Can Timeouts Change the Outcome of Basketball Games?

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In basketball, timeouts are believed to reverse the momentum of a game. However, here we show timeouts have no significant effect on the final outcomes of games. Moreover, we find that the timeout factor only appears to reinforce the game of dominant teams, meaning that only the most successful teams can find any positive benefit. We find no association with team payrolls, suggesting that richer teams are not particularly better at capitalizing on timeouts. Our findings support that strategic breaks have little impact on workplace performance and productivity.

Introduction

For many years, there has been a common belief that strategic breaks (known as timeouts in sports) can impact, positively or negatively, the performance of workers and players (*1–4*). One of the biggest debates in sports is whether timeouts can affect the outcome of a game. In basketball, timeouts are believed to be one the most important strategies in the game (*1*). Typically, teams call timeouts to change negative momentum, to rest or change players, to inspire morale, to communicate, or to modify their game strategy (*1, 2*). Indeed, previous research has shown that timeouts can change the momentum of a game over short periods of time (*1, 2*); however, it is currently unknown whether timeouts can actually change the final outcome of the game. Importantly, a wealth of data are available for sports, whose unambiguous performance measures provide an excellent opportunity to investigate untested ideas such as the timeout factor. Here, we tested the hypothesis that timeouts are significantly associated with changes in basketball outcomes across all teams in the National Basketball Association (NBA).

To test our hypothesis we used actual time series of scores and all timeouts called in more than 3000 games over three different regular seasons of the NBA from 2009 to 2012. These time series were collected directly from the NBA website (*5*), where there are detailed play-by-play records for each game. In particular, we studied whether *score differentials* can significantly increase or decrease after timeouts—what we called the timeout factor. Our methodology consisted of two steps (Methods). First, for each team, we quantified the total change in score differentials (the difference in the teams' scores at a given time) before and after timeouts across all quarters and games (Methods). Second, we compared the total change to the one that would be expected by chance if timeouts were called randomly during the game (Methods). Mathematically, our timeout factor for team i is defined as $z_i = (\rho_i - \langle \rho_i^* \rangle)/\sigma_{\rho_i^*}$, where ρ_i is the actual total change in score differentials and $\langle \rho_i^* \rangle$ and $\sigma_{\rho_i^*}$ are the average and standard deviation of expected total change across an ensemble of 1000 random replicates where the game timeouts are randomized (Methods). The greater the degree to which score differentials after actual timeouts differ from score differentials generated at random time windows (captured by the randomized timeouts), the stronger the timeout factor z_i. Values between $-2 < z_i < 2$ correspond to those teams where the timeout factor has no significant effect on the outcomes of their games.

Results

Surprisingly, our results rejected the hypothesis that timeouts have a significant effect on outcomes. Note that if one considers a binomial model $B(90, 0.05)$ over 90 cases (we considered 30 unique teams in each of the three seasons), the hypothesis would prevail if at most 13 cases showed no significant effect. However, Figure 1A shows that the timeout factor falls within the non-significant range in 78 out of 90 cases, revealing that timeouts have no significant effect on the outcomes of NBA games. Interestingly, we noticed that those few teams with a significant timeout factor were the ones with the lowest and highest number of wins in specific seasons, which could suggest that these were exceptionally bad or good teams, respectively.

Moreover, we found that on average timeouts only appear to reinforce the game of dominant teams. Figure 1B shows a significant ($p < 10^{-4}$ using Markov hypothesis testing), positive (slope 0.2) relationship between the timeout factor and the mean score differential when the timeout was called. This reveals that teams that experience timeouts with a positive score differential on average are able to capitalize and increase that differential in the long-run, and vice versa for teams with a negative score differential. These results suggest that despite the fact that timeouts may have a short-term impact on teams (*1, 2*), eventually the dominant team will win on average. Likewise, timeouts typically do not reverse a losing team's long-term outcome. Interestingly, we found no significant association ($p = 0.11$ using Markov hypothesis testing) between timeout factor and team payroll (*6*) (Fig. 1B), which suggests that richer teams are not particularly better at capitalizing on timeouts.

Discussion

In line with previous research that has shown that some common beliefs such as the "hot-hand" factor are not true in basketball (*7*), here we have statistically demonstrated that timeouts have no significant impact on basketball outcomes either. Importantly, these findings support empirical research showing that occasional rest breaks at workplaces have no significant effect on employees' productivity (*4*). Rest breaks and timeouts are important to improve people's work environment and to restore players' and workers' physical and mental fatigue. Indeed, managing fatigue is critical for medical, military and law enforcement personnel. However, our results reveal that strategic timeouts should not be considered either an advantage or a detriment to a team's performance.

