
# Brandeis International Business School

# NBA Team Value Estimations

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## Section 1: Introduction

NBA is one of the four popular sports leagues in North America. The value of a team may be affected by a variety of performance-related as well as macroeconomic factors. Team revenues, for example, could be an essential factor influencing the value. Higher team revenues could reflect people's willingness to spend more to watch superstars playing. People might also love seeing their home teams win, which is one of the reasons why performance affects team value. The size of a city's sports market may also contribute to a team's value. Supported by wealthier fans living in larger cities could make the team worth more.

This study investigates the factors that may affect NBA teams' value and the magnitude of the impact, which is valuable to both team managers and investors (supporting better hiring and investment decisions etc.).

Several studies explore the factors affecting the value of an NBA team. Liedekerke (2017) studies the determinants of franchise values and finds market performance, star players, and team brand to be significant determinants. Bonnal et al., (2013) look at the value of teams in MLB, NBA, NFL, NHL, American major leagues, and European soccer and find that historical performance has a significant positive impact on all the leagues.

## Section 2: Data Description

We use a panel data set that includes thirty NBA teams over five seasons from 2013 to 2017.

The dependent variable is the NBA team value. As shown in appendix I, independent variables include performance variables such as times of championships, winning percentage, average points per game, average assists per game, and average turnover per game. Other variables include team history in the city (in years), team revenue, location (east or west), number of all-star players, average attendance at home court, GDP per capita, and home city population. Detailed data descriptions are shown in appendix II. The variable 'salary' was dropped after the preliminary phase because it seemed more logical for the team value to affect salary rather than the other way around.

In general, the above variables could be classified as performance indicators and economic factors. The rationale for adding performance related variables is that better team performance leads to higher team value. For performance variables, assist measures the degree of cooperation in a team. We expect good collaboration within the team to translate into a higher team value. Point per game, winning percentage, and championship count measure the result of games from different aspects and are common standards to judge a team's performance. Turnover means that the team has lost control of the ball, which is a mistake and negatively influences the team's performance. The number of All-star players represents the quality of the players. We include variables related to home cities because we believe the wealthier people in the home city are, the more likely to watch the games and buy related products. The more people there are in the home city, the larger the sports market is.

The raw data is a short, unbalanced panel with missing data for team revenue, GDP per capita, and population variables. We calculated the above variables' average growth rate for the teams without missing data and used the number to estimate the missing data.

The dependent variable, team value, has a median of $825 million and a mean of $970 million. It is positively correlated with all independent variables except turnover. As shown in appendix III, team value has the strongest correlation with team revenue, probably because team revenue is the

most direct measure of team value. The performance variables have a positive correlation between 0.1 and 0.3 with team value. Not surprisingly, the correlation between team value and turnover is negative.

**Section 3: Methodology**

$$\text{Team Value} = \alpha_0 + \beta_0 \text{LagTeamValue} + \beta_1 \text{assist} + \beta_2 \text{turnover} + \beta_3 \text{point} + \beta_4 \text{win} + \beta_5 \text{allstar} + \beta_6 \text{history} + \beta_7 \text{championship} + \beta_8 \text{population} + \beta_9 \text{gdppercapita} + \beta_{10} \text{attendancerate} + \beta_{11} \text{revenue} + \text{factor(season)}$$

Our candidate models are OLS regression and a fixed/ random effects model. We believe that the NBA has distinct characteristics that vary across each team, such as basketball popularity in the home city, population, experience, coach performance, etc. and OLS would not account for this. Our statistical tests also tilt against using OLS. We have included α in the equation, which accounts for the individual-specific effect that varies across teams.

Given the likely presence of unobserved heterogeneity in our dataset, we introduced the fixed effects and the random-effects model. The fixed effect tries to control for the time-invariant factors so that their effect does not translate into coefficients of other variables and the results are unbiased (Torres, 2007). The random-effects model assumes that the variations across the entities (teams) are random. We believe that the unobserved differences across teams do not play a significant role in determining a team's value. The statistical tests also support our judgment of using a fixed-effects model.

**Section 4: Empirical Results**

The adjusted R2 statistic of 0.893 means the model explains most of the variation in the dependent variable. Moreover, the presented model has the lowest AIC (1544).

According to the results presented in Table 4.1 of Appendix IV, the lagged dependent variable plays a role in explaining the variation in the current year's team value. The coefficient is positive and significant, which means that team value has an inertia effect. Taking the lag value of "team value" also helps fix the serial correlation issue to some extent.

The variable 'turnover' is significant in our regression results. If the average turnover per game increases by one, team value is expected to fall by $57.8 million. This makes sense because if a team keeps losing possession, it would be expected to have a negative impact on team value.

The coefficient of variable 'history' seems surprising: for each additional year a team stays in its current home city, the team value decreases by $65 million. We initially guessed that such an intuitive counter result is caused by omitted variables that affect 'history' and 'team value' in the opposite direction. However, such omitted variables are tricky to find. Even more surprisingly, only the fixed effect model with categorical time control reports a negative coefficient for 'history'. All other models predict a positive relationship between history and team value, which is in line with the plot of history over team value. We believe that the intuitive counter result is caused by model limitation. Fixed effect estimates coefficients by demeans (current value minus the average). Since we include both 'season' (as categorical time control) and 'history' (as a numerical variable), the actual effect of 'history' may be disturbed by the categorical variable 'season'- if the (demeaned) value of history increases by one, 'season' changes too. Isolating the exact effect 'history' has on 'team value' is tricky because the coefficient may be distorted by

'season'. This seems like a multicollinearity problem, and we may solve it by transforming history into a grouped categorical variable (For example, Group A=History from 0~5 years).

