The Efficacy of Momentum-Stopping Timeouts on Short-Term Performance in the National Basketball Association

Sam Permutt
Senior Thesis in Economics
Spring 2011
Advisor: Professor David Owens

Abstract

There are conflicting theories on the importance psychological momentum plays in sports. While some academics argue that momentum does not exist in sports and the belief in it stems from misperceptions of random events, others believe that momentum is an important factor in determining the outcomes of games. In the National Basketball Association, many timeouts are called by coaches with the goal of stopping the opposing team's positive momentum. This paper explores the claim that timeouts enhance short-term performance following a series of negative events. Implications on the effectiveness of timeouts, existence of momentum, and decision-making strategies of coaches are discussed.

Contents

Introduction: Timeouts in the NBA

What factors define a sports teams' ability to perform well? There are a variety of answers to this question, including personnel, preparation, sport-specific strategies, and luck. Still, the inner workings of this fundamental question are widely examined on a regular basis by the media, by fans, by professionals in the sports world, and increasingly by experts from a diverse range of academic fields. Sports are important to both the common man and the academic; they can serve not only as entertainment, but also as models and examples of other subjects. Sports analysis can provide important insights into areas such as: workplace organization, individual response to success or failure, and leadership style.

As fans have become more connected, the demand for access and information has risen tremendously. Professional sports are a business; as owners, team officials, and coaches fight to create the best possible product, there is an increased scrutiny on statistical and logical breakdowns of the sport. Any detail or analysis which could provide a team with an edge is considered. As the sports industry has grown and become more detailed, both the availability and the desirability for descriptive statistics for sports analysis has increased. These statistics are used both by teams, attempting to pinpoint the indicators of positive performance, and by outsiders and fans, attempting to better understand the game. The large number and availability of detailed statistics is one of the reasons that studying sports is beneficial; there is more quantitative data to work with than in most other segments.

The coaches and managers of professional sports teams are frequently scrutinized. They are often fired and hired at very rapid rates. However, it is often difficult to separate a team's success or failure from their coaches' talents or shortcomings. Berri, Leeds, & Mondello (2009) attempt to explore the effectiveness of a coach by looking at the mobility of players and

evaluating coaches based on the returns they get out of individual players. However, because coaches do not have statistics outside of the team statistics, it is still difficult to identify their contributions to the team.

One factor that is widely considered to have some effect on team performance is the timeout, a factor that coaches also explicitly control. Out of the Big Four of professional sports in America (Major League Baseball, National Hockey League, National Basketball Association, National Football League), only baseball does not have official team timeouts as a part of the game rules. *All* coaches from these three major sports use timeouts, albeit in different situations, to different frequencies, and for different reasons. Timeouts are an important component of in-game strategy; the fact that they are employed on a consistent basis by all coaches regardless of differences in sport, individual preferences, and team composition suggests that coaches believe they can enhance their teams' performance.

Timeouts are one of the only things coaches have direct control over during a game, making it a potentially valuable object to study to better understand a coaches' value. Several studies explore the reasoning that coaches give for calling timeouts. While different methods were used to obtain results and there were coaches from different sports such as basketball (Duke & Corlett, 1992) volleyball (Hastie, 1999), table tennis (Wang, Chen, Lee & Hsu, 2010), and ice hockey (Hastie, 1999), there are clear patterns that emerge across studies. The Wang et. al. study asked coaches to respond to a 15-question survey designed to determine reasons that coaches called timeouts during table-tennis matches. The study breaks down the reasoning for timeouts into four main categories; defense, strategy, psychological/emotional, and attack. Coaches call timeouts because they believe that they can address issues and help their team achieve better performance in the short-term.

In basketball, timeouts are often used in an attempt to stop negative momentum (Weinbach, 2008). In a post-game interview, prominent college basketball coach Tom Izzo referred to "stop-the-bleeding timeouts" as a tool for correcting recent struggles. This type of language and references to momentum-stopping timeouts are widespread in postgame interviews and media recaps (Mayo; Benson; May). Though not explicitly examined by Wang et. al., momentum-stopping timeouts do not contradict their proposed categories, but can be seen as an underlying force for all of them. Stopping negative momentum can take the form of addressing defensive/offensive concerns, strategic concerns, and psychological/emotional concerns. Although stop-the-bleeding timeouts are common in basketball, timeouts are still called for other reasons unrelated to momentum; maintaining possession, making substitutions, dealing with injury, or changing the positioning of the ball on the floor for late-game situations.

