Market Efficiency and Profitable Wagering in the National Hockey League: Can Bettors Score on Longshots?

Author(s): Linda M. Woodland and Bill M. Woodland

Source: *Southern Economic Journal*, Apr., 2001, Vol. 67, No. 4 (Apr., 2001), pp. 983-995

Published by: Southern Economic Association

Stable URL: https://www.jstor.org/stable/1061582

Southern Economic Journal 2001, 67(4), 983–995

Market Efficiency and Profitable Wagering in the National Hockey League: Can Bettors Score on Longshots?

Linda M. Woodland* and Bill M. Woodland†

Sports betting and racetrack markets continue to provide researchers with opportunities to test the efficient market hypothesis. This paper investigates the efficiency of a relatively new sports betting market, the National Hockey League, for 1990–1996. The market is found to be somewhat inefficient and simple wagering strategies are identified that result in profitable returns. Consistent with previous research for football and baseball, bettors in hockey are inclined to overbet favorites relative to their observed chance of winning. Interestingly, the market does not appear to be converging to efficiency.

1. Introduction

Considerable research in economics and finance has been devoted to the investigation of the efficient markets hypothesis. The fundamental question is whether prices fully reflect available information. If not, then in financial markets, it would be possible for an investor to devise a strategy that would earn above-average returns. Several authors have turned to racetrack and sports betting markets to address these issues. These markets are appealing in that they are simplified versions of the more traditional financial markets. They have a large number of bettors (investors), and extensive information sets are publicly available. Thaler and Ziemba (1988) maintain that betting markets are actually superior to the stock market in tests of market efficiency because each wager has a specific termination point: Wagers are settled when the race or game is completed. In contrast, stocks are infinitely lived.

Generally, researchers investigate two different degrees of inefficiency. If the market is perfectly efficient, then all betting strategies should yield an expected loss equal to the commission for that market. If not, then the existence of profitable wagering strategies is examined. Of the four major professional sports, only the National Hockey League (NHL) remains unexplored. This paper addresses the question of market efficiency in this new market.

Although the racetrack market has received the majority of attention, professional sports betting markets have been gaining ground in recent years. For an extensive review of the racetrack literature, see Sauer (1998). We believe that more consideration should be given to sports betting markets, as they more closely resemble financial markets. For example, racetrack

---

* Department of Accounting, 406 Owen Building, College of Business, Eastern Michigan University, Ypsilanti, MI 48197, USA; E-mail linda.woodland@emich.edu; corresponding author.

† Professor of Economics, 7th Floor, Pray Harrold Building, Eastern Michigan University, Ypsilanti, MI 48197, USA; E-mail bill.woodland@emich.edu.

Received July 1999; accepted September 2000.

markets appear to draw a higher percentage of recreational gamblers, who view gambling as a consumption good rather than a strategy to maximize their expected wealth. Commissions of near 20% make long-term profitable gambling extremely difficult. In sports betting, the relatively modest commissions or "vigorish" of 2–7% are likely to attract a significant number of individuals who consider their handicapping abilities sufficiently reliable to eventuate in profitable wagering. In many cases, these sports bettors have been fans of the sport for years and believe they have some special expertise in handicapping a matchup.

Previous studies of professional sports-betting markets have included Zuber, Gandar, and Bowers (1985), Gandar, et al. (1988), Dare and MacDonald (1996), and Gray and Gray (1997), which focused attention on the National Football League (NFL). Camerer (1989) and Brown and Sauer (1993) have investigated the National Basketball Association while Woodland and Woodland (1994) studied Major League Baseball. Overall, both sports and racetrack betting markets have been found to be efficient. Although there are some deviations from the strict definition of perfect efficiency, there is little evidence to suggest the existence of long-term, profitable wagering strategies.

A major finding in the racetrack literature is the presence of a bias that is consistently observed, regardless of the racetrack or time period studied. The tendency of bettors to overbet longshots and underbet favorites relative to their chances of winning has been referred to as the "favorite–longshot bias." While rarely sufficient in magnitude to allow for profitable betting opportunities, much attention has been paid to explaining this longstanding behavior of racetrack bettors. Interestingly, the reverse bias has been shown for baseball bettors. Both of these markets employ an odds system of wagering as opposed to the spread system common in football and basketball. As the hockey betting market also utilizes an odds system of betting, it provides an excellent opportunity to further investigate this apparent behavioral inconsistency between baseball and racetrack gamblers. Results obtained in this paper for hockey may help answer the question "Is the favorite–longshot bias confined to the racetrack?"

