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Sportsbook pricing and the behavioral biases of bettors in the NHL

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Abstract

The betting market for the NHL is investigated using actual betting percentages on favorites and underdogs from real sportsbooks. Sportsbooks do not appear to attempt to price to balance the book as betting percentages are not proportional to set odds. As in the NFL and NBA, bettors are shown to have a strong preference for favorites and road favorites in particular. Simple strategies of betting against significant imbalances toward the favorite are shown to generate positive returns. Although not pricing to balance the book, sportsbooks do not appear to price to exploit known bettor biases in all cases. Clear bettor behavioral biases for road favorites are not priced into the odds as the prices set in these cases appear to be a forecast of game outcomes. Pricing as a forecast may ensure long-run viability for the sportsbook as it discourages entry into this market by informed traders and still allows the sportsbook to capture its commission on losing bets over time.

Keywords: Efficient Markets, Sports Betting, Sports, Gambling, Behavioral Finance, Behavioral Bias, Hockey

JEL Classification G1

The unearthing of actual betting data from real sportsbooks has allowed a more complete investigation of how sportsbooks truly set prices and, more importantly, has deepened our understanding of efficient markets, or lack thereof, within this market. Under the traditional models of sportsbook behavior, such as Pankoff (1968), Zuber et al. (1985), and Sauer et al. (1988), sportsbooks were assumed to set a market-clearing price by balancing the book. This price would split the betting action between both sides of the wagering proposition. Setting prices which balance the book allows sportsbooks to earn risk free returns when wagering balance is achieved, with sportsbooks earning their commission (under an 11-to-win-10 betting rule) on losing bets. Given that the observed price was assumed to be a result of the actions of bettors, sports betting markets became a natural place to test the efficient markets hypothesis. Findings in support of the efficient markets hypothesis within these wagering markets, where public sentiment is likely to run extremely high, served as a significant stamp of approval of this theory and supported the notion of the general "Wisdom of Crowds".

Levitt (2004) challenged the traditional models of sportsbook behavior. His hypothesis assumes sportsbooks set prices to maximize profits, rather than setting prices to balance the book. Through the use of data from a betting tournament for the NFL, Levitt showed that bettors tend to prefer certain wagers, such as road favorites, and sportsbooks incorporate these known bettor biases into prices. With biased prices, sportsbooks earn higher profits by becoming an active participant in the wager, effectively wagering on the less-popular side of the proposition. Under the Levitt hypothesis, sportsbooks are not only good at forecasting game outcomes, but also know the likely biases of bettors, and are able to exploit these advantages through their pricing.

One problem with the study of Levitt (2004) was the use of a betting tournament rather than data from an actual sportsbook. Given the betting tournament participants were a small group and paid only an entry fee to participate, marginal incentives (the outlay of money per bet and the actual payoff or losses occurring with each game bet) normally present in sports gambling markets were absent in the data from the betting tournament. Given the small number of participants and the lack of marginal incentives, doubts of the validity of these results were expressed.

In recent articles in the Journal of Prediction Markets and the International Journal of Sports Finance, Paul and Weinbach tested the Levitt model of sportsbook behavior using actual betting data from real sportsbooks. Through the use of actual sportsbook data from www.sportsbook.com and data from multiple sportsbooks collected by www.sportsinsights.com, Paul and Weinbach showed that betting dollars are not balanced evenly between favorites and underdogs (or overs and unders in the totals markets) in the NFL (Paul and Weinbach 2007) and in the NBA (Paul and Weinbach 2008). Unlike the assumptions of the traditional models, favorites receive a disproportionate share of the betting dollars. In each sport, as the pointspread on the favorite increased, the percentage of dollars bet on the favorite also increased. In addition, there was an additional increase in percentage of dollars bet on road favorites as opposed to home favorites.

These results cast doubt on the traditional models of sportsbook behavior as the betting dollars definitely do not appear balanced. Although the findings of these papers allow for a rejection of the null hypothesis that sportsbooks attempt to balance betting dollars evenly, the alternative hypothesis is not necessarily the hypothesis noted by Levitt (2004). The notion that sportsbooks price to maximize profits, using common bettor biases to their advantage, requires a much stronger result. This result would require sportsbooks to earn greater profits by pricing where bettors will be wrong more often than they are correct.

