Baseball Spending Efficiency

March 16, 2021

[1]:
```python
import sqlite3
import pandas as pd
import numpy as np
```

[2]:
```python
## Part 1
## Problem 1
sqlite_file = 'lahman2014.sqlite'
conn = sqlite3.connect(sqlite_file)
salary_query = "SELECT teamID, yearID, sum(salary) as total_payroll,␣
↪sum(salary)/count(salary) as team_payroll_mean FROM Salaries GROUP BY␣
↪teamID, yearID"
team_salaries = pd.read_sql(salary_query, conn)
```

[3]:
```python
team_salaries
```

[3]:
```
    teamID  yearID  total_payroll  team_payroll_mean
0      ATL    1985     14807000.0       6.730455e+05
1      BAL    1985     11560712.0       5.254869e+05
2      BOS    1985     10897560.0       4.359024e+05
3      CAL    1985     14427894.0       5.152819e+05
4      CHA    1985      9846178.0       4.688656e+05
..     …      …            …                …
855    SLN    2014    120693000.0       4.310464e+06
856    TBA    2014     72689100.0       2.907564e+06
857    TEX    2014    112255059.0       4.677294e+06
858    TOR    2014    109920100.0       4.396804e+06
859    WAS    2014    131983680.0       4.399456e+06

[860 rows x 4 columns]
```

[4]:
```python
conn = sqlite3.connect(sqlite_file)
winning_query = "select teamID, yearID,(w*100.0/G) as winning_per, G  from␣
↪Teams group by teamID, yearID"
winning_table = pd.read_sql(winning_query,conn)
```

```
result=pd.merge(winning_table, team_salaries, how='outer',␣
 ↪on=['teamID','yearID'])
result
# I use outer-join to join the 2 tables above, that is making any unmatched␣
 ↪pantry to NaN.
```

[4]:

```
     teamID  yearID  winning_per      G  total_payroll  team_payroll_mean
0       ALT    1884    24.000000   25.0            NaN                NaN
1       ANA    1997    51.851852  162.0     31135472.0       1.004370e+06
2       ANA    1998    52.469136  162.0     41281000.0       1.214147e+06
3       ANA    1999    43.209877  162.0     55388166.0       1.384704e+06
4       ANA    2000    50.617284  162.0     51464167.0       1.715472e+06
…       …      …            …      …              …                  …
2772    WS8    1889    32.283465  127.0            NaN                NaN
2773    WS9    1891    31.654676  139.0            NaN                NaN
2774    WSU    1884    41.228070  114.0            NaN                NaN
2775    NYM    2014          NaN    NaN     54806990.0       2.283625e+06
2776    SFG    2014          NaN    NaN    143510167.0       5.315191e+06

[2777 rows x 6 columns]
```

[ ]:

[5]:

```
import matplotlib.pyplot as plt

result['yearID']=result['yearID'].apply(lambda x:int(x))
temp=result[result['yearID']>=1990]
temp=temp[temp['yearID']<=2014]
team_ID_list = temp['teamID'].drop_duplicates()
temp.index=temp['teamID']
temp
```

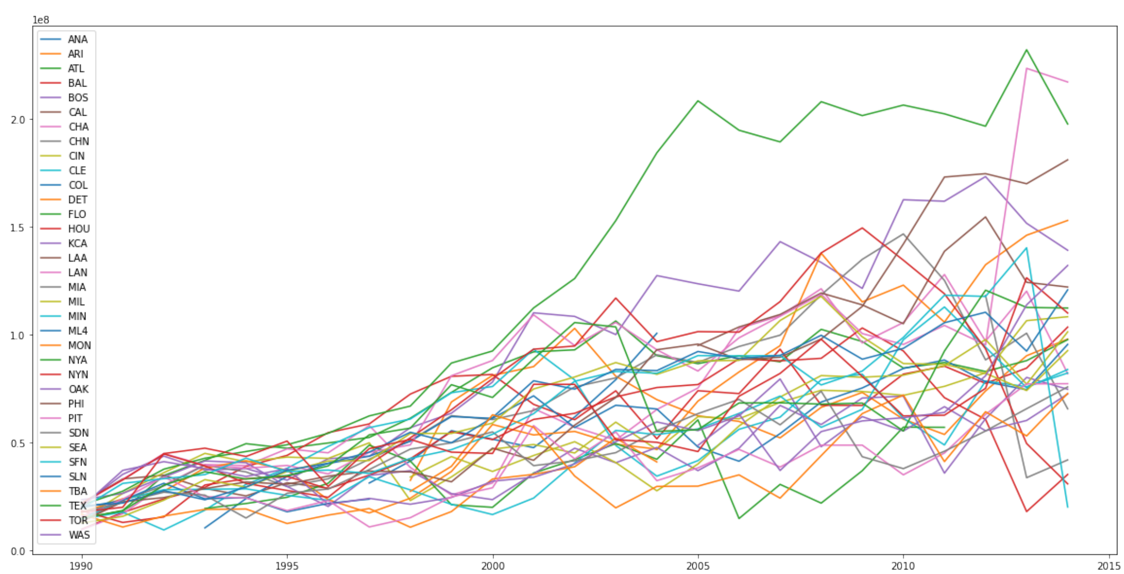
[5]:

```
       teamID  yearID  winning_per      G  total_payroll  team_payroll_mean
teamID
ANA       ANA    1997    51.851852  162.0     31135472.0       1.004370e+06
ANA       ANA    1998    52.469136  162.0     41281000.0       1.214147e+06
ANA       ANA    1999    43.209877  162.0     55388166.0       1.384704e+06
ANA       ANA    2000    50.617284  162.0     51464167.0       1.715472e+06
ANA       ANA    2001    46.296296  162.0     47535167.0       1.584506e+06
…         …      …            …      …              …                  …
WAS       WAS    2012    60.493827  162.0     80855143.0       2.695171e+06
WAS       WAS    2013    53.086420  162.0    113703270.0       4.548131e+06
WAS       WAS    2014    59.259259  162.0    131983680.0       4.399456e+06
NYM       NYM    2014          NaN    NaN     54806990.0       2.283625e+06
SFG       SFG    2014          NaN    NaN    143510167.0       5.315191e+06

[730 rows x 6 columns]
```

