Testing for Home Team and Favorite Biases in the Australian Rules Football Fixed Odds and Point Spread Betting Markets

by

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Abstract

In this paper, we test two different kinds of bias; the favorite-longshot/favorite-underdog and the home team bias, and distinguish between the two, using a distinctive feature of the Australian Football League (AFL), that many games are played on neutral grounds. This is the first empirical study, to the best of our knowledge, to make a clear distinction between the two types of bias. We conduct our tests by subjecting 2001-2004 data for the AFL to detailed scrutiny, using standard econometric weak-form efficiency models of point spread and fixed odds betting markets. Where the results suggest the presence of a bias, we test potential profitability via betting simulation. We are able to reject the existence of any significant pure favorite-longshot/favorite-underdog bias in either market, and to demonstrate the existence of a significant bias in favor of teams with an apparent home ground advantage in games played outside Victoria in the point spread market and in the fixed odds market during 2002, 2004 and the period as a whole. Games in Melbourne and in Geelong are free of such a bias (except for 2003 in the point spread market in Geelong). Betting simulations which attempt to exploit these inefficiencies yield modest profits.

***Keywords*:** market efficiency; betting markets; sports economics; Australian Rules football

1. Introduction

Risk aversion is a standard assumption in traditional economic theory. Yet, the generality of risk aversion seems to stop at betting markets, where most of the literature confirms the tendency of bettors to under-bet favorites and over-bet longshots/underdogs[2] relative to their chances of winning, this bias being known as the favorite-longshot or favorite-underdog bias.[3] Only a handful of papers, all using data on odds betting systems, present an empirical exception to this bias, i.e., a reverse favorite-longshot bias.[4]

The concept of home ground advantage has long been recognized as a contributing factor for sporting success.[5] Schwartz & Barsky (1977) proposed three explanations why the home ground advantage exists: learning factors (stadium and playing surface familiarity[6]), travel factors (physical and mental fatigue, disruption of routine) and crowd factors (social support). Courneya & Carron (1991) suggest also possible referee bias. The absolute extent of influence of the three factors varies from one sport to another.

Our goal in this paper is to disentangle the favorite-longshot/favorite-underdog biases, on the one hand, from any extant home team bias, on the other. This would be a novel contribution to the literature. Our analysis is based on four seasons of Australian Rules Football, 2001-2004.

We test the two dominant betting methods in team sports; the "Point spread" (also known as "line") wagering market, which is the dominant form of wagering on basketball and American football contests[7], and the fixed odds win (also known as "win") wagering market, which predominates in US baseball.[8] [9] As it happens, both of these markets operate on Australian Rules Football, yet economic literature relating to "Aussie Rules" is quite limited.[10]

We use a straight-forward method to test for the existence of these biases, facilitated by the fact that many games in our data sample are played on neutral grounds, so that the home ground bias is evidently absent. Given the number of games played on neutral grounds, we are able to test unambiguously for the existence of any significant favorite-longshot/favorite-underdog bias in either market for each of the four seasons individually and for the whole period.

Following the specific home ground character of the AFL, as explained below, we divide the data set into four categories, according to the nature of a priori home ground advantage and location of the relevant game; games played on neutral grounds regardless of location, games played outside Victoria where there is a priori home ground advantage, games played in Melbourne where there is a priori home ground advantage and games played in Geelong where Geelong Cats always has an a priori home ground advantage.[11] The reason for dividing the data set into three where there is a priori home ground advantage is that the distances traveled and/or the extent of crowd support vary considerably as between these three groups of locations. While there is travel symmetry vis-à-vis games played in Melbourne and outside Victoria, crowd support differs considerably. Thus, for example, the Sydney Swans were originally the South Melbourne Swans and thus continue to maintain a supporter base in Melbourne. Also, part of the Brisbane Lions is based on a former Melbourne team, the Fitzroy Lions. Finally, teams from outside Victoria play far more games in Victoria than do Victorian teams outside their state. Consequently, the home ground advantage enjoyed by Melbourne teams is likely to be less than that enjoyed by home teams playing outside Victoria. These assertions are supported by the data shown below in Table 2.

Our most clear-cut finding is that both betting markets are weak-form efficient when games are played either on neutral grounds or in Melbourne. Thus, we are able to reject the existence of any significant pure favorite-longshot or favorite-underdog bias in either market and any home or away team bias in games played in Melbourne. On this basis, we would imply that any bias(es) found in other subsets of the data would most likely be due to a home or away team bias and not due to a favorite-longshot or favorite-underdog bias. We demonstrate the existence of a significant bias in favor of teams with an apparent home ground advantage in games played outside Victoria in both markets for some seasons and the whole period, while games in same Geelong results are similar in the line market but the fixed odds market appears to be efficient. Betting simulations which attempt to exploit these inefficiencies yield modest profits.

The remainder of this paper is organized as follows: A summary of the basics of Australian Rules football, home ground advantage and betting markets relevant to an understanding of this paper is presented in Section 2. Section 3 describes our data set and highlights the problems to be explained,

section 4 discusses the weak efficiency econometric tests and the betting simulations, while section 5 concludes the paper.

2. Australian Rules football – basics, home grounds and betting

2.1 Basics

Australian Rules football is a high scoring, continuous-action game. For the 2001-2004 seasons, the average game score per team was 95 points, with a minimum of 25, a maximum of 196, and a standard error of 28. Each team has 18 players on the field at any given time and 4 substitutes are available for unrestricted, repeated substitutions as deemed fit by the team coach.

The home and away season comprises 176 games played over 22 weekly rounds of eight games each, between 16 teams. Following this is a final series between the top eight teams. The two surviving teams from this phase play for the premiership title in what is known as the "Grand Final". In total, 185 games are played in an entire season.[12] In 2005, the home and away season had a total attendance of 6,283,788, and the average per game attendance of 35,703 was the third highest of any professional sports league in the world (*http://www.answers.com/topic/australian-football-league*).