To determine if sportsbooks are earning greater profits through their choice to set prices other than prices which would balance the betting dollars, Paul and Weinbach (2007, 2008) tested and reported results where the sportsbook became active participants in the wagers. Specifically, returns were calculated and tested for significance in situations where betting dollars were significantly imbalanced. When the percentage bet on the favorite exceeded a certain threshold, such as 60% or 70%, returns to betting the favorite (the same side as the public) and returns to betting the underdog (the side the sportsbook is "betting" by not balancing the dollars) were calculated. If sportsbooks are truly pricing to maximize profits, the betting public should lose their bets on the favorites and the sportsbook should win with bets on the underdog.

In the case of the NFL (Paul and Weinbach 2007), pricing to exploit bettor biases was found to be successful. A strategy of wagering against the betting public was found to generate positive profits. Therefore, sportsbooks were winning often enough to earn higher profits by taking a position on the underdog. In the NBA, however, this was not the case. Favorites and underdogs were found to evenly split wins and losses against the pointspread; independent of how large of a betting imbalance toward the favorite was seen. Therefore, it was concluded for the NBA, sportsbooks are pricing more as a forecast of actual game outcomes, rather than to maximize their own profits. Pricing as a forecast may still be a long-run profit maximizing strategy, however, even in the presence of imbalanced betting dollars, due to the likely repeated game nature of sports wagering. In setting a price as a forecast where each side of the proposition wins in proportion to set odds, sportsbooks still earn their commission on losing bets in the long-run, without the transactions costs necessary to attempt to balance the book or price to exploit biases on a game-by-game basis. This strategy also lessens the incentive for informed bettors to enter the market, possibly taking away profits from sportsbooks in the long-run.

This paper expands the study of actual sportsbook behavior, comparing the traditional models to the Levitt hypothesis and considering alternative theories, by examining the betting market for the National Hockey League. The study of the NHL offers a few advantages as the market is relatively small compared to the NFL and prices are set in the form of odds, rather than a pointspread. The small nature of the market allows for examination of whether sportsbooks are pricing to exploit known bettor biases when the market is rather thin (as the Levitt (2004) suggests), if they are pricing to balance the book (as suggested in the traditional models), or pricing as a forecast (as suggested by Paul and Weinbach (2008)). In addition, given odds rather than a pointspread, the favorite-longshot bias can be investigated.

In professional sports which use odds in the betting market, such as Major League Baseball and the National Hockey League, a so-called "reverse favorite-longshot bias" was found. This reverse bias implies that favorites are overbet and underdogs are underbet meaning that bets on the underdog will win more often than implied by efficiency and could lead to profits, which is the opposite of results found in horse racing (the traditional favorite-longshot bias). These results were found by Woodland and Woodland (1994, 2001). Both sports were found to have a significant reverse favorite-longshot bias. Woodland and Woodland did not equate a unit bet on the favorite and the underdog in the proper manner, so their tests were corrected by Gandar et al. (2002) and by Gandar et al. (2004). After the corrections were implemented, the baseball betting market was shown not to exhibit the bias for all underdogs, but the bias remained significant for the subgroups of slight underdogs and home underdogs. Similarly, after the corrections, the bias was still found in the hockey betting market, although to a slightly lesser extent than originally estimated.

This study uses actual betting market data from four sportsbooks reported by www.sportsinsights.com for the NHL. Tests of whether the sportsbook proportionally balances the betting action compared to odds are performed. In addition, sportsbooks using a strategy of setting prices to maximize profits is investigated through simple betting simulations. The reverse favorite-longshot bias (likely the overbetting of good teams) and home/road biases are also explored.

1. Sports insights betting data—NHL 2005–06–2007–08 seasons

The NHL betting data contains information from three full seasons of the hockey betting market, following the lost lockout season of 2004–05. In these years, 2005– 06 to 2007–08, the dominant form of hockey betting changed to strictly odds (like baseball), as opposed to the previously popular "Canadian Line" where there existed a pointspread (typically a half-goal) and odds. Due to the addition of a shootout and the elimination of ties in hockey, the odds

wager became the most popular and common form of hockey betting, as each game now concludes with a winning and losing team.

Sports Insights presents combined data from four sportsbooks to show the percentage of bets on the favorite and underdog for its subscribers. The four on-line sportsbooks are BetUS.com, CaribSports.com, SportBet.com, and Sportsbook.com. Data were available for each game played in the three seasons, where odds were posted. The raw data set includes information on playoff games, all-star games, preseason games, etc. For the purposes of this study, however, only regular season games were included.

