

STAT 684

# NFL Ticket Prices

Professional Internship Report

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## Research Goals and Objectives

Given the recent success of the San Francisco 49ers in the 2019 season, the author wanted to attend a game in person. However, tickets were discovered to be surprisingly expensive. The purpose of this research was set out to discover how broadly NFL ticket prices varied between teams, and why some may cost more than others.

## Data Collection

Data was collected for a specific season of divisional play. The year was 2014. Divisional play consists of games between teams within the same division. The NFL has 8 division with 4 teams each. Every team plays every other team in its division twice, home and away, every season, for a total of 6 divisional games. The other 10 games per season, per team, are not included in this data set. Because these games are played consistently, fan excitement is expected to be more consistent season over season. Table 1 contains a sample of this data set, containing the Home Team, Away Team, Date, Division, and Average Ticket Price.

Table 1

Event	Division	Avg TP, \$
Baltimore Ravens at Pittsburgh Steelers Tickets on 02-Nov-2014 (9037819)	AFC North	202
Pittsburgh Steelers at Baltimore Ravens Tickets on 11-Sep-2014 (9037835)	AFC North	199
Cleveland Browns at Pittsburgh Steelers Tickets on 07-Sep-2014 (9037806)	AFC North	196
Cincinnati Bengals at Pittsburgh Steelers Tickets on 28-Dec-2014 (9037828)	AFC North	164
Pittsburgh Steelers at Cleveland Browns Tickets on 12-Oct-2014 (9037890)	AFC North	148
Cleveland Browns at Baltimore Ravens Tickets on 28-Dec-2014 (9037845)	AFC North	137
Cincinnati Bengals at Baltimore Ravens Tickets on 07-Sep-2014 (9037833)	AFC North	135
Cleveland Browns at Cincinnati Bengals Tickets on 06-Nov-2014 (9037858)	AFC North	102
Pittsburgh Steelers at Cincinnati Bengals Tickets on 07-Dec-2014 (9037859)	AFC North	89
Baltimore Ravens at Cleveland Browns Tickets on 21-Sep-2014 (9037889)	AFC North	83
Baltimore Ravens at Cincinnati Bengals Tickets on 26-Oct-2014 (9037854)	AFC North	83

To augment this data set, and provide contributing factors, additional information was procured from the website [www.pro-football-reference.com](http://www.pro-football-reference.com). That factor data was then joined to the initial data for either the Home Team or the Away (visiting) Team. Data sets included, for each team:

- Super Bowl wins, losses, and total games played through the 2013 season
- Season wins and losses for the 2013 season
- 2013 attendance numbers, which were then sorted for each team's Home and Away average attendance.

Subsets of each data set are included in Table 2, Tables 3 and 4, and Table 5, respectively.

Table 2

Rk	Tm	G	W	L
1	Pittsburgh Steelers	8	6	2
2	New England Patriots	7	3	4
3	San Francisco 49ers	6	5	1
4	Dallas Cowboys	8	5	3
5	Green Bay Packers	5	4	1
6	New York Giants	5	4	1
7	Oakland Raiders	5	3	2
8	Washington Redskins	5	3	2
9	Denver Broncos	7	2	5
10	Baltimore Ravens	2	2	0
11	Indianapolis Colts	4	2	2
12	Miami Dolphins	5	2	3
13	New Orleans Saints	1	1	0
14	New York Jets	1	1	0
15	Tampa Bay Buccaneers	1	1	0
16	Chicago Bears	2	1	1
17	Kansas City Chiefs	2	1	1
18	Philadelphia Eagles	2	0	2
19	Seattle Seahawks	2	1	1
20	St Louis Rams	3	1	2
21	Buffalo Bills	4	0	4
22	Minnesota Vikings	4	0	4
23	Atlanta Falcons	1	0	1
24	Carolina Panthers	1	0	1
25	Cincinnati Bengals	2	0	2
26	Arizona Cardinals	1	0	1
27	Tennessee Titans	1	0	1
28	San Diego Chargers	1	0	1

