Gambling Research, 16(2), p.67-75, Printed in Australia

THE BEHAVIOUR OF ALBERTA GAMBLERS: EVIDENCE FROM THE TOTE AT NORTHLANDS PARK

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Abstract:
We analyzed more than 500 races run at Northlands Park horse track in Alberta, Canada. Bettors are revealed to place their bets in a way that is inconsistent with the maximisation of expected monetary returns. In contrast to nearly all of the previous literature on betting market inefficiency, we find that bettors overbet the favourites and underbet the longshots: Where other researchers find that bettors have a preference for risky bets and the 'thrill of hitting the longshot', we find that Alberta bettors have a preference for the bets that have yield the highest frequency of wins even though the average return is lower. The behaviour of Alberta bettors is consistent with a betting strategy where one aims to have the lowest rate of decay in one's game bank or alternatively the lowest price per hour for an active gaming participant at the track.

Keywords:
risk preference, utility function, bettor preferences, power utility model, betting bias

Introduction

In this empirical paper we analyze the behaviour of horse track gamblers in the province of Alberta—a province notable in Canada for having the largest per-capita expenditure on gaming. In particular, we analyze the wagers made on each horse and the race outcomes of more than 500 races run at Northlands Park which is located in the city of Edmonton, the provincial capital of Alberta. Our purpose in analyzing the bets and race outcomes is to quantify the behaviour of Alberta bettors with respect to their revealed preferences over risk and return.

A number of hypotheses are examined statistically. We test the hypothesis that Alberta horse track gamblers place bets so that the expected return per dollar bet is equalized across alternative bets—the betting alternatives varying from the longshot horses to the favourite horses. This hypothesis represents what financial economists refer to as the efficient markets hypothesis, and it represents the outcome expected to obtain if bettors place their bets to maximise the expected value of their winnings from wagers. There are many other ways one could model the behaviour of bettors, such as the superstition hypothesis examined by Allen Windross (2003).

> *We also examine the revealed risk preferences of punters through the estimation of utility functions. We estimate Ali's (1977) power utility function which permits us to formally test the hypothesis of risk neutrality against the alternatives of risk preference and risk aversion. We also examine the skewness-preference hypothesis put forward by Golec and Tamarkin (1998). This hypothesis formalizes the "thrill of hitting the longshot" by including skewness explicitly into the representative bettor's utility function in addition to the average return and its variance.*

The empirical results reject the hypothesis that bettors place bets to maximise their expected return. In fact, Alberta gamblers bet too much on the favourite horses and too little on the longshots relative to the return-maximizing level of bets. Most studies of betting that reject the efficient markets hypothesis find that bettors overbet the longshot horses, and this is interpreted as evidence of risk preference. The interpretation of our results is that bettors are overly conservative as compared to maximisation of betting returns because they overbet the favourites. However, bettor behaviour is consistent with bettors minimising the rate of decay of their game bank.

Alternative Ways to Quantify Betting Behaviour

Horse tracks around the world use the parimutuel system of betting, also referred to as the 'tote'. In parimutuel betting markets, the track operator extracts a percentage of the betting pool and returns the remainder to winning bettors in proportion to their individual stakes on the outcome of the race. The net return per dollar from a bet on a particular horse i is given by

$$R_i=(1-t)\left(\frac{w}{x_i}\right)-1 \qquad (1)$$

where t is the track take; x_i is the total amount bet on horse i; and $w=\sum_i x_i$ is the total amount bet on all horses. Because the returns on each bet depend on the total amount bet on all horses, the actual payoffs to bets are not determined until all bets have been made.

If the proportion of the total betting pool bet on each horse were equal to each horse's win probability, returns across all horses would be equalized and the betting market could be considered economically efficient in that bettors have exploited all betting margins. However, if the pattern of betting resulted in a particular horse yielding a statistically larger expected return than another horse, this would be evidence against the hypothesis of bettors maximising their financial returns.

Do Punters Maximise Expected Returns?

