MSD Final Project Report

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```
teams <- read_csv(here('teams.csv'))
salaries <- read_csv(here('salaries.csv'))
```

```
teams$WSWin <- as.logical(teams$WSWin == 'Y')
teams <- teams %>%
  filter(1985 <= yearID & yearID <= 2016) %>%
  mutate(winPercentage = W / (W + L) * 1000)

salaries <- salaries %>%
  filter(1985 <= yearID & yearID <= 2016) %>%
  mutate(salaryMil = salary / 1000000)
```

```
teams <- teams %>%
  inner_join(salaries) %>%
```

```
  group_by(yearID, teamID, G, W, L, WSWin, winPercentage) %>%
  summarize(totalSalaryMil = sum(salaryMil))
```

```
salaries <- salaries %>%
  inner_join(teams) %>%
  mutate(salaryShare = salaryMil / totalSalaryMil * 100) %>%
  mutate(salaryShareSquared = salaryShare ^ 2) %>%
  select(yearID, teamID, playerID, salary, salaryShare, salaryShareSquared)
```

```
teams <- teams %>%
  inner_join(salaries) %>%
  group_by(yearID, teamID, G, W, L, winPercentage, WSWin, totalSalaryMil) %>%
  summarize(HHI = sum(salaryShareSquared))
```

```
teams_old <- teams %>%
  filter(1985 <= yearID & yearID <= 1998) %>%
  mutate(normalizedYear = yearID - 1985)

salaries_old <- salaries %>%
  filter(1985 <= yearID & yearID <= 1998)
```

```
summary(teams_old$winPercentage)
```

```
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##   327.2   456.8   498.4   500.0   543.2   703.7
```

```
sd(teams_old$winPercentage)
```

```
## [1] 66.22653
```

```
summary(teams_old$totalSalaryMil)
```

```
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##    0.88   12.76   22.32   25.16   36.29   72.36
```

```
sd(teams_old$totalSalaryMil)
```

```
## [1] 14.22702
```

```
summary(teams_old$HHI)
```

```
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##   427.5   668.6   756.3   815.6   879.1  5300.1
```

```
sd(teams_old$HHI)
```

```
## [1] 322.5687
```

```
linear_fixed_old <- lm(formula = winPercentage ~ totalSalaryMil + HHI +
                                                 normalizedYear + teamID + 0,
                       data = teams_old)
summary(linear_fixed_old)$coefficients[1:3,]
```

```
##                   Estimate Std. Error   t value     Pr(>|t|)
## totalSalaryMil  2.1493337  0.4551468  4.722287 3.404816e-06
## HHI            -0.0120376  0.0114311 -1.053057 2.930560e-01
## normalizedYear -5.4184670  1.5790948 -3.431375 6.738811e-04
```

```
linear_random_old <- lm(formula = winPercentage ~ totalSalaryMil + HHI + normalizedYear,
                        data = teams_old)
summary(linear_random_old)$coefficients[1:4,]
```

```
##                     Estimate  Std. Error   t value      Pr(>|t|)
## (Intercept)    494.46265725 10.80464965 45.763877 2.501463e-155
## totalSalaryMil   2.27827992  0.38799272  5.871966  9.513353e-09
## HHI             -0.01402974  0.01077516 -1.302045  1.937025e-01
## normalizedYear  -6.05527713  1.38637176 -4.367715  1.627858e-05
```

```
log_log_fixed_old <- lm(formula = log(winPercentage) ~ log(totalSalaryMil) + log(HHI) +
                                                       normalizedYear + teamID + 0,
                        data = teams_old)
summary(log_log_fixed_old)$coefficients[1:3,]
```

```
##                          Estimate  Std. Error   t value   Pr(>|t|)
## log(totalSalaryMil)  0.068481958 0.023048764  2.971177 0.00317594
## log(HHI)            -0.043092478 0.034083173 -1.264333 0.20696902
## normalizedYear      -0.006815679 0.003712079 -1.836081 0.06721103
```