The AFL is a national league which began as the Victorian Football League. The states and territories within Australia are not equally represented in the AFL; Victoria has ten representative teams, South Australia and Western Australia – two each, and Queensland and New South Wales – one each. Tasmania, Northern Territory and Australian Capital Territory are not currently represented although games are occasionally played in these areas.

2.2 Home grounds

Except for the Geelong Cats, all the other teams in the AFL derived from Melbourne and initially had their own home grounds. The addition of new teams from other states in the past two decades has

been accompanied by a policy of stadium consolidation in Melbourne. Thus, it has not been true for some years that each team has its own stadium. Of the sixteen teams that make up the AFL, only three have stadia which are uniquely home grounds, where it may be said that they have an advantage; the Brisbane Lions, the Sydney Swans and the Geelong Cats.[13] All the other teams play at grounds shared with one or more teams. Thus, dealing with the home advantage in the AFL requires further care and a compliment to the official home designation is necessary. Whenever we refer to *home teams* as either subsets of the data or dummy variables, we mean teams with an a priori home ground advantage. Teams which are officially designated as home teams but have no a priori home ground advantage are referred to as *Neutral*.[14] Data concerning the different grounds in the AFL are presented in Table 1. We can see that 53% of the games during 2001-2004 seasons were played in Melbourne, Victoria.

Table 1 *Home grounds in 2001-2004 AFL seasons*

Ground	Home teams	City	State/County	No. of games
AAMI Stadium (aka Football Park)	Adelaide Crows, Port Adelaide Power	Adelaide	South Australia	96 (12.97%)
Gabba	Brisbane Lions	Brisbane	Queensland	53 (7.16%)
Optus Oval (aka Princess Park)	Carlton Blues, Western Bulldogs	Melbourne	Victoria	34 (4.59%)
M.C.G[15]	Collingwood Magpies, Essendon Bombers, Richmond Tigers, Kangaroos, Melbourne Demons, Hawthorn Hawks	Melbourne	Victoria	184 (24.86%)
Telstra Dome (aka Docklands Stadium, Colonial Stadium)	Essendon Bombers, Western Bulldogs, St Kilda Saints, Kangaroos	Melbourne	Victoria	177 (23.92%)
Subiaco Oval	Fremantle Dockers, West Coast Eagles	Perth	Western Australia	89 (12.03%)
Skilled Stadium (aka Shell Stadium, Kardinia Park)	Geelong Cats	Geelong	Victoria	32 (4.32%)
S.C.G	Sydney Swans	Sydney	New South Wales	41 (5.54%)
Telstra Stadium (aka Olympic Stadium, Stadium Australia)	Sydney Swans	Sydney	New South Wales	11 (1.49%)
Aurora Stadium (aka York Park)*	Hawthorn Hawks	Launceston	Tasmania	11 (1.49%)
Manuka Oval*	Kangaroos	Canberra	Australian Capital Territory	11 (1.49%)
Marrara Stadium*	Western Bulldogs	Darwin	Northern Territory	1 (0.14%)

* These grounds are part of the AFL's policy to play games also in other states.

We report an official home ground advantage (as measured by average winning margin of home teams) of 8.63 points during 2001-2004, similar to Bailey & Clarke's (2004) 8 points over the last 110 seasons. When we test the real home ground advantage in our data, we report an advantage of 13.43 points, similar to Bailey & Clarke's 14.1 points when opponents travel from interstate to play. Moreover, because of the AFL teams' unique geographic division, as mentioned above, we divide the data into games played in Melbourne, games played in Geelong and games played outside Victoria,

and the results are presented in Table 2. We report a *real* home ground advantage of only 1.15 points in Melbourne, 10.87 in Geelong and 21.4 outside Victoria. This means, basically, that grounds in Melbourne almost do not provide a home ground advantage.[16]

Table 2 *AFL's home ground advantage*
For real (official) home teams during 2001-2004.

Subset	No. of games	Home win %	Home advantage (points)
All games	483 (740)	62.9 (59.2)	13.43 (8.63)
Melbourne	174	48.9	1.15
Geelong	31	58.1	10.87
Outside Victoria	278	72.3	21.4

2.3 Betting

Legalized betting in Australia is one of the largest industries nation-wide, involving both amateur and professional bettors. During 1997/8 82% of all adults participated in a gambling activity (Productivity Commission, 1999). In 2002/3, total gambling expenditure within Australia was A$15.3 billion (The Australian National University, 2004), approximately 2% of GDP. Sports betting comprise 0.5% of the above amount, while racing is 12.3%.

In point spread wagering on most sports, bookmakers offer bettors odds that a team will win by more than a certain number of points, known as the *line*. A typical line wager in the AFL requires that the bettor risk $1 for the chance to receive around $1.9 if successful.[17] This $1.9-for-$1 dividend requires that bettors must pick winners in 52.63 percent of bets to break even.[18] [19]

In fixed odds wagering, the bookmaker offers to pay a ratio of the amount wagered if a certain team wins. The fixed odds wager in the AFL requires that the bettor risk $1 for the chance to receive a fixed sum if successful.[20] As expressed below, the bookmaker sets odds to earn around five percent of the total amount bet if his book is balanced.[21] Therefore the bettor must pick around 52.5 percent of winners to break even.[22]

Bookmakers' lines/odds are generally posted each Tuesday for each of the games played per week, while the games are generally played between Friday and Sunday. On average, 3-5 days elapse

between the posting of the odds and the commencement of the game. The initial line/odds are based on the bookmaker's goal to evenly divide the amount bet between the sides of the bet, so his earns are around 5% of the total amount bet with certainty. Thereafter the bookmaker adjusts the line/odds.[23] There is no consensus in the literature whether these adjustments are made to reflect the collective judgment of gamblers about the outcome or because the bookmakers are setting prices in order to exploit bettors' biases. Levitt (2004), using data on prices and quantities of bets placed, found support for the latter hypothesis; i.e., that bookmakers do not try to set prices to equalize the amount of money bet on either side of a wager.

