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**EXPERT ANALYSIS AND INSIDER INFORMATION IN
HORSERACE BETTING: REGULATING INFORMED
MARKET BEHAVIOR**

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**EXPERT ANALYSIS AND INSIDER INFORMATION IN HORSE
RACE BETTING: REGULATING INFORMED
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ABSTRACT:

We present a new model analyzing the effect of uncertainty faced by bookmakers. It is shown that bettors with inside information or expert analysis decrease the odds set by profit maximizing bookmakers. Data on previously unraced two year old horses and those that have raced previously are used to examine the impact of the greater possibility of insider information on odds bias in relation to unraced horses. The price of a bet on unraced two year olds is found to be on average 15% higher and the effect varies as the probability of winning increases. The latter effect suggests a possible contribution to the favorite-longshot bias and the former shows the importance of insider information in the setting of market prices. The regulation of the use of insider information is discussed in the light of the similar impact of insider information and expert analysis on bookmaker odds.

KEUWORDS: Betting, horseracing, insider information, uncertainty

JEL CLASSIFICATION: D82 & L83

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I Introduction

The setting of odds on gambling events has been the subject of much academic attention over the last thirty years, see the reviews by Sauer (1998), Thaler and Ziemba (1988), Vaughan Williams (1999), Coleman (2004) and Clotfelter (2005). In particular, the impact of the use of insider information by gamblers has been examined in a large number of theoretical and academic studies, see Dowie (1976), Tuckwell (1983), Crafts (1985), Henery (1985), Bird and McCrae (1987), Shin (1991, 1992 and 1993), Schnytzer and Shilony (1995, 2003 and 2005), Vaughan Williams and Paton (1997), Paton, Vaughan Williams and Fraser (1999), Jullien and Salanié (2000), Law and Peel (2002) and Schnytzer and Snir (2008).

The purpose of the present study is to develop a realistic model of insider and expert gambling and the corresponding odds offered by bookmakers. The impact of insider trading and betting by experts is to increase the uncertainty faced by bookmakers and lead them to reduce the odds offered on events where there is greater likelihood of such bets. In the current study, this effect is quantified in order to measure directly the effect of insiders on the odds offered to gamblers without access to superior information. Unlike earlier studies, we make a clear distinction between the actions of gamblers with inside information and those who process publicly available information to give objectively accurate estimates of the probabilities of different horses winning, i.e. expert bettors.

The setting of odds by bookmakers on often repeated sporting events provides an excellent opportunity for economics to investigate the pricing by a market maker of a financial asset with an uncertain outcome in the face of the possibility of insider knowledge. The analysis presented here allows the extent of the impact of insider trading on asset prices to be measured more directly than previous models. This direct impact is different from the measurements of, for example, Shin (1991, 1992 and 1993), whose studies suggest the favourite-longshot bias is determined only by insiders' gambling. In contrast, our analysis shows that insider models equally well describe the outcomes following from the behaviour of well informed gamblers with *no* access to privileged information. For this reason, the empirical investigation of this paper employs a dataset in which the influence of expert opinion is likely to be less marked, and that of insider trading to be of importance. The need for regulation of insider gambling is examined in the light of our model and the quantification of its effect.

The paper is in four further sections. The second section reviews the literature on the setting of odds in the face of insider trading. The third section develops a new model of how bookmakers who maximize expected profits set odds in the face of insider and expert gambling. The fourth section tests the predictions of the model against extensive UK data sets of two year old horses that have never raced before, compared to those that have raced previously. The final section gives a conclusion and analyses the need for regulation of insider gambling and trading in the light of the theoretical and empirical evidence presented here.

II Past Studies of Insider Information

Given the explicit importance of probabilities in relation to odds in betting markets, it is useful to adopt a definition of bettor rationality suggested by Ali:

...bettors are rational in the sense that no one prefers a bet with a smaller winning probability and the same or lower return, or with a lower return and the same or lower winning probability, to that available to him.

(Ali 1977, p 809, footnote 9):

Ali goes on to distinguish rationality from sophistication, asserting that:

...bettors are sophisticated in the sense that the objective winning probabilities are known to them.