The paper is organized as follows. Section 2 describes the structure of the NHL betting market. The data are discussed in section 3. Section 4 conducts several tests of market efficiency. Bettors' perceptions of home-ice advantage are also examined. Profitable wagering strategies are explored in section 5. Section 6 investigates the favorite–longshot bias in the NHL and compares the results to those of other betting markets. Concluding remarks are contained in section 7.

2. The NHL Betting Market

Hockey is the last of the four major professional sports to become a fully established betting market, that is, the full slate of games is offered by most sports books. Only a handful of Las Vegas sports books offered hockey in the early 1980s. With an increase in the public's general interest in the league, coupled with an intensification of competition among both established and new sports books, hockey became a standard offering in the 1990s.

The dominant betting structure in hockey is based on the familiar "money" or odds line that is prevalent in baseball and boxing betting. An example of a "standard" money line quote for hockey is given by

Detroit Red Wings	−½	−150
Colorado Avalanche	+½	+120.

The last column represents the money line. A Red Wing bettor must lay \$1.50 to win \$1.00 while Avalanche backers wager \$1.00 to win \$1.20. We will label \$1.50 as the favorite price and \$1.20 as the underdog price. The differential reflects the commission paid to the sports book. For a detailed discussion of the money line, see Woodland and Woodland (1994, pp. 271–2). The 30¢ difference indicates that this line quote is taken from the 30¢ money line. The numbers in the second column represent half goals. Sports books post these numbers in a format that is comparable to spread bets. For example, a football team listed at (−7) must win by more than seven points to win the bet. For the previous hockey line, Detroit must win by more than half a goal, that is, win the game outright, in order for Detroit bettors to win. Conversely, Colorado bettors would win if the game ends in a tie. Because tie games are commonplace in hockey, this eliminates the possibility of a tie bet or "push," thus avoiding the book's return of all wagers. The absence of ties in baseball makes this addition of the money line unnecessary.

Hockey also differs from baseball in that lines are offered where both the underdog and the favorite bettors must wager more than their potential winnings. This arises when teams are more evenly matched. For example, for the 30¢ line,

Detroit Red Wings	−½	−120
Colorado Avalanche	+½	−110.

These lines will be referred to as "double-negative" lines. In this case, the Avalanche is the underdog team, because the required wager to win a dollar is smaller compared to the Red Wings bettors. The favorite price is \$1.20 and the underdog price is \$1.10.

Occasionally, sports books will put up a hybrid line of odds and spread, such as,

Detroit Red Wings	−2½	−140
Colorado Avalanche	+2½	+110.

The Red Wings must win by three or more goals to collect \$1.00 for a wager of \$1.40. Silberstang (1988, p. 328) states that favorite bettors loath to lay odds of more than 3:1. This line avoids excessive odds by shading the money line with goals.[1]

By the end of the 1980s, the 40¢ line, with its relatively high commissions ranging from 7% to 10% was commonplace. Competition eventually forced casinos to abandon the 40¢ line in favor of the 20¢ and 30¢ money lines, with commissions of 3.5–5% and 5–7%, respectively.

3. Data

Data were obtained from Computer Sports World, for the six seasons from 1990/91 to 1995/96. The odds quotes represent the closing line from the *Stardust Race and Sports Book,* arguably the leading sports book in Nevada. The starting date of the 1990/91 season was arbitrary. However, the hockey betting market during the 1980s was in a state of flux, with only minimal participation. The Stardust offered a 40¢ money line for the 1990/91 through 1993/94 seasons. Beginning with the 1994/95 season, a 30¢ money line was offered. Although some sports books offered a 20¢ money line, only data for opening lines were available. Because

[1] This practice is consistent with Woodland and Woodland (1991), who show that within a subjective utility framework, an individual's bet size decreases with odds. We hypothesize that profit-maximizing bookies introduced this line after observing decreased betting action on higher-odds games.

Table 1. 40¢ Line 1990/91–1993/94 Individual Line Tests of Efficiency: Underdog Bettor

$(-\beta_{1l}\cdot 100, (\pm)\beta_{2l}\cdot 100)$	c_l	n_l	$\hat{\pi}_l$	Z_l
(−120, −120)	0.100	216	—	—
(−125, −115)	0.099	420	0.510	0.856
(−130, −110)	0.098	395	0.453	−0.959
(−135, −105)	0.095	315	0.479	0.479
(−140, +100)	0.091	407	0.472	0.697
(−145, +105)	0.089	304	0.451	0.218
(−150, +110)	0.087	310	0.471	1.285
(−155, +115)	0.085	270	0.441	0.505
(−160, +120)	0.083	253	0.431	0.457
(−165, +125)	0.082	207	0.454	1.345
(−170, +130)	0.080	172	0.500	2.677*
(−175, +135)	0.078	139	0.439	1.128
(−180, +140)	0.077	128	0.453	1.593
(−185, +145)	0.075	101	0.386	0.182
(−190, +150)	0.074	84	0.417	0.879
(−195, +155)	0.073	25	0.400	0.378
(−200, +160)	0.071	16	0.437	0.671

