Int. J. Financial Stud. **2014**, *2*, 359–370; doi:10.3390/ijfs2040359

OPEN ACCESS
International Journal of
Financial Studies
ISSN 2227-7072
www.mdpi.com/journal/ijfs

Article

"Hot Hand" in the National Basketball Association Point Spread Betting Market: A 34-Year Analysis

Benjamin Waggoner, Daniel Wines, Brian P. Soebbing *, Chad S. Seifried and Jean Michael Martinez

School of Kinesiology, Louisiana State University, Baton Rouge, LA 70803, USA;
E-Mails: bwaggo2@lsu.edu (B.W.); dwines2@lsu.edu (D.W.); cseifried@lsu.edu (C.S.S.); jmmartinez@lsu.edu (J.M.M.)

***** Author to whom correspondence should be addressed; E-Mail: bsoebb1@lsu.edu; Tel.:+1-225-578-0849.

External Editor: Nicholas Apergis

Received: 4 November 2014; in revised form: 19 November 2014 / Accepted: 20 November 2014 / Published: 25 November 2014

Abstract: Several articles have looked at factors that affect the adjustments of point spreads, based on hot hands or streaks, for smaller durations of time. This study examines these effects for 34 regular seasons in the National Basketball Association (NBA). Estimating a Seemingly Unrelated Regression model using all 34 seasons, all streaks significantly impacted point spreads and difference in actual points. When estimating each season individually, differences emerged particularly examining winning and losing streaks of six games or more. The results indicate both the presence of momentum effects and the gambler's fallacy.

Keywords: basketball; hot hand; streak; point spread; NBA (National Basketball Association)

1. Introduction

Traditionally, sports betting markets have been compared to simple financial markets, which allowed researchers to examine financial phenomena difficult to observe in other markets [1]. For example, early research regarding sports betting markets focused on the efficiency of these markets (see Sauer [2]) through the rationality between the opening and closing betting lines [3]. Specifically,

Sauer's [4] review of the sports betting markets outlined three different types of market efficiency: weak, semi-strong, and strong. Within these forms of market efficiency, numerous other studies looked at biases such as the favorite/longshot bias [5–8], reverse favorite/longshot bias [5,9,10], racial bias [11], and sentiment bias [12–16].

The present research focuses on the team momentum (sometimes called the "hot hand" effect), which received considerable attention in the literature both from psychological [17] and financial [18] perspectives. Paton and Vaughan Williams [19] defined the hot hand as "[…] a tendency by bettors to overestimate the extent to which a team or individual's performance is positively autocorrelated" (p. 140). Generally, the literature examining the hot hand effect in betting markets focused on team's winning and losing streaks that occur throughout the regular season. When it comes to betting on the National Basketball Association (NBA), research suggests bettors tend to favor and over bet teams on winning streaks [7,20–23]. In addition, known as betting on the "hot hand", Arkes [18] found evidence showing gamblers overstate the importance of streaks and how it affects the next game's outcome. This belief of streaks is also more commonly known as the gambler's fallacy [24] (p. 1370). Within, it should be noted the over betting on winning streaks can adjust lines and eliminate possible opportunities for truly informed bettors to make a profit [7,22].

One problem with the existing research on the hot hand is the small sample period; thus it may lack generalizability and the data necessary to convince bettors and bookmakers it is indeed a fallacy. As an example, Camerer [20] collected data only from the 1983–1986 seasons, Paul and Weinbach [7] from 1995–2001, Paul and Weinbach [23] from 2004–2006, and Paul and Weinbach [25] from the 2008–2009 season. As Osborne [26] implied, previous research has not considered a long enough time frame to determine if inefficiencies exist in betting markets. In other words, while short-term effects are seen, it is unclear whether these effects persist in the long-term.

Another problem found in the current literature is that there was not much research examining losing streaks. Paul and Weinbach [7] noted, this lack of research could be due to the fact gamblers were more apt to follow teams on winning streaks *versus versus* losing streaks. However, a closer examination of losing streaks could reveal potential profitable betting strategies for bookmakers and bettors over time. While it is important to further current research in betting on favorites, it is just as interesting to analyze teams on losing streaks.

The purpose of the present research is to look at the impact that winning and losing streaks have in NBA point spread betting markets. The time period under examination is the 1979–1980 season through the 2012–2013 season. Covering more than 37,000 games during the sample period, results from a Seemingly Unrelated Regression model to examine point spreads and the actual difference in points scored during the contest indicate momentum effects do exist. However, significant variation is seen from season to season in terms of these momentum effects.

2. Literature Review

While the hot hand effect and potential bias has been a popular area of research in sports betting markets, it has been examined in other contexts as well. Seminal work by Gilovich, Vallone, and Tversky [27] illustrated individuals believed a basketball player would be more likely to make a free throw after making two or three free throws in a row prior to the attempt. Since their study, many other

studies have similarly looked at the hot hand belief. [1] Additional research by MacMahon, Köppen, and Raab [29] provided some context as to the reason why people may believe in hot hand effects. They outlined two reasons for the hot hand. The first reason is evolutionary where individuals can identify hot and cold streaks over time and rationalize them. The second reason is exposure based upon Tversky and Kahneman's [30] representativeness heuristic where people misinterpret the actions in front of them as generalized truths. Nickerson [31] stated individuals do not fully comprehend the role of randomness in sports outcomes.