In the National Basketball Association (NBA) timeouts occur frequently as compared to other sports; coaches are granted up to eight timeouts to use throughout the game (with some restrictions). The more timeouts that are available in a given game, the easier it is to gather significant results. The NBA is a useful arena to study timeouts because of the high availability of data. Furthermore, NBA timeouts are useful for understanding the momentum-stopping phenomenon because they are very often strategy-based, revolving around the coaches' instructions. In football, for example, a large number of timeouts are called to gain tactical advantages according to the rules of the game, such as stopping a running clock. Although there are some timeouts in basketball that have similar tactical advantages based on the game rules (advancing the ball), the majority of them (especially those used earlier in the game) give no explicit advantage to the team that takes them.

The NBA also has high-scoring games when compared to most other sports, as NBA teams combine to score an average of around 200 points per contest (199.98 in the 2007-2008 season). The scoring increments are also small; teams can only score between one and four points on a single possession. The increment size and amount of scoring are important because the frequency of separate scoring occurrences per game is very high. This is useful for the study of the short-term effectiveness of timeouts because performance can be measured by the statistic that is directly relevant to the outcome of the game, scoring. Since the goal of any basketball game is to have more points than the opposing team, the effect of timeouts on a teams' performance can be directly analyzed in short-term periods using points only. In games with less frequent scoring, indirect measures of performance become necessary, as teams are unlikely to score frequently enough in the short-term to provide a clear picture of performance. In studying timeouts in the NBA, the measures of performance can refer to the relative scoring frequency of a team compared to their opponents; a team playing well is not always winning, but the high frequency of scores in basketball dictates that score will indicate performance more often than in lower scoring frequency sports.

In table-tennis, the goals for timeouts are to make improvements that will enhance performance in the short-term (Wang et al., 2010). Coaches are permitted to meet with their players between games (seven games per match), so the usage of a timeout is designed to increase the ability of a player to win one individual short-term segment of the match. In the NBA, there are also semi-regular opportunities for coaches to meet and strategize with their teams, such as quarter breaks, halftime, and TV commercial breaks. For an NBA coach to call a timeout, he must believe he can enhance his team's short-term performance for a particular segment (otherwise he could wait for one of the natural opportunities to strategize with the team).

To determine the effectiveness of timeouts in the NBA, the performance of teams in a short time-period following the timeout is important to research.

This paper will seek to explore the effectiveness of calling timeouts on enhancing short-term performance in the NBA. If momentum is a powerful force in sports and timeouts are capable of halting negative momentum for the team which calls a timeout, timeouts will be expected to improve performance in the short-term. However, an over-estimation of the impact of momentum could explain the prevalent belief of coaches/fans/media that calling timeouts is a necessary and positive strategy for enhancing a team's performance.

Psychological Momentum & Identifying the Need for a Counterfactual

The idea of "psychological momentum" is one which is common to sports fans and has also been examined by academics in the sport psychology field. Psychological momentum is described as an "added or gained psychological power that changes interpersonal perceptions and influences an individual's mental and physical performance" (Iso-Ahola & Mobily, 1980). Researchers have explored the idea within sports and outside of them, but some of the most influential early research was done using basketball as the medium.

The hot-hand phenomenon is a theory that demonstrates the potential role of momentum in sports. In basketball games, insiders (players & coaches) as well as outsiders (fans & media) have a language of the hot-hand; they describe whether or not a shooter is succeeding or struggling in very specific terms. A "hot" shooter is one who has made a high percentage of recent shots; they are said to be "feeling it", "on fire", "in the zone"'; a shooter who is struggling is "cold". This language carries with it the statistical implication that players have more of a chance of making a shot if they made their previous shot/shots. The hot-hand theory says that there are streaks, patterns within the consistency of made shots for players as a result of psychological momentum.

Gilovich, Vallone and Tversky (1986) established that both fans and athletes (and coaches, though not explicitly studied) believe in the hot-hand theory by conducting a survey of fans. 91% of fans said that a player has a better chance of making a shot after a string of makes than after a string of misses. Gilovich et. al. go further to study the success rate of a shot after makes and misses in a variety of different settings (professional game live shooting, professional game foul shooting, controlled shooting drills). They find no evidence that the hot-hand phenomenon exists; there are not different conditional probabilities for a shot's success based on

previous shooting performance. They argue that the presence of shooting patterns, such as when several consecutive shots are made, exist because of chance. Fans, players, and coaches are misinterpreting random events (whether or not the shot goes on) as streak-shooting.

This paper spawned arguments from other researchers disagreeing with the claim of Gilovich et. al. that shooting is a stationary process (e.g. Hooke, 1989; Sun, 2004), as many in the academic community remained steadfast in the belief that the hot-hand exists in basketball. The fact that the commitment to the idea of the hot-hand is so strong is based on a human tendency to misinterpret patterns (Alter & Oppenheimer, 2006). The debate still has proponents on both sides in the academic world, though hot-hand terminology in the sports world is still prevalent and widely accepted.