Other betting methods are also available in the AFL, but a discussion of these is beyond the scope of this paper.[24]

3. The data

The data used in this paper are derived from publicly available sources,[25] i.e., internet-based sports statistical information. Thus, the game data come from *http://www.afl.com.au* and *http://stats.rleague.com/afl/seas/season_idx.html*, while the odds and lines are from *http://www.sportsbetting.com.au*, *http://www.goalsneak.com.au* and *http://www.centrebet.com*.[26] Our data consist of game performances, dates, grounds, odds and lines. We use data from the 2001 to 2004 seasons, for a total of 740 games (all home and away games plus the finals), and 1480 team observations. Line data are missing for 86 games, since the bookmakers do not publish a line in a match where both teams have equal (or very close) betting odds.[27]

In each team observation we denote the team from whose perspective the spread and result are defined as the *team of record*. We use the official home team as the team of record, as do Gandar *et al* (1988) and most of the other studies.[28]

In order to identify real a priori home ground advantage, we define the variable *HOME* as follows: *HOME* equals 1 if this home team is from different city than the away team, and the ground is the home team's ground (i.e., home advantage); *HOME* equals 0 if both teams are from the ground's city

or from two cities other than the ground's city (i.e., no home advantage) or if this away team is from different city than the home team, and the ground is the home team's ground (i.e., away disadvantage).[29] Our data present 483 games (65.3%) where there is a real home ground advantage, of which the advantaged team won 304 games (62.9%).[30]

Our home teams win 72 percent of their games outside Victoria in 2001-2004, 49 percent in Melbourne, 60 percent in Geelong, and 63 percent in all games, which compares with the 58 percent as reported by both Stefani & Clarke (1992) for 1980-1989 and Brailsford *et al* (1995) for 1987-1995, and the 60 percent by Clarke (2005) for 1980-1998. But it should be noted that we refer to *real* home teams, whereas the other papers (except Clarke, 2005) report for *official* home teams.

Approximately 34 percent of the games during 2001-2004 (in both markets) were played on neutral grounds, where neither team has any home ground advantage. We will use this category, being uncontaminated by home ground advantage considerations, to show the presence or absence of favorite-longshot/favorite-underdog biases.

4. Measuring weak efficiency: Econometric tests and Betting systems

4.1 Econometric Tests

Before proceeding to list other difficulties, it will prove useful to define some terms. Let *LINE* denote the point spread in the bookmaker's betting line and *PS* denote the actual point spread between the two teams (defined in a way that is consistent with the definition of *LINE*, i.e., according to the *official* home team), and let *WIN* denote the actual winner in the game (defined as a variable equal to 1 for the winning team, 0 for the losing team and 0.5 for draws). Further, let:

$$PRICE = 1/(1+odds)$$

$$NPRICE = normalized\ \ price = PRICE \Big/ \sum_{per\_game} PRICE \ .$$

If bettors use the available information efficiently, then we would expect the point spread/fixed odds to be the best unbiased forecast of the game's outcome. Let *i* and *j* denote two different teams playing in game *t*. Then, in general, the Efficient Market Hypothesis requires that:

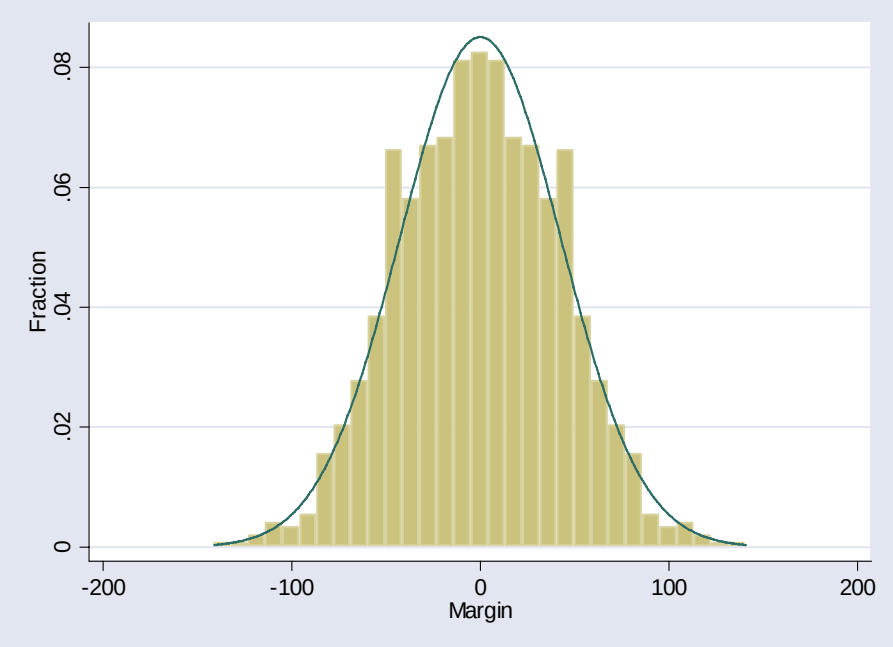
(1a) Median $[PS_{ijt} \mid \Omega_{t-1}] = LINE_{ijt}$

(1b) Median $[\mathrm{P}(WIN)_{ijt} \mid \Omega_{t-1}] = NPRICE_{ijt}$

where Ω_{t-1} is the set of all information available to the bettor prior to the game.

Similarly to Stern (1991) in the NFL and Bailey & Clarke (2004) in the AFL (testing more than 100 seasons, comprising 12462 games), we found that the distribution of the winning margin is not significantly different from the normal distribution at 5% significance level (equation 1a). We used four alternative tests for normality; Shapiro-Wilk, Shapiro-Francia, Skewness/Kurtosis and Interquartile Range (IQR), and find that the above results are consistent between the different seasons.[31] The histogram of the winning margin for the line AFL betting market appears in Figure 1.