(Ali 1977, p 809, footnote 9):

Thus, one may regard potential gamblers who have objective information of the probabilities of an event occurring as better informed than other gamblers.

There follows from Ali's classification an important distinction that we believe has been largely neglected hitherto in the literature. Namely, the distinction is rarely made between bettors who process publically available information, to form accurate objective estimates of the probability of horses winning, and those who have access to privileged information. We refer to these two types of gamblers as "experts" and "insiders" respectively.

Information based models of odds bias have received much attention in recent empirical studies of betting markets. Hurley and McDonough (1985) explored the asymptotic behaviour of "informed" bettors by assuming that, in contrast to the uninformed bettors, they know the true probabilities of horses winning and have acquired this information at zero cost. Informed bettors are further assumed to respond to the actions of their uninformed counterparts, pursuing a symmetric Nash game. The implication of their hypothesis is that the bias increases with the proportion of uninformed bettors in the market, as they bet disproportionately on the longshot. The favourite-longshot bias on this view has two components: one directly proportionate to transaction costs and the other component positively related to the cost of acquiring race specific information to evaluate true probabilities. They proceeded to show that the model is generalisable to an n runner race so that it becomes amenable to empirical testing in relation to observed market data.

In relation to horse racing, Vaughan Williams and Paton (1997) found that the favourite-longshot bias was more pronounced in low-grade races than in high class races. This finding is consistent with a reasonable assumption that the cost of acquiring information relevant to the race outcomes is higher for low-grade races than high class contests, because there is likely to be less public and media scrutiny of low grade runners.

Sobel and Raines (2003) identified a lower favourite-longshot bias in high volume betting markets, assumed to be better informed, than low volume markets, assumed to be proportionately more heavily populated by casual bettors. The starting point for the Sobel and Raines information model was to show that in the absence of any information regarding race outcomes, the expected proportion of public bets made on each runner in a pari-mutuel market will be $1/n$, where n is the number of race entrants. This represents the limiting case of extreme bias. To the extent that the betting public acquire race specific information to inform their assessment of the true chances of individual runners, the actual degree of bias will depart from this limiting case and the proportions bet will approach more closely the distribution of objective probabilities. The degree of bias is therefore largely a function of the amount of information available to bettors and the number of runners in the race.

Using a substantial dataset of greyhound racing pari-mutuel prices, Sobel and Raines found evidence of a conventional favourite-longshot bias associated with a high proportion of casual bettors, and of an opposite favourite-longshot bias (due to over-reaction to information) in the presence of a high proportion of 'serious' bettors (experts and insiders on our definition, though not differentiated between in their paper), substantiating their information model.

Smith, Paton and Vaughan Williams (2006) further substantiated the information based explanation of bias in a comparative study of betting exchange and bookmaker markets, finding bias to be positively related to transactions costs and negatively related to the amount of race specific information available to the public.

In contrast to bettors who process publically available information in a sophisticated manner - the experts - there exist bettors with access to privileged information. These bettors are typically labelled as insiders – see, for example, Crafts (1985) and Paton, Vaughan Williams and Fraser (1999). Schnytzer and Shilony (1995, 2003, 2005) develop models where the bookmaker responds to betting by insiders by adjusting the odds in the betting market.

The most innovative, frequently cited and used insider model of the setting of bookmaker odds, however, is that of Shin (1991, 1992 and 1993). Shin explains the favourite-longshot bias observed in bookmaking markets as the consequence of bookmakers' response to asymmetric information, where some bettors know the outcome of a race by virtue of their insider status. Bookmaker response is modelled by Shin as an adverse selection problem, with the empirical consequence that bookmaker odds on longshots as a class are depressed below fair odds to prevent losses in the face of insider activity. This action of bookmakers protects them against traders with privileged superior information. In the Shin model, this exposure to uncertainty is greater for low probability horses. Thus, in the Shin model, this effect of potential insider information declines in magnitude as the expected probability of winning increases, and can consequently explain the favourite-longshot bias.

