Winter 2020 BSA Article

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Redownloading the Data

Notes:

1. Spread is given for the team that won the toss. A positive spread indicates an underdog, a negative spread indicates a favorite.

2. For coin toss choice, "R" means that the team chose to receive, while "D" means that the team chose to defer.

2015 - 2019

Team.Won.Toss	Date	Opp	Result	Spread	Coin.Toss.Choice	Year
CIN	1/9/16	PIT	L	3.0	D	2015
HOU	1/9/16	KAN	L	3.0	D	2015
GNB	1/10/16	WAS	W	1.0	R	2015
SEA	1/10/16	MIN	W	-4.5	D	2015
GNB	1/16/16	ARI	L	7.0	D	2015
KAN	1/16/16	NWE	L	4.5	D	2015
SEA	1/17/16	CAR	L	2.5	D	2015
DEN	1/17/16	PIT	W	-7.5	D	2015
ARI	1/24/16	CAR	L	3.0	D	2015
NWE	1/24/16	DEN	L	-3.0	R	2015
CAR	2/7/16	DEN	L	-5.0	D	2015
OAK	1/7/17	HOU	L	4.0	D	2016
SEA	1/7/17	DET	W	-8.0	D	2016
MIA	1/8/17	PIT	L	11.0	D	2016
GNB	1/8/17	NYG	W	-5.0	D	2016
ATL	1/14/17	SEA	W	-6.5	D	2016
NWE	1/14/17	HOU	W	-16.0	D	2016
GNB	1/15/17	DAL	W	5.5	D	2016
PIT	1/15/17	KAN	W	2.5	R	2016
GNB	1/22/17	ATL	L	6.5	D	2016
NWE	1/22/17	PIT	W	-5.5	R	2016
ATL	2/5/17	NWE	L	3.0	D	2016
TEN	1/6/18	KAN	W	8.5	D	2017
ATL	1/6/18	LAR	W	6.5	D	2017
CAR	1/7/18	NOR	L	6.5	D	2017
JAX	1/7/18	BUF	W	-8.0	D	2017
ATL	1/13/18	PHI	L	-2.5	D	2017
NWE	1/13/18	TEN	W	-13.5	R	2017
MIN	1/14/18	NOR	W	-5.5	D	2017

Team.Won.Toss	Date	Opp	Result	Spread	Coin.Toss.Choice	Year
PIT	1/14/18	JAX	L	-7.0	D	2017
JAX	1/21/18	NWE	L	7.5	D	2017
PHI	1/21/18	MIN	W	3.0	D	2017
NWE	2/4/18	PHI	L	-4.5	D	2017
SEA	1/5/19	DAL	L	2.5	D	2018
HOU	1/5/19	IND	L	-2.0	D	2018
LAC	1/6/19	BAL	W	3.0	D	2018
CHI	1/6/19	PHI	L	-6.5	D	2018
DAL	1/12/19	LAR	L	7.5	D	2018
KAN	1/12/19	IND	W	-4.0	D	2018
PHI	1/13/19	NOR	L	8.5	D	2018
NWE	1/13/19	LAC	W	-3.5	R	2018
LAR	1/20/19	NOR	W	3.0	D	2018
KAN	1/20/19	NWE	L	-3.0	D	2018
LAR	2/3/19	NWE	L	2.0	D	2018
TEN	1/4/20	NWE	W	4.5	D	2019
HOU	1/4/20	BUF	W	-2.5	D	2019
MIN	1/5/20	NOR	W	7.5	R	2019
PHI	1/5/20	SEA	L	-1.0	D	2019
SFO	1/11/20	MIN	W	-7.0	D	2019
BAL	1/11/20	TEN	L	-10.0	D	2019
HOU	1/12/20	KAN	L	10.0	R	2019
SEA	1/12/20	GNB	L	4.5	D	2019
GNB	1/19/20	SFO	L	8.0	D	2019
KAN	1/19/20	TEN	W	-7.5	D	2019
SFO	2/2/20	KAN	L	1.5	D	2019

2002 - 2006

Team.Won.Toss	Date	Opp	Result	Spread	Coin.Toss.Choice	Year
ATL	1/4/03	GNB	W	6.5	R	2002
IND	1/4/03	NYJ	L	6.0	R	2002
CLE	1/5/03	PIT	L	8.0	R	2002
NYG	1/5/03	SFO	L	3.0	R	2002
ATL	1/11/03	PHI	L	7.5	R	2002
TEN	1/11/03	PIT	W	-4.5	D	2002
NYJ	1/12/03	OAK	L	5.5	R	2002
TAM	1/12/03	SFO	W	-6.0	R	2002
PHI	1/19/03	TAM	L	-4.0	R	2002
OAK	1/19/03	TEN	W	-9.0	R	2002
TAM	1/26/03	OAK	W	3.5	R	2002
DAL	1/3/04	CAR	L	3.0	R	2003
BAL	1/3/04	TEN	L	1.0	R	2003
SEA	1/4/04	GNB	L	7.5	D	2003
IND	1/4/04	DEN	W	-3.0	R	2003
CAR	1/10/04	STL	W	7.0	R	2003
TEN	1/10/04	NWE	L	6.0	R	2003
IND	1/11/04	KAN	W	3.0	R	2003
PHI	1/11/04	GNB	W	-4.0	R	2003
CAR	1/18/04	PHI	W	4.0	R	2003
NWE	1/18/04	IND	W	-3.5	R	2003

