UNC CHARLOTTE ECONOMICS WORKING PAPER SERIES

IS POINT SHAVING IN COLLEGE BASKETBALL WIDESPREAD?

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Working Paper No. 2016-012

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9201 University City Blvd
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September 2016

ABSTRACT

This paper investigates scoring patterns in NCAA men's college basketball to determine the practicality of widespread cheating in the form of point shaving. Previous research, notably Wolfers (2006), suggests that, because there are a large number of heavy favorites who win but do not cover the point spread as determined in the betting market, men's basketball is subject to potential corruption and that closer attention should be paid to these heavy favorites. Our analysis suggests that, after taking into account various incentives for heavy favorites and the status of the game at half time, a much smaller proportion of games identified in previous studies, are potentially susceptible to point shaving. We conclude that point shaving is not widespread because of its impracticality.

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Abstract

This paper investigates scoring patterns in NCAA men's college basketball to determine the practicality of widespread cheating in the form of point shaving. Previous research, notably Wolfers (2006), suggests that, because there are a large number of heavy favorites who win but do not cover the point spread as determined in the betting market, men's basketball is subject to potential corruption and that closer attention should be paid to these heavy favorites. Our analysis suggests that, after taking into account various incentives for heavy favorites and the status of the game at half time, a much smaller proportion of games identified in previous studies, are potentially susceptible to point shaving. We conclude that point shaving is not widespread because of its impracticality.

JEL Classifications: L83, Z22

Keywords: corruption, sports, cheating, college sports

1. Introduction

In a 2006 article, Justin Wolfers makes the highly controversial claim that there is *prima facie* evidence of widespread corruption in the form of point shaving by favorite teams in the betting market on NCAA basketball games. Wolfers' claim is based on an examination of the distribution of 'forecast errors,' the difference between the actual game point differential and the betting line on the game, the so-called point spread. After showing that point spreads are unbiased estimates of game outcomes, Wolfers assumes that the distribution of these forecast errors should be symmetric around zero. Hence, at any individual point spread or grouping of spreads, the proportion of favorites winning the game but not covering the point spread should be equal to the proportion of favorite game outcomes in the interval of equal width above the point spread where favorites both win the game and cover the point spread. Examining a very large sample of games from the betting market on college basketball, Wolfers finds that the proportion of favorites in the 'win and not cover' interval exceeds the proportion in the equivalent upper 'win and cover' interval. This 'probability discrepancy' is particularly apparent for strong favorites, teams favored to win the game by twelve or more points, and leads to his claim that as much as six percent of these strong favorites could be engaged in point shaving.[1]

Wolfers' controversial claim of widespread point shaving has been critically examined by a number of studies. Similarly skewed forecast error distributions have been found in the point spread betting markets for professional football and basketball (see, for example, Borghesi, 2008).[2] If one accepts the claim that the very high disutility of detection makes it unlikely that

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[1] For the strong favorite category, Wolfers finds 46.2% of game outcomes in the 'win and not cover' interval and 40.7% of game outcomes in the 'win and cover' interval of the same width for a probability discrepancy of 5.5%. However, Wolfers' argument that approximately 6% of these strong favorites may have engaged in point shaving is more subtle than simply rounding up this 5.5% difference in probabilities. He argues (pp. 281-282) that, in the absence of point shaving, the proportions of games falling into the two intervals would have been approximately equal so that point shaving led to approximately 3% of strong favorites who would have covered in the absence of point shaving not covering the spread (but still winning the game). Using his words, "since approximately half of the teams accepting bribes to point shave would have failed to cover regardless of the point shaver's behavior, this suggests that the proportion of strong favorites agreeing to point shave is twice as large, or 6 percent." We choose to focus on the original probability discrepancy of 5.5%; can we explain some or most of this discrepancy without resorting to the argument that it reflects only or even mostly corrupt behavior?

[2] In contrast, Schmidt and Stuck (2009) using an eleven season sample of college football games find both that the forecast error distribution is centered on zero and is symmetrically distributed.

highly paid professional athletes are engaging in Wolfers' version of point shaving, then there may be more innocent explanations for the asymmetry.

Some studies propose that the point spread consistently overrates favorites (see for example, Borghesi, 2008, and Weinbach and Paul, 2008) while others argue that strategic decisions by teams whether ahead or behind late in the game, create patterns in scoring that lead to the observed asymmetries (see for example, Bernhardt and Heston, 2010, and Gregory, 2014). Still other researchers examine changes in betting lines from the open to the close of betting on college games (Bernhardt and Heston, 2010) and the percentages of bets placed on favorites and underdogs (Paul and Weinbach, 2011) to see if there are patterns such as line movements away from favorites or heavy betting on underdogs consistent with the kind of point shaving claimed by Wolfers. Such patterns appear to be absent.[3]

Finally, two studies use another betting line on college basketball games – the totals or over-under betting line – to examine the widespread point shaving claim. Borghesi, Paul, and Weinbach (2010) show that asymmetric distributions of the difference between total scores and totals lines exist in both college basketball and a variety of other totals betting markets and attribute these skewed distributions to upwardly biased totals lines stemming from bettor preferences. In a different application, Borghesi and Dare (2009) use the combination of point spreads and totals to derive the market's expectation of the expected points scored by each team and compare these expectations to the actual points scored by the teams. While they do not find favorites (particularly strong favorites as identified by Wolfers) to be, on average, scoring fewer points than expected, they do find evidence that underdogs may underperform, a result they claim to be in line with the behaviors of identified point shavers.

This paper also critically examines the potential for widespread point shaving by strong favorites. We use information drawn from other betting markets on the same college basketball games which has not been utilized to date. In addition to the well-known point spread and the totals betting markets, sportsbooks frequently post money lines for betting on game winners and second half lines (both spreads and totals) on the same games. We use money lines for betting

[3] Further details on the use and interpretation of betting percentages to detect point shaving are explored in Diemer (2012) and in Paul and Weinbach (2012).

on which team will win the game to derive the betting market's subjective win probabilities and then use these probabilities (in combination with the unbiasedness property of the point spread) to estimate the probability of the favorite winning the game but failing to cover the point spread. This procedure allows us to circumvent the assumption of symmetry in the forecast error distribution that Wolfers makes to estimate this latter probability.

We believe that if point shaving were to occur, it would be most likely to occur in the second half of games. We use second half point spreads to examine how, after observing first half scoring, the betting market adjusts its expectations of second half and end-of-game scoring. The focus on the second half 'game within-a-game' enables us to make and test sharp distinctions between favorite teams potentially engaged in point shaving and those engaged in strategic game management.

Our focus throughout the paper is on the Wolfers' probability discrepancy for strong favorites: we are looking for evidence whether or not some or all of this discrepancy comes as a surprise to the betting markets. If some or all of the discrepancy is expected, then the likelihood of *widespread* point shaving by strong favorites is not credible. On the other hand, if a large portion of the discrepancy is unexpected, Wolfers' claim would be bolstered. The methodology we employ is similar to that used by Wolfers to uncover his probability discrepancy: we repeatedly compare proportions of outcomes falling into identically sized intervals such as the 'not cover' versus 'cover' intervals, and importantly, the 'win and not cover' versus the 'win and cover' intervals.

To preview our results, we first confirm that a Wolfers' type probability discrepancy exists in our sample of more recent seasons of college basketball games. We find some evidence that both game and second half spreads are shaded toward favorites, but even after adjusting point spreads for this bias the probability discrepancy remains. Using money lines on the same sample of games, we derive estimates of the proportion of games in the 'win and not cover' interval for strong favorites that are significantly higher than the proportion estimated under the symmetry assumption. Nevertheless, since the observed proportion of games in this interval still exceeds this money line proportion, a portion of the probability discrepancy, albeit considerably smaller, remains.

We examine the equivalent 'win and cover' versus 'win and not cover' intervals in the second half point spread market and find that the probability discrepancy for strong favorites is no longer significant. Most importantly, our examination of second half spreads and point differentials finds evidence that the market updates its expectations about game outcomes after observing the first half of play and that second half point differentials for strong favorites largely fulfill these updated expectations. However, we also find that strong favorites substantially ahead at the half tend to perform below expectations in the second half. Employing an alternative interval test on this group, we find evidence that these teams are more likely employing game management tactics than engaging in widespread point shaving. Finally, we examine the outcomes of individual teams in this group looking for repeated instances of the same team falling into the 'win and not cover' interval in the same or nearby seasons and find no evidence supporting point shaving. We conclude that there is little evidence of widespread point shaving in NCAA basketball.

The remainder of this paper is organized as follows. Section 2 describes our sample of game statistics and betting lines for six recent college basketball seasons, documents that Wolfers' asymmetry is present in these data, and examines the impact of line shading and overtime games. Section 3 derives subjective probabilities for estimating the 'win but not cover' interval from money lines and tests these against observed frequencies. Section 4 develops and analyses tests of second half point spreads and point differentials. In Section 5, we concentrate on the performance of strong favorites in the second half relative to both their first half performance and game point spreads adjusted for first half scoring. Section 6 concludes.