Our model predicts that, on average, each championship increases team value increases by $66 million. This result makes sense that successful teams win more championships tend to be more valuable than teams with fewer titles. Yet, the value of the coefficient is lower than expected. We come up with two possible explanations for this effect. Firstly, the impact of a championship on team value should not be huge if the team's performance is controlled. Secondly, winning a title has a diminishing marginal effect. The first championship should increase team value by more than the seventeenth championship would increase.

The coefficient for GDP per capita is highly significant and in line with the hypothesis. For every $1000 increase in the home city's GDP per capita, the team's value goes up by $22 million. This result makes sense since this variable captures the market of the home city. From a business perspective, wealthy cities have broader markets and more opportunities and increase teams' value.

The revenue coefficient posits that every million dollars increase in revenue leads to a $2.9 million increase in a team's value. This agrees with our prediction that higher team revenue would lead to a higher team value.

Surprisingly, the variable "all-star" is positive but insignificant in our model. The exact number of all-star players in each team is small, so isolating the value an additional all-star player adds is difficult. Meanwhile, a team full of all-stars should be much more valuable than a non-all-star team.

Finally, the team's performance indicators seem to have less impact on the team's value than non-performance variables.

**Section 5: Conclusion**

This project sought to estimate NBA team values with performed-based and economy based indictors. Fixed effect regression tends to be the optimal model.

The results showed that NBA teams' value (lagged by one season), championships count, team revenue, GDP per capita, and home city population all significantly influence the team value. Also, the average number of turnovers has a significantly negative impact on teams' value.

We believe that insights from this model could help managers and owners streamline their decision-making and serve as a premise for future research in the area. For example, team managers should consider cities with a higher population and higher GDP per capita in terms of relocation. Also, our study could help team managers to generate other strategies to increase team revenue.

Though the fixed effects model is considered the best model, we do recognize that it has certain flaws, including but not limited to endogeneity, heteroskedasticity, and serial correlation.

One of the fundamental causes for endogeneity in our model is omitted variable bias due to data unavailability. We did not have access to data such as average dunk per game, "brand value" of teams/players, elevision contracts information, which may also be essential determinants of teams' value. Missing these variables could result in biased coefficients and a higher error term. Another possible source of endogeneity is the unbalanced nature of our data. We tried to mitigate this issue by estimating missing data with the average growth rates of other teams.

We also observed heteroskedasticity in our model and fixed it by using robust standard errors. The serial correlation was mitigated by taking a lag of value. A lag of two periods would correct the issue, but data limitation tied our hands.

**Data Sources**

NBA All-Star Game. (2018). https://www.basketball-reference.com/allstar/NBA_2018.html

NBA Attendance. (2018). http://www.espn.com/nba/attendance/_/year/2018/order/false

NBA Team List. (2018). http://www.stat-nba.com/teamList.php

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Statista - The Statistics Portal. (2018). https://www.statista.com/search/?q=nba+team+value

**Bibliography**

Bonnal et al., (2013). “Determinants of Professional Sports Firm Values in the United States and Europe: A Comparison Between Sports over the Period 2004-2011”. International Journal of Sport Finance, West Virginia University.

Liedekerke. (2017). “Determinants of Franchise Value in the National Basketball Association” Duke University.

Stock, James H, & Watson, Mark W (2015). “Introduction to Econometrics. 3rd ed. New Jersey: Pearson Education, Inc.”

Torres-Reyna, O. (2007). Panel Data Analysis Fixed and Random Effects using Stata (v. 4.2) [Ebook]. Princeton University. https://www.princeton.edu/~otorres/Panel101.pdf

Williams, R. (2018). "Panel Data and Multilevel Models for Categorical Outcomes: Fixed Effects Versus Random Effects Models". [Ebook]. Princeton University. https://www3.nd.edu/~rwilliam/Taiwan2018/FixedVsRandom.pdf.

Wooldridge, Jeffery M (2016). “Introductory Econometrics. 5th ed. Boston, MA, USA: Cengage Learning.”

# Appendix

## Appendix I Variable Selection

Table 1.1 Preliminary variables

| Variable | Meaning | Expected Influence |
|---|---|---|
| Value (dependent variable) | NBA team value | + |
| Gdppercapita | GDP per capita of the home city | + |
| Population | Population of the city | + |
| History | How long the team has been in the current home city | + |
| Championship | Number of championships in history | + |
| Salary | Total salary of players in the team | + |
| Allstar | Number of All-star players in the team | + |
| Win | Win percentage in a regular season | + |
| Point | Team's average points per game | + |
| Assist | Team's average assists per game | + |
| Turnover | Team's average turnover per game | - |
| Attendancerate | Average number of attendances at home court | + |
| Revenue | Revenue that the team creates | + |
| East | Whether the team belongs to the East or West | + |
| Team | 30 NBA teams | NA |
| Season | NBA seasons from 13-17 | NA |

Table 1.2 Selected variables in final model and sources

| Variable | Meaning | Source |
|---|---|---|
| Value (dependent variable) | NBA team value | https://www.forbes.com/nba-valuations/list/#tab:overall |
| Population | Population of the city | https://factfinder.census.gov/faces/nav/jsf/pages/index.xhtml |
| History | How long the team has been in the city | https://baike.baidu.com/item/NBA#2_1 |
| Championship | Number of championships | https://stats.nba.com/teams/ |
| Allstar | Number of All-star players in the team | https://www.basketball-reference.com/allstar/NBA_2018.html |
| Win | Win percentage in a regular season | http://www.stat-nba.com/teamList.php |
| Point | Team's average points per game | http://www.stat-nba.com/teamList.php |
| Assist | Team's average assists per game | http://www.stat-nba.com/teamList.php |
| Turnover | Team's average turnover per game | http://www.stat-nba.com/teamList.php |
| Attendancerate | Average number of attendances at home court | http://www.espn.com/nba/attendance/_/year/2013/order/false |
| Revenue | Revenue that the team creates | https://www.statista.com/search/?q=nba+team+value |
| Gdppercapita | GDP per capita of the home city | Fed Reserve Bank |
| East | Whether the team belongs to the East or West | NBA official website |
| Team | 30 NBA teams | NBA official website |
| Season | NBA seasons from 13-17 | NA |