Figure 1 *Histogram of the winning margin in the AFL line market*



Therefore the true outcome of a game in the line market can be modeled as a normal random variable with mean equal to the point spread, and equation (1a) implies that:

(2a) $\mathrm{E}_{t-1}[PS_{ijt} \mid \Omega_{t-1}] = LINE_{ijt}$

Equations (1a-1b) and (2a) reflect the most general definition of efficiency, and a variety of efficiency tests have been performed based on equations (1a) and (2a), although equation (1b) remains untested in the context of team sports betting to the best of our knowledge. A natural test is based on the information contained in the set Ω_{t-1}. In general, Ω_{t-1} will contain the current lines and odds, past lines and odds, past outcomes, known game conditions (e.g., ground, home team), past game statistics, other public information (e.g., injuries, referees), and private information. For the tests of weak-form market efficiency with which we are concerned, Ω_{t-1} should *sensu stricto* contain only prices, but it is conventional to include information regarding home ground advantage as well.

The basic statistical test of weak efficiency for the line betting market involves the following model:

(3a) $PS_{ijt} = \alpha + \beta LINE_{ijt} + \varepsilon_{ijt}$

where α is a constant and ε_{ijt} is an independently and identically distributed random error. Equation (3a) is estimated using Ordinary Least Squares (OLS), as we test the linear relationship between point spreads and lines.

The parallel test in the fixed odds betting market is estimating $\mathrm{P}[WIN_{ijt} \mid \Omega_{t-1}]$. The expected winning team in a game is the one with P>0.5 and the relevant test involves the following specification, using OLS as well:

(3b) $WIN_{ijt} = \alpha + \beta NPRICE_{ijt} + \varepsilon_{ijt}$.

Owing to the relatively low number of observations in our data subsets, we used the non-parametric bootstrap method to test the power of all our tests. Using bootstrap (with 1,000 replications) for OLS in both betting markets, present estimated biases for the coefficients which are far less then 25% of the standard errors, thus, should not be a serious concern (Efron, 1982). Weak-form efficiency corresponds to the joint hypotheses with respect to equations (3a) and (3b) that α=0 and β=1.

Dare & Holland (2004) tried to disentangle the favorite/underdog and home team biases in the case of markets with very few games played on neutral grounds, as in most US sports. Due to the distinctive feature of the AFL, that many games are played on neutral grounds, we are able to suggest a different approach in order to identify the relevant biases, whereby we divide the data into subsets and test for all possible biases via separate regressions.[32] Results for line and fixed odds markets for the subsets of the data noted above are reported in Table 3a and Table 3b, respectively.

Table 3a *Weak efficiency estimates for the AFL line market*

Weak efficiency estimates for 2001-2004 AFL seasons for different subsets of the data. Each game is represented by one observation. The data are divided into the different game locations. Standard errors (corrected for bias by bootstrapping with 1,000 replications) are in parentheses.

$$PS_{ijt} = \alpha + \beta LINE_{ijt} + \varepsilon_{ijt}$$

	2001	2002	2003	2004	2001-2004
A. Home teams in games played outside Victoria					
LINE	1.22* (0.22)	0.56* (0.23)	0.71* (0.3)	0.66* (0.31)	0.88* (0.14)
CONS	2.81 (5.76)	15.86* (5.91)	12.72** (7.58)	15.79* (7.09)	9.29* (3.46)
F (CONS=0, LINE=1)	0.83#	4.7	1.84#	2.84##	6.13
Adj. R2	0.31	0.08	0.08	0.07	0.18
No. of obs	62	67	62	66	257
B. Home teams in games played in Melbourne					
LINE	1.01* (0.35)	0.69* (0.26)	0.99* (0.29)	1.17* (0.32)	1* (0.13)
CONS	4.06 (9.89)	-0.11 (5.74)	1.21 (5.73)	0.58 (7.81)	1.37 (3.2)
F (CONS=0, LINE=1)	0.20#	0.54#	0.02#	0.08#	0.09#
Adj. R2	0.2	0.1	0.22	0.17	0.24
No. of obs	38	42	35	34	149
C. Home teams in games played in Geelong					
LINE	0.95 (1.11)	2.05 (2.67)	-0.38 (0.77)	0.55 (0.66)	1.01* (0.39)
CONS	-3.96 (16.13)	8.37 (35.55)	-11.66 (9.59)	24.29* (10.57)	7.46 (6.62)
F (CONS=0, LINE=1)	0.04#	0.43#	4.12	4.22##	0.56#

Table 3a *(continued)*

Adj. R2	0.01	0.14	-0.08	0.03	0.14
No. of obs	7	8	6	8	29
D. Underdog teams in games played on neutral grounds					
LINE	1.02* (0.49)	0.61 (0.58)	1.87* (0.46)	1.07* (0.4)	1.07* (0.23)
CONS	8.81 (11.17)	-5.59 (9.5)	7.26 (8.72)	-0.4 (8.48)	1.58 (4.68)
***F* (*CONS*=0, *LINE*=1)**	1.49#	0.4#	2.19#	0.09#	0.06#
Adj. R2	0.07	0.02	0.18	0.1	0.09
No. of obs	54	53	50	62	219

* Significant at 5% level. ** Significant at 10% level.

The null hypothesis that *CONS*=0 and *LINE*=1 cannot be rejected at 5% level ($F_{2,30}$=3.32, $F_{2,120}$=3.07).

The null hypothesis that *CONS*=0 and *LINE*=1 cannot be rejected at 10% level ($F_{2,30}$=2.49, $F_{2,120}$=2.35).

