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Depth of Player Rotation on Game Performance and Outcomes in NCAA Men's Basketball

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Abstract

Coaches differ in in how they use the talents of their players and player rotation is among their most strategically important game management levers; some substitute sparingly while others routinely go to a deep bench. This research examines the impact of size of rotation on team performance and success among 7,154 NCAA Division I Men's Basketball team performances collected over multiple seasons. Study findings demonstrate that depth of player rotation has a significant positive effect on game outcomes and that the relationship is conditioned by number of personal fouls, overall team strength and home court advantage. The pathways through which a larger rotation results in greater odds of winning include offensive rebounding, steals and overall defensive efficiency, all areas where the fresh legs, quick hands and sustained energy levels characteristic of a deeper bench can make a measurable difference. Advantages of a smaller core rotation are manifested at the offensive end of the court, notably in shooting percentages, ball control and overall offensive ratings.

Key words**:** college basketball, NCAA, player rotation, player performance, game outcomes, personal fouls, team strength, home advantage

1. Introduction

Player rotation is a seemingly endless topic of concern and debate among basketball coaches, media and fans. Starting line-ups, playing time, depth of bench, team chemistry, foul trouble, player matchups, zone versus man-to-man defense, player injuries and many other questions all relate, directly or indirectly, to how coaches rotate their players on and off the court during the course of a game, and over the course of an entire season. Indeed, player rotation is one of the more powerful strategic levers that coaches wield in the on-court management of their teams and how they approach game preparation, individual match-ups and the anticipated and unanticipated effects of "foul trouble." And there are different rotational strategies. While the majority of coaches will establish a 7 or 8 player rotation, some will favor a deep bench and large player rotation with 9, 10 or even more players receiving significant playing time. Others prefer a tight rotation with as few as 5 or 6 players receiving as many minutes as they can handle. Much depends on the pool of talent coaches have to draw from and how successful they are at staying out of foul trouble.

Analytical Framework. To appreciate the importance of player rotation to game outcomes we consider it in the context of a larger conceptual framework, one in which player rotation and other "coach controlled" variables are seen as causally antecedent to the major on-court performance variables such as shooting percentages and rebounds. In turn, game success is closely shaped by the combination of these performance variables, particularly shots made from the field and the free throw line. Their effects are often joined with other performance variables such as rebounds and turnovers, into two overarching composite indicators: offensive and defensive ratings (Oliver, 2004; Kubatko *et al.*, 2007). Previous research confirms that defensive rebounds (Gómez *et al*., 2008a,b; Ibáñez *et al*., 2008; García *et al*., 2013), number of assists (Gómez *et al*., 2006; Ibáñez *et al*., 2008; García *et al*., 2013), free throws (Sampaio and Janeira, 2003; Ibáñez *et al*., 2003; 2008; Simović *et al*., 2011), and two and three-point field goals attempted (Kozar *et al*., 1994; García *et al*., 2003; Simović *et al*., 2011) are the on-court performance indicators that best differentiate between winning and losing teams.

In addition to the number of players in the game rotation, we think of shooting/scoring balance, player size and experience (age/year in school) as some of the more important variables that fall into the coach-controlled category and for which data are readily available from game score sheets and published team rosters, so meet the requirements of a large and pragmatic database. We also note that because coach-controlled and on-court performance variables tend to change throughout the game it is important to recognize that for this reason they can be highly interactive, for example the number of personal fouls called on a team is positively correlated with the number of players in the rotation for that game (as will be shown in the data presented below).

Both on-court and coach-controlled variables are in turn shaped by a core set of exogenous influences that we here refer to as "ecological variables." These variables include geospatial effects such as crossing time zones (Smith *et al*., 1997; Steenland and Deddens, 1997; Reilly and Waterhouse, 2009; Winter *et al*., 2009; Samuels, 2012; Clay, *et al*., 2014), playing at higher elevations (Pollard, 2006; Wilber, 2011; Nassis, 2013) or at colder temperatures (Clay *et al*., 2014). By far the most commonly observed exogenous influence on performance and outcomes is the benefit of playing in front of a friendly fan base, otherwise known as "home court advantage" (Greer, 1983; Smith *et al*., 2000; Carron, 2005; Borghesi, 2007).

