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The Crawford Line: An Analysis of Optimal Player Rotation Strategy

We decided to investigate the effect of substitutions, specifically the impact of fatigue and rest on a player's performance, measuring their performance during a game before and after getting a rest. As a use case, we focused on Jamal Crawford, the Clippers' backup shooting guard, during an April 17th, the 2016 Western Conference First Round Game 1 against the Portland Trail Blazers, which the Clippers won 115-95.

Background

One of a coach's most important choices in a game is to manage each player's minutes to produce the best results. Playing one's 5 best players is tempting, but comes with the downside of fatigue, which can lead to poorer play down the stretch, both in the game and the season. On the other hand, depending on the quality of the team's bench players, playing one's starters light minutes makes the likelihood of a loss far more likely. NBA coaches therefore must figure out a way to strike a balance between these two extremes, carefully rationing out the minutes between a starter and his backup in such a way as to keep the team as competitive as possible without wearing out the players and making them less effective in the future, either due to injury or fatigue.

Throughout his playing career, Jamal Crawford has served as "instant offense", often through a combination of superb ball handling and his offensive moves. Defensively, however, he is somewhat of a liability, making it difficult for a coach to play him heavy minutes guarding some of the best shooting guards in the league like James Harden, Klay Thompson, Jimmy Butler, etc. That is why Clippers Coach Doc Rivers opts to bring Crawford off the bench for approximately 27 minutes a game, backing up the likes of JJ Reddick and Chris Paul. In this capacity, Crawford is capable of carrying the offense while the starters rest, and can hide on defense against less capable bench players.

Our project attempts to quantify and discover the "Crawford Line" for different combinations of starters and backups on each team - the allocation of minutes that best utilizes a starter and a backup throughout a game, dependent on their baseline skill, deterioration due to fatigue, and chemistry with the rest of the players on the floor. By doing so, we hope to give

NBA teams a tool to help stagger their team's minutes more effectively, and potentially discover new rotations that will help their team best.

Methodology

To quantify the value that an individual player provides to his team, we used a combination of methods to express a player's value to his team. Since Crawford is primarily an offensive isolation scorer, the measures we looked at were field goal percentage, plus minus, and speed on the court.

We look at individual player substitutions, and the team around the player is mostly held fixed, so the difference in plus-minus between a starter and his bench replacement measures the difference in their performance. For example, we might expect Luc Mbah a Moute, the Clipper's starting SF in these past playoffs, to project a +10 plus-minus over 48 minutes at the start of the game, but that rate might fall to +5 when Mbah a Moute gets tired after several minutes of playing. Jamal Crawford, Mbah a Moute's backup, may post a plus-minus rate of +7 when first substituted into the same surrounding lineup. We want to find the optimal point to substitute Jamal Crawford into the game so that we can maximize plus-minus.

We also analyzed Crawford's field goal % during the game to determine trends in his efficiency over time. With higher minutes, we expected his field goal percentage to go down, but we also can see what the difference in his efficiency when he is fatigued compared to after he's gotten some rest. The difference in these two values provides us with a measure of the value of his rest in terms of increase in efficiency per minute rest, compared to his baseline field goal percentage.

Finally, we utilized the SportsVU player tracking data to determine Crawford's average speed throughout the game. After smoothing out the data to account for stoppages in the game and time on the bench, we were able to see how Crawford's quickness and stamina were affected by his minutes.

