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The Impact of Insider Trading on Forecasting in a Bookmakers' Horse Betting Market

by

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Abstract.

This paper considers the impact of insider trading on forecasting in a betting market when prices are set by bookmakers. We base our analysis on Schnytzer, Lamers and Makropoulou (2008) who showed that inside trading in the 1997-1998 Australian racetrack betting market represents somewhere between 20 and 30 percent of all trading in this market. They show that the presence of insiders leads opening prices to deviate from true winning probabilities. Under these circumstances, forecasting of race outcomes should take into account an estimate of the extent of insider trading per horse. We show that the added value of a measure of insider trading for profitable betting is sufficient to reduce the losses when only prices are taken into account. Since the only variables taken into account in either Schnytzer, Lamers and Makropoulou (2008) or this paper are price data, this is tantamount to a demonstration that the market is weak-form efficient.

Monday, 8 December 2008

1. Introduction

Successful forecasting of horse race outcomes requires that the forecaster has a clear understanding of the variables at his disposal. The most common, and arguably important, variables in a horse betting market are the odds of the horses in a race. In the case where bookmakers operate in such a market, it seems reasonable to suppose that the fixed odds they provide would be reasonably unbiased estimators of the horses' winning probabilities. And yet, there is a considerable literature which suggests that this isn't so (see, for example, Shin 1991, 1992 and 1993 and Schnytzer and Shilony 2003). What makes bookmakers' odds deviate from winning probabilities is agreed to be the extent of insider trading in the market, even though different authors characterize the mechanism underlying the concomitant distortion and its extent differently.

Accordingly, forecasting of race outcomes should take into account an estimate of the extent of insider trading per horse and of how this extent of insider trading in a bookmakers' horse betting market may be measured. Schnytzer, Lamers and Makropoulou (2008) [hereafter SLM] have developed a method for measuring the extent of insider trading in horse betting markets with bookmakers.¹ Their paper develops a theoretical model that examines the optimal price setting by bookmakers in the racetrack betting market and then uses it to measure the extent of insider trading in the market. Bookmakers are faced with the risk that insiders will account for information arriving after the opening odds (which may be assumed to contain most public information) have been set and will thus exploit any mis-pricing by the bookmaker by betting on horses whose price presents an expected profit for the insider. The model is an extension of the model developed by Makropoulou and Markellos (2007) and applied to the European soccer betting market. The basic intuition underlying the model is that fixed odds² offered by bookmakers at the track are examples of call options and that, while bookmakers hope to offer only net of premium out-of-the-money options, when they err by underestimating a particular horse's true winning probability, they are liable to offer a net in-the-money

¹ Theirs is not the first such method. Shin (1993) developed a method using a very different model.

² For the purposes of this paper, by odds, we mean that odds of, say 5 to 1 represent a net profit of \$5 for every \$1 bet on the winning horse.

option, which the insider (who is assumed to know her horse's true winning probability) will be glad to snap up.

It should be noted that (as with Shin (1993)), SLM rely exclusively on price data in order to measure the extent of insider trading in a race. Accordingly, it might be argued that both methods fall short in not introducing other public or private information into their models. We show that, to the extent that insider trading is profitable,³ a sufficiently accurate measure of its extent to permit profitable forecasting cannot apparently be obtained on the basis of price data alone. On the other hand, use of the SLM measure to predict race outcomes does lead to a reduction in losses.⁴ This amounts to a confirmation that this betting market is weak-form efficient.

We proceed as follows: In Section 2, the data are described and a brief discussion of our forecasting method is provided. The results are presented in Section 3, where it is shown that forecasting on the basis of opening prices only – these prices are readily available around 30 minutes before the race – yield moderate losses. The extent of these losses is reduced when insider trading is added, but the method employed here would be difficult, if not impossible, to implement in practice. Some conclusions are offered in section 4.

2. Data and Methodology

The data set used in this paper contains 45296 horses who ran in 4017 races during the 1997-1998 Australian horse racing season. The data include opening prices (hereafter OP) as set by bookmakers at the start of betting around 30 minutes before each race, middle prices (hereafter MP), which are prices provided in the data set usually, but not always, when there is a change in direction of the horses' odds between OP and odds at the end of the betting. Finally, we have starting prices (SP), the ruling prices at the end of betting. The data set contains all races for which MP are provided. The data were obtained from the CD version of the "Australasian Racing Encyclopedia '98".

SLM estimated several alternative measures of the extent of insider trading in this market and we use three of the estimates for the purposes of forecasting. However, in

³ See Schnytzer and Shilony (1995) for an indirect demonstration.

⁴ The Shin (1993) measure cannot be used in this context since it provides a measure of the extent of insider trading at the level of races alone.

order to facilitate an understanding of these measures and the differences between them, a summary of the SLM estimation procedure is in order. Bookmakers' odds as initially set (i.e. OP), may be viewed as call options which end in-the-money if the horse wins the race and out-of-the-money otherwise. As inside information enters the market, the odds change and the value of the call options change. As betting continues, the horses' winning probabilities as implied by the odds become more and more accurate until all inside information has entered the market and the betting comes to an end. Assuming that the inside information enters the market randomly from the point of view of the bookmakers, the dynamics underlying the changing implied winning probabilities may be modeled as a standard Wiener Process.