Given the importance of the home/road distinction found in studies of sports which use odds betting (specifically baseball and hockey) in Gandar et al. (2002) and Gandar et al. (2004), we decided to initially split the data into home favorites (road underdogs) and road favorites (home underdogs) to examine the actions of bettors and observe results of various betting strategies. If sportsbooks were basing odds off of the flow of dollars bet and setting prices to balance the betting dollars, under the assumptions of the traditional models of sportsbook behavior, the odds should reflect the percentage of bets received on the favorite and the underdog.

The easiest place to begin with these detailed data is to plot the results. To illustrate the possible references of bettors and betting strategy results, we have arranged the data from the biggest favorites to the smallest favorites for the groupings of home favorites and road favorites. Given the availability of the game odds set by the sportsbook, the percentages bet on favorites and underdogs, and actual game results, we decided to plot all data side-by-side in terms of betting percentages.

In terms of the favorite, the percentage of bets which the favorite should have attracted to balance the book (based on odds), the actual percentage bet on the favorite, and the actual win percentage of a strategy of betting the favorite are presented in Table 1. The data are arranged in terms of the percentage of unit bets which would constitute a proportionally balanced book, based on actual sportsbook odds, organized from highest percentage (biggest favorites) to lowest percentage (smallest favorites) from left-to-right. To clearly illustrate the tendencies and results, the actual betting percentages on favorites received by the sportsbook and the winning percentage of the favorite are shown as 25-game and 100-game moving averages, respectively. This plot allows an easy visual of this market.

For home favorites, the data appear somewhat closely grouped, although the expected percentages bet on the home favorite are generally slightly higher than the actual percentages bet on the home favorite. In addition, the moving average of the actual win percentage of the favorite appears to at least be within range of both other values.

The road favorites (home underdogs) tell a different story. As in Table 1 above, the expected percentage bet on the favorite based on the odds (to balance the book), the actual percentage bet on the road favorite, and the favorite win percentages are plotted together in Table 2.

In Table 2, it appears the expected percentage of bets (based on posted odds) on the favorite and the actual favorite win percentage appears to map rather closely together. On the other hand, the actual percentage bet on the road favorite exceeds the expected percentage bet (based on sportsbook odds) across the sample of road favorites. Visual evidence suggests odds are not set by the sportsbook based on the percentage wagered by bettors, as bettors seem to overestimate the odds of road favorites winning. It appears bettors prefer road favorites by a large margin, but this is not captured by the sportsbook odds, which, likely not coincidently, tend to map closer to actual favorite win percentages. The following sections present formal tests to explore the notion of bettor preferences, sportsbook pricing, and returns to various betting strategies.

Table 1 Expected betting percentages, actual betting percentages, and win percentage for home favorites in the NHL 2005–06 to 2007–08