Graphical Analysis

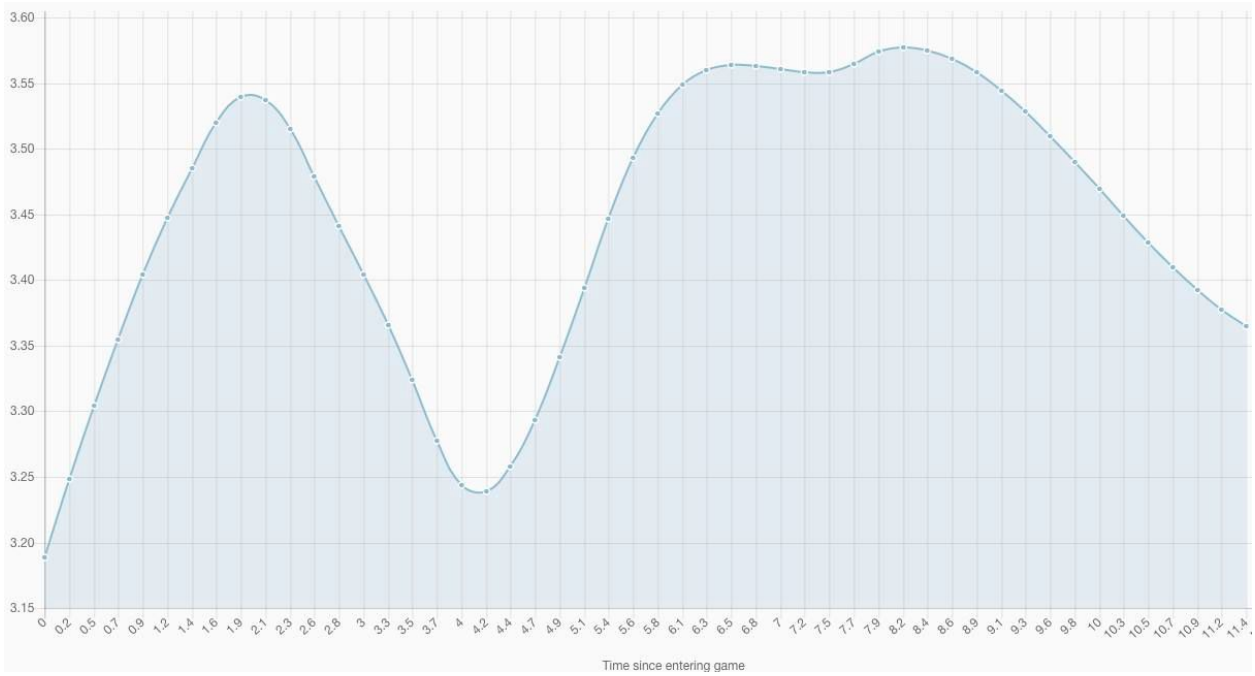
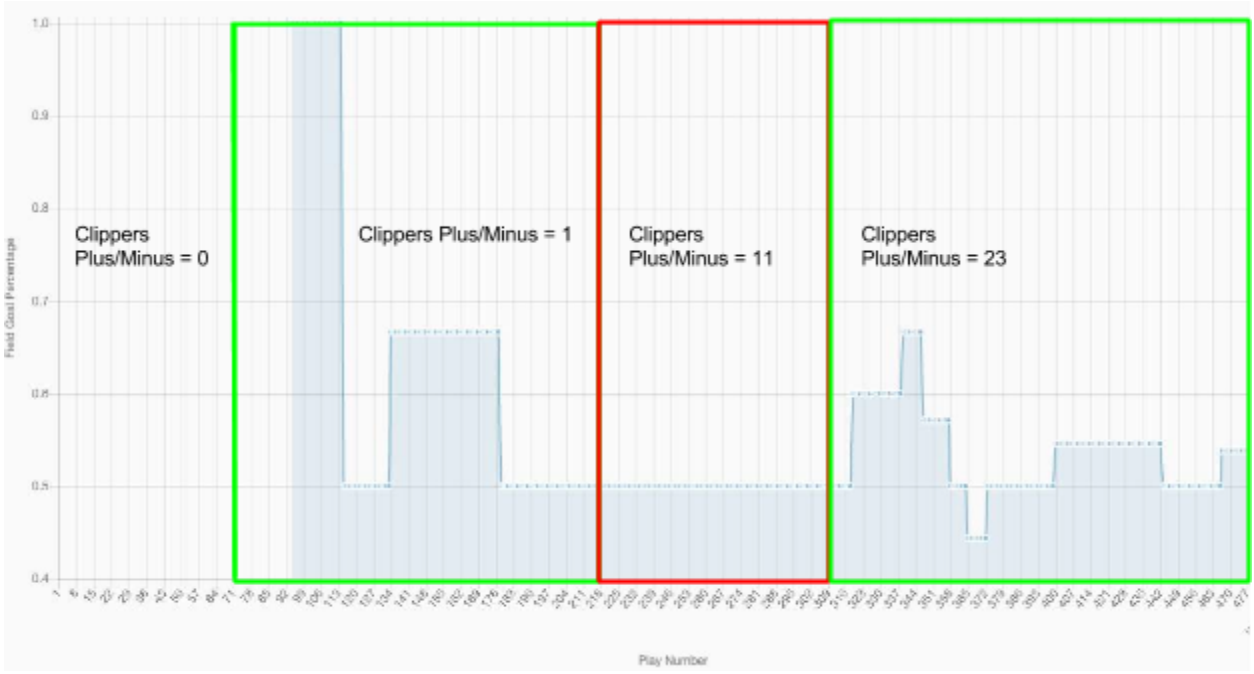


Figure 1. Jamal Crawford's speed vs. Time (in minutes) since being subbed into the game



Discussion

Our analysis shows a relationship between Crawford's minutes (and fatigue level) and his efficiency, speed, and overall plus/minus for the Clippers. From the data, we would say that had Crawford's minutes been better managed, the Clippers would have better utilized him during the game against Blazers. While the end result of the game was a win for the Clippers, they lost the overall series, due to injuries to some of their key players later in the series. Had the Clippers possibly been better at managing the time their players spent on the court throughout the season, then the risk of injury would have been reduced and they may have made it past the Blazers with a full team.

Examining the graphs, we see that Crawford's speed did not decline dramatically while playing, suggesting that Crawford still had enough energy to be productive when he was substituted out . Additionally, we see that Crawford's field goal percentage was fairly steady around a respectable 50%, which shows that Crawford's shot difficulty and shot-making ability did not regress either. Finally, we see that Crawford had a plus-minus of +13, similar to Mbah a Moute's +11, which means that both players performed similarly.

Conclusion

Our hope is that Crawford Line analysis will open up new ways for coaches and teams to help their team manage their minutes. The Crawford Line can help best utilize an aging veteran, who cannot play heavy minutes but can still contribute to a team, or a promising young player, who is unable to get many minutes to show their skill. Determining the Crawford Line for teams of players gives coaches a new way to determine their lineups, giving them the best hope to win on any given night.

Given our analysis of Crawford's performance in the 2016 Western Conference First Round Game 1, we see that Crawford was underutilized in the Clippers' lineup. Chris Paul and Blake Griffin may have been able to avoid injuries later on in the series if Crawford was able supplant some of the starters' minutes.