Super Bowl Standings Prior to the 2014 season

Table 3 and Table 4

Tm	W	L	T	Tm	W	L	T
New England Patriots	12	4	0	Philadelphia Eagles	10	6	0
New York Jets	8	8	0	Dallas Cowboys	8	8	0
Miami Dolphins	8	8	0	New York Giants	7	9	0
Buffalo Bills	6	10	0	Washington Redskins	3	13	0
Cincinnati Bengals	11	5	0	Green Bay Packers	8	7	1
Pittsburgh Steelers	8	8	0	Chicago Bears	8	8	0
Baltimore Ravens	8	8	0	Detroit Lions	7	9	0
Cleveland Browns	4	12	0	Minnesota Vikings	5	10	1
Indianapolis Colts	11	5	0	Carolina Panthers	12	4	0
Tennessee Titans	7	9	0	New Orleans Saints	11	5	0
Jacksonville Jaguars	4	12	0	Atlanta Falcons	4	12	0
Houston Texans	2	14	0	Tampa Bay Buccaneers	4	12	0
Denver Broncos	13	3	0	Seattle Seahawks	13	3	0
Kansas City Chiefs	11	5	0	San Francisco 49ers	12	4	0
San Diego Chargers	9	7	0	Arizona Cardinals	10	6	0
Oakland Raiders	4	12	0	St Louis Rams	7	9	0

Win/Loss/Tie Record for each AFC team (Table 3) and NFC team (Table 4)

Table 5

Tm	Total	Home	Away	Week 1	Week 2	Week 3	Week 4
Arizona Cardinals	997710	488271	509439	55279	60034	73057	44956
Atlanta Falcons	1080805	561795	519010	72348	70056	70660	70744
Baltimore Ravens	1106022	569084	536938	76977	71098	71168	68296
Buffalo Bills	1032476	502842	529634	69519	67819	76957	68296
Carolina Panthers	1112229	587544	524685	73294	67819	73748	Bye
Chicago Bears	1057075	498864	558211	62213	62181	61575	64552
Cincinnati Bengals	1001806	506377	495429	62213	64585	64633	71481
Cleveland Browns	1122750	569939	552811	71513	71098	63672	71481
Dallas Cowboys	1279578	704345	575233	85348	76952	80848	68601
Denver Broncos	1194145	614977	579168	76977	81285	76978	77002
Detroit Lions	1053841	510369	543472	62461	60034	80111	64552
Green Bay Packers	1191205	623577	567628	69732	78020	64633	Bye
Houston Texans	1103683	573271	530412	59522	71718	71168	71756

Attendance for each game, by team and week, with Total, Home, and Away averages

Additional data could be informative as well. Metropolitan financial data and demographics would be particularly interesting, however data collection for these metrics quickly proved to be out of the scope of this project.

### Statistical Methods

The collected data sets were pared down to non-overlapping factors:

- Y = Ticket Price
- Home Team Super Bowl Wins – Home.SB.W
- Home Team Super Bowl Total Games – Home.SB.G
- Home Team 2013 Win Percentage – Home.2013.Wp
- Home Team Average Home Game Attendance – Home.2013.Att
- Away Team Super Bowl Wins – Away.SB.W
- Away Team Super Bowl Total Games – Away.SB.G
- Away Team 2013 Win Percentage – Away.2013.Wp
- Away Team Average Away Game Attendance – Away.2013.Att

A linear regression model was fit to all available factors using R.

```
lm(Price ~ Home.SB.W + Home.SB.G + Home.2013.Wp +  
    Home.2013.Att + Away.SB.W + Away.SB.G +  
    Away.2013.Wp + Away.2013.Att)
```

With the following results:

Residuals:

Min	1Q	Median	3Q	Max
-107.687	-32.967	0.471	24.562	259.294

Coefficients:

	Estimate	Std. Error	t value	Pr(> t )	
(Intercept)	-6.009e+02	1.760e+02	-3.414	0.000974	***
Home.SB.W	1.274e+01	6.607e+00	1.928	0.057066	.
Home.SB.G	-7.307e+00	4.950e+00	-1.476	0.143462	
Home.2013.Wp	1.669e+02	3.404e+01	4.903	4.34e-06	***
Home.2013.Att	1.439e-04	1.051e-04	1.369	0.174493	
Away.SB.W	9.644e+00	6.414e+00	1.504	0.136275	
Away.SB.G	-1.564e+00	4.738e+00	-0.330	0.742120	
Away.2013.Wp	4.406e+01	3.374e+01	1.306	0.195037	
Away.2013.Att	9.980e-04	3.060e-04	3.261	0.001585	**

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Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 58.02 on 87 degrees of freedom

Multiple R-squared: 0.427, Adjusted R-squared: 0.3744

F-statistic: 8.105 on 8 and 87 DF, p-value: 4.029e-08

Afterward, all subsets of the full model were compared using the BIC model selection metric. This was accomplished with the dredge function from the R module “MuMIn”. A linear regression model was selected based on the minimum BIC value. The selected model used only 3 of the factors:

