

Strategic Play in Basketball when the Coach's Input Changes

Kaihao Ni

Boston University

Boston, MA 02215

nikaihao@bu.edu

501-428-7025

Joseph P. McGarrity.

Professor of Economics

University of Central Arkansas

Conway, Arkansas 72035

joem@uca.edu

501-450-5330

Abstract

Sometimes managers can make decisions and other times the manager must leave decisions to employees. This paper investigates the manager / worker relationship between coaches and players in the National Basketball Association. It examines the case when play is interrupted at regular intervals by timeouts, which allows the coach to decide who shoots the ball in a particular procession. In these cases, the coach makes good strategic decisions. It also examines the case when play is uninterrupted for long stretches, which leaves the shot allocation decisions to players. In this situation, the strategic decisions are not as good as the ones made by the coach.

Introduction

Sometimes managers are able to make strategic decisions and sometimes these decisions must be left to their underlings. This paper examines whether managers are better at sophisticated strategic decision making than the employees that they manage. We use decision making in the National Basketball Association as a natural laboratory to examine this issue. A basketball team must decide who will take a shot. Optimal mixed strategy play predicts that the expected payoffs will be the same, regardless of whether a star player takes a shot or whether the non-star players on the team shoot. The logic here is straightforward. If all offensive players receive the same defensive attention, the star player will always shoot because he will be the player who is most likely to score. However, if a star offensive player is more effective than his teammates, the defense will put more effort into stopping the star player. They may do this by putting their best defensive player on the star, or the defense may double team the star. These extra defensive precautions will reduce the effectiveness of the star, but increase the effectiveness of the non-stars. The defense will adjust, until the expected payoffs from having a star shoot is the same as the expected payoff from having another player shoot. Mixed strategy play also requires that the choice of who will shoot be randomly distributed. If it were not, the defense could spot patterns and exploit the predictable behavior.

For most of a basketball game, the coach cannot give specific directions concerning who should shoot. The team will have several possessions before the coach calls time out and gives them specific instructions. However, at the end of a close game, it is common for a coach to call a time out to discuss each offensive possession. This allows the coach to give detailed instructions for who should shoot for that particular possession.

This paper finds that during crunch time, when the coach is making decisions, the team makes good strategic decisions. It also finds that decisions during regular play are not optimal.

Players, when left to themselves, do not always distribute the ball randomly, and they do not distribute shots so that the expected pay-offs between shooters are equal. These results suggest that coaches have specialized in making good strategic decisions. This success suggests that good strategic decision making is a valuable input for a coach. These results also suggest that poor strategic decision making by players may be overlooked by a team in favor of the ability to physically perform.

Literature review

The matching pennies game, the mixed strategy game discussed in this article, models a two player situation where one player tries to play the same strategy as his opponent, but the other player tries to play a different strategy. This model has remained popular even though most of the empirical literature finds that people do not act as the game predicts that they should. However, most of this literature, especially the early literature, reports tests that were performed in a laboratory setting (see Cramerer (2003) for a review of the literature). Walker and Wooders (2001) argue that the laboratory setting has many drawbacks. They argue that laboratory participants often do not have possible winnings that are large enough to give them an incentive to learn how to play the game well. They also note that laboratory participants are often students who will only play the game once. They do not have an incentive to learn strategy so that they can use it in the future.

Walker and Wooders (2001) was the first paper to use professional sports as a natural laboratory for testing the predictions of mixed strategy play. They note that professional sports players are useful subjects for their tests and that they have several advantages over the students used in a classroom laboratory. First, professionals face large rewards if they can win. Therefore, they have an incentive to learn strategic play to help their chances of winning.

Second, professionals play their games for many years, so they have plenty of time to figure out how to play with good strategy.