[6]:
```python
# Problem 2
# for teamID in team_ID_list:
#     if(type(temp.loc[teamID,'yearID']) is not np.int64):
#         plt.plot(temp.loc[teamID,'yearID'],temp.
 ↪loc[teamID,'total_payroll'],label=teamID)
#         print("The figure below is for team " +teamID)
#         plt.show()

print("The figure below is a generalized one")
plt.figure(figsize=(20,10))
for teamID in team_ID_list:
    if(type(temp.loc[teamID,'yearID']) is not np.int64):
        plt.plot(temp.loc[teamID,'yearID'],temp.
 ↪loc[teamID,'total_payroll'],label=teamID)

plt.legend()

# Question 1
# From the plot below, we can see that the total_payroll of each team is␣
 ↪increasing by time in the long term.
# Also, the difference between the highest total_payroll and lowest␣
 ↪total_payroll is increasing by time as well.
```

```
The figure below is a generalized one
```

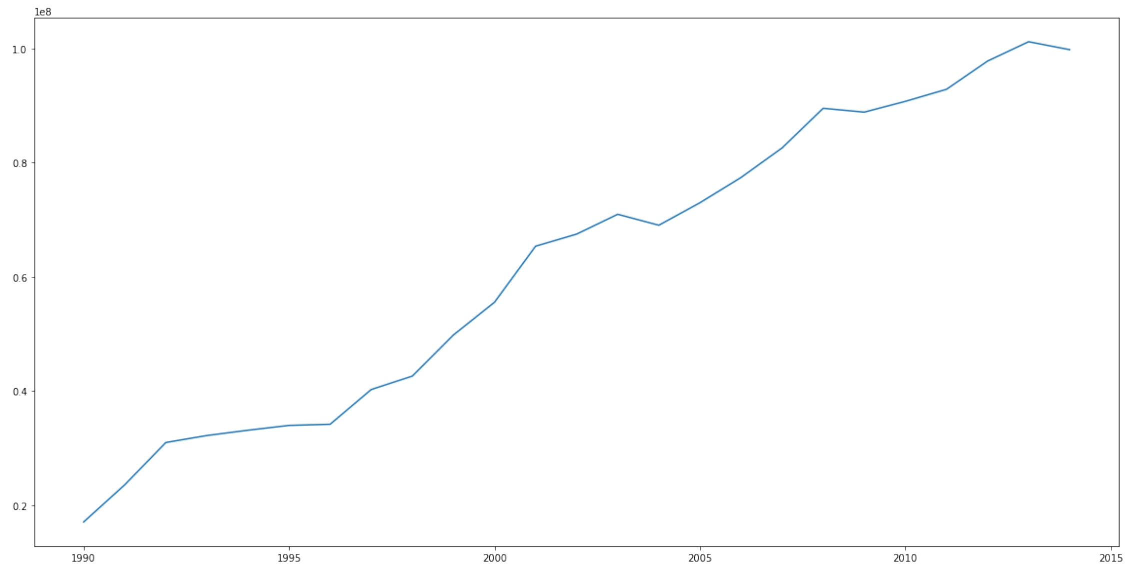
[6]:
```
<matplotlib.legend.Legend at 0x7fc6bcd25cd0>
```