Table 3b *Weak efficiency estimates for the AFL fixed odds market*

Weak efficiency estimates for 2001-2004 AFL seasons for different subsets of the data. Each game is represented by one observation. The data are divided into the different game locations. Standard errors (corrected for bias by bootstrapping with 1,000 replications) are in parentheses.

$$WIN_{ijt} = \alpha + \beta NPRICE_{ijt} + \varepsilon_{ijt}$$

	2001	**2002**	**2003**	**2004**	**2001-2004**
A. Home teams in games played outside Victoria					
NPRICE	1.21* (0.27)	0.54** (0.31)	1.13* (0.39)	0.38 (0.33)	0.91* (0.16)
CONS	-0.12 (0.17)	0.46* (0.22)	-0.01 (0.28)	0.51* (0.24)	0.14 (0.11)
***F* (*CONS*=0, *NPRICE*=1)**	0.29#	7.82	1.65#	3.29	5.78
Adj. R2	0.21	0.04	0.15	<0.01	0.13
No. of obs	69	70	70	69	278
B. Home teams in games played in Melbourne					
NPRICE	0.98* (0.37)	1.13* (0.33)	0.64 (0.38)	1.37* (0.29)	1.02* (0.16)
CONS	-0.02 (0.26)	-0.04 (0.18)	0.12 (0.18)	-0.21 (0.14)	-0.03 (0.09)
***F* (*CONS*=0, *NPRICE*=1)**	0.13#	0.1#	0.5#	0.58#	0.24#
Adj. R2	0.1	0.14	0.03	0.2	0.14
No. of obs	46	43	44	41	174
C. Home teams in games played in Geelong					
NPRICE	1.78 (1.21)	1.2 (1.71)	-1.08 (1.63)	-	0.88 (0.47)
CONS	-0.53 (0.7)	-0.13 (1.01)	0.9 (0.78)	-	0.14 (0.27)
***F* (*CONS*=0, *NPRICE*=1)**	0.43#	0.02#	1.16#	-	0.42#
Adj. R2	0.21	-0.03	0.03	-	0.06
No. of obs	7	8	8	8[33]	31
D. Longshot teams in games played on neutral grounds					
NPRICE	1.06** (0.59)	0.09 (0.58)	1.38* (0.47)	0.61 (0.48)	0.78* (0.27)

Table 3b *(continued)*

CONS	>-0.01 (0.2)	0.26 (0.22)	-0.16 (0.16)	0.11 (0.16)	0.06 (0.1)
***F* (*CONS*=0, *NPRICE*=1)**	0.05#	1.73#	0.29#	0.33#	0.56#
Adj. R2	0.03	-0.02	0.07	0.01	0.03
No. of obs	63	63	62	67	255

* Significant at 5% level. ** Significant at 10% level.

The null hypothesis that *CONS*=0 and *LINE*=1 cannot be rejected at 5% level ($F_{2,30}$=3.32, $F_{2,120}$=3.07).

The null hypothesis that *CONS*=0 and *LINE*=1 cannot be rejected at 10% level ($F_{2,30}$=2.49, $F_{2,120}$=2.35).

We examine the neutral category, as it provides us with the only test for a pure favorite-longshot or favorite-underdog bias, uncontaminated by home ground considerations, since all other regressions confound this question. And indeed, the category results imply efficiency for all models during all years, thus there is no evident favorite-longshot or favorite-underdog bias.

Results for the other categories imply that the AFL gambling market is not consistently efficient, as we find biases in favor of home teams in games played outside Victoria. We reject the efficiency hypothesis for home teams at 5% level in the line market and in the win market during 2002, 2004 and the whole period. We do not find such bias for games played in Melbourne or in Geelong (except 2003, 2004 in the line market in Geelong).

The rejection of efficiency in the other categories could be a result of home team, favorite-longshot or favorite-underdog biases. However, since the neutral category leads us to reject the presence of favorite-longshot or favorite-underdog biases, we may conclude that any biases in the relevant AFL gambling markets relate to the presence of an apparent home ground advantage.

4.2 Betting systems

To confirm the presence of the above-noted inefficiencies or otherwise, two simple betting systems were constructed in games played outside Victoria and in Geelong, both for line and fixed odds betting: (a) betting on all home teams and (b) betting on all neutral longshots/underdogs. The simulation results are presented in Table 4a and Table 4b, respectively.

Table 4a *Weak efficiency betting simulation for the AFL line market*

Betting simulation results for AFL games played during 2001-2004, for home teams in games played outside Victoria and in Geelong. Assume $1 is bet on each game that meets the above-mentioned criterions. [34]

Year	No. of games	No. of bets	Return rate	S1#	S2#
A. Home teams in games played outside Victoria					
2001	124	62	-0.050	0.5	0.007*
2002	134	67	0.159	0.033*	<0.001*
2003	124	62	0.032	0.223	0.001*
2004	132	66	0.117	0.07**	<0.001*
2001-4	514	257	0.067	0.02*	<0.001*
B. Home teams in games played in Geelong					
2001	14	7	-0.171	0.647	0.326
2002	16	8	-0.065	0.5	0.193
2003	12	6	-0.022	0.5	0.219
2004	16	8	0.413	0.079**	0.004*
2001-4	58	29	0.050	0.289	0.013*

S1 and S2 are, respectively, the significance levels for the null hypotheses of randomness and non-profitability. The relevant test statistics are given by Z_1 and Z_2, respectively:

$$Z_1 = \left[W - 0.5B\right] * \left[B(p)(1-p)\right]^{-0.5} ,$$

$$Z_2 = \frac{\left[D(W/B) - (L/B)\right]}{\left[1/B\left\{\left(D^2(W/B) + (L/B)\right) - \left(D(W/B) - (L/B)\right)^2\right\}\right]^{0.5}}$$

where W, L and B are, respectively, the number of wins, losses and total bets for a given scenario, and p=0.5. D is the mean dividend per scenario.[35]

* Rejection of the hypothesis at 5% level.