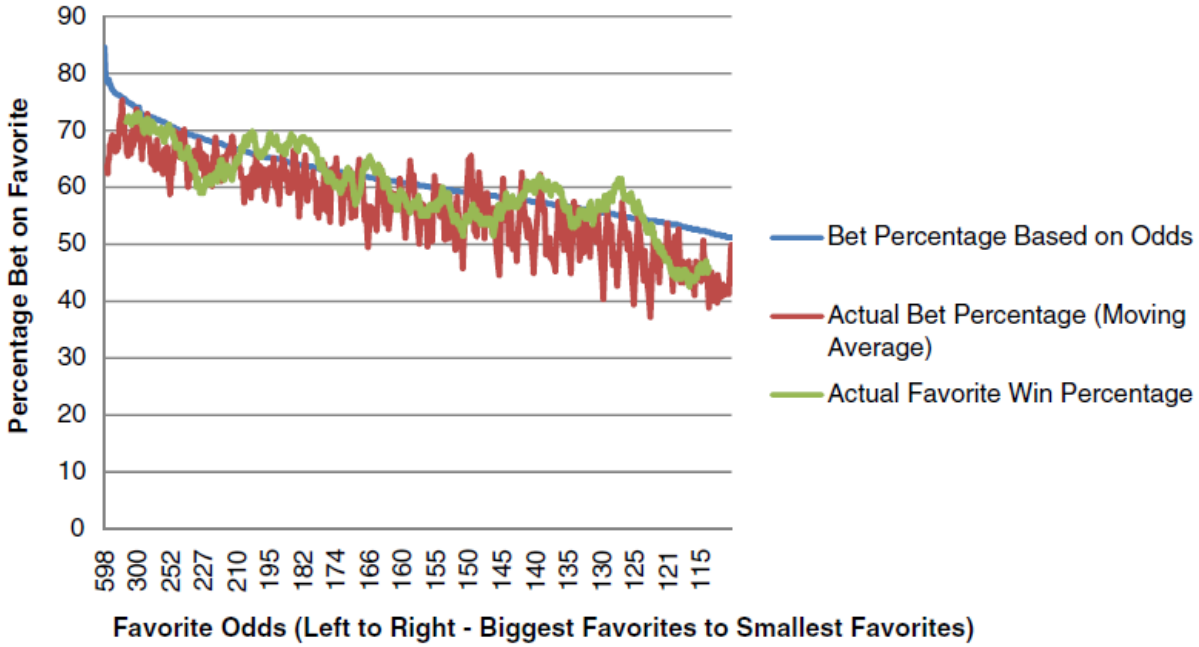
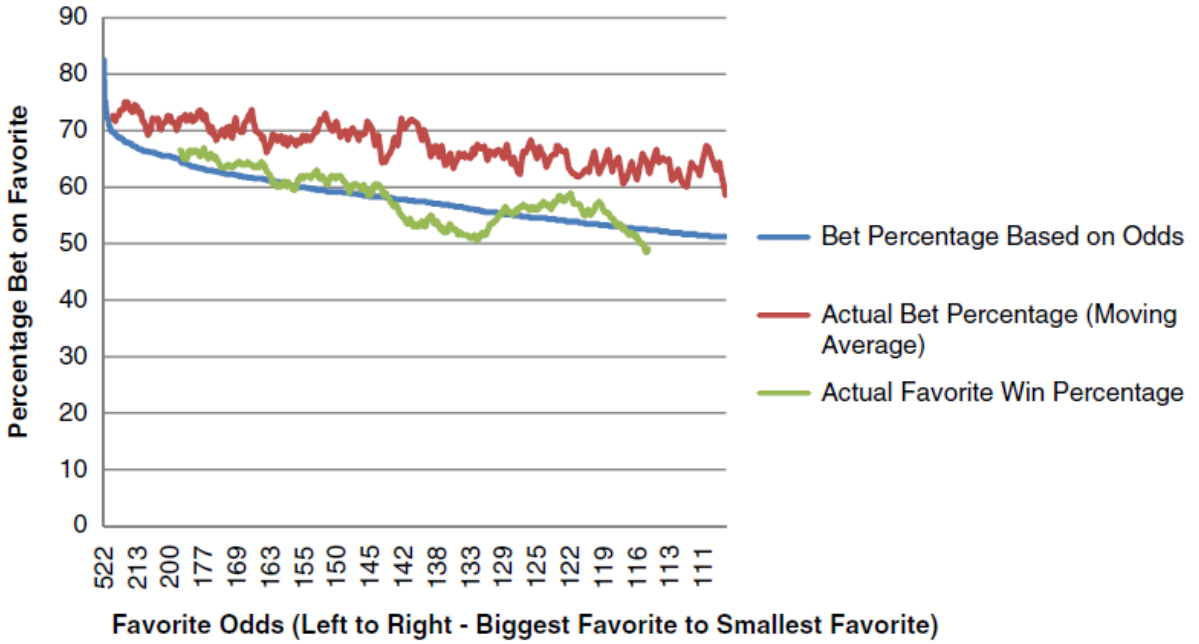


Table 2 Expected betting percentages, actual betting percentages, and win percentage for road favorites in the NHL 2005–06 to 2007–08



1.1 Testing balanced book assumptions using simple regressions

The premise of the traditional models of sportsbook behavior, in terms of pointspreads, was sportsbooks were attempting to attract even betting dollars on both sides of the proposition. If achieved, this position would clear the market and would allow the sportsbook to capture its commission on losing bets without risk. Extending this idea into odds wagering, such as hockey and baseball, sportsbooks were assumed to be attracting betting dollars proportionally with respect to odds.