[7]:
```python
# Problem 3
```

[8]:
```
plot_table=temp.groupby(['yearID']).mean()

plt.figure(figsize=(20,10))
plt.plot(plot_table.index,plot_table['total_payroll'])
```

[8]: [<matplotlib.lines.Line2D at 0x7fc6bd2ea310>]



[9]:
```
plot_table
```

[9]:

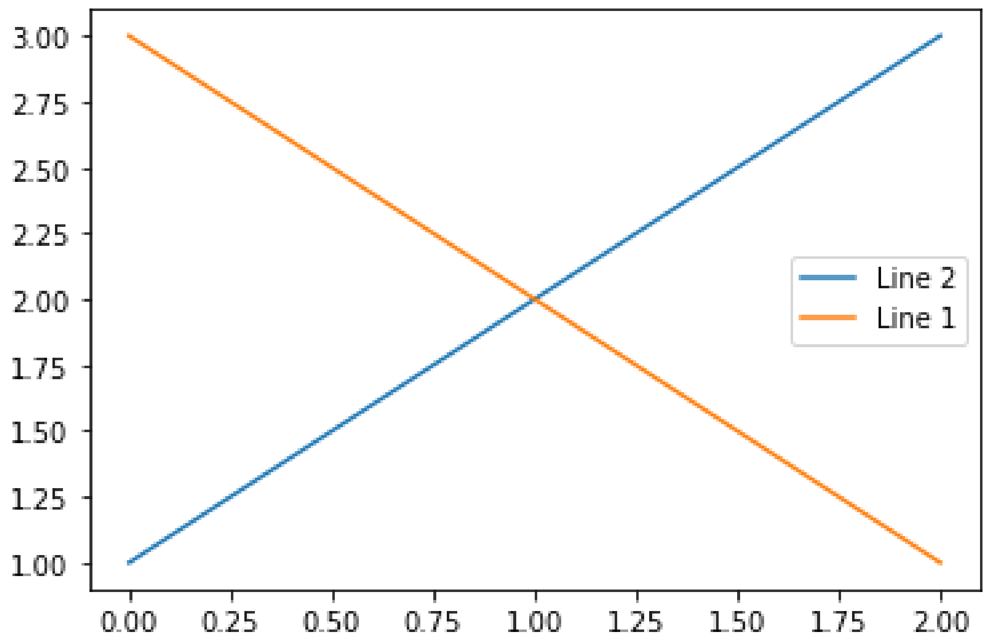
yearID	winning_per	G	total_payroll	team_payroll_mean
1990	49.998525	161.923077	1.707235e+07	5.139887e+05
1991	49.997193	161.846154	2.357879e+07	8.970479e+05
1992	50.000000	162.000000	3.098244e+07	1.056331e+06
1993	49.975925	162.071429	3.220500e+07	9.879449e+05
1994	49.993326	114.285714	3.313701e+07	1.063055e+06
1995	49.970376	144.071429	3.398105e+07	9.721240e+05
1996	49.976884	161.928571	3.417798e+07	1.038646e+06
1997	49.998494	161.857143	4.026021e+07	1.233943e+06
1998	49.955924	162.133333	4.260943e+07	1.299881e+06
1999	49.967969	161.866667	4.980762e+07	1.505079e+06
2000	49.980566	161.933333	5.553784e+07	2.001520e+06
2001	49.981469	161.933333	6.535544e+07	2.266839e+06
2002	49.978274	161.733333	6.746925e+07	2.398339e+06
2003	49.978927	162.000000	7.094207e+07	2.579230e+06
2004	49.994121	161.866667	6.902220e+07	2.485419e+06
2005	49.979550	162.066667	7.295711e+07	2.658144e+06
2006	49.999744	161.933333	7.738242e+07	2.846905e+06

2007	49.997980	162.066667	8.255630e+07	2.948564e+06
2008	49.996443	161.866667	8.949529e+07	3.145653e+06
2009	49.996693	162.000000	8.882423e+07	3.291229e+06
2010	50.000000	162.000000	9.071200e+07	3.304888e+06
2011	50.000128	161.933333	9.281684e+07	3.331578e+06
2012	50.000000	162.000000	9.775804e+07	3.446412e+06
2013	49.997475	162.066667	1.011509e+08	3.678754e+06
2014	50.000000	162.000000	9.975993e+07	4.609605e+06

[10]:
```
l=temp['yearID'].tolist()
```

[11]:
```
line_up, = plt.plot([1, 2, 3], label='Line 2')
line_down, = plt.plot([3, 2, 1], label='Line 1')
plt.legend(handles=[line_up, line_down])
```

