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Market Efficiency and the Favorite-Longshot Bias: The Baseball Betting Market

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ABSTRACT

This paper examines the efficiency of the legal gambling market for major league baseball. Weak-form tests of market efficiency within and across odds lines are performed. Surprisingly, the consistently observed favorite-longshot bias in racetrack betting is shown to exist in reverse for baseball bettors. However, these and other deviations from efficiency are shown to be insufficient to allow for profitable betting strategies when commissions are considered.

MARKETS FOR STOCKS AND sports wagers are similar in many ways. Future outcomes are uncertain, there are many participants, and information on past performances is readily available. In recent years, numerous studies have examined the market for parimutuel racetrack betting within a framework previously applied to financial markets. Moreover, Thaler and Ziemba (1988) argue that this market is better suited than the stock market for tests of market efficiency. Each bet has a well-defined termination point at which time its value is known with certainty, whereas stocks are infinitely lived. This paper extends the analysis to the legal gambling market in Nevada for major league baseball, a sport that has been virtually ignored in previous research. Although there has been some investigation of the professional football market, the results obtained are generally not comparable with those obtained in the racetrack literature. While both the baseball and racetrack markets employ an odds or "money" line, football uses a point spread system.

Aside from simply being a new market to examine, the baseball betting market merits consideration because it possesses several advantages over racetrack betting. The baseball market is a true market, similar to the stock market, in that an individual is able to buy and sell assets or bets. A baseball bettor is permitted to bet for or against a team, whereas in racetrack betting, only bets in favor of the horse (win, place, or show) are offered. Another

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inherent disadvantage of the racetrack market stems from the additional uncertainty of the payoffs created by the parimutuel system of betting. Winning bets divide the total money wagered less the track take. Consequently, bettors do not know the eventual payoffs of the gamble at the time that the bet is placed, although the current odds do provide some information about the final odds.[1] The baseball odds are fixed at the time of the bet, regardless of subsequent changes in the line.[2] Furthermore, racetrack gambling appears to be more of a pleasure-oriented activity for most participants, rather than a serious undertaking to change one's wealth status. In addition, it has long been recognized by sports book management that baseball gamblers are among the most knowledgeable and sophisticated of all sports bettors.[3] Finally, in racetrack betting, commissions range from 15 to 25 percent, while baseball bettors enjoy a relatively minor fee of approximately 2 to 3 percent. This significant difference in commissions provides a greater opportunity for baseball bettors to sustain long-term professional gambling activity.

The focus of this paper is a comparison of the racetrack and baseball gambling markets. Specifically, the question of market efficiency in the baseball betting market is examined. Although racetrack markets are generally efficient, some inefficiencies have been identified. (See, for instance, Hausch, Ziemba, and Rubinstein (1981), Asch, Malkiel, and Quandt (1982, 1984), Hausch and Ziemba (1985), Asch and Quandt (1986), and Ziemba and Hausch (1987).) In particular, there is a well-documented tendency of racetrack bettors to consistently overbet longshots and underbet favorites relative to their observed frequency of winning. (See, for instance, Ali (1977), Snyder (1978), Asch, Malkiel, and Quandt (1982), Asch and Quandt (1987), and Ziemba and Hausch (1987).)[4] A similar bias has been detected by Rubinstein (1985, 1987) in the equity options market.[5] Thus, in addition to general tests of market efficiency, we also investigate whether this particular bias extends to the baseball betting market.

Although the favorite-longshot bias may be the result of market inefficiency, there are several alternative explanations. It could be due to the bragging rights associated with a winning longshot wager. Alternatively,

[1] Most studies have focused on the North American racetrack market, which employs the parimutuel system. Some countries, such as England, offer fixed-odds wagering.

[2] These fixed odds have implications for the bookie. In baseball, line movements affect the commissions collected, whereas in racetrack betting, the commission is a guaranteed percentage.

[3] This is stated in numerous sports handicapping books and was supported in our discussions with Michael "Roxy" Roxborough, president of Las Vegas Sports Consultants, who is generally recognized as the nation's linemaker.

[4] An exception to this bias has been noted by Busche and Hall (1988) for racetrack bettors in Hong Kong.

[5] It was established that shorter maturity options (longshots) are overpriced.

some authors attribute it to risk-seeking behavior.[6] For a complete discussion of these and other explanations, see Thaler and Ziemba (1988) and Ziemba and Hausch (1987). This paper ignores these alternative theories and assumes that bettors are expected value maximizers.