The odds biases observed in empirical studies employing information based models are frequently attributed to the betting of insiders. Models of expert and insider gamblers are, in fact, difficult to distinguish, as the impact of the two types of gambler on bookmakers' odds is the same (and will also be the same for the odds given by pari-mutuel systems of gambling). Thus, assuming that experts also possess superior estimates of probabilities of winning, models that

attribute the cause of bias in bookmaker odds entirely to gambling by insiders are incorrect. The cause of bias could equally be the response of bookmakers to expert gamblers processing the publicly available information or, more likely, both types of gamblers could cause the biases. Additionally, it is not clear that all the bias is caused by the bookmaker responding to betting by informed gamblers. There may well be other causes of the favourite-longshot bias. Thus, there are two reasons why past studies may have overestimated the impact on odds of insiders gambling. Policymakers need to be aware of this overestimation when framing regulations to deal with insider trading in such markets.

In any model of odds, it is also necessary to consider the behaviour of a third class of bettor, namely the less well informed or casual gambler. Behavioural finance studies typically challenge the assumption that decision-makers are proficient at assessing objective probabilities, i.e. they question the *sophistication* of bettors, and attribute the bias to an inability of decision making agents to compute objective probabilities accurately (Kahneman and Tversky, 1979; Tversky, Kahneman and Slovic, 1982; Tversky and Kahneman 1992). For example, individuals are found to overestimate the probability of catastrophic loss in the imputed calculation of the expected value of a risky proposition. In respect of large potential losses in wealth, they will therefore behave in a risk-averse manner and insure, whereas faced with large potential gains they will gamble. The negative expected value associated with premiums in the case of insurance, and stakes in the case of a gamble, are in such cases understated relative to the potential losses and gains respectively, due to individuals computing objective probabilities wrongly or because they adopt “min/max” or “regret” heuristics (Shleifer 2000 and Shiller 2001).

In relation to models of gambling, these unsophisticated decision-makers correspond to the uninformed or casual gamblers identified in Hurley and McDonough (1985) and Sobel and Raines (2003). It is suggested that the observed biases in odds are not just explained by the betting of informed gamblers but that the behaviour of uninformed and casual gamblers is likely to contribute to the effect.

In the following analysis, the behaviour of uninformed or casual gamblers is not the focus of attention; rather it is the impact of insiders and experts on the odds offered by bookmakers that is of interest.

III The Bookmaker Model

The reported odds for betting on British horse races at off-course betting offices are derived from a sample of on-course bookmaker odds, forming the basis of the *starting price*, a unique odds value for each horse determined by official on-course odds inspectors. In the absence of a specified fixed-odds value agreed between bookmaker and bettor, winning bets are settled at starting price. In this analysis, we make the assumption, employed by Shin (1991, 1992 and 1993), that odds are set by a single representative bookmaker. The major justification for this assumption is that the setting of odds is an infinitely repeated game by bookmakers who can easily observe and respond to price cutting by rivals, are well known to each other, and meet

frequently. Consequently, we expect that there is a high degree of trust between them. These conditions make it very likely that bookmakers set prices that maximize joint expected profits (see Binmore, Kirman and Tani, 1993). Thus, we consider prices to be set simultaneously on all n horses in a race, by a single bookmaker.

The price of a ticket that pays £1 on the i th horse winning is q_i . The expected probability of the i th horse winning p_i is known to the bookmaker. The bookmaker knows the expected probabilities p_i but this expectation is determined by a probability density function ϕ for the different probabilities of winning for each of the competitors. The bookmaker knows the probability density function, i.e. understands the degree of uncertainty, but not the actual outcome of the probability for any horse winning.

X_i is the number of bets by uninformed bettors and is paid out by the bookmaker on the i th horse winning. Uninformed bettors are defined as those whose objective expected return is negative, as they bet on horses whose objective probability of winning is less than the price. N_i is the number of identical informed bettors who bet on the i th horse. Y_i is the number of bets by an informed bettor on the i th horse and $N_i Y_i$ is the amount paid out by the bookmaker to informed bettors on the i th horse winning. Informed gamblers are limited in number and defined as bettors who know the outcome of the draw from the probability density function ϕ .¹ Informed gamblers either bet nothing or a positive amount with an expected return that is positive. The expected bookmaker profits are

$$\Pi = \sum_1^n X_j (q_j - p_j) + \int \sum_1^n N_j Y_j (p_j^*, q_j) (q_j - p_j^*) \phi(\mathbf{p}^*) d\mathbf{p}^* \quad (1)$$

where \mathbf{p}^* is a column vector.