2. The Wolfers' Probability Discrepancy in the 2007-08 Through 2012-13 College Basketball Seasons

The data sets used by Wolfers and most other researchers to examine the college basketball betting market generally terminate with the 2004-2005 or 2005-2006 seasons. This paper uses data for six recent seasons (2007-2008 through 2012-13) of college basketball games obtained from SportsbookReview.com. This data set, covering 22,219 NCAA Division I college basketball games, contains first half, second half, and overtime points scored by both teams and betting lines from Las Vegas sportsbooks. In addition to the usual point spread and totals lines, almost all of the games have money lines for both teams and second half point spread and totals lines. After eliminating games where betting lines (either closing game point spreads, closing money lines on favorites and underdogs, or second half point spreads) are missing or no favorite was established at the close of betting against the game point spread (so-called 'pick-em' games), our complete data set contains 21,190 games.

Table 1 presents summary statistics for the game point differential (or winning margin) from the favorite team's perspective, GPD, the closing betting line (or point spread) again from the favorite team's perspective, FL[4], and the difference between GPD and FL. For all favorites, the mean difference between GPD and FL is -0.29 (*t*-statistic of -4.023 with a ρ-value < 0.001), the median difference is 0, and the error distribution is significantly skewed.[5] Much of this non-normality in the error distribution for all favorites stems from the group of strong favorites, defined as FL≥12. Here, while the mean difference is not significantly different from zero, the median difference is -0.5 and the distribution is strongly right-skewed.

The performance of favorites against game point spreads is described in Panel A of Table 2. All favorites 'cover' the point spread (GPD>FL) in 48.52 percent of games and do 'not cover' the point spread (GPD<FL) in 49.35 percent of games. Given the large sample size, the small difference in these proportions is statistically significant (a Z-statistic of 1.710 with a ρ-value of 0.087). The proportion of all favorites in the particular intervals of interest, the 'win and not cover' (0<GPD<FL) interval and the equivalently sized 'win and cover' (FL<GPD<2FL) interval, are 23.74 percent and 22.56 percent respectively and the difference in these proportions is again statistically significant (Z-statistic of 2.868 and ρ-value of 0.004). Almost all of the difference in these proportions for all favorites stems from differences in these proportions for the strong favorites that 'win and cover' in only 39.31 percent of games but 'win and not cover' in 44.79 percent of games (a Z-statistic of 5.311 with a ρ-value<0.001). This 5.48 percent difference in proportions for strong favorites in our -sample period (2007-08 through 2012-13)

[4] For the reader's convenience but contrary to betting convention we define this and other point spreads as non-negative (FL≥0) throughout the paper.

[5] In addition, when GPD is regressed on FL using the entire sample, the null hypothesis that closing betting lines are unbiased estimators of winning margins is rejected: the intercept term is significantly negative; the slope term is significantly greater than one; and the joint test the intercept and slope are respectively (0, 1) is decisively rejected. The point spreads are unbiased when focusing only on strong favorites.

almost exactly matches Wolfers' 'probability discrepancy' of 5.5 percent for the 1989-90 through 2004-05 seasons.

As noted earlier, a number of Wolfers' critics have argued that line shading toward favorites, especially strong favorites, contributes to this probability discrepancy. Like Bernhardt and Heston (2010), we think that this bias is too small to account for much of the probability discrepancy in our sample of games. Panel B of Table 2 shows how the proportions in the various intervals of interest change when the minimum possible line change of ½ point is deducted from each point spread. While this small adjustment to the game point spread causes the difference between the 'win and cover' and 'win and not cover' proportions for all favorites to disappear, it may be too large in the sense that it causes the proportion in the broader 'cover' interval to rise to 50.65 percent and the 'no cover' proportion to fall to 47.50 percent, a difference that is statistically significant (Z-statistic of -6.484 and ρ-value<0.001). More importantly, this small adjustment to FL does not eliminate the differences in the 'win and cover' versus 'win and not cover' proportions for games involving strong favorites: the difference of 2.28 percent remains statistically significant (Z-statistic of 2.210 with a ρ-value of 0.027).

In an interesting paper, Johnson (2009) argues that a portion of the probability discrepancy stems from the effect of overtime games on the distribution of GPD around FL. Games tied at the end of regulation go into 5 minute overtime periods until a game winner is determined. Because favorites, particularly strong favorites, forced into overtime tend to win, the lack of ties means that winning margins of zero are largely redistributed rightwards into the 'win and not cover' interval. In our sample of college basketball games, there are 1,259 overtime games (5.94 percent of all games). Favorites win 752 of these overtime games (59.73 percent) and a much higher proportion of these games fall into the 'win and not cover' interval (432 games or 34.31 percent) versus the 'win and cover' interval (145 games or 11.52 percent). There are 100 overtime games involving strong favorites, 69 of which are won by that favorite with all outcomes falling into the 'win and not cover' interval. Panel C of Table 2 explores the impact of excluding overtime games on proportions of games in the intervals of interest. While the adjustment virtually eliminates the difference between the 'win and cover' and 'win and not cover' proportions (Z-statistic of -0.451 and ρ-value of 0.652) for all favorites, it does not do this for strong favorites. Here, while the probability discrepancy is reduced to 4.06 percent by excluding overtime games, this difference remains statistically significant (Z-statistic of 3.883 and ρ-value<0.001).

3. Using Money Lines to Estimate the Proportion of 'Win and Not Cover' Games

In order to test whether the proportion of game outcomes in the `win and not cover' interval (0<GPD<FL) is unduly large, Wolfers is forced to take a "simple shortcut" (p.281) and assume that the distribution of the differences between game outcomes and betting lines (GPD-FL) is symmetric around zero. This symmetry assumption allows him to test the proportion in the 'win and not cover' interval against the proportion of game outcomes falling into the equally sized upper 'win and cover' interval (FL<GPD<2FL). We can circumvent the need to assume symmetry of the distribution of game outcomes around betting lines by using favorite team win probabilities estimated from the money line betting market on the same games to derive a direct estimate of the probability mass in the lower 'win and not cover' interval.

Money line betting is about betting on the game winner, regardless of the final score. Money lines are normally quoted as negative numbers for favorites and as positive numbers for underdogs. For example, on January 26th, 2008 Fordham played Charlotte at Charlotte. The closing favorite and underdog money lines on the game were Charlotte -310 and Fordham +260 (Charlotte was a 7.5 point favorite on the closing game point spread).[6] At this money line, a winning unit bet on Charlotte had a gross payoff of (1 + (1/3.10)) = $1.32 and a winning unit bet on Fordham a gross payoff of (1 + 2.60) = $3.60. These payoffs are readily converted into probabilities of the favorite and underdog winning the game. First, win odds probabilities, FP^O and UP^O, are derived as the inverse of these payoffs; here $FP^O = 1/(1+(1/3.10)) = 0.7561$ and $UP^O = 1/(1+2.60) = 0.2778$. Since the booksum, $FP^O + UP^O$, is greater than one , these win odds probabilities are normalized by dividing each by the booksum to produce the normalized win probabilities, FP^N and UP^N. Here, the booksum = 1.0339, the $FP^N = 0.7313$, and $UP^N = 0.2687$.[7]

[6] We do not mean to brag on our university with this example. While Charlotte won this game by 16 points, it was an even bigger favorite in the following home game against Richmond (the game point spread was 11.5 points and favorite and underdog money lines were -625 and +500). Charlotte lost this game by 6 points.

[7] Further details on the calculation of normalized win probabilities from money lines are provided in Berkowitz *et al*. (2016a).

It is straightforward to use these normalized favorite probabilities, FP^N, to estimate the probability mass in the 'win and not cover' interval. Assuming, like Wolfers, that the distribution of game outcomes (GPD) around betting lines (FL) is centered at zero for all favorites in our sample of games,[8] the probability of a favorite winning or losing (covering or not covering) against FL is 0.5, so that an estimate of the probability mass in the 'win and not cover' (0<GPD<FL) interval is simply (FP^N - 0.5).

Panel A of Table 3 contains the summarized results of calculating the standardized favorite win probabilities for all games in our sample. With money lines varying from (-107, -103) to (-94500, +69250), favorite win probabilities cover almost the entire range between 0.5 and 1.0 (that is, $0.505 \leq FP^N \leq 0.999$). The average win probability is 72.83 percent for all favorites and 91.70 percent for strong favorites. Favorites actually win games at a significantly higher frequency than these win probabilities: the observed win frequency is 74.39 percent for all favorites (Z-statistic of -3.641 and ρ-value<0.001) and 94.30 percent for strong favorites (Z-statistic of -4.871 and ρ-value<0.001). This significant difference between average win probabilities and actual win frequencies is indicative of a favorite-longshot bias in the money lines on college basketball: favorites (underdogs) win games with a higher (lower) frequency than expected.[9]

Panel B of Table 3 reports, for all favorites and for the two sub-groups of favorites, the observed proportions in the 'win and not cover' interval, the 'win and cover' interval, and the normalized win probability estimate of the proportion in the 'win and not cover' interval. While the differences between the observed 'win and cover' proportion and the (FP^N - 0.5) estimate and the observed 'win and not cover' proportion and the (FP^N - 0.5) estimate are small and statistically insignificant for weak-to-moderate favorites, these differences are large and statistically significant for strong favorites with the (FP^N - 0.5) estimate of 41.96 percent being statistically significantly larger than the observed 'win and cover' proportion of 39.31 percent (see Table 1) but significantly smaller than the observed 'win and not cover' proportion of 44.79 percent.