If sportsbooks are not setting odds based on the betting percentages received on favorites and underdogs, they are not pricing to balance the book. If not pricing to balance the book, findings of market efficiency based on the actions of bettors in gambling markets are quite suspect. Bettors in the aggregate may not be revealing "The Wisdom of Crowds", but may actually be quite biased, while the sportsbook may be setting the price (odds) for other purposes.

To test the null hypothesis that sportsbooks set odds to balance the book, we test the following simple regression model:

$$(\text{Actual \% bet on Favorite}) = \beta_0 + \beta_1(\text{Expected \% Bet on Favorite based on Odds}) + \varepsilon_i.$$

The dependent variable is the actual percentage bet on the favorite by bettors from the Sports Insights data. The independent variable is the percentage of unit bets on the favorite required to produce a proportionally balanced book, based on the posted sportsbook odds. If sportsbooks are setting prices to balance the book, $\beta_0 = 0$ and $\beta_1 = 1$. Therefore, a simple F-test for this null hypothesis is tested for the groups of home favorites and road favorites. Coefficients and t-statistics for the intercept and independent variable are presented along with the F-statistic for the null hypothesis of balanced book behavior by sportsbook in Tables 3 (home favorites) and 4 (road favorites).

The null hypothesis that sportsbooks set prices to balance the book is rejected for both samples. The actual percentage of bets on the favorite is not one-to-one with the odds set by the sportsbook. Within the relevant range within the sample, home favorites receive a slightly lower betting percentage than expected under the posted odds. For the sample of road favorites, as clearly illustrated in the graph in the previous section, road favorites attract higher betting percentages than expected under the set odds.

Overall, the null hypothesis that sportsbooks set odds (prices) to balance the book can be rejected. Sportsbooks do not set odds based solely on the actions of market participants. The alternative hypothesis here is not that sportsbooks set prices to maximize profits based on bettor misperceptions (as seen in Levitt (2004)), but simply that prices are not being set to balance the book. How and why sportsbooks are pricing the NHL market requires additional tests to determine if they are exploiting known bettor biases or pricing as a forecast to capture commissions in a long-run repeated game and discourage entry by informed bettors.

1.2 Returns to betting strategies—NHL 2005–06 to 2007–08

To determine if sportsbooks are truly pricing to maximize profits, as suggested by Levitt (2004), we examine returns to simple betting strategies. Examination of returns to simple betting strategies allows us to determine if the pricing by sportsbooks is efficient and if the sportsbook earns higher returns by pricing through some mechanism other than balancing the book. To begin, we simply calculate returns to betting strategies based on simple rules of wagering on all favorites or all underdogs for the entire sample and at various thresholds. As in the previous section, the sample is split into home favorites and road favorites. Table 5 presents the results for home favorites (road underdogs) and Table 6 presents the results for road favorites (home underdogs).

Table 5 shows a simple strategy of wagering on the underdog earns positive but not significant returns. Betting all road underdogs earns nearly two cents (0.0198) per dollar wagered and betting on all road underdogs where favorite odds are −200 or greater earns nearly six cents (0.0591) per dollar wagered. As in many other sports, a strategy of wagering on home favorites earns lower returns than wagering on road underdogs. It appears that sportsbooks in our sample shade the odds higher

Table 3 Market clearing regression tests—home favorites. Dependent variable: percentage of bets on the home favorite

Independent variable	Coefficient (T-statistic)
Intercept	−8.9144*** (−4.4874)
Expected percentage bet on home favorite based on odds	1.0690*** (33.1116)
F-statistic—null hypothesis $\beta_1=0$ and $\beta_2=1$ (probability Value)	265.5867 (0.0000)

Table 4 Market clearing regression tests—road favorites. Dependent variable: percentage of bets on the road favorite

Independent variable	Coefficient (T-statistic)
Intercept	25.2119*** (6.7813)
Expected percentage bet on road favorite based on odds	0.7392*** (11.5863)
F-statistic—null hypothesis $\beta_1=0$ and $\beta_2=1$ (probability Value)	571.9286 (0.0000)

than the market clearing price would imply, perhaps guarding against being overly lopsided on certain favorites. This slightly higher price set by the sportsbooks allows for contrarian bettors, those that prefer underdogs, to earn slightly positive returns, but these returns are not found to be statistically significant.