Informed bettors are assumed to bet on (at most) only one horse in a race² and the expected profit maximum is given by the condition:

¹ It is possible to generalise the analysis and allow insiders to have different probability density functions. Thus, informed gamblers' degree of understanding of the probability density function varies. For example, in particular circumstances known to one type of informed gambler, they know that the probability of a horse winning is p_j , whereas another informed gambler with superior information may know the underlying probability density function that has the mean p_j . This improvement is relatively straight forward to include in the model but slightly complicates the presentation of the analysis, though the results remain the same. For this reason we omit the more general model.
² It is very unlikely that an insider has privileged information on more than one horse in a race and this justifies the assumption that insiders only bet on (at most) one horse in race. It is possibly that expert gamblers may hedge their bets and bet on more than one horse in a race. This greatly complicates the analysis but the results presented here carry over approximately to the more general case of the possibility of an informed gambling betting on more than horse in a race, see for details Sung, Johnson and Peirson (2008).

$$\frac{\partial \Pi}{\partial q_i} = \sum_{j=1}^n \frac{\partial X_j}{\partial q_i} (q_j - p_j) + X_i \quad (2)$$

$$+ \int N_i \frac{\partial Y_i}{\partial q_i} (q_i - p_i^*) \phi(\mathbf{p}^*) d\mathbf{p}^* + \int N_i Y_i \phi(\mathbf{p}^*) d\mathbf{p}^* = 0$$

All terms with Y in them are positive as informed bettors only bet when the expected return is positive, i.e. $(q_j - p_j)$ and $\partial Y_i / \partial q_i$ are negative.

The uncertainty facing the bookmaker has two components and is important, in the manner of Shin, in determining the prices set. Firstly, the bookmaker faces uncertainty about the number of informed gamblers, and secondly, uncertainty about the nature of the distribution of the probability density function ϕ . An increase in uncertainty follows from either an increase in the number of informed gamblers or a mean preserving movement of probability mass outwards from the mean of the density function ϕ .

An increase in the uncertainty facing the bookmaker from a greater number of informed gamblers simply increases the terms with Y in them. Thus, both the terms in Y increase in magnitude. An increase in the number of informed gamblers does not affect the betting by outsiders. Consequently, this change in uncertainty increases the first order condition (2) and raises the profit maximising price.

An increase in the degree of uncertainty in the probability from a change in the probability density function ϕ has a different effect. Investigation of this effect requires consideration of the determination of the amount bet by a bettor. An informed bettor is assumed to have a subjective assessment p_i^s of the probability of the jth horse winning a given race. Whether the trader places a bet, and the size of the bet, are determined by the probability assessment, the price of the bet and the utility function. It is assumed that an informed gambler makes only one bet on a race. Expected utility is given by:

$$EU = p_i^s U(w + (1 - q_i) Y_i) + (1 - p_i^s) U(w - q_i Y_i) \quad (3)$$

where w is the initial wealth of the gambler and Y_i is the number of bets placed on horse i . It is simple to show that the optimal number of bets Y_i is given by

$$\partial EU / \partial Y_i = (1 - q_i) p_i^s U'(w + (1 - q_i) Y_i) - q_i (1 - p_i^s) U'(w - q_i Y_i) = 0 \quad (4)$$

where R is the level of absolute risk aversion.

Taking the total derivative of equation (4) for a change in the price of a bet we obtain:

$$\frac{dY_i}{dq_i} = \frac{-1/((1-q_i)q_i) + Y_i R(w + (1-q_i) Y_i) - Y_i R(w - q_i Y_i)}{(1-q_i) R(w + (1-q_i) Y_i) + q_i R(w - q_i Y_i)} \quad (5)$$