[8] We note that while this assumption does not strictly hold for all favorites where the mean difference of -0.291 is significantly different from zero (*t*-statistic of 4.023 with ρ-value<0.001), it does hold for the sub-group of interest here – the mean difference for strong favorites is 0.010 (*t*-statistic of 0.631 with ρ-value of 0.528).

[9] For more details on the favorite-longshot bias in college basketball, see Berkowitz *et al*. (2016b).

Panels A and B of Table 3 also show average Shin favorite win probabilities, FP^S, and estimates of proportions in the 'win and not cover' interval, (FP^S - 0.5). Shin (1992, 1993) develops a model to explain the favorite-longshot bias in horse racing as a response to the presence of insiders with superior information to bookmakers. While Shin's concern is to estimate the proportion of monies bet by insiders, Jullien and Salanié (1994) show that the Shin procedure can be used in reverse to calculate win probabilities largely corrected for the favorite-longshot bias. These Shin probabilities have been shown to be more accurate predictors of actual outcomes than are the normalized probabilities across a number of odds betting markets in addition to horse racing (for examples, see Cain, Law, and Peel, 2002 and 2003, Smith, Paton and Vaughan Williams, 2009, and Strumbelj, 2014 and 2016).[10]

The Shin probabilities make a difference here. Relative to the normalized probabilities, the Shin probabilities raise favorite win probabilities, especially for strong favorites, and substantially reduce the difference between observed win frequencies and these win probabilities for all favorites and for strong favorites. More importantly for explaining the probability discrepancy for strong favorites, the probability mass estimate using (FP^S - 0.5) for the 'win and not cover' interval of 43.19 percent is higher than the (FP^N - 0.5) estimate of 41.96 percent so that the differences between these proportions and the observed 44.79 percent proportion in the 'win and not cover' interval are reduced to the point where the Z-statistic testing the null hypothesis of the equality of these proportions is no longer significant at any conventional level of significance (Z-statistic of -1.540 with an associated ρ-value of 0.124). That is, the 5.48 percent Wolfers' probability discrepancy in our sample is cut in half by the (FP^N - 0.5) estimate to 2.83 percent and is reduced by more than two-thirds by the (FP^S - 0.5) estimate to 1.60 percent. As a result, the proportion of games with what Wolfers argues is potential point shaving is substantially reduced.

4. Second-Half Point Spreads and Point Differentials

Many of the larger Las Vegas sportsbooks offer second half betting lines (both point spreads and totals) to their in-house customers with winning and losing bets being determined solely by

[10] Further details on Shin probabilities in the context of money line betting markets are provided in Berkowitz *et al*. (2016a).

second half (including overtime) scoring. This market opens at the end of the first half and closes about 20 minutes later with the resumption of play in the second half. As well as being of short duration, bet limits in this betting market are usually lower than for whole game bets, and line changes are much less frequent. Despite possible limitations arising from its ‘thinness,’ this second half betting market provides a window into the expectations of second half scoring: market participants have observed first half play and have updated their beliefs about the relative strengths of the two teams and the potential strategies that each team may use in the second half in order to win the game. Of particular importance for the Wolfers’ widespread point shaving claim, an examination of second half lines and scoring may provide insight into the market’s beliefs about the likelihood of strong favorites covering or not covering the game line, FL, and of the likelihood of the game outcome (GPD) falling into the ‘win and cover’ or the ‘win and not cover’ intervals.[11]

We start with an examination of second half point differentials (SHPD), point spreads (SHFL), and forecast errors (SHPD-SHFL) as shown in Table 4. On average, favorites win the second half by slightly fewer points than expected by the betting market (mean SHPD and SHFL are 3.3 points and 4.0 points respectively), so the mean forecast error (SHPD – SHFL) is significantly negative and the median forecast error is -0.5. Second half lines have the same shading toward favorites that characterizes game lines.

As shown in Panel A of Table 5, the result of this line shading is that all favorites ‘cover’ (SHPD>SHFL) against these second half lines in only 45.83 percent of games while the ‘not cover’ (SHPD<SHFL) proportion is 51.65 percent, a difference of 5.82 percent. Most of this significant difference stems from weak-to-moderate favorites (where the difference between the ‘cover’ and ‘not cover’ proportions is 6.63 percent) rather than from strong favorites (where the difference between these proportions is only 2.95 percent). However, like the bias in FL, the bias in SHFL is slight. Adjusting SHFL downward by a half-point reduces the difference between the ‘cover’ and ‘not cover’ proportions for all favorites to an insignificant 0.70 percent and this adjustment for strong favorites creates a significant imbalance in favor of the ‘cover’ proportion (see Panel B of Table 5).

[11] For more information about second-half lines see Berkowitz, *et al*. (2016c).

The more relevant comparison is between proportions in the 'win and not cover' versus the 'win and cover' intervals. For all favorites and for strong favorites considered separately, the proportions of second half point differentials falling into the 'win and not cover' ($0<SHPD<SHFL$) interval and 'win and cover' ($SHFL<SHPD<2SHFL$) interval are almost identical (again, see Panel A of Table 5). That is, there is no equivalent to the Wolfers' probability discrepancy for strong favorites in the second half betting market.

We do not wish to put too much weight on these 'win and not cover' versus 'win and cover' results for strong favorites. To us, it seems highly unlikely that, even if point shaving on game outcomes is pervasive, such point shavers would attempt to also point shave against second half spreads. In reality, it is highly unlikely that potential point shavers closeted in a half-time locker room would even be aware of SHFL for their game. And even if point shavers somehow knew this information, it is difficult to believe that point shavers could simultaneously orchestrate 'win and not cover' strategies against both FL and SHFL. Rather, we believe attention should be placed on how strong favorites perform in the second half relative to their first half performance and to their expected second half performance after taking first half performance into account.

5. The Performance of Strong Favorites in the Second-Half

The Performance of Strong Favorites in the Second-Half Relative to the First-Half

Before undertaking a comparison of second half expectations relative to second half outcomes, we briefly examine second half point differentials (SHPD) for strong favorites relative to first half differentials (FHPD). To facilitate this comparison, we divide the 4,561 games involving strong favorites into three groups based on their first half point differential, FHPD: Group 1 contains those games where strong favorites are tied or losing at the half ($FHPD\leq 0$); Group 2 contains strong favorites who are leading but have not yet covered the game point spread ($0<FHPD<FL$); and Group 3 contains strong favorites who have matched or exceeded the game point spread ($FHPD\geq FL\geq 12$). Panel A of Table 6 documents how favorites in the three groups perform in the second half relative to the first half.

Consider first the performance of Group 1 teams - strong favorites who have performed relatively poorly in the first half. Given the disutility of losing (which we assume impacts all teams irrespective of whether they are point shaving or not), we expect to see a higher proportion of these teams exhibiting improved second half performance (SHPD>FHPD) than the proportion whose second half performance falls short of their (already weak) first half performance (or SHPD<FHPD). Further, to avoid actually losing the game (GPD<0), we would expect SHPD>(-FHPD). There are 729 games in Group 1. In 667 games (91.50 percent) these favorites improve in the second half (SHPD>FHPD) while in 58 games (7.96 percent) these favorites do worse. Strong favorites tied or losing at the half overwhelmingly do better in the second half. These favorites not only do better in the second half but in most games they do sufficiently well in the second half to win the game: of the 667 games where favorites improve in the second-half, in 564 games (84.56 percent) strong favorites improve sufficiently to win the game (SHPD>|FHPD| or GPD>0).

Now consider the other extreme, Group 3 where strong favorites have matched or exceeded the game point spread by half-time (FHPD≥FL≥12). There are 990 games involving strong favorites in this position at the half. The overwhelming majority (930 of the 990 games or 93.94 percent) have lower point differentials in the second half than in the first half (SHPD<FHPD) while less than 5 percent do better (SHPD>FHPD). While strong favorites substantially ahead at the half mostly do worse in the second half, these teams still win the second half game in most cases (670 of the 990 games or 67.68 percent have SHPD>0 compared to 267 games or 26.97 percent where SHPD<0).

Finally, consider the 2,842 games in Group 2 where strong favorites are ahead but have not covered the game point spread at the half. Here, point differentials in the second half relative to the first half increase in 1,187 games (41.77 percent) and decrease in 1,548 games (54.47 percent). While performance in the second half relative to the first half more often than not declines for games in this group, the proportions of games where this happens is much lower than that equivalent proportion in Group 3. This difference between Groups 2 and 3 leads to a further difference - a higher proportion of strong favorites in Group 2 win the second half than lose the second half (2,283 of the 2,842 games or 80.33 percent have SHPD>0 while 477 games or 16.78 percent have SHPD<0).

A clear pattern emerges from this comparison of first and second half point differentials: the great majority of strong favorites substantially ahead at the half do worse in the second half (but not sufficiently worse to lose the overall game) while strong favorites losing or tied at the half overwhelmingly improve in the second half (so that they generally win the overall game). The obvious question now is whether or not the betting market recognizes this pattern and adjusts its expectations about second half performance.

