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RACETRACK BETTING AND INFORMED BEHAVIOR

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Horse racing data permit interesting tests of attitudes toward risk. The present paper studies a new sample of racetrack results from Atlantic City, New Jersey. The questions examined are: (1) Are the market odds the best data for predicting the order of finish? (2) Do horses go off at odds that reflect their true probability of winning? (3) Is there any evidence that late bettors have better information than early bettors? It is found that market odds predict the order of finish well, but that 'favorites' are good bets and 'long shots' are poor ones. The data suggest that there does exist an 'informed' class of bettors and that bettors are on the whole neither risk neutral nor risk averse.

1. Introduction

Racetrack betting shares many similarities with investing in the stock market. In both situations future earnings are not known with certainty,[1] there are a large number of participants, there is extensive information available, professional advice abounds, and each participant has information about the activities of other bettors (investors). Horse racing data, therefore, permits interesting tests of attitudes toward risk and 'investment' behavior.

This paper studies a new sample of racetrack results from Atlantic City, New Jersey, and asks a number of questions concerned with betting rationality. These include:

(1) Are the market odds, as determined by the betting behavior of the public, the best data available for predicting the order of finish in a race?

[1]The dollar payoffs if the horse wins of fails to win are, of course, known at the start of the race but which of the two outcomes materializes is not.

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(2) Do all horses go off at odds that reflect their true probability of winning as suggested by Baumol (1965) or is there a systematic tendency to overbet long-shots and underbet favorites as has been suggested by Rosett (1977), Ali (1977), and Snyder (1978)?
(3) Since each bet is recorded on a parimutuel tote board almost immediately after it is made, there may be some advantages for those with inside information to place their bets late in the betting period just before the race goes off. Such a strategy will minimize the time in which the signal produced by the bet will be available to other bettors. Is there then any evidence that people who bet late in the betting period have better information than other bettors?

The availability of betting information at different time periods is a unique feature of our data set. It permits the testing of somewhat different hypotheses than those that have concerned previous investigators. Section 2 discusses data and definitions. Section 3 contains the results.

2. Data and definitions

2.1. The data set

Observations are based on the entire 1978 thoroughbred racing season at the Atlantic City (NJ) Race Course, which includes 729 races and 5805 horses.[2] The data consist of:

(1) The 'morning line' odds for each horse in each race, determined by the track's professional handicapper and printed in the daily racing program. These are the handicapper's estimates of the winning probabilities for each horse that confront bettors before the start of each betting period. These odds are determined by the judgment of the handicapper and rely on such variables as a horse's past performance, class of the competition, weight carried by the horse, distance of the race, etc. This subjectively determined set of odds, as will be shown below, contains considerable information about the probability of winning for each horse.

(2) Parimutuel odds for each horse in each race at various points ('cycles') during the betting period. Twenty-four cycles are typically recorded, showing the minute-by-minute course of the actual betting for each race. Only some of the available cycles were employed in the analysis. These were chosen to represent periods during which roughly equal amounts of money were bet. Knowing the odds and amounts bet during the various cycles, we were able

[2]The data were provided by Eric Weiss. Thirty-six races were discarded from an initial group of 765. The most common reason for discarding was the late removal ('scratch') of an entered horse. Since scratches occur at various times prior to the beginning of a race, it was felt that the odds-behavior of the remaining horses might be distorted in an unsystematic fashion.

to calculate implicit marginal odds for various time periods within the betting period.

(3) Final parimutuel odds for each horse, given at the final betting cycle and comprising the betting pattern over the full betting period. The odds are determined by the ratio of the betting pool available for distribution to the amount bet on each horse. The racetrack is allowed to subtract a percentage or 'take' from the total betting pool to cover taxes, expenses and profits. In addition, the track enjoys 'breakage', the gain from being allowed to round payoffs downward to the nearest 10¢ or 20¢ (on a \$2 bet). The total betting pool minus the 'take', including breakage, is paid on the winning horse. Only the 'win' betting pool is considered here.

(4) The outcome of each race: First, second, and third-place finishers.