The amount an informed bettor gambles is given by the integral of the derivative (5) between the subjective probability assessment (p_i^s) and the market price (q_i). Thus, for a mean preserving shift of the probability density function that moves probability mass to the tails of the distribution, the amount bet by individual bettors will increase. Thus, the Y_i term in (2) increases. The effect of probability mass shifts on the derivative term in Y_i is more complex. The term $(q_i - p_j)$ increases in magnitude. The terms $\partial Y_i / \partial q_i$ would be expected to increase or perhaps approximately remain constant, but this result is not necessarily unambiguous. The impact of the probability mass shift is to increase the amount bet. This effect is investigated by taking the derivative of (5) with respect to Y_i .

$$\begin{aligned} \frac{d^2 Y_i}{dq_i dY_i} = & \frac{\left[(-1+2q_i - q_i^2) R'(w + (1-q_i) Y_i) + q_i^2 R'(w - q_i Y_i) \right] - 1/((1-q_i)q_i) + Y_i R(w + (1-q_i) Y_i) - Y_i R(w - q_i Y_i)}{\left((1-q_i) R(w + (1-q_i) Y_i) + q_i R(w - q_i Y_i) \right)^2} \\ & + \\ & \frac{R(w + (1-q_i) Y_i) - R(w - q_i Y_i) + Y_i \left[(1-q_i) R'(w + (1-q_i) Y_i) + q_i R'(w - q_i Y_i) \right]}{(1-q_i) R(w + (1-q_i) Y_i) + q_i R(w - q_i Y_i)} \end{aligned} \quad (6)$$

The expression (6) is zero for constant absolute risk aversion. The second term of expression (6) is negative for decreasing absolute risk aversion. The square bracketed term in the first term is positive and the whole term negative if $(1-2q)$ is positive and R' is constant and negative. Thus, either for constant absolute risk aversion or for prices less than 0.5 and decreasing absolute risk aversion with an approximately fixed R' , the expression (6) is negative. A negative expression (6) ensures that for an increase in uncertainty from a change in the probability density function ϕ there is an increase in the magnitude of the term $\partial Y_i / \partial q_i$. Consequently, there is an increase in the term containing $\partial Y_i / \partial q_i$.

An increase in uncertainty does not affect the betting by outsiders as the expected probability remains the same and terms in X_i take the same value. Consequently, for an increase in the second cause of uncertainty, the first order condition becomes positive and the profit maximising q_i increases. Thus, whatever the cause of an increase in uncertainty for the bookmaker, the response is to increase the price of a bet.

In the present model, compared to the Shin models (1991, 1992 and 1993), informed

gamblers bet at the same time as outsiders. Informed gamblers and outsiders vary the amount they bet in a manner related to the price of the bet and their view of the chance of a horse winning. Informed bettors are assumed to be risk averse, and do not know exactly what is going to happen in a race but are better informed than the bookmaker setting the book on the race. The book prices are set simultaneously on all horses running in a race and the demand for betting on one horse depends on all prices. These aspects of the present model represent improvements over the Shin models (1991, 1992 and 1993).

IV Empirical Investigation

In our model of bias, the principal explanatory factor is uncertainty about insiders using privileged information and experts using public information. In order to isolate the impact of insider gambling and the response of bookmakers, it is therefore necessary to examine races and horses on which it is likely that there is a significant amount of insider trading rather than a relatively large proportion of experts gambling. In relation to our chosen markets, the observations are prices corresponding to bookmaker odds, and objective probabilities derived from race results. Our dataset is made up of two year old racehorses competing in Flat races run in the UK during the period 2000-2003, comprising four Flat racing seasons. We make the reasonable assumption that the degree of uncertainty regarding the use of inside information will be greater for unraced two year olds than for those that have had previous racetrack runs. Our reasoning is that knowledge concerning the ability, temperament and racing style of unraced two year olds can only be inferred indirectly from breeding, training, and home trials conducted by trainers off-course, not observed directly on the racecourse. This information is likely to be protected by trainers, stable staff and owners.

For unraced two year old horses, we expect greater odds bias than for previously raced horses, on two counts. Firstly, consistent with the Hurley and McDonough, and Sobel and Raines hypotheses, the distribution of subjective probabilities contained in the odds will be on average closer to $1/n$ than is justified by the *ex post* objective probabilities. This is a consequence of not knowing important attributes of horses that affect the outcome of a race, which are not yet revealed because of the absence of historical race data. Secondly, following Shin's reasoning, bookmakers may reasonably anticipate a greater insider advantage than the norm possessed by, for example, stable connections in relation to unraced horses, and protect the book against the unknown incidence of potential losses by depressing odds offered on unraced two year olds.