Despite the pervasive nature of player rotation as one of the more fundamental coach-controlled strategic tools, research on how it varies and how it affects game outcomes is virtually nonexistent. Is there a point at which a small core rotation becomes too small, or a deep rotation becomes too deep when viewed through the lens of offensive and defensive efficiencies, or, more importantly, in terms of who wins and who loses? From a scientific standpoint, as observable, measurable facts, we simply do not know the answer to these questions. In this study we carefully sift through an extensive multi-year

NCAA Men's Basketball data base to examine how, and through which channels, player rotation affects the odds of winning.

Depth of Rotation as a Strategic Lever. That coaches vary in their strategies about depth of player rotations is not surprising given the competing advantages of one style over another. Before we look at some of those differences it is instructive to establish a shared definition of what we mean by rotation size. Our interest is not in knowing the total number of players who enter the game at one point or another. This would include even those players who come into the game for just a minute or two, which often happens at the end of a game where one team has a large lead. Instead we limit the definition to players who see "significant time" on the court; 10 or more minutes of action in a given game is the cutoff we apply in this study. While somewhat arbitrary this threshold will serve well for our analytical purposes of distinguishing between larger and smaller rotations. We will come back to this definition in greater detail in the Methods section below, with a look at the resulting distributions of the rotation variables used in this study.

Turning to the advantages/disadvantages of larger and smaller rotations we can distill the following from our review of observations made by coaches, media and online instructional materials:

Advantages of a longer rotation:

1. Reduces the player fatigue, maintaining fresh players and higher energy levels. This factor becomes particularly important in overtime games. Rests key players for the crucial part of the game, especially in the final minutes.
2. Increases options for responding to team foul trouble.
3. Increases options for achieving desirable player match-ups.
4. Helps to change game rhythm when necessary.
5. Has longer-term advantage of giving more players game experience in which to develop their skills and confidence playing in front of large/hostile crowds.
6. Improves team harmony and concerns about minutes played.

Advantages of a shorter rotation:

1. Places stronger players on the court for more of the time.
2. Improves team coordination due to time playing together.
3. Improves on-court team chemistry due to time playing together.
4. Helps to keep players on the court in the rhythm of the game, reducing the disruptive effects of frequent substitution.

The number of players in the rotation for any particular game is highly conditioned by the flow of the game, with the number of personal fouls committed by starters being a dominant factor. When a starting player is called for his second foul in the first half, most college coaches will quickly sit that player for the rest of the half, opening the door for a larger rotation for the game. A deeper bench of experience players can be a significant advantage, particularly for teams prone to foul trouble. However it is equally important to recognize that foul trouble is not necessarily a random misfortune that a team must endure. Many teams that accumulate larger numbers of fouls do so as an accepted consequence of an aggressive defensive strategy, where players push the limits in going for offensive rebounds, steals and through high pressure man-to-man (sometimes full court press) coverage.

In studying the flow of the game one can easily see the logic in how coaches balance defensive aggressiveness, fouls and player rotation to maximize their odds of winning (manage the risk of losing). While much can be said about the tactical adjustments that coaches make in their rotations and style of play in the context of a single game, it is equally true that teams will approach this balancing act very strategically, over the course of an entire season, or even longer. There are coaches who become known for particular styles of play that affect, and are affected by, player rotation: Rick Pitino (Kentucky) and Billy Donovan (Florida) are two coaches known for the full court press, for example; Jim Boeheim (Syracuse) is recognized for his success with a 2-3 zone defense that results in few fouls and impressively low defensive ratings.

But in stepping back and looking at different rotational strategies, especially over the course of a full season and across thousands of games, the glaring question is whether these opposing strategies result in different degrees of success in game performance, and more importantly in game outcomes. Those questions constitute the focus of the present research.

Our review of previous scientific research on the effects of player rotations on game outcomes reveals that the question has not been squarely addressed by the scientific community; and this appears equally true for other sports such as hockey, which has similar strategic levers in the number of lines used, how those lines are composed, and how they are managed in terms of line changes and time on the ice.

This is not to say that the question of basketball rotations and hockey line changes do not receive ample attention as a matter of voiced concerns and opinions. They certainly do. Coaches, media and an abundance of training materials are replete with competing views and recommendations for how to succeed and managing these critical coach-controlled levers. For example, the Journal Sentinal notes that in 2012-13 coach Buzz Williams played a very deep rotation that enabled Marquette to play “10-deep, waves of substitutions, frenetic offense-for-defense changes with its point guards and big men” which is “almost unprecedented in the college game” (Hunt 2013). And the Golden Eagles were successful that year with a 14-4 record in the Big East and a deep run in the NCAA Tournament.

