# Offense vs. Pitching: An Econometric Analysis of What Drives Winning in Major League Baseball

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[2]:
```
# Importing Pandas Library
import pandas as pd

# Importing excel sheets as data frames
off_fg_df = pd.read_excel("/content/drive/MyDrive/Colab Notebooks/ECON 5283 -␣
 ↪Data Visualization with Python/Project/MLB_Team_Offensive_Data_2015-2024_FG.
 ↪xlsx")
off_br_df = pd.read_excel("/content/drive/MyDrive/Colab Notebooks/ECON 5283 -␣
 ↪Data Visualization with Python/Project/MLB_Team_Offensive_Data_2015-2024_BR.
 ↪xlsx")
pitch_fg_df = pd.read_excel("/content/drive/MyDrive/Colab Notebooks/ECON 5283 -␣
 ↪Data Visualization with Python/Project/MLB_Team_Pitching_Data_2015-2024_FG.
 ↪xlsx")
pay_st_df = pd.read_excel("/content/drive/MyDrive/Colab Notebooks/ECON 5283 -␣
 ↪Data Visualization with Python/Project/MLB_Payroll_Data_2015-2024_ST.xlsx")
```

[3]:
```
# Removing unnecessary columns from each DataFrame (Including OPS+ and FIP- for␣
 ↪robustness checks)
off_fg_df.drop(off_fg_df.columns.difference(['Season','Team', 'wRC+']), axis=1,␣
 ↪inplace=True)
off_br_df.drop(off_br_df.columns.difference(['Season','Team', 'W', 'L',␣
 ↪'OPS+']), axis=1, inplace=True)
pitch_fg_df.drop(pitch_fg_df.columns.difference(['Season','Team', 'FIP-',␣
 ↪'ERA-']), axis=1, inplace=True)

# Ensuring each table has 300 rows (30 teams * 10 years)
print(off_fg_df)
print(off_br_df)
print(pitch_fg_df)
print(pay_st_df)
```

```
     Season Team  wRC+
0      2024  LAA    91
1      2024  BAL   114
2      2024  BOS   105
3      2024  CHW    75
```

```
4      2024  CLE   100
..      …  …   …
295    2015  PHI    86
296    2015  PIT    97
297    2015  STL    97
298    2015  SDP    90
299    2015  SFG   104

[300 rows x 3 columns]
     Season Team    W   L  OPS+
0      2024  LAA   63  99    89
1      2024  ARI   89  73   114
2      2024  ATL   89  73   100
3      2024  BAL   91  71   115
4      2024  BOS   81  81   107
..      …  …  …  ..   …
295    2015  STL  100  62    95
296    2015  TBR   80  82   100
297    2015  TEX   88  74    98
298    2015  TOR   93  69   115
299    2015  WSN   83  79    96

[300 rows x 5 columns]
     Season Team  ERA-  FIP-
0      2024  LAA   112   113
1      2024  BAL    99    97
2      2024  BOS    97   100
3      2024  CHW   116   108
4      2024  CLE    91    98
..      …  …   …   …
295    2015  PHI   120   110
296    2015  PIT    84    88
297    2015  STL    77    91
298    2015  SDP   110   103
299    2015  SFG   100   106

[300 rows x 4 columns]
     Year Team    Payroll
0    2024  NYY  315601274
1    2024  PHI  244253627
2    2024  LAD  266640208
3    2024  NYM  320513315
4    2024  CHC  232067975
..    …  …        …
295  2015  TBR   73241552
296  2015  CLE   77404413
297  2015  ARI   76781801
298  2015  OAK   80491339
```

```
299  2015  MIA   72990525

[300 rows x 3 columns]
```

[4]:
```python
# Renaming column in Payroll table
pay_st_df = pay_st_df.rename(columns={'Year': 'Season'})

# Merging DataFrames
mlb_df = off_fg_df.merge(off_br_df, on=['Season', 'Team'], how='inner') \
                  .merge(pitch_fg_df, on=['Season', 'Team'], how='inner') \
                  .merge(pay_st_df, on=['Season', 'Team'], how='inner')

print(mlb_df.head())
```

```
   Season Team  wRC+   W    L  OPS+  ERA-  FIP-     Payroll
0    2024  LAA    91  63   99    89   112   113  172189987
1    2024  BAL   114  91   71   115    99    97  111345494
2    2024  BOS   105  81   81   107    97   100  190037445
3    2024  CHW    75  41  121    76   116   108  141710031
4    2024  CLE   100  92   69   100    91    98  106824582
```

[5]:
```python
# Importing NumPy
import numpy as np

# Removing the 2020 Season (only 60 games played instead of the usual 162)
mlb_df = mlb_df[mlb_df["Season"] != 2020]

# Adding Winning Percentage (WPct)
mlb_df['WPct'] = (mlb_df['W'] / (mlb_df['W'] + mlb_df['L']))
mlb_df = mlb_df[['Season', 'Team', 'W', 'L', 'WPct',
                 'wRC+', 'FIP-', 'OPS+', 'ERA-', 'Payroll']]

# Changing Payroll to be in Millions & Log Payroll
mlb_df['log_Payroll'] = np.log(mlb_df['Payroll'])

# Cleaned Dataset (300 - 30 rows from 2020 = 270 rows)
print(mlb_df)

# Checking for null values
print("=== Missing Values by Column ===")
print(mlb_df.isnull().sum())

# Checking for duplicate rows
print("=== Number of Duplicate Rows ===")
print(mlb_df.duplicated().sum())

# Checking for missing teams by season
```

```
print("=== Team Count by Season ===")
team_counts = mlb_df.groupby('Season')['Team'].nunique().sort_index()
print(team_counts)
```

```
     Season Team    W    L      WPct  wRC+  FIP-  OPS+  ERA-    Payroll  \
0      2024  LAA   63   99  0.388889    91   113    89   112  172189987
1      2024  BAL   91   71  0.561728   114    97   115    99  111345494
2      2024  BOS   81   81  0.500000   105   100   107    97  190037445
3      2024  CHW   41  121  0.253086    75   108    76   116  141710031
4      2024  CLE   92   69  0.571429   100    98   100    91  106824582
..      …   …   …   …       …    …    …    …    …         …
295    2015  PHI   63   99  0.388889    86   110    89   120  141722639
296    2015  PIT   98   64  0.604938    97    88    97    84   99435606
297    2015  STL  100   62  0.617284    97    91    95    77  132178951
298    2015  SDP   74   88  0.456790    90   103    91   110  107915272
299    2015  SFG   84   78  0.518519   104   106   101   100  181613630

     log_Payroll
0      18.964109
1      18.528148
2      19.062732
3      18.769293
4      18.486699
..           …
295    18.769382
296    18.415021
297    18.699667
298    18.496857
299    19.017392

[270 rows x 11 columns]
=== Missing Values by Column ===
Season         0
Team           0
W              0
L              0
WPct           0
wRC+           0
FIP-           0
OPS+           0
ERA-           0
Payroll        0
log_Payroll    0
dtype: int64
=== Number of Duplicate Rows ===
0
=== Team Count by Season ===
```

```
Season
2015    30
2016    30
2017    30
2018    30
2019    30
2021    30
2022    30
2023    30
2024    30
Name: Team, dtype: int64
```

