KENNESAW STATE UNIVERSITY
COLES COLLEGE OF BUSINESS
Bagwell Center for the Study of Markets and Economic Opportunity

Commentary

Title:

"Overtime Rules"

Author(s):

James Boudreau, Sean Ellermeyer, Brett Katzman, Timothy Mathews, and Jesse Schwartz

February 2024

For many fans, it's exciting when a major sporting event goes into overtime. Two teams, evenly matched at the end of regulation time, get to compete a while longer. What more could fans want?

For National Football League (NFL) fans and many others, overtime also provides an exciting opportunity to complain about the current system and offer suggestions for improvement. This could be because only one team can win, which means the other team's fans can always find something "unfair" about the process. Or, in the NFL's regular season and some other sports, the game could end in a tie, which is in some ways even less satisfying for fans. But the NFL's overtime rules come under special scrutiny due to the emphasis they place on the toss of a coin.

At the beginning of NFL games it must be decided which team begins "with the ball" on offense. Hence the ceremonial opening coin toss, with the winner given the opportunity to choose whether they begin on offense or defense, or if they want to defer that choice to the beginning of the second half. Since there is plenty of time left at the beginning of the game, and whichever team does not choose to begin the first half gets to make the choice for the second half, this seems "fair" in the eyes of most fans. At the beginning of overtime, however, the coin toss—a truly random event—may have excessive influence on the outcome of the game due to the particulars of the NFL's overtime rules.

For most of the NFL's modern era (since the AFL-NFL announced their merger in 1966), the NFL used a sudden death format for overtime: if the game was tied at the end of four quarters, the two teams played overtime until one scored, with that team named the winner whether they scored a touchdown or a field goal. At first this seemed relatively "fair," as teams winning the overtime toss won only 47% of the time from 1974-1993.[1] As kickers improved, however, it became easier and easier for the team who won the toss to move just close enough for a field goal and win on their first possession. That advantage was reflected in the fact that between 1994 and 2011 the team winning the toss won nearly 60% of the overtime games, 34% on its opening drive.[2]

In an attempt to remedy this perceived unfairness, the NFL changed its overtime rules in 2010. Starting with playoff games in the 2011 season, there would still be a coin toss with the winner choosing whether to begin on offense. If the team on offense scored a touchdown on its first drive, the game would be over with that team as the winner. If the opening drive resulted in only a field goal, however, the other team would have the opportunity to go on offense. If the second team's subsequent drive resulted in no score, the first team would win; if the second team's drive led to a touchdown, that team would be declared the winner; if it ended in a field goal, the game would go to sudden death. Similarly, if the team that started on offense failed to score on its opening drive, the game would go to sudden death.[3]

Perhaps unsurprisingly, this rule change did little to stem the criticism of the coin toss's influence on overtime games, with the winner still having a perceived advantage. (Whether or not that perception is true remains somewhat debatable, as we explain later.) An especially contentious playoff game between the Buffalo Bills and Kansas City Chiefs on January 23rd, 2022 prompted more public outcry, as the Chiefs not only came back to tie the game in a mere 13 seconds, but then won the overtime coin toss and scored a touchdown on their first possession of overtime, thereby ending the game. It also prompted the authors of this *Commentary* to engage in their own dialogue about how the rules could be improved.

---

[1] Prior to 1974 the sudden death format was still used for overtime, but only for playoff games. Regular season games ending in a tie simply ended in a tie.

[2] Leake and Pritchard (2016), "The Advantage of the Coin Toss for the New Overtime System in the National Football League," *The College Mathematics Journal*.

[3] If a safety was scored on the first possession of overtime, the game would end with the team scoring the safety as the winner.

From an academic standpoint, sports present a fascinating opportunity to see how rules shape incentives, and in turn behavior and outcomes. In fact, the subfield of economics and game theory known as *mechanism design* is dedicated to the creation of specific rules for strategic situations with specific objectives in mind. That is, we use our understanding of incentives to guide the construction of rules so that the outcomes they lead to match the intentions of those crafting the rules. Examples include the study of auction formats or voting mechanisms, which can be constructed to induce truthful bidding or voter participation.

In the case of football, the NFL uses the coin flip as a mechanism to determine which team is allocated possession of the ball to begin overtime; the scoring criteria (e.g. sudden death) then determine who is named the victor. The question is whether those rules—and the outcomes they shape—match the league's objectives. If the primary objective is strictly to have the "better team" win in a "fair" manner, allowing an arbitrary random occurrence like the flip of a coin to be involved might seem curious, especially if the team beginning with the ball has any kind of advantage. Under the original sudden death rules, being able to simply kick a field goal for the win evidently presented such an advantage once kickers were reliable enough from long distances, but even under the NFL's newer overtime rules the team starting with the ball can end the game on its first drive by scoring a touchdown. An improved set of rules would eliminate any such "unfair" advantage, but this presents the question of what "fair" means in this context.