In the previous section it was shown bettors clearly prefer road favorites, placing an extremely high percentage of wagers on these teams. Despite this clear behavioral bias, the sportsbook does not appear to set prices to exploit these biases (or price to maximize profits in terms of Levitt (2004)). Prices appear to be set much closer to true probabilities on outcomes of games. A simple strategy of betting against popular public sentiment, wagering on the home underdog, does not earn positive profits. This strategy loses more than three cents (−0.0332) per dollar wagered, posting higher losses than a simple strategy of betting on the road favorite (−0.0137). Bigger road favorites, for instance those with favorite odds of −150 or greater, actually earn positive (but insignificant) returns (0.0311) in this small sample.

Although bettors have a clear behavioral bias for road favorites, sportsbooks appear to price more as a forecast of game outcomes rather than post higher prices

Table 5 NHL gambling market—home favorites—returns to simple betting. strategies of "bet the favorite" or "bet the underdog"

Odds	Return to betting favorite per $1 Bet	Return to betting underdog per $1 Bet	Observations
≥400	−0.1410	0.3250	20
≥350	−0.0821	0.1531	52
≥300	−0.0549	0.0705	156
≥250	−0.0337	0.0215	312
≥200	−0.0556	0.0591	703
≥190	−0.0526	0.0532	800
≥180	−0.0347	0.0191	934
≥170	−0.0370	0.0232	1139
≥160	−0.0327	0.0154	1377
≥150	−0.0356	0.0188	1638
≥140	−0.0373	0.0198	1958
≥130	−0.0345	0.0143	2255
≥120	−0.0347	0.0120	2559
≥110	−0.0433	0.0198	2798

For tests of whether actual returns are equal to expected returns, z-statistics reveal no statistical difference at conventional levels for this sample

Table 6 NHL gambling market—road favorites—returns to simple betting strategies of "bet the favorite" or "bet the underdog"

Odds	Return to betting favorite per $1 Bet	Return to betting underdog per $1 Bet	Observations
≥200	0.0145	−0.0860	89
≥190	0.0375	−0.1298	103
≥180	0.0664	−0.1754	122
≥170	0.0311	−0.1084	172
≥160	0.0093	−0.0705	209
≥150	0.0311	−0.0960	321
≥140	0.0040	−0.0557	441
≥130	−0.0125	−0.0332	542
≥120	0.0088	−0.0573	690
≥110	−0.0137	−0.0333	890

For tests of whether actual returns are equal to expected returns, z-statistics reveal no statistical difference at conventional levels for this sample

on road favorites. This result is similar to the sides and totals markets for the NBA (Paul and Weinbach 2008). Given the NHL market is even smaller than the daily market for the NBA, sportsbooks could be pricing as a forecast to discourage entry into this market by informed bettors, who may easily recognize the behavioral biases of the hockey betting public. This action prevents losses to "wiseguys" and still earns the sportsbook its commission on losing bets in the long-run. Given that betting behavior is likely to be a repeated game, as most bettors enjoy the act of betting on sporting events (the "consumption" element of betting), the sportsbook may actually earn higher profits by earning their commission on losing bets over a season (or many seasons) as opposed to pricing to exploit known biases, where recreational bettors may lose their bankroll for gambling quickly, and may not re-enter the market.

Given the availability of the betting percentages, determination of returns from other simple betting strategies are possible. One angle we examined were cases where the actual percentage bet was significantly higher or lower than the percentage bet suggested by the actual betting market odds. If odds were truly set to balance the book, with the assumption of equal expected returns to bets on the favorite and bets on the underdog, the betting odds can be used to calculate the percentage of unit bets on the favorite and underdog that would offer proportional balance to the sportsbook. Given this information and the actual betting percentage, it is possible to isolate games where the public has a higher percentage bet on one side than would be implied by the odds (or a lower percentage bet than implied by the odds).