[6]:
```
# Descriptive Statistics
import numpy as np
mlb_df.describe()
pd.set_option('display.float_format', '{:,.5f}'.format)
mlb_df.describe()
```

[6]:

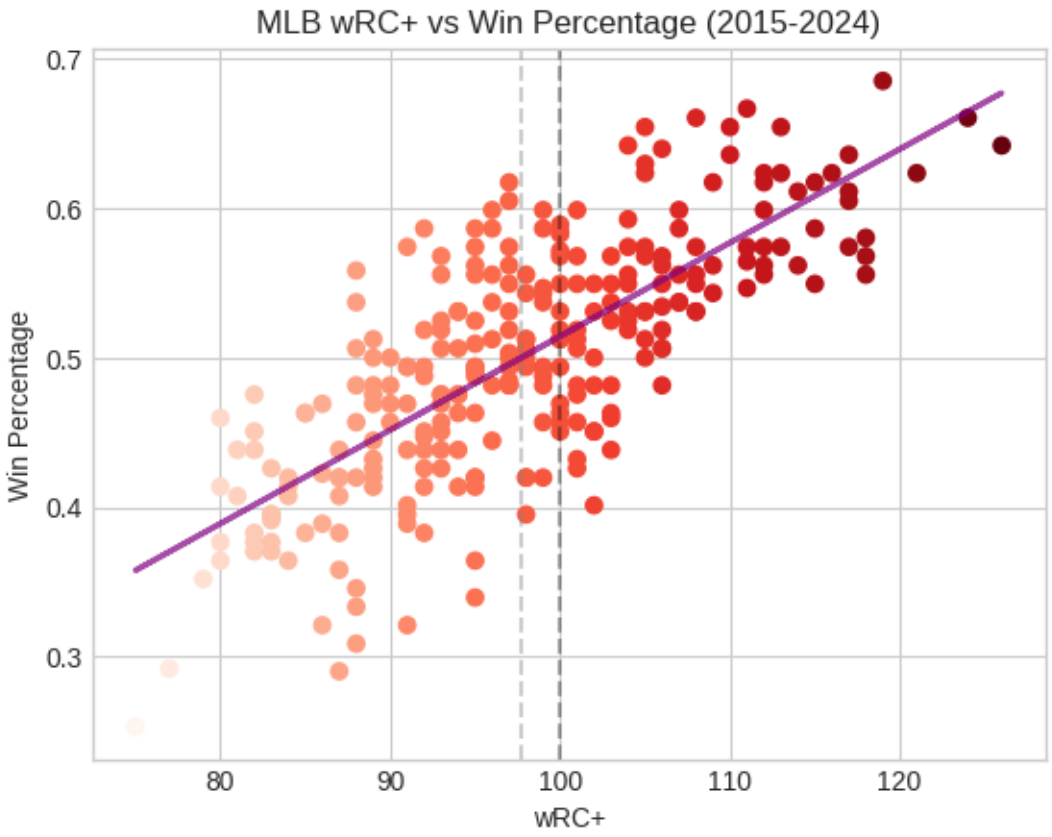
| | Season | W | L | WPct | wRC+ | FIP- | OPS+ | \ |
|---|---|---|---|---|---|---|---|---|
| count | 270.00000 | 270.00000 | 270.00000 | 270.00000 | 270.00000 | 270.00000 | 270.00000 | |
| mean | 2,019.44444 | 80.97778 | 80.97778 | 0.49999 | 97.72222 | 100.05556 | 97.89630 | |
| std | 3.02816 | 13.04323 | 13.02412 | 0.08047 | 9.62304 | 8.43963 | 8.91286 | |
| min | 2,015.00000 | 41.00000 | 51.00000 | 0.25309 | 75.00000 | 75.00000 | 76.00000 | |
| 25% | 2,017.00000 | 72.00000 | 72.00000 | 0.44444 | 91.00000 | 95.00000 | 92.00000 | |
| 50% | 2,019.00000 | 81.50000 | 80.00000 | 0.50464 | 97.00000 | 100.00000 | 97.50000 | |
| 75% | 2,022.00000 | 90.75000 | 90.00000 | 0.55760 | 104.00000 | 106.00000 | 104.00000 | |
| max | 2,024.00000 | 111.00000 | 121.00000 | 0.68519 | 126.00000 | 124.00000 | 126.00000 | |

| | ERA- | Payroll | log_Payroll |
|---|---|---|---|
| count | 270.00000 | 270.00000 | 270.00000 |
| mean | 100.04074 | 144,273,876.64074 | 18.70913 |
| std | 11.03805 | 56,702,754.54537 | 0.40306 |
| min | 71.00000 | 42,421,870.00000 | 17.56317 |
| 25% | 92.00000 | 99,595,787.50000 | 18.41663 |
| 50% | 99.50000 | 140,318,618.00000 | 18.75942 |
| 75% | 107.00000 | 179,283,155.25000 | 19.00448 |
| max | 133.00000 | 346,277,812.00000 | 19.66275 |

[7]:
```
# Loading libraries
%matplotlib inline
import matplotlib.pyplot as plt
import numpy as np
plt.style.use('seaborn-v0_8-whitegrid')

# Establishing plot variables
x=mlb_df['wRC+']
y=mlb_df['WPct']
```

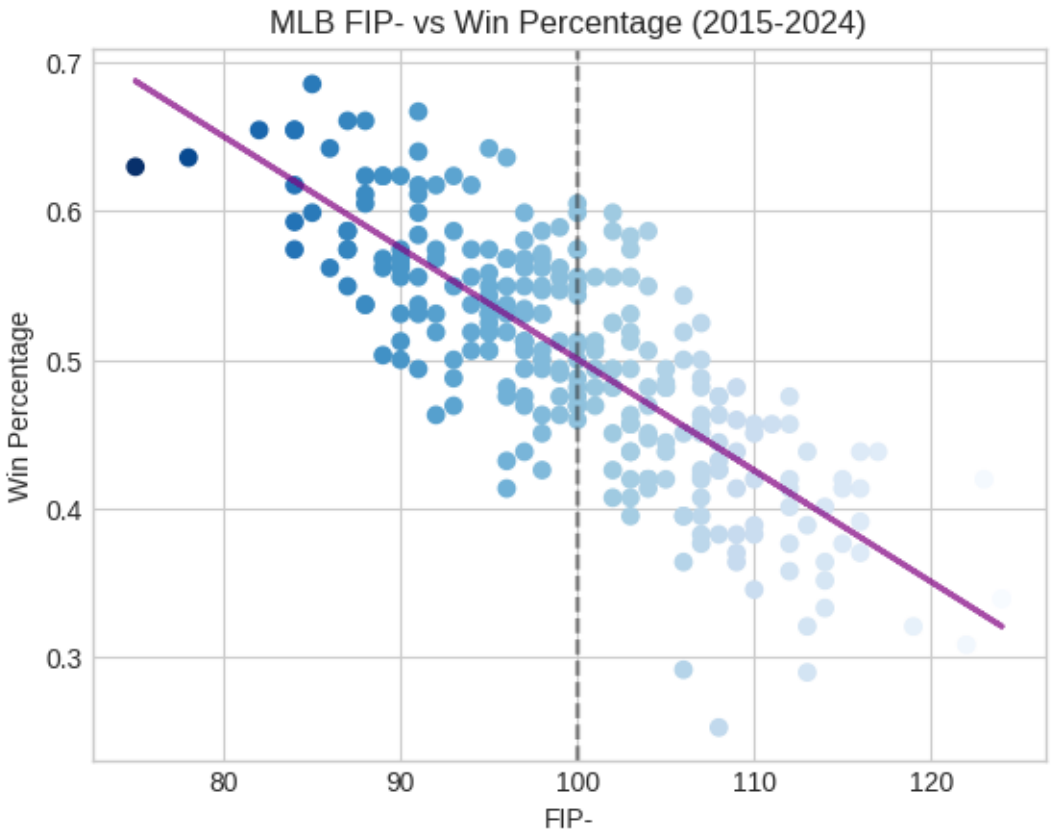
```
# Mapping color
color = np.sqrt((x**2-70**2) + (y**2-0.2**2))

# Plotting graph
plt.scatter(x, y, c=color, cmap='Reds')
plt.axvline(x=97.7222, color='gray', linestyle='--', alpha=0.4)
plt.axvline(x=100, color='black', linestyle='--', alpha=0.35)

# Plotting line of best fit
slope, intercept = np.polyfit(x, y, 1)
line = (slope * x) + intercept
plt.plot(x, line, color='purple', linewidth=2, alpha=0.7)

# Customization
plt.xlabel('wRC+')
plt.ylabel('Win Percentage')
plt.title('MLB wRC+ vs Win Percentage (2015-2024)')
```