Under the interpretation that "fair" means the rules are completely unbiased, not favoring either team, the answer could be quite simple: let the coin toss itself determine the winner. No overtime period(s) of play, just a coin toss. Though it might seem silly at first, if the two teams prove evenly matched at the end of regulation, neither has established themselves as the "better" team within that format. Given that the league is likely juggling its objectives with time constraints, perhaps due to player health concerns and/or the concerns of networks broadcasting (or streaming) the game, a coin toss would end things both very quickly and fairly in the sense that each of the evenly matched teams has an identical chance of victory: 50-50. In contrast to playing an overtime period in which one team is randomly favored by winning a coin toss and getting the ball first (ignoring the fact that they are evenly matched through the game so far), this could reasonably be seen as more fair.

Of course, ending the game with a random device such as a coin toss, however unbiased, is likely unappealing to fans (perhaps even less satisfying than a tie). So, at the other end of the spectrum, we could consider a mechanism that does away with luck entirely. To do so, it helps to keep in mind that while the coin toss is meant to determine which team kicks the ball off and which receives (starting on defense and offense, respectively), the kickoff itself and subsequent return determine where on the field the receiving team begins its offensive drive. In fact, the receiving team can return the kickoff to win the game on that play alone by returning it all the way to the other team's endzone and scoring a touchdown. This means that beginning the overtime period with any kind of kickoff likely favors the receiving team, however that team is determined.

To open the game without random luck or a kickoff involved, we can use a known, analogous situation from mechanism design: the cake-cutting problem. In a cake-cutting problem, the "cake" is a metaphor for some asset that must be divided. Examples include a bankrupt firm's assets to be split between claimholders, an inheritance to be split between heirs, or even a dessert to be split between two children. These are also known as "fair division" problems, since the goal is a split that is deemed fair according to specified criteria, and importantly for our purposes, many of these problems have solutions.

For cake-cutting problems involving just two identical parties (who view all crumbs of the cake as equally valuable), the standard solution method is known as *divide and choose*: one party cuts the cake into two pieces, and then the other party chooses which piece to take. The incentives involved and resulting strategies for each player are then straightforward. Knowing the second party will choose the bigger piece, the first party cuts the cake precisely in half so they don't end up with less. The mechanism's simplicity comes in part from the fact that both have the same objective: to end up with more cake.

Applying this concept to NFL overtime, we can consider the field as the cake. One team—perhaps designated by a coin toss but in the end it won't matter—chooses the place on the field where the ball will be placed for the opening drive. The other team then decides whether they want to begin on offense or defense. Picturing the field as an interval from 100 down to zero (a 100-yard cake), the first team makes the cut by deciding how many yards the team beginning with possession will have to travel to score a touchdown. The closer the ball is placed to the "zero yard line," the greater the odds of victory for the team starting on offense; the further the ball is placed from the "zero yard line," the better the odds of victory for the team starting on defense. If both teams are evenly matched and have the same information, the first team should choose the spot on the field (i.e., distance from opponent's end zone) where both teams are precisely indifferent between starting on offense or defense. This is why the initial determination of who makes the first choice is irrelevant. The first team knows if it places the ball too close, the second team has the advantage on offense and vice versa. Hence, this mechanism would eliminate the influence of the coin toss without favoring either side. Sudden death scoring rules could then be used to end the game as quickly as possible given time constraints, and each team would begin with an even chance at victory.

As simple and elegant as that solution is, we were not surprised to find out "The Simpsons already did it."[4] Both economists[5] and mathematicians[6] have already considered the problem of NFL overtime and independently arrived at the same solution, itself a version of the divide and choose method. To allow for asymmetric teams with differing information regarding the odds of victory at any point on the field, however, both Che and Gale (2008) and Brams and Sanderson (2013) borrow another tool from the field of mechanism design: auctions.

Auctions are great mechanisms for making people reveal information that they otherwise wouldn't want to share. Sellers, for example, usually want to charge buyers the highest price they possibly can, but buyers would prefer not to reveal that information. Why would they openly tell a seller the maximum price they'd be willing to pay for something? But if a seller uses an auction mechanism, they use the competition between buyers to make them reveal their true willingness to pay (at least in part) as they bid the price up in an effort to win. So, if we're not sure about where the teams should begin on the field to start overtime (where to cut the cake), we can have them "bid" for the opportunity to go on offense first.

If both teams are truly even in terms of offense and defense *and* both have perfect information regarding both their and the other's chance of victory at any given point on the field, it's arbitrary which team makes the decision of where the ball is placed to begin. Either team will choose the same point of indifference so as not to be disadvantaged. If teams have differing strengths on offense and/or defense, however, or if they are not fully aware of the other's capabilities or the amount of attrition suffered during regulation time, they may not make the same

---

[4] https://en.wikipedia.org/wiki/Simpsons_Already_Did_It

[5] Che and Hendershott (2008), "How to divide the possession of a football?" *Economics Letters*.

[6] Brams and Sanderson (2013), "Why you shouldn't use a toss for overtime," https://plus.maths.org/content/toss-overtime.

choice. This means that one team may be advantaged by making the initial decision of where to place the ball, which may not be deemed "fair."