Table 1.3 Type of Variables

| Variable | Type |
|---|---|
| Value<br>(dependent variable) | Numerical variable |
| Gdppercapita | Numerical variable |
| Population | Numerical variable |
| History | Numerical variable |
| Championship | Numerical variable |
| Allstar | Numerical variable |
| Win | Numerical variable |
| Point | Numerical variable |
| Assist | Numerical variable |
| Turnover | Numerical variable |
| Attendancerate | Numerical variable |
| Revenue | Numerical variable |
| East | Dummy variable<br>1: East, 0: West |
| Team | Categorical Variable<br>Including:<br>ATL, BOS, BRO, CHA, CHI, CLE, DAL, DEN, DET, GSW,<br>HOU, IND, LAC, LAL, MEM, MIA, MIL, MIN, NOP, NYK,<br>OKL, ORL, PHI, PHX, POR, SAC, SAS, TOR, UTA, WAS, |
| Season | Categorical Variable<br>Including:<br>Season 13, season 14, season 15, season 16, season 17 |

**Appendix II Variable Distribution**

Table 2.1: Details of numerical and dummy variables

| Varivable Name | Observation | Mean | S.D | Min | Max |
|---|---|---|---|---|---|
| Season | 150 | NA | NA | NA | NA |
| Value | 150 | 970 | 600 | 312 | 3,300 |
| 3pattempt (dropped) | 150 | 23 | 5 | 14 | 40 |
| Assist | 150 | 22 | 2 | 18 | 30 |
| Turnover | 150 | 14 | 1 | 11 | 17 |
| Point | 150 | 101 | 5 | 92 | 116 |
| Win | 150 | 50 | 16 | 12 | 89 |
| Allstar | 150 | 1 | 1 | 0 | 4 |
| Salary (dropped) | 150 | 8,629 | 1,983 | 5,336 | 13,934 |
| History | 150 | 37 | 17 | 1 | 71 |
| Championship | 150 | 2 | 4 | 0 | 17 |
| Population | 150 | 1,692,497 | 2,109,589 | 191,697 | 8,622,698 |
| GDP Per Capita | 150 | 58,301 | 10,226 | 41,113 | 89,978 |
| Attendence rate | 150 | 17,660 | 1,926 | 13,487 | 21,876 |
| Revenue | 150 | 183 | 56 | 109 | 426 |

Table 2.2 Details of Categorical Variables

| Variable | Observation | Value | Frequency | Percent | Cum.Percent |
|---|---|---|---|---|---|
| Season | 150 | 2013 | 30 | 0.2 | 0.2 |
| | | 2014 | 30 | 0.2 | 0.4 |
| | | 2015 | 30 | 0.2 | 0.6 |
| | | 2016 | 30 | 0.2 | 0.8 |
| | | 2017 | 30 | 0.2 | 1 |

