

# Association of Domed Stadium to Winning NFL Games

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## Abstract

Several teams in the National Football League (NFL) play their home games in domed stadiums. Because of the rarity of a domed stadium, these teams may have advantages when playing at home. Meanwhile, they may have disadvantages when playing away from home due to unfamiliarity with playing outside. The aim of this study is to examine whether type of home stadium is associated with winning the NFL games at home and away from home. Winning percentages at home and away from home for each NFL team in the past five NFL regular seasons were analyzed based on type of home stadium (domed vs. outdoor) by using a rank regression analysis, while adjusting for quality of offense and defense as well as strength of schedule. The results revealed that playing in a domed stadium at home did not appear to provide significant advantages in terms of winning NFL games. On the other hand, the teams with domed home stadiums won significantly fewer games away from home than did the teams with outdoor home stadiums ( $p < 0.05$ ). These results suggest that the teams that play in domed stadiums at home may need extra preparation for the game when playing in outdoor stadiums away from home.

**Key Words:** rank regression, National Football League (NFL), domed stadium, outdoor stadium

## 1. Introduction

In the modern era of professional sports, we see more domed stadiums, and the National Football League (NFL) is no exception. As of 2013, of the 32 NFL teams, five of them (Atlanta Falcons, Detroit Lions, Minnesota Vikings, New Orleans Saints, and St. Louis Rams) play in a domed stadium at home, and another four teams (Arizona Cardinals, Dallas Cowboys, Houston Texans, and Indianapolis Colts) play in a retractable home stadium where the roof can be opened or closed [1, 2]. There are several differences to take into account when playing in a domed stadium compared to playing in a traditional outdoor stadium, including temperature, wind, turf condition, and noise by a home crowd.

In the 2013 NFL season, it was rumored that Payton Manning of the Denver Broncos did not play well in cold weather [3]. He spent the first 13 seasons of his NFL career in a domed home stadium (RCA Dome and Lucas Oil Stadium, Indianapolis, IN), and then played the past two seasons in an outdoor home stadium (INVESCO Field at Mile High, Denver, CO) [4]. According to Ruby [3], Payton Manning's performance is worse in cold weather conditions when the temperature is 40°F or below. Table 1 (recreated from the information provide by Ruby [3]) compares his career statistics and statistics in cold

weather. His winning percentage in such condition is 0.478 (vs. career winning percentage of 0.693), and his quarterback rating is 86.2 (vs. 96.9 in his career) with the difference of 10.7 ( $p = 0.066$ ).

**Table 1:** Peyton Manning's Statistics in Career vs. Cold Weather

	Career	Cold Weather <sup>a</sup>	Difference
Win%	0.693	0.478	0.215
Completion%	65.4	63.1	2.3
Yards per Attempt	7.7	7.5	0.2
Quarterback Rating	96.9	86.2	10.7*

Note: Win% = winning percentage; Completion% = pass completion percentage

<sup>a</sup> ≤ 40°F; 23 games in total

\*  $p = 0.066$

Because of the rarity of a domed stadium, the teams with domed home stadiums may have advantages when playing at home. Meanwhile, these teams may have disadvantages if they play away from home owing to unfamiliarity with playing outside. A previous report indicated that there were advantages of playing home games in a domed stadium for better team performance in the NFL [5]. Table 2 lists the winning percentages at home and away from home for the five NFL teams currently playing in a domed home stadium during a 10-year period (data obtained from Sporting Charts [6]). It is not apparent from this table that these teams play better at home and worse away from home than do the rest of the teams. The aim of this study is to further examine whether type of home stadium is associated with winning the NFL games at home and away from home.

**Table 2:** Winning Percentages at Home and Away from Home for Five NFL Teams Playing in Domed Stadium (2002–2011 Season)

Team	Overall Win%	Home Win%	Away Win%	Difference
Atlanta Falcons	0.547	0.625	0.468	0.157
Detroit Lions	0.294	0.400	0.188	0.213
St. Louis Rams	0.350	0.438	0.263	0.175
New Orleans Saints	0.563	0.563	0.563	0.000
Minnesota Vikings	0.481	0.600	0.363	0.238
League Average	0.500	0.572	0.428	0.145

Note: Win% = winning percentage

## 2. Methods

### 2.1 Data Collection

The present study analyzed data from the 2009–2013 NFL regular seasons (= 5 years). The data for stadiums and team performance were obtained from SEZ: Stadiums [7] and PRO-FOOTBALL-REFERENCE.COM [8], respectively. Type of home stadium was classified as: domed stadium, outdoor stadium, or retractable stadium. Since the roof of a retractable stadium can be opened or closed depending on weather, it was excluded from our data analysis. Team performance was measured by winning percentage (Win%) at home and away from home. Additionally, the data for the following two variables were collected: simple rating system (SRS; team quality of offense and defense relative to

average; average = 0.0) and strength of schedule (SoS; average quality of opponent measured by simple rating system) [8].