[11]: <matplotlib.legend.Legend at 0x7fc6bd9a1f10>



[12]:
```
# Problem 4
```

[13]:
```
salary_mean_query = "SELECT  teamID,yearID, sum(salary)/count(salary) as␣
↪payroll_mean FROM Salaries GROUP BY teamID,yearID"
winning_query = "SELECT  teamID,yearID, W*100/G as winning_percentage FROM␣
↪Teams GROUP BY teamID,yearID"
salary_mean_table = pd.read_sql(salary_mean_query, conn)
winning_table = pd.read_sql(winning_query,conn)
```

```
group_table = pd.merge(salary_mean_table, winning_table, how='outer',␣
 ↪on=['yearID','teamID'])

bins = [1989,1994,1999,2004,2009,2015]
group_names = ['1990-1994','1995-1999','2000-2004','2005-2009','2010-2015']
#categories = pd.cut(group_table['yearID'],bins,labels=group_names)
group_table['categories'] = pd.cut(group_table['yearID'], bins,␣
 ↪labels=group_names)
group_table['categories'].tolist()
grouped = group_table.groupby('categories')
group1 = grouped.get_group('1990-1994')
group2 = grouped.get_group('1995-1999')
group3 = grouped.get_group('2000-2004')
group4 = grouped.get_group('2005-2009')
group5 = grouped.get_group('2010-2015')
group1
```

[13]:

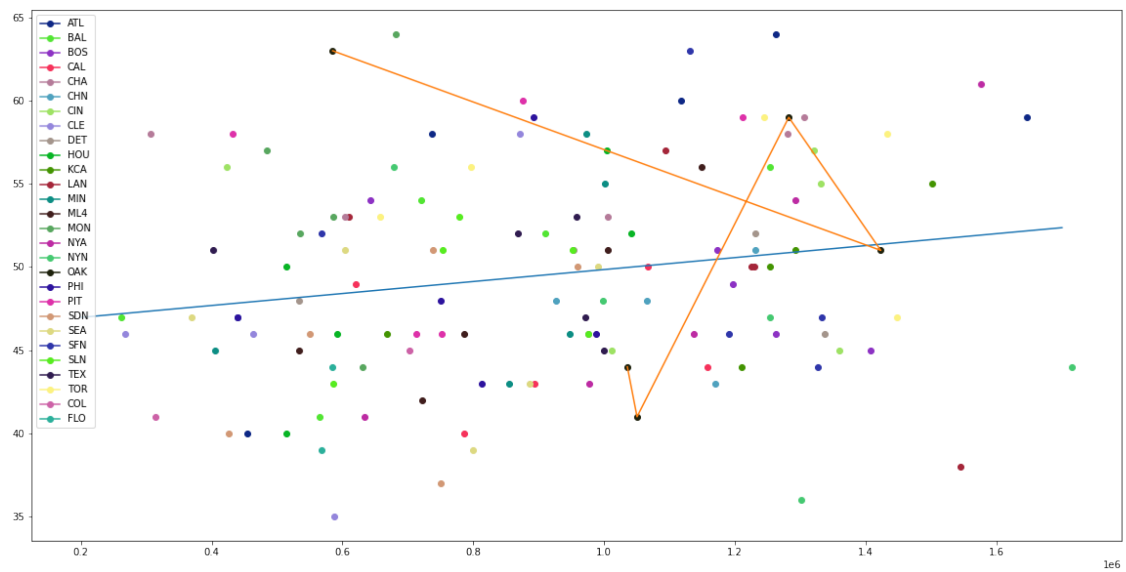
```
    teamID  yearID  payroll_mean  winning_percentage categories
130    ATL    1990  4.548594e+05                40.0  1990-1994
131    BAL    1990  2.616239e+05                47.0  1990-1994
132    BOS    1990  6.424479e+05                54.0  1990-1994
133    CAL    1990  6.205714e+05                49.0  1990-1994
134    CHA    1990  3.061774e+05                58.0  1990-1994
..     …      …           …                  …         …
259    SEA    1994  8.857121e+05                43.0  1990-1994
260    SFN    1994  1.332458e+06                47.0  1990-1994
261    SLN    1994  9.758534e+05                46.0  1990-1994
262    TEX    1994  9.991999e+05                45.0  1990-1994
263    TOR    1994  1.447789e+06                47.0  1990-1994

[134 rows x 5 columns]
```