- Home Team 2013 Win Percentage – Home.2013.Wp
- Away Team Super Bowl Wins – Away.SB.W
- Away Team Average Away Game Attendance – Away.2013.Att



```
lm(Price ~ Home.2013.Wp + Away.SB.W + Away.2013.Att)
```

With these following results:

Residuals:

	Min	1Q	Median	3Q	Max
	-116.590	-32.074	-8.185	28.877	254.435

Coefficients:

	Estimate	Std. Error	t value	Pr(> t )	
(Intercept)	-5.711e+02	1.314e+02	-4.346	3.57e-05	***
Home.2013.Wp	1.654e+02	3.144e+01	5.261	9.30e-07	***
Away.SB.W	8.019e+00	3.496e+00	2.294	0.0241	*
Away.2013.Att	1.119e-03	2.372e-04	4.718	8.47e-06	***

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Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 58.87 on 92 degrees of freedom

Multiple R-squared: 0.3762, Adjusted R-squared: 0.3559

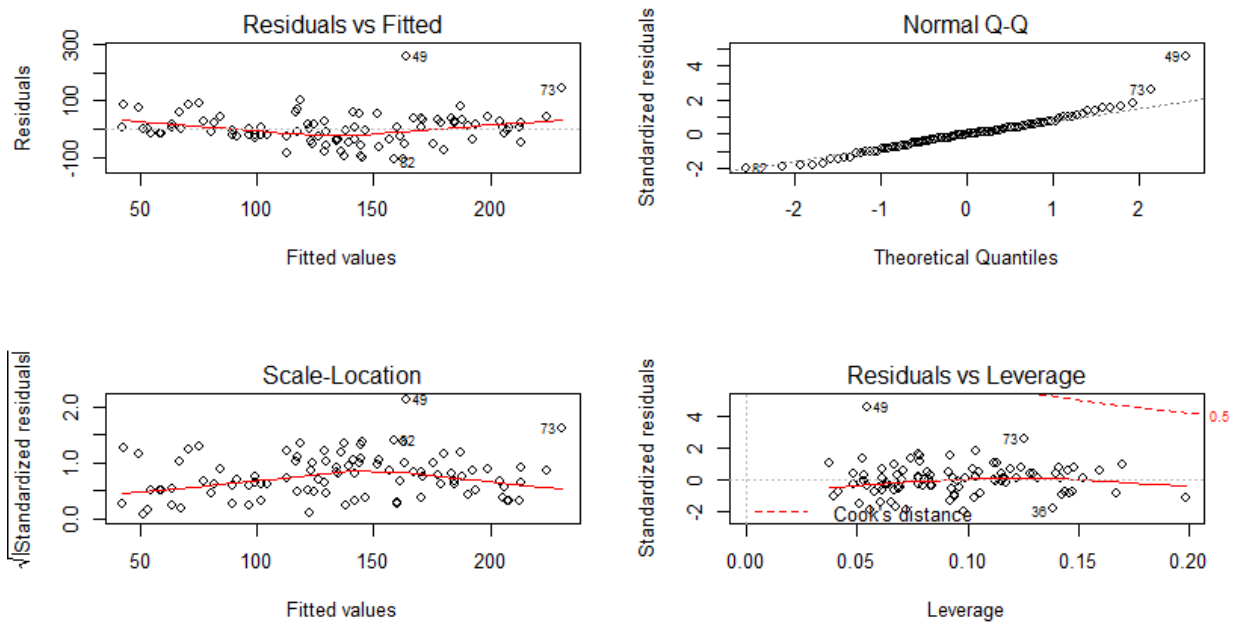
F-statistic: 18.49 on 3 and 92 DF, p-value: 1.797e-09

## Statistical Analysis

The All Factors Model yielded residual plots that indicate a fairly good fit, albeit with 2 outliers, as shown in Diagram 1. The square roots of the standardized residuals remain fairly flat across fitted values, indicating an appropriate fit. There is a peak in the middle, but it is not very pronounced. The Q-Q plot is fairly consistent throughout the middle part of the fitted values, only tailing out at extreme values, also indicating an appropriate fit.