2.2. Some definitions

The following definitions are employed: B is the total amount bet on the race and b_h is the amount bet on horse h, $h=1,2,\ldots,H$, where H is the number of horses in the race. It follows that

$$B=\sum_{h=1}^{H} b_h.$$

Let t be the total 'take' of the track including breakage, all expressed as a percentage amount of the total amount bet. The odds of horse h may then be stated as

$$O_h=(B(1-t)-b_h)/b_h=B(1-t)/b_h-1.$$

We define the favorite as the horse with the lowest final odds, the second favorite as the horse with the second lowest odds, etc. We define the (bettors' subjective) probability of horse h winning the race as P_h. It follows then that

$$P_h=b_h/B=(1-t)/(1+O_h).$$

Suppose now we wish to examine the implicit or marginal odds derived from bets made late in the betting period, on the assumption that late bettors may have more or better information than early bettors. The betting period is approximately 25 minutes, which is the time between races. Define cycle 1 as the betting cycle encompassing the first 17 minutes (the first 2/3) of the betting period, and cycle 2 as the betting cycle encompassing the last eight minutes (the last 1/3) of the betting period.[3] The marginal odds on horse h in

[3]The two cycles used here are aggregates of the many betting cycles we recorded. One would suspect that 'informed' bettors might postpone their bets to the very end of the betting period — perhaps to the last minute or two. Our data did not permit calculation of implicit odds for this brief segment. The odds implicit in the last eight minutes of betting are thus likely to be only a rough measure of informed betting patterns.

betting cycle 1, $O_{h,1}=B_1(1-t)/b_{h,1}-1$, where B_1 is the total amount bet up to the end of cycle 1, and $b_{h,1}$ is the amount bet on horse h up to the end of cycle 1. The final odds on horse 1 (which are also the odds on the horse derived from all betting up to and including cycle 2) are

$$O_{h,2}=B_2(1-t)/b_{h,2}-1.$$

Define the marginal odds as the odds derived from the betting *during* a particular cycle, but *not* including previous cycles. What we specifically want are the marginal odds created by bettors in cycle 2, i.e., the bets of the 'late money', or what is hypothesized to be the 'smart money'. The marginal odds on horse h in cycle 1 are simply the regular odds, i.e.,

$$O^m_{h,1}=O_{h,1}.$$

The marginal odds on horse h in cycle 2 can be derived from the odds at the end of cycles 1 and 2, as follows:

$$O^m_{h,2}=(O_{h,2}b_{h,2}-O_{h,1}b_{h,1})/(b_{h,2}-b_{h,1}).$$

Finally, define a payoff W_h from horse h as unity plus the final odds if h wins and zero otherwise. A horse that goes off at odds of three-to-one pays \$4 for each dollar bet if the horse wins. A rate of return R from betting one dollar on one horse in each of N races is

$$R=(\sum W_h-N)/N,$$

where $\sum W_h$ is the sum of payoffs in the N races.

3. Some results

How well do betting odds predict the order of finish in a race? The answer is — 'very well indeed'. Table 1 compares the subjective probability of a horse winning the race (as derived from the 'market' odds of the betting public) with the objective probabilities of winning derived from actual experience. For similar computations, see Ali (1977). In table 1, horses are grouped by the degrees to which they are favorites of the betting crowd. For example row 1 presents the results for the first favorites of bettors, i.e., for horses that go off at the lowest odds and therefore have the highest subjective probability of winning. Row 2 presents results for the second favorites, etc. The subjective probabilities of horse h winning the race are derived from the betting odds as described above.

Table 1

Subjective and objective probabilities of winning in 729 Atlantic City (NJ) races in 1978 (total number of horses = 5805).

Favorites[a] (1)	No. of races[b] (2)	Obj. prob.[c] (3)	Subj. prob. (4)	(Subj. prob. − obj. prob.)/ st. error of obj. prob.[d] (5)
1st	729	0.361	0.325	−2.119[e]
2nd	729	0.218	0.205	−0.903
3rd	729	0.170	0.145	−1.972[e]
4th	724	0.115	0.104	−0.961
5th	692	0.071	0.072	0.074
6th	598	0.050	0.048	−0.279
7th	431	0.030	0.034	0.480
8th	289	0.017	0.025	1.096
9th	165	0.006	0.018	2.095[e]

[a]Lowest odds horses.