**Appendix III Variable Plots**

Figure 1: Correlation Plot

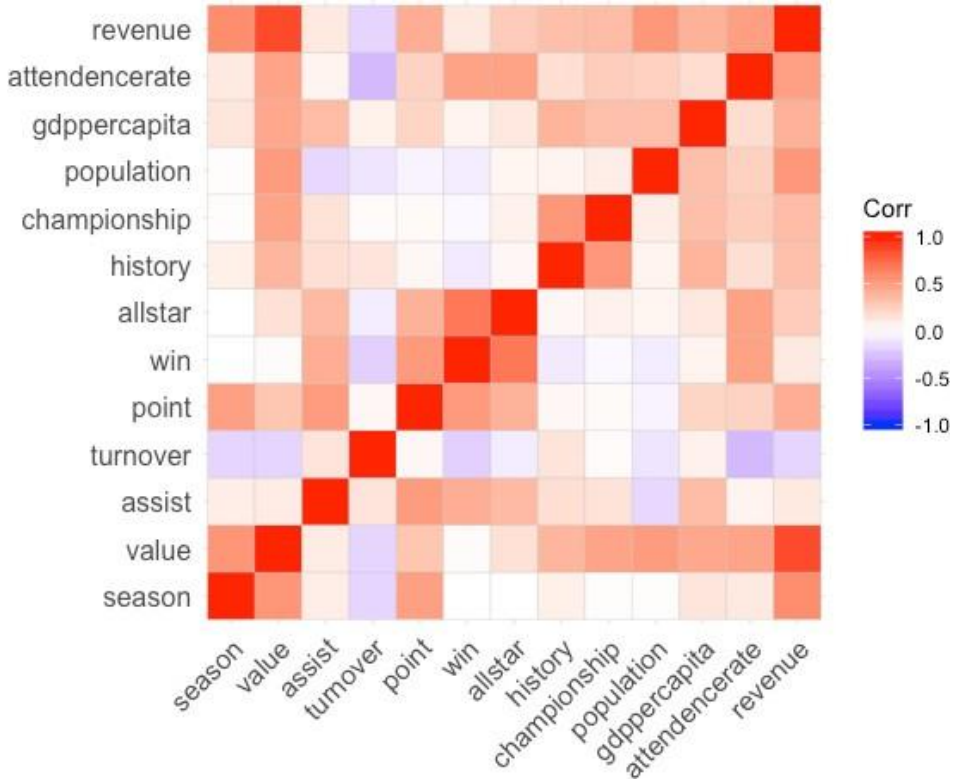



Figure 2: Plot of Team Value by Revenue, 2013-2017

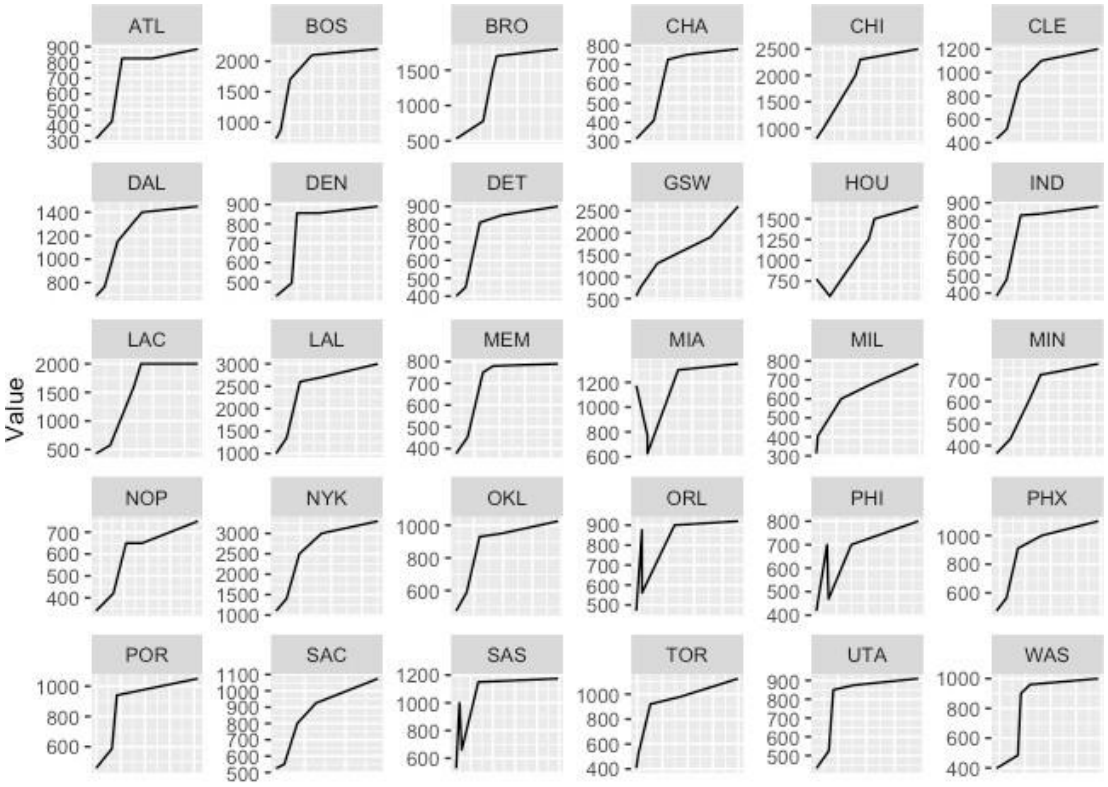


Figure 3: Plot of Team Value by Win, 2013-2017

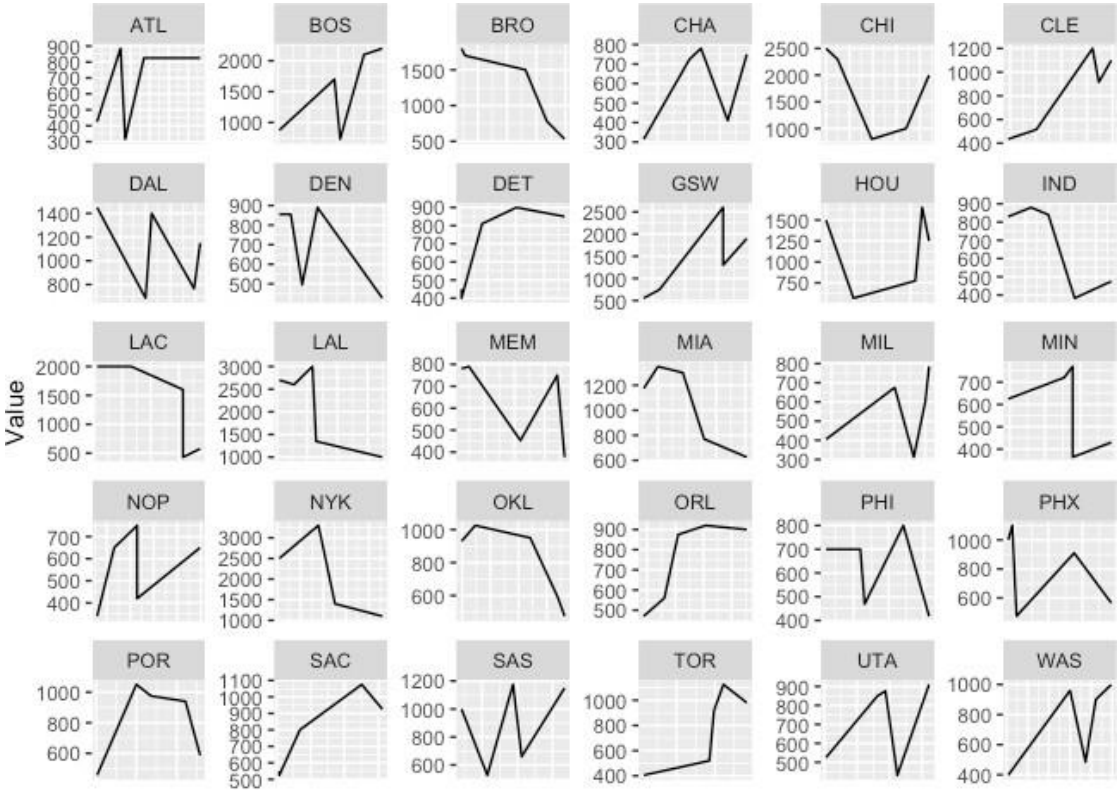



Figure 4: Plot of Team Value by Turnover, 2013-2017

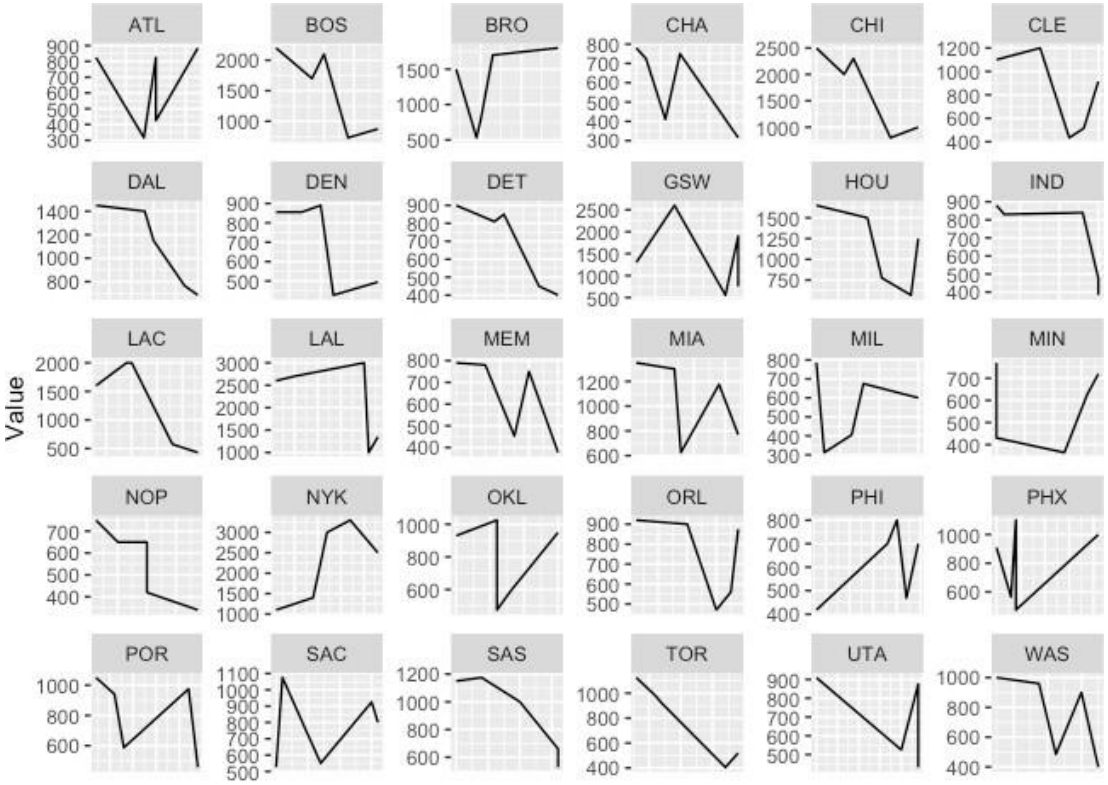