[7]: Text(0.5, 1.0, 'MLB wRC+ vs Win Percentage (2015-2024)')



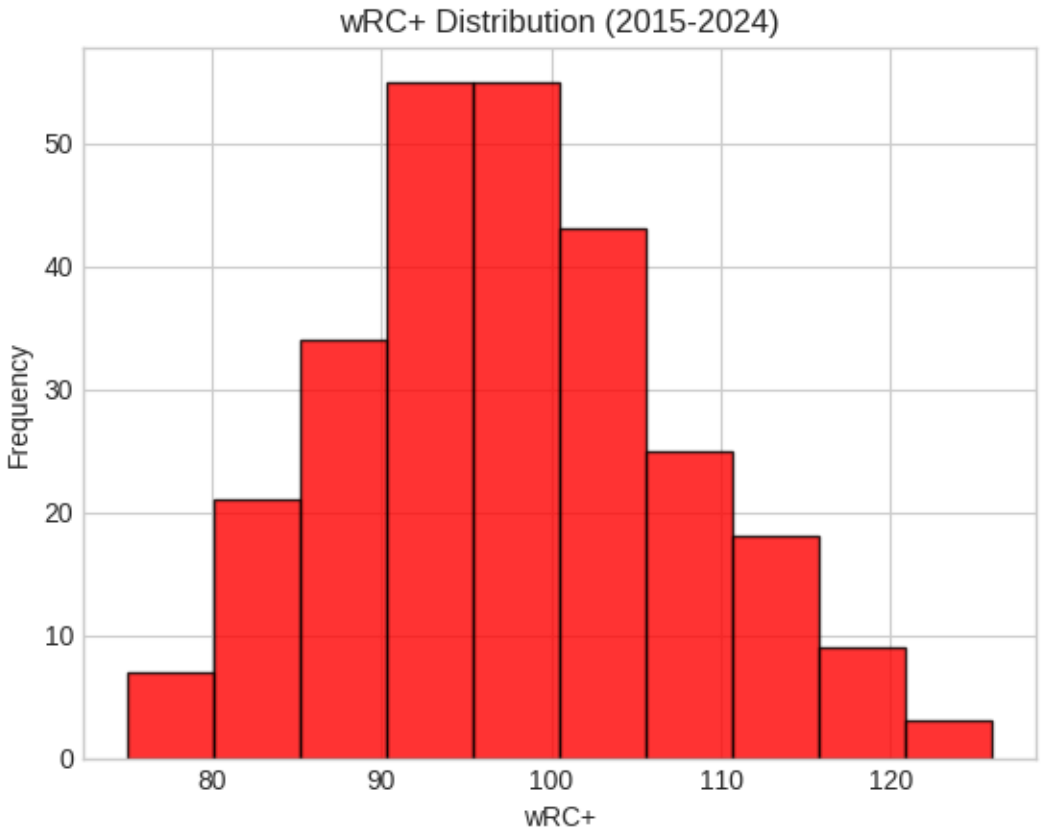
[8]:
```
# Establishing plot variables
x1=mlb_df['FIP-']
y1=mlb_df['WPct']

# Mapping color
color = np.sqrt(((x1**2)-(70**2)) + ((y1**2)-(0.7**2)))

# Plotting graph
plt.scatter(x1, y1, c=color, cmap='Blues_r')
plt.axvline(x=100.06, color='gray', linestyle='--', alpha=0.4)
plt.axvline(x=100, color='black', linestyle='--', alpha=0.35)

# Plotting line of best fit
slope, intercept = np.polyfit(x1, y1, 1)
line = (slope * x1) + intercept
plt.plot(x1, line, color='purple', linewidth=2, alpha=0.7)

# Customization
plt.xlabel('FIP-')
plt.ylabel('Win Percentage')
plt.title('MLB FIP- vs Win Percentage (2015-2024)')
```

[8]:
```
Text(0.5, 1.0, 'MLB FIP- vs Win Percentage (2015-2024)')
```



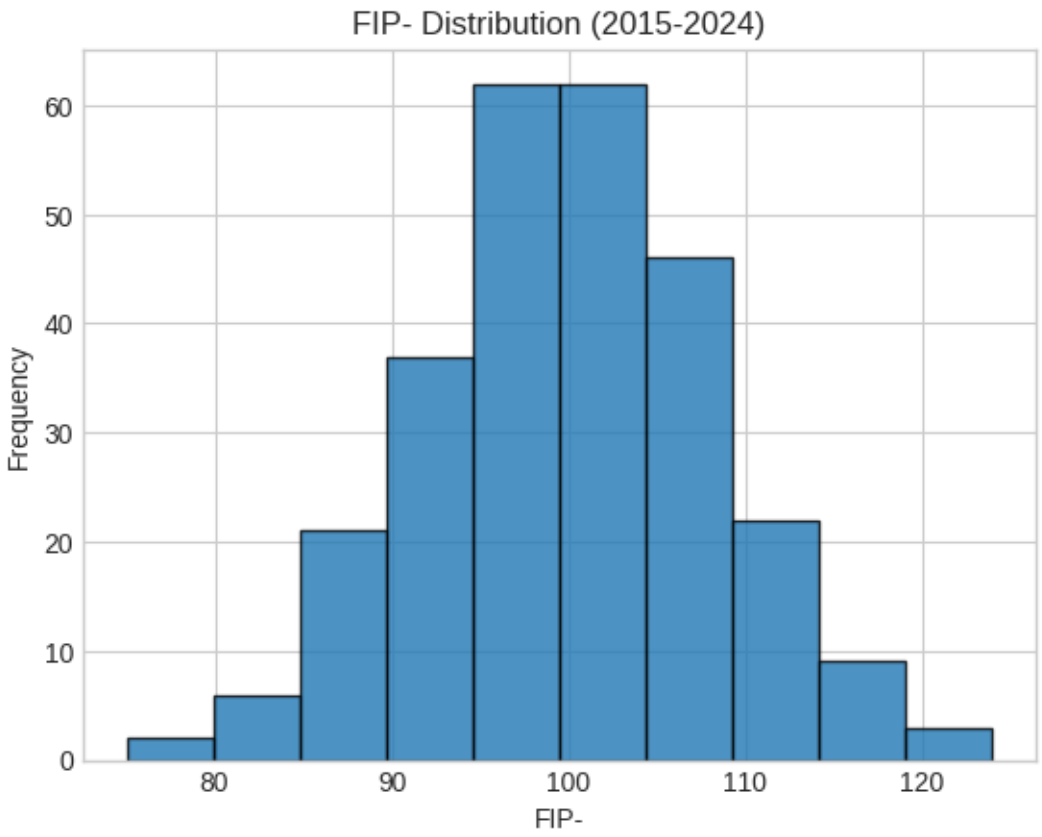
[9]:
```
# wRC+ Histogram
plt.hist(mlb_df["wRC+"], bins = 10, color = 'red', alpha=0.8, edgecolor='black')

# Customization
plt.xlabel('wRC+')
plt.ylabel('Frequency')
plt.title('wRC+ Distribution (2015-2024)')
```