The Expected and Actual Performance of Strong Favorites in the Second Half

We noted above that, in addition to potential point shaving, there are two alternative, innocent explanations for the Wolfers' probability discrepancy: the shading of game point spreads toward favorites, especially strong favorites; and late game strategic management. While line shading is present in game point spreads, such shading likely accounts for a relatively minor portion of the 5.48 percent probability discrepancy in our sample. We now address the idea that strategic game management may explain the Wolfers' probability discrepancy. In brief, the hypothesis is that teams who are substantially ahead or behind the other team at the half adopt very different strategies for playing the second half. Those substantially ahead at the half are likely to adopt second half strategies (such as clock management, minimizing turnovers, and high probability shooting) intended to hold onto the lead and to minimize the risk of losing the game. Those teams in the opposite situation at the half frequently adopt high risk strategies in the second half to maximize the number of offensive opportunities (by fouling when on defense and shooting quickly, often from behind the three-point line, when on offense) in order to increase their chances of winning the game. The potential result of both strategies is that more game outcomes fall into the 'win and not cover' interval than expected under Wolfers' symmetry assumption.[12]

There is a crucial difference between the strategic game management and the widespread point shaving hypotheses. Relative to the information set available prior to the start of the game, the market has much more information at the half: playing the first half has revealed information

[12] For more details on the potential impact of second half strategic management on end-of-game point differentials, see Gregory (2014). There, Gregory develops a model of within-game scoring, then uses first half play to generate the structural parameters to simulate second half play. He finds that teams leading at the half make larger strategic adjustments than do trailing teams and that second half point differentials tend to shrink (or grow less rapidly) than they would if each team chose a strategy to maximize expected points per possession. These adjustments result in right skewed distributions of winning margins, especially for large favorites, to the extent that the Wolfers' probability discrepancy largely disappears.

on the relative strengths of the two teams, injuries, individual player match-ups, and so on. Perhaps more importantly, after observing the first half, the market can anticipate the strategies both teams are likely to adopt in the second half and how these strategies may impact scoring margins by game's end and can incorporate these expectations into second half point spreads. In contrast, second half point shaving should neither be anticipated nor incorporated into these second half spreads. Hence, a simple but direct way to test these competing hypotheses is to locate second half point spreads of strong favorites within the 'cover' versus 'not cover' and 'win and cover' versus 'win and not cover' intervals (suitably revised by the results of the first half of play) and then compare these expectations against actual second half outcomes.

In terms of end-of-game outcomes relative to game point spreads, the 'not cover' and 'cover' intervals are GPD<FL and GPD>FL and the 'win and not cover' and the 'win and cover' intervals are 0<GPD<FL and FL<GPD<2FL. Given that the game point differential is the sum of the first and second half point differentials, GPD = FHPD + SHPD, we restate the 'not cover' and 'cover' intervals in terms of the second-half scoring differential as SHPD<(FL-FHPD) and SHPD>(FL-FHPD) and in the same manner, restate the 'win and not cover' and 'win and cover' intervals as (-FHPD)<SHPD<(FL-FHPD) and (FL-FHPD)<SHPD<(2FL-FHPD). Market expectations about the second-half performance of these strong favorites can be observed by replacing SHPD by SHFL in these intervals

The distribution of SHFL across various intervals centered on the difference between the game point spread and the first half point differential (FL-FHPD) for these groupings of strong favorites is shown in Panel B of Table 6,[13] the distribution of SHPD across the same intervals is shown in Panel C of Table 6 and Z-statistics for expected versus actual proportions in the various intervals are shown in Panel D of this table. Using the division of strong favorites into three groups based on their first half performance reveals marked differences across these groups between expected and actual second half performance.

[13] Very few second half lines (165 or 3.62 percent of the 4,561 games involving strong favorites) are set equal to the difference between the end-of-game line and the first half point differential (that is, SHFL = (FL – FHPD); it is clear that second-half lines are not mechanically set. Instead, it is evident that the betting market's expectations for the second half are strongly influenced by first half performance. For more details on how first half play impacts second half lines, see Berkowitz *et al*. (2016b).

We have previously noted that the great majority of Group 1 teams, those strong favorites tied or losing at the half, improve on their lackluster first-half performance in the second half. The betting market anticipates this: the second half betting line is positive for all 729 games. Moreover, while 7 percent of these strong favorites are not expected to improve sufficiently in the second half to win the overall game, the remaining 93 percent are expected to do sufficiently better in the second half to win the game but crucially, not to cover the game point spread. That is, 93 percent of games in this group are expected to fall into the 'win and not cover' interval and all games in this group are expected to end in the 'not cover' interval. Actual second half performance is slightly different from these expectations. Instead of all games falling into the 'not cover' interval, second half point differentials are such that only 88 percent do so (Z-statistic of 9.874 with a ρ-value<0.001).

While many more favorite teams than expected actually lose both the second half and the overall game (over 22 percent versus the expected 7 percent), a significant proportion (over 10 percent) do better than expected and end up in the 'win and cover' interval (and two teams actually do so well in the second half to finish in the blow-out interval). That is, because many more teams in this group either do worse than expected and lose the game or perform better than expected and cover the game point spread, collectively there are far fewer games than expected in the 'win and not cover' interval. Strong favorites in this group do not appear to be the source of the Wolfers' overrepresentation of strong favorites in the 'win and not cover' interval.

The comparison of expected versus actual outcomes for Group 2 teams is also informative. No strong favorites in this group are expected to lose the game ((SHFL<(-FHPD)) or to blow-out the underdog (SHFL≥(2FL-FHPD)).[14] Crucially, more strong favorites in this grouping are expected to have game outcomes in the 'win and not cover' interval (50.91 percent) than in the 'win and cover' interval (43.28 percent). These 'win and not cover' expectations are confirmed by actual second half outcomes: 1,423 of the 2,842 games (50.07 percent) fall into the

[14] Unlike Group 1 where all teams were expected to win the second half (SHFL>0), there is one game in this group with a non-positive second half line. In a first round NIT game on March 16, 2010, Arizona State, a number one seed, played at home against Jacksonville, a number eight seed. Arizona State, a 14.5 favorite on the closing game point spread (FL=14.5), won the first half by 4 points (FHPD=4) but was a 'pick-em' for second half play (SHFL=0). Jacksonville, after trailing by 11 points with 4 minutes left to go in the game, staged a comeback and won the game on a three-point shot at the buzzer, 67 to 66. Perhaps the second half betting market perceived that Arizona State, bitterly disappointed about its omission from the NCAA tournament, did not have its full attention on winning this game?

‘win and not cover’ interval (Z-statistic of 0.637 with a ρ-value=0.524). While the proportion of second half outcomes in the ‘win and cover’ interval of 41.03 percent, it is 2.25 percent lower than expected (Z-statistic of 1.720 with a ρ-value=0.085), because 79 games (2.78 percent) are unexpected blow-outs (SHPD≥(2FL-FHPD);. there is no significant difference between expected and actual proportions in the ‘cover’ interval (43.28 percent versus 43.81 percent for a Z-statistic of -0.401 with a ρ-value=0.688). Lastly, because there are fewer ‘pushes’ (SHPD=(FCL-FHPD)) than expected but more actual losses than expected, the proportion of game outcomes in the ‘not cover’ category is higher than expected (53.34 percent versus 50.91 percent for a Z-statistic of -1.833 with a ρ-value=0.067).

In summary, the proportion of second half outcomes falling into the ‘win and not cover’ interval is almost exactly as expected, and, while the proportion of second half outcomes in the ‘win and cover’ interval is lower than expected, there are a sufficient number of unexpected blow-outs for the proportion of games in the ‘cover’ interval to match expectations for this broader interval. Collectively, teams in Group 2 of the strong favorites, like those in Group 1, do not appear to be the source of the Wolfers’ overrepresentation of strong favorites in the ‘win and not cover’ interval.

We have previously noted that the great majority of Group 3 teams, strong favorites who are substantially ahead at the half, do not perform as well in the second half. None of the 990 games in this group have SHFL>FHPD, that is, the market correctly anticipates this performance drop-off. However, the expected second half performance drop-off is neither large enough for any team to be expected to fall below the ‘win and cover’ interval , ((FL-FHPD)<SHFL<(2FL-FHPD)), nor is the expected second half drop-off so small that many teams are expected to end the game in the blow-out interval, (SHFL≥(2FL-FHPD)).

Actual game outcomes are very different. A much smaller than expected proportion of these strong favorites actually have second half outcomes in the ‘win and cover’ interval (55.86 percent versus the expected 89.49 percent for a Z-statistic of 18.135 with a ρ-value<0.001). However, because there are considerably more second half blowouts than expected (28.28 percent versus the expected 10.51 percent), the difference between the proportion of actual second half outcomes in the broader ‘cover’ interval and the expected proportion in this interval

(84.14 percent versus the expected 100 percent) is somewhat smaller but still significant (Z-statistic of 13.660 with a p-value<0.001). Likewise, the expectation of no second half outcomes in the lower 'not cover' interval is not realized; 14.34 percent of second half outcomes fall into the 'win and not cover' interval and two strong favorites from this group do so badly in the second half that they actually lose the overall game.[15]

In summary, for this group of strong favorites, actual second half outcomes are very different from expected outcomes. While there are 176 teams whose larger than expected second half score differentials land them in the blow-out interval, there are only 144 teams whose lower than expected second-half score differentials land them in the 'not cover' interval. Furthermore, there is a much higher than expected proportion of second half outcomes in the 'win and not cover' interval and a much lower than expected proportion of second half outcomes in the 'win and cover' interval. Given this deviation between expected and actual second half performance, the source of the Wolfers' overrepresentation of strong favorites in the 'win and not cover' interval likely originates in this group of strong favorites. But the vital question remains: as a group, does this weaker than expected second half performance stem from teams engaging in point shaving or strategic game management?