Walker and Wooders (2001) found that that tennis players had equal payoffs from serving to an opponent's forehand or backhand, as game theory would predict. However, they found that the servers alternated between backhand and forehand shots too often. An opponent could potentially spot this pattern and take advantage of it. Using a larger data set, Hsu, Huang, and Tang (2007) find strong evidence of mixed strategy play in tennis. Chiappori, Levitt, and Groseclose (2002), Palacios-Huerta (2003), and Coloma (2007) all report evidence that soccer players seem to adopt good mixed strategy play when they choose where in the net to direct penalty kicks. In studies of National Football league play calling, McGarrity and Linnen (2010) find evidence of mixed strategy play, while Kovash and Levitt (2009) find evidence against it. Similarly, McGarrity (2012) finds evidence of mixed strategy play in baseball, while Kovash and Levitt (2009) report evidence against it.

Empirical Section

First, we examine the mixed strategy prediction that the expected payoffs are equal regardless of who shoots the ball. We look at the shooting success of 15 star players as well as the shooting success of their teammates. We define a player as a star if he 1) scores at least 25 points per game on average and/or 2) scores more than 20 points per game on average and bests his remaining individual teammates by at least 5 points per game. We find 15 players who fit these qualifications. They are listed in Table 1.

We use true shooting percentage rather than the more common field goal percentage to measure shooting effectiveness. The standard field goal percentage diverges wildly between inside and outside players. For example, a typical inside star player, such as Dwight Howard,

shoots a 59.29% field goal percentage during the 2010-2011 season. In contrast, a typical outside star player, Kevin Martin, has a 45.07% field goal percentage in the same season. At first glance, we could conclude that Howard is a better player than Martin. Indeed, almost all the inside players shoot better field goal percentages than most outside players. However, the field goal percentage does not accurately represent the offensive scoring contribution. In fact, outside players shoot more 3 point shots, which are worth one point more than the two point field goal. Also, outside players generally have a better free throw shooting percentage simply because they are better shooters than inside players. The “true shooting percentage (TS %),” makes adjustments to account for these concerns. This variable, which is reported by ESPN, is found with the following formula: True Shooting Percentage = (Total points x.50) divided by [(FGA + (FTA x 0.44)].

Back to the example of Howard and Martin, Howard has a 61.64% true shooting percentage and Martin has a 60.08% true shooting percentage. This productivity measure causes a similar convergence of shooting productivity among the remaining inside and outside players

While examining the prediction of equal expected payoffs among star players and non-star players on a team, we first look at the case of normal play. This period covers most of the game. The coach is not able to give detailed instructions for each possession because the team will have to make several decisions about who will shoot before the coach gets a chance to talk to the team during a time out or at the end of a quarter. We refer to this time of play as non-clutch time.

This section tests whether the true shooting percentage for star players and the rest teams varies in non-clutch game time. To gather the data, we watched every game for the teams with a star player during the 2010-2011 season. Games or shooting attempts are

excluded if 1) no star player is on court to play; 2) a team's division standing cannot be meaningfully changed (as for example in the case where the Golden State Warriors are unable to get into the playoffs even by winning their last eight games, but they needed at least 9 victory to tie Memphis Grizzlies for the 8th position in Western Conference ; 3) a last second free throw is shot when the possessing team is leading by 1 or 2 points (as a player will often run down the time by deliberately missing the shot).

Table 1 summarizes the performance measures. Out of a total 51,252 non-clutch team attempts, the total true shooting percentage is 0.5471, while 21,872 non-clutch star player attempts yield a total true shooting percentage is 0.5704. The star player shoots 4.27% better than the rest of the team. This performance measures suggests that star players score more efficiently than their teammates. A two-tail 2-sample T-test allows us to reject at one percent level (t-statistic =-2.9989) the null hypothesis that a star player has the same shooting percentage as the team does. During non-clutch time play, the team could improve its scoring productivity if it let star players take more shots.

Next, we consider clutch time play. NBA coaches call timeouts much more frequently in clutch time than non-clutch time. This allows them to make decisions on almost every possession. During clutch time, the coach has much more input into the decision making on shot distribution than he has during non-clutch time play. We define clutch time play as a game in the 4th quarter or overtime, less than 5 minutes left, with neither team ahead by more than 5 points.