```
log_log_random_old <- lm(formula = log(winPercentage) ~ log(totalSalaryMil) + log(HHI) +
                                                        normalizedYear,
                         data = teams_old)
summary(log_log_random_old)$coefficients[1:4,]
```

```
##                          Estimate  Std. Error   t value     Pr(>|t|)
## (Intercept)          6.336734123 0.228514736 27.730090 9.463580e-93
## log(totalSalaryMil)  0.077748160 0.019984364  3.890450 1.184254e-04
## log(HHI)            -0.046572660 0.031165596 -1.494361 1.359244e-01
## normalizedYear      -0.008653452 0.003294086 -2.626966 8.969280e-03
```

Reproduction Notes

- original author did not describe how time fixed effects are accounted for (across expansion periods or every year)
- no discussion about limiting to 25 man roster vs 40 man roster
- no discussion of cut players, traded players
- no discussion of signing bonuses

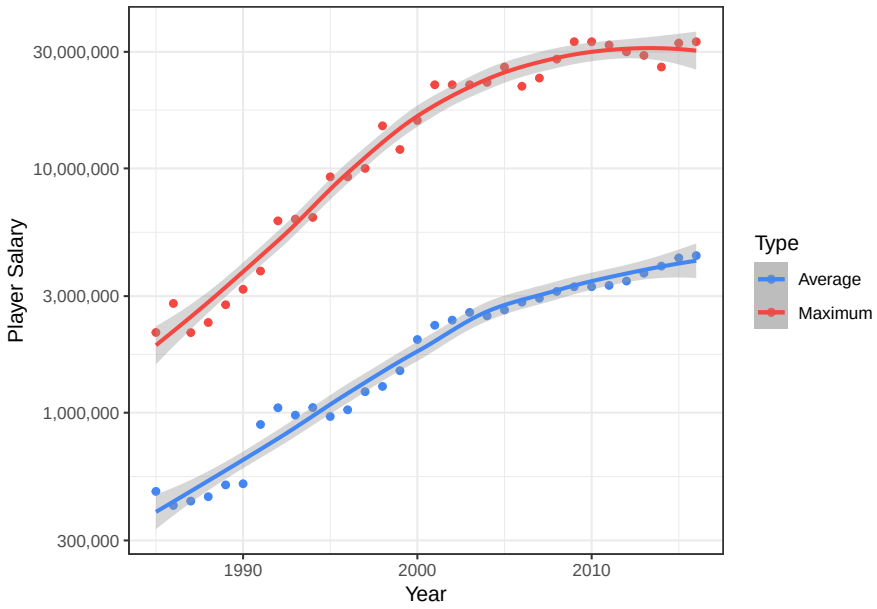
Reproduction Analysis

Extension

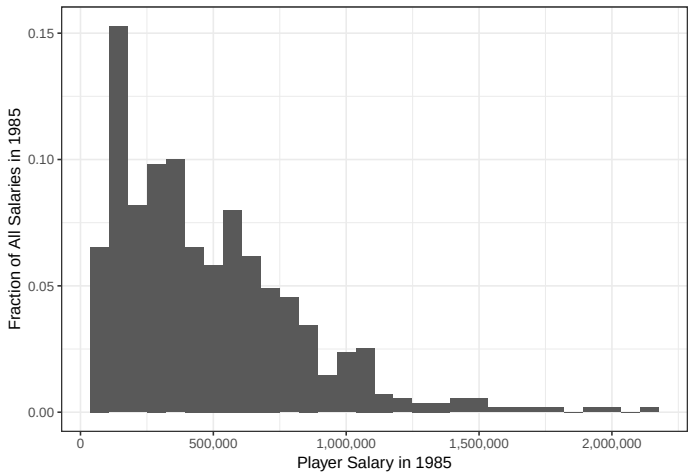
Extension Code