The paper is organized as follows. Section I describes the structure of the baseball betting market. The data and implications for tests of efficiency are discussed in Section II. Section III presents several weak-form tests of market efficiency. Section IV analyzes these test results with respect to the existence of a favorite-longshot bias. Final remarks are contained in Section V.

I. Baseball and the Money Line

The terms "vigorish" and "juice" refer to the fee collected by the bookie for providing the sports-betting service. The bookie has no desire to participate as an active gambler. Rather, he establishes a line or price to balance the wagers so that his commission is independent of the final outcome of the contest. If the opening odds line achieves this balance, there is no risk for the bookie. While the margin of victory is critical for football spread bettors, baseball bettors are only concerned with the eventual winner of the contest. Participants are permitted to bet for or against any team at the posted odds when the bet is purchased, regardless of subsequent line changes. However, there is a differential between the odds prices offered to the favorite and underdog bettors. This differential determines the vigorish retained by the bookie.

An example of an odds wager would be $(-180, +170)$, i.e., a gambler can wager \$1.00 to win \$1.70 on the underdog, or \$1.80 to win \$1.00 on the favorite. This odds quote is taken from the 10¢ or "dime" line. The differential of 0.10 between the odds prices, however, is not constant throughout the dime line. The complete line and the corresponding commissions are displayed in columns 1 and 2 of Table I.

The commissions are determined as follows. Define β_1 and β_2 as the favorite and underdog prices respectively, i.e., a bettor can wager β_1 to win \$1 or \$1 to win β_2, where $\beta_1 > \beta_2 > 1$. Let X and Y represent the number of unit bets purchased by the favorite and underdog bettors, respectively. A unit bet for a favorite bettor is β_1 to win \$1. When the wagers are balanced, the net receipts for the bookie are the same regardless of the

[6] Proponents of this argument include Ali (1977), Asch, Malkiel, and Quandt (1982, 1984) and Quandt (1986). Conversely, Hirshleifer (1966), Bailey, Olson, and Wonnacott (1980), Thaler and Ziemba (1988), and Woodland and Woodland (1991) conclude that observed gambling behavior is inconsistent with the assumption of risk-seeking behavior.

Table I

Major League Baseball Dime Line: 1979 to 1989

For each line, β_1 and β_2 represent the favorite and underdog prices for a unit bet; c is the commission; n is the number of games placed in each closing line; β is the subjective odds; and W represents the number of games won by the underdog team.

$(-\beta_1 \cdot 100, \beta_2 \cdot 100)$	c	n	β	W
(−105, −105)	2.50	757	1.000	—
(−110, +100)	2.44	2626	1.050	1276
(−115, +105)	2.38	1908	1.100	945
(−120, +110)	2.33	2150	1.150	1005
(−125, +115)	2.27	1969	1.200	928
(−130, +120)	2.22	2053	1.250	932
(−135, +125)	2.17	1687	1.300	757
(−140, +130)	2.13	1820	1.350	737
(−145, +135)	2.08	1432	1.400	644
(−150, +140)	2.04	1466	1.450	621
(−155, +145)	2.00	1164	1.500	485
(−160, +150)	1.96	1086	1.550	430
(−165, +155)	1.92	789	1.600	319
(−170, +160)	1.89	766	1.650	287
(−175, +165)	1.85	511	1.700	176
(−180, +170)	1.82	471	1.750	177
(−185, +175)	1.79	219	1.800	70
(−190, +180)	1.75	234	1.850	82
(−195, +185)	1.72	6	1.900	0
(−200, +185)	2.56	516	1.925	170
(−210, +190)	3.33	132	2.000	43
(−215, +195)	3.28	4	2.050	3
(−220, +200)	3.23	332	2.100	105
(−225, +205)	3.17	4	2.150	3
(−230, +210)	3.13	62	2.200	14
(−235, +215)	3.08	1	2.250	0
(−240, +220)	3.03	189	2.300	64
(−250, +230)	2.94	21	2.400	6
(−260, +240)	2.86	127	2.500	38
(−270, +250)	2.78	7	2.600	1
(−280, +260)	2.70	59	2.700	16
(−300, +260)	5.26	35	2.800	10
(−320, +280)	5.00	0	3.000	0
(−350, +300)	5.88	0	3.250	0
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winner of the contest.[7] Therefore, $-X + Y = \beta_1 X - \beta_2 Y$, which implies $X = [(\beta_2 + 1)/(\beta_1 + 1)]Y$. The vigorish is simply the net receipts divided by the total number of unit bets or

$$c = \frac{-X+Y}{X+Y} = \frac{-[(\beta_2+1)/(\beta_1+1)]Y+Y}{[(\beta_2+1)/(\beta_1+1)]Y+Y} = \frac{\beta_1-\beta_2}{\beta_1+\beta_2+2}.$$

