NBA's Hot Hand Theory Literature Review

While numerous statisticians, economists, and data scientists have attempted to assess whether the Hot Hand Theory in basketball is fact or fallacy, two major papers represent each side of the argument. Gilovich et al. (1985)[1] initially provided convincing evidence that the hot hand was a fallacy, but more recently Bocskocsky et al. (2014)[2] take a different approach to show that the hot hand theory is, in their opinion, a fact.

The seminal paper by Gilovich et al. takes a hard look at the statistics behind the hot hand theory and also examines the public perception of the theory, both from a fan and a player standpoint. Through a series of studies, the paper examines whether the perception is supported by the data, and where this perception stems from. Overall they find that though the large majority of fans and players believe in the hot hand theory, the data does not support the idea.

In their surveys of fans, players and coaches, the study finds that the hot hand belief influences a variety of perceptions. Fans and players alike believe that players who have made a previous shot are more likely to make the next one, and a player that misses a previous shot is less likely to make the next one. This belief extends to free throws as well, with both parties estimating that a successful first free throw increases the percentage that the next one would go in. These perceptions contribute to the opinion that teammates should look to pass the ball to a perceived "hot" shooter and focus team strategy around the given player.

Upon looking at shooting data for the Philadelphia 76ers for an entire season, as well as running a controlled experiment with Cornell varsity basketball players, the researchers found no correlation between past shots and future success, and in some cases found negative correlation. When considering individual shooting percentage, number of shooting streaks players went on, and elevation in performance, the statistics went counter to the hot hand theory in all cases and no support was found for the idea that a player became more accurate of a shooter due to previously made shots.

The paper finishes with remarks on why the hot hand fallacy is perceived to be real by so many people. Various ideas contribute, such as successful shooting events being more

[1] Gilovich, T., Vallone, R., & Tversky, A. (1985). The hot hand in basketball: On the misperception of random sequences. *Cognitive psychology*, *17*(3), 295-314.
[2] Bocskocsky, A., Ezekowitz, J., & Stein, C. (2014, March). The hot hand: A new approach to an old "fallacy". In *8th Annual Mit Sloan Sports Analytics Conference*.

memorable, misconceptions about global percentages affecting local statistics, and misperception about what was streak shooting versus chance success unaffected by prior outcomes. Overall the paper concludes that the statistical evidence does not support the hot hand theory despite the effect it may have on shooting, passing, and defensive game strategies.

Close to three decades after the findings of Gilovich et al., Bocskocsky et al. directly challenge the findings of Gilovich et al. and provide evidence for why the hot hand may be to some degree a real phenomenon. In Bocskocsky et al., the authors take a different approach to testing the validity of the Hot Hand Theory. The authors believe that the many arguments refuting the legitimacy of the theory neglect to consider the differences in shot selection that result from player-perceived hotness or coldness. The authors create a model to account for this factor, and hypothesize that the Hot Hand Theory is at least somewhat plausible.

The authors use a more comprehensive set of determinants than the studies before them. Their dataset consists of data collected from an optical tracking system called SportVU, equipped in 15 different arenas over the 2012-2013 season. The authors create a metric for shot difficulty using SportVU with control data broken down into four categories: Game Condition Controls, Shot Controls, Defensive Controls, and Player Fixed Effects. “Game Conditions” contains data on score differential, game pressure, and player fatigue. “Shot Controls” contains data on distance from the basket and shot-type. “Defense Controls” contains data on defensive intensity, defender’s distance from the shooter, and defensive angles relative to the basket. “Player Fixed Effect” is a control variable that accounts for the overall talent of the player and the skill differences between players. These attributes help the authors to control for shot difficulty in final regressions. The authors also utilize a metric for heat they call “complex heat,” which takes into account the expected probability that some shot n will go in.

Similar to Gilovich et al.’s survey data, Bocskocsky et al. also consider whether players themselves believe in the existence of hot hand. The authors argue that if players believe that making their most recent shots results in a higher percentage chance of making their next shot, they will be more likely to attempt a more difficult shot on their next attempt. The authors’ classify three categories that increase shot difficulty; the player’s distance from the basket, the defender’s distance from the player, and the likelihood that they player will be taking the next

shot for their team. They found all of these factors to be statistically significant, and combined them to create a term that controls for the increase in shot-difficulty resulting from the differences in shot selection when a player believes they have the "hot hand."

The authors completed their analysis by running an OLS regression to determine the effect and significance of "Complex Heat" as a predictor of the probability of a player making his next shot. In this regression, the authors control for the effects of shot difficulty, shot selection, and player fixed effects. The results of this regression show that if a player has made one or more of their last four shots, then the percentage chance of making their next shot increases by 1.2%. When a player has made two or more his last four shots, that percentage increases by about 2.4%. Thus, the authors have found that while the effect is modest, there is certainly at least a plausible argument for the existence of the hot-hand theory.