```
salary_vs_time <- salaries %>%
  group_by(yearID) %>%
  summarize(avg = mean(salary), max = max(salary))

ggplot(data = salary_vs_time) +
  geom_point(aes(x = yearID, y = avg, color = 'Average')) +
  geom_smooth(aes(x = yearID, y = avg, color = 'Average')) +
```

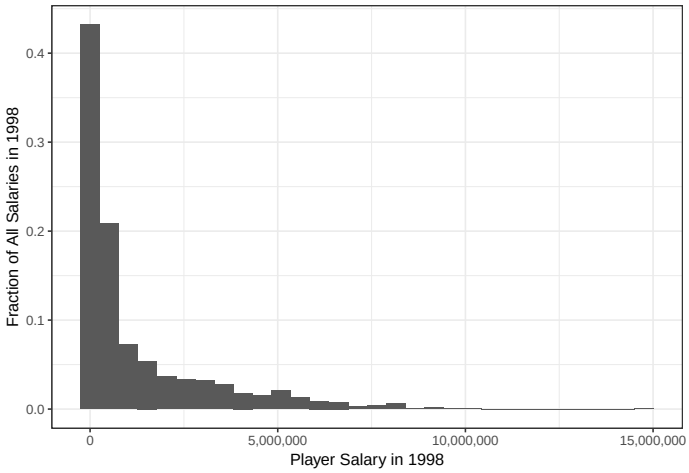
```
  geom_point(aes(x = yearID, y = max, color = 'Maximum')) +
  geom_smooth(aes(x = yearID, y = max, color = 'Maximum')) +
  scale_color_manual(values = c('#4286f4', '#f44741')) +
  scale_y_log10(labels = comma) +
  labs(color = 'Type') +
  xlab('Year') +
  ylab('Player Salary')
```



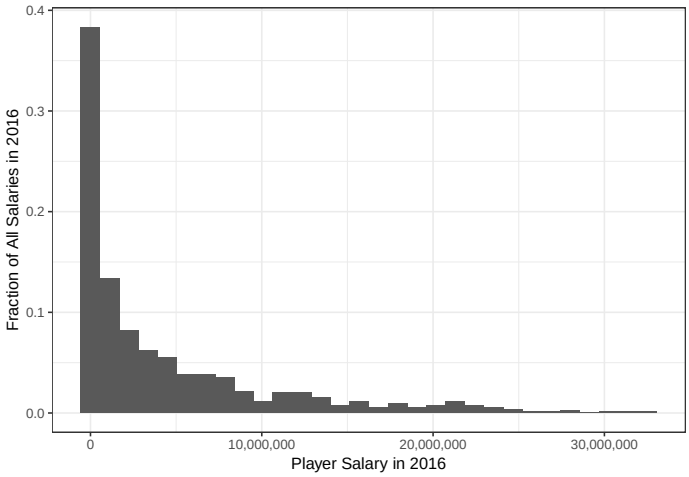

```
salaries_1985 <- filter(salaries, yearID == 1985)
salaries_1998 <- filter(salaries, yearID == 1998)
salaries_2016 <- filter(salaries, yearID == 2016)

ggplot(data = salaries_1985) +
  geom_histogram(aes(x = salary, y = (..count..) / sum(..count..))) +
  scale_x_continuous(labels = comma) +
  xlab('Player Salary in 1985') +
  ylab('Fraction of All Salaries in 1985')
```