In sports betting markets, previous research examining the hot hand based on winning and losing can also be classified as momentum effects [18]. Camerer [20] sought to understand whether NBA betting markets take into account streaks by measuring the profitability of placing a bet on teams on winning and losing streaks. Examining three seasons of NBA betting odds, he found evidence of momentum effects existing in betting markets but not in actual game outcomes. This finding, he observed, was evidence of the hot hand. However, individuals betting on teams on winning or losing streaks could not make a profit. Interestingly, Brown and Sauer [21], questioned Camerer's [20] original premise of the hot hand being a misrepresentation of randomness when they examined winning and losing streaks of two or three games and four and more games. Within, Brown and Sauer [21] argued Camerer's [20] results reflected a mythical hot hand and did not examine whether observable changes in both point spreads and actual game outcomes were a function of a hot hand. Brown and Sauer [21] found support for Camerer's [20] hypothesis but did not find any support for an actual hot hand. Gray and Gray [32] similarly analyzed the role that NFL team's winning and losing streaks have in betting outcomes (*i.e.*, covering the spread) from 1976 through 1994. Their results found the point spread market during this time period reacted more quickly to recent performance of the NFL teams, but was slow in reacting to the winning and losing streaks of teams over the course of the season.

Paul and Weinbach [7] discovered in their analysis of point spreads 1995–1996 through 2001–2002 the existence of the hot hand effect where bettors over bet teams on winning streaks. However, they did not find that bettors tended to over bet teams on losing streaks. Paul and Weinbach [7] attributed this difference to a gambler's lower utility with betting on losing teams. Examining the NBA totals market, which is a bet on the combined final point total for the two teams playing in the game, during the same time period, Paul and Weinbach [7] found the hot hand belief did not affect betting behavior.

Paul, Weinbach, and Wilson [22] also found that using streaks to create betting strategies of either betting with the streak or against the streak is not profitable. The only case where the fair bet was violated involved betting the under in games where both teams are coming into play on two or more game under streaks. In addition, they tested strategies of betting with or against streaks under the hot hand hypothesis and no profitability was found. These findings were similar to the results found for totals in professional football, baseball, and hockey. In all cases, the null of a fair bet could be rejected for the largest favorites or largest totals as underdogs won significantly more than 50% of the time. The authors suggested the size of the basketball market is not large enough for uninformed bettors to dominate informed bettors. Therefore, the totals market for the NBA was found to violate a fair bet, but not profitability.

---

[1] See Bar-eli, Avugos, and Raab [28] and Avugos *et al.* [17] for a recent review of this literature regarding the hot hand effect.

Paul, Weinbach, and Humphreys [33] further looked at the role the hot hand effect plays in betting volume of NBA games over a period from 2003–2004 season through the 2008–2009 season. Their hypothesis was bettors influenced by the hot hand effect would bet more for teams that are winning streaks compared to losing streaks. Results from their research supported this hypothesis. Specifically, they found away teams on winning streaks of two games generated a higher percentage of bets compared to home teams on winning streaks. Home teams on winning streaks of four games or more generated a higher proportion of bets (2.2%) compared to away teams on similar streaks (1.9%).

Other recent research by Arkes [18] examined team momentum in NBA betting markets, which was defined by winning and losing streaks but also the strength of game outcomes. Examining a longer sample of NBA regular season games, Arkes [18] concluded hot hand effects were real. Despite gamblers being correct that a hot hand effect exists, there was evidence showing gamblers overstated the importance of streaks and their effect on the streaking team's next game's outcome [18].

In summary, a rich literature has been developed toward examining team momentum in all different contexts. Within sport betting markets, momentum effects present evidence that bettors believe in a mythical hot hand effect. However, there are conflicting findings showing whether or not the hot hand is real. One limitation of the previous research is the short sample periods to look at this effect. As Osborne [26] remarked, previous studies looking at inefficiencies in the sports betting markets do not examine a long enough time horizon. Thus, momentum effects such as the winning and losing streak of teams may persist in the short-term but not necessarily in the long-term. The present research investigates this effect over a longer time period.

3. Methods

To examine the hot hand in the NBA, the sample period looks at regular season point spreads and game outcomes from the 1979–1980 season through the end of the 2012–2013 season. NBA regular season game data from multiple websites including Basketball Reference and NBA.com were retrieved. Information regarding the point spread data for these games was collected from both online websites as well as newspapers. In total, there were 37,179 individual games over this period of time. Over the time period, there were 17 games in which point spreads were not located when using various sources such as websites and newspaper articles. Thus, the final data set includes 37,162 NBA games during the sample period.