[14]:

```
# For group 1
team_list = group1['teamID']
plot_table=group1.drop(columns=['yearID','categories'])
plot_table.index=range(1,135)
plot_table


plot_table
dict_team={}
plt.figure(figsize=(20,10))
for i, row in plot_table.iterrows():
    team_name = row['teamID']

    if team_name in dict_team:
```

```
            plt.
 ↪plot(row['payroll_mean'],row['winning_percentage'],marker='o',color=dict_team[team_name])

        else:
            a=np.random.rand(3,)
            plt.
 ↪plot(row['payroll_mean'],row['winning_percentage'],marker='o',label=row['teamID'],color=a)
            dict_team[team_name]=a
line=np.polyfit(plot_table['payroll_mean'],plot_table['winning_percentage'],1)
p = np.poly1d(line)
xp=np.linspace(200000, 1700000, 10)
yp=p(xp)
plt.plot(xp,yp)
oak_table=group1.loc[group1['teamID']=='OAK']
plt.plot(oak_table['payroll_mean'], oak_table['winning_percentage'])
plt.legend()
```

[14]: <matplotlib.legend.Legend at 0x7fc6bde30f10>



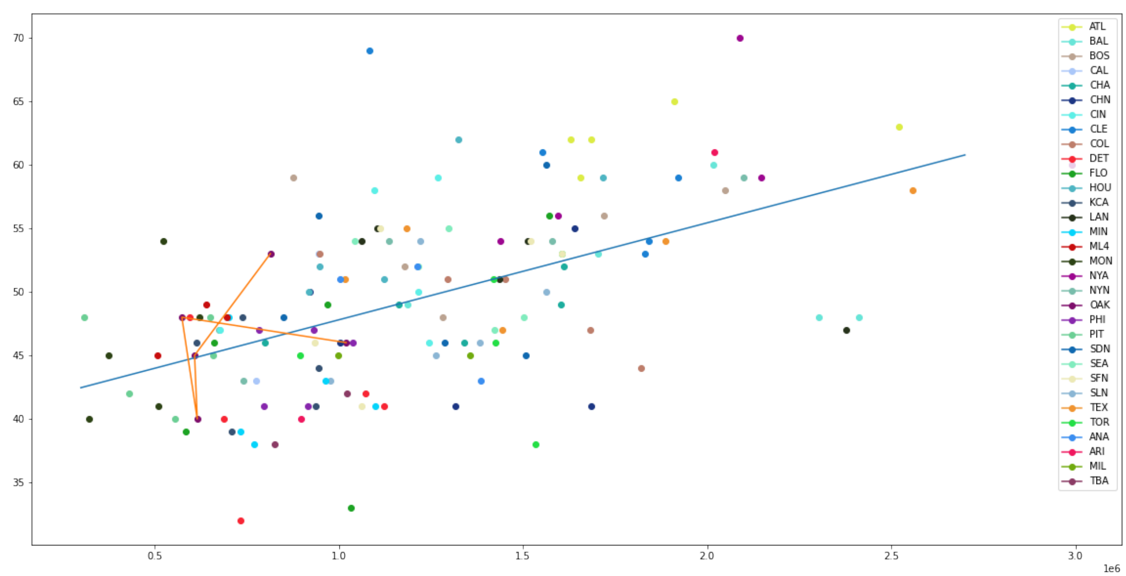
[15]:
```
np.random.rand(3,)
```

[15]: array([0.10018232, 0.75966964, 0.39105821])

[16]:
```
# For group 2
team_list = group2['teamID']
plot_table=group2.drop(columns=['yearID','categories'])
plot_table.index=range(1,len(plot_table)+1)
plot_table
```