* Significant at the 5% level.

questions of market efficiency can only be addressed after the line has been adjusted to reflect public opinion, that is, the closing line, we conducted this analysis using the Stardust data.

Tables 1 and 2 give summary statistics for the 40¢ and 30¢ money lines, respectively. A total of 5402 regular season games were played over these six seasons.[2] Due to the player lockout, fewer games were played in the 1994/95 season.

Suppose the lth standard line is given by

$$(-\beta_{1l}\cdot 100, +\beta_{2l}\cdot 100),$$

where $\beta_{1l} > \beta_{2l} \geq 1$ are the favorite and underdog prices, respectively. Vegas lines are typically posted in multiples of 100. The subjective odds for this line, β_l, are simply the midpoint of the two prices. For the lth double-negative line,

$$(-\beta_{1l}\cdot 100, -\beta_{2l}\cdot 100),$$

the subjective odds are given by $(\beta_{1l} + 1)/(\beta_{2l} + 1)$. The commission for the lth line is denoted by c_l while n_l is the number of games offered in that line.[3]

---

[2] Tables 1 and 2 exclude 36 games, as the sample size is insufficient for the subsequent hypothesis tests.

[3] For the lth standard line, the commission is given by $(\beta_{1l} - \beta_{2l})/(\beta_{1l} + \beta_{2l} + 2)$. For a complete derivation of the commission for the standard line, see Woodland and Woodland (1994, pp. 271–3). For the double-negative lines $(-\beta_{1l}\cdot 100, -\beta_{2l}\cdot 100)$, where $\beta_{1l} > \beta_{2l}$, the commission is $(\beta_{1l}\beta_{2l} - 1)/(\beta_{1l} + \beta_{2l} + 2)$. A unit bet is defined as betting β_{1l} to win \$1.00 for the favorite bettor, and betting β_{2l} to win \$1.00 for the underdog bettor. Let X and Y represent the number of unit bets on the favorite and underdog, respectively. Net receipts to the bookie are $(-X + \beta_{2l}Y)$ when the favorite wins and $(-Y + \beta_{1l}X)$ when the underdog wins. In equilibrium, net receipts are equal, implying $X = [(\beta_{2l} + 1)/(\beta_{1l} + 1)]Y$. The commission is defined as net receipts relative to the total number of unit bets, or $c_l = (-X + \beta_{2l}Y)/(X + Y) = (\beta_{1l}\beta_{2l} - 1)/(\beta_{1l} + \beta_{2l} + 2)$. For the double-negative lines, the subjective odds is not simply the midpoint of the prices. The subjective probability, ρ_l, is such that the expected return to the favorite and underdog bettors is $-c$. For the favorite bettor, the expected return is $\rho_l - \beta_{1l}(1 - \rho_l) = -[(\beta_{1l}\beta_{2l} - 1)/(\beta_{1l} + \beta_{2l} + 2)]$, which implies $= (\beta_{1l} + 1)/(\beta_{1l} + \beta_{2l} + 2)$. For the underdog bettor, the probability of winning is $(1 - \rho_l) = (\beta_{2l} + 1)/(\beta_{1l} + \beta_{2l} + 2)$. Therefore, the odds are $\beta_l = (\beta_{1l} + 1)/(\beta_{2l} + 1)$.

Table 2. 30¢ Line 1994/95–1995/96 Individual Line Tests of Efficiency: Underdog Bettor

$(-\beta_{1l}\cdot 100, (\pm)\beta_{2l}\cdot 100)$	c_l	n_l	$\hat{\pi}_l$	Z_l
(−115, −115)	0.075	96	—	—
(−120, −110)	0.074	203	0.493	0.121
(−125, −105)	0.073	122	0.516	0.877
(−130, +100)	0.070	181	0.503	1.015
(−135, +105)	0.068	109	0.459	0.087
(−140, +110)	0.067	159	0.447	0.053
(−145, +115)	0.065	106	0.528	1.942
(−150, +120)	0.064	119	0.353	−1.602
(−155, +125)	0.062	74	0.419	0.039
(−160, +130)	0.061	98	0.490	1.644
(−165, +135)	0.060	49	0.429	0.408
(−170, +140)	0.059	71	0.310	−1.420
(−175, +145)	0.058	51	0.451	0.974
(−180, +150)	0.057	43	0.465	1.187
(−185, +155)	0.056	31	0.323	−0.551
(−190, +160)	0.054	41	0.585	2.951*
(−200, +170)	0.053	51	0.373	0.324

* Significant at the 5% level.

