NBA Championship Indicators

An Analysis of Advanced Team Statistics & Its Effects on Achieving NBA Championship Success in the Modern Era

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Abstract

One of the most entertaining aspects of the National Basketball Association (NBA) is the continuous evolution the league undergoes due to the players' constant skill development, the rapid advancement in style of play, and the ever-changing philosophies of head coaches. Specifically, over the past several seasons, the Golden State Warriors have transformed the NBA's landscape by placing a greater emphasis on pinpoint shooting accuracy, unselfish passing ability, and increased pace of play, ultimately culminating in two NBA Championships over the past three seasons. Subsequently, the purpose of this study is to analyze the current era of the NBA (since 2012-13) and determine which team characteristics are the most influential to winning NBA Championships. Ultimately, the study focuses on six key advanced team statistics, concluding that a team's true shooting percentage and assist-to-turnover ratio are most indicative of NBA Championship caliber success.

Introduction

During a recent podcast interview with *The Ringer's* Bill Simmons, 7-time NBA Champion and current Golden State Warriors Head Coach Steve Kerr was asked to identify the three key statistics that he believes are most important to his team's winning ways. Contrary to the casual fan's assumption, he did not reference lethal three-point precision, lightning quick offensive tempo, or anything else pertaining to his team's infectious run-and-gun style of play that has captivated the league over the past several seasons. Instead, Coach Kerr unhesitatingly pointed out that team assist totals, team turnover totals, and the opponent's field goal percentage are the first stats that he looks at following a game, and that those three statistics are ultimately the best on-court performance indicators for his team's overall success. Consequently, Coach Kerr's statement piqued my interest in what team metrics are most influential to an NBA Championship caliber team.

There have been several studies that examine the relationship between specific team statistics and the team's overall level of achievement. Interestingly, some of them, such as *Onwuegbuzie (2008)*, focus on traditional box score statistics – such as average points scored per game, average 3-point shooting percentage, and total rebounds per game – to determine which statistics best explain a team's winning percentage. While others, such as *Cross and Teramoto (2010)*, utilize offensive and defensive efficiency ratings, along with the "Four Factors" (effective field goal percentage, turnover percentage, rebound percentage, and free throw rate), to determine which statistics are most important during the regular season versus during the playoffs. Another study, *Yang (2015)*, even made use of team's individual player statistics – such as player efficiency

rating (PER) – to determine how the performance of individual players affected their team's overall regular season record.

Surprisingly, however, I was unable to find any studies that particularly examined the relationship between advanced team statistics and winning the NBA Championship. Consequently, that is the question that this study will be attempting to answer. Specifically, this study will use bivariate, multivariate, and probit regression analysis to examine the contributions of six advanced team statistics (four offensive and two defensive) to determine which metrics are most indicative of winning the NBA Championship.

The Data & Data Sources

Ultimately, this study examines the success of all 30 NBA teams since the beginning of the 2012-13 NBA season, including the five NBA Championship winning teams during that period. Therefore, the data being utilized is drawn from the 2012-13 through 2016-17 seasons, excluding the present 2017-18 season because it is ongoing. Moreover, the data collected for this study was drawn from various reputable statistical basketball sources across the Internet, including stats.nba.com, basketball-reference.com, as well as, teamrankings.com. Stats.nba.com is the official website of the National Basketball Association, and collects an array of NBA statistics from traditional box scores to advanced player tracking. Basketball-reference.com is a website that collects statistics and history for all sports, including the NBA. Teamrankings.com is data-driven predictive analytics website that focuses on presenting team statistics for a variety of professional sports, including the NBA. A brief summary of the descriptive statistics for the NBA data collected for this study follows:

Variable	Observations	Mean	Standard Deviation	Minimum	Maximum
TrueShooting	150	0.541	0.020	0.46	0.597
AstToTurnover	150	1.554	0.170	1.16	2.06
RebRate	150	0.500	0.015	0.46	0.5474
Pace	150	93.913	2.637	88.25	100.47
OppTrueShooting	150	0.541	0.016	0.50	0.577
OppTurnover	150	14.749	1.233	11.70	17.70

Variable Analysis

Throughout this study, six advanced team metrics will be utilized to connect a team's on-court performance with their propensity to win the NBA Championship. Specifically, the six independent variables employed will be comprised of four advanced offensive team statistics and two advanced defensive team statistics. The offensive statistics include team true shooting percentage (TS%), team assist-to-turnover ratio (AST/TO), team rebounding rate (REB%), and pace of play (Pace). The defensive statistics include opponent true shooting percentage (Opp. TS%) and opponent turnover rate (Opp. TOV%).