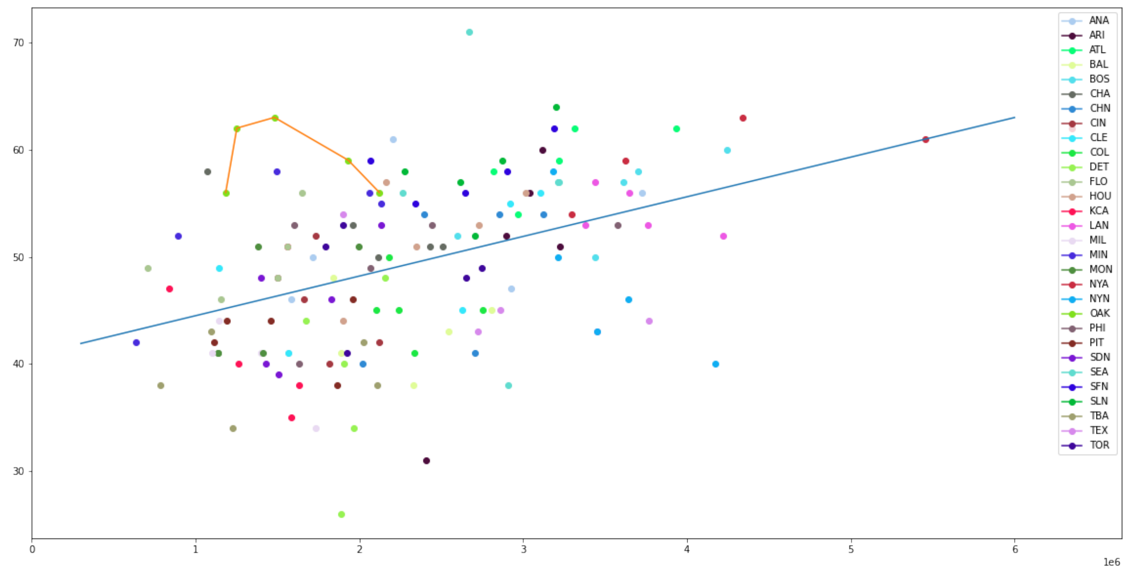
```
plot_table
dict_team={}
plt.figure(figsize=(20,10))
for i, row in plot_table.iterrows():
    team_name = row['teamID']

    if team_name in dict_team:
        plt.
 ↪plot(row['payroll_mean'],row['winning_percentage'],marker='o',color=dict_team[team_name])

    else:
        a=np.random.rand(3,)
        plt.
 ↪plot(row['payroll_mean'],row['winning_percentage'],marker='o',label=row['teamID'],color=a)
        dict_team[team_name]=a
line=np.polyfit(plot_table['payroll_mean'],plot_table['winning_percentage'],1)
p = np.poly1d(line)
xp=np.linspace(300000, 2700000, 2)
yp=p(xp)
plt.plot(xp,yp)
oak_table=group2.loc[group2['teamID']=='OAK']
plt.plot(oak_table['payroll_mean'], oak_table['winning_percentage'])
plt.legend()
```

[16]: <matplotlib.legend.Legend at 0x7fc6bde48eb0>



[17]:
```
# For group 3
team_list = group3['teamID']
plot_table=group3.drop(columns=['yearID','categories'])
plot_table.index=range(1,len(plot_table)+1)
plot_table


plot_table
dict_team={}
plt.figure(figsize=(20,10))
for i, row in plot_table.iterrows():
    team_name = row['teamID']

    if team_name in dict_team:
        plt.
 ↪plot(row['payroll_mean'],row['winning_percentage'],marker='o',color=dict_team[team_name])

    else:
        a=np.random.rand(3,)
        plt.
 ↪plot(row['payroll_mean'],row['winning_percentage'],marker='o',label=row['teamID'],color=a)
        dict_team[team_name]=a
line=np.polyfit(plot_table['payroll_mean'],plot_table['winning_percentage'],1)
p = np.poly1d(line)
xp=np.linspace(300000, 6000000, 2)
yp=p(xp)
plt.plot(xp,yp)
oak_table=group3.loc[group3['teamID']=='OAK']
plt.plot(oak_table['payroll_mean'], oak_table['winning_percentage'])
plt.legend()
```

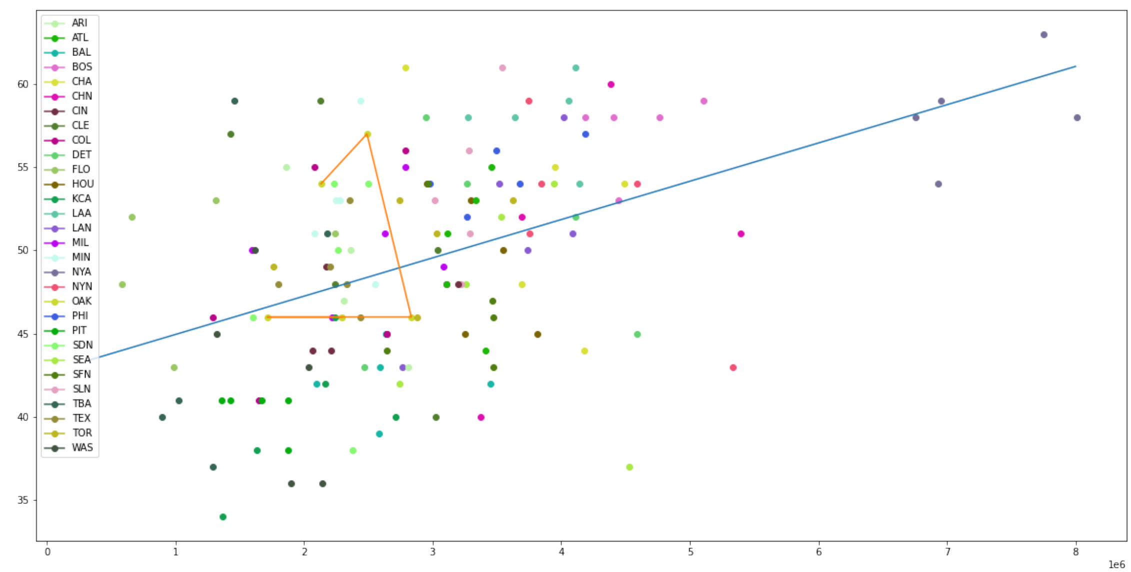
[17]: <matplotlib.legend.Legend at 0x7fc6bde48df0>