4. Statistical Tests of Efficiency

This section presents several tests of the strict definition of market efficiency, that is, all wagering strategies yield expected losses equal to the bookie's commission. The first two subsections examine betting rules based solely on historical prices. In the final subsection, the information set is expanded to include the status of the team with respect to venue, that is, road or home games.[4]

Tests of Individual Lines

In this subsection, market efficiency is tested separately for each of the closing odds. Without loss of generality, outcomes are presented from the underdog bettor's perspective.

Let π_l represent the objective probability that the underdog team wins for a game in the lth line. The mean return, per unit bet, for this underdog wager is given by

$$\mu_l = (\beta_{2l} + 1)\pi_l - 1$$

for the standard line and

$$\mu_l = (\beta_{2l} + 1)\pi_l - \beta_{2l}$$

for the double-negative line. Testing the null hypothesis that $\mu_l = -c_l$ is equivalent to a test of $\pi_l = \rho_l$, where ρ_l is the subjective probability that the underdog team wins, or $\rho_l = 1/(1 + \beta_l)$. The proportion of games actually won by the underdog for the lth line is $\hat{\pi}_l$.

Tables 1 and 2 report the individual line test results for the 30¢ and 40¢ lines, respectively.[5]

[4] In the finance literature, tests based only on historical prices are referred to as weak form while semistrong tests include other publicly available information, such as home-ice status.

[5] For a detailed derivation of this test, see Woodland and Woodland (1994). Lines are omitted if either $n_l\rho_l < 5$ or $n_l(1 - \rho_l) < 5$, to allow for the normal approximation of the binomial distribution. The 312 even-odds games were excluded from the analysis of the first two subsections, because neither team is an underdog or a favorite.

The market is highly efficient with only 2 of 32 lines indicating statistically significant deviations from efficiency at a 5% level. However, individual line tests suffer from low power due to a relatively small number of games. Thus, the following subsection considers a combined test across lines.

Tests Across Lines

To examine questions of efficiency over time and across odds, various partitions of the data will be investigated. Games will be aggregated within the 30¢ or 40¢ line over different years. Although the offered wager (−150, +120) taken from the 30¢ line has the identical odds as (−155, +115) taken from the 40¢ line, they must be treated separately due to differences in the commissions.

Define γ_l to be the relative frequency of games in the lth line, where $l = 1, \ldots, L$. Then $\gamma_l = n_l/N$, where $N = \sum_{l=1}^{L} n_l$ is the total number of games under examination. Let $\bar{R}$ represent the average return for this collection of games. It follows that the mean return for $\bar{R}$ is given by $\mu_{\bar{R}} = \sum_{l=1}^{L} \gamma_l \mu_l$. The variance of the return for the lth line, σ_l^2, is given by $(\beta_{2l} + 1)^2\pi_l(1 - \pi_l)$. Finally, the variance for $\bar{R}$ is $\sigma_{\bar{R}}^2 = 1/N \sum_{l=1}^{L} \gamma_l \sigma_l^2$.

To test whether a strategy of betting the underdog yields average returns higher than those implied by perfect efficiency, the appropriate hypotheses are

$$H_o: \qquad \mu_{\bar{R}} = -\bar{c}$$

$$H_1: \qquad \mu_{\bar{R}} > -\bar{c},$$

where $\bar{c} = \sum_{l=1}^{L} \gamma_l c_l$. Examining whether $\mu_{\bar{R}}$ exceeds zero would be a test of profitability.

Table 3 reports the average payoff to the underdog bettor, the corresponding standardized test statistic, Z, and total number of games. Probability values (p values) are reported in parentheses below the test statistics. Because we are interested in testing efficiency over time in this developing market, results are given for each year individually, groupings of two years, the entire 40¢ line (1990/91–1993/94), the complete 30¢ line (1994/95–1995/96), as well as the full six seasons (1990/91–1995/96).