The empirical consequence is that, for the same objective probability of winning, an unraced two year old horse would be set at lower odds, i.e. the price of a betting ticket to win a given amount will be higher for unraced horses. The testing methodology used two sets of data: the results and prices for previously unraced and raced two year old horses. The horses were separated into price categories corresponding to odds. The hypothesis of the analysis was tested on the equivalent null hypothesis that the probabilities of winning in the two data sets are equal for matching odds categories.

A test statistic was constructed on the basis that a horse race can be considered as a binomial experiment with all horses in the same price category having the same probability of

winning. Within each price category, estimated probabilities were calculated from the number of winners and runners for the two datasets. The difference of the estimated probabilities has a normal distribution under the null hypothesis and when the number of observations and expected winners/losers is sufficiently large. Thus, when the number of observations was less than 30 and/or the number of expected winners/losers was less than five for either raced or unraced horses, the price category was dropped. This left 40 matched price categories. The test statistic was normalised by an estimate of the standard deviation of the sampling distribution to give a standardised normal variate as a test statistic.

Table 1 reports for the 40 individual price categories: the test statistics; the bias for raced and unraced two year olds;³ a summed test statistic for the four groups of ten price categories normalised to give a standardised normal variate; and the corresponding average differences in bias. The results show a statistically significant greater bias up to prices of about 0.4 and the additional bias is of importance. The additional bias disappears for prices greater than 0.4. Thus, as predicted by the theory, the statistical investigation shows that for horses with prices of less than 0.4, bookmakers offer prices on unraced two year old horses that are statistically significantly different and the difference is represents on average an additional bias of 15%.

V Implications and Conclusions

A model is developed of the setting of odds by profit-maximizing bookmakers that explicitly incorporates the impact of insider and expert gambling. The model is tested against data from races in which two year old horses run. The use of this data allows estimation of the degree to which bookmakers respond to insider gambling by worsening the odds offered to other less informed gamblers. The merit of the data used in the present study is that it refers to circumstances which, amongst all possible horse races, are the most likely to reflect strong evidence of insider gambling. It is argued that previous theoretical and empirical studies have made little or no distinction between insider and expert gamblers in this way. This is understandable as the effects of the two types of bettors on the odds offered by bookmakers are likely to be very similar. However, it is not appropriate to attribute all bias to the gambling of insiders and ignore the impact of expert gamblers who have a similar effect on bookmaker prices. Additionally, the behaviour of more casual or informed gamblers may also determine some of the observed bias in prices.

The reported results suggest that the potential presence of insiders leads bookmakers to increase the price of bets by a significant amount for unraced two year old horses. It should be noted that the comparison is with the bias in the prices for raced horses which may contain a bias caused by insider gambling on these horses. The additional bias in the prices for unraced two year olds is not present for high prices. This may be explained by the greater information available and media attention given to unraced horses with a high probability of winning. Such information and attention is likely to prevent the existence of privileged information on the probability of a horse winning.

³ The biases are calculated from the expression $(1-p/q)$ where p is the probability estimated from the number of winners and runners in the price category.

It might be argued that a negative effect of insider gambling is the possibility of bookmakers suffering losses. This effect is likely to be reflected in bookmakers allowing for and protecting against such losses through setting higher ticket prices (lower odds). The more important negative effect of insider gambling is less informed gamblers facing higher prices, see Crafts (1985) and Paton, Vaughan Williams and Fraser (1999). The evidence presented here suggests that the bias in bookmakers' prices may be raised in the region of 15% (a rough average of the values in the final column of Table 1) by the possibility of insider gambling on unraced two year olds. This additional cost imposed on less well informed gamblers would appear to be of importance and constitutes an argument for regulating against insider gambling.

It has been suggested that insider gambling is an acceptable reward for those involved in owning and training horses (see the discussion in Crafts, 1985). However, in most countries of the world, the use of insider business information is illegal and it is difficult to argue that horse racing has any features that would make insider gambling acceptable. Thus, there is a strong economic argument for regulation of insider gambling. However, the detection of insider gambling raises many practical problems.