[9]:
```
Text(0.5, 1.0, 'wRC+ Distribution (2015-2024)')
```




[10]:
```
# FIP- Histogram #
plt.hist(mlb_df["FIP-"], bins = 10, alpha=0.8, edgecolor='black')

# Customization
plt.xlabel('FIP-')
plt.ylabel('Frequency')
plt.title('FIP- Distribution (2015-2024)')
```

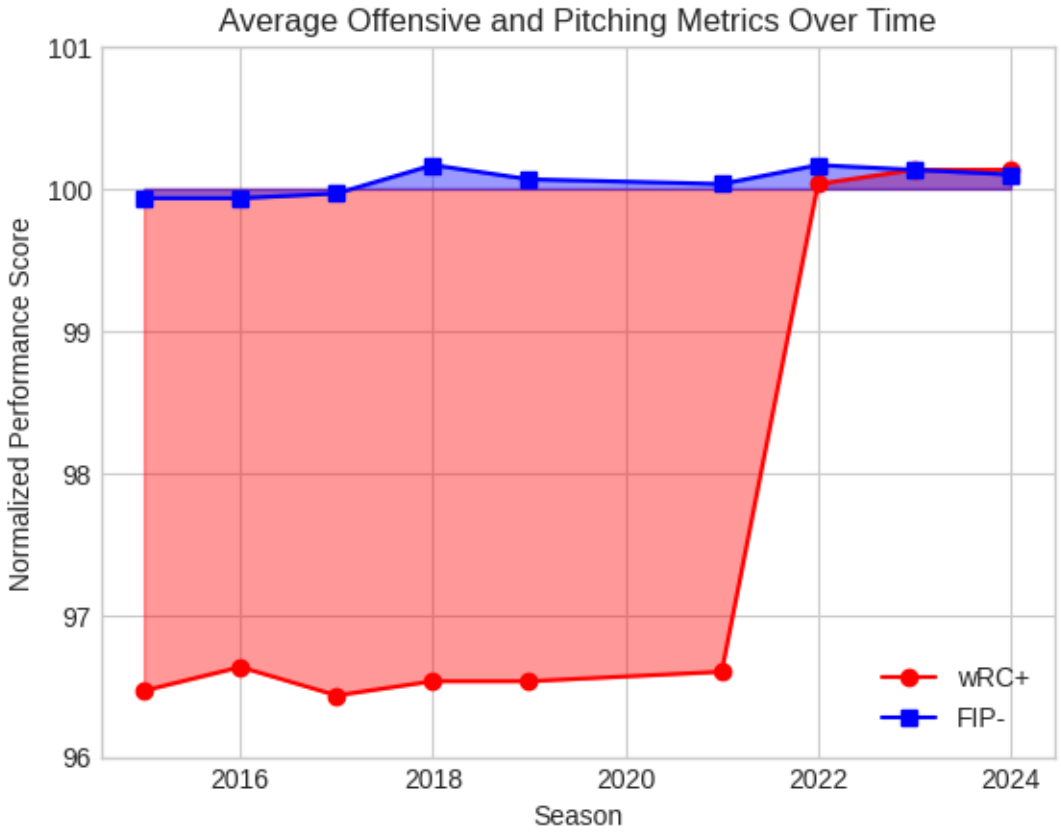
[10]: Text(0.5, 1.0, 'FIP- Distribution (2015-2024)')




[11]:
```
# Creating plot background
fig, ax = plt.subplots()

# Average wRC+ and FIP- values per Season
avg_wrc_and_fip = mlb_df.groupby('Season')[['wRC+', 'FIP-']].mean()

# Plotting time series lines
ax.plot(avg_wrc_and_fip.index, avg_wrc_and_fip['wRC+'], marker='o',␣
 ↪label='wRC+', color='red')
ax.plot(avg_wrc_and_fip.index, avg_wrc_and_fip['FIP-'], marker='s',␣
 ↪label='FIP-', color='blue')

# Filling in space between lines to 100
fill_in_area_wrc = (avg_wrc_and_fip['wRC+'] >= 100) | (avg_wrc_and_fip['wRC+']␣
 ↪<= 100)
fill_in_area_fip = (avg_wrc_and_fip['FIP-'] >= 100) | (avg_wrc_and_fip['FIP-']␣
 ↪<= 100)
```

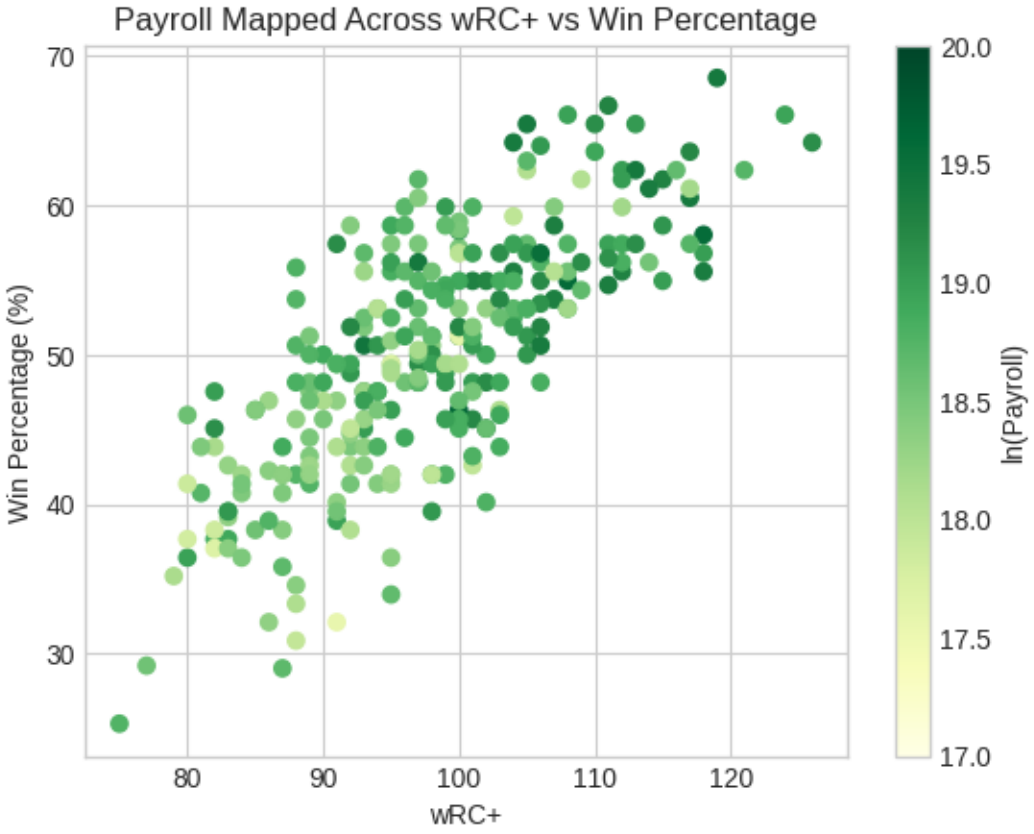
```
ax.fill_between(avg_wrc_and_fip.index, avg_wrc_and_fip['wRC+'], 100, where =␣
 ↪fill_in_area_wrc, color = 'red', alpha = 0.4)
ax.fill_between(avg_wrc_and_fip.index, avg_wrc_and_fip['FIP-'], 100, where =␣
 ↪fill_in_area_wrc, color='blue', alpha = 0.4)

# Customizing
plt.ylim(96, 101)
plt.xlabel('Season')
plt.ylabel('Normalized Performance Score')
plt.title('Average Offensive and Pitching Metrics Over Time')
plt.legend(loc='lower right')
```