```
ggplot(data = salaries_1998) +
  geom_histogram(aes(x = salary, y = (..count..) / sum(..count..))) +
  scale_x_continuous(labels = comma) +
  xlab('Player Salary in 1998') +
  ylab('Fraction of All Salaries in 1998')
```

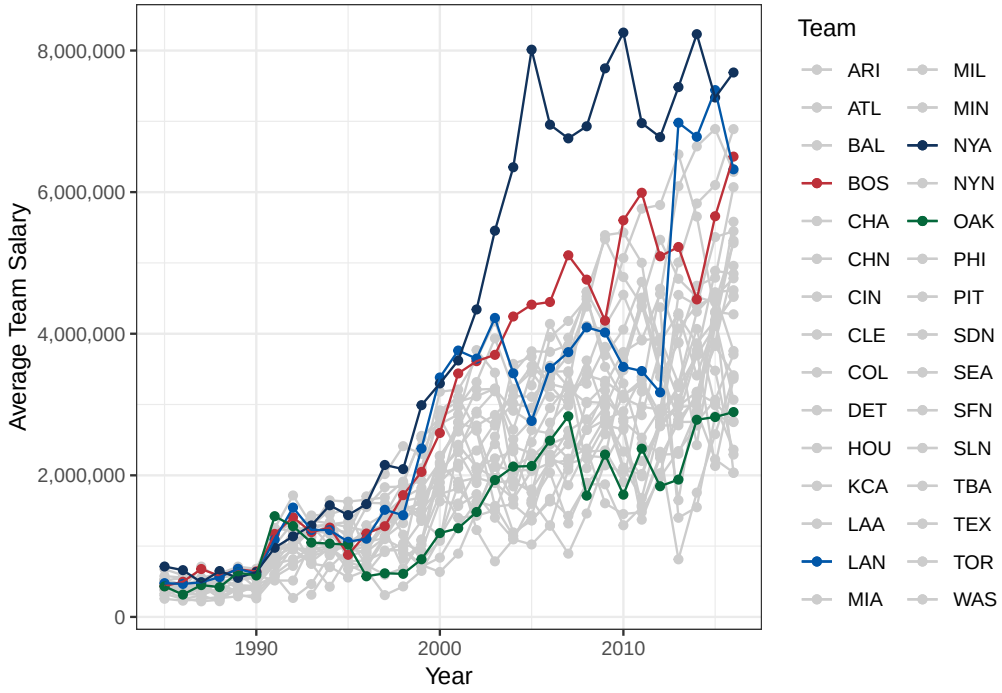



```
ggplot(data = salaries_2016) +
  geom_histogram(aes(x = salary, y = (..count..) / sum(..count..))) +
  scale_x_continuous(labels = comma) +
  xlab('Player Salary in 2016') +
  ylab('Fraction of All Salaries in 2016')
```

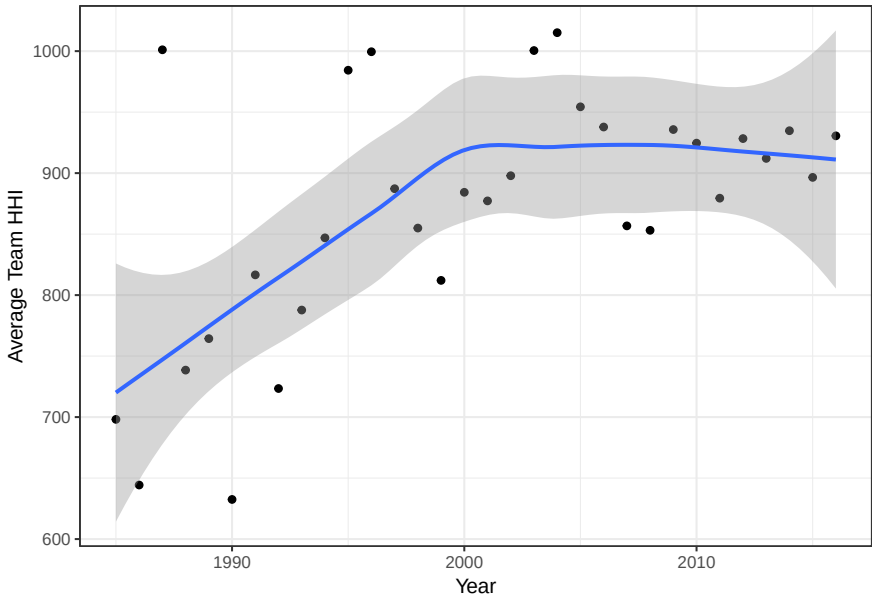