The analysis of the present study shows that there is little difference between the impact of the operation of insider and expert gambler on the prices set by bookmakers. However, the latter use the power of publicly available information and analysis to support their gambling. By comparison with the business world, it is difficult to argue that such gambling should be made illegal. Rather, it is to be applauded just as much as data driven analysis leading to successful financial market investment.

References

- Ali, M. M. (1977) 'Probability and Utility Estimates for Racetrack Bettors', *Journal of Political Economy*, 85 (4), pp. 803-815.
- Binmore, K., Kirman, A. and Tani, P. (eds.) (1993) '*Frontiers of Game Theory*', Cambridge, MA: MIT Press.
- Bird, R. and McCrae, M. (1987) 'Tests of the Efficiency of Racetrack Betting Using Bookmaker Odds', *Management Science*, 33 (12), pp.1552-1562.
- Clotfelter, C.T. (2005) "Gambling Taxes" in S. Cnossen (ed.) *Theory and Practice of Excise Taxation: Smoking, Drinking, Gambling, Polluting and Driving*, Oxford: Oxford University Press, pp
- Coleman, L. (2004) 'New Light on the Longshot Bias', *Applied Economics*, vol. 36(4), pp. 315-326.
- Crafts, N. F. R. (1985) 'Some Evidence of Insider Knowledge in Horse Race Betting in Britain', *Economica*, 52, 295-304.
- Dowie, J. (1976) 'On the Efficiency and Equity of Betting Markets', *Economica*, 43, pp. 139-150.
- Henery, R. J. (1985) 'On the Average Probability of Losing Bets on Horses with Given Starting Price Odds', *Journal of the Royal Statistical Society*, 148 (4), pp. 342-349.
- Hurley, W. and McDonough, L. (1995) 'A Note on the Hayek Hypothesis and the Favourite-Longshot Bias in Parimutuel Betting', *American Economic Review*, 85 (4), pp. 949-955.
- Jullien, B. and Salanie, B. (2000) 'Estimating Preferences under Risk: The Case of Racetrack Bettors', *Journal of Political Economy*, 108(3), pp. 503-530.
- Kahneman, D., and Tversky, A. (1979) 'Prospect Theory: An Analysis of Decision Under Risk', *Econometrica*, 47, pp. 263-291.
- Kahneman, D., and Tversky, A. (1982) 'Intuitive prediction: Biases and Corrective Procedures', in Tversky, A., Kahneman, D., Slovic, P. (eds.), *Judgment Under Uncertainty: Heuristics and Biases*, Cambridge: Cambridge University Press, pp. 414-421.
- Law, D. and Peel, D. A. (2002) 'Insider Trading, Herding Behaviour, and Market Plungers in the British Horse Race Betting Market', *Economica*, 69, pp. 327-338.
- Sauer, R. D. (1998) 'The Economics of Wagering Markets', *Journal of Economic Literature*, 36, pp. 2021-2064.
- Paton, D., Vaughan Williams, L., and Fraser, S.(1999) 'Regulating Insider Trading in Betting Markets', *Bulletin of Economic Research*, 51 (3), pp.237-241.
- Schnytzer, A. and Shilony, Y. (1995) 'Inside-Information in a Betting Market', *Economic Journal*, 105, pp. 963-971.
- Schnytzer, A. and Shilony, Y. (2003) 'Is the Presence of Insider Trading Necessary to Give Rise to a Favourite-Longshot Bias?', in Vaughan Williams, L. (ed.), *The Economics of Gambling*, London: Routledge.