Team.Won.Toss	Date	Opp	Result	Spread	Coin.Toss.Choice	Year
CAR	2/1/04	NWE	L	7.0	R	2003
STL	1/8/05	SEA	W	4.0	R	2004
SDG	1/8/05	NYJ	L	-6.5	D	2004
IND	1/9/05	DEN	W	-10.0	R	2004
MIN	1/9/05	GNB	W	6.0	R	2004
NYJ	1/15/05	PIT	L	9.0	R	2004
ATL	1/15/05	STL	W	-6.5	R	2004
MIN	1/16/05	PHI	L	8.0	R	2004
IND	1/16/05	NWE	L	1.0	R	2004
ATL	1/23/05	PHI	L	6.0	R	2004
PIT	1/23/05	NWE	L	3.0	R	2004
PHI	2/6/05	NWE	L	7.0	R	2004
TAM	1/7/06	WAS	L	-2.5	R	2005
NWE	1/7/06	JAX	W	-8.0	R	2005
CAR	1/8/06	NYG	W	3.0	R	2005
PIT	1/8/06	CIN	W	-3.0	R	2005
NWE	1/14/06	DEN	L	3.0	R	2005
SEA	1/14/06	WAS	W	-8.5	R	2005
PIT	1/15/06	IND	W	8.5	R	2005
CAR	1/15/06	CHI	W	3.0	R	2005
CAR	1/22/06	SEA	L	5.5	R	2005
DEN	1/22/06	PIT	L	-3.5	R	2005
SEA	2/5/06	PIT	L	4.0	R	2005
KAN	1/6/07	IND	L	6.5	R	2006
SEA	1/6/07	DAL	W	-2.0	R	2006
NYG	1/7/07	PHI	L	6.0	R	2006
NWE	1/7/07	NYJ	W	-9.0	R	2006
BAL	1/13/07	IND	L	-4.0	R	2006
NOR	1/13/07	PHI	W	-4.5	R	2006
SDG	1/14/07	NWE	L	-5.0	R	2006
CHI	1/14/07	SEA	W	-8.5	R	2006
NOR	1/21/07	CHI	L	3.0	R	2006
NWE	1/21/07	IND	L	3.0	R	2006
CHI	2/4/07	IND	L	6.5	R	2006

	Team.Won.Toss	Date	Opp	Result	Spread	Coin.Toss.Choice	Year
2	PIT	1/5/08	JAX	L	2.5	R	2007
4	WAS	1/5/08	SEA	L	3.5	R	2007
6	NYG	1/6/08	TAM	W	3.0	R	2007
8	TEN	1/6/08	SDG	L	10.0	R	2007
10	GNB	1/12/08	SEA	W	-7.5	R	2007
12	JAX	1/12/08	NWE	L	13.5	R	2007
14	IND	1/13/08	SDG	L	-11.0	R	2007
16	NYG	1/13/08	DAL	W	7.0	R	2007
18	GNB	1/20/08	NYG	L	-7.5	D	2007
20	SDG	1/20/08	NWE	L	14.0	R	2007
22	NYG	2/3/08	NWE	W	12.5	R	2007
24	ARI	1/3/09	ATL	W	-2.0	R	2008
26	SDG	1/3/09	IND	W	2.5	R	2008
28	MIN	1/4/09	PHI	L	3.5	D	2008

	Team.Won.Toss	Date	Opp	Result	Spread	Coin.Toss.Choice	Year
30	MIA	1/4/09	BAL	L	3.5	D	2008
32	CAR	1/10/09	ARI	L	-10.0	R	2008
34	TEN	1/10/09	BAL	L	-3.0	D	2008
36	PIT	1/11/09	SDG	W	-6.5	D	2008
38	NYG	1/11/09	PHI	L	-4.0	R	2008
40	ARI	1/18/09	PHI	W	3.5	R	2008
42	BAL	1/18/09	PIT	L	6.0	D	2008
44	ARI	2/1/09	PIT	L	6.5	D	2008
46	DAL	1/9/10	PHI	W	-3.5	R	2009
48	CIN	1/9/10	NYJ	L	-2.5	R	2009
50	NWE	1/10/10	BAL	L	-4.0	R	2009
52	GNB	1/10/10	ARI	L	-2.5	R	2009
54	IND	1/16/10	BAL	W	-6.5	R	2009
56	ARI	1/16/10	NOR	L	7.0	R	2009
58	DAL	1/17/10	MIN	L	2.5	R	2009
60	NYJ	1/17/10	SDG	W	9.0	D	2009
62	IND	1/24/10	NYJ	W	-8.5	R	2009
64	MIN	1/24/10	NOR	L	3.5	R	2009
66	NOR	2/7/10	IND	W	4.5	R	2009
68	NOR	1/8/11	SEA	L	-10.0	R	2010
70	IND	1/8/11	NYJ	L	-2.0	R	2010
72	PHI	1/9/11	GNB	L	-2.5	R	2010
74	KAN	1/9/11	BAL	L	3.0	D	2010
76	PIT	1/15/11	BAL	W	-3.0	D	2010
78	GNB	1/15/11	ATL	W	1.5	D	2010
80	NWE	1/16/11	NYJ	L	-9.5	D	2010
82	SEA	1/16/11	CHI	L	10.0	R	2010
84	CHI	1/23/11	GNB	L	3.5	D	2010
86	NYJ	1/23/11	PIT	L	4.0	D	2010
88	GNB	2/6/11	PIT	W	-3.0	D	2010
90	CIN	1/7/12	HOU	L	4.0	D	2011
92	DET	1/7/12	NOR	L	10.5	R	2011
94	NYG	1/8/12	ATL	W	-3.0	R	2011
96	DEN	1/8/12	PIT	W	7.5	D	2011
98	SFO	1/14/12	NOR	W	3.5	D	2011
100	DEN	1/14/12	NWE	L	13.5	D	2011
102	BAL	1/15/12	HOU	W	-8.0	D	2011
104	GNB	1/15/12	NYG	L	-8.0	D	2011
106	NWE	1/22/12	BAL	W	-7.0	D	2011
108	NYG	1/22/12	SFO	W	2.0	D	2011
110	NWE	2/5/12	NYG	L	-3.0	D	2011
112	GNB	1/5/13	MIN	W	-11.0	D	2012
114	HOU	1/5/13	CIN	W	-4.0	R	2012
116	WAS	1/6/13	SEA	L	3.0	R	2012
118	IND	1/6/13	BAL	L	7.0	D	2012
120	DEN	1/12/13	BAL	L	-9.0	D	2012
122	SFO	1/12/13	GNB	W	-3.0	R	2012
124	ATL	1/13/13	SEA	W	-3.0	R	2012
126	HOU	1/13/13	NWE	L	9.5	R	2012
128	SFO	1/20/13	ATL	W	-4.5	D	2012
130	BAL	1/20/13	NWE	W	7.5	D	2012
132	BAL	2/3/13	SFO	W	4.5	D	2012