```
current_teamIDs <- c('ARI', 'ATL', 'BAL', 'BOS', 'CHA', 'CHN', 'CIN', 'CLE', 'COL', 'DET',
                     'HOU', 'KCA', 'LAA', 'LAN', 'MIA', 'MIL', 'MIN', 'NYA', 'NYN', 'OAK',
                     'PHI', 'PIT', 'SDN', 'SEA', 'SFN', 'SLN', 'TBA', 'TEX', 'TOR', 'WAS')
team_colors <- c('#cccccc', '#cccccc', '#cccccc', '#BD3039', '#cccccc',
                 '#cccccc', '#cccccc', '#cccccc', '#cccccc', '#cccccc',
                 '#cccccc', '#cccccc', '#cccccc', '#0157a8', '#cccccc',
                 '#cccccc', '#cccccc', '#11325b', '#cccccc', '#04683b',
                 '#cccccc', '#cccccc', '#cccccc', '#cccccc', '#cccccc',
                 '#cccccc', '#cccccc', '#cccccc', '#cccccc', '#cccccc')
colored_teamIDs <- c('BOS', 'LAN', 'NYA', 'OAK')
```

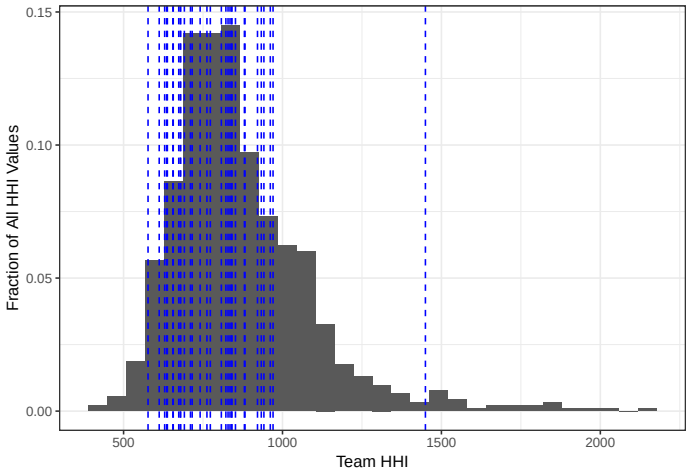
```
team_salary_vs_time <- salaries %>%
  filter(teamID %in% current_teamIDs) %>%
  group_by(yearID, teamID) %>%
  summarize(avg = mean(salary)) %>%
  mutate(flag = teamID %in% colored_teamIDs)

underlay_data <- filter(team_salary_vs_time, !flag)
overlay_data <- filter(team_salary_vs_time, flag)

ggplot() +
  geom_point(data = underlay_data, aes(x = yearID, y = avg, color = teamID)) +
  geom_line(data = underlay_data, aes(x = yearID, y = avg, color = teamID)) +
  geom_point(data = overlay_data, aes(x = yearID, y = avg, color = teamID)) +
  geom_line(data = overlay_data, aes(x = yearID, y = avg, color = teamID)) +
  scale_y_continuous(labels = comma) +
  scale_color_manual(values = team_colors) +
  labs(color = 'Team') +
  xlab('Year') +
  ylab('Average Team Salary')
```




```
hhi_vs_time <- teams %>%
  group_by(yearID) %>%
  summarize(avg = mean(HHI))

ggplot(data = hhi_vs_time) +
  geom_point(aes(x = yearID, y = avg)) +
  geom_smooth(aes(x = yearID, y = avg)) +
  xlab('Year') +
  ylab('Average Team HHI')
```




```
ggplot(data = filter(teams, mean(teams$HHI) - 5 * sd(teams$HHI) <= HHI & HHI <= mean(teams$HHI) + 5 * sd
  geom_histogram(aes(x = HHI, y = (..count..) / sum(..count..))) +
  geom_vline(data = filter(teams, WSWin), aes(xintercept = HHI), color = 'blue', linetype = 'dashed') +
  xlab('Team HHI') +
  ylab('Fraction of All HHI Values')
```