Methods

Statistical analysis. In the first part of our statistical analysis, we considered each timeout and the end of each quarter as an event, and measured the score differential Δ_j during each event j. For each team i and each quarter q of game k separately, we quantified the change in score differentials δ_{ijq_k} between the event j and the event $j-1$ as $\delta_{ijq_k} = \Delta_{ijq_k} - \Delta_{i-1jq_k}$. Finally, the total change ρ_i for team i is the sum of all δ_{ijq_k} across all games played: $\rho_i = \sum_{k=1}^{K} \sum_{q_k=1}^{q_k=4} \sum_{i=2}^{N_{qk}} \delta_{ijq_k}$, where K and N_{q_k} are, respectively, the total number of games and total number of events in quarter q_k. For instance, in the 2009-2010 season, the Chicago Bulls faced the Miami Heat and in the second quarter there were three timeouts. When the first timeout was called, the score differential Δ_1 was 15 (37-22) in favor of Miami, in the second time out the score differential Δ_2 was 18 in favor of Miami, in the third timeout the score differential was 16 for Miami and at the end of the quarter the differential was 30 again for Miami. This generated three changes in score differentials for Miami of $\delta_2 = 18 - 15 = 3$, $\delta_3 = 16 - 18 = -2$ and $\delta_4 = 30 - 16 = 14$, with a total change of $\rho_i = 3 + (-2) + 14 = 15$. For Chicago, the values are the same but with the opposite sign. This means that in this quarter, Miami had a total positive change of 15 points after the three timeouts. In the second part of the statistical analysis, we compared the actual total change ρ_i to the total change ρ_i^* that would be expected by chance during the game. To calculate ρ_i^*, we took the actual time series of scores for each game k, randomly placed the timeouts preserving the number of timeouts of each quarter, then calculated the expected total change as normal. Mathematically, our timeout factor is defined as $z_i = (\rho_i - \langle \rho_i^* \rangle)/\sigma_{\rho_i^*}$, where ρ_i is the total actual change in score differentials and $\langle \rho_i^* \rangle$ and $\sigma_{\rho_i^*}$ are the average and standard deviation of expected total change across an ensemble of 1000 random replicates within which the timeouts in each game have been randomized. Actual timeouts are more likely to occur during certain game times, for example near the end of the last quarter, yet our results hold even when we preserve the probability distribution of timeouts per minute and if we analyze each quarter separately.

Acknowledgments

We would like to thank Peter Mucha for useful comments on a previous manuscript. We also thank the Kellogg School of Management, Northwestern University, the Northwestern Institute on Complex Systems (NICO), and the Army Research Laboratory under Cooperative Agreement W911NF-09-2-0053 for financial support. SS also thanks NUCATS grant UL1RR025741.

References

1. Mace, F. C., Lalli, M. L., Shea, M. C. & Nevin, J. A. Behavioral momentum in college basketball. *J. of Applied Behavior Analysis* **25**, 657-663 (1992).

2. Roane, H. S., Kelley, M. E., Trosclair, N. M. & Hauer, L. S. Behavioral momentum in sports: a partial replication with womens' basketaball. *J. of Applied Behavior Analysis* **37**, 385-390 (2004).

3. Danzinger, S. Levav, J. & Avnaim-Pesso, L. Extraneous factors in judicial decisions. *Proc. of the Nat. Acad. Sci. USA* **108**, 6889-6892 (2011).

4. Dababneha, A. J. Swansona, N. & Shell, R. L. Impact of added rest breaks on the productivity and well being of workers. *Ergonomics* **44**, 164-174 (2001).

5. NBA, `www.nba.com`.

6. NBA payrolls, `http://content.usatoday.com/sportsdata/basketball/nba/salaries`.

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

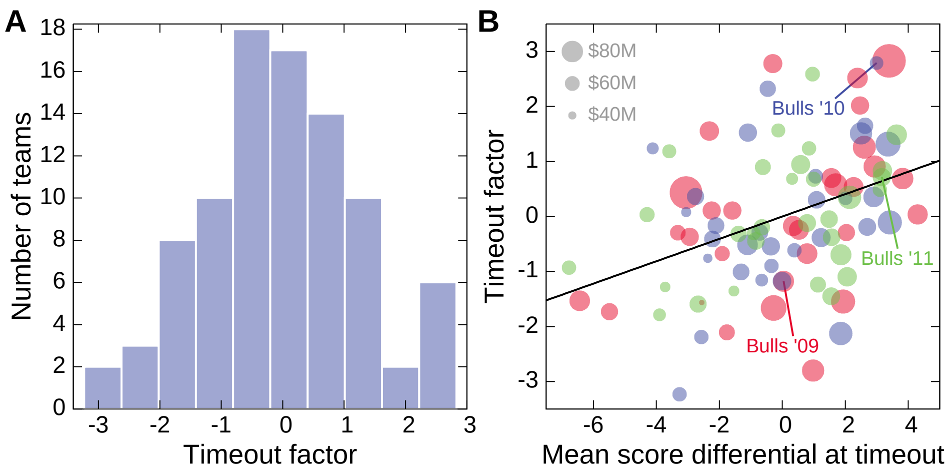

Figure 1: The timeout factor. (**A**) The distribution of timeout factors across all the NBA teams. Note that we considered 30 unique teams in each of the three seasons, which generated 90 cases. Importantly, we found that 78 out of 90 cases show a non-significant effect $-2 < z_i < 2$, which is supporting evidence to reject (using a binomial model $B(90, 0.05)$) the hypothesis that timeouts have a significant effect on basketball outcomes. (**B**) There is a significant ($p < 10^{-4}$ using Markov hypothesis testing), positive (slope 0.2) relationship between the timeout factor z_i and the mean score differential at the time when the timeout was called. The line corresponds to the best linear fit. Symbol colors and sizes represent season and team payroll, respectively. This reveals that teams that experience timeouts with a positive score differential on average, typically are able to capitalize and increase that differential, and vice versa for teams with a negative differential. Surprisingly, we did not find significant ($p = 0.11$ using Markov hypothesis testing) association between timeout factor and payroll, which suggests that richer teams are not particularly better at capitalizing on timeouts. For instance, the Chicago Bulls displayed their best timeout factor in the same season (2010-11, blue) when they also had their lowest payroll. Interestingly, in that season the respective winners of Coach of the Year and Most Valuable Player were Tom Thibodeau and Derrick Rose, both from the Bulls.