One common reason that basketball coaches call timeouts is to attempt to stop the other team's positive momentum. Many of the more detailed reasons that coaches gave as reasons for calling timeouts, such as to address specific strategy issues, aid in fatigue recovery, address motivational concerns (e.g. Duke & Corlett, 1992; Hastie, 1999; Wang, Chen, Lee & Hsu, 2010) can be traced to a more fundamental purpose of trying to turn recent mistakes into future successes. Many studies have shown that psychological momentum changes the *perception* of athletes; athletes competing in head-to-head competition have different evaluations and expectations for future contests depending on whether or not they experienced early success (Mack et al., 2008). Whether or not this change in an athlete's perception influences that athlete's performance in future events is still contested among academics, but the widespread belief among coaches and their athletes is that positive momentum exists in sport. Sports insiders believe that they perform better after positive events than after negative events.

In a 2004 paper, Mace, Lalli, Shea, and Nevin attempt to view the effect that timeouts taken in college basketball games can have on shifting momentum. The researchers looked at seven college basketball games and recorded how often teams responded to negative events (defined as a turnover, missed shot, or foul) with a positive play (scoring, forced turnover) on the following possession. Mace et al. separated play into three groups, based on how many *positive* plays were happening per minute (high, medium, and low). They defined the reinforcement rate as the likelihood that a team responds to a negative event (adversity) with an immediate positive event. When positive plays per minute were at high levels in the 3-minute segment prior to adversity, teams were more likely to respond to the adversity with positive events, meaning a higher rate of reinforcement.

Regarding timeouts, Mace et al. compared the reinforcement rates in the 3-minute time periods before and after a timeout between the two teams. The opposing team (team that did not call the timeout) had a reinforcement rate that was 2.63 times the target team (team that called the timeout) in the time prior to a timeout, whereas that ratio dropped to only 1.11 in the 3 minutes following the timeout. The researcher argues that their findings not only support the hot-hand theory, but are useful beyond that in showing that timeouts can serve as a highly effective interruption of positive momentum. The implication is that if a coach that calls a timeout at the correct moment, he is capable of helping his team succeed in the short-term (defined as three minutes) by decreasing the opposing team's rate of reinforcement.

Using a sample of six games, Roane, Kelley, Trosclair, and Hauer (2004) replicated the Mace et al. study with several key variations. The main change they made was to study women's college basketball as opposed to men's college basketball. One other significant change was to use 4.5 minute periods (instead of 3-minutes) for before and after analysis. Their

conclusions replicated the findings from the Mace et al. study, finding an average reinforcement rate ratio of 2.35 before the timeout (for the opposing team) reduced to .64 after the timeout.

These two studies attempt to study the effectiveness of timeouts and come to the same conclusion. If a coach calls a timeout when an opponent has been performing very well in the short-term, they can halt the negative momentum for their team (positive momentum for the other team) by calling a timeout. The timeout helps their team perform better in the short-term, which they concluded due to the reduced reinforcement rate for the opposing team after a timeout is called. Although these studies reach the same conclusion, there are concerns about the accuracy of their methods.

The sample sizes for both of these studies are small (a total of only 13 games between the two). The studies are correlative; though they show a relationship between reinforcement rates and timeouts, there is no way of distinguishing why or how this relationship exists using the statistics. The inferences that are drawn about the effectiveness of timeouts are based on the belief that psychological momentum influences performance on the basketball court, a theory which is still contested amongst academics. A team tends to perform better after timeouts than before; this may be due to chance, as Gilovich et. al. argued with the hot-hand theory. Coaches call timeouts when their team is struggling; then, it is natural to expect that performance after a timeout would be better than performance before a timeout. Since the performance before a timeout is *extreme*, meaning that it is far from the normal series of events one would expect out of random chance, the following result (performance after a timeout) is expected to be closer to normal. This is the regression to the mean phenomenon; a very bad period of basketball is likely to be followed by a more normal period of basketball, regardless of whether or not a timeout is taken.

To my knowledge, this is the first study to investigate the efficacy of timeouts on short-term performance that accounts for the possibility of the regression to the mean phenomenon. Considering the results from the Mace and Roane studies as potentially biased due to their lack of accounting for the regression to the mean phenomenon, this paper hopes to better understand the role of timeouts as they pertain to a team's ability to perform better in the short-term.

Description of Data

The data used for this research was obtained from the online database at *www.basketball-reference.com*. This website contains detailed play-by-play history for NBA games. A play-by-play is the diary of a game which describes the game action using all of the common statistical occurrences (shot attempts, points, rebounds, assists, blocks, steals, turnovers, fouls, timeouts, and substitutions). This study covers all regular season games from the years 2006-2007, 2007-2008, and 2008-2009. The total sample contained 3,690 games.

