pitcher*	*Opp. Pitcher*
Oakland	.084	-.180a	.047	-.222a	.089
Minnesota	.079	.119	.031	.192a	-.188a
Boston	-.030	.119	.219a	.088	-.019
Detroit	-.087	.158a	.168a	.046	.033
Milwaukee	.138	.123	.093	.012	-.098
Toronto	.101	-.024	.043	.073	-.007
New York	-.016	-.059	.088	-.388a	-.068
Kansas City	.048	.118	.063	.156a	-.037
Cleveland	.092	-.001	.118	.121	-.189a
California	.101	.005	-.068	-.086	-.149
Chicago	-.143	.065	.101	-.011	-.051
Texas	-.147	-.350a	.063	-.298a	.082
Seattle	-.151	-.173a	.065	-.185a	-.051
Baltimore	-.062	-.009	.194a	.116	-.096
Overall	.022	.082	.086	.064	.003

a = significant step-wise multiple regression with alpha = .05

TABLE 6
The Pearson Correlations Between the Outcome of each Game and the Outcome of the Previous Game, the Team's Record against the Opponent, the Home Court Advantage, the Pitcher's Winning Percentage, and the Opposing Pitcher's Winning Percentage for the 12 National League Teams for the 1988 Season

Team	*Previous*	*Record*	*Home*	*Pitcher*	*Opp. Pitcher*
New York	.090	.027	.161a	.114	.038
Los Angeles	-.006	.264a	-.051	.046	-.202
Cincinnati	-.207a	-.036	.039	.143	-.205a
Pittsburgh	.028	-.070	.005	.000	-.018
San Diego	-.013	-.091	.125	.124	-.084
San Francisco	.006	.021	.081	-.033	-.033
Montreal	.044	-.013	.068	.234a	-.036
Houston	.043	-.026	.068	.189a	-.154
Chicago	-.097	-.176a	.019	-.152a	-.110
St. Louis	.003	.101	.069	.001	-.074
Philadelphia	.041	.017	.150a	-.308a	-.145
Atlanta	-.010	-.247a	.031	.033	-.098
Overall	.014	.073	.063	.097	-.094

a = significant step-wise multiple regression with alpha = .05

individual games. The results of two step-wise multiple regression analysis by teams—essentially identical to the one performed for basketball—are presented in Tables 5 and 6. The outcome of each game was the dependent variable and the outcome of the previous game, team record, the home court variable, and the pitchers' records were the predictors. The letter a immediately following the correlation coefficient in Tables 5 and 6 means that the step-wise multiple regression for that predictor was significant. An examination of the tables reveals that although the record of the team's pitcher, the home field advantage, and the team's record were significant predictors in a number of instances, no variable consistently predicted the outcome of individual games.

A similar step-wise multiple regression analysis was performed for all teams combined (i.e., for all 4,170 games) with the alpha to enter and to remove equal to .05. This analysis yielded an R of .080 for the pitching variable for the first step. This increased to .111 with the addition of the home field predictor in the second step and to .129 (1.7% of the variance) with the addition of the team's record as a predictor in the third step. The outcome of the previous game did not account for a significant amount of the variance in the outcome of individual games.

The Wald-Wolfowitz Runs Test on the home field variable revealed that all but three teams (New York Mets, San Diego, New York Yankees) had fewer runs than would be expected on the basis of chance ($p < .001$). Thus, baseball schedules are generally favorable for producing strings of wins or losses *if* there is a home field effect. Given that there is a home field effect for most of the teams when the entire season is considered, it is surprising that the two effects, in combination, did not produce streak performance beyond what might be anticipated on the basis of chance. It may be important, as Abelson (1985) has indicated, to distinguish between the effect a variable has for individual games and the cumulative effect obtained by considering the entire season.

There is an unwillingness to accept the present evidence supporting the conclusion that recent team performance is not a useful predictor of current team performance. For example, one reviewer indicated that he would analyze the baseball and basketball data very differently. He would arbitrarily pick a point somewhere in the season, say after 60 games. He would then take the first games (say the first 50) as a measure of team ability and the last 10 games as their "streak." A regression analysis could then be performed in which the outcome of the 61st game would be predicted by using the record on the first 50 games and the record on the last 10 (i.e., the "streak"). The record for the first 50 games would be entered first. If we can assume that performance on the first 50 games provides a good measure of ability, the analysis should allow us to assess whether the presence or absence of a streak (i.e., the relative size from 0–10) predicts performance on the 61st game.