In the racetrack market and to a lesser extent in baseball, odds size has been shown to influence expected returns. To investigate this potential relationship in hockey, data were also partitioned into three odds subgroups, each with an approximately equal number of games: Low Odds: $\beta_l \leq 1.15$; Medium Odds: $1.20 \leq \beta_l \leq 1.35$; and High Odds: $\beta_l \geq 1.4$.

Table 3 documents the presence of inefficiency in the NHL betting market. For the 5054 games played during six seasons and all odds lines, the average payoff to the underdog bettor was −0.030 while the average commission was 0.082. The resulting standardized test statistic of $Z = 3.378$ has a p value of 0.000. Despite the relatively low power, three of the six individual years were significant at the 5% level. Additionally, point estimates for the average returns exceeded the expected returns implied by market efficiency, $-\bar{c}$, for all six years.

Is Home Ice an Advantage?

In this subsection, the impact of a variable readily available to the betting public, that is, whether the team is playing at home or on the road, will be considered. It is common knowledge that a home-field advantage exists in football, baseball, and basketball, where home teams win more than half of all games played. Winning in this case refers to beating the opponent, not to be confused with covering the spread. Inefficiencies may result if bettors incorrectly weigh the

Table 3. Underdog-Team Bettor Tests of Efficiency

Season	All Odds $\bar{R}$	All Odds Z (p value)	All Odds N	Low Odds $\bar{R}$	Low Odds Z (p value)	Low Odds N	Medium Odds $\bar{R}$	Medium Odds Z (p value)	Medium Odds N	High Odds $\bar{R}$	High Odds Z (p value)	High Odds N
1990/91	−0.080*	0.246 (0.403)	797	−0.067*	0.479 (0.316)	264	−0.065*	0.391 (0.348)	300	−0.133	−0.446 (0.672)	233
1991/92	−0.070*	0.505 (0.307)	825	−0.083*	0.243 (0.404)	282	−0.074*	0.230 (0.409)	298	−0.050*	0.401 (0.344)	245
1992/93	−0.023*	1.828 (0.034)	924	−0.096*	0.020 (0.492)	261	−0.052*	0.621 (0.267)	314	0.058*	2.272 (0.012)	349
1993/94	0.007*	2.803 (0.003)	959	−0.114	−0.279 (0.610)	323	−0.015*	1.400 (0.081)	379	0.190*	3.848 (0.000)	257
1994/95	−0.056*	0.211 (0.416)	554	−0.107	−0.476 (0.683)	196	−0.083	−0.213 (0.584)	171	0.022*	0.945 (0.172)	187
1995/96	−0.003*	1.766 (0.039)	946	0.031*	1.779 (0.038)	310	−0.045*	0.363 (0.358)	322	0.006*	0.963 (0.168)	314
1990/92	−0.075*	0.533 (0.297)	1622	−0.075*	0.508 (0.306)	546	−0.070*	0.439 (0.330)	598	−0.081	−0.023 (0.509)	478
1992/94	−0.008*	3.286 (0.001)	1906	−0.106	−0.194 (0.577)	584	−0.032*	1.453 (0.073)	693	0.110*	4.191 (0.000)	629
1994/96	−0.014*	1.841 (0.033)	1508	−0.022*	1.100 (0.136)	506	−0.058*	0.168 (0.433)	493	0.037*	1.824 (0.034)	509
1990/94	−0.038*	2.832 (0.002)	3546	−0.091*	0.214 (0.415)	1130	−0.049*	1.363 (0.087)	1291	0.030*	3.218 (0.001)	1125
1990/96	−0.030*	3.378 (0.000)	5054	−0.070*	0.780 (0.218)	1636	−0.052*	1.241 (0.107)	1784	0.032*	3.682 (0.000)	1634

* The average return is higher than the expected return implied by market efficiency.

Table 4. Road-Team Bettor Tests of Efficiency

Season	$\bar{R}$	Z (p value)	N
1990/91	−0.073*	0.417 (0.338)	816
1991/92	−0.105	−0.410 (0.659)	865
1992/93	0.008*	2.644 (0.004)	931
1993/94	−0.031*	1.655 (0.049)	985
1994/95	−0.054*	0.292 (0.385)	540
1995/96	−0.032*	0.948 (0.171)	937
1990/92	−0.088*	0.045 (0.482)	1688
1992/94	−0.013*	3.010 (0.001)	2036
1994/96	−0.030*	1.280 (0.101)	1550
1990/94	−0.049*	2.170 (0.015)	3744
1990/96	−0.043*	2.514 (0.006)	5294

* The average return is higher than the expected return implied by market efficiency.

strength of this advantage. Although hockey analysts have argued that home-ice advantage is slight, we were surprised to find that of the 5402 games in our sample, the home team won only 2702 times, or 50.02%.

