NBA Timeouts and Team Performance

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1 Introduction

June 19, 2019 — The Raptors are 3 minutes away from winning the NBA Championship on their home court. Kawhi Leonard is on a 10 point scoring run to put the Raptors up by 6 points. At this very moment, Raptors fans around the world were shocked when their team's coach, Nick Nurse, took a timeout. The fans' claim: Nurse had intervened on the scoring momentum that his team had built. After the timeout, the opponent went on a 9-2 scoring run and the Raptors lost the game.

Was the timeout worth taking? Would it have in fact been a better decision to lose the timeout and continue playing? While the Raptors went on to win the 2019 NBA Championships, what might have happened in the counterfactual world where Nick Nurse did not take this timeout? We'll never know, but this raises an interesting question: what is the value of a timeout? Is taking a timeout in anticipation of losing it always worth it?

We'll define a baseline to compare a timeout against, gather covariates, and isolate for the effect of a timeout in the game of basketball.

2 Data

This analysis is run over all timeouts in the 2018-2019 NBA season. Our objective is to measure the causal effect of a timeout on a team's immediate future performance. Note that we are interested in understanding the effect of a timeout on the team who chose to take the timeout. While one team requests to intervene on the game with a timeout, both teams take the break in game to gather by their team's bench.

In order to measure a causal effect, we need baseline performance (placebo) to compare against. In an NBA game, a natural baseline to compare against does not explicitly exist.

We can, however, treat any moment across the entire basketball season as a moment when a timeout could have occurred. There were approximately 10,000 timeouts taken in the NBA season last year. We sampled, uniformly at random, 10,000 game times across the season and labelled these moments, non-timeouts.

Each non-timeout was assigned a treatment value of 0 and assigned randomly to either the home or away team as the team that elected to take the timeout. Instances when timeouts were taken are assigned a treatment value of 1.

We would like to understand how this treatment affects team performance in the immediate period after timeout. We chose to measure this performance as the point differential in the 3

minutes after a timeout from the frame of reference of team that elected to take timeout. We refer to this measure as a team's "three minute scoring run". A positive three minute scoring run indicates that the team of reference is outperforming the opponent. A negative three minute scoring run indicates that the opponent is outperforming our team of reference.

We selected four covariates to achieve conditional exchangeability, as explained in Section 3:

1. Scoring Run - the three minute scoring run leading up to the timeout from frame of reference of the team who elected to take timeout.

2. Coach experience - the number of seasons that the head coach of the team who took the timeout has been a head coach in the NBA.

3. Time since last break - the time elapsed since the last break in play (the minimum of time since the start of the last period and the time since last timeout).

4. Overall point differential - the difference in score at the moment the timeout is taken from the frame of reference of the team who elected to take the timeout.

The three minute scoring run immediately after the timeout is used as the outcome of the treatment from frame of reference of the team who took the timeout.

NBA play-by-play data was transformed and augmented with coaching experience data to create our dataset for analysis. The data transformation pipeline can be found on GitHub [3].

3 Methods

To understand the effect of intervening on an NBA basketball game with a timeout, we employ g-methods to mimic a conditionally randomized control trial. We employ IP Weighting and Standardization. Both methods are used independently and their outcomes are compared, a common practice to test for model misspecification [1].

Let's show that we are meeting the assumptions necessary to use these methods: conditional exchangeability, consistency and positivity.

First, we believe that we have gathered sufficient covariates to achieve conditional exchangeability, see Figure 1. There is no way to empirically verify that we have produced conditional exchangeability with these covariates, this is left for critique by the reader.

Second, the consistency assumption is the condition that the treatments under comparison are well-defined and correspond to versions of treatment in the data. The intervention of a timeout in the game of basketball is well-defined. One team elects to take a timeout, the game clock stops and both teams take a break. While there are two different lengths of timeout, "short" and "long", we are not distinguishing between the two. The non-treatment case, a non-timeout, is well-defined and documented in Section 2. Code for how the non-timeouts were calculated is available on GitHub [3].