The proposed analysis would only consider one game per team so it was modified to obtain more data for the regression analysis. This was done by using 14 games for each baseball team and 7 games for each basketball team. For the baseball teams, the outcome of the 22nd game of the season and every 10th game thereafter (i.e., 32, 42, 52) was considered up to and including the 152 game. For basketball teams, the outcome of the 22nd game of the season and every 10th game thereafter (i.e., 32, 42, 52) was considered up to and including the 82 game. Thus a total of 539 games were considered. A win was coded as 1 and a loss was coded as 0. Performance on the previous 10 games was determined to obtain a measure of recent performance. Performance on all the previous games except the most recent 10 games and the first game of the season was used to assess the team's record.

A Pearson Product Moment Correlation between the outcome of individual games and recent performance for both sports was .003. The correlation between outcome and team record was .129. The correlation between recent performance and team record was .414. The multiple regression analysis in which team record and recent performance were used to predict the outcomes—with team record entered first—yielded no support for the importance of recent performance. Team record accounted for only 1.7% of the variance in outcomes. If only basketball games are considered, the correlation between outcome and recent performance is .178 and the correlation between outcome and record is .236. If only baseball games are consider, the correlation between outcome and recent performance is -.104 and the correlation between outcome and record is .051. Thus, this analysis is consistent with the previous results reported in that recent performance was not a useful predictor of current performance. For the next analysis we turn from sports to the stock market.

STUDY 3—THE STOCK MARKET

In the arena of investing, outcomes are rarely if ever attributed to random fluctuations; they have to be explained. The numerous explanations offered for the daily performance of the stock market are curious in that a number of analyses support the conclusion that stock prices are generally consistent with random walk models (Andreassen, 1987; Fama, 1965a, 1965b; Malkiel, 1990; Osborne, 1959, 1962). Investigators have found that little correlation exists in successive price changes, the number of runs is not less than what might be expected given a random walk model, and that simulated models of investment strategies do not produce more profits than what is obtained through random selection (Levy, 1968; Malkiel, 1990). Perhaps, the biased perception of randomness that most people have may account for the fact that many see patterns in stock prices when most economists believe there is only randomness (Malkiel, 1990).

On the other hand, there are many technical analysts and at least some behavioral economists who believe that random walk models do not account for the performance of the stock market. Schachter, Hood, Andreassen, and Gerin (1986) accept Fama's (1965a) conclusion concerning the random nature of the stock market for the period from October 1, 1957 to September 28, 1962, but they have a sharply different view, based on their own analyses, for the period between 1966 and 1979. After considering the serial correlations and deviations from the expected numbers of runs for a variety of broad indices, Schachter et al. (1986) conclude that from February of 1966 until the end of 1979, the stock market is not adequately described as a random walk. The investigators suggest that the bullish nature of the stock market between 1957 and 1966 may have led investors to be largely immune to situational factors (i.e., many adopted a buy-and-hold strategy) that produced trends in the market for the period from 1966 to the end of 1979. Given the lack of agreement concerning the appropriateness of a random walk model for the stock market, additional analyses are warranted.

If additional analyses support a random walk model for the stock market even though many technical analysts and others believe there are clear market trends, the results will be consistent with the view that many have a preference for deterministic over probabilistic explanations. The preference for deterministic explanations may be due, at least in part, to an inaccurate conception of randomness. The two phenomena (stock market, athletic contests) are believed to be more probabilistic than most people are willing to admit. In order to obtain support for this position and to stress the similar probabilistic nature of sports and the stock market, the analyses used for sports were used to analyze the performance of the stock market for the decade of the 80s. Analyzing the market by using runs tests and multiple regression techniques is not new, but the conditional probability analyses probably are.

Procedure

The current analyses for stocks were designed to be comparable to the conditional-probability, Wald-Wolfowitz Runs Tests, and multiple regression analyses for sports. The daily closing of the Dow Jones Industrial Average for the ten years beginning January 1, 1980 through the last market day in December of 1989 was obtained from the Standard and Poor's *Daily price record* for these years. The conditional probability analysis and Wald-Wolfowitz Runs Tests were virtually identical to the ones performed for the sports teams except that the comparison of interest was between successive closings of the Dow Jones Industrial Average. An increase in the Dow Jones closing average from Day n to Day n + 1 was labeled a win or up-day for Day n + 1. A decrease was labeled a loss or down-day for Day n + 1. After the closing average was labeled for each market day for the ten year period, successive days were compared to determine whether the P(U|U) was greater than P(U|D). That is, performance on market Day n + 1 was always considered relative to performance on market Day n. There was a total of 250 to 252 market days to consider each year depending on the number of market days in the year and ties. If the closing average was identical on successive days, the second day was ignored in conducting the analysis. The previous year's closing on the Dow was always used to determine whether the first market day of each year was an up-day or a down-day. The second market day of each year was the beginning point for the conditional probability analyses. A multiple regression analysis was also performed to assess whether there was any relation between performance on successive market days.