## 2.2 Data Analysis

Descriptive statistics were calculated for Win% at home and away from home by type of home stadium (domed stadium vs. outdoor stadium). A series of rank regression analyses were performed to examine whether type of home stadium is associated with winning the NFL games at home and away from home. The independent or predictor variable was type of home stadium (dichotomous categorical variable; domed stadium vs. outdoor stadium). The dependent or outcome variable was Win% at home and away from home transformed into ranks by each season. Regression models by the standard regression method (i.e., entering all predictors in a regression model simultaneously) were developed for predicting: 1) Win% at home and 2) Win% away from home, while using SRS and SoS as covariates. A bootstrap 95% confidence interval (CI) with 1,000 iterations was calculated for each regression coefficient.

## 3. Results

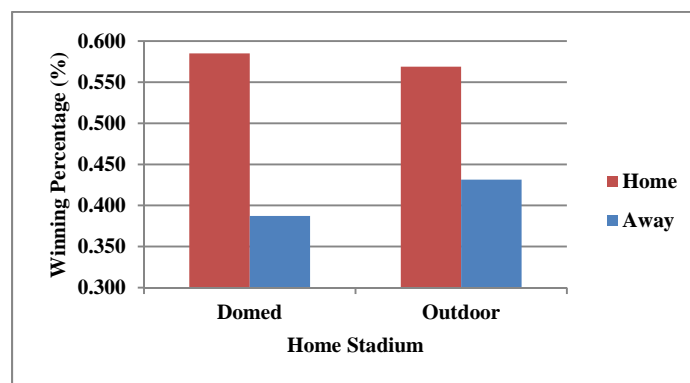
### 3.1 Descriptive Statistics

Table 3 and Figure 1 summarize Win% at home and away from home by type of home stadium. Regardless of type of home stadium, the teams won more games at home than away from home (58.5% vs. 38.7% for the teams with domed home stadiums; 56.9% vs. 43.2% for the teams with outdoor home stadiums), showing home-court advantage. Meanwhile, the difference between home wins and away wins was larger for the teams with domed home stadiums than for those with outdoor home stadiums. Specifically, the teams with domed home stadiums won an average of 1.6 games more games at home than away from home (4.7 wins vs. 3.1 wins), whereas the difference was 1.1 games for the teams with outdoor home stadiums (4.6 wins vs. 3.5 wins).

**Table 3:** Winning Percentages at Home and Away from Home by Type of Home Stadium

		Type of Home Stadium	
		Domed ( <i>n</i> = 25)	Outdoor ( <i>n</i> = 115)
Win% (Average Number of Wins)	Home	0.585 (4.7)	0.569 (4.6)
	Away	0.387 (3.1)	0.432 (3.5)

Note: Win% = winning percentage



**Figure 1:** Comparisons of Winning Percentages by Type of Home Stadium

### 3.2 Rank Regression Analysis

The results of the rank regression analysis are summarized in Table 4. Both of the two regression models were significant:  $F(3, 136) = 80.668, p < 0.01, R^2 = 0.640$ , Adjusted  $R^2 = 0.632$  for predicting Win% at home;  $F(3, 136) = 61,425, p < 0.01, R^2 = 0.575$ , Adjusted  $R^2 = 0.566$  for predicting Win% away from home. Approximately, 56.6% and 63.2% of the variability in Win% at home and away from home, respectively, were explained by type of home stadium, SRS, and SoS. Both SRS and SoS were significant predictors for Win% at home and away from home ( $p < 0.05$ ). Specifically, SRS accounted for more than half of the variability in Win% in the two regression models ( $sr^2 = 0.567$  and  $0.558$ ), while the unique contributions of SoS to the regression models were small ( $sr^2 = 0.092$  and  $0.018$ ).

The analysis revealed that type of home stadium had different effects on the two regression models. Playing in a domed home stadium was not significantly associated with Win% at home ( $p = 0.280$ ). Meanwhile, the teams with domed home stadiums had won significantly fewer games away from home than those with outdoor home stadiums ( $B = -2.098, t = -2.234, p = 0.024$ ), although its contribution to the regression model was minimal ( $sr^2 = 0.010$ ).

**Table 4:** Summary of Rank Regression Analysis of Type of Home Stadium on Predicting Winning NFL Games

	Predictor	B (SE <sup>d</sup> )	$\beta$	$p$	95% CI <sup>d</sup>	$sr^2$
Win%:	Type of Stadium <sup>c</sup>	1.214 (1.103)	0.059	0.280	-0.883 to 3.359	0.003
Home <sup>a</sup>	SRS	0.741 (0.047)	0.754	0.001	0.065 to 0.833	0.567
( $N = 140$ )	SoS	-0.301 (0.051)	-0.306	0.001	-0.401 to -0.206	0.092
Win%:	Type of Stadium <sup>c</sup>	-2.098 (0.939)	-0.101	0.024	-3.946 to -0.275	0.010
Away <sup>b</sup>	SRS	0.734 (0.054)	0.075	0.001	0.627 to 0.835	0.558
( $N = 140$ )	SoS	-0.132 (0.054)	-0.135	0.020	-0.241 to -0.024	0.018

Note: Win% = winning percentage; SRS = simple rating system; SoS = strength of schedule; B = regression coefficient; SE = standard error;  $\beta$  = standardized regression coefficient; CI = confidence interval;  $sr^2$  = squared semipartial correlation coefficient