By contrast, Coach Krzyzewski of Duke is noted in the Bleacher Report for preferring a smaller rotation, even with a wealth of talent on the bench. As columnist Dantzler Smith notes, “The theoretical benefit of a small rotation is that it builds familiarity and develops players through huge amounts of game-time experience. In short, each player has a role and the coaching staff knows exactly what it's getting from players it has seen so much of on the court” (Smith 2013). The downside for Coach Krzyzewski, he notes, is that, “With a roster full of players deserving of minutes, it’ll be difficult to keep everyone happy.” In like manner, Matt Bollant, coach of the Illinois women’s team, does not mince words in his preference for a short bench, especially in close games, where he always wants his best players on the floor. He further notes that “other coaches play extra players to keep them happy, and I’ve never believed that’s the right philosophy” (News-Gazette 2013).

Our conclusion is that while much of the existing literature is both thoughtful and thought provoking, it tends to be experientially and anecdotally based, rather than the product of rigorous scientific inquiry. One of the main reasons for the absence of scientific research is that it requires a large and specialized player-level database, ideally one that extends over multiple years and teams so that it can capture slight differences in player rotations as well as variations in fouls, strength of team and other covariates that can confound the effects of player rotation on performance. Another damper on research is the dearth of methodological progress made on how to conceptualize and measure differences in rotation, or broader substitution patterns that coaches employ. This study takes a first cut at both of these challenges en route to an empirical examination of how player rotation strategies affect game performance and outcomes.

2. Methods

The data for this study are based on a 7,154 NCAA Division I Men’s Basketball team performances (from 3,577 games) collected for three seasons: 2001-2002, 2010-2011, and 2011-2012. The focus is on teams from the nine major college basketball conferences in the U.S.: Atlantic Coast (ACC), Atlantic 10, Big 12, Big East, Big 10, Conference USA, Mountain West, Pac 12, and Southeastern (SEC). There are 110 teams represented, though due to changes in conference membership (departures and arrivals) a small number of schools not are represented in all three study years. Included in the data base are all games played by each team against the other teams in its own conference (77.2%) and against teams in any of the other nine major conferences (22.8%); many of the games in this latter category are those in the high profile tournaments such as the Maui Classic, the Great Alaska Shootout, the NIT Season Tip-Off as well as the ACC-Big Ten Challenge and the Big East-SEC Challenge. Thus, few if any of the matchups can be considered “warm up” games where coaches build a 30-point lead at half-time and then sit their starters for the second half, departing from what might otherwise be a normal player rotation. Fewer than 2.9% of games in the study sample ended with a winning margin of greater than 30 points.

Table 1. Mean Number of Players in Core Rotation over Full Season

Mean Number of Players	Percent	N
5.00 - 6.99	16.7	1,198
7.00 - 7.49	30.9	2,214
7.50 - 7.99	32.3	2,310
8.00+	20.0	1,432
Total	100.0	7,154

The primary dimension of player rotation of interest in this study is rotation *size* and how larger rotations compare to shorter rotations. We measure players in rotation as the number of players logging 10 or more minutes in a game, or approximately half of the average player's 20.8 minutes per game. While there are players who regularly contribute fewer minutes than 10 per game as a part of a broader rotation, for purposes of this study we reason that the 10 minute threshold identifies players who form a part of the "core" playing rotation. Players with 10+ minutes account for an average of 95.4% of total minutes played (ranging from 80-100%), or approximately 191 of the 200 minutes played in regulation time. Using the 10-minute threshold, the majority of teams in our sample (72.9%) employed 7-8 player rotation in any given game, with those using a smaller rotation of 5-6 players 13.5% of the time and a larger rotation of 9-11 players in 14.6% of their games.

To understand the impact of how coaches used player rotations *strategically* over the long-haul, as opposed to *tactically* in individual games, we computed averages in player rotations for each team across entire seasons. Grouping this season-long rotation variable into four categories (Table 1) we note that most coaches (63.2%) take a middle range approach over the course of the season with a 7-player rotation, split between the upper and lower 7's. Yet there are significant groups of coaches that strategically opt for a smaller, less than 7-player rotation (16.7%) or for a relatively large rotation of eight or more players (20.0%). We believe that comparing these four groups will yield insights as to how different rotational strategies affect team performance.