The most direct way to examine betting market efficiency is to test whether punters allocate bets across horses to equalize returns. This is equivalent to testing if bettors' subjective probabilities are equal to the objective probabilities. The method of grouping data and calculating statistics to test the market efficiency hypothesis was developed by Ali (1977). First, horses in each race are grouped by rank order of betting volume; the horses with largest bet fractions are the first favourite grouping, the horses with the second largest bet fractions are the second favourite grouping, and so on. The fractions of money bet on horses are the subjective probabilities (Rosett, 1965) and these probabilities are compared to the objective probabilities (fractions of wins) within each grouping. Instead of grouping horses into categories on the basis of the subjective win probability, Busche and Hall (1988) argue that ranking by favourite position is preferred; both methods have been used in the literature. We use the subjective win probability ranking because the analysis requires more categories than are available using favourite positions Rosett (1965) showed that if risk-neutral bettors have unbiased expectations of win probabilities, then the proportion of money bet on a horse will equal the win probability. If the difference between subjective probability and objective probability is zero, the return from each horse will be equalized at the average loss due to the track's extraction of a portion of the betting pool. We can test the null hypothesis that the subjective probability (ψ) equals the objective probability (ζ) in each favourite position by treating the number of wins as a binomial statistic: Let the probability of a horse winning equal ζ, the win fraction. In n races, the expected number of wins is $n\zeta$ and the variance is $n\zeta(1-\zeta)$. For a sample of n observations, the statistic

$$z=(\psi-\zeta)\sqrt{n/\zeta(1-\zeta)} \qquad (2)$$

has a limiting normal distribution with mean zero and unit variance (Hogg and Craig, 1978, p. 195); the normal distribution is a good approximation for modest sample sizes and it is a nearly exact approximation given the large sample sizes used in this research. Very large or small z-statistics, as compared with the upper or lower percentage points of the normal distribution, provides statistical evidence of overbetting or underbetting on horses in each favourite position.

Modeling Bettor Preferences Directly

Two other ways of quantifying and testing bettor behaviour are based on alternative specifications of a representative bettor's utility function. Modeling bettor utility is based primarily on the work of Ali (1977, 1979) where a representative bettor has utility function $u(\cdot)$. A bet on horse h returns X_h dollars if the horse wins and zero otherwise. The utility function is normalized so that the utility of a winning bet on the longest-odds horse is unity and the utility of any losing bet is zero. In this formulation, the utility of a winning bet on horse h is $u(x_h)=p_H/p_h$, where p_H is the objective win probability on the least-favourite horse and p_h is the objective win probability on horse h.

Power Utility Model

Ali (1977) fits a power function to approximate utility so $u(x_h)=\mathrm{a}x_h^{\mathrm{b}}$ and he estimated this using the logarithmic transformation:

$$\ln u(x_h)=\alpha+\beta\ln x+\mu. \qquad (3)$$

Risk-neutrality is implied in this equation if the exponent β equals unity; risk preference is indicated if β is greater than unity; and risk aversion is indicated if β is less than unity. Modeling utility as a power function is arbitrary and it implies constant relative risk aversion. As an alternative Golec and Tamarkin (1998) suggest using a cubic utility model.

Cubic Utility Model

Golec and Tamarkin (1998) suggest that we approximate the unknown utility function $u(x_h)$ by expanding a third-order Taylor series approximation. (Deriving the cubic utility model is beyond the scope of this empirical paper. See Kimball (1990) and Pratt and

Zeckhauser (1987) for a derivation and discussion of the higher-order derivatives of the utility function.) The Taylor series approximation results in a cubic utility model estimable by least-squares regression:

$$u(x_h)=\alpha+\beta_1 x+\beta_2 x^2+\beta_3 x^3+\mu. \tag{4}$$

Risk-neutrality is implied when $ß_2=0$; risk preference is implied when $ß_2>0$; and risk aversion is implied when $ß_2<0$. Skewness-neutrality is implied when $ß_3=0$, and skewness preference and aversion are implied when $ß_3>0$ or<0, respectively. If skewness and variance are highly correlated, and skewness is not incorporated into the analysis, bettors could appear to have risk preferences when in fact they prefer skewness and are risk averse. An implication of expected utility theory is that the constant in the cubic utility model is equal to zero. We do not reject the null hypothesis that equals zero in our results.