[b]The number of races declines because many races have only a small number of entrants. It should be noted that there are numerous races in which there is a tie for which horse is the first favorite, or second favorite, etc. The pool of first favorites was taken to consist of all horses with the lowest odds, including ties, and similarly for the other positions.

[c]Note that these probabilities are the probabilities for the ith favorite conditional on there being an ith favorite in a particular race. Hence they need not sum to unity.

[d]The standard errors were computed by taking the objective probabilities as the 'true' probabilities and assuming a binomial process. Thus the standard error is $[p(1-p)/n]^{\frac{1}{2}}$ [see Ali (1977)], where p is the objective probability and n the number of races.

[e]Significant at the 0.05 level.

The objective probability of the first favorites winning the race is simply the number of times the first favorite wins divided by the total number of races. The calculation is then repeated for the second favorites,..., ith favorites, with the divisor in each case being the number of races in which there existed an ith favorite.

Note that the subjective odds of the betting public do a good job overall of predicting the true objective probabilities. The first favorites do have the highest objective probabilities of winning. They win approximately one-third of the time. The second favorites have the second highest objective probabilities of winning, and so forth. But there is also a clear tendency [as was found by Ali (1977)] that favorites tend to be underbet and long-shots overbet. The objective probability of the favorites winning (0.361) is actually higher than the subjective probabilities (0.325), as estimated by the betting crowd. On the other hand, the subjective estimates for long-shots winning (i.e., the estimates for the 8th and 9th favorites) are well above the objective probabilities of winning. The last column displays the test criterion which is distributed as $N(0,1)$ under the null hypothesis of no difference between subjective and objective probabilities. In three cases the departure is significant at the 0.05 level. In other words, long-shots seem to go off at lower odds (higher subjective probabilities of winning) than their true objective probabilities of winning would seem to warrant.

We can shed more light on this finding by calculating rates of return from bets on horses with different odds levels in order to provide a further indication of the tendency of the betting public to overbet long-shots. With risk neutrality and in a perfect market, rates of return would tend to be equal for each odds class. In other words, the rates of return for betting horses with short odds ought to be the same as the results of betting horses with intermediate odds and with long odds. Because the track take, including breakage, is about 18.5 percent, however, all rates of return should be negative. On average, bettors should lose roughly 18.5 percent of their 'investments'.

Table 2 shows that this is not the case. There is a clear tendency for the bettor to lose less money betting short odds horses and more money betting on long shots. For example, calculating the rates of return for all races, a bettor would have lost 13.7 percent betting on all horses with odds of 2 to 1 or less and 63.7 percent betting on long shots with odds above 25 to 1. These findings are again similar to those of Ali (1979) and of Snyder (1978). These results are consistent with a view that racetrack bettors are risk lovers, a finding that supports Weitzman's (1965) results.

Table 2

Rates of return from bets on horses with different odds levels for all races and for late races (races 8 and 9).

	Rates of return	
Odds level O (1)	All races (2)	Late races (3)
$0 \leq 2$	−0.1366	−0.0428
$2 < 0 \leq 3.5$	−0.3177	−0.3210
$3.5 < 0 \leq 5$	−0.1758	−0.0288
$5 < 0 \leq 8$	−0.2242	−0.5238
$8 < 0 \leq 14$	−0.1602	−0.1698
$14 < 0 \leq 25$	−0.3255	−0.3618
$25 < 0$	−0.6372	−0.6858

The last column of Table 2 shows the rates of return from betting results only for the last two races of the day (that is, races 8 and 9). In these races the tendency to underbet favorites and overbet long shots is even stronger. In the late races, betting on favorites produces a loss of just over 4 percent while betting on long shots produces a loss of almost 69 percent. Such findings may be related to the fact that since on average, bettors lose almost

20 percent of their capital, the total capital available to them declines during the racing day. This change in capital could be responsible for a change in risk attitude of the representative bettor. Toward the end of the racing day, bettors at the racetrack may be betting on horses with odds sufficiently long so as to give them a chance of breaking even. This phenomenon was also noted by McGlothlin (1956).