Table 2. Study Variables Operationalization and Descriptive Statistics

Variable	N	Mean	Std Dev	Range
Game outcome (1 = won, 0 = lost)	7,154	0.50	0.50	0 - 1
Players in rotation (10+ min) during game	7,154	7.51	0.97	5 - 11
Mean players in rotation (10+ min) over season	7,154	7.51	0.54	6.04 - 8.8
Team strength (team's final RPI ranking x 1000)	7,154	555.53	57.86	403 - 679
Home court advantage (1 = home, 0 = visiting)	7,154	0.50	0.50	0 - 1
Team performance variables:				
Field goal percentage (made/attempted)	7,154	43.60	7.22	17.39 - 72.9
Free Throw Percentage (made/attempted)	7,154	69.45	12.68	0 - 100
Offensive rebounds	7,154	9.85	3.91	0 - 28
Defensive rebounds	7,154	21.66	4.76	6 - 43
Total rebounds (offensive + defensive)	7,154	31.50	6.37	9 - 59
Assists	7,154	13.22	4.20	2 - 34
Steals	7,154	6.42	2.98	0 - 36
Blocks	7,154	3.64	2.36	0 - 18
Turnovers (committed by team)	7,154	13.01	4.09	1 - 34
Personal fouls (committed by team)	7,154	18.22	4.31	2 - 38
Offensive Rating (Points Per Possession)	7,154	102.59	15.47	52.2 - 160.5
Defensive Rating (Opponent's PPP)	7,154	102.59	15.47	52.2 - 160.5

Other study variables are summarized in Table 2, along with those discussed above. *Game outcomes* are measured as a simple binary won-loss variable (1 = won, 0 = lost). We place special emphasis on controlling for *foul trouble* to ensure an unbiased estimation of player rotation (more fouls requires a larger rotation). The number of personal fouls committed by teams provides us with this indicator. Because *strength of team* is such an important determinant of game performance and results, as well as the number of fouls committed (stronger teams are called for fewer fouls), it must be controlled to ensure an isolated estimation of the impacts of player rotation on performance and outcomes. Team strength is measured as the team's final (end of season) RPI ranking x 1000. Home court advantage (1 = home, 0 = visiting) is also included as a covariate given its recognized effects on NCAA basketball outcomes.

Team performance is measured by a suite of indicators as listed in the lower half of Table 2. We include 10 on-the-court performance variables commonly tracked in the NCAA for statistical purposes, such as field goal percentages, rebounds, turnovers and personal fouls. We also include two aggregate measures of team-level performance regularly used in basketball analytics as overall measures of how well, or poorly, a team played in a given game. They are offensive and defensive efficiency ratings, also known as offensive points scored per possession (PPP), and defensive points per possession, i.e., the opponent’s PPP (Oliver 2004; Kubatko, 2007).

Team possessions are computed as:

$$Possessions = FGA - OREB + TOV + (0.4 * FTA)$$

Offensive and defensive efficiency ratings (PPP) are computed as:

$$PPP = \frac{Points\ Scored}{Possessions} * 100$$

Where: FGA=field goals attempted, OREB=offensive rebounds, TOV=turnovers, FTA=free throw attempts

3. Findings and Discussion

In our first step we examine the bivariate relationship between rotation size and game outcomes. Table 3 shows that win percentages are significantly greater for teams playing smaller rotations. This is true both for rotation size measured at the individual game level and for the longer-term season average rotation. Of the two, season rotation shows the larger separation in win percentages with a 10.4% higher win percentage difference between the smallest and largest rotation categories. We also find that the simple correlation coefficient (*r*) between rotation size and win percentages is consistently negative: -.05 for the game-level player rotation and -.07 for the season rotation, both significant at the $p < .001$ level.