For my research, scores of any kind (foul shot, two point baskets, three point baskets) are recorded. Any timeout called by a team is also recorded. All scores and timeouts contain variables identifying the game, the time at which the event occurred, and which team was the actor. My analysis specifically examines points/timeouts scored after six consecutive points for either team. Every time a team scores six consecutive points, all scores and timeouts within a short-term period of a scoring run are examined. Each observation, then, is the short-term period following a six-point run; how many points are scored and by which team, and whether or not timeouts are taken and by which team.

Methods

Identify Points of Interest: Opportunities Where Momentum may be Present

To study the effect timeouts may have on momentum, it is necessary to identify situations where a coach perceives that a high level of positive/negative momentum exists and is impacting the game. Consecutive streaks of points could indicate that one team has the momentum. For the purposes of this study, any time during the game when a team scores six consecutive points (called a 6-0 run) is marked. Since one of the main usages of timeouts is to stop momentum, 6-0 runs can be seen as possible opportunities for the coach on the losing end of the run to call a timeout for momentum-stopping purposes. Scoring six consecutive points unanswered is a short enough occurrence that it happens frequently (average of 2.62 home team runs per game, 2.38 visiting team runs per game across sample) but long enough that it encompasses either two large scoring plays (three-point baskets) or more likely, several smaller scoring plays. This ensures that the 6-0 run is common enough that we have a large number of observations, while uncommon enough that it is a significant event which coaches notice and consider the possible influence of momentum.

Every 6-0 run is an opportunity for the opposing coach to call a momentum-stopping timeout. After one team scores in basketball, the other team automatically is given possession of the ball. In order for a team to have six consecutive points scored on them (to be on the losing side of a 6-0 run), they must have not scored on their last two possessions or more. It also means that they have allowed the opposing team to score on two or more of their most recent possessions. Since two possessions is the *minimum* number for both of these scenarios, it is understandable that a coach could interpret a 6-0 run made by the opposing team as a situation where their team has negative momentum. A 6-0 run cues a coach to analyze the current game

situation with an evaluation of momentum; the most recent number of offensive possessions (somewhere between 2 and 10) have not had positive results for their team (a score) and some of the most recent defensive possessions have had negative results (a score against).

Using a 6-0 runs as indicators of instances where momentum is potentially influential, we can develop a more effective way of measuring the efficacy of timeouts. By comparing the short-term performance of teams when a timeout is called immediately after a 6-0 run to the short-term performance of teams when a timeout is not called after a 6-0 run, evidence for the true value of the timeout as a run-stopping strategy is generated. Instead of comparing the performance prior to the timeout (extremely negative performance) to the performance after, this method mirrors the ideal experimentally controlled scenario, where coaches would be randomly assigned to call timeouts or not to call timeouts. This type of experimental control is impossible; however, comparing the short-term performance following 6-0 runs based on whether a timeout is called or not should have more accurate results regarding the true value of timeouts.

Short-Term Windows and Short-Term Performance

In order to determine short-term performance, we must first decide a suitable window to capture the short-term. With a clear definition of the parameters of "short-term" in this study, we can determine the effects of timeouts within the given window. I define a short-term window in as the time it takes for ten points to be scored by the two teams combined. Scoring baskets is done by both teams throughout the course of the game. By combining the scoring of the two teams in the short-term, we are able to look at both offensive and defensive performance of each individual team. If a team scores at a high rate but also allows the opposing team to score at a high rate, this is less valuable then scoring at a lesser rate but allowing the opposing team to score even fewer points. The ten-point window is long enough to capture some sense of the flow

of the game while still short enough to minimize results which are not closely related to each other. In most instances, the tenth point following a timeout is scored within 2-4 minutes of the timeout (similar to the 3-minute short-term window used by Mace. et. al).

In order to more accurately describe the data, the short-term window following a timeout is the *time period* it takes for ten points to be scored in the game, as opposed to limiting the window to exactly ten points. The window is determined by a fixed amount of scoring (10 points), not a fixed amount of time. However, by using the time period it takes the two teams to reach the 10-point marker, I prevent some relevant points from being discounted. For a play where multiple points were scored at the same time (two, three, or four point plays), it would be less accurate to discount the later points in the play than to include them. For example, if 11 points are scored during this time period, with a 2-point basket scored while the total was at 9 points, including the 11^{th} point gives a better description of the events within the window then if we arbitrarily cut off the window at the 10^{th} point. Short-term windows are used to examine short-term performance after a point of interest (whether a timeout is called or not).