Tables 4–6 present the summary statistics for the road, road favorite, and road underdog teams. For the six seasons combined, the average return for the road team of -0.043 is significantly higher than $-\bar{c} = -0.082$. The standardized test statistic of 2.514 has a corresponding p value of 0.006. Although some inefficiency exists, average returns are negative for all but one of the six years, eliminating any possibility of profitability.

For 1990/91–1995/96, average returns to the road favorite and the road underdog are -0.101 and -0.005, respectively. The road favorite holds no promise for profitable wagering, as the efficient market hypothesis is retained for all years and subgroups. In contrast, the hypothesis of efficiency is easily rejected for the road underdog with a probability value of 0.000. There is a definite indication of inefficiency for the latter years of the data set. Further examination of road-underdog betting is considered in the next section on profitability.

5. Tests of Profitability

The market is said to be inefficient, if a strategy exists, yielding average returns higher than a strategy based on random selection of teams. This restrictive concept of perfect efficiency, tested in section 4, has limited appeal beyond academics. In this section, we will concentrate on the existence of profitable wagering strategies, a topic of more general interest to the gaming

Table 5. Road-Favorite Team Bettor Tests of Efficiency

Season	$\bar{R}$	Z (*p* value)	N
1990/91	−0.059*	0.490 (0.312)	300
1991/92	−0.135	−0.635 (0.737)	311
1992/93	−0.048*	0.602 (0.273)	304
1993/94	−0.142	−0.843 (0.800)	401
1994/95	−0.042*	0.287 (0.387)	157
1995/96	−0.132	−0.938 (0.826)	305
1990/92	−0.094	−0.035 (0.514)	618
1992/94	−0.103	−0.318 (0.625)	794
1994/96	−0.095	−0.496 (0.690)	493
1990/94	−0.103	−0.395 (0.654)	1432
1990/96	−0.101	−0.588 (0.722)	1925

* The average return is higher than the expected return implied by market efficiency.

public. With high commissions of 5.5–10% for hockey relative to baseball (2–3%) and football (4.5%), the hurdle is more difficult. However, it pales in comparison to the typical 18–20% commission paid by racetrack bettors.

Reviewing the various odds subgroups in Tables 3 and 6 reveals few opportunities for profitable strategies, with the exception of the heavy underdog group. Table 7 contains the underdog and road-underdog test statistics of profitability for the high-odds group. As the first two seasons were efficient, tests of profitability are not reported for these individual years. For the last four years, there is evidence of profitable wagering strategies for the heavy underdogs. Aggregating all six seasons results in an average return of 0.032 for underdog bettors, and 0.054 for road-underdog bettors, with probability values of 0.131 and 0.052, respectively. Omitting the first two efficient seasons raises the returns to 0.077 and 0.105, with probability values of 0.012 and 0.005. However, the potential for exploitable opportunities may be diminishing.

6. The Reverse Favorite–Longshot Bias

Numerous studies on racetrack markets have documented the favorite–longshot bias. Although this bias rarely provides opportunities for profitability, economists have speculated for decades as to why racetrack bettors consistently misprice favorites and longshots. This tendency of racetrack bettors to underbet the favorite does not extend to sports betting markets. In football, bettors consistently wager such that the closing point spread overestimates the favorite's chance of winning. Baseball bettors tend to overbet favorites relative to their probability of winning.