Taken at face value, one is tempted to posit an immense advantage for coaches opting for a smaller player rotation, challenging the wisdom of a deep bench strategy. But such a conclusion would be premature. That is because we know the relationship between player rotation size and game success to be seriously conditioned by the number of personal fouls committed. Indeed, both game and season rotation sizes are positively linked to foul trouble: $r = .19$ for game rotation and $r = .19$ for season rotation (both significant at the $p < .001$ level). Moreover, team strength must also enter the equation as it is an important determinant of win percentages ($r = .35$) and of fouls committed ($r = -.10$).

Table 3. Winning Percentage by Game and Season Player Rotation

Players in Rotation	Win %	(N=)
Game Rotation‡		
5-6	53.3%	962
7	53.2%	2,721
8	46.7%	2,423
9-11	46.4%	1,048
Total	50.0%	7,154
Season Rotation‡		
5.00 - 6.99	56.1%	1,198
7.00 - 7.49	51.0%	2,214
7.50 - 7.99	48.5%	2,310
8.00+	45.7%	1,432
Total	50.0%	7,154

‡Pearson Chi-Square, Sig < 0.000

It is noteworthy that teams called for many personal fouls will go to a deeper rotation, either as an adjustment in a particular game in which they experience foul trouble or as an overall game strategy of using a deep bench, playing aggressive defense and absorbing the large number of personal fouls that can come with this game plan. The "Hack-a-Shaq" strategy (Pollakoff, 2013; Tebo, 2014) employed by the Dallas Mavericks and other NBA teams in the late 1990s and early 2000s epitomized this game plan often used against vulnerable free throw shooting teams, most notably against the Chicago Bulls (with Dennis Rodman) and the Los Angeles Lakers (with Shaquille O'Neal).

Logistic Regression. Next we examine the independent effects of depth of player rotation on game outcomes using a logistic regression model, which is suitable to the binary (win–loss) dependent variable. In the interest of simplicity (avoiding redundancy) we present here only the model results using the *season* rotation variable. We make a side note that both the game-level and the season-level variables yield similar and statistically significant estimates, though moderately more pronounced in the case of the season-long player rotation variable. We believe this is because the full season indicator represents coaches' longer-term strategic approach to player substitution and that the effects of the longer term approach are of particular interest to coaches, fans, media representatives and other readers of this study.

Table 4 reports the results of the logistic regression model in two sequential steps. In Step 1 we introduce season-long player rotation and, as observed earlier, at the bivariate level a significant inverse relationship emerges. In short, the odds ratio of winning (.781) is less than even (1.0); otherwise stated, the odds of *losing* (inverse odds ratio) are 28.1 percent higher for each additional player in rotation (DesJardins, 2001).

However, it is in Step 2 that the true effects of player rotation emerge. In this step we introduce into the equation the set of key covariates thought to shape and condition the effects of player rotation on game performance, and those shown by previous research to be important determinants of game outcomes: personal fouls, team strength and home court advantage. In controlling for these covariate effects we observe that more players in rotation is not at all the liability first observed; rather, it emerges as a significant *asset* to teams once the confounding covariate effects are neutralized. The expanded model in Step 2 shows that the odds ratio of winning is 1.195, or 19.5% higher odds of winning with each additional player brought into the rotation. In stripping out the effects of more fouls typically accumulated by lower ranked teams, the advantages of a larger rotation significantly outweigh those of a smaller rotation.

Table 4. Logistic Regression: Likelihood of Winning (Odds Ratio) by Number of Players in Rotation (Season), Controlling for Personal Fouls and Team Strength

	Variables in the Equation	B	S.E.	Wald	df	Sig.	Odds Ratio Exp. (B)	Inverse Odds Ratio‡	Wins Correctly Predicted (%)
Step 1									52.8%
+	Players in rotation (season)	-.248	.044	31.098	1	.000	.781	1.281	
	Constant	1.861	.335	30.942	1	.000	6.429		
Step 2									71.3%
	Players in rotation (season)	.178	.052	11.629	1	.001	1.195		
+	Personal fouls	-.136	.007	377.325	1	.000	.873	1.146	
+	Team strength	.015	.001	760.663	1	.000	1.015		
+	Home court advantage	1.064	.055	371.502	1	.000	2.899		
	Constant	-7.460	.524	202.964	1	.000	.001		

+ Signifies new variables in the equation at that step
‡ For ease of interpretation inverse odds ratio computed for negative log odds (B)

Identifying the Performance Channels. Having isolated the underlying positive effects of a larger player rotation strategy, we now turn our attention to understanding some of the performance-based pathways through which rotation size can affect game outcomes. Table 5 reports the results of a series of analysis of variance (ANOVA) models that compare estimated means for each of the 11 key performance variables described earlier in this study and known in the research literature as important determinants of game outcomes. Predicted means are compared systematically across the four categories of players in rotation over the full season.