In the present research, the following model is estimated:

$$DV_{hags} = \alpha_{DV} + A_{hgs} + A_{ags} + STRK_{hgs} + STRK_{ags} + \varepsilon_{hags} \quad (1)$$

where *h* indexes home teams, *a* indexes away teams, *g* indexes games and *s* indexes seasons, and ε is the equation error term. There are two dependent variables in the present research. The first is the point spread for the game in relation to the home team (*PS*). The second dependent variable is the difference in the final score between the home team and the away team (*DP*). A_{hgs} is a parameter examining the home ability index for team h in game g in season s. A_{ags} is the visiting ability index for team a in game g in season s.[2] ε is the equation error term. The main variables of interest are the streaks for the home ($STRK_{hgs}$) and away ($STRK_{ags}$) teams prior to the observed game. In the present research, these

[2] The ability indexes for the home and visiting team are measured using home and visiting team fixed effects.

streak variables look at winning and losing streaks of two, four, and six or more games. For example, the variable *VL2* takes the value of 1 if the away team is on a losing streak of two or three games going into the observed game. As a result, there are 12 indicator variables.

Table 1 presents the summary statistics for the variables in the present research. It shows the average point spread is −3.77 meaning the home team is favored by 3.77 points which reflects the home court advantage in the NBA. The average difference in points is −3.71 meaning the home team won by an average of 3.71 points during the sample period. *Error* is the difference between the point spread and the actual difference in points showing that the spread favors the home team by about 0.06 of a point compared to the actual final difference in points. This reflects the accuracy of the bookmakers in predicting the final outcome of the match.

Table 1. Summary Statistics (n = 37,162).

Variable	Description	Mean	Std. Dev.	Min	Max
PS	Closing point spread in observed game	−3.775	6.208	−25	49
DP	Actual difference in points in observed game (visiting team–home team)	−3.714	12.885	−68	56
Error	Difference between the closing point spread and difference in points	0.061	11.398	−61.5	62.5
VL2	Visiting team has a losing streak of 2 or 3 games	0.215	0.411	0	1
VL4	Visiting team has a losing streak of 3 or 4 games	0.065	0.246	0	1
VL6	Visiting team has a losing streak of 6 or more games	0.045	0.208	0	1
VW2	Visiting team has a winning streak of 2 or 3 games	0.136	0.343	0	1
VW4	Visiting team has a winning streak of 3 or 4 games	0.046	0.208	0	1
VW6	Visiting team has a winning streak of 6 or more games	0.031	0.174	0	1
HL2	Home team has a losing streak of 2 or 3 games	0.131	0.338	0	1
HL4	Home team has a losing streak of 3 or 4 games	0.045	0.208	0	1
HL6	Home team has a losing streak of 6 or more games	0.036	0.186	0	1
HW2	Visiting team has a winning streak of 2 or 3 games	0.221	0.415	0	1
HW4	Home team has a winning streak of 3 or 4 games	0.066	0.248	0	1
HW6	Home team has a winning streak of 6 or more games	0.044	0.205	0	1

The main variables of interest are the 12 streak variables. A visiting team with a losing streak of two or three games occurred in more than 21 percent of the sample. Similar percentages were found for a two or three game home winning streak. The smallest streak that occurred in the sample was a home team on a losing streak of six or more games (3.6% of the sample observations).

Consistent with Brown and Sauer's [21] research, the present research estimates a Seemingly Unrelated Regression (SUR) to analyze the relationship between the point spreads and the actual game outcomes. We use generalized least squares in the SUR technique to control for the heteroscedasticity of both error terms [34]. As Arkes [18] explained, "[t]he justification [for using SUR] is that the error terms for both models would inclu*de fact*ors known to the odds makers and gamblers, but not observable or quantifiable to the Researcher" (p. 36). These factors could include the game's referee assignments and knowledge of injuries to players. Similar to Brown and Sauer [21], all the seasons are pooled into one model. Thus, there are home and away abilities for each team for each season to control for the changing abilities of teams from year to year.

4. Results and Discussion

Table 2 presents the SUR results. The "R^2" reported in both models is consistent with previous research where Equation 1 explains more of the observed variation in the point spreads than in the actual difference in points. Looking at Table 2, significant results are found for all but one of the streak variables' coefficients. Only the coefficient for the variable indicating the visiting team is on a winning streak of two or three games is insignificant. This result could be that bettors do not perceive visiting teams on a small winning streak to be "hot".

Table 2. Seemingly Unrelated Regression (SUR) Regression Results: Pooled Model.

Dep. Var.	**Point Spread**			**Difference in Points**		
Variable	Coef.	Stnd.Error	*p*-value	Coef.	Stnd.Error	*p*-value
VL2	−0.176	0.035	<0.001	−4.320	0.129	<0.001
VL4	−0.646	0.056	<0.001	−4.408	0.206	<0.001
VL6	−1.182	0.069	<0.001	−4.583	0.252	<0.001
VW2	0.032	0.043	0.458	7.574	0.157	<0.001
VW4	0.435	0.066	<0.001	7.288	0.241	<0.001
VW6	0.727	0.080	<0.001	7.203	0.292	<0.001
HL2	0.121	0.043	0.005	7.608	0.159	<0.001
HL4	0.683	0.066	<0.001	7.601	0.243	<0.001
HL6	1.463	0.076	<0.001	7.651	0.280	<0.001
HW2	−0.130	0.035	<0.001	−4.401	0.128	<0.001
HW4	−0.398	0.055	<0.001	−4.148	0.202	<0.001
HW6	−0.745	0.068	<0.001	−4.402	0.250	<0.001
"R2"	0.8472			0.5236		

Looking specifically at the other eleven significant coefficients, the signs on the coefficients are expected based upon previous research. For example, the coefficient on the variable where the visiting team is on a losing streak of two or three games decreases the point spread by 0.176 points meaning the home team is more favored in the match. Overall, the results presented in Table 2 are consistent with Arkes' [18] findings and the belief in momentum effects showing up in point spreads. The results provided within this paper also confirm belief in the hot hand within betting markets as shown in earlier research such as Camerer [20], Brown and Sauer [21] and Paul and Weinbach [7]. Thus, when a home team is on a losing streak, the point spread will react by increasing, meaning that the home team is becoming more of an underdog.