To shed some light on the meaning of the advanced offensive statistics, team true shooting percentage (TS%) is an APBR (Association of Professional Basketball Research) metric used to measure a team's shooting efficiency more accurately than traditional box score shooting percentages, by accounting for 2-point field goal efficiency, 3-point field goal efficiency, and free throw efficiency collectively within the same metric. For comparison, a team true shooting percentage around 50% is poor, while approaching 55% is about average, and approaching 60% is considered exceptional. Assist-to-turnover ratio (AST/TO) is used to measure a team's passing ability against how effectively the team takes care of the basketball by measuring the number of team

assists against the number of team turnovers. For comparison, a team assist-to-turnover ratio around 1.25 is poor, while approaching 1.50 is about average, and approaching 2.00 is considered exceptional. Rebounding rate is used to measure how effectively a team rebounds missed field goal and free throw attempts more accurately than traditional box score rebounding totals by accounting for factors that are out of the team's control, such as opponent's total shots taken and percentage of shots made. For comparison, a team rebounding rate around 45% is poor, while approaching 50% is about average, and approaching 55% is considered exceptional. Finally, pace of play (Pace) measures how fast or slow a team plays by accounting for the team's number of possessions per 48 minutes. For comparison, a pace of play around 90 is slow, approaching 95 is about average, and approaching 100 is considered fast in today's game.

As for the advanced defensive statistics, opponent true shooting percentage (Opp. TS%) is a measurement of how effectively a team guards the opposing team's shooters by accounting for the opponent's shooting efficiency on 2-point field goals, 3-point field goals, and free throws. For comparison, an opponent's true shooting percentage approaching 60% indicates poor shooting defense, approaching 55% indicates average shooting defense, and around 50% indicates exceptional shooting defense. Furthermore, opponent turnover rate (Opp. TOV%) is a measurement of how effectively a team guards the opposing team's ball handlers by accounting for the number of turnovers an opponent averages per 100 of their own possessions. For comparison, an opponent's turnover rate around 10% indicates poor ball handling defense, approaching 15% indicates average ball handling defense, and approaching 20% indicates exceptional ball handling defense.

Ultimately, this study examines the relationship between these six independent variables and a dependent dummy variable called *Championship*. *Championship* accounts

for whether the team won that season's NBA Championship, equaling "1" if they won the NBA Championship and "0" if they did not. Consequently, since this study analyzes the past five seasons, there will be five total teams whose *Championship* variable equals "1".

Bivariate Regression Analysis

The first model will be a simple bivariate regression using the main independent variable of interest, true shooting percentage (TS%), to determine its effect on winning an NBA Championship. The results of this bivariate regression are as follows:

$$\hat{Championship}_i = -1.58 + 2.98 TrueShooting_i$$

After analyzing the results of this bivariate regression, we determine that a 1-unit increase in true shooting percentage leads to an estimated 2.98 increase in the likelihood of winning an NBA Championship. However, since *TrueShooting* is a percentage and a 1-unit increase by default would be equivalent to a 100% increase, we will instead define a 1-unit increase in *TrueShooting* as equivalent to an increase of 0.01, or 1%. Consequently, a 1-unit (0.01, or 1%) increase in true shooting percentage leads to an estimated 0.0298 (or 2.98%) increase in the likelihood of winning an NBA Championship. Furthermore, the constant of -1.58 indicates that when a team's true shooting percentage equals zero, the estimated likelihood of the teams winning the NBA Championship is -1.58. Of course, the chance of a team's true shooting percentage equaling zero is incredibly unlikely, not to mention -1.58 is not even a possible value for our *Championship* dummy variable, but this interpretation has been included purely for the purposes of demonstrating the concepts that we have studied.

It is also important to point out that the coefficient on *TrueShooting* has a t-stat of 4.32 and is consequently statistically significant at the 99.9% confidence level.

Multivariate Regression Analysis

The second model will be a multivariate regression using all six independent variables, including the natural log of *TrueShooting*, to determine their effect on winning an NBA Championship. The results of this multivariate regression are as follows:

$$Championship_i = 0.85 + 1.14 lnTrueShooting_i + 0.18 AstToTurnover_i + 0.33 RebRate_i + 0.001 Pace_i - 1.47 OppTrueShooting_i + 0.01 OppTurnoverRate_i$$

After analyzing the results of this multivariate regression, we are able to come to several conclusions. First, the coefficient on *lnTrueShooting* (logged true shooting) means that a 1% increase in team true shooting percentage leads to an estimated 0.0114 (or 1.14%) increase in the likelihood of winning an NBA Championship. It is important to note that the t-stat of *lnTrueShooting* is 2.603, meaning that *lnTrueShooting* is statistically significant at the 95% confidence level. Thus, these results lead us to conclude that team true shooting percentage and winning the NBA Championship are strongly related.