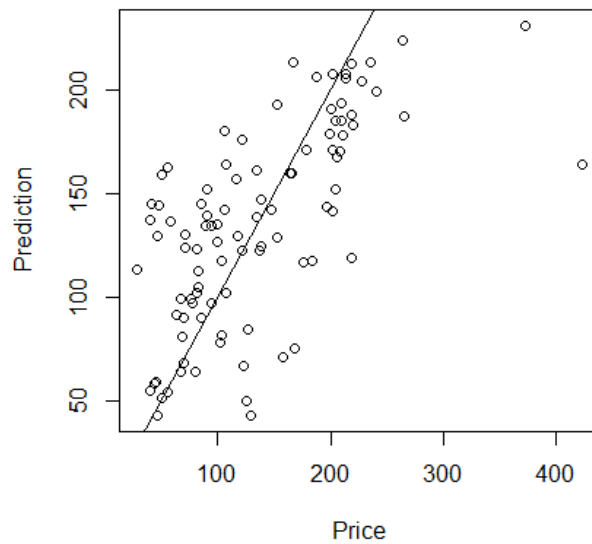
Diagram 2 shows the predicted values compared to the real values, and how well correlated the values are against the fitted line. There is some unexplained variation, but the fitted line appears to be appropriate.

Diagram 1



Residual Plots for the All Factors Model

Diagram 2

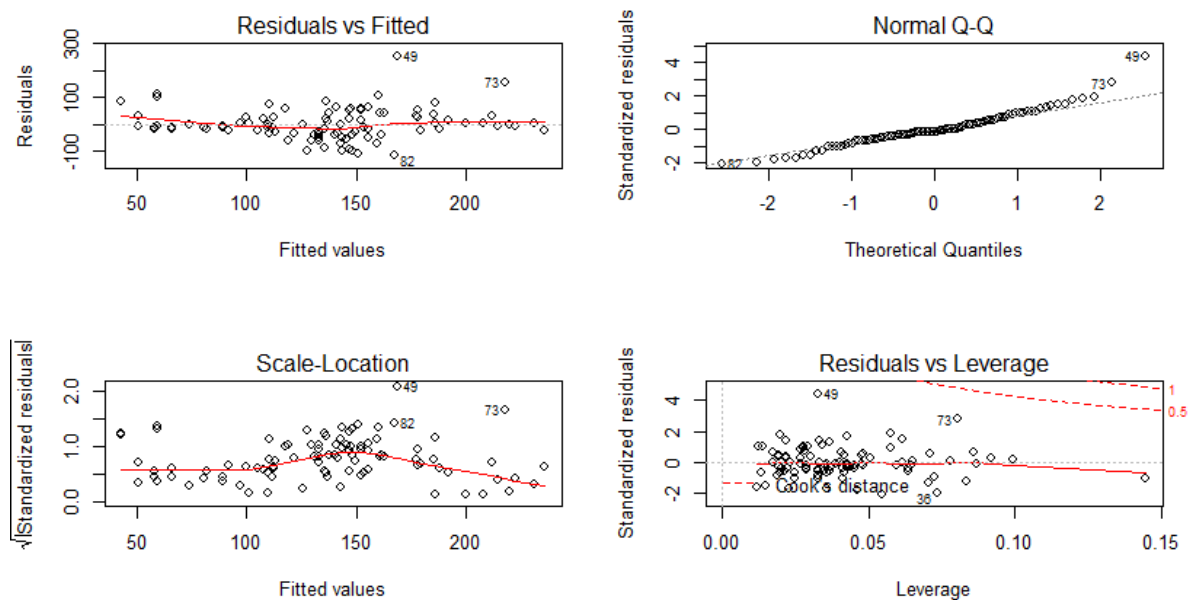


Correlation Plot between All Factors Model Predictions and Actual Ticket Prices

Diagram 3 and Diagram 4 show very similar relationships for the BIC-selected model as the All Factors Model. The peak in the standardized residuals values is slightly more pronounced, but the diagnostics for both models are very similar. The BIC-selected model appears to be similarly appropriate, and account for most of the variation also accounted for in the All Factors Model.