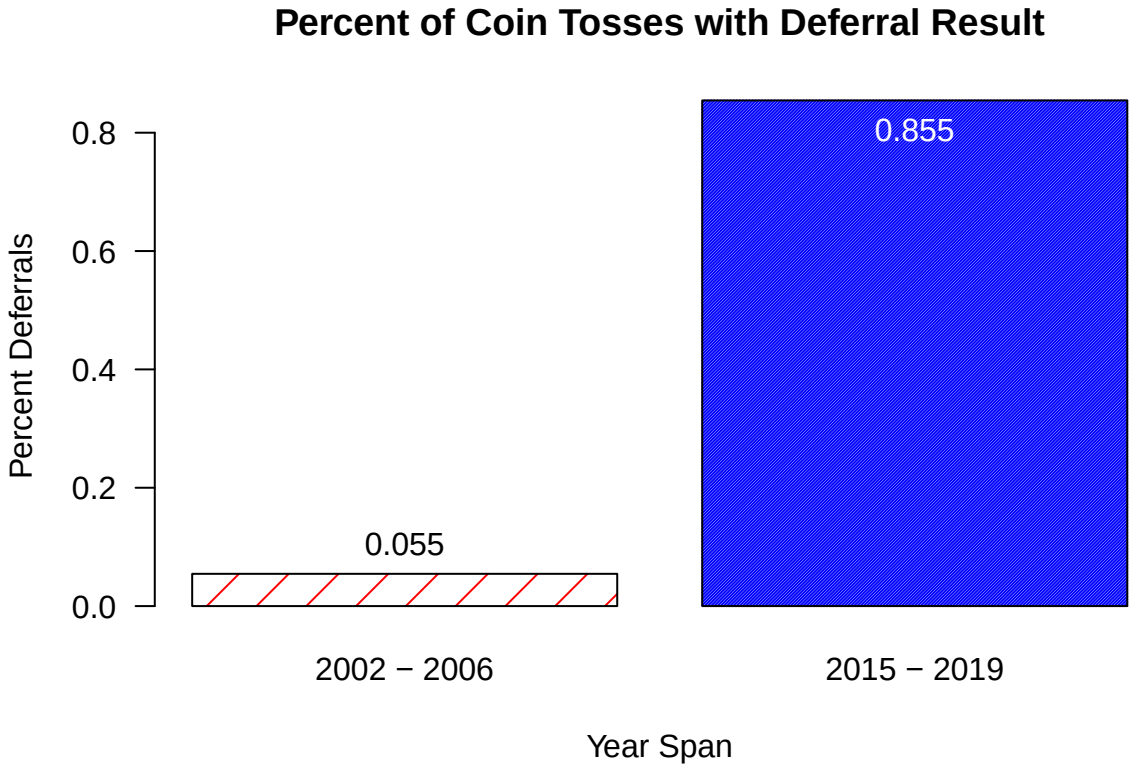
	Team.Won.Toss	Date	Opp	Result	Spread	Coin.Toss.Choice	Year
134	PHI	1/4/14	NOR	L	-3.0	R	2013
136	KAN	1/4/14	IND	L	-2.5	R	2013
138	CIN	1/5/14	SDG	L	-6.0	D	2013
140	SFO	1/5/14	GNB	W	-3.0	R	2013
142	SEA	1/11/14	NOR	W	-9.0	D	2013
144	IND	1/11/14	NWE	L	7.0	R	2013
146	DEN	1/12/14	SDG	W	-7.5	D	2013
148	CAR	1/12/14	SFO	L	1.0	D	2013
150	DEN	1/19/14	NWE	W	-5.0	D	2013
152	SFO	1/19/14	SEA	L	4.0	D	2013
154	SEA	2/2/14	DEN	W	2.5	D	2013
156	PIT	1/3/15	BAL	L	-3.0	R	2014
158	ARI	1/3/15	CAR	L	6.5	R	2014
160	DAL	1/4/15	DET	W	-6.5	R	2014
162	IND	1/4/15	CIN	W	-3.0	R	2014
164	NWE	1/10/15	BAL	W	-7.0	D	2014
166	CAR	1/10/15	SEA	L	11.5	R	2014
168	DEN	1/11/15	IND	L	-7.0	D	2014
170	DAL	1/11/15	GNB	L	6.0	R	2014
172	SEA	1/18/15	GNB	W	-8.5	D	2014
174	NWE	1/18/15	IND	W	-7.0	D	2014
176	SEA	2/1/15	NWE	L	0.0	D	2014