In order to measure short-term performance, we use the ratio of points scored by the home-team to the total points scored by both teams for a specific short-term window. For the short-term window following a point of interest, this ratio demonstrates how well the team performed. Using the assumption that teams are (on average) evenly matched, it seems the expected ratio for points scored should be 0.5 (50%) for any given time period.

A ratio above 0.5 demonstrates that the home team is outperforming the visiting team, while a ratio below 0.5 demonstrates that the visiting team is outperforming the home team. If these ratios are extended past short-term windows to the whole game, any ratio greater than .5 would allow the home team to win and any ratio less than .5 would allow the visiting team to win.

Define Variables & Techniques

I will use an ordinary least squares regression model to attempt to determine the impact of momentum-stopping timeouts on short-term performance. Using the scoring ratio for a short-term window following a 6-0 run as the dependent variable, the primary independent variable I will examine is the usage of a timeout (whether or not one is called). This independent variable is set up in the data as a dummy variable with a value of 1 when a timeout is called immediately following a 6-0 run and a value of 0 when a timeout is not immediately called. An additional independent variable is the travel status of the team (home or away). The home team wins about 60.6% of the time in the NBA for regular season games (Schuhmann 2009); there is also lots of literature dissecting the home-team advantage, including in the NBA (Entine & Small, 2008; Pollard & Pollard 2005, Smith 2003). The home team variable is a dummy variable; a value of 1 means that the home team is on the losing end of the 6-0 run, and a value of 0 means that the visiting team is on the losing end of the 6-0 run. Although the main focus of this study will be the effect of timeouts, we expect that the home team will perform better across all dimensions, regardless of timeout usage or the possible existence of momentum. Adding this independent variable helps isolate the true effect of the timeout. In addition, an interaction term multiplying the home team dummy variable by the timeout dummy variable will be added to the OLS regression analysis.

In addition to looking at all 6-0 runs and the effect of timeouts and home-team advantage, the data will also be restricted to the first half of games. Although timeouts that are called immediately following 6-0 runs by the opposing team are likely to be momentum-stopping timeouts regardless of when they are called, there are still other possibilities as to why coaches call the timeouts. A higher percentage of these non-momentum stopping timeouts occur in the

second half, especially in the fourth quarter. Coaches are much more likely to call timeouts late in the game to set up specific offensive or defensive plays, advance the ball, or make substitutions. These timeouts are not related to stopping momentum, so eliminating as many of those timeouts as possible increases the predictive power of the regression with regards to momentum-stopping timeouts. Although there is no way of separating out all of the timeouts coaches call for momentum-stopping reasons from the timeouts called for other reasons, limiting the results to only first-half points of interest (6-0 runs) may decrease the percentage of timeouts taken for non-momentum-stopping reasons. The disadvantage to this restriction is a smaller sample size, but this reduction in sample size is acceptable because of the possibility of heightened validity. The reduction in sample size is also not problematic because of the large number of observations; there are 18,267 observations without the first-half restriction and 9,328 observations with the first-half restriction. Though the number of observations is cut in half, the sample is large enough that the remaining observations enough to expect statistically significant results where applicable.

Results & Discussion

Figure 1: OLS Regression Results

Independent Variable	Coefficient	T-Statistic	P-Value
Unrestricted			
Timeout Dummy	.00073	0.15	.883
Home Team Dummy	.03514	11.72	.000
Home Team * Timeout	.00665	0.91	.363
Constant	.49017	236.23	.000
With First Half Restriction			
Timeout Dummy	-.00831	-1.19	.234
Home Team Dummy	.03428	8.48	.000
Home Team * Timeout	.03044	2.93	.003
Constant	.49175	176.78	.000

****OLS regression for both restricted and unrestricted models. Notice that the timeout dummy is very small and not statistically significant in either model**

Figure 1 displays the results of the regression analysis without the first half-restriction. We expected the constant to be around .5 and the value of the home-team variable to be positive (reflects home-team advantage), but the main point of interest is the value of the timeout variable. The coefficient for the timeout dummy variable is extremely small (.0007309) and is not statistically significant on any level. The interaction term is also not statistically significant, but the value of the home-team dummy variable is .03514 and is statistically significant at the five-percent level.

According to the regression results, the home team using a timeout is predicted to enhance their short-term performance in the time period after the timeout (.5327 with timeout

Figure 2: Descriptive Breakdown of the Effect of Timeouts on Short-Term Performance

Team	Timeout Called	First Half Restricted	# of Observations	Mean Ratio
Home	Yes	No	1417	0.5327
Home	No	No	7275	0.5253
Away	Yes	No	1671	0.4909
Away	No	No	7904	0.4901
Home	Yes	Yes	644	0.5479*
Home	No	Yes	3727	0.5264
Away	Yes	Yes	787	0.4834
Away	No	Yes	4146	0.4915

Team refers to the team which is on the negative side of the initial 6-0 scoring run (and ultimately calls the timeout). For example, if the visiting team goes on a 6-0 run, the home-team is the team identified under the team column. The mean ratio is the total number of points scored by the home team divided by the total number of points scored by both teams during a short-term window of approximately ten points.