** Rejection of the hypothesis at 10% level.

Table 4b *Weak efficiency betting simulation for the AFL fixed odds market*

Betting simulation results for AFL games played during 2001-2004, for home teams in games played outside Victoria and in Geelong. Assume $1 is bet on each game that meets the above-mentioned criterions.

Year	No. of games	No. of bets	Return rate	S1#	S2#
A. Home teams in games played outside Victoria					
2001	124	62	-0.017	0.102	<0.001*
2002	134	67	0.252	<0.001*	<0.001*
2003	124	62	0.145	<0.001*	<0.001*
2004	132	66	0.172	<0.001*	<0.001*
2001-4	514	257	0.141	<0.001*	<0.001*
B. Home teams in games played in Geelong					
2001	14	7	-0.330	0.647	0.317
2002	16	8	-0.144	0.5	0.171
2003	12	6	0.067	0.793	0.371
2004	16	8	0.755	0.002*	-
2001-4	58	29	0.103	0.177	0.002*

#, *, ** See Table 4a.

Following Tryfos *et al* (1984), Gandar *et al* (1988) and Russo *et al* (1989), we test the significance of the results in two ways; first, a *Z*-test for the null hypothesis that the successful bet rates are random (the assumption being that chance yields a fifty percent success rate). The second and more

stringent test is Tryfos *et al*'s (1984) *Z*-test for the null hypothesis that a given scenario is unprofitable against the alternative that it is profitable. If we insistent stringently upon a rejection of the two null hypotheses, each at a five percent level of significance, there are two profitable betting systems in the line market; 2002 and the whole period outside Victoria, although season 2004 is also close at 7 percent, and so is 2004 in Geelong at 8 percent. There are four such systems in the win market; 2002, 2003, 2004 and the whole period outside Victoria. 2004 in Geelong has a highly significant S1, yet S2 is missing, since as explained above, Geelong won all of its home games in 2004.[36]

Nevertheless, it is important to note that during 2001-2003 Geelong finished 12th, 9th and 12th out of 16, respectively, on the AFL ladder, yet in 2004 they improved dramatically and finished 4th. Thus, it may be that the results for Geelong in 2004 in Tables 4a and 4b are merely a case of the market lagging behind their improvement in performance and not a measure of chronic inefficiency.

5. Conclusions

In this paper we have tested the weak-form efficiency of the line and fixed odds betting markets for the Australian Football League over the four seasons, 2001 through 2004, and tried to disentangle the two different biases of favorite-longshot/favorite-underdog on one hand, and home team on the other.

We have shown that there is neither a favorite-longshot nor a favorite-underdog bias in either of these markets once the possibility of a home ground advantage has been removed. We have done this by taking advantage of the fact that many games in the AFL are played on neutral grounds.

However, where the home ground advantage is sufficiently great (namely, in games played outside Victoria but involving visiting interstate teams), the home teams appear to be under-bet. Our results for the intermediate case of Geelong are inconclusive.

Notes

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[2] We thank an anonymous referee, for demonstrating the distinction between the concepts of favorite-underdog and favorite-longshot bias, as the latter term should not be applied to the point spread market at all because it refers to the possibility of different expected returns in different odds ranges, while in the point spread market wagers are relatively at similar odds.

[3] For thorough reviews of the literature, see Sauer (1998) and Vaughan Williams (1999).

[4] Busche & Hall (1988) in Hong Kong racetracks; Woodland & Woodland (1994), Gandar, Zuber, Johnson & Dare (2002) (in some extent) and Woodland & Woodland (2003), in the Major League Baseball (MLB); Swindler & Shaw (1995), in a second tier Texas racetrack; and Woodland & Woodland (2001), in the National Hockey League (NHL). Woodland & Woodland (2003), based on the fact that the proportion of underdog wins (beating the spread) in Gray & Gray (1997) and in Iskoe (1998) was 0.526 and 0.531, respectively, which is over half of their games, note that the reverse bias exists also in the National Football League (NFL) point spread market, yet there has been no empirical testing to support this finding.

[5] See, for example, Schwartz & Barsky (1977) in baseball, football, ice hockey and college basketball; Amoako-Adu, Marmer & Yagil (1985) in the NFL; Golec & Tamarkin (1991) in the NFL and college football; Courneya & Carron (1992), listing 16 studies in different sports; Holder & Nevill (1997) in tennis and golf; Vergin & Sosik (1999) in the NFL; Gandar, Zuber & Lamb (2001) in the NBA and MLB; and Clarke (2005) in the AFL.

[6] For example, in the AFL there are open grounds and closed ones, which matters since the strength and direction of the wind plays an important role in the game, grounds are of different sizes (both in length and width) and different lighting, etc.

[7] See Bassett (1981), Dobra, Cargill & Meyer (1990) and Woodland & Woodland (1991).

[8] See Woodland & Woodland (1994).

[9] Currently, both types are available for most team sports, and one can even bet according to either of them with the same bookmaker. Nonetheless, empirical research comparing these two alternative methods, to the best of our knowledge, not has yet been published.

[10] See Stefani & Clarke (1992), who reported a home ground advantage for each of the AFL teams during 1980-1989, and a bigger advantage for teams outside of Melbourne and for those that do not share a home ground. They were able to predict the correct winning team in 68 percent of games; Brailsford, Easton, Gray & Gray (1995), who reported a favorite-longshot bias in the AFL. Their success rate from betting on home teams during 1987-1995 was 58 percent, yet the return rate was negative; Bailey & Clarke (2004), who use data from 1997-2003 and present models predicting correctly up to 67 percent of winners, and producing betting profits of up to 15 percent; and Clarke (2005) who demonstrated that individual clubs have home ground advantages to different degrees, non-Victorian teams having a larger advantage. His results lend support to the conclusion that crowd effects are the main determinant of home ground advantage.

[11] Initially, we divided the data set into two further categories, according to market expectations of the outcome; a priori close games and a priori one-sided games. Close games were defined as games in which the line (in its absolute value) is less than 17.5 (the median line over our sample). Nevertheless, since the results of the two categories do not differ significantly, we do not present them. Results are available upon request.