Table 6. Road-Underdog Team Bettor Tests of Efficiency

	All Odds			Low Odds			Medium Odds			High Odds		
Season	$\bar{R}$	Z (p value)	N	$\bar{R}$	Z (p value)	N	$\bar{R}$	Z (p value)	N	$\bar{R}$	Z (p value)	N
1990/91	−0.062*	0.510 (0.305)	480	−0.062*	0.379 (0.352)	128	−0.037*	0.635 (0.262)	161	−0.083	−0.045 (0.518)	191
1991/92	−0.079*	0.175 (0.430)	506	−0.091*	0.070 (0.472)	144	−0.126	−0.485 (0.686)	169	−0.027*	0.621 (0.267)	193
1992/93	0.043*	2.873 (0.002)	567	−0.086*	0.140 (0.444)	155	0.011*	1.278 (0.101)	174	0.149*	3.135 (0.001)	238
1993/94	0.030*	2.547 (0.005)	512	0.030*	1.514 (0.065)	156	−0.061*	0.378 (0.353)	204	0.154*	2.596 (0.005)	152
1994/95	−0.043*	0.383 (0.351)	337	−0.091	−0.195 (0.577)	111	−0.073	−0.064 (0.526)	101	0.024*	0.804 (0.211)	125
1995/96	0.020*	1.871 (0.031)	582	0.083*	1.950 (0.026)	166	−0.038*	0.373 (0.355)	192	0.024*	1.038 (0.150)	224
1990/92	−0.070*	0.481 (0.315)	986	−0.077*	0.310 (0.378)	272	−0.083*	0.095 (0.462)	330	−0.055*	0.409 (0.341)	384
1992/94	0.041*	4.011 (0.000)	1110	−0.028*	1.700 (0.121)	311	−0.028*	1.145 (0.126)	378	0.155*	4.267 (0.000)	421
1994/96	0.010*	2.100 (0.018)	961	0.013*	1.386 (0.083)	277	−0.050*	0.264 (0.396)	293	0.052*	1.849 (0.032)	391
1990/94	−0.011*	3.241 (0.001)	2096	−0.051*	1.068 (0.143)	583	−0.053*	0.901 (0.184)	708	0.055*	3.352 (0.000)	805
1990/96	−0.005*	3.860 (0.000)	3057	−0.030*	1.660 (0.048)	860	−0.052*	0.897 (0.185)	1001	0.054*	3.80 (0.000)	1196

* The average return is higher than the expected return implied by market efficiency.

Table 7. Tests of Profitable Strategies High-Odds Games

	Underdog Bettor		Road Underdog Bettor	
Season	$\bar{R}$	Z (*p* value)	$\bar{R}$	Z (*p* value)
1992/93	0.058	0.961 (0.168)	0.149	2.039 (0.021)
1993/94	0.190	2.707 (0.003)	0.154	1.703 (0.044)
1994/95	0.022	0.256 (0.399)	0.024	0.228 (0.410)
1995/96	0.006	0.093 (0.463)	0.024	0.302 (0.381)
1990/92	−0.081	−1.552 (0.940)	−0.055	−0.942 (0.827)
1992/94	0.110	2.432 (0.008)	0.155	2.814 (0.002)
1994/96	0.037	0.707 (0.240)	0.052	0.874 (0.191)
1992/96	0.077	2.259 (0.012)	0.105	2.601 (0.005)
1990/96	0.032	1.123 (0.131)	0.054	1.621 (0.052)

As documented in the second subsection of section 4, this reverse favorite–longshot bias extends to the NHL betting market. However, the bias is more pronounced in hockey, as profitable strategies are evident. There is one notable difference. While the bias decreased slightly with the higher odds games in baseball, the opposite is true for hockey. Table 3 indicates that for the six seasons combined, average returns to an underdog wager, from the low to high odds groups, increase from −0.070 to −0.052 to +0.032. The same pattern occurred for four of the six individual years.

There have been various explanations offered for the favorite–longshot bias in horseracing. Thaler and Ziemba (1988) suggested that bettors may overestimate low probability events, or possibly bettors simply find it more entertaining to successfully pick a horse with long odds. Quandt (1986) showed that the favorite–longshot bias could result from bettors who are risk seekers. Terrell and Farmer (1996) theorized that the presence of informed bettors and transactions costs may explain the bias. Tests conducted in this paper for hockey and those reported for baseball challenge some of these hypotheses. Do hockey and baseball bettors underestimate low probability events, are they risk averse, or are informed bettors absent in these markets? Proposed theories should be broad enough to explain the original and reverse bias.[6]

Why do sports bettors tend to overbet the favorite? Because hockey and baseball use an odds system, theories involving the risk attitudes of bettors could provide possible explanations.

[6] To our knowledge, only Williams and Paton (1998) have addressed both biases. Their model suggests that the reverse bias in baseball may be a consequence of the relatively low commission in comparison to horseracing. To obtain this result, the authors assumed that informed bettors receive utility by betting on the favorite. This could stem from the utilization of their superior knowledge over the uninformed bettors in selecting the probable winner. Of the two groups, it seems less likely for the informed or sophisticated bettors to base bets on nonmonetary criteria. Furthermore, because hockey commissions are higher than those of baseball, if a reverse bias is present, their model would predict a smaller reverse bias rather than the larger bias documented in this paper.

Football, however, employs the spread system of wagering where all bettors gamble $11.00 to win $10.00. Given the absence of risk differentials among wagers, the tendency of some uninformed bettors to overestimate the strength of the favorite team might be the only reasonable explanation. As respected Las Vegas handicapper Banker states, "The bookies know that most people would rather bet on favorites than underdogs. . . . The bettor who plays favorites often has to pay for his choice by giving up more points than he should" (Banker and Klein 1986, p. 63).