Results

The Dow closed at 838.74 on the last trading day of 1979 and at 2753.20 on the last trading day of 1989 so there was a clear upward trend over the ten year period. The question is whether there were clear market trends beyond what would be anticipated given chance fluctuations and the overall upward bias. The results of the analyses for the ten years is presented in Table 7. An examination of the results indicates no overall support for the presence of streak performance beyond chance levels. The P(U|U) was virtually identical to the P(U|D). The P(U|U) was slightly greater than the P(U|D) in 1989, 1987, 1984, 1982, and 1981, but the reverse was true for the other five years. The Wald-Wolfowitz Runs Tests also failed to provide any evidence for significant streak effects. The correlation obtained by using the previous market day as a predictor of current performance was -.001. Thus, there is no evidence for the presence of streak effects greater than chance.

TABLE 7
The Probability of an Up-Day on the Dow Jones Industrial Average, the conditional probability of an Up-Day, the yearly change in the Dow, and the Wald-Wolfowitz Runs Test for the Years 1980-89

Year	*P[Up]*	*P[Up|Up]*	*P[Up|Dn]*	*Yr. Close*	*Change*	*Runs*	*Z-Score*
1989	.548	.551	.544	2753	585	122	- .461
1988	.523	.478	.576	2168	230	138	1.369
1987	.562	.585	.532	1938	43	118	- .894
1986	.542	.515	.574	1895	348	134	1.013
1985	.536	.522	.552	1547	336	129	.391
1984	.454	.469	.442	1211	- 48	120	- .746
1983	.540	.537	.543	1259	212	128	.154
1982	.466	.479	.455	1047	172	128	.208
1981	.460	.474	.448	875	- 89	123	- .480
1980	.560	.543	.580	964	125	132	.757
Mean	.519	.515	.525	1566	191		

GENERAL DISCUSSION

Despite the presence of a strong upward trend in the stock market over the ten year period of the 1980s, substantial differences in the success rate of the various professional teams considered, and a strong home court or home field effect, there was no evidence for trends in performance beyond what would be predicted by a random model. The numerous explanations offered for the performance of the market and professional teams do not appear to perpetuate trends, at least as measured in the present study. Individuals who look for streaks and who are selective in terms of the data examined, could certainly find patterns in the results reported that reinforce a belief in streak effects. This would be easy to do because a long run of hits or misses is salient and, given a biased view of randomness, likely to be judged as an unusual outcome that needs to be explained. However, when all the results are considered, there is no support for trends beyond what might be anticipated on the basis of chance.

With the exception of the home court advantage for basketball, the present study failed to find consistently strong predictors of the outcome of individual professional baseball or basketball games. Given that the three best predictors for baseball (pitching, home field, and record against the opponent) together accounted for only 1.7% of the variance in the outcomes of individual games, there is good reason to question the use of these variables as explanations for the outcomes of individual games. The present results bear considerable similarity to Abelson's (1985) finding that skill differences in batting among baseball players account for less than 1% of the variance for a single time at bat (i.e., getting a hit versus not getting a hit). Yet, skill differentials are still very important because their effects cumulate during the season. Small differences for individual times at bat become much more meaningful when cumulated over the entire season.

The psychological claim of the present study is that we should be cautious about offering explanations for the outcomes of individual sporting events or for the daily performance of the stock market because it is difficult to find independent variables that accurately predict individual outcomes. Although team streaks only minimally exist, most people believe that recent performance and current performance are dependent. This misconception is believed to influence the way individuals interpret events in that deterministic explanations are likely to be preferred when probabilistic accounts are probably more appropriate. The present study does not directly tie the erroneous beliefs of individuals to the misconception of stock market and athletic team performance, but the results are consistent with this interpretation.

The implications for gambling behaviors are straightforward. If most people have an inaccurate conception of randomness that results in their offering causal explanations for outcomes that can be accounted for with a random model, then we should not be surprised to find that gamblers also offer causal explanations for events that are more appropriately attributed to chance, as has been noted by a number of investigators (King, 1990; Wagenaar, 1988). The present findings support the conclusion offered by a number of theorists (e.g., Corney & Cummings, 1985; Shaffer & Gambino, 1989; Wagenaar, 1988) that cognitive biases play an important role in gambling. The present findings are also consistent with Dawes' view that we have a bias to offer causal explanations for outcomes that can be accounted for with a random model. We prefer deterministic to probabilistic explanations even though in a number of circumstances (e.g., many gambling situations) we would be better served by acknowledging uncertainty and modifying our attributions and strategies accordingly. An unwillingness to do so is probably due, at least in part, to an inaccurate conception of randomness.

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