---

to .5253 without timeout), whereas for the away team, the usage of a timeout is predicted to hurt their short-term performance slightly (.4909 with the timeout to .4901 without the timeout). However, it is important to note that neither of these predicted differences is statistically significant.

When the sample is limited to the 6-0 runs that occur only in the first half, the results are similar, but more pronounced. Again, for the home team (.5478 with timeout and .5264 without timeout) and the away team (.4834 with timeout and .4915 without timeout), a called timeout is predicted to enhance the performance of the team calling the timeout over a short-term window. The difference between the home-team taking a timeout and not taking a timeout is statistically significant at the 5% level.

For all eight variations (timeout called/uncalled, home/away, first half/whole game), the ratio is favorable to the team that just gave up six consecutive points, the team on the losing end

Figure 3: First Half Restricted with Next Point Measure

Team	Timeout Called	# of Observations	Next Basket
Home	Yes	644	0.6369*
Home	No	3727	0.5941
Away	Yes	787	0.3344*
Away	No	4146	0.3995

Team refers to the team which is on the negative side of the scoring run (and ultimately calls the timeout). For example, if the visiting team goes on a 6-0 run, the home-team is the team identified under the team column. The next basket category gives the percentage of the first point scored following a 6-0 run scored by the home team. The * means that the mean ratio is different from the line below it at the 5% level.

---

of the 6-0 run. The ratio is above .5 for the home-team observations and below .5 for the visiting team observations; the teams that just surrendered six consecutive points consistently "win" the short-term period following the run. This is counterintuitive; we would expect that whichever team has more six-point scoring runs in their favor is, on average, the better team and more likely to win the game. If a team is more likely to win the game, they are more likely to win any short-term period during the game. However, one mediating factor which explains this result is that the team that gives up six consecutive points starts the short-term period (whether a timeout is called or not) with possession of the ball. On a made basket, the team that was scored upon receives the ball. With this factor in mind, whichever team begins a short-term period with possession is more likely to outscore their opponents, since a team can only score when they have possession of the ball. In the case of a 6-0 run, our point of interest, the team that surrendered the six consecutive points always starts the short-term window with the ball.

In order to better understand the efficacy of timeouts in the short-term and also the impact that starting with possession may have on increasing success for a short-term window, a new measure must be used. Instead of looking at a short-term window as the next ten points, we modified the post 6-0 run window to the shortest possible measure; the team that scores first. This eliminates the risk of the effects of a timeout wearing off during the short-term window.

Figure 3 demonstrates that there are significant performance improvements following a 6-0 run (as measured by higher rates of scoring on the next possession) for those calling a timeout for both the home team (.6369 with timeout and .5941 without timeout) and the away team (.3344 with timeout and .3995 without timeout). The larger effect sizes and statistical significance of this measure compared with the short-term window measures suggest that the impact of timeouts might be largely based on a team's improvement in the first possession following a timeout. This could mean that most of the effect of calling a timeout on short-term performance is incurred on the first possession; the longer lasting impact of timeouts (even in the short-term) may be overestimated.

The home team also has significantly higher ratios than the visiting team, regardless whether timeouts are called or not. Home teams possess a natural advantage and outscore visiting teams by an average of 4.63 points per game (Albert, Bennet, & Cochran, 2005), so again, this result is expected.

With the first-half restriction in place, the difference in ratios between calling a timeout and not calling a timeout are larger, for both home and away teams. This result supports the idea that first-half timeouts may be more useful to study when determining the effectiveness of run-stopping timeouts, as they capture these timeouts on a more consistent basis.

The data also support the regression to the mean phenomenon. A 6-0 run is an extreme short-term result; for a short term time-period following a timeout, the results are expected to normalize. The mean of the ratio for the short-term period following an extreme run is close to the expected value (0.5) of the ratio. This finding also suggests that the role of positive momentum is not as powerful as some researchers and sports enthusiasts believe. Teams succeed immediately after times where the momentum seems to be against them, regardless if a

timeout is called. Nowhere in the data is there any implication that the victims of 6-0 run are likely to continue to struggle in the short-term unless some action is taken (a timeout).