It is also observed that streaks of six or more games whether on winning or losing or home or away, showed a greater influence on the point spread than teams on streaks of four or more. This observation may be attributed to the gambler's fallacy [24]. Streaks of two or three games occur frequently throughout the season of the NBA. When a team is on a losing streak of four or five games, bettors may believe that the team will win (lose) soon because they are "due" for a win (loss) since they have lost (won) several games in a row, thus committing the gambler's fallacy. However, when these streaks continue on and become streaks of six or more games, bettors may be more likely to contribute

this scenario to the team being legitimately good if they are on a winning streak or legitimately bad if they are on a losing streak.

Examining the results with the dependent variable being the difference in actual points scored, all of the streak variables' coefficients are significant with the expected signs. Recall a negative difference in points means that the home team scores more points than the away team. In Table 2, a visiting team on a losing streak of two or three games decreases the difference in points by 4.3. Looking at the magnitude of the coefficients, visiting team winning streaks and home team losing streaks have a higher impact in terms of the difference in points compared to visiting team losing streak and home team winning streaks. These results are inconsistent with Brown and Sauer's [21] findings. In their research, they found streaks did not have any effect on actual game outcomes.

Alternative Estimation

While the pooled model looks at the impact of the hot hand effect over the course of the 34-year period, significant variation could exist between seasons in examining the hot hand effects. Thus, we estimated Equation 1 for each individual season, consistent with Soebbing and Humphreys' [34] approach for examining the perception of tanking in NBA betting markets. Table 3 presents the findings for the point spread portion of the SUR model while Table 4 provides the difference in points. The coefficients in bold on both tables are significant at the 1 percent level while the last column and last row on both tables reflect the totals for the row/column. In looking at Table 3, there are approximately three significant streak parameters per year. The largest streaks (*HL6*, *HW6*, *VL6*, *VW6*) are the highest frequency in terms of the significance at the 1 percent level. This finding is evidence of the mythical hot hand or team momentum effects since point spreads adjust the most for winning and losing streaks of six or more games. Examining Table 4, there are almost 11 significant streak parameters per season when looking at the difference in points. In contrast to Table 3 where the largest streaks had the highest frequency in terms of significance, they tend to have the lowest frequency in terms of significance for the actual difference in points. While there cannot be any definitive conclusions, it would seem to indicate the presence of an occurrence where bettors tend to perceive that long streaks will continue and bookmakers account for this perception. In actuality, however, there is no indication that large streaks affect the actual difference in points.

Overall, the results presented in Table 4 shows team momentum do consistently impact actual game outcomes throughout the same period. There is no indication that gambling behavior changes systematically from one year to the next year. When examining changes in the NBA, however, there are several reasons why this result may occur. The first reason is changes in the NBA's amateur draft, the mechanism in which amateur players are allocated to professional clubs, to deter teams to intentionally lose late in the regular season to earn a higher probability of selecting first overall in the amateur draft [34]. Thus, the significant coefficients on the winning and losing streak variables may reflect this behavior that has been found in previous research to occur throughout this time period (see Soebbing and Humphreys for a review of this literature [34]). The second reason is due to additional fundamental factors that may impact the point spread and actual game outcomes. Research by Brown and Sauer [35] found evidence that point spreads are impacted by fundamental factors rather than just

irrelevant noise. The significant coefficients in both Table 3 and Table 4 may also reflect some of these fundamental factors.

Table 3. Season SUR Results: Point Spread.