Furthermore, each additional 1-unit increase in team assist-to-turnover ratio leads to an estimated 0.18 (or 18%) increase in the team's likelihood of the winning the NBA Championship. Though since assist-to-turnover ratios are typically quite small, we will instead define a 1-unit increase in *AstToTurnover* as an increase of 0.1. Therefore, a 0.1 increase in team assist-to-turnover ratio leads to a 0.018 (or 1.8%) increase in the team's likelihood of winning the NBA Championship. This interpretation is much more realistic, and it is important to note that the t-stat of *AstToTurnover* is 1.901, meaning that *AstToTurnover* is statistically significant at the 90% confidence level. Thus, these results

lead us to conclude that team assist-to-turnover ratio and winning the NBA Championship possess a fairly strong relationship.

Additionally, each additional 1-unit increase (defined as an increase of 0.01) in team rebounding rate leads to an estimated 0.0033 (or 0.33%) increase in the team's likelihood of winning the NBA Championship. Not only is the magnitude of the coefficient fairly weak, but also *RebRate* is highly statistically insignificant. Thus, these results lead us to conclude that rebounding rate and winning the NBA Championship are weakly related.

Similarly, each additional 1-unit increase in team pace of play leads to an estimated 0.001 (or 0.1%) increase in the team's likelihood of winning the NBA Championship. Similar to *AstToTurnover*, not only is the magnitude of the *Pace* coefficient very weak, but also *Pace* is highly statistically insignificant. Thus, these results lead us to conclude that pace and winning the NBA Championship are very weakly related.

Next, each additional 1-unit increase (defined as an increase of 0.01) in opponent true shooting percentage leads to an estimated 0.0147 (1.47%) decrease in the defensive team's likelihood of winning the NBA Championship. Interestingly, while the magnitude of the coefficient on *OppTrueShooting* is fairly strong, the absolute value of its t-stat is just 1.489, meaning that it just narrowly falls short of statistical significance at the 90% confidence level. Thus, these results lead us to conclude that opponent true shooting percentage and winning the NBA Championship are just somewhat related.

Finally, each additional 1-unit increase in opponent turnover rate leads to an estimated 0.01 (or 1%) increase in the defensive team's likelihood of winning the NBA Championship. Similarly to *OppTrueShooting*, while the magnitude of the coefficient on

OppTurnoverRate is somewhat strong, its t-stat is just 0.822, meaning that it falls well short of statistical significance at the 90% confidence level. Thus, these results lead us to conclude that opponent turnover rate and winning the NBA Championship are weakly related.

Also, while it is extremely unlikely, for the purposes of demonstrating the concepts that we have studied, in the case that all six independent variables equal zero, the likelihood of winning the NBA Championship would be just 0.85 (represented by the constant in our equation).

Statistical F Test

Now that we understand the multivariate results, next we are going to conduct a statistical test of team assist-to-turnover ratio and pace of play to check for multicollinearity. Specifically, we are going to conduct an *F* test using an *F* statistic derived from the multivariate results.

We start by specifying a null hypothesis of H_0: $\beta_2 = \beta_4 = 0$. Consequently, the results of the restricted model for H_0: $\beta_2 = \beta_4 = 0$ follow (note how *AstToTurnover* and *Pace* have fallen out of the equation):

$$Championship_i = 1.97 + 1.48 lnTrueShooting_i - 0.26 RebRate_i$$
$$-1.83 OppTrueShooting_i + 0.007 OppTurnoverRate_i$$

Using the F Statistics equation, we determine that the F Statistic is 0.803 for this F Test. Additionally, our critical value in this case is 3.00. Consequently, since the F Statistic is less than the critical value, we *fail to reject* the null hypothesis.