[12] For further information about the AFL, see its official website: *http://www.afl.com.au*.

[13] The Geelong Cats are the only team from Victoria which is not from Melbourne, since Geelong is located 70 Km from Melbourne. Sydney and Brisbane are located 1,050 and 1,700 Km from Melbourne, respectively.

[14] In what is probably a unique, albeit bizarre, feature of the AFL, there are even games in which the official home team is playing an opponent with a genuine a priori home ground advantage! A recent example is provided in Round 9 of the 2005 season, when the Western Bulldogs, a Melbourne-based team, were the official home team in their game against the Sydney Swans, while the game was played in Sydney!

[15] The Melbourne Cricket Ground, opened in 1854, is the most famous Australian sporting venue, which serves throughout the winter as the home of Australian Rules football, and hosts the Grand Final. Regulations now limit the capacity to approximately 99,000, yet until the 1970s, more than 120,000 people were occasionally accomodated in the venue. For an early history of the M.C.G., see: K. Dunstan, *The Paddock that Grew* (Melbourne, 1962).

[16] It is interesting to ask why don't teams from outside Victoria suffer when playing in Melbourne? Possible answers to this question are, first, that Victoria is the home of Australian football and so has fans of all teams. Second, since there are only three grounds in Melbourne, outside teams play there often whereas teams only ever visit Brisbane, Sydney and Geelong once a season excluding possible finals.

[17] In contrast to the US market, the winning dividend per $1 point spread wager in the AFL is not fixed. The range of this dividend in our data of 2001-2004 was $1.78-$2.05, while in 66% of the games it was $1.9, and the average was $1.9 as well. We utilize in this paper the Australian usage of the term "dividend", which includes the original $1 bet.

[18] The percentage of winning bets (*WP*) necessary to break even, 52.63 percent, is obtained by setting the expected value of the random variable, a gamble $WP * 0.9 + (1 - WP) * (-1)$, equal to zero.

[19] See, for further discussion, Vergin & Scriabin (1978), Gandar, Zuber, O'Brien & Russo (1988), and Dana & Knetter (1994).

[20] The range of actual payouts in our data set is $1.03-$10, while the average sum is $2.36.

[21] The average bookmakers' commission during our 2001-2004 data was 3.9%, while the average during 1998-2004 was 5.5%. Bailey & Clarke (2004) noted that the commission could be as low as 2-3%.

[22] In the event the outcome is identical to the line, known as a "push" or a "no bet", the gambler's wager is refunded. In the very rare event where the outcome is a draw, the fixed odds bettor wins half the amount he would have won had his team won. Our data contains only 5 draws (0.7%). One can bet on a draw for most games at odds of 65 to 1, but this is part of an exotic category of bets. Note that this seems a high price given that there are over 700 games in our sample!

[23] Nonetheless, Levitt (2004) noted that the adjustments in the line/odds are typically small and relatively infrequent; in the five days preceding an NFL game, the posted price changing an average of 1.4 times per game, and in 85 percent of those changes, the line moved by the minimum increment of one-half of a point. Yet, he noted that in horse racing, the odds set by bookmakers change more frequently. Avery & Chevalier (1999) noted that in 64 percent of NFL's games during 1983-1994 the line moved by half a point in the week prior to the game, and in 85 percent - by one point. Unfortunately, we do not have the relevant data for the AFL in order to shed more light on this.

[24] These methods include: *Even money line* (also known as *Points*), which is simply a "double or nothing" line bet, i.e., the bettor will either lose his stake or double it; *Draw*, where the bettor bets on the chance that the final result will be a draw; Point spread in 10 point gaps; *1-39* and *40+*, where the bettor bets on the chance that the point spread will be between 1 and 39 points and 40 or above, respectively; Highest scoring quarter; First goal scorer in each quarter; Most goals kicked; Most free kicks; and also different future odds bets, including

Different medals; Premiership; Final eight; Highest placed Victorians or non-Victorians; Team to reach Grand Final; First coach to depart and many others.

[25] Although it should be noted, that not all data from previous seasons or games are available on-line today.

[26] It should be noted, that although there are around 30 registered interactive bookmakers that accept AFL bets, the odds and lines do not vary significantly.

[27] Response to a query from one of the authors by one of Australia's leading bookmakers, Sportsbet Pty Ltd.

[28] See Golec & Tamarkin (1991) for a discussion about the different methods of choosing the team of record.

[29] For example, if the Kangaroos host Essendon in the M.C.G, *HOME* equals zero for both, since both are from Melbourne, and the ground's city is Melbourne; If Frementale host Carlton in Subiaco Oval, *HOME* equals 1 for Frementale and 0 for Carlton, since Frementale are from Perth, as the Ground, and Carlton are from Melbourne.

[30] Compared to Clarke's (2005) findings of 80% and 60% (or 62% after 1987), respectively.

[31] We can not reject normality for the normalized price.

[32] Evidently, this is not applicable to most US sports, where there are almost no neutral grounds games.

[33] Statistical results for this category could not be obtained, since the home teams won all of these games.

[34] It should be noted that the betting simulations in Table 4a and Table 4b are using in-sample data, yet they suffice to make our point. Before recommending them as a basis for betting in practice, out-of-sample tests would obviously need to be conducted!

[35] This differs from Tryfos, Casey, Cook, Leger & Pylpiak (1984) and their successors, Gandar *et al* (1988) and Russo, Gandar & Zuber (1989), as they tested the NFL line betting market where the winning odds are fixed at 10 to 11. We expand Tryfos *et al*'s (1984) test to include not only a constant dividend (as in the NFL line market), but also variety of fixed dividends (as in the AFL line and fixed odds markets).

[36] The equivalent results of Tryfos *et al* (1984) and Gandar *et al* (1988) were 3 profitable scenarios out of 70, and 0 out of 14, respectively.