To remedy these problems of asymmetry, we continue to imagine the field as a 100-yard "cake" (with the zero-yard line as the goal line the team opening on offense must cross to score a touchdown – i.e., the goal line of their opponent's end zone), but have both teams simultaneously bid on where the ball is placed to begin. The team with the lower bid begins on offense and the team with the higher bid begins on defense, but the ball is placed midway between the bids. Although the teams are different, meaning they will have differing points of indifference, for simplicity here let's assume each knows their *own* point of indifference. That is, each team knows the place on the field where they have equal odds of victory whether they start on offense or defense. Some basic insights from Game Theory reveal that a team can expect to do no better than simply bidding its true indifference point, given the other team does likewise.

Without going into too much detail, to see why each has an incentive to bid its own indifference point we can consider what would happen if one team did not do so while the other did. Suppose Team A's indifference point is less than Team B's, and A wins with a bid below its true indifference point. Then they'd have been better off bidding their true indifference point and starting closer on offense. By bidding above its true indifference point while B still bids truthfully, Team A could be made better off by bidding a little higher to start even closer to the end zone, but note that since they do not *know* B's true indifference point, the incentive to over-bid is limited (this is where the extra details come in, see Che and Gale (2008) for those). If they bid too high and lose the auction, they end up starting on defense further back than their indifference point.

Team B faces the same incentives, with no reason to bid below their true point of indifference and limited incentive to bid above. In the end, if both bid (close to) their true points of indifference on the field, whichever team starts on offense, both end up *at least* as well off as if they did start at their indifference point. By meeting halfway between, each is similarly advantaged relative to their own point of indifference. And—crucially from the perspective of "fairness"—whichever team begins on offense, they would not prefer the other team's role of playing on defense from that point and vice versa.

This version of divide and choose results in neither team being disadvantaged to begin overtime and no need for a coin toss (unless both teams have the same indifference point, in which case maybe the coin toss could decide which begins on offense but again neither is disadvantaged). It may take a while for teams to learn their own points of indifference, especially since that point will likely vary depending on the opposing team and other circumstances, but given the prevalence of analytics these days it seems likely they'd learn quickly.

With this type of solution method not only well known, but also published in both the academic and popular press,[7] those frustrated with the NFL's current overtime rules may wonder why the NFL hasn't (to our knowledge) explored such an option. If so many people have independently arrived at the mechanism design approach to solve the problem of overtime rules, it might be worth considering.

The answer could be that the NFL simply has many differing objectives that we have not accounted for. While they may prefer more fair outcomes over less, they may also have some value for including the coin toss and kickoff as part of overtime so that the structure of the overtime period is more similar to the game in regulation time. This is in contrast to sports such as hockey or soccer that use penalty shots to break ties, a format quite different from the game itself. That

[7] For example see this 2003 article from the *Wall Street Journal Online*: http://faculty.haas.berkeley.edu/hender/ot_wsj.pdf

may also be the reason they have not used the overtime rules from collegiate football, in which teams alternate possessions without kicking off.

In March 2022, the NFL made another change to overtime rules,[8] seemingly in response the public outcry[9] following the Bills-Chiefs game. Starting with the 2023 playoff season, there will still be a coin toss to determine which team starts on offense in overtime, but each team is guaranteed to possess the ball at least once (unless a safety is scored on the opening possession of overtime). If the team on offense first doesn't score a touchdown, or if the score is tied after each team has had the ball, the next score ends the game. Rather than a mechanism design approach, they have chosen to stick with a format that more closely resembles the game in regular time. Whether the latest change will eliminate the advantage formerly conferred by winning the toss is yet to be seen, as no games have gone into overtime as of the date of this paper.

In closing, and in fairness to the NFL, some additional details may be worth considering. By the end of the 2021 season, 164 total overtime games had been played since the 2011 rule change. Teams winning the coin toss went on to win the game 86 times (52.44%) and lost 68 times (41.46%), with 10 games ending in a tie (6.1%). This still means an advantage for the coin toss winner, but the numbers are an improvement over the previous system's most recent record, and are surprisingly close to those calculated theoretically by Leake and Pritchard (2016).[10] The most recent rule change was likely due to the observation that in the 12 playoff games going to overtime since 2011, the team winning the toss went on to win 10 times, 7 times on the first possession.[11]

---

[8] https://www.si.com/nfl/2023/01/12/nfl-new-overtime-rules-guidelines-2023-playoffs-explained.

[9] https://www.si.com/nfl/2022/01/24/nfl-overtime-rules-playoff-stats-coin-toss-chiefs-bills.

[10] Leake and Pritchard (2016), "The Advantage of the Coin Toss for the New Overtime System in the National Football League," *The College Mathematics Journal*.

[11] https://www.sportingnews.com/us/nfl/news/nfl-overtime-playoff-games-history/v2ac7w5vi1xr1ufwe68uu37d8