Results

The sample of data contains the amounts bet and finishing results for each horse in 509 races held at Northlands Park horse track in Edmonton, Alberta Canada. Before estimation can take place, the data must be grouped into categories on the basis of the subjective win probabilities—each horse's share of the aggregate bet volume. Golec and Tamarkin (1998) choose their probability cutoffs so that there are more categories in the high-probability range; however, the grouping in their paper is arbitrary so there is no algorithm to duplicate it with our sample. In our analysis, we select the probability ranges using three methods: 1) equalize the number of horses in each group, 2) equalize the turnover on each group of horses, and 3) overweight the favourites as suggested by Golec and Tamarkin (1998). The amount of money bet provides a natural grouping that weights favourites more heavily than grouping to equalize observations. Golec and Tamarkin (1998) state that, "because much more money is bet on a favourite than on a long shot (by definition), equal weighting of long shots and favourites tends to underweight favourites" (p. 213).

Table 1 shows the descriptive statistics and *z*-statistics for the full sample of horse races grouped by subjective win chance. The data are consistent with data from earlier studies (Ali, 1977; Hausch et al., 1981; Asch and Quandt, 1987) in that there is a consistent pattern of variance and skewness increasing, with skewness increasing faster than variance, as the objective probability declines. We observe that variance increases as win chances fall and skewness increases even more; this is consistent with the cubic utility hypothesis. The *z*-statistics for the null hypothesis that the subjective win probability equals the objective win probability are displayed in the right-hand column of the table. The first six rows (favourite groupings) in the table have *z*-statistics larger than two, indicating that horses in these groupings are overbet. The *z*-statistics for the bottom eight rows are all less than minus 2, indicating that horses in these longshot categories are all underbet. We can clearly reject that Alberta horse track gamblers behave in a way consistent with maximizing expected monetary returns per dollar bet.

Table 1:
Distribution of Returns: Equal Weighting

horses	*wins*	*objective probability*	*subjective probability*	*mean*	*variance*	*skewness*	*z-statistic*
210	9	0.0429	0.4106	-0.9126	0.1707	0.3184	6.3847
210	11	0.0524	0.3046	-0.8587	0.3612	0.8723	5.5224
210	14	0.0667	0.2577	-0.7870	0.6349	1.7576	4.6983
210	13	0.0619	0.2185	-0.7672	0.8214	2.7068	4.2911
210	19	0.0905	0.1925	-0.6140	1.4977	5.2333	3.0288
210	16	0.0762	0.1667	-0.6247	1.7074	7.1280	2.9332
210	21	0.1000	0.1452	-0.4341	2.8817	13.0453	1.5885
210	29	0.1381	0.1262	-0.1007	5.0472	23.7896	-0.4521
210	22	0.1048	0.1113	-0.2265	5.1127	29.8393	0.2677
210	26	0.1238	0.0974	0.0440	7.7135	48.9374	-1.1643
210	34	0.1619	0.0856	0.5537	12.4967	81.0930	-3.6157
210	26	0.1238	0.0745	0.3644	13.1751	109.2425	-2.5161
210	33	0.1571	0.0642	1.0112	21.6956	190.4041	-5.1426
210	34	0.1619	0.0539	1.4717	31.6238	326.4480	-6.5628
210	34	0.1619	0.0445	1.9959	46.4620	581.3518	-7.8851
210	44	0.2095	0.0344	4.0320	95.5279	1332.8310	-13.4484
210	57	0.2714	0.0242	8.3471	234.5146	3691.8407	-22.7315
215	67	0.3116	0.0116	27.7973	831.8545	63775.4059	-40.6980

Note: Groupings were determined by sorting horses in decreasing order of bet fraction (subjective probability) into eighteen equal groups, with the remainder added to the final group.