Season/ Streak	VL2	VL4	VL6	VW2	VW4	VW6	HL2	HL4	HL6	HW2	HW4	HW6	Total
1979	0.16	−0.26	−0.45	0.16	−0.59	0.38	−0.06	−0.46	**1.23**	0.01	0.28	−0.33	1
1980	0.12	0.02	−0.21	0.04	0.44	**−0.67**	0.02	0.17	0.79	0.25	0.31	−0.07	1
1981	−0.16	**−1.18**	**−1.84**	0.10	0.07	0.53	0.11	−0.01	**2.53**	0.07	−0.30	−0.62	3
1982	−0.26	−0.54	**−1.49**	0.46	**1.45**	0.97	−0.37	−0.35	0.64	−0.12	−0.01	−0.81	2
1983	−0.29	−0.82	−1.36	−0.10	0.29	0.13	−0.21	−0.29	−0.03	−0.21	**−1.14**	−1.03	1
1984	−0.28	−0.27	**−2.16**	0.00	**1.20**	**1.43**	−0.03	**1.46**	**2.30**	0.01	−0.11	**−1.04**	6
1985	−0.09	−0.27	−0.95	−0.41	0.25	0.38	0.08	**1.13**	1.12	−0.24	−0.35	−0.43	1
1986	0.16	−0.54	−0.86	−0.15	−0.04	0.25	0.27	−0.40	0.82	−0.15	−0.61	−0.58	0
1987	−0.05	0.10	0.36	−0.18	−0.10	0.79	0.28	0.59	0.65	−0.40	−0.05	**−1.16**	1
1988	0.06	−0.40	**−1.76**	0.07	0.02	0.62	0.03	−0.18	1.06	−0.25	−0.75	−0.97	1
1989	−0.09	−0.67	**−0.92**	−0.13	**1.16**	0.98	0.41	0.71	**1.25**	**−0.51**	−0.34	**−0.90**	5
1990	−0.11	−0.62	**−1.08**	0.09	0.24	0.63	−0.06	0.93	0.76	−0.18	−0.30	−0.28	1
1991	−0.10	**−1.38**	**−1.80**	−0.12	0.76	1.14	0.21	**1.19**	**1.77**	−0.10	−0.29	−1.15	4
1992	−0.34	−0.82	−0.97	−0.34	−0.08	**1.33**	0.28	0.78	**1.28**	−0.09	**−1.08**	**−1.45**	4
1993	−0.42	−0.55	**−1.36**	0.22	**1.24**	0.07	0.07	0.33	**1.08**	−0.28	−0.39	**−0.78**	4
1994	0.04	−0.18	−0.75	0.16	0.51	**1.24**	−0.08	0.21	0.43	−0.07	−0.38	−0.99	1
1995	−0.11	−0.59	−0.64	−0.18	0.65	**1.46**	−0.05	0.60	0.99	−0.32	−0.65	**−1.24**	2
1996	−0.11	−0.40	−0.60	−0.06	0.48	0.91	0.45	0.51	**1.79**	−0.53	−0.50	−0.44	1
1997	−0.27	−0.39	−0.79	−0.28	0.41	**1.38**	0.15	0.59	**1.20**	−0.25	**−0.80**	−0.48	3
1998	−0.26	−0.10	−0.44	−0.67	−0.32	0.93	0.27	**1.43**	0.80	−0.15	−0.66	−0.16	1
1999	−0.04	−0.41	**−1.42**	0.08	0.47	**1.41**	−0.27	0.60	**2.00**	−0.05	−0.50	−0.02	3
2000	−0.21	−0.39	−0.83	0.23	0.42	0.50	0.12	0.31	**1.35**	−0.19	−0.44	−1.00	1
2001	−0.17	**−1.45**	−0.97	0.04	0.32	0.51	0.23	1.06	**1.64**	−0.42	−0.02	−0.61	2
2002	−0.14	−0.77	**−1.34**	0.25	0.67	0.58	0.00	0.59	0.60	0.10	−0.15	−0.54	1
2003	−0.21	−0.71	**−1.12**	0.20	**1.39**	**1.89**	0.05	0.31	**2.58**	0.12	−0.42	**−1.67**	5
2004	−0.37	**−0.99**	**−1.28**	0.14	**1.86**	**1.54**	0.43	**1.36**	**2.32**	−0.22	−0.75	**−1.52**	7
2005	−0.47	**−1.00**	**−2.40**	0.30	0.86	0.64	0.03	**1.11**	**1.31**	0.09	**−0.92**	−1.05	5
2006	**−0.61**	**−1.75**	**−1.76**	0.12	0.51	0.73	0.27	0.99	**2.71**	−0.07	**−0.88**	−0.85	5
2007	**−0.75**	−0.86	−1.17	−0.11	0.30	0.47	0.12	**1.51**	1.16	−0.19	−0.38	−0.89	2
2008	0.35	−0.16	−1.09	0.08	0.25	1.06	−0.11	0.89	1.05	−0.33	−0.70	**−1.56**	1
2009	0.22	−0.17	**−1.29**	0.04	0.73	**1.56**	**0.71**	0.85	**1.79**	−0.08	−0.51	−0.93	4
2010	−0.22	−0.53	**−1.12**	0.42	−0.14	1.01	0.12	**1.39**	**1.76**	0.22	−0.24	−0.71	3
2011	−0.38	−0.95	**−1.94**	−0.01	0.28	0.61	0.02	1.03	**2.51**	0.02	−0.01	**−3.10**	3
2012	−0.21	−0.56	**−1.15**	0.14	−0.03	0.57	0.14	0.53	**2.33**	−0.11	−0.34	−0.47	2
Total	2	6	19	0	6	10	1	8	20	1	5	10	

Table 4. Season SUR Results: Difference in Points.