[18]:
```
# For group 4
team_list = group4['teamID']
plot_table=group4.drop(columns=['yearID','categories'])
plot_table.index=range(1,len(plot_table)+1)
plot_table


plot_table
dict_team={}
plt.figure(figsize=(20,10))
for i, row in plot_table.iterrows():
    team_name = row['teamID']

    if team_name in dict_team:
        plt.
 ↪plot(row['payroll_mean'],row['winning_percentage'],marker='o',color=dict_team[team_name])

    else:
        a=np.random.rand(3,)
        plt.
 ↪plot(row['payroll_mean'],row['winning_percentage'],marker='o',label=row['teamID'],color=a)
        dict_team[team_name]=a


line=np.polyfit(plot_table['payroll_mean'],plot_table['winning_percentage'],1)
p = np.poly1d(line)
xp=np.linspace(300000, 8000000, 2)
yp=p(xp)
```

```
plt.plot(xp,yp)


oak_table=group4.loc[group4['teamID']=='OAK']
plt.plot(oak_table['payroll_mean'], oak_table['winning_percentage'])

plt.legend()
```

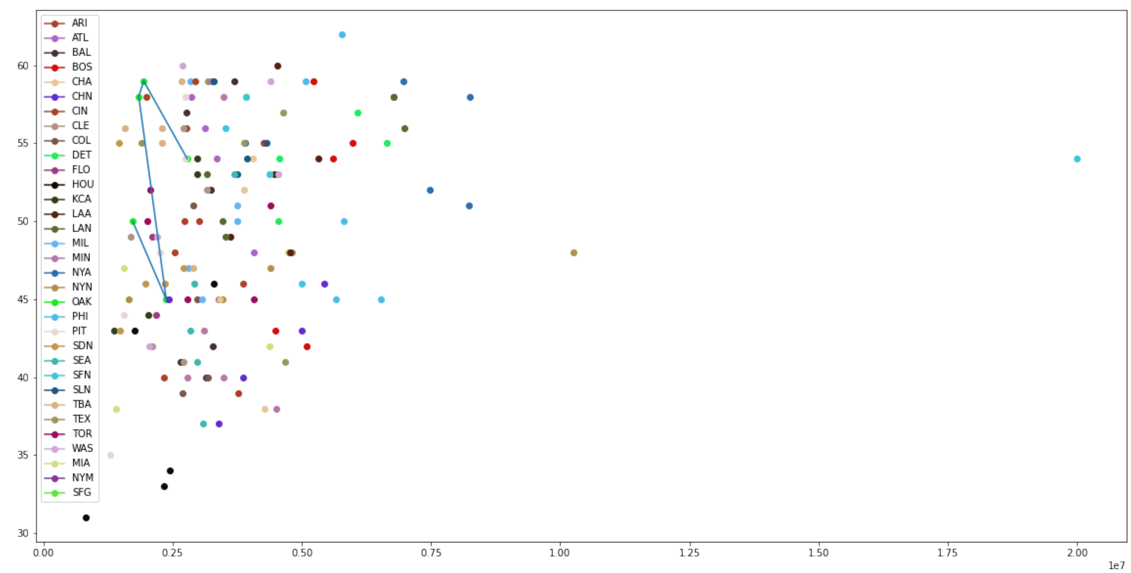
[18]: <matplotlib.legend.Legend at 0x7fc6be37d2b0>



[19]:
```
# For group 5
team_list = group5['teamID']
plot_table=group5.drop(columns=['yearID','categories'])
plot_table.index=range(1,len(plot_table)+1)
#plot_table['payroll_mean']=plot_table['payroll_mean'].apply(lambda x:x/1000)


plot_table
dict_team={}
plt.figure(figsize=(20,10))
for i, row in plot_table.iterrows():
    team_name = row['teamID']

    if team_name in dict_team:
        plt.
↪plot(row['payroll_mean'],row['winning_percentage'],marker='o',color=dict_team[team_name])

    else:
```

```
        a=np.random.rand(3,)
        plt.
 ↪plot(row['payroll_mean'],row['winning_percentage'],marker='o',label=row['teamID'],color=a)
        dict_team[team_name]=a
# line=np.
 ↪polyfit(plot_table['payroll_mean'],plot_table['winning_percentage'],1)
# p = np.poly1d(line)
# xp=np.linspace(300000, 8000000, 2)
# yp=p(xp)
# plt.plot(xp,yp)

oak_table=group5.loc[group5['teamID']=='OAK']
plt.plot(oak_table['payroll_mean'], oak_table['winning_percentage'])
plt.legend()
# print(plot_table['payroll_mean'].tolist())
# print(plot_table['winning_percentage'].tolist())
# In this case, we cannot find a regression line by np.ployfit since it does␣
 ↪not converge by least square
```