[11]: <matplotlib.legend.Legend at 0x7a0258cc44d0>



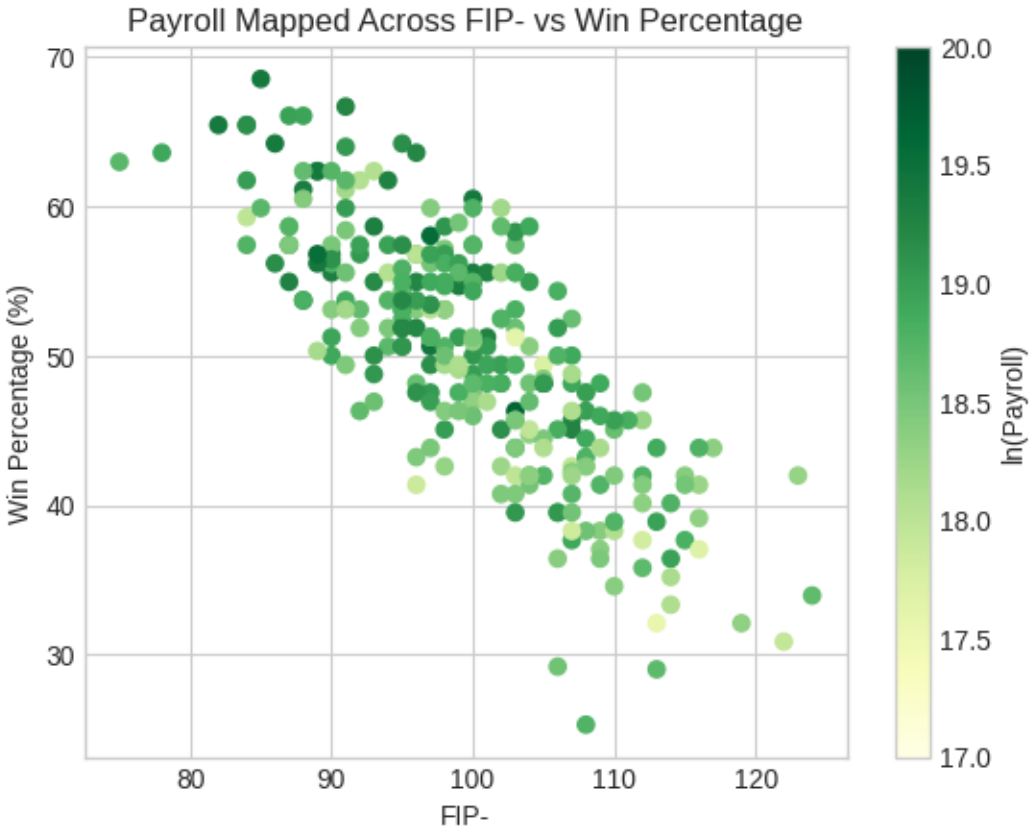

[12]:
```
# Establishing plot variables
x2=mlb_df['wRC+']
y2=mlb_df['WPct'] * 100

# Mapping color
color = mlb_df['log_Payroll']
```

```
# Scatter plot
plt.scatter(x2, y2, c=color, cmap='YlGn', vmin=17, vmax=20)

# Customization
plt.xlabel('wRC+')
plt.ylabel('Win Percentage (%)')
plt.title('Payroll Mapped Across wRC+ vs Win Percentage')
plt.colorbar(label='ln(Payroll)')
plt.show()
```




[13]:
```
# Establishing plot variables
x2=mlb_df['FIP-']
y2=mlb_df['WPct'] * 100

# Mapping color
color = mlb_df['log_Payroll']

# Scatter plot
plt.scatter(x2, y2, c=color, cmap='YlGn', vmin=17, vmax=20)
```

```
# Customization
plt.xlabel('FIP-')
plt.ylabel('Win Percentage (%)')
plt.title('Payroll Mapped Across FIP- vs Win Percentage')
plt.colorbar(label='ln(Payroll)')
plt.show()
```




[14]:
```
# Importing libraries
import statsmodels.api as sm

# Defining the predictors and response variables
X = mlb_df[['wRC+', 'FIP-', 'log_Payroll']]
X = sm.add_constant(X)
y = mlb_df['WPct']

# Fitting the regression model
model = sm.OLS(y,X).fit()

print(model.summary())
```

```
                            OLS Regression Results
==============================================================================
Dep. Variable:                   WPct   R-squared:                       0.782
Model:                            OLS   Adj. R-squared:                  0.779
Method:                 Least Squares   F-statistic:                     317.8
Date:                Wed, 07 Jan 2026   Prob (F-statistic):           1.29e-87
Time:                        02:22:17   Log-Likelihood:                 503.30
No. Observations:                 270   AIC:                            -998.6
Df Residuals:                     266   BIC:                            -984.2
Df Model:                           3
Covariance Type:            nonrobust
==============================================================================
                 coef    std err          t      P>|t|      [0.025      0.975]
------------------------------------------------------------------------------
const          0.5796      0.127      4.580      0.000       0.330       0.829
wRC+           0.0039      0.000     13.406      0.000       0.003       0.005
FIP-          -0.0052      0.000    -16.128      0.000      -0.006      -0.005
log_Payroll    0.0029      0.006      0.448      0.654      -0.010       0.015
==============================================================================
Omnibus:                        1.673   Durbin-Watson:                   2.012
Prob(Omnibus):                  0.433   Jarque-Bera (JB):                1.363
Skew:                           0.135   Prob(JB):                        0.506
Kurtosis:                       3.220   Cond. No.                     7.78e+03
==============================================================================

Notes:
[1] Standard Errors assume that the covariance matrix of the errors is correctly
specified.
[2] The condition number is large, 7.78e+03. This might indicate that there are
strong multicollinearity or other numerical problems.
```