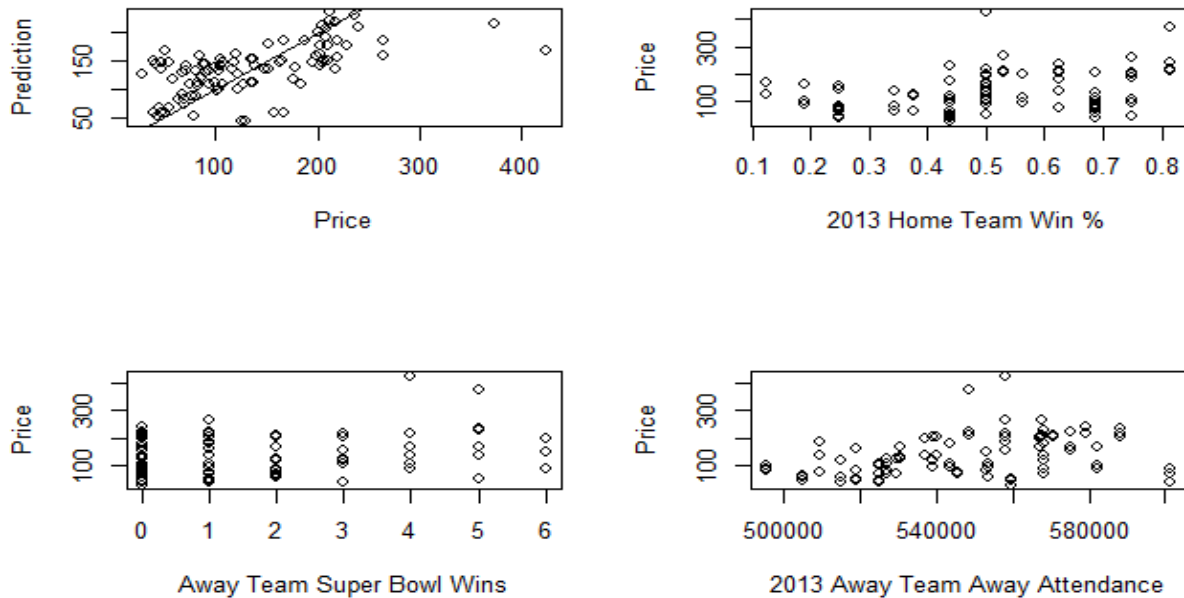
Additionally, Diagram 4 shows the correlation plot between the BIC-selected Model Predictions and the Actual Ticket Prices, plus plots for each of the 3 selected factors, individually compared to the Actual Ticket Prices.

Diagram 3



Residual Plots for the BIC-selected Model

Diagram 4



Correlation Plot between BIC-selected Model Predictions and Actual Ticket Prices, also  
 Price compared to factors in the BIC-selected Model Predictions

Finally, some descriptive statistics of the Price of the tickets is posted here, to be referenced in the next section:

Min.	1st Qu.	Median	Mean	3rd Qu.	Max.
29.00	79.25	121.50	135.23	199.50	423.00

### Research Summary & Interpretation

Two major outliers in the data are unexplained by the model. The highest price belongs to the Green Bay Packers at the Chicago Bears on September 28, 2014. The average ticket price was \$423. The second highest price was for the game featuring the San Francisco 49ers at the Seattle Seahawks. That price was \$373.

The third and fourth most expensive tickets were between the same teams, but at the other teams' Home stadiums. However, those 2 games were not outliers.

These are major rivalry games, but there are other major rivalry games, with playoff implications, that were not outliers for the model. Still, an interesting factor to include would be whether a game is a rivalry game, or whether the game has playoff implications. These are both difficult factors to quantify, particularly the latter, since playoff implications become more clear as the season progresses.

The 3 selected factors can be viewed as follows:

- Away Team Super Bowls won: Visiting team's prestige
- Away Team Away Attendance: Visiting team's excitement factor
- Home Team Win %: Likelihood for the home team to win

An increase in these 3 factors shows a correlation for an increase in ticket price.

These 3 factors make sense for explaining ticket prices. Fans are more likely to want to see a game against an exciting or prestigious opponent. Away Team Away Attendance could also be an indicator for how well a team "travels" to away games. A higher win percentage in the previous season is expected to be a strong indicator for fan excitement in their home team. A better team is more exciting, and that should entice more fans to come see the games. More demand with fixed supply means higher prices.

Finally, the best indicator for ticket prices is likely to be previous year's ticket prices. However, this relationship is not insightful, and does not serve as an answer as to why some teams have more expensive tickets than others.

## Data Sources

- <https://www.kaggle.com/fivethirtyeight/fivethirtyeight-nfl-ticket-prices-dataset/version/106>
- <https://www.pro-football-reference.com/years/2013/>
- <https://www.pro-football-reference.com/super-bowl/standings.htm>
- <https://www.pro-football-reference.com/years/2013/attendance.htm>