Probit Regression Analysis

The third model will be a probit model using all six independent variables. First, we will setup a linear probability model (LPM). The results are as follows:

$$\text{Prôb}(Championship_i = 1) = \Phi(-0.99 + 2.17TrueShooting_i + 0.17AstToTurnover_i + 0.31RebRate_i + 0.001Pace_i - 1.46OppTrueShooting_i + 0.01OppTurnoverRate_i)$$

By running the model, we can determine that *TrueShooting* has the most influential effect on *Championship* because it has the coefficient with the greatest magnitude. Additionally, the minimum fitted value from this model is -0.125 (or 12.5%) and the maximum fitted value from this model is 0.273 (or 27.3%). Here we see one of the limits to linear probability models. Specifically, since the minimum fitted value is a negative number, this means that the fitted line goes below zero. This is problematic because probabilities must lie between 0 and 1.

Next, we will run the probit model regression. The results are as follows:

$$\text{Prôb}(Championship_i = 1) = \Phi(0.74 + 60.61TrueShooting_i + 4.46AstToTurnover_i + 15.98RebRate_i - 0.31Pace_i - 40.57OppTrueShooting_i - 0.13OppTurnoverRate_i)$$

When comparing the results from the LPM model and the probit model, the statistical significance (and lack thereof) of the coefficients is the same. Specifically, *TrueShooting* and *AstToTurnover* are statistically significant, while *RebRate, Pace, OppTrueShooting,* and *OppTurnoverRate* are all statistically insignificant.

The minimum fitted value from this model is 2.220446e-16, while the maximum fitted value from this model is 0.7607 (or 76.07%). It is notable to point out that using the probit model instead of the linear probability model yields minimum and maximum

probabilities between 0 and 1, and corrects the issue of trying to graph the fitted values using a straight line.

Finally, using the observed-value, discrete-differences approach we determine that the simulated effect of a one standard deviation increase in *TrueShooting* on the probability of winning the NBA Championship (when *Championship* = 1) is an increase of 0.0647, or 6.47%.

A brief table illustrating our three regressions follows on the next page:

	Dependent variable:		
	championship		
	OLS		probit
	(1)	(2)	(3)
trueShooting	2.981***		60.613**
	(0.690)		(27.189)
log_trueShooting		1.135**	
		(0.436)	
assistToTurnover		0.176*	4.464*
		(0.093)	(2.551)
reboundingRate		0.329	15.981
		(1.091)	(33.090)
pace		0.001	-0.306
		(0.006)	(0.221)
oppTrueShooting		-1.474	-40.572
		(0.990)	(34.831)
oppTurnoverRate		0.010	-0.125
		(0.012)	(0.360)
Constant	-1.578***	0.848	0.743
	(0.374)	(1.255)	(38.956)
Observations	150	150	150
R2	0.112	0.154	
Adjusted R2	0.106	0.119	
Log Likelihood			-9.463
Akaike Inf. Crit.			32.925
Residual Std. Error	0.170 (df = 148)	0.169 (df = 143)	
F Statistic	18.634*** (df = 1; 148)	4.355*** (df = 6; 143)	
Note:			*p<0.1; **p<0.05; ***p<0.01

Endogeneity

Every aspect of on-court NBA performance is comprised of countless smaller components that are pivotal in determining the outcome of each possession, game, and season. Consequently, it is next to impossible for any study to thoroughly correct for endogeneity, since the explanatory variables chosen will almost always be correlated with at least something in the error term. In addition to using precautions when selecting our independent variables, we have attempted to use the two-stage least squares approach to check for endogeneity, though since we are using observational data it is difficult to determine an instrument that undoubtedly satisfies the exclusion condition.

Conclusion

The results of this study determine that team true shooting percentage and team assist-to-turnover ratio are most indicative of NBA Championship success. While opponent true shooting percentage was also close to making the cut, the variable simply was not quite statistically significant enough. Contrastingly, team rebounding rate, pace of play, and opponent turnover rate were all weakly related to NBA Championship success.

These results were consistent with the findings of *Onwuegbuzie (2008)* and *Teramoto and Cross (2010)* in the sense that team shooting percentage is the most significant indicator of team success. An additional consensus was that the observed offensive variables were more indicative of team success than were the observed defensive variables, with the particularly fascinating caveat from *Teramoto and Cross*

(2010) that team defensive statistics become increasingly important as the team continues to win and advances to further rounds of the playoffs.

To supplement this research, it could potentially be worthwhile to incorporate a variable that measures the effect of individual players on their team's likelihood of winning the NBA Championship. Specifically, player impact estimate (PIE) is an advanced metric that measures a player's overall statistical contribution against their team's total statistical output and could be an effective way of accounting for this effect. This study could even be taken a step further to determine advanced statistical categories in which it would be most important to have dominant player contributions.

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