Using data from clutch time play, we examine the true shooting percentage of star player as well as this performance measure for the remainder of the team. Table 2 reports the results. In a total of 2,158 clutch team attempts, their total true shooting percentage is 0.5562; while in total 1,587 clutch time star player attempts, their total true shooting percentage is

0.5542. As you can see, the shooting percentages are nearly the same and the difference is not significant at conventional level. A two-tail 2-sample T-test cannot reject the null hypothesis that the star player and the team have the same true shooting percentages. ($t=.4443$, $p=.6607$) Compared with non-clutch time, this suggests that in clutch time, teams make decisions just like game theory predicts.

Taken together, the clutch and non-clutch results suggest that strategic play is improved when coaches, rather than players, make choices. Tables 1 and 2 also report additional evidence that decision making is different in clutch versus non-clutch play. These tables report the ratio of the star player shot attempts divided by the total team shot attempts (star player(s) attempts plus the rest of the team attempts). This ratio shows the distribution of the shooting attempts between the star and the team. Star players take an average 37.04% of their team shots in clutch time, in contrast to 29.91% of the shots in non-clutch time. They shoot 24% more often in clutch time. A one-tail 2-sample T-test shows us to reject the null hypothesis that the star player is equally likely to shoot in clutch time as in non-clutch time. ($t=-1.852$, $p=.0401$). This is strong evidence in favor of the proposition that a team will let the star player shoot more to maximize their payoffs in clutch time. Just as game theory predicts, to equalized scoring efficiency in clutch time, star players took more shots.

Next, we examine a second prediction from mixed strategy play. We try to determine if shots decisions are made as if they are drawn randomly from a probability distribution. If these choices are not randomly generated, then a defense can exploit this information for their own gain. In Table 3, we examine the clutch time randomness by using the Wald–Wolfowitz runs test. We randomly pick five teams from the teams in our sample reported in Tables 1 and 2 and test the randomness in clutch time decisions of who should shoot. For teams with 2 stars,

we try to consider each star as well as the non star members of the team; in addition, we consider 2 stars together and the team. For New York Knicks, since they gained there second star player, Carmelo Anthony, by trade at the middle of the season, we consider it as 2 periods and label them: 1 star (before trade), and 2 stars (after trade). Each teams shows that they call mixed strategy play in clutch time. This suggests that when a team has enough time outs, the coach will call the play and play mix strategy to maximize payoffs.

To test whether the shot distribution is random in non-clutch time, we draw data from the five games with the most clutch attempts for all of the teams found in Table 3. As shown in Table 4, we can reject the null hypothesis at 95% level that the Bulls and Knicks shoot randomly in non-clutch time ($z=2.260$ and $z= -3.127$). However, it is important not to overstate these results. In 8 of the 10 cases, players were randomly distributing the shots. Therefore, in a majority of the cases, players were following this prediction of good strategic play.

Conclusion

This paper compares the ability of players and coaches in making good strategic play as predicted by mix strategy play in game theory. We find that when coaches are making the decisions, the shooting choices are made so that the expected points from shots by a stars and non-stars are equal. This is good strategic play in a mixed strategy game. However, we also find that when players make the choices on how to distribute shots, the non-stars shoot too often. Along this dimension, players are not as good at making good strategic choices as coaches.

We also find evidence, although more limited, that coaches are better than players at distributing shots randomly so the defense cannot react to the pattern and exploit it. While 100% of the coaches were able to randomly distribute the ball when they were the primary decision makers, 80% of the players were able to perform this task as well. So while 20% of the teams

distribute the ball in a way that does reveal a pattern, the vast majority of teams can perform this aspect of good strategic play when players are the primary decision makers.