Data Analysis

Is there a difference in deferral percentage across eras?

H_0: $p_1 = p_2$
H_a: $p_1 < p_2$

- p_1: Deferral percentage for 2002 - 2006
- p_2: Deferral percentage for 2015 - 2019



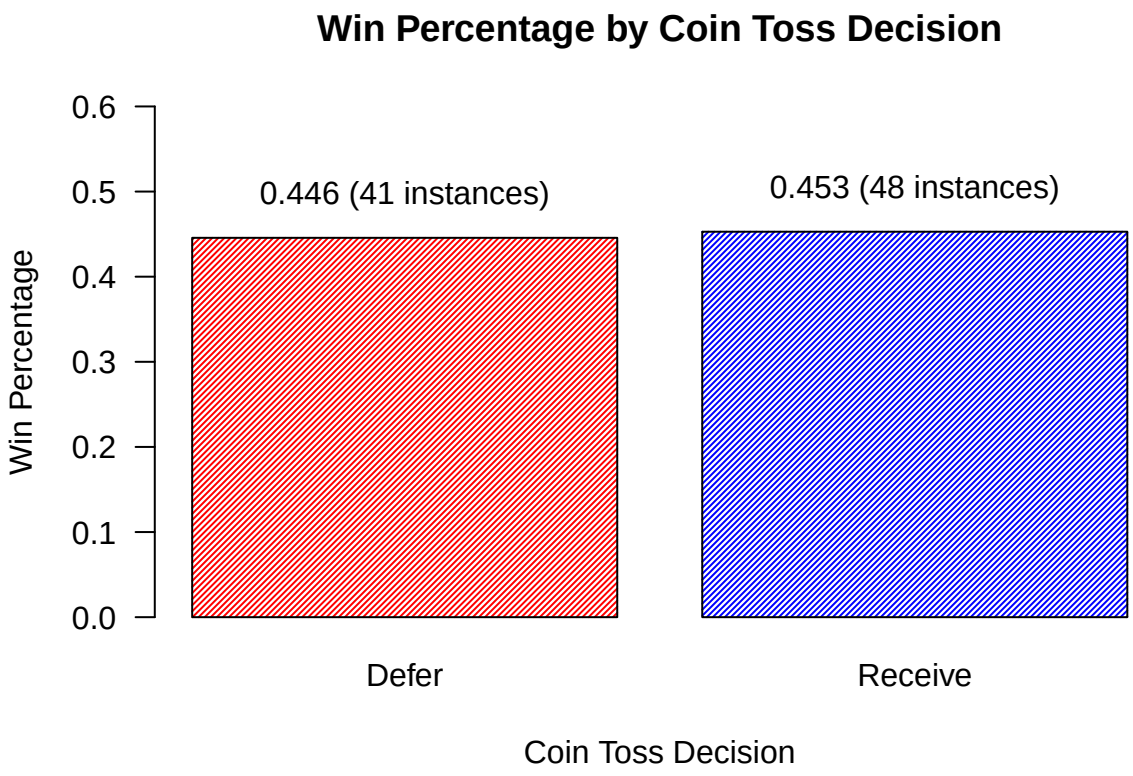

```
    2-sample test for equality of proportions without continuity correction

data:  c(X1, X2) out of c(nrow(cointoss20022006), nrow(cointoss20152019))
X-squared = 70.987, df = 1, p-value < 2.2e-16
alternative hypothesis: less
95 percent confidence interval:
 -1.000000 -0.706988
sample estimates:
    prop 1     prop 2
0.05454545 0.85454545

[1] 1.798236e-17
```

Since $p < \alpha$, we reject H_0. We do have evidence which supports the alternative hypothesis H_a that the deferral percentage for winners of the coin toss is less for the years 2002 - 2006 than for the years 2015 - 2019.

Does deferring provide a statistically significant advantage in win percentage?