<sup>a</sup> $F(3, 136) = 80.668, p < 0.01, R^2 = 0.640$ , Adjusted  $R^2 = 0.632$

<sup>b</sup> $F(3, 136) = 61,425, p < 0.01, R^2 = 0.575$ , Adjusted  $R^2 = 0.566$

<sup>c</sup>Reference category = outdoor home stadium

<sup>d</sup>From bootstrap sampling (1,000 samples)

## 4. Discussion

It appears that type of home stadium is not an important factor for winning the games at home in the NFL. This is not in agreement with the previous findings indicating that playing in a domed home stadium could facilitate better performance for a home team [5]. We speculate that one reason for this discrepancy in the study findings is that domed stadiums are no longer extremely rare these days, helping the teams get accustomed to playing in an indoor field. As mentioned previously, in the NFL today, more than one quarter of the teams have either domed or retractable home stadiums. Another reason could be that playing in a domed stadium makes it easier for the visiting team to prepare for the upcoming game. That is, the visiting team does not need to be concerned about factors associated with weather, such as temperature, wind, and turf condition. Consequently, the visiting team can focus on their own game plans rather than these

external factors. If these external factors could be eliminated, the visiting team might gain more benefits than the disadvantages caused by playing in an unfamiliar domed stadium.

On the other hand, the teams with domed home stadiums won significantly fewer games away from home than did the teams with outdoor stadiums in our data analysis, even after the results were adjusted for the quality of an opponent and strength of schedule. One possible explanation is temperature. A majority of the NFL regular season games are played during the winter, and on cold days, ambient temperature on the field can be well below a freezing point [9]. The teams with domed home stadiums may not be accustomed to playing under such an extremely cold temperature. These teams play half of the regular season games in a domed home stadium where temperature is well controlled and maintained throughout the game and practice. The human body needs to adjust to cold environment, and cold acclimatization does not occur in a short period of time [10]. For example, muscle contraction, reaction time, and motor skills can be impaired by exposure to low temperature [11]. Hence, the teams with domed home stadiums may have disadvantages when playing away from home, especially in a cold weather.

The limitations of our study should be mentioned. First, each NFL team plays only 16 regular season games in a single season; therefore, it may be that we did not find more apparent relationships potentially due to small sample sizes. Future research should include more data in the analysis. Second, this study used winning percentage as a measure of team performance. However, team performance can also be evaluated by other factors, such as offense and defense, and this limitation should be addressed in future research. Third, there may be other variables not included in this study that could affect the outcome of the game or team performance, such as weather condition on the actual game day, climate, and playing style (running team vs. passing team).

The results of our study indicate that playing in a domed stadium at home does not appear to provide significant advantages in terms of winning NFL games. On the other hand, the teams with domed home stadiums may have more difficult time in playing away from home than do the teams with outdoor home stadiums. The teams that play in domed stadiums at home may need extra preparation for the game when playing in outdoor stadiums away from home.

## References

- [1] SEZ: Stadiums. (n.d.). NFL Stadiums 2013. Retrieved July 24, 2014, from <http://www.southendzone.com/stadiums/2013/n/>.
- [2] WIKIPEDIA. (n.d.). List of current National Football League stadiums. Retrieved July 24, 2014, from [http://en.wikipedia.org/wiki/List\\_of\\_current\\_National\\_Football\\_League\\_stadiums](http://en.wikipedia.org/wiki/List_of_current_National_Football_League_stadiums).
- [3] Ruby, K. (2013). Does Peyton Manning play worse in cold weather? The Minitab Blog. Retrieved July 24, 2014, from <http://blog.minitab.com/blog/the-statistics-game/does-peyton-manning-play-worse-in-cold-weather>.
- [4] PRO-FOOTBALL-REFERENCE.COM. (n.d.). Peyton Manning. Retrieved July 24, 2014, from <http://www.pro-football-reference.com/players/M/MannPe00.htm>.
- [5] Zeller, R. A., & Jurkovic, T. (1989). A dome stadium: does it help the home team in the national football league? *Sport Place*, 3(3), 36–39.
- [6] Sporting Charts. (2012). Home field advantage broken down by NFL team. Retrieved July 24, 2014, from

- <http://www.sportingcharts.com/articles/nfl/home-field-advantage-broken-down-by-nfl-team.aspx>.
- [7] SEZ: Stadiums. Retrieved from <http://www.southendzone.com/stadiums/>.
- [8] PRO-FOOTBALL-REFERENCE.COM. Retrieved from <http://www.pro-football-reference.com/>.
- [9] Borghesi, R. (2007). The home team weather advantage and biases in the NFL betting market. *Journal of Economics and Business*, 59, 340–354.
- [10] Shephard, R. J. (1985). Adaptation to exercise in the cold. *Sports Medicine*, 2(1), 59–71.
- [11] Phetteplace, G. (2000). Integrating cold weather impacts on human performance into army M&S applications, *Proceedings of the 2000 Winter Simulation Conference*, 1, 1020–1024.