Heavy Favorites That Cover in the First Half: Widespread Point Shaving or Strategic Game Management?

Under either the point shaving or late game strategic management hypothesis, we should expect more strong favorites in the position of teams in Group 3 to have lower winning margins in the second half (SHPD<FHPD) than those who improve on their (already large) first half margins (SHPD>FHPD). However, the two hypotheses have very different expectations as to the extent

[15] It is worthwhile detailing lines and scores for these two games to see how first-half scoring influenced the second-half line. In the first game, played on February 14, 2009, Washington State was a 12 point favorite at home against Oregon State (FL=12). At the half, Washington State was ahead 32 points to 20 (FHPD=12). Despite this lead, the second half line was Washington State by 4.5 points (SHFL=4.5). In the second half, Washington State was outscored 20 points to 33 (SHPD=-13), and lost the overall game by 52 points to 53 points (GPD=-1). In the second game, played on January 12, 2012, Iona was a 13 point favorite at home against Manhattan (FL=13). At the half, Iona was ahead 39 points to 22 points (FHPD=17). Despite Iona's large half-time lead, the second-half line was only 3 points (SHFL=3). In the second half, Iona was outscored 33 points to 53 (SHPD=-20) to lose the game by 3 points (GPD=-3). In both games, the market correctly anticipated that the favorite's first half dominance would not continue in the second-half (but of course, did not expect either favorite to 'not cover' against the game point spread let alone lose the game).

of the decline in the second half point differential. First, consider the second half scoring implications for point shaving. Given that strong favorites in Group 3 have met or exceeded the game point spread by half-time (FHPD≥FL), successful point shaving requires SHPD<(FL-FHPD). However, in order to avoid the disutility of losing, it also requires SHPD>(-FHPD). Hence, ‘successful’ point shaving for Group 3 favorites requires (-FHPD)<SHPD<(FL-FHPD); that is, the same interval as the ‘win and not cover’ interval. However, as Wolfers points out, not all attempts to point shave will be successful. In order to capture the results of both successful and (at least some) unsuccessful point shaving, we broaden the potential point shaving interval to (-FHPD<SHPD<0). If attempts at point shaving are widespread, we would expect the proportion of second half outcomes in the (-FHPD<SHPD<0) interval to exceed the proportion in the equivalently sized (0<SHPD<FHPD) upper interval (where point shaving fails).

In contrast, if teams in this grouping of strong favorites engage in successful second-half strategic game management, we would not expect to see this concentration in the lower (-FHPD<SHPD<0) interval. Successful strategic game management requires only that GPD>0 which, for this group of strong favorites, is achieved as long as SHPD>-FHPD but there is no reason to expect SHPD to be overly concentrated in the lower (-FHPD<SHPD<0) interval. Moreover, we have a suspicion that most coaches, if not most players, would likely measure successful game management more strictly, preferring that the strategy produce SHPD>0. If this supposition is correct, then we might expect to see a higher proportion of second half outcomes falling into the upper (0<SHPD<FHPD) interval rather than the lower (-FHPD<SHPD<0) interval.

The placement of second half outcomes into these intervals for Group 3 favorites is shown in Table 7. As we noted earlier, SHPD<FHPD in 930 (93.94 percent) of the 990 games in Group 3. Of these 930 games, 610 (65.59 percent) have second half outcomes in the upper (0<SHPD<FHPD) interval versus only 265 (28.49 percent) outcomes in the lower (-FHPD<SHPD<0) interval. The Z-statistic for testing that these proportions are equal is -17.254 (ρ-value<0.001). Considered as a group, strong favorites substantially ahead at the half appear to be succeeding in game management rather than acting as pervasive point shavers.

A natural question to ask is whether lesser favorites also substantially ahead at the half behave in the same manner. Table 7 divides weak-to-moderate favorites into two roughly equally spaced intervals, 0<FL<6 and 6≤FL<12, and examines how these teams perform in the second half when they have the same substantial lead (FHPD≥12) at the half as do Group 3 strong favorites. Like strong favorites in Group 3, a great majority of these less favored teams do worse in the second half (SHPD<FHPD). And like strong favorites, moderate favorites (6≤FL<12) doing worse in the second half have a significantly higher proportion of second half outcomes in the upper (0<SHPD<FHPD) interval (49.82 percent) than have second half outcomes in the lower (-FHPD<SHPD<0) interval (41.98 percent). Only weak favorites (0<FL<6) doing worse in the second half have a significantly lower proportion of second half outcomes in the upper (0<SHPD<FHPD) interval (34.73 percent) than in the lower (-FHPD<SHPD<0) interval (55.28 percent). Since these weak favorites are not suspected as point shavers, we speculate that these teams are less capable second half game managers.

The above analysis of second half outcomes relative to expectations in the (FL-FHPD) intervals is predicated on the belief that, if point shaving exists, then it is more likely than not a second half phenomenon. In addition, we posit that if a team is engaged in point shaving, then it likely that this behavior, rather than being a one-off phenomenon, is repeated.[16] As a final check on Group 3 teams, we examine the records of the individual teams in this group: first for teams with more second half outcomes in the 'win and not cover' interval than in the 'win and cover' interval; second, for teams who have more than one 'win and not cover' outcome in a single season; and third, for teams with the most appearances in Group 3. Before proceeding, we want to make it absolutely clear that by naming any team we are not accusing that team of engaging in point shaving.

The summary records of teams in these categories are shown in Table 8. Panel A of this table shows the summary records of the 16 teams with more second half outcomes in the 'win and not cover' interval than in the 'win and cover' interval. Most of these teams (10 of 16) appear only twice as Group 3 teams: while 2 of these 10 teams (Colorado State and Marshall)

[16] We refer the reader to Borghesi and Dare (2009) who provide details on the two identified cases of point shaving in the Wolfers' sample period of 1989-2005. In both instances, the teams (Arizona State and Northwestern) engaged in fixing multiple games in a given season (in the first instance, four games in the 1993-1994 season and in the second instance, three games in the 1994-1995 season).

have both outcomes ending in the ‘win and not cover’ interval (but crucially, these outcomes did not occur in the same season), the remainder have an outcome ending in the blow-out interval to offset the single ‘win and not cover’ outcome. The remaining 6 teams with three or more appearances have either a balanced or greater number of outcomes in the combined ‘win and cover’ plus blow-out intervals than in the ‘win and not cover’ interval (which here is the same as the ‘not cover’ interval). Collectively, the 16 teams have 23 outcomes in the ‘win and not cover’ interval but 22 outcomes in the combined ‘cover’ interval: as a group they do not look like repeat, successful point shavers.[17]

Panel B of Table 8 shows the summary records of the seven teams that have two outcomes in the ‘win and not cover’ interval in a single season (no team has more than two outcomes per season in this interval). Wichita State is the sole team appearing in this group that also appears in the group with more ‘win and not cover’ outcomes (3) than ‘win and cover’ outcomes (2). Two other teams, Murray State and Seton Hall, have balanced numbers of outcomes in the two intervals while the remaining four teams all have more outcomes in the upper than in the lower interval. However, when the combined ‘cover’ interval is compared against the ‘not cover’ interval, all teams but Murray State and Seton Hall have many more outcomes in the ‘cover’ interval. Again, we need to be clear here that we are not singling out these two teams as potential point shavers. In the same season that both had two outcomes in the lower ‘win and not cover’ interval both also had a third outcome in the upper ‘win and cover’ interval. With such a small number of total games for each team (6 for Murray State and 4 for Seton Hall), it is highly likely that pure chance (or not quite as successful as hoped for second half game management) could produce these results.

Finally, Panel C of Table 8 shows the summary records of the six teams appearing most frequently in Group 3. These teams, all highly successful basketball programs that tend to dominate their respective conferences over our sample period, uniformly have many more

[17] Only 16 of the 172 individual teams with more than one appearance in Group 3 have more outcomes in the broader (-FHPD <SHPD<0) interval relative to outcomes in the equivalent upper (0<SHPD<FHPD) interval. However, because the upper end of the (-FFPD<SHPD<0) interval necessarily includes some part of the ‘win and cover’ interval only 6 of these coincide with the 16 teams with more outcomes in the ‘win and not cover’ than the ‘win and cover’ intervals.

second half outcomes in the 'win and cover' interval than in the 'win and not cover' interval and an even more disproportionate number in the 'cover' interval versus the 'not cover' interval.

In summary, looking at the performance of individual teams in this group of strong favorites, we find no evidence that suggests any individual team has engaged in repeated point shaving.

6. Discussion and Conclusions

This paper critically examines the Wolfers claim of widespread point shaving by strong favorites in college basketball games. Wolfers bases this claim on the probability discrepancy for strong favorites between game outcomes in the 'win and not cover' interval and those in the upper 'win and cover' interval. Using a sample of six more recent seasons of college basketball, we find almost the identical probability discrepancy in game outcomes of strong favorites. Our focus is on whether, by using information drawn from other betting markets on the same games but much the same methodology as employed by Wolfers, we can explain most or all of this probability discrepancy: if some or all of the discrepancy is expected in these other markets, then the claim of *widespread* point shaving lacks credibility. Conversely, if some or all of the probability discrepancy is unexpected, that claim may be enhanced.