[7] When the books are not in balance, the bookie is an active participant in the gambling process and his or her receipts are now dependent on the final outcome of the game. In this situation, it is difficult to disentangle the implied commission from the return resulting from the bookie's gambling activity. Furthermore, in this situation, questions of market efficiency cannot be addressed because subjective probabilities are revealed only when the books are balanced.

For example, if the line is $(-180, +170)$, then the vigorish is $(1.8 - 1.7)/(1.8 + 1.7 + 2) = 0.0182$ or 1.82 percent.[8]

II. Data

This analysis includes the 24,603 major league baseball games for the 1979 to 1989 seasons.[9] Data were obtained from Computer Sports World. By symmetry of favorite and underdog bets, it is only necessary to study each game from one perspective. We chose to examine outcomes from the underdog bettor's viewpoint, since this is comparable to the large majority of racetrack bets, i.e., betting \$1 to win β, where $\beta > 1$.[10] Since there is no favorite for the even line $(-105, -105)$, these 757 games are ignored.

Previous racetrack studies have been forced to aggregate outcomes in one of two ways: first, according to the horse's rank as determined by the market odds, or second, into intervals of similar subjective odds. In either case, classification problems exist.[11] In baseball, however, the consensus of the bettors results in the placement of each game into one of the L possible closing lines, as given in Table I. No further aggregation is necessary.

III. Statistical Tests of Market Efficiency

This paper considers various tests of weak-form market efficiency, i.e., tests based solely on historical price information. If the market is efficient, then all betting strategies would yield expected losses equal to the bookie's vigorish. If the baseball betting market fails this highly restrictive definition of efficiency, then the existence of profitable betting strategies will be investigated.[12]

[8] Alternatively, the commission can be viewed from the perspective of the individual bettor. Assuming the subjective odds, β, are equal to the midpoint of the odds prices, then the expected loss for all bettors is equal to the commission. For the underdog bettor, the expected return would be

$$(\beta_2)[1/(\beta + 1)] + (-1)[\beta/(\beta + 1)] = (\beta_2 - \beta_1)/(\beta_1 + \beta_2 + 2) = -c.$$

The same result can be derived for the favorite bettor. For the even line, $(-105, -105)$, the expected return is $(1)(1/2) + (-1.05)(1/2) = -0.025$.

[9] The dime line has been the predominant odds line offered by legal sports books for baseball since 1979. This was selected as our initial season to preserve continuity of commissions charged for a given odds line. While competition drove sports books from a 20¢ line to the dime line (with lower commissions), the 20¢ line is still the standard for baseball totals, football proposition bets, and the football money line bets. For additional discussion, see Rhoden and Roxborough (1988).

[10] For instance, see Ziemba and Hausch (1987) for a presentation of the 10,000 races examined by Fabricand. Ninety-nine percent of the wagers in the win market had odds exceeding one.

[11] In the first approach, problems could result due to the variability of odds across races for horses of a given rank. Average objective and subjective probabilities could coincide due solely to aggregation and then be misinterpreted as market efficiency. In the second approach, since horses in the same race could be classified in the same interval, a minor bias results as each race has only one winner. For further discussion of these classification problems, see Busche and Hall (1988) and Ali (1977).

[12] The distinction between degrees of market inefficiencies is discussed in Asch, Malkiel, and Quandt (1984) and Thaler and Ziemba (1988).

For each of the L offered lines, define n_l as the number of games placed in the lth line; ρ_l as the subjective probability that the underdog team wins a game, calculated using the midpoint, β_l, of the prices in the lth closing line, i.e., $\rho_l = 1/(1 + \beta_l)$; and π_l as the objective probability that the underdog team wins for a randomly selected game classified by the public in the lth line. The following tests investigate the significance of any differences between the subjective and objective probabilities.

A. Tests by Individual Betting Line

Efficiency implies that for a randomly selected game, in a given betting line, there are no differences in the objective and subjective probabilities of an underdog win. Otherwise, the expected losses would differ for the favorite and underdog bettors. The appropriate null hypothesis, $\pi_l = \rho_l$, considers whether on average, games in the lth line win according to the probability implied by the subjective line. This does not preclude a fundamental analyst from observing differences between subjective and objective probabilities for a particular game in the lth line.