References

Amoako-Adu, B., Marmer, H. & Yagil, J. 1985. The efficiency of certain speculative markets and gambler behavioral. *Journal of Economics and Business* 37: 365-378.

Avery. C. & Chevalier, J. 1999. Identifying investor sentiment from price paths: the case of football betting. *The Journal of Business* 72: 493-521.

Bailey, M.J. & Clarke, S.R. 2004. Deriving profit from Australian rules football: a statistical approach. In: H. Morton (ed). *Proceedings of the seventh Australian conference on mathematics and computers in sport.* Massey University: Palmerston Nth.

Bassett, G.W., Jr. 1981. Points spreads versus odds. *Journal of Political Economy* 89: 758-768.

Brailsford, T.J., Easton, S.A., Gray, P.K. & Gray, S.F. 1995. The efficiency of Australian football betting markets. *Australian Journal of Management* 20: 167-195.

Busche, K. & Hall, C.D. 1988. An exception to the risk preference anomaly. *The Journal of Business* 61: 337-346.

Clarke, S.R. 2005. Home ground advantage in the Australian football league. *Journal of Sports Sciences* 23*:* 375-385.

Courneya, K.C. & Carron, A.V. 1992. The home advantage in sport competitions: a literature review. *Journal of Sport and Exercise Psychology* 14: 13-27.

Dana, J.D. & Knetter, M.M. 1994. Learning and efficiency in a gambling market. *Management Science* 40: 1317-1328.

Dare, W.H. & Holland, S.A. 2004. Efficiency in the NFL betting market: modifying and consolidating research methods. *Applied Economics* 36: 9-15.

Dobra, J.L., Cargill, T.F. & Meyer, R.A. 1990. Efficient markets for wagers: the case of professional basketball wagering. In: Goff & Tollison (ed.) *Sportometrics*. Texas: College Station.

Efron, B. 1982. *The Jackknife, the Bootstrap and Other Resampling Plans*. Philadelphia: Society for Industrial and Applied Mathematics.

Gandar, J.M., Zuber, R.A., Johnson, R.S. & Dare, W. 2002. Re-examining the betting market on Major League Baseball games: is there a reverse favourite-longshot bias? *Applied Economics* 34: 1309-1317.

Gandar, J.M., Zuber, R.A. & Lamb, R.P. 2001. The home field advantage revisited: a search for the bias in other sports betting markets. *Journal of Economics and Business* 53: 439-453.

Gandar, J., Zuber, R., O'Brien, T. & Russo, B. (1988). Testing rationality in the point spread betting market. *Journal of Finance* 43: 995-1008.

Golec, J. & Tamarkin, M. 1991. The degree of inefficiency in the football betting market: statistical tests. *Journal of Financial Economics* 30: 311-323.

Gray, P.K. & Gray, G.G. 1997. Testing market efficiency: evidence from the NFL sports betting market. *Journal of Finance* 52: 1725-1737.

Holder, R.L. & Nevill, A.M. 1997. Modeling performance at international tennis and golf tournaments: is there a home advantage? *The Statistician* 46: 551-559.

Iskoe, A. 1998, Logical Approach's pointspread encyclopedia: Vol. 1. NFL teams and situations. Las Vegas, NV: Logical Approach.

Levitt, S.D. 2004. Why are gambling markets organized differently from financial markets? *Economic Journal* 114: 223-246.

Productivity Commission, Australian government. 1999. Australia's Gambling Industries. *Http://www.pc.gov.au/inquiry/gambling/index.html*.

Russo, B., Gandar, J.M. & Zuber, R.A. 1989. Market rationality tests based on cross-equation restrictions. *Journal of Monetary Economics* 24: 455-470.

Sauer, R.D. 1998. The economics of wagering markets. *Journal of Economic Literature* 36: 2021-2060.

Schwartz, B. & Barsky, S.E. 1977. The home advantage. *Social Forces* 55: 641-661.

Stefani, R. & Clarke, S. 1992. Predictions and home advantage for Australian rules football. *Journal of Applied Statistics* 19: 251-261.

Stern, H. 1991. On the probability of winning a football game. *American Statistician* 45: 179-183.

Swindler, S. & Shaw, R. 1995. Racetrack wagering and the "uninformed" bettor: a study of market efficiency. *The Quarterly Review of Economics and Finance* 35: 305-314.

The Australian National University, Centre for Gambling Research. 2004. Gambling expenditure in Australia: facts and issues. *Http://gambling.anu.edu.au/factsheets/Facts2004/ FactsheetAUSF&I04-Final.pdf*.

Tryfos, P., Casey, S., Cook, S., Leger, G. & Pylypiak, B. 1984. The profitability of wagering on NFL games. *Management Sceince* 30: 123-132.

Vaughan Williams, L. 1999. Information efficiency in betting markets: a survey. *Bulletin of Economic Research* 51: 1-30.

Vergin, R. & Scriabin, M. 1978. Winning strategies for wagering on national football league games. *Management Science* 24: 809-818.

Vergin, R.C. & Sosik, J.J. 1999. No place like home: an examination of the home field advantage in gambling strategies in NFL football. *Journal of Economics and Business* 51: 21-31.

Woodland, B.M. & Woodland, L.M. 1991. The effects of risk aversion on wagering: point spread versus odds. *Journal of Political Economy* 99: 638-653.

Woodland, B.M. & Woodland, L.M. 1994. Market efficiency and the favorite-longshot bias: The baseball betting market. *Journal of Finance* 49: 269-279.

Woodland, L.M. & Woodland, B.M. 2001. Market efficiency and profitable wagering in the National Hockey League: can bettors score on longshots? *Southern Economic Journal* 67: 983-995.

Woodland, L.M. & Woodland, B.M. 2003. The reverse favourite-longshot bias and market efficiency in Major League Baseball: an update. *Bulletin of Economic Research* 55: 113-123.

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