Conclusion

The existing research on the effectiveness of timeouts on short-term performance in basketball (Mace et. al.; Roane et. al.) supported the idea that timeouts can be highly effective at aiding short-term performance. The findings from this paper support this idea that timeouts can be effective at enhancing performance, but at a smaller magnitude. Regardless of whether a team was home or away, the short-term scoring ratio for teams that called timeout following six consecutive points being scored against them was higher than the short-term scoring ratio for teams that did not call a timeout following six consecutive points being scored against them. The most significant of these results, the home-team with the first-half restriction, shows a .21 increase in average ratio for the next ten points, meaning that calling a timeout predicts that the home-team will score 5.47 out of the next ten points as opposed to 5.26 points when a timeout is not called. This result is small, but supports the idea that timeouts can be a marginally effective tool for coaches to use to help their teams win.

Furthermore, the larger effect sizes for timeout effectiveness when using the first point scored after a 6-0 scoring run as a measure instead of the ratio of scoring during a short-term window suggests that timeouts may be most effective for setting up individual plays and aiding in execution for one play following a timeout. Coaches give specific strategic reasons for calling timeouts (Wang et. al., Duke & Corlett) and increased analysis on a team's execution immediately following a timeout (Weinbach, 2008) seem to be merited. This type of analysis, exploring which coaches are able to get their team to perform the best on the possessions immediately following timeouts, could give insight into the effectiveness of coaches and managers. Although timeouts called for setting up a scheme and refocusing strategy for the

upcoming play may also have momentum-stopping elements, these types of timeouts can be fundamentally different than those taken with the exclusive purpose of changing momentum.

The commonly held belief expressed by coaches, fans, and the media that timeouts are necessary to halt positive momentum is not supported by the data in this study. Under this belief, if a timeout is not called when an opposing team possesses positive momentum, the momentum will allow the opposing team to continue to have heightened success. Using 6-0 runs as an indicator of instances where momentum would be a factor, teams were successful at "reversing" momentum even without the timeout as a mediator, as demonstrated by scoring ratios above 0.5 for short-term periods following 6-0 runs. Even if we interpret the presence of momentum as a legitimate force before a timeout is called, the fact that teams are capable of bouncing back without having taken a timeout does not demonstrate that timeouts are important for halting momentum. This is the counterfactual that was missing from the Mace et. al. and Roane et al. studies, which led them to prematurely conclude that timeouts were effective in stopping momentum.

Gilovich, Vallone and Tversky argued that the "hot-hand" theory of streak shooting is a misinterpretation of a random sequence of events. Although this claim has been highly contested in other literature, the data from this study further supports the idea that a random sequence of events can be misinterpreted, in this case on the team level instead of the individual level. The misinterpretation of chance patterns happens not only in sports, but in other fields as well (Camerer, 1989). When a team goes on an extended scoring run, it can be interpreted as a psychological momentum phenomenon (similar to the hot-hand theory) or as a chance happening within a stationary process. The data provides more support for the idea that the belief in

momentum in sports may be a perceptional bias as opposed to an accurate depiction of the inner workings of a sport.

The availability heuristic (Tversky & Kahneman, 1973) states that individuals tend to predict events they are familiar with based on examples/experiences that they can readily call to memory. This heuristic can produce cognitive biases because people tend to remember more unusual or extreme events more easily. In this case, highly negative performance by a team followed by a decent or positive performance is memorable because the initial event was unusual. Thus, if a coach calls a timeout after negative performances, they are likely to remember the turn-around when considering the effectiveness of timeouts, leading to a potential overestimation of the impact of momentum-stopping timeouts.

Another possible bias that could partially explain the prevalence of the momentum-stopping timeout theory is the illusion of control theory (Langer 1975). People tend to over-estimate the amount of control they have over given situations. Coaches have a limited amount of formal power during the course of an NBA game; timeouts are one of the few ways they are capable of directly influencing the happenings during the game. When a coach calls a timeout and team performance changes, they are more likely to attribute this change to *their* control over the situation, even if the change in performance occurred at random.

Regarding the increased desire for in-depth statistical analysis of the factors that go into making a sports' team successful, this paper helps illuminate the role of timeouts in influencing short-term performance. The implication is that although timeouts may not be effective for halting momentum, they still tend to benefit the performance of the teams who call them. Specifically, performance in the single play immediately following a negative run may be significantly enhanced if a timeout is called. Though timeouts may be overvalued, the data

supports the calling of timeouts as useful. However, a shift in focus from calling timeouts to stop momentum to calling timeouts to design and focus on executing individual plays could be a beneficial strategy for coaches.