Figure 5: Plot of Team Value by All-star, 2013-2017

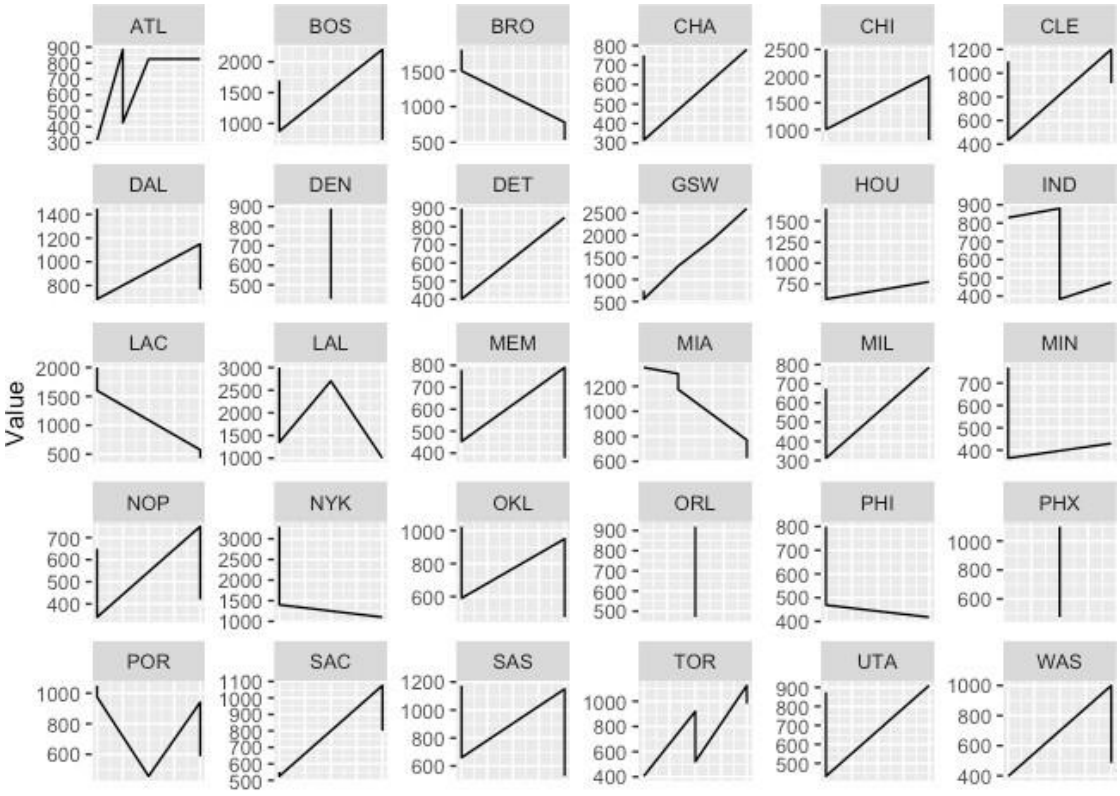



Figure 6: Plot of Team Value by History, 2013-2017

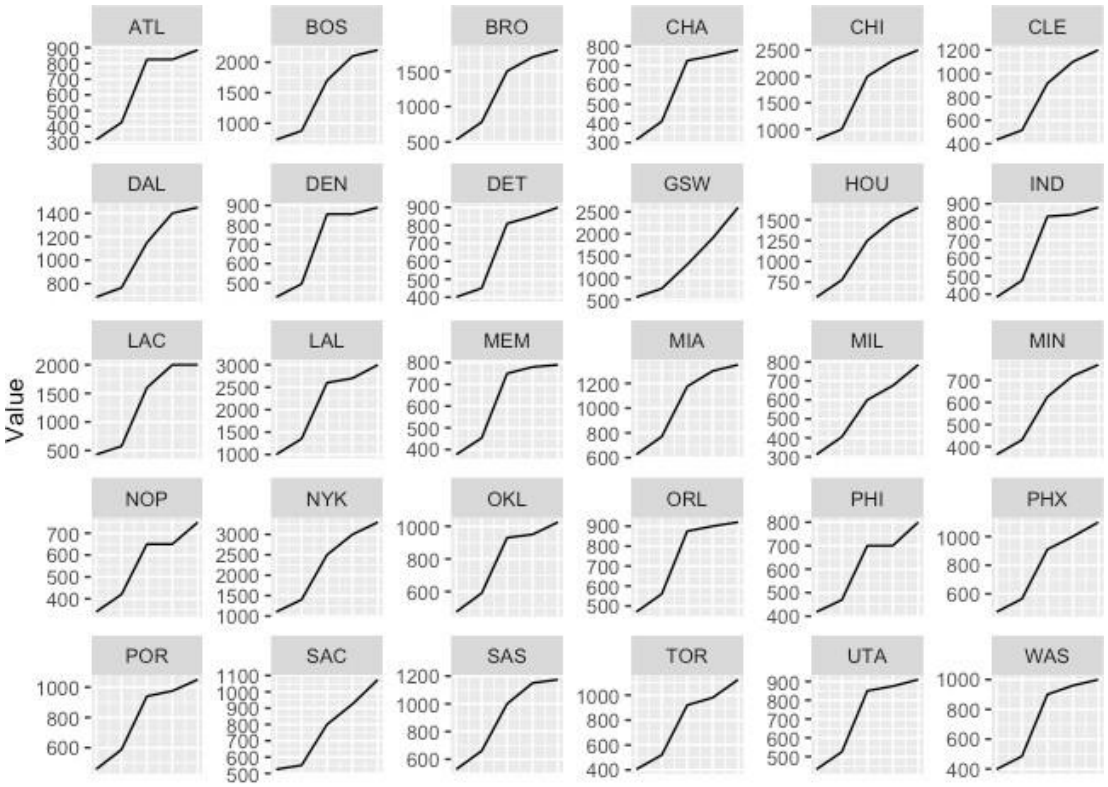


Figure 7: Plot of Team Value by Point, 2013-2017

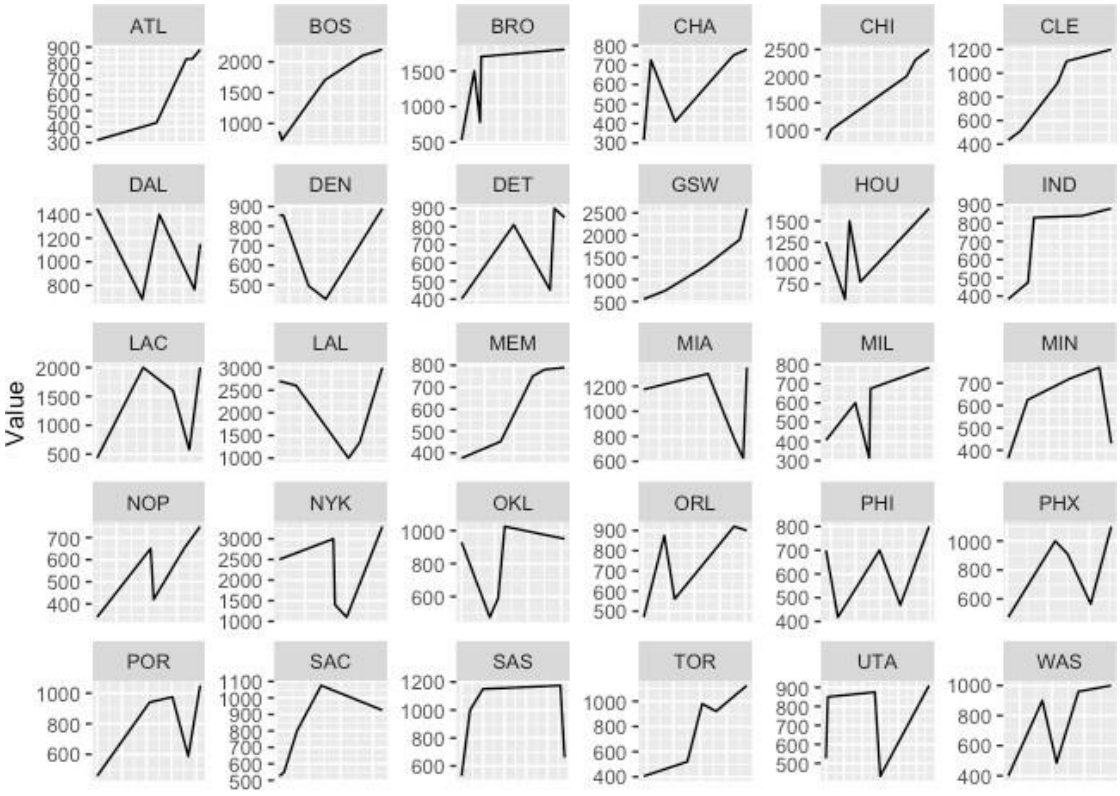



Figure 8: Plot of Team Value by Championship, 2013-2017

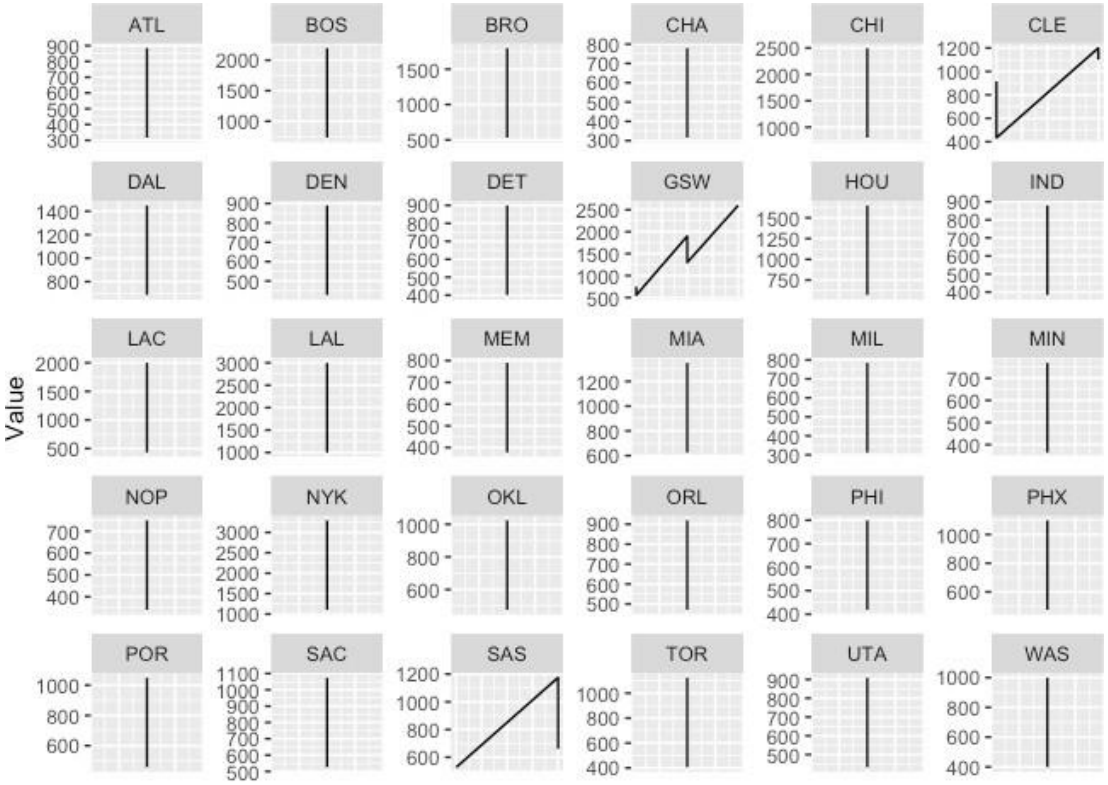


Figure 9: Plot of Team Value by GDP per capita, 2013-2017