Using Monte Carlo simulation we are able to derive the option value for each horse. The true winning probability for each horse is simulated in 1000 time steps using a standard Wiener Process. When the simulated probability is larger than the strike price at the 1000th and final step, the option value is this positive difference; otherwise, the option value is zero. For each horse, the option value is calculated as the average value out of 1000 repetitions. In order to calculate the extent of insider trading, a weighting is applied to the option values. The following three different weightings used provide us with our estimates of insider trading for use in this paper.

The first weight used for each horse is the estimated initial winning probability as implied by OP, $P(0)$. The remaining two additional weights are based on plunge behavior⁵ in the market and calculated as follows. The first is the relative size of a plunge, called PW: $\max((MP-OP)/OP,0) + \max((SP-MP)/MP,0)$. The second weight is the absolute size of the plunge called PW2: $\max(MP-OP,0) + \max(SP-MP,0)$. Using these weights, the weighted average degree of insider trading for each of the races in the sample is calculated. The simple average of these values is the extent of insider trading in the dataset.

Table I displays the extent of plunges in the data set, where an early plunge is defined as a positive percentage price change from OP to MP and a late plunge is defined as a positive percentage price change from MP to SP. A sustained plunge is defined in the

⁵ A horse is said to be plunged when its odds suddenly decrease meaningfully owing to large bets placed on the same horse with different bookmakers simultaneously. Schnytzer and Shilony (1995) show that plunges contain inside information.

case where the horse in question is subject to both early and late plunges; the extent of the sustained plunge is then the percentage change from OP to SP. It can be seen in Table I that the majority of the 13852 plunges in the dataset are late plunges, suggesting insider trading at MP. However, the average extent of early plunges exceeds that of late plunges.

Table I: The extent of plunges in the dataset

Plunges	Number	Average extent
Early Plunge	1281	21.25%
Late Plunge	9783	15.72%
Sustained Plunge	2788	26.33%
All	13852	18.37%

Note: An early plunge is defined as a positive percentage change from OP to MP. A late plunge is defined as a positive percentage change from MP to SP. When there are both early and late plunges, this forms a sustained plunge.

The extent of insider trading, as estimated by SLM is shown in Table II.

Table II: Measures of degree of insider trading for each specification

Weight	Degree of insider trading
P(0) – OP	32.68%
PW	26.38%
PW2	26.48%

Notes: P(0) – OP is true winning probability at time 0. PW is the $[\max((MP-OP)/OP,0) + \max((SP-MP)/MP,0)]$. PW2 is $[\max(MP-OP,0) + \max(SP-MP,0)]$.

Armed with opening prices and various measures related to the extent of insider trading for each horse, we proceed to forecast the winners of each race in the data set. We use the generally preferred method of forecasting in the betting literature, namely; the conditional logit model (hereafter CL) of McFadden (1974). We estimate several CL models. The first estimates the probability of horse i winning race j based solely on information contained in OP, as follows:

$$p_{ij}^o = \exp(a_1 OP_{ij}) / \sum_{i=1}^{n_j} \exp(a_1 OP_{ij}) \quad (1)$$

where $i = 1, 2, \dots, n_j$, OP_{ij} is the OP of horse i in race j , n_j is the number of runners in race j and a_1 indicates the contribution which OP makes to the horse's chance of winning race j . We then run four more regressions adding different predictors to OP in turn. These variables are as follows: First, the option value for each horse as estimated in SLM. This variable is zero for most horses in the sample and positive for one or two in each race. $Optionvalue_{ij}$ is positive if the horse i 's winning probability in race j is estimated via Monte Carlo simulation to be greater than the winning probability implied by OP and is measured as the difference. In this case, the model estimated may be written:

$$p_{ij}^o = \exp(a_2 OP_{ij} + b_1 Optionvalue_{ij}) / \sum_{i=1}^{n_j} (a_2 OP_{ij} + b_1 Optionvalue_{ij}) \quad (2)$$

where $i = 1, 2, \dots, n_j$. The coefficients a_1 , a_2 and b_1 in regressions (1) and (2) are measured by maximizing the joint probability of observing the winners of all the races in the sample. Next we add $EarlyPlunge_{ij}$, which is equal to the difference between MP and OP, when this difference is positive and zero otherwise.⁶ Our fourth predictor is the extent of insider trading on horse i in race j as measured by SLM ($Insidertrading_{ij}$). Finally, we add $TotalPlunge_{ij}$, which measures the total extent of early and late plunges on horse i in race j . We expect, a priori, that all variables would, by themselves, add to a horse's winning probability and should thus receive positive coefficients.

⁶ The winning probabilities, when this and subsequent variables are added, may be estimated by models that follow trivially from (1) and (2) and thus are not noted explicitly.