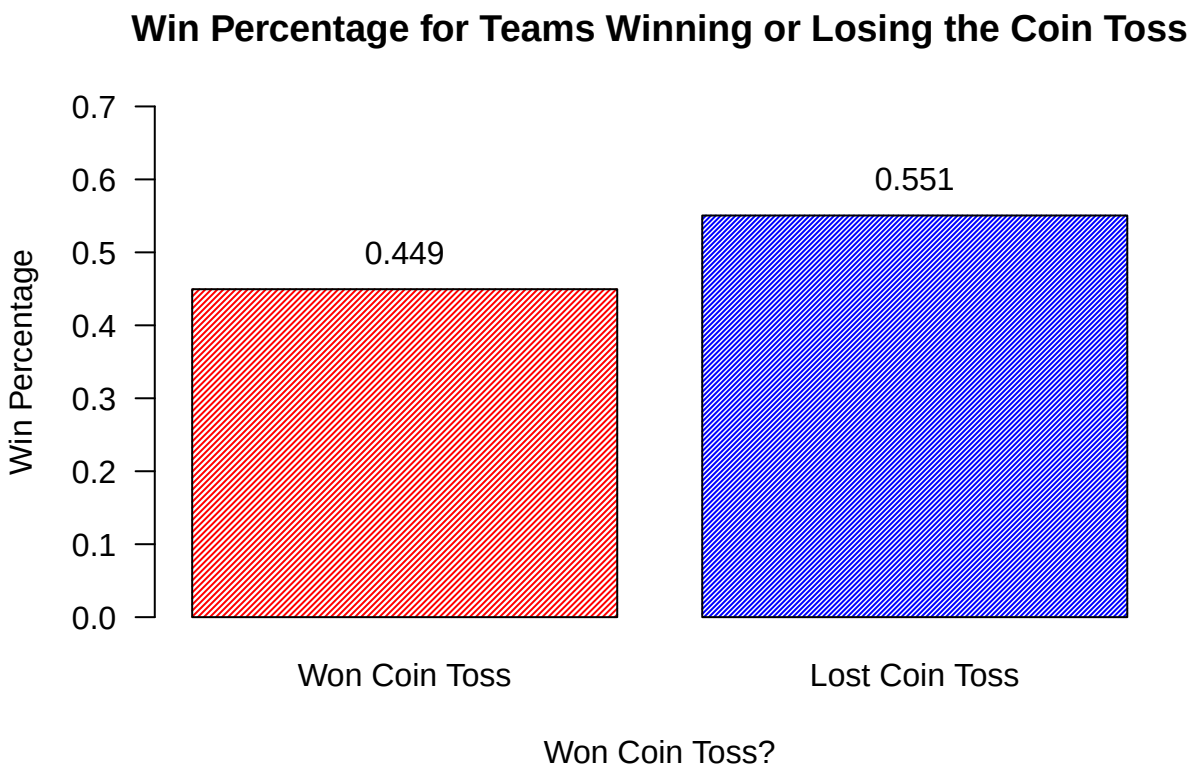
H_0: $p_1 = p_2$
H_a: $p_1 \neq p_2$

- p_1: Win percentage for deferring
- p_2: Win percentage for receiving



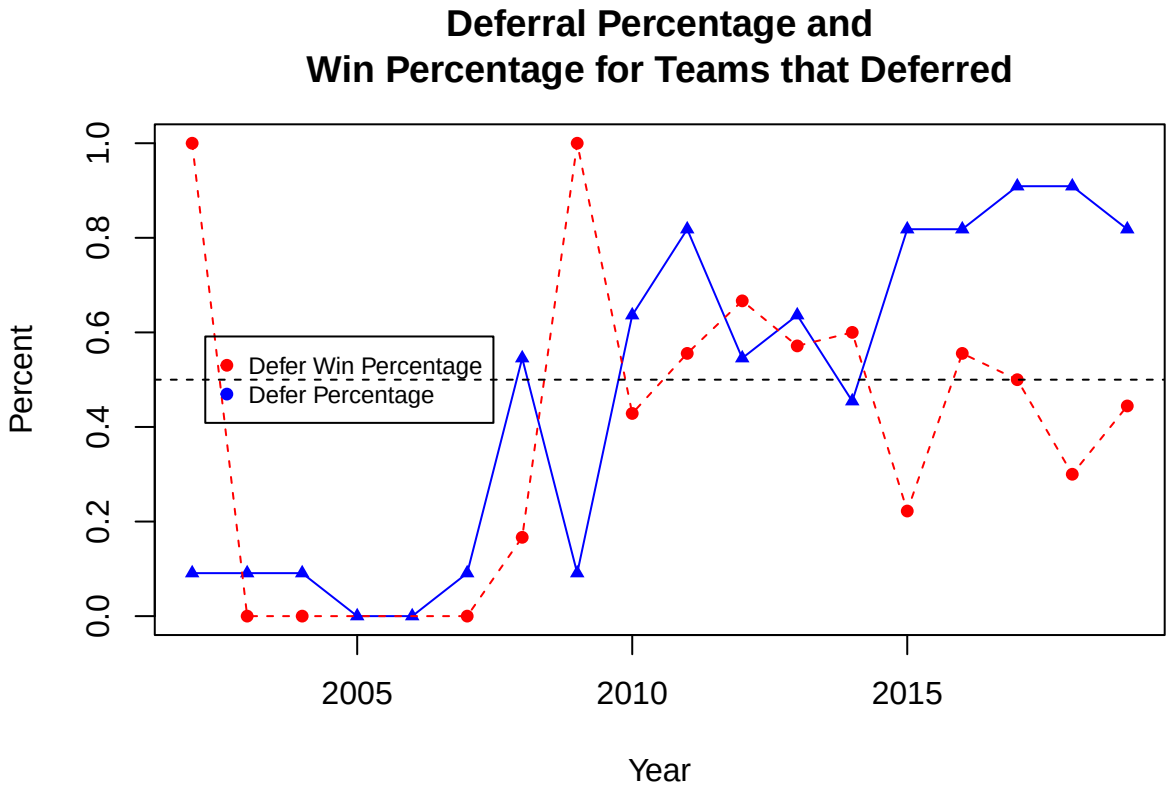

```
    2-sample test for equality of proportions without continuity correction

data:  c(defer_wins, receive_wins) out of c(nrow(defer), nrow(receive))
X-squared = 0.010255, df = 1, p-value = 0.9193
alternative hypothesis: two.sided
95 percent confidence interval:
 -0.1460838  0.1317278
sample estimates:
   prop 1    prop 2
0.4456522 0.4528302
```