The observed proportion of underdog wins in the lth line, $\hat{\pi}_l$, approaches a normal distribution with mean, π_l, and variance, $[\pi_l(1 - \pi_l)]/n_l$, for sufficiently large n_l. The analysis excludes those lines with an insufficient number of games to permit the normal approximation to the binomial distribution, i.e., lines are excluded if $n_l \rho_l < 5$ or $n_l(1 - \rho_l) < 5$. Table II reports the standardized test statistic, z_l, where[13]

$$z_l = \frac{\hat{\pi}_l - \rho_l}{\sqrt{\dfrac{\rho_l(1 - \rho_l)}{n_l}}}.$$

The market is remarkably efficient. Only 3 of the 26 lines tested lead to rejection of the null hypothesis at a 10 percent level of significance.

B. Aggregated Tests across Betting Lines

Consistent with Asch and Quandt (1987, 1988), a regression equation is estimated to determine whether there exists any inherent bias in the public's perception of win probabilities when all lines are considered simultaneously. The objective probability of an underdog win is regressed versus the subjective probability over all lines, or

$$\pi_l = \alpha_0 + \alpha_1 \rho_l + \varepsilon_l.$$

[13] This differs from the approach used by Ali (1977) and Asch, Malkiel, and Quandt (1982) where their z_l statistic was given by $(\hat{\rho}_l - \hat{\pi}_l)/\sqrt{[\hat{\pi}_l(1 - \hat{\pi}_l)]/n_l}$. They assumed that the objective probability, π_l, was given by its estimate, $\hat{\pi}_l$. Otherwise, the appropriate test would have been a comparison of proportions from two populations. Questions of efficiency in this paper investigate whether realized prices reflect the values assigned to them by bettors, i.e., does $\pi_l = \rho_l$? In this case, ρ_l is a number for a given line, not an unknown parameter.

Table II

Tests of Market Efficiency by Individual Line

For the lth closing line, β_l is the subjective odds; n_l is the number of games; ρ_l is the subjective probability of an underdog win; $\hat{\pi}_l$ is the observed proportion of underdog wins; and z_l is the standard normal test statistic under the null hypothesis of equal subjective and objective probabilities and includes the correction for continuity when appropriate.

β_l	n_l	$\rho_l = 1/(\beta_l + 1)$	$\hat{\pi}_l$	z_l
1.050	2626	0.4878	0.4859	−0.1747
1.100	1908	0.4762	0.4953	+1.6469*
1.150	2150	0.4651	0.4674	+0.1946
1.200	1969	0.4545	0.4713	+1.4709
1.250	2053	0.4444	0.4540	+0.8464
1.300	1687	0.4348	0.4487	+1.1307
1.350	1820	0.4255	0.4049	−1.7526*
1.400	1432	0.4167	0.4497	+2.5103**
1.450	1466	0.4082	0.4236	+1.1761
1.500	1164	0.4000	0.4167	+1.1308
1.550	1086	0.3922	0.3959	+0.2249
1.600	789	0.3846	0.4043	+1.1005
1.650	766	0.3774	0.3747	−0.1160
1.700	511	0.3704	0.3444	−1.1688
1.750	471	0.3636	0.3758	+0.5007
1.800	219	0.3571	0.3196	−1.0879
1.850	234	0.3509	0.3504	−0.0144
1.925	516	0.3419	0.3295	−0.5485
2.000	132	0.3333	0.3258	−0.0923
2.100	332	0.3226	0.3163	−0.1875
2.200	62	0.3125	0.2258	−1.3357
2.300	189	0.3030	0.3386	+0.9856
2.400	21	0.2941	0.2857	−0.0845
2.500	127	0.2857	0.2992	+0.2385
2.700	59	0.2703	0.2712	+0.0159
2.800	35	0.2632	0.2857	+0.1111
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* denotes significant at $\alpha = 0.1$.
** denotes significant at $\alpha = 0.05$.