Beyond basketball, the impact of momentum is still being explored. The results from this study could be generalized to support the idea that momentum can be overvalued in a way which creates inefficiencies. For example, the overvaluing of momentum in the sports gambling world has led some researchers to conclude that betting against a "hot" team (team on recent winning streak) is a consistently profitable method (Camerer, 1989; Brown & Sauer, 1993). Understanding the dynamics and intersections of momentum and random occurrences in the basketball world as it pertains to timeouts could be relevant to determining the value of momentum in other sports as well as other markets.

Works Cited

Albert, Jim, Jay Bennett, and James J. Cochran. *Anthology of Statistics in Sports*. Philadelphia, PA: Society for Industrial and Applied Mathematics, 2005.

Alter, Adam, and Daniel Oppenheimer. "From a Fixation on Sports to an Exploration of Mechanism: The Past, Present, and Future of Hot Hand Research." *Thinking & Reasoning* 12.4 (2006): 431-44.

Berri, David J., Michael A. Leeds, and Michael Mondello. "Is It the Teacher or the Students? Understanding the Role of a Team Manager."

Brown, W. and Sauer, R. (1993). Does the Basketball Market Believe in the 'Hot Hand,'? Comment, *The American Economic Review* 83, 1377-1386

Camerer, C. (1989). Does the Basketball Market Believe in the `Hot Hand,'? *The American Economic Review*, Vol. 79, No. 5 (Dec., 1989), pp. 1257-1261

Duke, A. & Corlett, J. (1992). Factors affecting university women's basketball coaches' timeout decisions. *Canadian Journal of Sports Sciences,* 17, 333-337.

Entine, O. A. and Small, D. S. (2008) The Role of Rest in the NBA Home-Court Advantage, *Journal of Quantitative Analysis in Sports*: Vol. 4 : Iss. 2, Article 6.

Hastie, P. (1999). An instrument for recording coaches' comments and instructions during timeouts. *Journal of Sport Behavior,* 22, 4, 467-478.

Hooke, R. (1989). Basketball, Baseball, and the Null Hypothesis. *Chance: New Directions for Statistics and Computing,* 2, 35-37

Iso-Ahola, S.E.& Mobiliy, K. (1980). Psychological momentum and competitive performance: A field study. *Perceptual and Motor Skills*, 62, 763-768

Gilovich, T., Vallone, R. & Tversky, A. (1985). The hot hand in basketball: On the misperception of random sequences. *Cognitive Psychology* 17, 295-314

Langer, E. J. (1975). The *illusion of control*. *Journal **of** Personality and Social Psychology*, 32, 311-328 10.1037//0022-3514 .32.2.311.

Mace, F. C., Hock, M. L., Lalli, J. S., West, B. J., Belfiore, P. & Pinter, E. (1988). Behavioral momentum in the treatment of noncompliance. *Journal of Applied Behavior Analysis*, 21, 123-141.

May, Peter. "Rondo's Slam Signals a Momentum Shift - NBA - Yahoo! Sports." *Yahoo! Sports - Sports News, Scores, Rumors, Fantasy Games, and More*.

Mayo, Edward. "No 'stop-the-bleeding Timeouts' Needed by Tom Izzo in Spartans' Win over Penn State." *Michigan Local News, Breaking News, Sports & Weather - MLive.com*.

Nevin, J. A. (1996). The momentum of compliance. *Journal of Applied Behavior Analysis,* 29, 535-547.

Pollard, R., and G. Pollard. "Long-term Trends in Home Advantage in Professional Team Sports in North America." *Journal of Sports Sciences* 23.4 (2005): 337-50.

Roane, H. S., Kelley, M. E., Trosclair, N. M. & Hauer, L. S. (2004). Behavioral momentum in sports: A partial replication with women's basketball. *Journal of Applied Behavior Analysis,* 37, 385-390 10.1901/jaba.2004 .37-385.

Schuhmann, John. "NBA.com: Home-court Is an Advantage ... Especially in the Playoffs." *NBA.com*. Web.

Sun, Y. (2004). Detecting the hot hand: An alternative model. In K. Forbus, D. Gentre & T. Reiger (Eds.), *Proceedings of the 26th Annual Conference of the Cognitive Science Society* (pp. 1279-1284). Mahwah, NJ: Lawrence Erlbaum Associates, Inc.

Tversky, A., & Kahneman, D. (1973). Availability: a heuristic for judging frequency and probability. *Cognitive Psychology* **5**, 207-232.

Wang, M. Y., Chen C. E., Lee S. C., & Hsu, C. Y. (2010). A Study on the compilation of a Behavioral Scale for Timeout Decision of Taiwan's Table-tennis Players. *International Journal of Table Tennis Sciences*, 6, 21-27.

Weinbach, Jon. "The Art of the Timeout - WSJ.com." *Business News & Financial News - The Wall Street Journal - Wsj.com*. Web.