- Schnytzer, A. and Shilony, Y. (2005) 'Insider Trading and Bias in a Market for State-Contingent Claims', in Vaughan Williams, L.(editor), *Information Efficiency in Financial and Betting Markets*, Cambridge: Cambridge University Press.
- Schnytzer, A., and Snir, A. (2008) 'Herding in Imperfect Betting Markets with Inside Traders', *Journal of Gambling Business and Economics*, 2 (2), pp. 1-15.
- Shin, H. S. (1991) 'Optimal Betting Odds Against Insider Traders', *Economic Journal*, 101, pp. 1179-1185.
- Shin, H. S. (1992) 'Prices of State Contingent Claims with Insider Traders, and the Favourite-Longshot Bias', *Economic Journal*, 102, pp. 426-435.
- Shin, H. S. (1993) 'Measuring the Incidence of Insider Trading in a Market for State-contingent Claims', *Economic Journal*, 103, pp. 1141-1153.
- Smith, M.A., Paton, D. and Vaughan Williams, L.(2006) 'Market Efficiency in Person-to-Person Betting', *Economica*, 73, pp. 673-689.
- Sobel, R. S. and Raines, S. T. (2003) 'An Examination of the Empirical Derivatives of the Favourite-Longshot Bias in Racetrack Betting', *Applied Economics*, 35, pp. 371-85.
- Sung, M.C., Johnson, J.E.V. and Peirson, J. (2008) 'Understanding the Weekend Effect: Insights from a Market for State Contingent Claims', Working Paper, Centre for Risk Research, University of Southampton.
- Thaler, R. and Ziemba, W. (1988) 'Parimutuel Betting Markets: Racetracks and Lotteries', *Journal of Economic Perspectives*, 2, pp. 161-174.
- Tuckwell, R. (1983) 'The Thoroughbred Gambling Market: Efficiency, Equity and Related Issues', *Australian Economic Papers*, 22, pp. 106-108.
- Tversky, A. and Kahneman, D. (1992) 'Advances in Prospect Theory: Cumulative Representation of Uncertainty', *Journal of Risk and Uncertainty*, 5, pp. 297-323.
- Vaughan Williams, L. and Paton, D. (1997) 'Why is there a Favourite-Longshot Bias in British Racetrack Betting Markets?', *Economic Journal*, 107, pp. 150-158.
- Vaughan Williams, L (1999) 'Information Efficiency in Betting Markets', *Bulletin of Economic Research*, 51 (1), pp. 1-30.

Table 1 – Test Statistics for Differences of Estimated Probabilities

Price	Probability Test Statistic	Bias Unraced TYOs	Bias Raced TYOs	Average Test Statistic	Average Increase in Bias
0.029	-0.44	0.71	0.66		
0.038	-0.44	0.54	0.48		
0.048	0.52	0.44	0.50		
0.059	-2.48	0.57	0.26		
0.067	-2.20	0.58	0.31		
0.077	-0.40	0.30	0.24		
0.083	0.74	0.18	0.42		
0.091	-0.73	0.30	0.20		
0.100	0.46	0.06	0.16		
0.111	-0.78	0.19	0.07	-1.98**	7.4%
0.125	-3.19	0.41	-0.05		
0.133	-1.55	0.39	0.04		
0.143	-2.68	0.50	0.13		
0.154	0.49	0.08	0.18		
0.167	-0.46	0.24	0.17		
0.182	0.73	-0.09	0.05		
0.200	-0.22	0.20	0.17		
0.222	-1.96	0.35	0.07		
0.231	0.93	-0.11	0.18		
0.250	-0.96	0.12	-0.03	-2.79*	11.7%
0.267	-1.11	0.30	0.07		
0.286	-0.74	0.10	-0.04		
0.308	-0.12	0.05	0.03		
0.333	0.07	-0.03	-0.01		
0.348	-1.89	0.31	-0.21		
0.364	-0.73	0.28	0.12		
0.381	-3.26	0.60	-0.10		
0.400	-1.63	0.42	0.06		
0.421	-0.82	0.28	0.08		
0.444	-0.97	0.17	-0.06	-3.24*	24.4%
0.455	0.25	-0.10	-0.01		
0.476	-1.10	0.40	0.10		
0.500	-0.85	0.29	0.05		
0.524	1.22	-0.23	0.09		
0.545	-0.06	0.08	0.06		
0.556	-0.07	0.04	0.02		
0.579	-0.57	0.14	-0.03		
0.600	0.36	-0.03	0.06		
0.636	0.00	0.06	0.06		
0.692	0.77	-0.08	0.11	-0.02	0.3%

** statistically significant at 5%

* statistically significant at 1%