Third, the positivity assumption is the condition that for each populated strata (defined by the covariates) has both treated and untreated individuals. We defined five buckets for each covariate and retrieved the strata populated by treated individuals but not untreated individuals. Approximately 1.8% of the treated population existed in strata that were not populated by untreated individuals. We decided that this is sufficient to continue with the analysis.

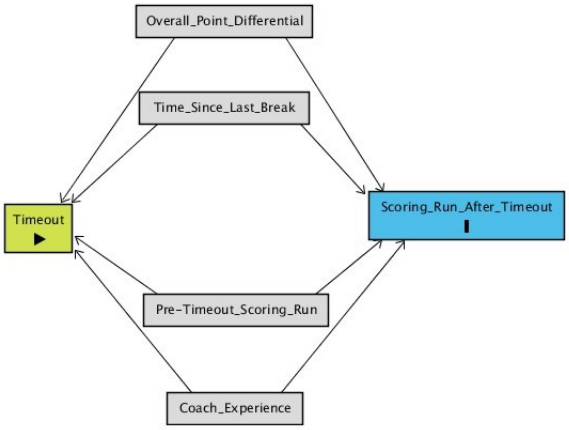

Figure 1: DAG representing relationships between treatment, outcome and covariates.

4 Evaluation

While we don't have experience coaching basketball, the author has watched a lot of (too much) basketball. It is quite common to see a coach take a timeout when the opponent is on a significant scoring run with the intent of stopping the opponents momentum and giving his team a chance to mentally reset. For this reason, we believe that it is worth evaluating the average treatment effect of timeouts conditionally, on negative vs. positive scoring runs leading up to the timeout.

We applied IP Weighting and Standardization for both the overall ATE and the ATE on the two subpopulations described above (conditional average treatment effects, or CATE). A naive method of evaluating ATE, taking the difference between means conditional on treatment, are included for reference.

	ATE	**CATE (+ve Scoring Run)**	**CATE (-ve Scoring Run)**
Naive	1.07, CI: (0.94, 1.19)	-0.77, (-0.98 -0.56)	1.75, (1.58, 1.91)
IP Weighting	0.23, (0.05 0.42)	-0.32, (-0.61 -0.02)	1.68, (1.45, 1.91)
Standardization	0.59, (0.40, 0.78)	-0.42, (-0.75, -0.09)	1.59, (1.34, 1.84)

The estimates from our two g-estimators are closely aligned so we do not suspect significant model misspecification.

The intervention of a timeout has a slightly positive effect for the team electing to take the timeout in general. However, conditioning on the scoring run leading up to the timeout has proven very valuable. Specifically, we find that a timeout acts as a significant shift in the game, for better or for worse. A team who is being outplayed, comes out of a timeout and on average outplays their opponent while a team who is outplaying their opponent, comes out of a timeout and on average gets outplayed by their opponent.

5 Conclusion

After game 5 of the 2019 NBA finals, Nick Nurse was asked about his thought process taking the timeout in the midst of his team's scoring run. He replies,

> "... well we had two free ones that you lose at the 3 minute mark... and decided to give the guys a rest... we thought we could use the extra energy push." [2]

Nurse begins with stating that he did not want to lose free timeouts. With the information proposed in this analysis, Nick Nurse should have opted to lose the timeouts given the run his team was on. He does go on to suggest that his team could have used a rest, but if the sole reason was the belief that all timeouts are value-add to a team's performance, we consider that calling the timeout was a mistake.

The Raptors of course went on to win game 6 at the Warriors' arena to clinch the championship. But, could they have won the championship in five games?

References

[1] Hernán MA, Robins JM. *Causal Inference: What If*. Boca Raton: Chapman and Hall/CRC, 2019.

[2] House of Highlights. *Nick Nurse Postgame Interview - Game 5 — Warriors vs Raptors — 2019 NBA Finals*. https://youtu.be/HwfA9IMqzK0?t=303, 2019.

[3] Alex Mansourati, nba-timeouts, (2019), GitHub repository, https://github.com/alexmanalex/nba_timeouts