Alberta bettors appear not to be maximizing returns because they could reallocate bets from favourite horses to longshot horses in a way that would increase the expected returns for the same amount bet. In some ways our empirical finding is no surprise, because the nearly universal result of empirical research on horse track betting finds that bettors do not behave in a way consistent with maximising financial returns. The results of Ali (1977), Fabricand (1977), Hausch, Ziemba, and Rubinstein (1981), Asch and Quandt (1987), Asch, Malkiel, and Quandt (1982, 1984), and other authors all point toward market inefficiency in horse wagering. The survey articles by Vaughan-Williams (1999), Sauer (1998), Thaler and Ziemba (1988), and the Hausch, Lo and Ziemba (1994) volume contain a more complete listing of horse betting papers that echo these results. Few published papers have found evidence consistent with market efficiency. Busche and Hall (1988), Busche (1994), and Busche and Walls (2000) used the same empirical methods as previous researchers and obtained results consistent with optimizing behaviour on the part of racetrack bettors.

> *However, the most well-established market inefficiency—known in gambling parlance as the favourite-longshot bias—is that the favourite or low-odds horses are systematically underbet relative to the longshot or high-odds horses. In our empirical work, we find exactly the opposite—that favourites are being overbet relative to longshots.*

Table 2:

Distribution of Returns: Equal Bet Volume

horses	*wins*	*objective probability*	*subjective probability*	*mean*	*variance*	*skewness*	*z-statistic*
76	1	0.0132	0.4768	-0.9771	0.0393	0.0667	4.2340
82	5	0.0610	0.3877	-0.8707	0.2575	0.4795	3.7182
84	6	0.0714	0.3443	-0.8298	0.3768	0.7697	3.4514
106	2	0.0189	0.3083	-0.9498	0.1310	0.3354	4.4637
97	6	0.0619	0.2830	-0.8205	0.4887	1.2428	3.4666
109	9	0.0826	0.2635	-0.7431	0.7331	1.9042	3.1576
106	7	0.0660	0.2403	-0.7744	0.7201	2.1357	3.1900
140	7	0.0500	0.2188	-0.8124	0.6687	2.2583	3.7739
141	9	0.0638	0.2017	-0.7405	0.9879	3.5039	3.2569
159	16	0.1006	0.1828	-0.5479	1.8265	6.5542	2.1899
186	17	0.0914	0.1626	-0.5383	2.1187	8.7456	2.2028
211	21	0.0995	0.1426	-0.4267	2.9741	13.7224	1.5346
221	31	0.1403	0.1237	-0.0684	5.3196	25.4191	-0.6540
228	22	0.0965	0.1081	-0.2663	5.0408	30.9329	0.5037
285	36	0.1263	0.0920	0.1292	8.8190	58.9192	-1.8210
354	55	0.1554	0.0749	0.7080	15.8591	120.1680	-5.3166
441	66	0.1497	0.0555	1.2377	28.4515	298.0775	-8.1590
759	193	0.2543	0.0264	10.5721	392.7186	8783.0263	-38.1000

Note: Groupings were determined by sorting horses in decreasing order of bet fraction (subjective probability) into eighteen groups while equalizing the sum of the bets across groups.

Tables 2 and 3 display the equal-turnover and overweighted-favourite groupings of horses, respectively. In these tables, we also see that variance increases rapidly moving from the favourite groupings down toward the longshot groupings, and we also observe that skewness increases even more rapidly. Also, in both tables, we find that favourite horses are overbet—have *z*-statistics larger than 2. The longshot horses are underbet—have *z*-statistics less than minus 2.