This allows for an investigation of games involving informed betting, where the public is exploiting a weak line posted by the sportsbook or games involving uninformed betting, where the public overestimates the probability of a given team winning. If informed bettors truly exist and are betting to exploit incorrect betting lines, a betting strategy of wagering with the money should lead to profits. When the betting is uninformed, however, a betting strategy of wagering against the public

Table 7 Betting strategies based on actual % of bets compared to expected % of bets based on odds: home favorites

Percentage of bets greater (more on favorite) or less than (more on dog) implied by odds	Return to betting favorite	Return to betting underdog	Observations
≥20	−0.1581	0.2244	16
≥15	−0.1321	0.1707	71
≥10	−0.0967	0.1030	240
≥5	−0.0833	0.0928* (z=1.8988)	514
All	−0.0795	0.0711**,^ (z=2.0727, 1.6578)	956
≤20	−0.0333	0.0213	248
≤15	−0.0241	0.0031	501
≤10	−0.0265	0.0034	886
≤5	−0.0325	0.0065	1344
All	−0.0244	−0.0078	1840

* and ** represent rejections of the null hypothesis that actual returns equal expected returns (given the commission on bets) at the 10% and 5% levels respectively. ^ represents the rejection of the null hypothesis that returns are greater than zero at the 10% level

money should lead to profits. Given public preferences for favorites, our initial notion (based on previous studies) was that it was likely that higher percentages of betting dollars on favorites would likely constitute uninformed betting action, while higher percentages of betting dollars on underdogs could indicate informed "smart money" plays. Table 7 presents the results for home favorites and Table 8 presents the results for road favorites.

Table 8 Betting strategies based on actual % of bets compared to expected % of bets based on odds: road favorites

Percentage of bets greater (more on favorite) or less than (more on dog) implied by odds	Return to betting favorite	Return to betting underdog	Observations
≥20	−0.0175	−0.0038	101
≥15	−0.0544	0.0398	234
≥10	−0.0448	0.0197	398
≥5	−0.0654	0.0414	541
All	−0.0487	0.0162	671
≤20	0.2600	−0.4725	4
≤15	−0.0568	0.0220	25
≤10	0.0488	−0.1097	58
≤5	0.1016	−0.1875	124
All	0.0937	−0.1849	219

Not surprisingly, given the chart in the previous section, betting against the public when they overbet (compared to projected percentages based on posted odds) home favorites is found to be profitable. From Table 7, in all games where the percentage bet on the favorite exceeds the expected percentage bet on the favorite as implied by the odds, a strategy of wagering on underdogs earns more than seven cents (0.0711) per dollar bet, while wagering on these popular favorites loses nearly eight cents (−0.0795) per dollar bet. These returns reject the null of a fair bet (returns are equal to expected returns—given the commission charged on bets) and also rejects the null of no profitability (returns are greater than zero) at the ten percent level. In games where the public clearly favors the home favorite, yet the actual odds on the favorite are lower than the true price which would balance the book, wagering against public sentiment is profitable.

In relation to games where road underdogs receive a higher percentage of bets than implied by the odds, little in the way of profitability is found. For all games which meet this criteria, wagering with the public (betting on the underdog) loses slightly less than one cent (−0.0078) per dollar bet, while wagering against the public (betting on the favorite) loses more than two cents (−0.0244) per dollar bet. With road underdogs, finding a higher percentage of betting dollars on this side of the proposition does not imply “smart money” as it does not earn positive returns.

For the sample of road favorites (home underdogs), as presented in Table 8, statistically significant returns are not found in any of the wagering strategies. Positive returns are found for contrarian bettors in both cases (situations where more money is wagered on the road favorite than implied by the sportsbook odds and the case where more money is wagered on the home underdog than implied by the sportsbook odds) presented in Table 8. Given the sample size available to test these strategies, however, significance is not found.

These results imply that the sportsbook does earn some additional profits when the public bets games in a different proportion than those implied by the odds. This is not necessarily evidence, however, of pricing to exploit known bettor biases in all cases. In general, however, It does appear that bettors who follow a contrarian strategy, essentially wagering on the same side as the sportsbook (due to their non-proportional betting action compared to the odds), outperform those who wager with public sentiment.

2 Conclusions and discussion of sportsbook behavior

The availability of actual betting percentages allows for a more detailed study of the betting market for the National Hockey League. The traditional sportsbook models were based on the assumption of a balanced book, where equal amounts of money were attracted on each side of the proposition. This allowed for the testing of the efficient

markets hypothesis, where the pointspread was tested as an optimal and unbiased predictor of the outcome of the game. Findings in support of the efficient markets hypothesis were deemed a result of market participants and contributed to the notion that bettors on the whole displayed the "wisdom of crowds" as pointspreads and totals generally appeared to represent reasonable, if not perfect, forecasts of outcomes of games.