Especially revealing in this table is that certain performance variables improve with a deeper rotation, yet others decline, instead showing better performance among teams that use a shorter player rotation. More specifically, we find that teams using a larger rotation tend to rebound better, particularly on the offensive end. They also have more steals. By contrast, smaller rotation teams tend to shoot the ball better, both field goals and free throws, and they are more effective at taking care of the ball, resulting in fewer turnovers. For all of these performance variables the trends are subtle but unmistakable and statistically significant, and in the game of basketball even slightest advantage can make a difference in the game's final outcome.

Table 5. ANOVA: On-Court Performance (Predicted Means) by Rotation Size (Season), Controlling for Personal Fouls, Team Strength and Home Court Advantage

	Number of Players in Rotation (Season Average)					
On-Court Performance Variable	5.00-6.99	7.00-7.49	7.50-7.99	8.00+	Total	Sig.*
Field goal percentage	43.6	43.7	43.7	43.2	43.6	0.000
Free Throw Percentage	69.9	70.0	69.4	68.5	69.5	0.000
Offensive rebounds	9.5	9.8	10.0	10.0	9.9	0.001
Defensive rebounds	21.2	22.1	21.6	21.5	21.7	0.000
Total rebounds	30.7	31.8	31.6	31.5	31.5	0.003
Assists	13.0	13.3	13.2	13.3	13.2	0.170
Steals	6.5	6.3	6.3	6.8	6.4	0.000
Blocks	3.5	3.7	3.6	3.6	3.6	0.051
Turnovers	12.6	12.9	13.1	13.4	13.0	0.000
Offensive Rating	103.0	102.7	103.1	101.3	102.6	0.000
Defensive Rating	103.7	102.9	102.7	100.9	102.6	0.005
N=	1,198	2,214	2,310	1,432	7,154	

*Significance of main effects (players in rotation).

Our interpretation of these findings is that adopting a larger player rotation leads to an advantage in areas where physical energy and "fresh legs" make a difference, with offensive rebounding being the classic case in point as an aspect of the game that demands high physical exertion, first "crashing the boards" and then getting back on defense. Steals are the same, requiring sustained aggressiveness on defense. Conversely, teams that adopt a small rotation strategy tend to excel in the high-skill offensive categories such as shooting and ball control (limiting turnovers). This is certainly an advantage enjoyed by teams that work to keep their star players on the court for as many minutes as possible.

Looking further down the list of performance variables in Table 5, we come to the two composite variables—offensive and defensive efficiency ratings—both of which are known in the literature to be closely correlated with game outcomes (Oliver 2004; Kubatko, 2007). Based on the differences in performance observed above it comes as no surprise that offensive ratings (points per possession) are at their best among smaller rotation teams and that better defensive ratings (low PPP scored by opponents) tend to be enjoyed by teams adopting a larger rotation strategy. These relationships are captured in Figure 1, illuminating the tendency for smaller rotation teams to have notably better offensive ratings than do large rotation teams but quite the opposite on the defensive end. The cross-over point lies at a rotation size somewhere between 7 and 8 players. Perhaps more telling is the observation that defensive ratings are more affected by size of rotation than are offensive ratings, the latter showing little variation until dropping off precipitously at player rotations of 8 or more. This is also seen in its steeper slope and greater extremes at both ends of the defensive ratings curve.