Finally, it is observed that the reverse favorite–longshot bias does not appear to be diminishing over time. Malkiel (1989) argues that "pricing irregularities may well exist and even persist for periods of time, and markets can at times be dominated by fads and fashions. Eventually, however, any excesses in market valuations will be corrected." Table 3 reveals that while the first two years were highly efficient, with average losses close to the commission, three of the last four seasons were inefficient when tested at a 5% significance level. In contrast, the profitable returns identified in section 5 have generally decreased during the last two years. This could be the consequence of informed bettors entering and driving expected profits to zero.

7. Conclusion

The NHL betting market was found to be somewhat inefficient, and the presence of the reverse favorite–longshot bias was confirmed. As shown for football, baseball, and now for hockey, a strategy of betting on the underdogs yields higher average returns compared to wagering on favorites. Additionally, strategies have been identified that provide bettors with opportunities for profitable wagering. Although some researchers and gamblers have proposed profitable strategies in the past for football and horseracing, many of these are complicated and somewhat arbitrary. In hockey, a simple strategy of wagering on teams that are heavy underdogs, especially those on the road, was found to be profitable over the last four seasons. In fact, road-underdog bettors would have enjoyed returns of nearly 11% over this period. Unlike the typical tout services, however, we make no claims regarding future performance. While market inefficiencies persist, the profitable-wagering opportunities appear to be diminishing.

Results in this paper confirm those documented previously for Major League Baseball. In sports betting markets with odds, there is a reversal of the favorite–longshot bias found in racetrack markets. Although there are differences in these markets, such as fixed versus pari-mutuel odds and the size of the commissions, models that purport to explain the bias in racetrack markets should also address the reverse bias in sports betting markets. Otherwise, authors are implicitly assuming that racetrack bettors are unique. This may in fact be true. If so, it greatly diminishes the value of investigating the racetrack market as a means to answer general questions regarding efficiency and decision making.

References

Banker, Lem, and Frederick C. Klein. 1986. *Lem Banker's book of sports betting.* New York: E. P. Dutton.

Brown, William O., and Raymond D. Sauer. 1993. Does the basketball market believe in the hot hand? Comment. *American Economic Review* 83:1377–86.

Camerer, Colin F. 1989. Does the basketball market believe in the hot hand? *American Economic Review* 79:1257–61.

Dare, William H., and Scott MacDonald. 1996. A generalized model for testing the home and favorite team advantage in point spread markets. *Journal of Financial Economics* 40:295–318.

Gandar, John M., Richard A. Zuber, Thomas O'Brien, and Ben Russo. 1988. Testing rationality in the point spread betting market. *Journal of Finance* 43:995–1007.

Gray, Philip K., and Stephan F. Gray. 1997. Testing market efficiency: Evidence from the NFL sports betting market. *Journal of Finance* 52:1725–37.

Malkiel, Burton G. 1989. Efficient market hypothesis. In *The new Palgrave-finance,* edited by John Eatwell, Murray Milgate, and Peter Newman. New York: W. W. Norton & Company, Inc., pp. 127–34.

Quandt, Richard E. 1986. Betting and equilibrium. *Quarterly Journal of Economics* 101:201–7.

Sauer, Raymond D. 1998. The economics of wagering markets. *Journal of Economic Literature* 36:2021–64.

Silberstang, Edwin. 1988. *The winner's guide to sports betting.* New York: New American Library.

Terrell, Dek, and Amy Farmer. 1996. Optimal betting and efficiency in parimutuel betting markets with information costs. *The Economic Journal* 106:846–68.

Thaler, Richard H., and William T. Ziemba. 1988. Parimutuel betting markets: Racetracks and lotteries. *Journal of Economic Perspectives* 2:161–74.

Williams, Leighton V., and David Paton. 1998. Why are some favourite-longshot biases positive and others negative? *Applied Economics* 30:1505–10.

Woodland, Bill M., and Linda M. Woodland. 1991. The effects of risk aversion on wagering: Point spread versus odds. *Journal of Political Economy* 99:638–53.

Woodland, Linda M., and Bill M. Woodland. 1994. Market efficiency and the favorite-longshot bias: The baseball betting market. *Journal of Finance* 49:269–79.

Zuber, Richard A., John M. Gandar, and Benny D. Bowers. 1985. Beating the spread: Testing the efficiency of the gambling market for National Football League games. *Journal of Political Economy* 93:800–6.