Table 3:

Distribution of Returns: Overweight Favourites

horses	*wins*	*objective probability*	*subjective probability*	*mean*	*variance*	*skewness*	*z-statistic*
30	1	0.0333	0.5239	-0.9476	0.0798	0.1171	2.5614
70	3	0.0429	0.4328	-0.9185	0.1483	0.2578	3.7349
60	2	0.0333	0.3790	-0.9275	0.1524	0.3094	3.4272
80	6	0.0750	0.3443	-0.8213	0.3938	0.7975	3.3239
100	2	0.0200	0.3100	-0.9471	0.1372	0.3486	4.3265
120	7	0.0583	0.2823	-0.8304	0.4644	1.1926	3.9122
140	11	0.0786	0.2571	-0.7490	0.7390	1.9902	3.5905
200	11	0.0550	0.2237	-0.7981	0.7006	2.2894	4.4446
220	18	0.0818	0.1967	-0.6582	1.3109	4.5799	3.4440
240	21	0.0875	0.1685	-0.5734	1.8982	7.6356	2.7871
240	24	0.1000	0.1438	-0.4283	2.9412	13.4512	1.6552
260	35	0.1346	0.1221	-0.0938	5.2788	25.9673	-0.5392
260	24	0.0923	0.1042	-0.2719	5.2129	33.5266	0.5641
240	38	0.1583	0.0891	0.4601	11.3326	71.4124	-3.4305
320	47	0.1469	0.0743	0.6276	15.3864	120.4163	-4.5846
300	46	0.1533	0.0590	1.1443	25.3894	246.1770	-6.5305
420	77	0.1833	0.0423	2.6260	58.5687	733.6479	-13.7644
485	136	0.2804	0.0194	15.5905	706.3237	18352.8330	-40.8262

Note: Groupings were determined by sorting horses in decreasing order of bet fraction (subjective probability) into eighteen groups, starting with 30 horses in the most favourite group and increasing the proportion of horses in each subsequent group.

Columns 4–6 of Table 4 show the regression results for the power and cubic utility models corresponding to the equalized bet volume and overweighted favourite groupings of horses. Again, the power utility model has an estimated coefficient on ln$x$ of slightly less than unity in each regression, but in each case the coefficient is not statistically different from unity at the 5% significance level; the estimates of the power utility model do not allow us to reject the hypothesis of risk neutrality. The cubic utility estimates indicate that utility is increasing in mean and decreasing in variance and skewness, but only the coefficients on mean and variance are significantly different from zero at the 5% level. The cubic utility model estimates now show a significant aversion to risk that is consistent with the observed bettor behaviour.

Table 4:
Statistical Estimates of Bettor Preference Functions

	Equal Horses		*Equal Betvol*		*Overweight Favourite*	
	Lnu	*u*	*lnu*	*u*	*lnu*	*U*
Constant	-2.045	1.47e-3	-2.193	1.11e-3	-1.867	-2.20e-3
	(0.009)	(1.81e-3)	(0.014)	(1.73e-3)	(0.008)	(3.05e-3)
	[0.009]	[1.72e-3]	[0.014]	[1.42e-3]	[0.008]	[2.99e-3]
ln$x$	0.987		0.988		0.993	
	(0.011)		(0.016)		(0.010)	
	[0.011]		[0.017]		[0.016]	
x		8.28e-2		5.99e-3		1.42e-2
		(3.74e-4)		(3.37e-4)		(8.33e-4)
		[5.52e-4]		[3.87e-4]		[1.22e-3]
x^2		3.74e-5		-4.30e-7		-1.94e-6
		(1.26e-5)		(1.06e-5)		(4.00e-5)
		[1.58e-5]		[1.14e-5]		[6.15e-5]
x^3		3.25e-7		5.57e-8		-2.52e-7
		(7.44e-7)		(5.97e-8)		(3.56e-7)
		[8.87e-7]		[6.48e-8]		[5.62e-7]
R^2	0.99	0.99	0.99	0.99	0.99	0.99

Notes: All equations estimated by least-squares regression. The estimates for Equal Horses, Equal BetVol, and Overweight Favourites correspond to the distribution of returns reported in Tables 1, 2, and 3, respectively. Least-squares standard errors are in parentheses. White’s (1980) robust standard errors are in brackets.