In order to test the proportion of game outcomes in the 'win and not cover' interval, Wolfers is forced to assume that the distribution of game outcomes around betting lines is both centered at zero and is symmetric. Using money lines on game winners, we estimate two versions of favorite win probabilities, the normalized win probabilities FP^N and the Shin win probabilities, FP^S, and directly estimate the expected proportion of game outcomes in the 'win and not cover' interval without recourse to the assumption of symmetry. Using these estimates substantially reduces the probability discrepancy for strong favorites – from 5.48 percent to 2.83 percent using FP^N and to 1.60 percent using FP^S. Moreover, this relatively small remaining discrepancy is insignificant at conventional significance levels.

Second half point spreads allow for tests of market expectations incorporating additional information (relative to game point spreads) on how both teams have performed in the first half. We adjust the various full game outcome intervals ('cover' versus 'not cover' and 'win and cover' versus 'win and not cover') for first half performance in order to compare expected and actual second half outcomes and to facilitate comparisons, we split strong favorites into three groups based on their first half performance. The first group, strong favorites who are tied and losing at the half, tend to perform better in the second half and have more second half outcomes in the adjusted 'win and cover' interval than expected and fewer second half outcomes in the adjusted 'win and not cover' interval than expected. The second group, strong favorites who are winning at the half but have not yet covered the game point spread, perform as expected by the market: there are no significant differences between the expected and actual proportions in the adjusted 'win and not cover' and the adjusted 'win and cover' intervals. The great majority of the third group, strong favorites who have tied or covered the game point spread at the half, tend to perform worse in the second half. While the market expects some performance drop-off, it does not appear to anticipate the full extent of this lowered performance: the result is that there are more second half outcomes in the adjusted 'win and not cover' interval than expected and fewer outcomes in the adjusted 'win and cover' interval than expected.

Despite these second half 'surprises' we do not believe that this group of strong favorites is engaged in widespread point shaving. Two hypotheses might explain why these favorites tend to perform much worse in the second half (relative to their strong first half performance). The first hypothesis, widespread attempted point shaving, requires that the majority of second half outcomes fall in the lower half of the interval between the first half point differential and the negative of that differential. The second, strategic game management, requires only that the complete game point differential is positive or that the second half point differential exceeds the negative of the first half point differential but, crucially, under this hypothesis there is no reason for second half outcomes to be concentrated in the lower half of this interval.

An examination of the second half performances of this group shows a significantly higher proportion in the upper half rather than the lower half of this interval. We also find similar results in the second half game outcomes for moderate favorites (a group not suspected of point shaving) who have the same strong first half performance. We conclude that the more likely explanation of this relatively poorer second half performance stems from strategic game management. Our second reason for believing that strong favorites in this group are not engaging in widespread point shaving comes from our examination of the records of individual teams in the group. We find no evidence of individual teams with out-of-the ordinary numbers of games in the ‘win and not cover’ interval for any single season or for all six seasons as a whole.

So what conclusions emerge from this examination? We believe that our results both confirm and extend the current evidence against widespread point shaving as the explanation of the Wolfers’ probability discrepancy. Like earlier studies, we find line shading toward favorites and overtime games explains a portion (albeit small) of the probability discrepancy. Like Borghesi and Dare’s (2009) use of totals lines and point spread lines to estimate the expected scores of the two teams in a game to compare against actual team scoring, Bernhardt and Heston’s (2010) use of line changes from open to close to see if there are line movements away from strong favorites consistent with foreknowledge of point shaving by such teams, and Paul and Weinbach’s (2011) use of information about the percentages of bets placed on favorites and underdogs to see if there is heavy betting on underdogs, we use information drawn from other betting markets on the same games to chip away at the probability discrepancy. At the end of this process, we believe we have successfully shown that little or none of this discrepancy remains to be explained by widespread point shaving. Of course, we would be foolish to claim that no teams have, are, or will engage in point shaving. But we believe that the evidence assembled here, along with the evidence provided in earlier studies, points to the absence of widespread point shaving by strong favorites in college basketball games.

References

Berkowitz, Jason P., Craig A. Depken, II and John M. Gandar (2016a). "The conversion of money lines into win probabilities: reconciliations and simplifications." *mimeo,* Department of Economics UNC Charlotte.

Berkowitz, Jason P., Craig A. Depken, II and John M. Gandar (2016b). "A favorite-longshot bias in fixed-odds betting markets: Evidence from college basketball and college football." *Quarterly Review of Economics and Finance* (in press).

Berkowitz, Jason P., Craig A. Depken, II and John M. Gandar (2016c). "Does the first half matter?" *mimeo,* Department of Economics UNC Charlotte.

Bernhardt, Dan and Steven Heston (2010). 'Point shaving in college basketball: a cautionary tale for forensic economics.' *Economic Inquiry*, 48(1), 14-25.

Borghesi, Richard (2008). 'Widespread corruption in sports gambling: fact or fiction?' *Southern Economic Journal*, 74(4), 1063-69.

Borghesi, Richard and William Dare, (2009). 'A test of the widespread-point-shaving theory.' *Finance Research Letters,* 6, 115-121

Borghesi, Richard, Rodney J. Paul, and Andrew P. Weinbach (2010). 'Totals market as evidence against the widespread point shaving.' *mimeo,* available at http://ssrn.com/abstract=2149704.

Cain, M., D. Law, and D. Peel (2002). "Is one price enough to value a state-contingent asset correctly? Evidence from a gambling market." *Applied Financial Economics*, 12(1), 33-38.

Cain, M., D. Law, and D. Peel (2003). "The favourite-longshot bias, bookmaker margins and insider trading in a variety of betting markets." *Bulletin of Economic Research*, 55(3), 263-273.

D'Agostino, Ralph B., Albert Berlanger, and Ralph B. D'Agostino Jr. (1990). 'A suggestion for using powerful and informative tests of normality.' *The American Statistician*, 44(4), 516-521.

Diemer, George C. (2012). 'Comment on "Investigating allegations of point-shaving in NCAA basketball using actual sportsbook betting percentages."' *Journal of Sports Economics*, 13 (2), 207-210.

Gregory, Jesse (2014). 'Do basketball scoring patterns reflect strategic play or illegal point shaving?' *mimeo,* University of Wisconsin.

Jullien, B. and B. Salanie (1994). "Measuring the incidence of insider trading: a comment on Shin." *Economic Journal*, 104(427), 1418-1419.

Johnson, Neal (2009). 'NCAA "point shaving" as an artifact of the regression effect and the lack of tie games.' *Journal of Sports Economics*, 10(1), 59-67.

Paul, Rodney J. and Andrew P. Weinbach (2011). ‘Investigating allegations of point shaving in NCAA’s basketball using actual sportsbook betting percentages.’ *Journal of Sports Economics*, 12(4), 432-447.

Paul, Rodney J. and Andrew P. Weinbach (2012). ‘Response to ‘comment on “investigating allegations of point-shaving in NCAA basketball using actual sportbook betting percentages.”’ *Journal of Sports Economics*, 13 (2), 211-217.

Schmidt, Martin B. and Lee M. Stuck (2009). ‘Point shaving: corruption in NCAA college football?” *Economics Letters*, 105, 90-92.

Shin, H. S. (1992). “Prices of state contingent claims with insider trading and the favourite-longshot bias.” *Economic Journal*, 102(411), 426-435.

Shin, H. S. (1993). “Measuring the incidence of insider trading in a market for state contingent claims.” *Economic Journal*, 104(420), 1141-1153.

Smith, M. A., D. Paton, and L. Vaughan Williams (2009). “Do bookmakers possess superior skills to bettors in predicting outcomes?” *Journal of Economic Behavior and Organization*, 71(2), 539-549.

Strumbelj, E. (2014). “On determining probability forecasts from betting odds.” *International Journal of Forecasting*, 30(4), 934-943.

Strumbelj, E. (2016). “A Comment on the Bias of Probabilities Derived from Betting Odds and Their Use in Measuring Outcome Uncertainty,” *Journal of Sports Economics,* 17(1), 12-26.

Weinbach, A. and R. J. Paul (2008). “The link between information and the favorite-longshot bias in pari-mutuel wagering markets." *Journal of Gambling Business and Economics, 2(1), 30-44*.

Wolfers, Justin (2006). ‘Point shaving: corruption in NCAA basketball.” *American Economic Association, Papers and Proceedings*, 96 (2), 279-283.

Table 1
Summary Statistics: Game Point Differentials, Game Point Spreads, and Forecast Errors

	Statistic	All Games (FL>0)	Weak-to-Moderate Favorites (FL<12)	Strong Favorites (FL≥12)
Number of Games[1]		21,190	16,629	4,561
Game Point Differential	Mean	7.600	5.138	16.578
(GPD = FPS-UPS)	Std. Dev.	12.044	10.944	11.602
	Median	8.0	5.0	16.0
Favorite Point Spread	Mean	7.891	5.536	16.479
(FL)	Std. Dev.	5.595	2.974	4.382
	Median	6.5	5.0	15.0
Forecast Error	Mean	-0.291	-0.398	0.010
(GPD - FL)	Std. Dev.	10.516	10.478	10.647
	Median	0.0	0.0	-0.5
	t-statistic for zero mean	-4.023	-4.894	0.631
	(ρ-value)	(0.000)	(0.000)	(0.528)
	Skewness	0.041	0.006	0.161
	Z-statistic for skewness[1]	2.442	0.294	4.422
	(ρ-value)	(0.015)	(0.775)	(0.000)

Notes: FPS = Favorite Points Scored (at end of game); UPS = Underdog Points Scored (at end of game); FL = Favorite Line.