[15]:
```python
# Importing library
from statsmodels.stats.outliers_influence import variance_inflation_factor

# Calculating VIF for each predictor to test for multicollinearity
X = mlb_df[['wRC+', 'FIP-', 'log_Payroll']]
X = sm.add_constant(X)
vif_data = pd.DataFrame()
vif_data["Variable"] = X.columns
vif_data["VIF"] = [variance_inflation_factor(X.values, i) for i in range(X.
  ↪shape[1])]
print("\nVariance Inflation Factor:")
print(vif_data)
```

```
Variance Inflation Factor:
      Variable         VIF
0        const 3,025.82324
```

```
1          wRC+     1.49436
2          FIP-     1.37586
3  log_Payroll      1.25628
```

[16]:
```python
# Heteroskedasticity check
from statsmodels.stats.diagnostic import het_breuschpagan

bp_test = het_breuschpagan(model.resid, model.model.exog)
lm_stat, lm_pvalue, f_stat, f_pvalue = bp_test

print("LM Statistic:", lm_stat)
print("LM p-value:", lm_pvalue)
print("F Statistic:", f_stat)
print("F p-value:", f_pvalue)
```

```
LM Statistic: 7.138642194413447
LM p-value: 0.06760763328490281
F Statistic: 2.4079598963830935
F p-value: 0.06754058266656329
```

[17]:
```python
# F-Test (H0 = Beta1 + Beta2 = 0)
hypothesis = 'wRC+ + FIP- = 0'
f_test = model.f_test(hypothesis)
print(f_test)
```

```
<F test: F=5.750974246880449, p=0.017168938877853975, df_denom=266, df_num=1>
```

[18]:
```
# Importing libraries
import statsmodels.api as sm

# Defining the predictors and response variables
X = mlb_df[['OPS+', 'ERA-', 'log_Payroll']]
X = sm.add_constant(X)
y = mlb_df['WPct']

# Fitting the regression model
model2 = sm.OLS(y,X).fit()

print(model2.summary())
```

```
                            OLS Regression Results
==============================================================================
Dep. Variable:                    WPct   R-squared:                       0.874
Model:                            OLS   Adj. R-squared:                  0.872
Method:                 Least Squares   F-statistic:                     613.5
Date:                Wed, 07 Jan 2026   Prob (F-statistic):          3.68e-119
Time:                        02:22:17   Log-Likelihood:                 577.08
No. Observations:                 270   AIC:                            -1146.
Df Residuals:                     266   BIC:                            -1132.
Df Model:                           3
Covariance Type:            nonrobust
==============================================================================
                 coef    std err          t      P>|t|      [0.025      0.975]
------------------------------------------------------------------------------
const          0.6327      0.094      6.746      0.000       0.448       0.817
OPS+           0.0036      0.000     15.681      0.000       0.003       0.004
ERA-          -0.0050      0.000    -27.226      0.000      -0.005      -0.005
log_Payroll    0.0003      0.005      0.072      0.943      -0.009       0.010
==============================================================================
Omnibus:                        1.926   Durbin-Watson:                   1.942
Prob(Omnibus):                  0.382   Jarque-Bera (JB):                1.699
Skew:                          -0.085   Prob(JB):                        0.428
Kurtosis:                       3.349   Cond. No.                     7.59e+03
==============================================================================

Notes:
[1] Standard Errors assume that the covariance matrix of the errors is correctly
specified.
[2] The condition number is large, 7.59e+03. This might indicate that there are
strong multicollinearity or other numerical problems.
```

[19]:
```
# Importing library
from statsmodels.stats.outliers_influence import variance_inflation_factor
```

```
# Calculating VIF for each predictor to test for multicollinearity
X = mlb_df[['OPS+', 'ERA-', 'log_Payroll']]
X = sm.add_constant(X)
vif_data2 = pd.DataFrame()
vif_data2["Variable"] = X.columns
vif_data2["VIF"] = [variance_inflation_factor(X.values, i) for i in range(X.
  ↪shape[1])]
print("\nVariance Inflation Factor:")
print(vif_data)
```

```
Variance Inflation Factor:
      Variable         VIF
0        const 3,025.82324
1         wRC+     1.49436
2         FIP-     1.37586
3  log_Payroll     1.25628
```

[20]:
```
# Heteroskedasticity check
from statsmodels.stats.diagnostic import het_breuschpagan

bp_test2 = het_breuschpagan(model2.resid, model2.model.exog)
lm_stat2, lm_pvalue2, f_stat2, f_pvalue2 = bp_test2

print("LM Statistic:", lm_stat2)
print("LM p-value:", lm_pvalue2)
print("F Statistic:", f_stat2)
print("F p-value:", f_pvalue2)
```

```
LM Statistic: 7.33247336981223
LM p-value: 0.06202282818335681
F Statistic: 2.475166917145029
F p-value: 0.061885206634377125
```