The appropriate null hypothesis for efficiency is a joint test of $\alpha_0 = 0$ and $\alpha_1 = 1$. Table III presents the regression results using the 26 odds lines from Table II. The first regression is obtained using ordinary least squares under the assumption of homoskedasticity, i.e., $\mathrm{Var}(\hat{\pi}) = \sigma^2 I$. The F-statistic of 0.474 and corresponding probability value of 0.628 provide no evidence of market inefficiency. However, since the dependent variable, $\hat{\pi}$, is only an estimate of the objective probability, its variance is inversely related to the number of games in a given line. This has a pronounced effect on the statistical efficiency of our estimates, since the number of games placed by the public into each line is not uniform.[14] The White test for heteroskedastic-

[14] This was not a problem for Asch and Quandt (1987, 1988) since they aggregated their data into groups of equal size.

Table III

Simultaneous Test of Bias: $\alpha_0 = 0$ and $\alpha_1 = 1$

π_l and ρ_l represent the objective and subjective probabilities of an underdog win for the lth line. Var($\hat{\pi}$) denotes the assumed variance structure of the dependent variable, the observed proportion of underdog wins. $\Omega(N)$ is a diagonal matrix with lth diagonal element $\omega_{ll} = \sigma^2/n_l$, where n_l is the number of games in the lth line. F^* is distributed F with $(2, 24)$ degrees of freedom under the null hypothesis of $\alpha_0 = 0$ and $\alpha_1 = 1$. Standard errors are reported below the estimated coefficients. In the second equation, R^2 is the proportion of the variation of $\hat{\pi}$ from its mean, which is explained using the generalized least squares estimate.

Var($\hat{\pi}$)	$\pi_l = \alpha_0 + \alpha_1 \rho_l + \varepsilon_l$	R^2	F^*	Probability Value
$\sigma^2 I$	$\hat{\pi}_l = -0.026 + 1.073\ \rho_l$ (0.029) (0.076)	0.892	0.474	0.628
$\Omega(N)$	$\hat{\pi}_l = -0.013 + 1.046\ \rho_l$ (0.029) (0.068)	0.889	2.577	0.0968

ity (see Maddala (1988), pp. 162 and 163) is conducted using the residuals of the first regression. The presence of heteroskedasticity due to n_l is supported with probability values of 0.018 and 0.104. Accordingly, a second regression is estimated using generalized least squares. We assume a diagonal variance-covariance matrix, $\Omega(N)$, whose lth diagonal element is defined as $\omega_{ll} = \sigma^2/n_l$. Residuals originating from lines with more games are given proportionately more weight. This second regression rejects the hypothesis of market efficiency at a 10 percent level of significance.

A final test examines whether a strategy of wagering only on underdogs yields returns significantly higher than those implied by efficiency. This strategy is motivated by the consistently observed tendency of football bettors to overvalue the favorites.[15]

Define R_{il} as the random variable for the payoffs for an underdog bet on the ith game placed in the lth line; β_{2l} refers to the underdog price for the lth line; and π_l denotes the objective probability that the underdog team wins for a randomly selected game in the lth line. The underdog bettor wins β_{2l} with probability π_l, and loses one dollar with probability $1 - \pi_l$. For each of the games in the lth line, the mean and variance of an underdog bet are

$$\mu_{R_l} = \pi_l(\beta_{2l} + 1) - 1,$$

and

$$\sigma_{R_l}^2 = (\beta_{2l} + 1)^2 \pi_l (1 - \pi_l).$$

The average return for all underdog bets in the lth line is

$$\overline{R}_l = \frac{1}{n_l} \sum_{i=1}^{n_l} R_{il}.$$

[15] For instance, see Carroll, Palmer, and Thorn (1988) and Silberstang (1988). This behavior was confirmed in our discussions with Roxborough.

The mean return for all wagers across all lines is

$$\overline{R} = \sum_{l=1}^{L} \gamma_l \overline{R}_l,$$

where $\sum_l n_l = N$ and $\gamma_l = n_l/N$. The total number of games played is represented by N and γ_l is the relative frequency of games placed by bettors into the lth line. Then

$$\mu_{\overline{R}} = \sum_{l=1}^{L} \gamma_l \mu_{\overline{R}_l} = \sum_{l=1}^{L} \gamma_l \mu_{R_l},$$

and

$$\sigma_{\overline{R}}^2 = \frac{1}{N} \sum_{l=1}^{L} \gamma_l n_l \sigma_{\overline{R}_l}^2 = \frac{1}{N} \sum_{l=1}^{L} \gamma_l \sigma_{R_l}^2.$$

The central limit theorem implies that $\overline{R}_l$ approaches a normal distribution. Since $\overline{R}$ is a linear combination of approximately normal random variables, $\overline{R}$ is also approximately normally distributed.