3. Results

Table III shows the results of our five regressions.

Table III: Predicting horses' winning probabilities

Specification	1	2	3	4	5
Dependent variable	Win	Win	Win	Win	Win
OP	6.7117 (50.58)*	6.6583 (47.09)*	6.5204 (45.73)*	6.4404 (44.91)*	6.3347 (43.88)*
Optionvalue		2.1108 (1.09)	1.5214 (0.78)	-2.7790 (-1.32)	-13.7064 (-5.63)*
EarlyPlunge			10.824 (6.79)*	10.1933 (6.39)*	
Insidertrading				0.2741 (5.80)*	0.2079 (4.32)*
TotalPlunge					9.3020 (9.62)*
N	45296	45296	45296	45296	45296
Pseudo – R²	0.1389	0.1390	0.1412	0.1430	0.1456

Notes: Z-scores are reported in parentheses. A * indicates significance up to a 1% confidence level. Optionvalue are the option values generated by SLM. EarlyPlunge is the extent of early plunges as measured by $\max(\text{MP-OP}, 0)$. Insidertrading is the incidence of insidertrading on a specific horse, as generated by SLM. TotalPlunge is the extent of both early and late plunges, as measured by $\max(\text{MP-OP}, 0) + \max(\text{SP-MP}, 0)$.

It is clear on the basis of these results that OP is by far the most important predictor of winning probabilities, both in terms of coefficient size and statistical significance. Given the bookmakers' stake in the outcome of betting, it is clear that OP will reflect as much useful information as possible unless bookmakers deliberately distort prices as a defense mechanism against insiders.⁷ With the exception of option value, all other variables receive positive coefficients and these are statistically significant in at least one of the regressions. When option value is used as the sole predictor of winning probabilities, it receives a positive and highly significant coefficient⁸, leading us to conclude that the unexpected results here are the result of multicollinearity.

The following table shows the results of betting \$1 on each predicted favorite in the ever race in the sample on the basis of the five regressions shown in Table V.

⁷ See SLM, Schnytzer and Shilony (2003) and Shin (1991 and 1992) for more discussion on this point.

⁸ Complete results available upon request.

Table IV: Betting Simulations

Betting based on favourite predicted by specification					
	1	2	3	4	5
Number of races and bets	4017	4017	4017	4017	4017
Profit (\$)	-409.83	-379.40	-360.20	-285.00	-301.50
Rate of Return (%)	-10.20	-9.44	-8.97	-7.09	-7.51

Notes: Betting takes place in all races as in each race there is a favorite as measured by the highest win probability predicted after each regression specification. Betting takes place at SP, the last quoted prices before the race starts.

The results obtain are in line with what the regression results in Table III might have led us to believe. Thus, insider trading is seem to influence profits (in this case, losses) in an upward direction, although the tone is clearly set by OP, and betting on the basis of it alone leads to a loss 10.2 percent. The best performance is achieved by adding option values, early plunges and the extent of insider trading to OP, but this only adds a little over 3 percent to the reduction in losses. However, since SLM rely exclusively of price data in their simulations, these results show that this market is weak-form efficient. Further, even if the results are calculated as if betting takes place at the best odds available during the betting (as we would expect insiders to bet), rather than SP, returns are better but remain negative throughout.⁹ Finally, it may seem strange that the losses incurred in simulation 5, when all plunges are taken into account along with the other variables, should exceed those in simulation 4, when only early plunges are added to the model. The reason would appear to be the herding on late plunges in this market.¹⁰

⁹ Full results available upon request.

¹⁰ See Schnytzer and Snir (2008).

4. Conclusions

In this paper we have shown that insider trading has a moderate impact on forecasting. Adding various different measures relating to insider trading by horse to a conditional logit model using only opening prices to predict winning probabilities, reduces moderate losses but does not generate positive profits. Therefore, the relevance of insider trading in this market, *in principle*, cannot be refuted. However, it should be pointed out that even the small gains in forecasting demonstrated here may be difficult to implement in practice.

It is unlikely that the simulations used by SLM could be carried out in the short time required before each race. Thus, a knowledge of price changes is critical and if the latest prices used in the simulation were to be those ruling in the market five minutes or so before the race start, that would leave less than five minutes for the estimations. Since the simulations carried out by SLM required several days to run, a system based on our estimates could be applied only on a computer far more powerful than is generally available today outside the Pentagon! Furthermore, given the moderate gains generated by the addition of these variables to the basic model, it may be wondered whether it would be worthwhile to struggle for a solution to the computing problem.

So why has the extent of inside information not contributed more dramatically to the forecasts? To the extent that the SLM model provides a reasonable measure of the extent of insider trading, it must be concluded that the reliance on price data alone in forecasting horse races in a bookmakers' market is doomed to failure. On the other hand, perhaps the basic weakness in regression models in forecasting is that they provide predictions on the basis of "on average" results, whereas insiders bet on particular horses in particular races when as many as possible relevant factors unbeknownst to outsiders have been taken into account.

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