[21]:
```
# F-Test (H0 = Beta1 + Beta2 = 0)
hypothesis2 = 'OPS+ + ERA- = 0'
f_test2 = model2.f_test(hypothesis2)
print(f_test2)
```

```
<F test: F=14.650040579938667, p=0.00016141211653187258, df_denom=266, df_num=1>
```

```
[ ]: !sudo apt-get install texlive-xetex texlive-fonts-recommended␣
      ↪texlive-plain-generic
     !apt-get install -y pandoc


     import nbformat

     notebook_path = '/content/drive/MyDrive/Colab Notebooks/ECON 5283 - Data␣
      ↪Visualization with Python/Project/Econometrics Project.ipynb'

     with open(notebook_path) as f:
         nb = nbformat.read(f, as_version=4)

     nb['metadata']['title'] = 'Offense vs. Pitching: An Econometric Analysis of␣
      ↪What Drives Winning in Major League Baseball'
     nb['metadata']['authors'] = [{
         'name': 'Adrian Montez'
     }]

     with open(notebook_path, 'w') as f:
         nbformat.write(nb, f)


     !jupyter nbconvert --to pdf '/content/drive/MyDrive/Colab Notebooks/ECON 5283 -␣
      ↪Data Visualization with Python/Project/Econometrics Project.ipynb'
```

```
Reading package lists… Done
Building dependency tree… Done
Reading state information… Done
The following additional packages will be installed:
  dvisvgm fonts-droid-fallback fonts-lato fonts-lmodern fonts-noto-mono
  fonts-texgyre fonts-urw-base35 libapache-pom-java libcommons-logging-java
  libcommons-parent-java libfontbox-java libgs9 libgs9-common libidn12
  libijs-0.35 libjbig2dec0 libkpathsea6 libpdfbox-java libptexenc1 libruby3.0
  libsynctex2 libteckit0 libtexlua53 libtexluajit2 libwoff1 libzzip-0-13
  lmodern poppler-data preview-latex-style rake ruby ruby-net-telnet
  ruby-rubygems ruby-webrick ruby-xmlrpc ruby3.0 rubygems-integration t1utils
  teckit tex-common tex-gyre texlive-base texlive-binaries texlive-latex-base
  texlive-latex-extra texlive-latex-recommended texlive-pictures tipa
  xfonts-encodings xfonts-utils
Suggested packages:
  fonts-noto fonts-freefont-otf | fonts-freefont-ttf libavalon-framework-java
  libcommons-logging-java-doc libexcalibur-logkit-java liblog4j1.2-java
  poppler-utils ghostscript fonts-japanese-mincho | fonts-ipafont-mincho
  fonts-japanese-gothic | fonts-ipafont-gothic fonts-arphic-ukai
  fonts-arphic-uming fonts-nanum ri ruby-dev bundler debhelper gv
  | postscript-viewer perl-tk xpdf | pdf-viewer xzdec
```

```
  texlive-fonts-recommended-doc texlive-latex-base-doc python3-pygments
  icc-profiles libfile-which-perl libspreadsheet-parseexcel-perl
  texlive-latex-extra-doc texlive-latex-recommended-doc texlive-luatex
  texlive-pstricks dot2tex prerex texlive-pictures-doc vprerex
  default-jre-headless tipa-doc
The following NEW packages will be installed:
  dvisvgm fonts-droid-fallback fonts-lato fonts-lmodern fonts-noto-mono
  fonts-texgyre fonts-urw-base35 libapache-pom-java libcommons-logging-java
  libcommons-parent-java libfontbox-java libgs9 libgs9-common libidn12
  libijs-0.35 libjbig2dec0 libkpathsea6 libpdfbox-java libptexenc1 libruby3.0
  libsynctex2 libteckit0 libtexlua53 libtexluajit2 libwoff1 libzzip-0-13
  lmodern poppler-data preview-latex-style rake ruby ruby-net-telnet
  ruby-rubygems ruby-webrick ruby-xmlrpc ruby3.0 rubygems-integration t1utils
  teckit tex-common tex-gyre texlive-base texlive-binaries
  texlive-fonts-recommended texlive-latex-base texlive-latex-extra
  texlive-latex-recommended texlive-pictures texlive-plain-generic
  texlive-xetex tipa xfonts-encodings xfonts-utils
0 upgraded, 53 newly installed, 0 to remove and 1 not upgraded.
Need to get 85.0 MB/182 MB of archives.
After this operation, 571 MB of additional disk space will be used.
Get:1 http://archive.ubuntu.com/ubuntu jammy/universe amd64 libpdfbox-java all
1:1.8.16-2 [5,199 kB]
Get:2 http://archive.ubuntu.com/ubuntu jammy/universe amd64 texlive-latex-
recommended all 2021.20220204-1 [14.4 MB]
Get:3 http://archive.ubuntu.com/ubuntu jammy/universe amd64 texlive-pictures all
2021.20220204-1 [8,720 kB]
Get:4 http://archive.ubuntu.com/ubuntu jammy/universe amd64 texlive-latex-extra
all 2021.20220204-1 [13.9 MB]
Get:5 http://archive.ubuntu.com/ubuntu jammy/universe amd64 texlive-plain-
generic all 2021.20220204-1 [27.5 MB]
Get:6 http://archive.ubuntu.com/ubuntu jammy/universe amd64 tipa all 2:1.3-21
[2,967 kB]
Get:7 http://archive.ubuntu.com/ubuntu jammy/universe amd64 texlive-xetex all
2021.20220204-1 [12.4 MB]
Fetched 84.0 MB in 6s (14.0 MB/s)
debconf: unable to initialize frontend: Dialog
debconf: (No usable dialog-like program is installed, so the dialog based
frontend cannot be used. at /usr/share/perl5/Debconf/FrontEnd/Dialog.pm line 78,
<> line 53.)
debconf: falling back to frontend: Readline
debconf: unable to initialize frontend: Readline
debconf: (This frontend requires a controlling tty.)
debconf: falling back to frontend: Teletype
dpkg-preconfigure: unable to re-open stdin:
Selecting previously unselected package fonts-droid-fallback.
(Reading database … 117528 files and directories currently installed.)
Preparing to unpack …/00-fonts-droid-fallback_1%3a6.0.1r16-1.1build1_all.deb
…
```

```
Unpacking fonts-droid-fallback (1:6.0.1r16-1.1build1) …
Selecting previously unselected package fonts-lato.
Preparing to unpack …/01-fonts-lato_2.0-2.1_all.deb …
Unpacking fonts-lato (2.0-2.1) …
Selecting previously unselected package poppler-data.
Preparing to unpack …/02-poppler-data_0.4.11-1_all.deb …
Unpacking poppler-data (0.4.11-1) …
Selecting previously unselected package tex-common.
Preparing to unpack …/03-tex-common_6.17_all.deb …
Unpacking tex-common (6.17) …
Selecting previously unselected package fonts-urw-base35.
Preparing to unpack …/04-fonts-urw-base35_20200910-1_all.deb …
Unpacking fonts-urw-base35 (20200910-1) …
Selecting previously unselected package libgs9-common.
Preparing to unpack …/05-libgs9-common_9.55.0~dfsg1-0ubuntu5.13_all.deb …
Unpacking libgs9-common (9.55.0~dfsg1-0ubuntu5.13) …
Selecting previously unselected package libidn12:amd64.
Preparing to unpack …/06-libidn12_1.38-4ubuntu1_amd64.deb …
Unpacking libidn12:amd64 (1.38-4ubuntu1) …
Selecting previously unselected package libijs-0.35:amd64.
Preparing to unpack …/07-libijs-0.35_0.35-15build2_amd64.deb …
Unpacking libijs-0.35:amd64 (0.35-15build2) …
Selecting previously unselected package libjbig2dec0:amd64.
Preparing to unpack …/08-libjbig2dec0_0.19-3build2_amd64.deb …
Unpacking libjbig2dec0:amd64 (0.19-3build2) …
Selecting previously unselected package libgs9:amd64.
Preparing to unpack …/09-libgs9_9.55.0~dfsg1-0ubuntu5.13_amd64.deb …
Unpacking libgs9:amd64 (9.55.0~dfsg1-0ubuntu5.13) …
Selecting previously unselected package libkpathsea6:amd64.
Preparing to unpack …/10-libkpathsea6_2021.20210626.59705-1ubuntu0.2_amd64.deb
…
Unpacking libkpathsea6:amd64 (2021.20210626.59705-1ubuntu0.2) …
Selecting previously unselected package libwoff1:amd64.
Preparing to unpack …/11-libwoff1_1.0.2-1build4_amd64.deb …