Season/ Streak	VL2	VL4	VL6	VW2	VW4	VW6	HL2	HL4	HL6	HW2	HW4	HW6	Total
1979	−4.18	**−3.37**	**−5.46**	**7.68**	1.26	4.77	**8.15**	**7.33**	**7.66**	**−4.02**	−3.00	−4.07	7
1980	**−2.67**	−2.34	−3.17	**8.84**	−0.71	**8.98**	**7.36**	**4.53**	**8.01**	**−4.31**	−1.04	−1.87	7
1981	**−2.68**	−3.14	−3.08	**8.02**	**6.74**	**7.77**	**7.69**	**6.92**	**6.16**	**−3.46**	**−3.85**	−2.84	9
1982	**−4.34**	**−5.10**	**−4.11**	**7.52**	**4.96**	**7.92**	**6.34**	**7.98**	**8.13**	**−5.33**	**−3.87**	**−7.36**	12
1983	**−2.10**	−2.59	−3.06	**8.09**	**8.45**	**5.99**	**9.10**	**7.86**	**8.96**	**−4.22**	**−3.77**	−0.71	9
1984	**−4.74**	**−5.52**	−4.50	**7.49**	**8.63**	**6.59**	**8.11**	**5.87**	**8.48**	**−4.64**	**−3.51**	**−4.15**	11
1985	**−4.83**	**−4.88**	−3.55	**8.28**	**5.90**	**7.71**	**7.69**	**9.29**	**6.05**	**−4.12**	**−3.55**	−3.16	10
1986	−3.18	−2.41	−3.04	**9.33**	**7.15**	5.88	**8.91**	**10.58**	**10.13**	**−3.53**	−2.22	−4.32	6
1987	**−3.29**	**−4.17**	**−3.60**	**7.51**	**7.04**	**9.73**	**8.75**	**7.69**	**10.33**	**−3.26**	**−3.48**	−3.70	11
1988	**−3.72**	**−3.84**	**−3.83**	**8.68**	**9.03**	**8.69**	**7.87**	**6.20**	**8.33**	**−3.34**	**−4.29**	−3.58	11
1989	**−4.15**	**−5.29**	**−5.07**	**7.80**	**7.47**	**7.66**	**8.87**	**8.34**	**6.61**	**−3.35**	**−4.24**	**−7.64**	12
1990	**−4.02**	**−4.76**	−2.75	**9.42**	**7.21**	**10.42**	**8.09**	**7.12**	**11.60**	**−2.95**	−2.82	**−4.04**	10
1991	**−5.04**	**−3.71**	**−4.11**	**7.27**	**7.62**	**5.24**	**6.82**	**6.55**	**8.84**	**−4.24**	**−5.24**	**−5.46**	12
1992	**−4.44**	**−4.17**	**−5.98**	**6.42**	**6.86**	**9.42**	**9.33**	**9.12**	**8.95**	**−5.00**	**−6.39**	**−5.13**	12
1993	**−3.91**	**−5.68**	**−4.07**	**7.80**	**5.38**	**6.72**	**7.49**	**8.25**	**7.55**	**−4.49**	**−3.96**	**−3.68**	12
1994	**−5.18**	**−4.08**	−2.19	**7.92**	**8.30**	**7.23**	**7.38**	**7.13**	**7.17**	**−4.68**	**−5.65**	**−5.37**	11
1995	**−4.68**	**−3.66**	**−5.54**	**7.34**	**8.45**	**7.69**	**8.59**	**5.25**	**7.41**	**−3.08**	**−4.76**	−3.65	11
1996	**−5.97**	**−6.52**	**−5.74**	**7.21**	**9.98**	**9.82**	**5.44**	**6.32**	**5.45**	**−4.60**	−2.85	**−4.51**	11
1997	**−4.47**	**−5.13**	**−3.22**	**7.33**	**7.02**	**8.55**	**7.15**	**8.47**	**6.60**	**−4.22**	**−3.59**	**−4.16**	12
1998	**−4.87**	**−4.63**	−4.04	**7.71**	**6.95**	**9.17**	**7.02**	**8.26**	3.49	**−3.56**	−2.50	**−6.32**	9
1999	**−3.92**	−2.09	**−5.10**	**7.82**	**7.61**	**8.40**	**6.86**	**8.02**	**7.29**	**−4.44**	**−4.51**	−2.09	10
2000	**−4.91**	**−6.36**	**−6.56**	**7.25**	**8.68**	**5.91**	**6.61**	**4.72**	**8.31**	**−4.69**	**−5.42**	**−4.60**	12
2001	**−4.21**	**−5.52**	**−6.34**	**7.58**	**9.21**	**7.48**	**5.58**	**7.02**	**7.27**	**−5.23**	**−4.88**	**−6.97**	12
2002	**−4.74**	**−3.36**	**−5.30**	**7.73**	**7.57**	**6.93**	**7.74**	**6.43**	**4.77**	**−4.94**	**−5.12**	**−6.87**	12
2003	**−3.50**	**−4.45**	**−4.93**	**6.40**	**6.87**	**8.91**	**8.15**	**10.00**	**8.04**	**−4.42**	**−5.25**	**−5.79**	12
2004	**−5.12**	**−4.14**	**−4.39**	**6.72**	**9.34**	**6.26**	**6.67**	**7.38**	**5.72**	**−4.76**	**−4.46**	**−7.01**	12
2005	**−4.01**	**−3.24**	**−5.16**	**8.07**	**8.81**	**8.39**	**7.55**	**7.26**	**8.87**	**−4.09**	**−5.87**	**−4.56**	12
2006	**−5.41**	**−5.65**	−2.33	**6.68**	**8.49**	**7.16**	**7.70**	**8.48**	**8.61**	**−5.20**	**−4.21**	**−3.95**	11
2007	**−3.62**	−2.79	**−4.26**	**7.96**	**8.35**	**9.43**	**6.29**	**10.40**	**7.34**	**−5.66**	**−6.19**	**−5.45**	11
2008	**−3.68**	**−5.28**	**−5.55**	**7.67**	**6.34**	**7.69**	**8.06**	**7.17**	**8.71**	**−4.47**	**−5.83**	**−5.98**	12
2009	**−5.06**	**−5.62**	**−6.88**	**8.87**	**8.12**	**7.52**	**7.30**	**7.00**	**7.02**	**−5.49**	**−3.13**	**−5.19**	12
2010	**−4.68**	**−3.51**	**−5.75**	**6.65**	**6.96**	**8.55**	**7.93**	**7.69**	**6.23**	**−5.05**	**−4.84**	−3.12	11
2011	**−5.54**	**−5.11**	**−5.79**	**6.60**	**8.29**	**6.78**	**8.60**	**8.40**	**8.90**	**−4.57**	**−4.47**	**−9.99**	12
2012	**−4.78**	**−6.20**	**−4.61**	**7.64**	**7.60**	**8.41**	**8.21**	**8.18**	**7.11**	**−5.10**	**−3.01**	−2.56	11
Total	32	26	24	34	32	32	34	34	33	34	28	22	