The estimates of a representative bettor’s preferences through the utility function appear to be fragile with respect to how the data are organized. The estimates are also fragile with respect to the functional form. It appears that the best way to quantify bettor behaviour is to calculate the overbetting/underbetting statistics as was done in Tables 1–3.

Conclusions

We have analyzed more than 500 races run at Northlands Park horse track in Alberta, Canada. Bettors are revealed to place their bets in a way that is inconsistent with the maximization of expected monetary returns. In contrast to nearly all of the previous literature on betting market inefficiency, we find that bettors overbet the favourites and underbet the longshots: Where other researchers find that bettors have a preference for risky bets and the ‘thrill of hitting the longshot’, we find that Alberta bettors have a preference for the bets that yield the highest frequency of wins even though the average return is lower. The behaviour of Alberta bettors is consistent with a betting strategy where one aims to have the lowest rate of decay in one’s game bank or the lowest price per hour for an active gaming participant at the track.

Acknowledgements:
This research was supported by a grant from the Alberta Gaming Research Institute.

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References

Ali, M. (1977). Probability and utility estimates for racetrack bettors. *Journal of Political Economy, 85,* 803–815.

Ali, M. (1979). Some evidence on the efficiency of a speculative market. *Econometrica, 47*(2),387–392.

Asch, P., Malkiel, B., & Quandt, R. (1982). Racetrack betting and informed behavior. *Journal of Financial Economics*, *10,* 187–94.

Asch, P., Malkiel, B., & Quandt, R. (1984). Market efficiency in racetrack betting. *Journal of Business*, *57*(2),165–175.

Asch, P. & Quandt, R. (1987). Efficiency and profitability in exotic bets. *Economica*, *54*, 289–98.

Busche, K. (1994). Efficient market results in an Asian setting. In D. Hausch, V. Low, & W.T. Ziemba, (Eds.), *Efficiency of racetrack betting markets* (pp. 615–616). New York: Academic Press.

Busche, K. & Hall, C. D. (1988). An exception to the risk preference anomaly. *Journal of Business*, *61*, 337–46.

Busche, K. & Walls, W. D. (2000). Decision costs and betting market efficiency. *Rationality and Society, 12*(4), 477–492.

Fabricand, B. P. (1977). *The Science of Winning*. New York:Van Nostrand Reinhold.

Golec, J. & Tamarkin, M. (1998). Bettors love skewness, not risk, at the horse track. *Journal of Political Economy*, *106*(1), 205–225.

Hausch, D., Ziemba, W., & Rubinstein, M. (1981). Efficiency in the market for racetrack betting. *Management Science*, *27*, 1435–1452.

Hausch, D. B., Lo, V. S. Y., & Ziemba, W. T. (Eds.). (1994). *Efficiency in Racetrack Betting Markets*. New York: Academic Press.

Hogg, R. V. & Craig, A. T. (1978). *Introduction to Mathematical Statistics* (4^{th} ed). New York: Macmillan.

Kimball, M. S. (1990). Precautionary saving in the small and in the large. *Econometrica, 58*(1), 53–73.

Pratt, J. W. and Zeckhauser, R. J. (1987). Proper risk aversion. *Econometrica*, 55(1):143–54.

Rosett, R. N. (1965). Gambling and rationality. *Journal of Political Economy*, *73,* 595–607.

Sauer, R. (1998). The economics of wagering markets. *Journal of Economic Literature, 36*(4), 2021–2085.

Thaler, R. & Ziemba, W. T. (1988). Parimutuel betting markets: Racetracks and lotteries. *Journal of Economic Perspectives*, *2*,161–74.

Williams, V.L. (1999). Information efficiency in betting markets: A survey. *Bulletin of Economic Research, 51*(1), 1–30.

White, H. (1980). A heteroskedasticity-consistent covariance matrix estimator and direct test for heteroskedasticity. *Econometrica*, *48,* 817–838.

Windross, A. J. (2003). The luck of the draw: Superstition in gambling. *Gambling Research*, *15*(1), 73–