1. This is the Z-statistic for testing that skewness is zero (as required for normality) suggested by D'Agostino, Belanger, and D'Agostino (1990)

Table 2
The Performance of Favorites Against Game Point Spreads

	All Favorites (FL>0)		Weak-to-Moderate Favorites (0<FL<12)		Strong Favorites (FL≥12)	
	N	(%)	N	(%)	N	(%)
Panel A: Game Point Differentials (GPD) Against Game Point Spreads (FL)						
GPD<0	5,427	25.61	5,167	31.07	260	5.70
0<GPD<FL	5,030	23.74	2,987	17.96	2,043	44.79
GPD=FL	452	2.13	348	2.09	104	2.28
FL<GPD<2FL	4,781	22.56	2,988	17.97	1,793	39.31
GPD≥2FL	5,500	25.96	5,139	30.90	361	7.91
Game Totals	21,190	100.00	16,629	100.00	4,561	100.00
Z1 (ρ-value)[1]	1.710	(0.087)	0.296	(0.767)	3.123	(0.000)
Z2 (ρ-value)[2]	2.868	(0.004)	-0.014	(0.989)	5.311	(0.000)
Panel B: Game Point Differentials (GPD) Against Adjusted Game Point Spreads (FL*= FL - 0.5)						
GPD<0	5,427	25.61	5,167	31.07	260	5.70
0<GPD<FL*	4,639	21.89	2,692	16.19	1,947	42.69
GPD=FL*	391	1.85	295	1.77	96	2.10
FL*<GPD<2FL*	4,617	21.79	2,774	16.68	1,843	40.41
GPD≥2FL*	6,116	28.86	5,701	34.28	415	9.10
Game Totals	21,190	100.00	16,629	100.00	4,561	100.00
Z1 (ρ-value)[1]	-6.484	(0.000)	-6.761	(0.000)	-1.068	(0.286)
Z2 (ρ-value)[2]	0.259	(0.796)	-1.213	(0.225)	2.210	(0.027)
Panel C: Game Point Differentials (GPD) Against Game Point Spreads (FL) - Overtime Games Excluded						
GPD<0	4,920	24.69	4,691	30.32	229	5.13
0<GPD<FL	4,598	23.07	2,624	16.96	1,974	44.25
GPD=FL	408	2.05	304	1.97	104	2.33
FL<GPD<2FL	4,636	23.26	2,843	18.38	1,793	40.19
GPD≥2FL	5,369	26.94	5,008	32.37	361	8.09
Game Totals	19,931	100.00	15,470	100.00	4,461	100.00
Z1 (ρ-value)[1]	-4.881	(0.000)	-6.099	(0.000)	1.038	(0.299)
Z2 (ρ-value)[2]	-0.451	(0.652)	-3.265	(0.000)	3.883	(0.000)

Notes: GPD = Game Point Differential; FL = Favorite Line; FL* = Adjusted Favorite Line

1. This is the Z-statistic for testing the null hypothesis of equality of proportions of games falling into the 'Not Cover' interval (either GPD<FL or GPD<FL*) and the 'Cover' interval (either GPD>FL or GPD>FL*).

2. This is the Z-statistic for testing the null hypothesis of equality of proportions in the 'Win but Not Cover' interval (either (0<GPD<FL) or (0<GPD<FL*) and the equivalent upper 'Win and Cover' interval (either FL<GPD<2*FL) or (FL*<GPD<2FL*).

Table 3

Estimates of the Favorite Team 'Win' and 'Win and Not Cover' Probabilities

	All Favorites (FL>0)	Weak-to-Moderate Favorites (0<FL<12)	Strong Favorites (FL≥12)
Panel A: Favorite Team Objective & Subjective Win Probabilities			
Favorite Wins Game	15,763	11,462	4,301
Total Games[1]	21,190	16,629	4,561
Observed Favorite Win Frequency, FWP	0.7439	0.6893	0.9430
Average Normalized Favorite Win Probability, FP^N	0.7283	0.6766	0.9170
Average Shin Favorite Win Probability, FP^S	0.7358	0.6829	0.9286
Z-Statistic [H_0: FP^N = FWP]	-3.641	-2.485	-4.871
(ρ-value)	(0.000)	(0.013)	(0.000)
Z-Statistic [H_0: FP^S = FWP]	-1.898	-1.253	-2.806
(ρ-value)	(0.058)	(0.210)	(0.005)
Panel B: Favorite Team 'Win and Not Cover' (WNC) Proportions			
Normalized Win Probability Estimate of WNC, prob(FP^N - 0.5)	0.3119	0.2383	0.4196
Shin Win Probability Estimate of WNC, prob(FP^S - 0.5)	0.3216	0.2467	0.4319
Symmetry Estimate of WNC, prob(FL<GPD<2FL)	0.2256	0.1797	0.3931
Observed (Actual) WNC, prob(0<GPD<FL)	0.2374	0.1796	0.4479
Z-Statistic [H_0: prob(FP^N - 0.5) = prob(FL<GPD<2FL)]	20.134	1.170	2.578
(ρ-value)	(0.000)	(0.242)	(0.001)
Z-Statistic [H_0: prob(FP^S - 0.5) = prob(FL<GPD<2FL)]	22.295	1.325	3.767
(ρ-value)	(0.000)	(0.185)	(0.000)
Z-Statistic [H_0: prob(FP^N - 0.5) = prob(0<GPD<FL)]	17.241	-1.172	-2.728
(ρ-value)	(0.000)	(0.241)	(0.006)
Z-Statistic [H_0: prob(FP^S - 0.5) = prob(0<GPD<FL)]	19.399	1.327	-1.540
(ρ-value)	(0.000)	(0.182)	(0.124)

Notes: FWP = Observed Favorite Win Frequency; FP^N= Normalized Favorite Win Probability; FP^S = Shin Favorite Win Probability; FL = Favorite Line; GPD = Game Points Differential

Table 4
Summary Statistics: Second Half Point Differentials, Point Spreads, and Forecast Errors

	Statistic	All Games (FL>0)	Weak-to-Moderate Favorites (FL<12)	Strong Favorites (FL≥12)
Number of Games[1]		21,190	16,629	4,561
Second Half Point Differential	Mean	3.332	2.293	7.120
(SHPD = SHFPS-SHUPS)	Std. Dev.	8.809	8.608	8.491
	Median	3.0	2.0	7.0
Second Half Line	Mean	4.025	3.107	7.372
(SHFL)	Std. Dev.	2.826	2.010	2.601
	Median	3.5	3.0	7.0
Second Half Forecast Error	Mean	-0.693	-0.813	-0.252
(SHPD - SHFL)	Std. Dev.	8.293	8.330	8.144
	Median	-0.5	-0.5	-0.5
	t-statistic for zero mean	-12.157	-12.151	-2.094
	(ρ-value)	(0.000)	(0.000)	(0.036)
	Skewness	-0.025	-0.040	0.038
	Z-statistic for skewness[1]	-1.501	-2.097	1.056
	(ρ-value)	(0.133)	(0.036)	(0.291)

Notes: SHPD = Second Half Point Differential; SHFPS = Second Half Favorite Points Scored; SHUPS = Second Half Underdog Points Scored; SHFL = Second Half Favorite Line. 1. This is the Z-statistic for testing that skewness is zero (as required for normality) suggested by D'Agostino, Belanger, and D'Agostino (1990)

Table 5
The Performance of Favorites Against Second Half Point Spreads

	All Favorites (FL>0)		Weak-to-Moderate Favorites (FL<12)		Strong Favorites (FL≥12)	
	N	(%)	N	(%)	N	(%)
Panel A: Second Half Point Differentials (SHPD) Against Second Half Point Spreads (SHFL)						
SHPD≤0	7,615	36.90	6,632	41.24	983	21.57
0<SHPD<SHFL	3,045	14.75	1,745	10.85	1,300	28.52
SHPD=SHFL	520	2.52	394	2.45	126	2.76
SHFL<SHPD<2SHFL	3,051	14.78	1,781	11.08	1,270	27.86
SHPD≥2SHFL	6,407	31.04	5,528	34.38	879	19.28
Game Totals[1]	20,638	100.00	16,080	100.00	4,558	100.00
Z1 (ρ-value)[2]	11.856	(0.000)	11.941	(0.000)	2.809	(0.005)
Z2 (ρ-value)[3]	-0.083	(0.934)	-0.643	(0.520)	0.698	(0.485)
Panel B: Second Half Point Differentials (SHPD) Against Adjusted Second Half Point Spreads (SHFL*=SHFL-0.5)						
SHPD<0	6,880	35.69	5,897	40.07	983	21.57
0<SHPD<SHFL*	2,609	13.53	1,423	9.67	1,186	26.02
SHPD=SHFL*	436	2.26	322	2.19	114	2.50
SHFL*<SHPD<2SHFL*	3,571	18.53	2,175	14.78	1,396	30.63
SHPD≥2SHFL*	5,780	29.99	4,901	33.30	879	19.28
Game Totals[4]	19,276	100.00	14,718	100.00	4,558	100.00
Z1 (ρ-value)[2]	1.406	(0.160)	2.845	(0.005)	-2.221	(0.026)
Z2 (ρ-value)[3]	-13.385	(0.000)	-13.422	(0.000)	-4.888	(0.000)

Notes:

1. The 552 games with SHFL=0 have been omitted here in order to maintain the comparability of the (SHPD=SHFL) and (SHPD≥2SHFL) intervals with their equivalent complete game intervals.