5. Conclusions

The theory of the “hot hand” has been a topic studied by several researchers in different fields. Within sports betting markets, team momentum effects are a popular area of analysis with particular emphasis looking at NBA games. While previous research indicates that point spreads are adjusted based upon winning and losing streaks indicating the myth of the hot hand occurs, the research is mixed in terms of how winning and losing streaks affect actual games outcomes, which would signify

an actual hot hand. However, previous research examined only short sample periods. The present research looked at a 34-year period of NBA regular season point spreads and actual games outcomes. A pooled sample found streaks impacted both point spreads and actual games outcomes. Furthermore, estimating each year individually found significant variation in how streaks impact point spreads and actual games outcomes. In particular, it was found that large winning and losing streaks imposed the most effect on point spreads but not on actual game outcomes.

Overall the findings looking at the hot hand effect measured by streaks in the present research are consistent with Arkes' [18] findings in a larger study of NBA regular season games. Furthermore, Arkes [18] concluded that momentum effects do exist and are not mythical. The results in Table 2 would suggest that momentum effects are indeed real and they affect both the point spreads set by bookmakers and the actual difference in points scored by the two teams.

Finally, although this research is not examining a strategy of betting on the streaks, it does provide information that future research could use to look at long-term betting strategies. As recent research provides increasing information that bookmakers are profit maximizers instead of balancing the dollar values between the favorites and underdogs of a particular match (e.g., [23,36,37]), future research could look at how book makers use betting beliefs regarding the hot hand to maximize profits. Recent research by Paul *et al.* [33] began to analyze this phenomenon using five years of betting volume data. An additional area of future research would be the analysis of how the point spread changes from the opening line to closing line to see how accurately the original point spread was set. The movement of the point spread would also reflect the placement of bets that would occur on a game.

Acknowledgments

We would like to thank Andy Weinbach and Richard Gandar for their assistance in obtaining many of the earlier point spreads used in this manuscript and Josh Pratt for his helpful research assistance.

Author Contributions

Benjamin Waggoner and Daniel Wines constructed the streak variables, collected 5 seasons of NBA point spreads and provided the initial statistical analysis. Brian P. Soebbing merged the data together and conducted the final statistical analysis. Soebbing along with Chad S. Seifried and Jean Michael Martinez wrote the final manuscript.

Conflicts of Interest

The authors declare no conflict of interest.

References

1. Gandar, J.M.; Dare, W.H.; Brown, C.R.; Zuber, R.A. Informed traders and price variations in the betting market for professional basketball games. *J. Financ.* **1998**, *53*, 385–401.
2. Sauer, R.D. The state of research on markets for sports betting and suggested future directions. *J. Econ. Financ.* **2005**, *29*, 416–426.