Table 3 presents statistics that shed light on the general efficiency of the final odds and on our conjecture of the behavior of 'informed' bettors with respect to the timing of their bets. Column 2 presents the ratio of final parimutuel odds to morning line odds. It will be noted that for winning horses, the final odds tend to be lower than the morning line odds whereas for horses finishing out of the money, the final odds are much higher. These data suggest that the final parimutuel odds are better predictors than the morning line odds.[4]

Table 3

Average ratios of final (O_F) and marginal odds (O_{M2} and $O_{M2'}$) to morning line odds (O_{ML}) for 729 Atlantic City (NJ) races in 1978.

Horses finishing (1)	O_F/O_{ML} (2)	$O_{M2'}/O_{ML}$ (3)	O_{M2}/O_{ML} (4)
First	0.96	0.82	0.79
Second	1.16	1.06	1.01
Third	1.22	1.17	1.07
Also rans	1.59	1.63	1.49

The last two columns of table 3 present the ratio of marginal odds to morning line odds. The marginal odds O_{M2} represent the marginal odds produced by bettors during the last third (the last eight minutes) of the betting period. The marginal odds $O_{M2'}$ are those produced in the final five minutes of the betting period. We have suggested above that because of the potential signaling effect, bettors who feel they have inside information would prefer to bet late in the period so as to minimize the time that the signal was available to the general public. As table 3 shows, the marginal odds of the late bettors appear to be at least as good as and perhaps better than the final odds in predicting the order of finish. Horses that win have marginal odds that average 79 to 82 percent of their morning line odds (depending on

[4]A similar conclusion would be reached if table 1 is recalculated on the basis of morning line odds rather than final odds. Again, the final odds appear to be somewhat superior to handicappers' odds. It is curious that, on average, the final odds tend to be higher than the morning odds. We suspect this results because the professional handicappers are really providing a set of rankings rather than a set of odds consistent with potential payoffs after accounting for the track take.

which definition of marginal odds is employed). In other words, winning horses are especially favored by the late bettors.

4. Conclusions

The central conclusions of this paper are as follows:

(1) Racetrack favorites are 'good' bets and longshots are 'bad' bets — an observation that is in accord with the findings of earlier studies. Such patterns may reflect either an inefficiency in the betting market or variation in attitudes toward risk among bettors [see Losey and Talbott (1980), and Hausch, Ziemba and Rubinstein (1981) who analyze place and show bets].

(2) The data contain a suggestion that there is an 'informed' class of racetrack bettors. It is not possible, however, to define the rates of return that may be earned by this group.[5]

(3) The data suggest that racetrack bettors are on the whole, neither risk neutral nor risk averse.

(4) Despite the variation in rates of return among horses, it is not possible to devise a successful strategy based on observable betting-odds behavior.[6] Whether the variation is attributable to inefficiency or to departures from risk neutral behavior by racetrack patrons, it cannot be exploited by a risk neutral bettor. The variation is too small to overcome the unfairness of the betting terms.

[5]Indeed, if the 'informed' rate of return could be isolated, the informed pattern of betting might become vulnerable to imitation, in which case the information would lose its value.

[6]We shall not comment on the likelihood that this paper would have been published, had such a strategy been identified!

References

Ali, Mukhtar M., 1979, Some evidence of the efficiency of a speculative market, Econometrica 47, 387–392.

Ali, Mukhtar M., 1977, Probability and utility estimates for racetrack betting, Journal of Political Economy 85, 803–815.

Baumol, William J., 1965, The stock market and economic efficiency (Fordham University Press, New York).

Hausch, D.B., W.T. Ziemba and M. Rubinstein, 1981, Efficiency of the market for racetrack betting, Management Science 27, 1435–1452.

Losey, R.L. and J.C. Talbott, Jr., 1980, Back on the track with the efficient markets hypothesis, Journal of Finance XXXV, 1039–1043.

McGlothlin, W.H., 1956, Stability of choices among uncertain alternatives, American Journal of Psychology 69, 604–615.

Rosett, R.N., 1971, Weak experimental verification of the expected utility hypothesis, Review of Economic Studies 38, 481–492.

Snyder, Wayne N., 1978, Horse racing: Testing the efficient markets model, Journal of Finance XXXII, 1109–1118.

Weitzman, M., 1965, Utility analysis and group behavior: An empirical study, Journal of Political Economy LXXIII, 18–26.