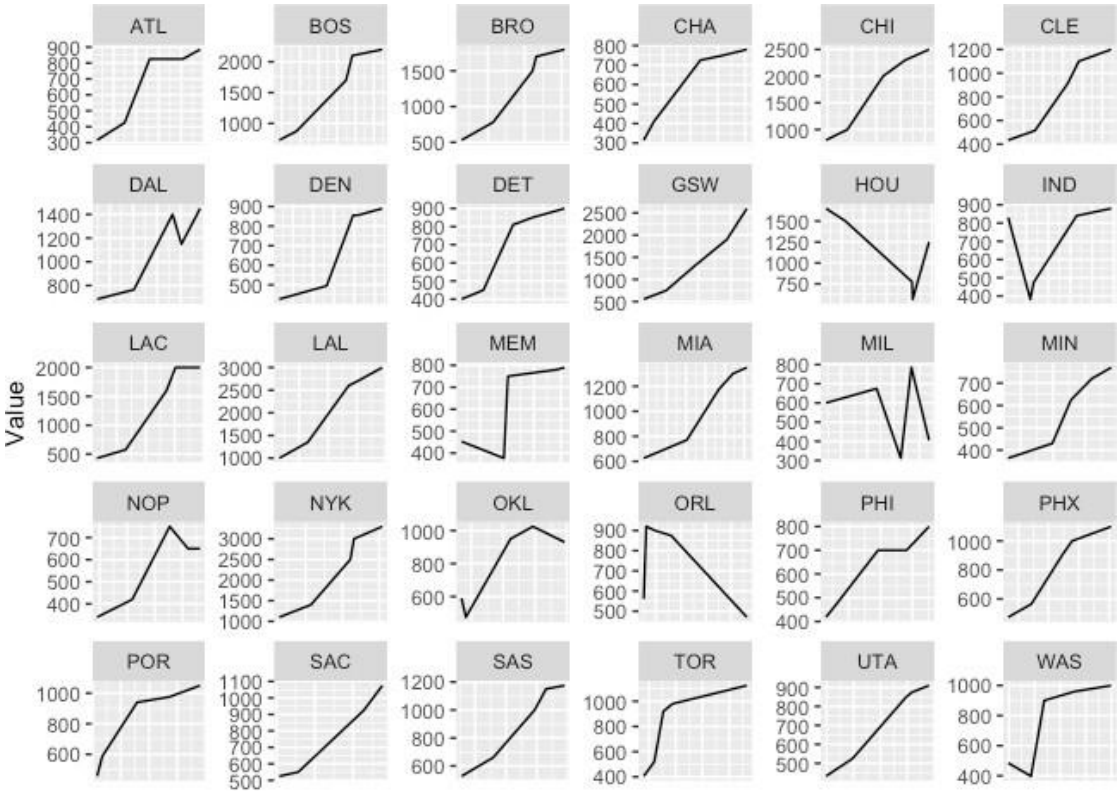
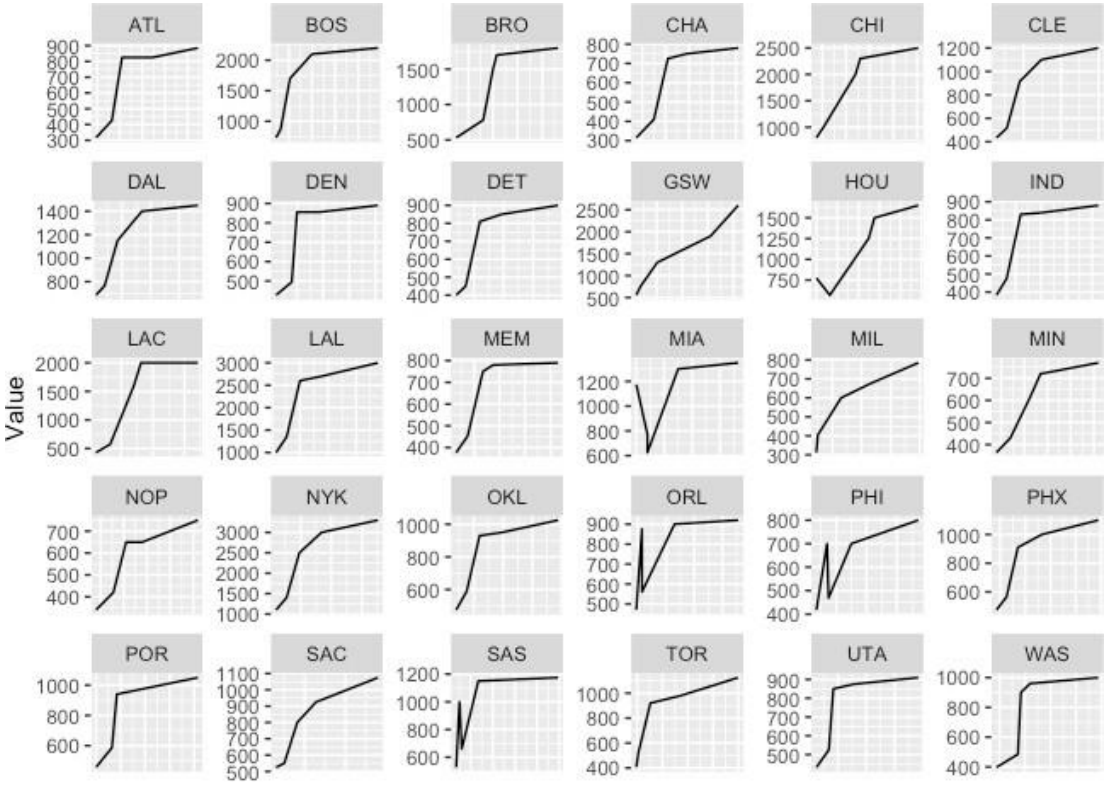



Figure 10: Plot of Team Value by Revenue, 2013-2017



**Appendix IV Estimated Regression Model**

Table 4.1: Estimated Regression model

| Variable | Coefficient and standard error |
|---|---|
| NBA team value (Lag one season) | 0.680***<br>(0.046) |
| Team's average assists per game | 20.677<br>(12.772) |
| Team's average turnover per game | -57.825***<br>(20.219) |
| Team's average points per game | 2.813<br>(7.899) |
| Win percentage in a regular season | -2.184<br>(1.532) |
| Number of All-star players in the team | 4.385<br>(19.575) |
| How long the team has been in current home city | -65.479***<br>(19.183) |
| Number of championships in history | 65.625**<br>(31.066) |
| Population | 0.001*<br>(0.001) |
| GDP per capita of the home city | 0.022***<br>(0.008) |
| Average number of attendances at home court | -0.008<br>(0.017) |
| Revenue that the team creates | 2.973***<br>(0.601) |
| Team | Yes |
| Seasons | Yes, as categorical variable |
| East/West Side | Yes |
| Constant | Yes |
| Observations | 120 |
| R-Square | 0.932 |
| Adjusted R-Square | 0.893 |
| Note: | *p<0.1; **p<0.05; ***p<0.01 |