Efficiency requires that $\pi_l = \rho_l$. For the lines in Table II, this implies a mean return[16] of $\mu_{\overline{R}} = -0.0222$ with $\sigma_{\overline{R}} = 0.0074$. To test whether the underdog strategy yields a higher average return than that implied by efficiency, the appropriate hypotheses are

$$\mathrm{H}_0\colon \mu_{\overline{R}} = -0.0222$$
$$\mathrm{H}_1\colon \mu_{\overline{R}} > -0.0222.$$

The average payoff to the underdog bettor, based on the 23,824 games is -0.0072. The resulting standardized test statistic of $z = 2.02$ yields a probability value of 0.0218, indicating the presence of some inefficiency. If bets are made only on lines below $+160$, the test results are even more significant with an average payoff of -0.0013 and a probablity value of 0.0038. This restricted betting rule is motivated by suggestions in several books on sports and baseball handicapping. For example, Lee (1981) and Silberstang (1988) recommend avoiding games with heavy favorites, i.e., laying odds of 1.70 to 1.80 or more.[17]

Although such a simple betting strategy does demonstrate some deviation from efficiency, it is not sufficient to allow for profitable wagering. Potential profitable wagering would require more sophisticated betting strategies. Some examples could include trend analysis of the lines, such as those discussed by Camerer (1989) and Vergin and Scriabin (1978) for basketball and football, respectively; or fundamental methods which include specific game variables

[16] Since efficiency implies that for the lth line $\mu_{R_l} = -c_l$, the mean loss over all lines can also be represented as a weighted average of the bookie's commissions, or $\mu_{\overline{R}} = -\sum_{l=1}^{L} \gamma_l c_l$.

[17] In fact, they recommend avoidance of heavy favorites. Our rule states that bettors should instead avoid the heavy underdogs. It is not uncommon to find the so-called "experts" touting strategies that yield lower returns than a purely randomized system. See Snyder (1978) for examples of handicapper bias in racetrack betting.

(ERA, batting averages, etc.), similar to the approach used by Zuber, Gandar, and Bowers (1985) in examining the football market.

IV. The Favorite-Longshot Bias

The favorite-longshot bias refers to the consistently observed tendency of racetrack bettors to overbet underdogs and underbet favorites. The nature of the baseball betting market differs in terms of the range of odds choices offered to bettors. For example, odds greater than 4 to 1 comprise the majority of racetrack bets in the win market, but are virtually nonexistent in baseball.[18] Alternatively, odds less than 1 to 1 comprise a relatively small percentage of the wagers available in the racetrack market (to win). Yet these odds are available in all baseball games except for even money contests. Despite these differences, the favorite-longshot bias implies that for a given game, the expected return for a wager on the favorite should exceed that of a wager on the underdog. Tests conducted in this article suggest that a reverse bias exists in the baseball betting market.

Point estimates from the regression and the z-test across lines indicate that baseball bettors overbet the favorites, rather than the underdogs. This reverse bias is even more pronounced when heavy underdogs are excluded from consideration. Finally, a sign test is performed to determine if underdogs are underbet, i.e., do the objective probabilities exceed the subjective probabilities? While no significant bias is detected across all lines, 10 of the 12 lines below $+160$ have higher objective probabilities. Under the null hypothesis of no differences between objective and subjective probabilities, the corresponding probability value, calculated from the binomial distribution, is only 0.019.

V. Summary and Concluding Remarks

The major league baseball betting market is found to be highly efficient. Tests performed for individual betting lines reveal no significant differences between the objective and subjective win probabilities. The hypothesis of efficiency is rejected when all lines are considered simultaneously. In particular, a simple strategy of betting only on underdogs yields expected losses significantly lower than those implied by market efficiency; this is a reversal of the well-documented favorite-longshot bias present in racetrack betting. However, these minor inefficiencies are not sufficient to allow for profitable betting strategies when commissions are considered.

As a final observation, we note that risk-seeking attitudes of bettors do not provide a satisfactory explanation of the reverse favorite-longshot bias because, ceteris paribus, a preference for a favorite wager over the corresponding underdog wager provides no information regarding an individual's risk

[18] For example, 79 percent of the available wagers for the win market in Fabricand's study had odds above 4:1. See Ziemba and Hausch (1987).

attitude. Thus the long-standing preference of bettors to overbet favorite teams may represent a true market inefficiency.

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