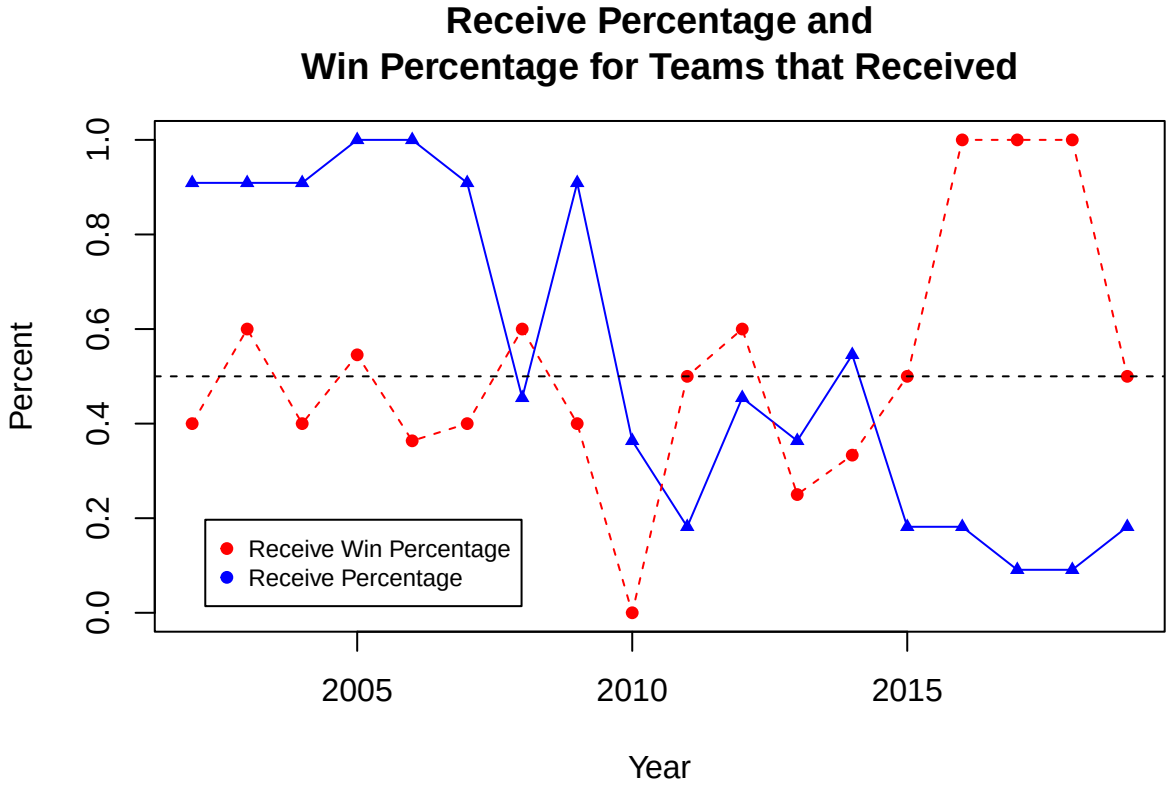
```
[1] 0.9193371
```


Win Percentage for Teams Winning or Losing the Coin Toss
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
Win Percentage
0.449
0.551
Won Coin Toss
Lost Coin Toss
Won Coin Toss?