Levitt (2004) challenged the view that sportsbooks set prices to balance the book (based on the actions of market participants) and showed, using a betting tournament, that sportsbooks will exploit clear bettor biases to maximize profits. The betting tournament data, however, did not perfectly mimic a true sportsbook, as it was a relatively small sample of bettors and did not include the marginal costs and benefits normally seen in these markets.

The availability of actual betting data from real sportsbooks, through www. sportsinsights.com, allows for a deeper understanding of sportsbook behavior and actions of participants within this market. In the odds-based market for the NHL, a few items are clear. First, sportsbooks do not set prices to balance the book. There are significant systematic imbalances of actual bets compared to expected bets proportional to the odds set by the sportsbook. This was seen through a simple plotting of the data for home and road favorites and also through f-tests based on simple regression results. Bettors definitely prefer road favorites, as percentages bet on these teams generally exceed the percentage of bets which would be expected based on the odds set by the sportsbook.

When sportsbooks do not price to balance the book, they do not necessarily price to exploit known biases to maximize profits. In some cases, odds (prices) are set slightly too high and the sportsbook earns greater profits given more of the betting dollars are on the losing side of the proposition. In most cases, however, it appears sportsbooks price as a forecast of the actual game outcome. This results in win frequencies for favorites and underdogs that are in line with the posted odds on the game. Therefore, in the long-run, simple strategies do not win enough to earn statistically significant profits despite the presence of bettor biases.

This long-run strategy of setting the odds as a forecast of actual game outcomes may occur for a variety of reasons, which could lead to greater profits for the sportsbook in the long-run. One reason for this strategy by the sportsbook is that betting is not generally a one-shot game, but a repeated game over a season or many seasons for the majority of bettors. When sportsbooks price as a forecast and favorites and underdogs have win percentages in line with posted odds, bettors are expected to lose the sportsbook commission (on losing bets) over a long period of time as they wager over the course of a season (or many seasons). If sportsbooks did price in line with bettor preferences (higher odds (prices) for road favorites, for instance), bettors may lose a greater sum more quickly, but may not continue their activity of betting over time. Therefore, a long-run strategy of pricing as a forecast may earn greater profits over time for the sportsbook, rather than pricing to exploit well-known biases for each game.

Another potential reason why sportsbooks may price as a forecast is to discourage entry into this market by informed bettors. If sportsbooks were to "shade" the odds toward road favorites (for example), informed bettors may enter the market and capture some of the profitability of the sportsbook for themselves. Pricing as an optimal and unbiased forecast discourages entry, as informed bettors are expected to lose the sportsbook commission on losing bets, and may allow the sportsbook to keep more of the profits for themselves, rather than simply transferring money from the uninformed public to informed bettors.

A third reason why sportsbooks may price as a forecast, as opposed to attempting to exploit known bettor biases, is that the active management of the sportsbook in setting biased odds may be quite costly. The transactions costs involved in attempting to limit or deny the betting actions of informed traders (to prevent them from exploiting the biased odds) may be more costly than the long-run profits which could be earned by setting biased odds. Given the size of the betting market, especially the hockey betting market, it may simply not be worth it to try to actively exploit bettor biases to earn higher profits[1]. Given that hockey gamblers may also wager on other sports or place bets in on-line casinos (or play slots or table games in actual casinos which also offer sports wagering in Nevada), pricing to exploit the biases of these bettors may lead to these recreational gamblers to lose enough money in a short period of time to quit gambling altogether or drive them to bet at competing sportsbooks that tend to offer more attractive odds on favorites. This may ultimately lead to fewer long-run profits for sportsbooks and the gambling business in general, if they chose to actively pursue this pricing strategy.

The findings that sportsbooks do not set prices to balance the book calls into question the source of past findings of market efficiency in sports wagering markets and its underlying support for the forecasting power of prediction markets. Under the balanced book assumption, findings of market efficiency were deemed a result of the actions of bettors. When sportsbooks do not desire a balanced book, due to pricing as a forecast of game outcomes,

[1] For sports with extremely large betting volume, such as the NFL, it may become worth the transactions costs to actively price to exploit known bettor biases, which could be why betting on home underdogs (against road favorites) were found to earn profits in the professional football betting market (Levitt 2004).

findings where the null hypothesis of efficient markets could not be rejected may be the result of excellent forecasting on the part of the sportsbook, rather than the actions of biased bettors.

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