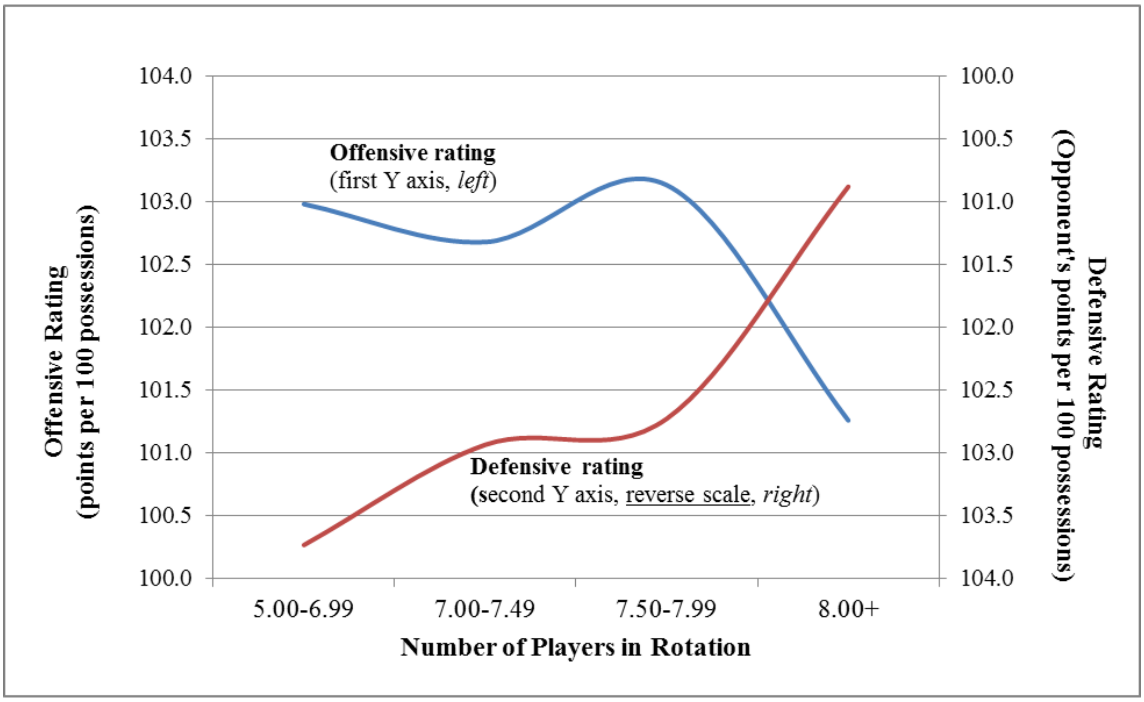

Figure 1. Mean Predicted Offensive and Defensive Ratings by Number of Players in Rotation, Controlling for Covariates

4. Conclusion

While there is much hoopla made over how coaches rotate their players, there is surprisingly little research showing whether and how this coach controlled strategic lever actually plays out through on-court performance and game outcomes. Sometimes thought to be a simple matter of coaching style, available talent and individual matchups, we find that coaches have particular philosophies about their rotations and whether to keep them short (The News-Gazette, 2013) or deep (Hunt, 2013). The fact of the matter is that while coaches do use rotations tactically from game to game in response to foul trouble or bad match-ups, they also have longer-term strategies in the rotations they use and often these strategies play out over entire seasons. Some have become well known for how extensively they use their benches (or not). So it seems logical to us that individual game depth of rotation is highly correlated with average seasonal depth of rotation.

We find that depth of player rotation matters immensely to on-court performance and game outcomes and that it is strongly influenced (confounded) by number of personal fouls, overall team strength and home court advantage. In controlling for these covariates, virtually all of which have been shown in the literature to be determinants of game outcomes (Gómez *et al*., 2008a,b; Ibáñez *et al*., 2008; García *et al*., 2013; Simović *et al*., 2011), we see that the effect of a larger rotation shifts from a strong negative effect on the odds of winning to a significant positive effect on winning.

Examining the pathways through which a larger rotation results in greater odds of winning yields important insights. We find that the difference plays out primarily through stronger defense and its sister metric, offensive rebounding—areas where fresh legs, quick hands and sustained energy count for so much. By contrast, the advantages of a smaller core rotation are manifested at the offensive end of the court, notably in shooting percentages, ball control and overall offensive ratings. These findings are fully consistent with earlier research (Kozar *et al*., 1994; García *et al*., 2003; Simović *et al*., 2011) that has found field goal attempts and other offensive skills to be among the major determinants of who wins and who loses in European league professional basketball. Our research does not allow us to compare early game versus late game results, but we think it reasonable to hypothesize that much of the difference in fatigue levels plays out in the fourth quarter of the game. All agree that having top offensive players on the court at the end of a tight game is essential; this study suggests that it may be even more important that these players have the level of energy to come up with the offensive rebounds and the big steals and other defensive plays when it really counts.

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