3. Gandar, J.M.; Zuber, R.A.; O'Brien, T.; Russo, B. Testing rationality in the point spread betting market. *J. Financ.* **1998**, *43*, 995–1008.
4. Sauer, R.D. The economics of wagering markets. *J. Econ. Lit.* **1998**, *36*, 2021–2064.
5. Gandar, J.M.; Zuber, R.A.; Johnson, R.S.; Dare, W. Re-examining the betting market on Major League Baseball games: Is there a reverse favourite-longshot bias? *Appl. Econ.* **2002**, *34*, 1307–1317.
6. Golic, J.; Tamarkin, M. The degree of inefficiency in the football betting market. *J. Financ. Econ.* **1991**, *30*, 311–323.
7. Paul, R.J.; Weinbach, A.P. Bettor misconceptions in the NBA: The overbetting of large favorites and the "hot hand". *J. Sport. Econ.* **2005**, *6*, 390–400.
8. Williams, L.V.; Paton, D. Why are some favourite-longshot biases positive and others negative? *Appl. Econ.* **1998**, *30*, 1505–1510.
9. Woodland, L.M.; Woodland, B.M. The reverse favourite-longshot bias and market efficiency in Major League Baseball: An update. *Bull. Econ. Res.* **2003**, *55*, 113–123.
10. Woodland, L.M.; Woodland, B.M. Market efficiency and the favourite-longshot bias: The baseball betting market. *J. Financ.* **1994**, *49*, 269–279.
11. Larsen, T.; Price, J.; Wolfers, J. Racial bias in the NBA: Implications for betting markets. *J. Quant. Anal. Sport.* **2008**, *4*, Article 7.
12. Avery, C.; Chevalier, J. Identifying investor sentiment from price paths: The case of football betting. *J. Bus.* **1999**, *72*, 493–521.
13. Bernile, G.; Lyandres, E. Understanding investor sentiment: The case of soccer. *Financ. Manag.* **2011**, *40*, 357–380
14. Braun, S.; Kvansnicka, M. National sentiment and economic behavior: Evidence from online betting on European football. *J. Sport. Econ.* **2013**, *14*, 45–64.
15. Feddersen, A.; Humphreys, B.R.; Soebbing, B.P. Sentiment bias in National Basketball Association Betting. Available online: http://www.be.wvu.edu/phd_economics/pdf/13-03.pdf (accessed on 14 April 2014).
16. Forrest, D.; Simmons, R. Sentiment in the betting market of Spanish football. *Appl. Econ.* **2008**, *40*, 119–126.
17. Avugos, S.; Köppen, J.; Czienskowski, U.; Raab, M.; Bar-Eli, M. The "hot hand" reconsidered: A meta-analytic approach. *Psychol. Sport. Exerc.* **2013**, *14*, 21–27.
18. Arkes, J. Do gamblers correctly price momentum in NBA betting markets? *J. Predict. Mark* **2011**, *5*, 30–52.
19. Paton, D.; Vaughan Williams, L. Forecasting outcomes in spread betting markets: Can bettors use 'Quarbs' to beat the book? *J. Forecast.* **2005**, *24*, 139–154.
20. Camerer, C.F. Does the basketball market believe in the "hot hand"? *Am. Econ. Rev.* **1989**, *79*, 1257–1261.
21. Brown, W.O.; Sauer, R.D. Does the basketball market believe in the 'hot hand'? *Am. Econ. Rev.* **1993**, *83*, 1377–1386.
22. Paul, R.J.; Weinbach, A.P.; Wilson, M. Efficient markets, fair bets, and profitability in NBA totals 1995–96 to 2001–02. *Q. Rev. Econ. Financ.* **2004**, *44*, 624–632.
23. Paul, R.J.; Weinbach, A.P. Price setting in the NBA gambling market: Tests of the Levitt model of Sportsbook behavior. *Int. J. Sport Financ.* **2008**, *3*, 137–145.

24. Ayton, P.; Fischer, I. The hot hand fallacy and the gambler's fallacy: Two faces of subjective randomness? *Mem. Cogn.* **2004**, *32*, 1369–1378.
25. Paul, R.J.; Weinbach, A.P. The determinants of betting volume for sports in North America: Evidence of sports betting as consumption in the NBA and NHL. *Int. J. Sport Financ.* **2010**, *5*, 128–140.
26. Osborne, E. Efficient markets? Don't bet on it. *J. Sport. Econ.* **2001**, *2*, 50–61.
27. Gilovich, T.; Vallone, R.; Tversky, A. The hot hand in basketball: On the misperception of random sequences. *Cogn. Psychol.* **1985**, *17*, 295–314.
28. Bar-Eli, M.; Avugos, S.; Raab, M. Twenty years of "hot hand" research: Review and critique. *Psychol. Sport Exerc.* **2006**, *7*, 525–553.
29. MacMahon, C.; Köppen, J.; Raab, M. The hot hand belief and framing effects. *Res. Quart. Exerc. Sport.* **2014**, *85*, 341–350.
30. Tversky, A.; Kahneman, D. Belief in the law of small numbers. *Psychol. Bull.* **1971**, *76*, 105–110.
31. Nickerson, R.S. The production and perception of randomness. *Psychol. Rev.* **2002**, *109*, 330–357.
32. Gray, P.K.; Gray, S.F. Testing market efficiency: Evidence from the NFL sports betting market. *J. Financ.* **1997**, *52*, 1725–1737.
33. Paul, R.J.; Weinbach, A.P.; Humphreys, B. Revisiting the "hot hand" hypothesis in the NBA betting market using actual sportsbook betting percentages on favorites and underdogs. *J. Gambl. Bus. Econ.* **2011**, *5*, 42–56.
34. Soebbing, B.P.; Humphreys, B.R. Do gamblers think that teams tank? Evidence from the NBA. *Contemp. Econ. Policy* **2013**, *31*, 301–313.
35. Brown, W.O.; Sauer, R.D. Fundamentals or Noise? Evidence from the professional basketball betting market. *J. Financ.* **1993**, *48*, 1193–1209.
36. Humphreys, B.R. Point spread shading and behavioral biases in NBA betting markets. *Rivista Di Diritto Ed Economia Dello Sport* **2010**, *VI*, 13–26.
37. Levitt, S.D. Why are gambling markets organized so differently from financial markets? *Econ. J.* **2004**, *114*, 223–245.