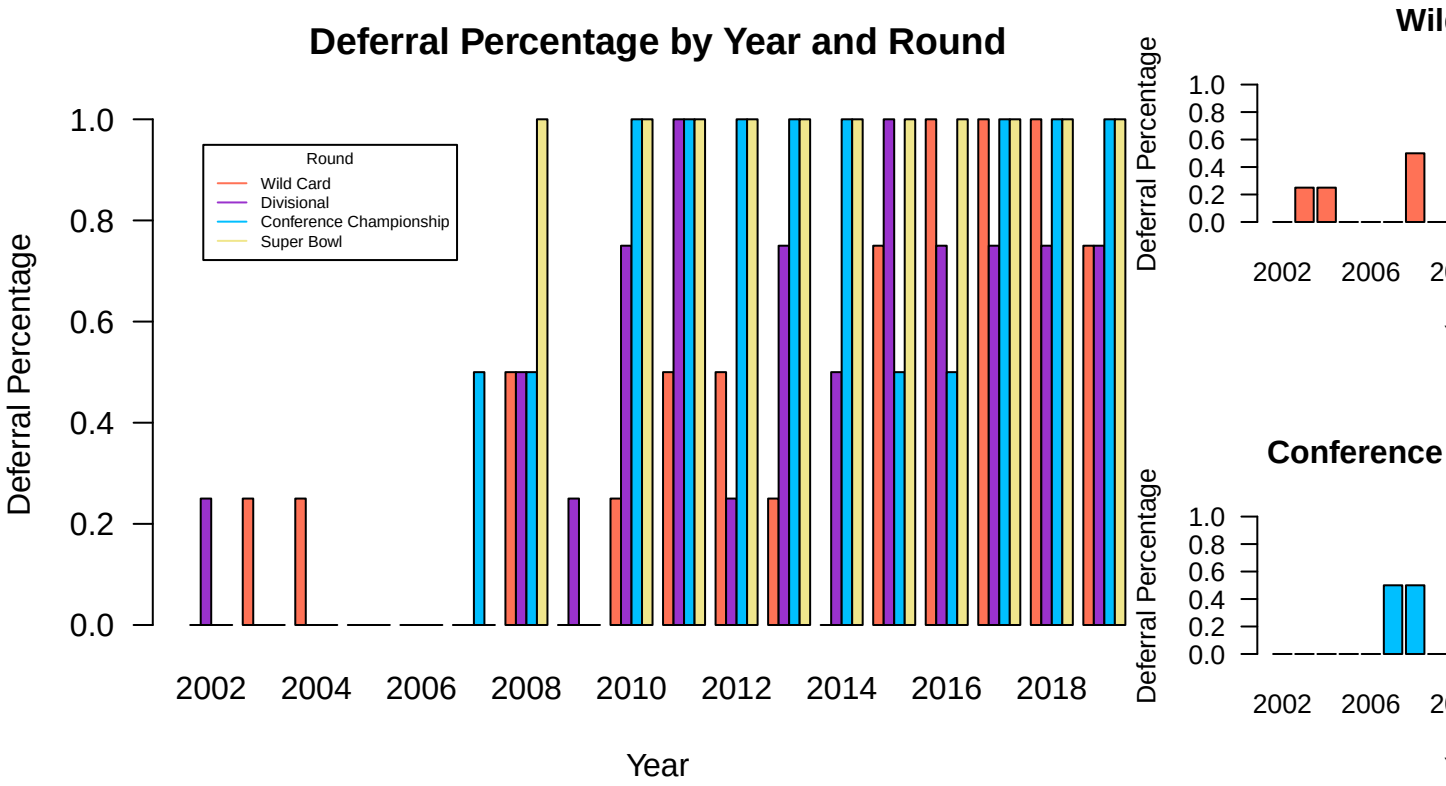
Data Visualization

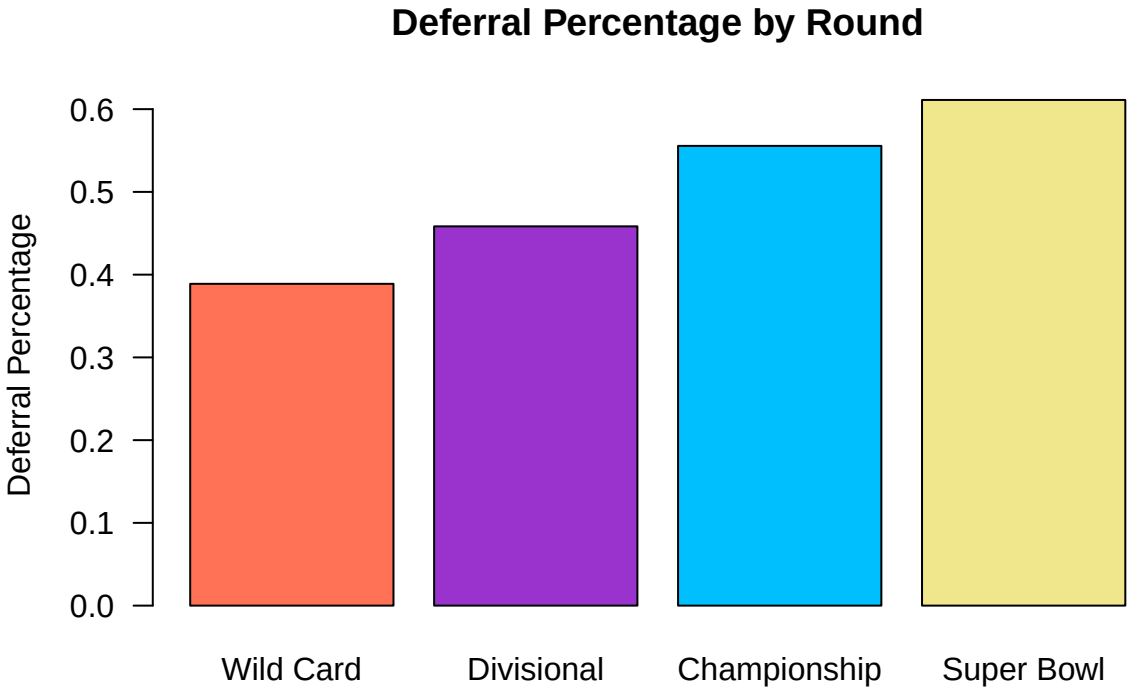
Line Plots





Deferrals by Round





Four Sample Test for Equality of Proportions (Chi-Square GoF)

```
4-sample test for equality of proportions without continuity correction
```

```
data:  rounds_defer_number out of 18 * c(4, 4, 2, 1)
X-squared = 4.4211, df = 3, p-value = 0.2194
alternative hypothesis: two.sided
sample estimates:
   prop 1    prop 2    prop 3    prop 4
0.3888889 0.4583333 0.5555556 0.6111111
```