Unpacking libwoff1:amd64 (1.0.2-1build4) …
Selecting previously unselected package dvisvgm.
Preparing to unpack …/12-dvisvgm_2.13.1-1_amd64.deb …
Unpacking dvisvgm (2.13.1-1) …
Selecting previously unselected package fonts-lmodern.
Preparing to unpack …/13-fonts-lmodern_2.004.5-6.1_all.deb …
Unpacking fonts-lmodern (2.004.5-6.1) …
Selecting previously unselected package fonts-noto-mono.
Preparing to unpack …/14-fonts-noto-mono_20201225-1build1_all.deb …
Unpacking fonts-noto-mono (20201225-1build1) …
Selecting previously unselected package fonts-texgyre.
Preparing to unpack …/15-fonts-texgyre_20180621-3.1_all.deb …
Unpacking fonts-texgyre (20180621-3.1) …
Selecting previously unselected package libapache-pom-java.
```

```
Preparing to unpack …/16-libapache-pom-java_18-1_all.deb …
Unpacking libapache-pom-java (18-1) …
Selecting previously unselected package libcommons-parent-java.
Preparing to unpack …/17-libcommons-parent-java_43-1_all.deb …
Unpacking libcommons-parent-java (43-1) …
Selecting previously unselected package libcommons-logging-java.
Preparing to unpack …/18-libcommons-logging-java_1.2-2_all.deb …
Unpacking libcommons-logging-java (1.2-2) …
Selecting previously unselected package libptexenc1:amd64.
Preparing to unpack …/19-libptexenc1_2021.20210626.59705-1ubuntu0.2_amd64.deb
…
Unpacking libptexenc1:amd64 (2021.20210626.59705-1ubuntu0.2) …
Selecting previously unselected package rubygems-integration.
Preparing to unpack …/20-rubygems-integration_1.18_all.deb …
Unpacking rubygems-integration (1.18) …
Selecting previously unselected package ruby3.0.
Preparing to unpack …/21-ruby3.0_3.0.2-7ubuntu2.11_amd64.deb …
Unpacking ruby3.0 (3.0.2-7ubuntu2.11) …
Selecting previously unselected package ruby-rubygems.
Preparing to unpack …/22-ruby-rubygems_3.3.5-2ubuntu1.2_all.deb …
Unpacking ruby-rubygems (3.3.5-2ubuntu1.2) …
Selecting previously unselected package ruby.
Preparing to unpack …/23-ruby_1%3a3.0~exp1_amd64.deb …
Unpacking ruby (1:3.0~exp1) …
Selecting previously unselected package rake.
Preparing to unpack …/24-rake_13.0.6-2_all.deb …
Unpacking rake (13.0.6-2) …
Selecting previously unselected package ruby-net-telnet.
Preparing to unpack …/25-ruby-net-telnet_0.1.1-2_all.deb …
Unpacking ruby-net-telnet (0.1.1-2) …
Selecting previously unselected package ruby-webrick.
Preparing to unpack …/26-ruby-webrick_1.7.0-3ubuntu0.2_all.deb …
Unpacking ruby-webrick (1.7.0-3ubuntu0.2) …
Selecting previously unselected package ruby-xmlrpc.
Preparing to unpack …/27-ruby-xmlrpc_0.3.2-1ubuntu0.1_all.deb …
Unpacking ruby-xmlrpc (0.3.2-1ubuntu0.1) …
Selecting previously unselected package libruby3.0:amd64.
Preparing to unpack …/28-libruby3.0_3.0.2-7ubuntu2.11_amd64.deb …
Unpacking libruby3.0:amd64 (3.0.2-7ubuntu2.11) …
Selecting previously unselected package libsynctex2:amd64.
Preparing to unpack …/29-libsynctex2_2021.20210626.59705-1ubuntu0.2_amd64.deb
…
Unpacking libsynctex2:amd64 (2021.20210626.59705-1ubuntu0.2) …
Selecting previously unselected package libteckit0:amd64.
Preparing to unpack …/30-libteckit0_2.5.11+ds1-1_amd64.deb …
Unpacking libteckit0:amd64 (2.5.11+ds1-1) …
Selecting previously unselected package libtexlua53:amd64.
Preparing to unpack …/31-libtexlua53_2021.20210626.59705-1ubuntu0.2_amd64.deb
```

```
…
Unpacking libtexlua53:amd64 (2021.20210626.59705-1ubuntu0.2) …
Selecting previously unselected package libtexluajit2:amd64.
Preparing to unpack
…/32-libtexluajit2_2021.20210626.59705-1ubuntu0.2_amd64.deb …
Unpacking libtexluajit2:amd64 (2021.20210626.59705-1ubuntu0.2) …
Selecting previously unselected package libzzip-0-13:amd64.
Preparing to unpack …/33-libzzip-0-13_0.13.72+dfsg.1-1.1_amd64.deb …
Unpacking libzzip-0-13:amd64 (0.13.72+dfsg.1-1.1) …
Selecting previously unselected package xfonts-encodings.
Preparing to unpack …/34-xfonts-encodings_1%3a1.0.5-0ubuntu2_all.deb …
Unpacking xfonts-encodings (1:1.0.5-0ubuntu2) …
Selecting previously unselected package xfonts-utils.
Preparing to unpack …/35-xfonts-utils_1%3a7.7+6build2_amd64.deb …
Unpacking xfonts-utils (1:7.7+6build2) …
Selecting previously unselected package lmodern.
Preparing to unpack …/36-lmodern_2.004.5-6.1_all.deb …
Unpacking lmodern (2.004.5-6.1) …
Selecting previously unselected package preview-latex-style.
Preparing to unpack …/37-preview-latex-style_12.2-1ubuntu1_all.deb …
Unpacking preview-latex-style (12.2-1ubuntu1) …
Selecting previously unselected package t1utils.
Preparing to unpack …/38-t1utils_1.41-4build2_amd64.deb …
Unpacking t1utils (1.41-4build2) …
Selecting previously unselected package teckit.
Preparing to unpack …/39-teckit_2.5.11+ds1-1_amd64.deb …
Unpacking teckit (2.5.11+ds1-1) …
Selecting previously unselected package tex-gyre.
Preparing to unpack …/40-tex-gyre_20180621-3.1_all.deb …
Unpacking tex-gyre (20180621-3.1) …
Selecting previously unselected package texlive-binaries.
Preparing to unpack …/41-texlive-
binaries_2021.20210626.59705-1ubuntu0.2_amd64.deb …
Unpacking texlive-binaries (2021.20210626.59705-1ubuntu0.2) …
Selecting previously unselected package texlive-base.
Preparing to unpack …/42-texlive-base_2021.20220204-1_all.deb …
Unpacking texlive-base (2021.20220204-1) …
Selecting previously unselected package texlive-fonts-recommended.
Preparing to unpack …/43-texlive-fonts-recommended_2021.20220204-1_all.deb …
Unpacking texlive-fonts-recommended (2021.20220204-1) …
Selecting previously unselected package texlive-latex-base.
Preparing to unpack …/44-texlive-latex-base_2021.20220204-1_all.deb …
Unpacking texlive-latex-base (2021.20220204-1) …
Selecting previously unselected package libfontbox-java.
Preparing to unpack …/45-libfontbox-java_1%3a1.8.16-2_all.deb …
Unpacking libfontbox-java (1:1.8.16-2) …
Selecting previously unselected package libpdfbox-java.
Preparing to unpack …/46-libpdfbox-java_1%3a1.8.16-2_all.deb …
```

```
Unpacking libpdfbox-java (1:1.8.16-2) …
Selecting previously unselected package texlive-latex-recommended.
Preparing to unpack …/47-texlive-latex-recommended_2021.20220204-1_all.deb …
Unpacking texlive-latex-recommended (2021.20220204-1) …
Selecting previously unselected package texlive-pictures.
Preparing to unpack …/48-texlive-pictures_2021.20220204-1_all.deb …
Unpacking texlive-pictures (2021.20220204-1) …
Selecting previously unselected package texlive-latex-extra.
Preparing to unpack …/49-texlive-latex-extra_2021.20220204-1_all.deb …
Unpacking texlive-latex-extra (2021.20220204-1) …
Selecting previously unselected package texlive-plain-generic.
Preparing to unpack …/50-texlive-plain-generic_2021.20220204-1_all.deb …
Unpacking texlive-plain-generic (2021.20220204-1) …
Selecting previously unselected package tipa.
Preparing to unpack …/51-tipa_2%3a1.3-21_all.deb …
Unpacking tipa (2:1.3-21) …
```

[ ]:
```
from google.colab import files

files.download('cleaned_data.csv')
```