2. This is the Z-statistic for testing the null hypothesis of equality of proportions of games falling into the 'Not Cover' interval (either SHD<FSHL or SHPD<FSHL*) and the 'Cover' interval (either SHPD>FSHL or SHPD>FSHL*).

3. This is the Z-statistic for testing the null hypothesis of equality of proportions in the 'Win but Not Cover' interval (either (0<SHPD<FSHL) or (0<SHPD<FSHL*) and the equivalent upper 'Win and Cover' interval (either FSHL<SHPD<2FSHL) or (FSHL*<SHPD<2FSHL*).

4. In addition to omitting the 552 games with SHFL=0, the 1,362 games with SHFL=0.5 are omitted here in order to maintain comparability of the (SHPD=SHFL*) and (SHPD≥2SHFL*) intervals with the equivalent second half intervals shown in Panel A.

Table 6
The Second-Half Performance of Strong Favorites

	All Strong Favorites (FL≥12)		Group 1 (FHPD≤0)		Group 2 (0<FHPD<FL)		Group 3 (FHPD≥FL)	
	Games	%	Games	%	Games	%	Games	%
Panel A: Second-Half Point Differentials (SHPD) Relative to First-Half Point Differentials (FHPD)								
SHPD>FHPD	1,901	41.68	667	91.50	1,187	41.77	47	4.75
SHPD=FHPD	124	2.72	4	0.55	107	3.76	13	1.31
SHPD<FHPD	2,536	55.60	58	7.96	1,548	54.47	930	93.94
Totals	4,561	100.00	729	100.00	2,842	100.00	990	100.00
Panel B: Second-Half Point Spreads (SHFL) Relative to Adjusted Game Point Spreads (FL-FHPD)								
(SHFL≤-FHPD)	51	1.12	51	7.00	0	0.00	0	0.00
(-FHPD<SHFL<(FL-FHPD))	2,125	46.59	678	93.00	1,447	50.91	0	0.00
(SHFL=(FL-FHPD))	165	3.62	0	0.00	165	5.81	0	0.00
((FL-FHPD)<SHFL<(2FL-FHPD))	2,116	46.39	0	0.00	1,230	43.28	886	89.49
(SHFL≥(2FL-FHPD))	104	2.28	0	0.00	0	0.00	104	10.51
Totals	4,561	100.00	729	100.00	2,842	100.00	990	100.00
Panel C: Second-Half Point Differentials (SHPD) Relative to Adjusted Game Point Spreads (FL-FHPD)								
(SHPD≤-FHPD)	260	5.70	165	22.63	93	3.27	2	0.20
(-FHPD<SHPD<(FL-FHPD))	2,043	44.79	478	65.57	1,423	50.07	142	14.34
(SHPD=(FL-FHPD))	104	2.28	10	1.37	81	2.85	13	1.31
((FL-FHPD)<SHPD<(2FL-FHPD))	1,793	39.31	74	10.15	1,166	41.03	553	55.86
(SHPD≥(2FL-FHPD))	361	7.91	2	0.27	79	2.78	280	28.28
Totals	4,561	100.00	729	100.00	2,842	100.00	990	100.00
Panel D: Z-Statistics (ρ-values) For Differences between Expected vs. Actual Proportions								
Expected vs. Actual 'Not Cover' Proportions	-2.661 (0.008)		9.874 (0.000)		-1.833 (0.067)		-12.981 (0.000)	
Expected vs. Actual 'Cover' Proportions	1.383 (0.167)		-9.211 (0.000)		-0.401 (0.688)		13.660 (0.000)	
Expected vs. Actual 'Win and Not Cover' Proportions	1.724 (0.085)		13.735 (0.000)		0.637 (0.524)		-12.875 (0.000)	
Expected vs. Actual 'Win and Cover' Proportions	6.851 (0.000)		-9.075 (0.000)		1.720 (0.085)		18.135 (0.000)	

Notes: SHPD = Second Half Point Differential; FHPD = First Half Point Differential; FL = Favorite Line; SHFL = Second Half Favorite Line.

Table 7

The Second Half Performance of Favorite Teams Substantially Ahead at Half Time

	Strong Favorites (FL≥12 & FHPD≥12)		Moderate Favorites (6≤FL<12 & FHPD≥12)		Weak Favorites (0<≤FL<6 & FHPD≥12)		Weak-to-Moderate Favorites (6≤FL<12 & FHPD≥12)		Moderate Favorites (6≤FL<12 & FHPD≥6)	
	Number	%	Number	%	Number	%	Number	%	Number	%
Second Half Performance Relative to First Half Performance										
SHPD>FHPD	47	4.75	59	3.93	21	1.91	80	3.07	443	13.30
SHPD=FHPD	13	1.31	17	1.13	8	0.73	25	0.96	79	2.37
SHPD<FHPD	930	93.94	1,427	94.94	1,071	97.36	2,498	95.97	2809	84.33
Total Games	990	100.00	1,503	100.00	1,100	100.00	2,603	100.00	3331	100.00
All Games with SHPD<FHPD										
SHPD<-FHPD	2	0.22	47	3.29	64	5.98	111	4.44	205	7.30
(-FHPD<SHPD<0)	265	28.49	599	41.98	592	55.28	1,191	47.68	1074	38.23
SHPD=0	53	5.70	70	4.91	43	4.01	113	4.52	165	5.87
(0<SHPD<FHPD)	610	65.59	711	49.82	372	34.73	1,083	43.35	1365	48.59
Total Games	930	100.00	1,427	100.00	1,071	100.00	2,498	100.00	2809	100.00
Z-Statistic (ρ-value) H_o: prob(-FHPD<SHPD<0) = prob(0<SHPD<FHPD)	-17.254 (0.000)		-4.219 (0.000)		9.761 (0.000)		3.071 (0.000)		-7.875 (0.000)	

Notes: SHPD = Second Half Point Differential; FHPD = First Half Point Differential.

Table 8

The Overall Records of Selected Group 3 Teams[1]

	Number of Games	Lose SHPD<-FHPD	Win & Not Cover (-FHPD<SHPD<(FL-FHPD)	Push SHPD=(FL-FHPD)	Win & Cover (FL-FHPD)<SHPD<(2FL-FHPD)	Blow-Out SHPD≥(2FL_FHPD)
Panel A: Teams with More Games in the 'Win & Not Cover' Interval than in 'Win & Cover' Interval						
California San Bernadino	3	0	1	0	0	2
Cleveland State	2	0	1	0	0	1
Colorado State	2	0	2	0	0	0
DePaul	2	0	1	0	0	1
Drexel	3	0	1	0	0	2
Eastern Kentucky	3	0	2	0	0	1
Illinois State	2	0	1	0	0	1
Marshall	2	0	2	0	0	0
Michigan State	5	0	2	0	1	2
Northern Arizona	2	0	1	0	0	1
South Carolina	3	0	2	0	0	1
Tennessee State	2	0	1	0	0	1
Texas Tech	2	0	1	0	0	1
Western Michigan	2	0	1	0	0	1
Wichita State	8	0	3	0	2	3
Wofford	2	0	1	0	0	1
	45	0	23	0	3	19
Panel B: Teams with Two Games in the 'Win & Not Cover' Interval in a Single Season[2]						
Memphis	15	0	4	0	6	5
Murray State	6	0	3	0	3	0
Seton Hall	4	0	2	0	2	0
Syracuse	19	0	4	0	10	5
UCLA	13	0	3	0	8	2
Virginia Commonwealth	13	0	2	0	8	3
Wichita State	8	0	3	0	2	3
	78	0	21	0	39	18
Panel C: Teams with More Than 15 Appearances in Group 3						
Brigham Young	18	0	4	1	8	5
Davidson[3]	21	0	2	0	15	4
Gonzaga	18	0	2	0	10	6
Kansas	20	0	3	0	11	6
Kentucky	17	0	1	0	10	6
Syracuse	19	0	4	0	10	5
	113	0	16	1	64	32

Notes: 1. There are 219 individual teams appearing in one or more games of the 990 games in Group 3: 47 of these appear only once and 152 appear 5 or fewer times.2. No team had more than two games in the 'win and not cover' interval in any single season. 3. Davidson's 21 appearances may surprise some until one remembers that Stephen Curry, one of today's NBA superstars, played for Davidson for the first two seasons of our sample period, 2007-08 and 2008-09. Davidson was a Group 3 team 9 times in these two seasons, compiling a record of 1 game in the 'win and not cover' interval versus 5 games in the 'win and cover' interval and 3 games in the blow-out interval.