McGarrity and Linnen (2010) found evidence of good strategy in football for the types of choices that coaches made. They noted that in football the coach can specialize in strategic decision making and that the player does not have to perform this function. They compared their result to Walker and Wooders (2001) who found that service decisions in tennis did not always exhibit good strategy. McGarrity and Linnen attribute the tennis result to a difference between football and tennis decision making. In tennis, strategic decisions and physical performance are both the responsibility of the player. If players are very good physically, they may be able to get away with playing a less effective strategy. When these functions are divided, as they are in football, the coach will have less leeway to make bad strategic decisions because he cannot make it up with good performance on the field. This paper fits into this narrative in an interesting way. Within a single sport, it identifies cases when the coach is the primary decision maker and other cases when players are the primary decision makers. Consistent with McGarrity and Linnen's argument, we find that coaches are more likely to implement good strategic decisions than players are.

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Table 1 Non-Clutch data

Team	TSP	Player	TSP	Player Atps/Team Atps	Player TSP/Team TSP
LAL	0.5444	Bryant	0.5492	0.3486	1.0087
ORL	0.5322	Howard	0.6130	0.2759	1.1518
MIA	0.5609	James	0.5940	0.3084	1.0591
MIA	0.5687	Wade	0.5845	0.3106	1.0421
GSW	0.5465	Ellis	0.5314	0.2813	0.9723
HOU	0.5286	Martin	0.6019	0.3030	1.1386
DEN	0.5859	Anthony	0.5461	0.3281	0.9321
DAL	0.5394	Nowitzki	0.6110	0.2975	1.1326
CHI	0.5348	Rose	0.5523	0.3162	1.0327
OKC	0.5472	Durant	0.5919	0.3061	1.0817
OKC	0.5709	Westbrook	0.5403	0.2816	0.9873
IND	0.5248	Granger	0.5579	0.2756	1.0630
NYN	0.5593	Stoudemire	0.5642	0.3095	1.0087
NYN	0.5550	Anthony	0.5803	0.2820	1.0375
POR	0.5264	Aldridge	0.5521	0.2671	1.0489
Ave	0.5471	Player Ave	0.5704	0.2991	1.0427

Table 2 Clutch data

Team	TSP	Player	TSP	Player Atps/Team Atps	Player TSP/Team TSP
LAL	0.5353	Bryant	0.5360	0.4540	1.0013
ORL	0.5230	Howard	0.7008	0.1800	1.3399
MIA	0.6283	James	0.5950	0.3725	0.9470
MIA	0.6283	Wade	0.5133	0.2966	0.8169
GSW	0.5620	Ellis	0.6008	0.3633	1.0691
HOU	0.5209	Martin	0.5839	0.3261	1.1208
DEN	0.6104	Anthony	0.5593	0.4236	0.9164
DAL	0.6212	Nowitzki	0.6215	0.3297	1.0005
CHI	0.5783	Rose	0.5268	0.4508	0.9109
OKC	0.5556	Durant	0.5579	0.3898	1.0040
OKC	0.5556	Westbrook	0.5165	0.3837	0.9296
IND	0.5194	Granger	0.4725	0.2916	0.9096
NYN	0.5551	Stoudemire	0.5763	0.3059	1.0381
NYN	0.5551	Anthony	0.4995	0.4023	0.8998
POR	0.5393	Aldridge	0.5076	0.2889	0.9413
Ave	0.5562	Player Ave	0.5542	0.3704	0.9965

Table 3 Clutch Runs Test

	Z =	p-value =
CHI	-0.120	0.904
IND	0.806	0.420
POR	-0.907	0.364
NYN 1 star	-0.276	0.783
NYN 2 stars	-0.849	0.396
NYN Anthony	0.505	0.613
NYN Stoudemire	-0.849	0.396
OKC 2 stars	-0.684	0.494
OKC Durant	1.205	0.228
OKC Westbrook	1.403	0.161

Table 4 Non-Clutch Runs Test

	Z =	p-value =
CHI	2.260	0.012
IND	0.862	0.194
POR	-1.207	0.114
NYN 1 star	0.193	0.577
NYN 2 stars	1.250	0.894
NYN Anthony	-1.223	0.111
NYN Stoudemire	--3.127	0.001
OKC 2 stars	-0.927	0.177
OKC Durant	1.260	0.896
OKC Westbrook	0.218	-0.779