```
year_to_period <- function(year) {
  if (year <= 1992) {
    return('Pre 1993')
  }
  else if (1993 <= year & year <= 1997) {
    return('Between 1993 and 1997')
  }
  else {
    return('Post 1997')
  }
}

hhi_vs_total_salary <- teams %>%
  mutate(period = year_to_period(yearID))
```

```r
hhi_vs_total_salary$period <- factor(hhi_vs_total_salary$period, levels = c('Pre 1993', 'Between 1993 a

ggplot(data = hhi_vs_total_salary) +
  geom_point(aes(x = totalSalaryMil * 1000000, y = HHI, color = period)) +
  scale_x_log10(labels = comma) +
  scale_y_log10() +
  labs(color = 'Period') +
  xlab('Total Team Salary') +
  ylab('Team HHI')
```


```r
teams_new <- teams %>%
  filter(1999 <= yearID & yearID <= 2016) %>%
  mutate(normalizedYear = yearID - 1999)

salaries_new <- salaries %>%
  filter(1999 <= yearID & yearID <= 2016)
```

```r
linear_fixed_new <- lm(formula = winPercentage ~ totalSalaryMil + HHI +
                                                 normalizedYear + teamID + 0,
                       data = teams_new)
summary(linear_fixed_new)$coefficients[1:3,]
```

```
##                   Estimate Std. Error   t value     Pr(>|t|)
## totalSalaryMil  0.4631102 0.12923492  3.583476 0.0003719897
## HHI            -0.0553023 0.01424983 -3.880909 0.0001178918
## normalizedYear -1.6956041 0.71841311 -2.360208 0.0186447534
```

```r
linear_random_new <- lm(formula = winPercentage ~ totalSalaryMil + HHI + normalizedYear,
                        data = teams_new)
summary(linear_random_new)$coefficients[1:4,]
```

```
##                     Estimate  Std. Error   t value      Pr(>|t|)
## (Intercept)    504.53034280 15.53375065 32.479622 9.998674e-129
## totalSalaryMil   0.68988493  0.08449909  8.164406  2.324053e-15
## HHI             -0.04525471  0.01386628 -3.263651  1.169986e-03
```

```
## normalizedYear  -2.52975572  0.62573170 -4.042876  6.054218e-05
```

```
log_log_fixed_new <- lm(formula = log(winPercentage) ~ log(totalSalaryMil) + log(HHI) +
                                                       normalizedYear + teamID + 0,
                        data = teams_new)
summary(log_log_fixed_new)$coefficients[1:3,]
```

```
##                         Estimate  Std. Error   t value     Pr(>|t|)
## log(totalSalaryMil)  0.097454270 0.021330706  4.568732 6.177390e-06
## log(HHI)            -0.104976526 0.030167336 -3.479808 5.452894e-04
## normalizedYear      -0.004010857 0.001459855 -2.747436 6.221456e-03
```

```
log_log_random_new <- lm(formula = log(winPercentage) ~ log(totalSalaryMil) + log(HHI) +
                                                        normalizedYear,
                         data = teams_new)
summary(log_log_random_new)$coefficients[1:4,]
```

```
##                         Estimate  Std. Error   t value      Pr(>|t|)
## (Intercept)          6.285422459 0.222740979 28.218528 4.704158e-108
## log(totalSalaryMil)  0.125655854 0.014620475  8.594512  9.189347e-17
## log(HHI)            -0.085180977 0.028918094 -2.945594  3.363412e-03
## normalizedYear      -0.005434256 0.001300813 -4.177585  3.439323e-05
```

Extension Notes

- note that minimum salary has increased over time: https://www.baseball-reference.com/bullpen/Minimum_salary

Extension Analysis