Chi Square Test for Independence

Test if the proportion of deferrals in each round remains the same over all years

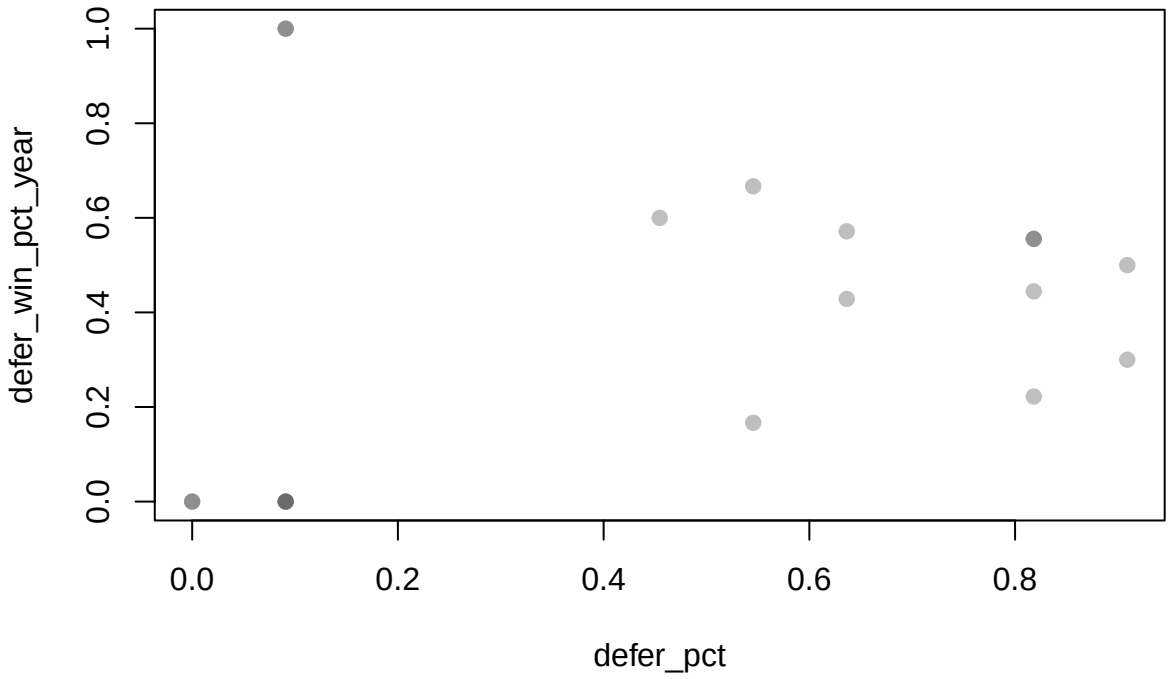
```
Warning in prop.test(defer_win_pct_year * defers, defers): Chi-squared
approximation may be incorrect


    16-sample test for equality of proportions without continuity
    correction

data:  defer_win_pct_year * defers out of defers
X-squared = 12.592, df = 15, p-value = 0.6338
alternative hypothesis: two.sided
sample estimates:
   prop 1    prop 2    prop 3    prop 4    prop 5    prop 6    prop 7    prop 8
1.0000000 0.0000000 0.0000000 0.0000000 0.1666667 1.0000000 0.4285714 0.5555556
   prop 9   prop 10   prop 11   prop 12   prop 13   prop 14   prop 15   prop 16
0.6666667 0.5714286 0.6000000 0.2222222 0.5555556 0.5000000 0.3000000 0.4444444
```

Relationship between Defer Percentage and Win Percentage

```
      2002       2003       2004       2005       2006       2007       2008
0.09090909 0.09090909 0.09090909 0.00000000 0.00000000 0.09090909 0.54545455
      2009       2010       2011       2012       2013       2014       2015
0.09090909 0.63636364 0.81818182 0.54545455 0.63636364 0.45454545 0.81818182
      2016       2017       2018       2019
0.81818182 0.90909091 0.90909091 0.81818182
```

```
     2002      2003      2004      2007      2008      2009      2010      2011
1.0000000 0.0000000 0.0000000 0.0000000 0.1666667 1.0000000 0.4285714 0.5555556
     2012      2013      2014      2015      2016      2017      2018      2019
0.6666667 0.5714286 0.6000000 0.2222222 0.5555556 0.5000000 0.3000000 0.4444444
```

```
     2002      2003      2004                          2007      2008      2009
1.0000000 0.0000000 0.0000000 0.0000000 0.0000000 0.0000000 0.1666667 1.0000000
     2010      2011      2012      2013      2014      2015      2016      2017
0.4285714 0.5555556 0.6666667 0.5714286 0.6000000 0.2222222 0.5555556 0.5000000
     2018      2019
0.3000000 0.4444444
```




```
Call:
lm(formula = defer_win_pct_year ~ defer_pct)

Residuals:
    Min      1Q  Median      3Q     Max
-0.3058 -0.2757 -0.0118  0.1293  0.6942

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept)   0.2855     0.1302   2.193   0.0434 *
defer_pct     0.2239     0.2258   0.992   0.3361
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.327 on 16 degrees of freedom
Multiple R-squared:  0.0579,    Adjusted R-squared:  -0.0009778
F-statistic: 0.9834 on 1 and 16 DF,  p-value: 0.3361
```