[19]: <matplotlib.legend.Legend at 0x7fc6bec3efd0>



[20]:
```
# Question 2
# The payroll increases across all these periods.
#
# For the Oakland A's spending efficiency, I notice that the lines of Oakland A␣
 ↪go across the regression
# line for the first, second and fourth time period, which suggests that its␣
 ↪spending efficiency is close to the mean.
```

```
# For the third time period, the lines of Oakland A is above the regression␣
↪line, which means the spending efficiency
# is high. For the fifth time period, np.polyfit() cannot give a regression␣
↪line, but it seems that Oakland A still have
# a spending efficiency close to the mean.
```

[21]:
```
# Problem 5
import statistics
question3_df = team_salaries.copy()
question3_df=question3_df.drop(columns=['total_payroll'])
mean_payroll_table=question3_df.groupby(['yearID']).mean()
std_payroll_table=question3_df.groupby(['yearID']).std()
std_payroll_table


result['standardized_payroll']=pd.Series(np.nan, index=result.index)

for i, row in result.iterrows():
    year = row['yearID']
    if year>=1985 and year <=2014:
        mean=mean_payroll_table.loc[year,'team_payroll_mean']
        std = std_payroll_table.loc[year,'team_payroll_mean']
        team_payroll_mean = row['team_payroll_mean']
        std_payroll = (team_payroll_mean-mean)/std
        result.loc[i,'standardized_payroll']=std_payroll

        #print(row['standardized_payroll'])


result
```

[21]:

	teamID	yearID	winning_per	G	total_payroll	team_payroll_mean	\
0	ALT	1884	24.000000	25.0	NaN	NaN	
1	ANA	1997	51.851852	162.0	31135472.0	1.004370e+06	
2	ANA	1998	52.469136	162.0	41281000.0	1.214147e+06	
3	ANA	1999	43.209877	162.0	55388166.0	1.384704e+06	
4	ANA	2000	50.617284	162.0	51464167.0	1.715472e+06	
…	…	…	…	…	…	…	
2772	WS8	1889	32.283465	127.0	NaN	NaN	
2773	WS9	1891	31.654676	139.0	NaN	NaN	
2774	WSU	1884	41.228070	114.0	NaN	NaN	
2775	NYM	2014	NaN	NaN	54806990.0	2.283625e+06	
2776	SFG	2014	NaN	NaN	143510167.0	5.315191e+06	

	standardized_payroll
0	NaN
1	-0.528661

```
2                 -0.168201
3                 -0.181448
4                 -0.362224
…                     …
2772                    NaN
2773                    NaN
2774                    NaN
2775              -0.694316
2776               0.210621

[2777 rows x 7 columns]
```

[22]:
```python
#Problem 6



problem6_df = result.copy()
problem6_df = problem6_df.loc[problem6_df['yearID']>=1990]
problem6_df = problem6_df.loc[problem6_df['yearID']<=2014]
problem6_df=problem6_df.drop(columns=['G','total_payroll','team_payroll_mean'])
problem6_df.dropna()
```

[22]:
```
     teamID  yearID  winning_per  standardized_payroll
1       ANA    1997    51.851852             -0.528661
2       ANA    1998    52.469136             -0.168201
3       ANA    1999    43.209877             -0.181448
4       ANA    2000    50.617284             -0.362224
5       ANA    2001    46.296296             -0.856538
…      …      …          …                   …
2683    WAS    2010    42.592593             -0.856099
2684    WAS    2011    49.689441             -0.774365
2685    WAS    2012    60.493827             -0.623936
2686    WAS    2013    53.086420              0.536327
2687    WAS    2014    59.259259             -0.062730

[728 rows x 4 columns]
```

[23]:
```python
bins = [1989,1994,1999,2004,2009,2015]
group_names = ['1990-1994','1995-1999','2000-2004','2005-2009','2010-2015']
#categories = pd.cut(group_table['yearID'],bins,labels=group_names)
problem6_df['categories'] = pd.cut(problem6_df['yearID'], bins,␣
 ↪labels=group_names)
problem6_df['categories'].tolist()
grouped = problem6_df.groupby('categories')
group1 = grouped.get_group('1990-1994')
group2 = grouped.get_group('1995-1999')
group3 = grouped.get_group('2000-2004')
group4 = grouped.get_group('2005-2009')
```

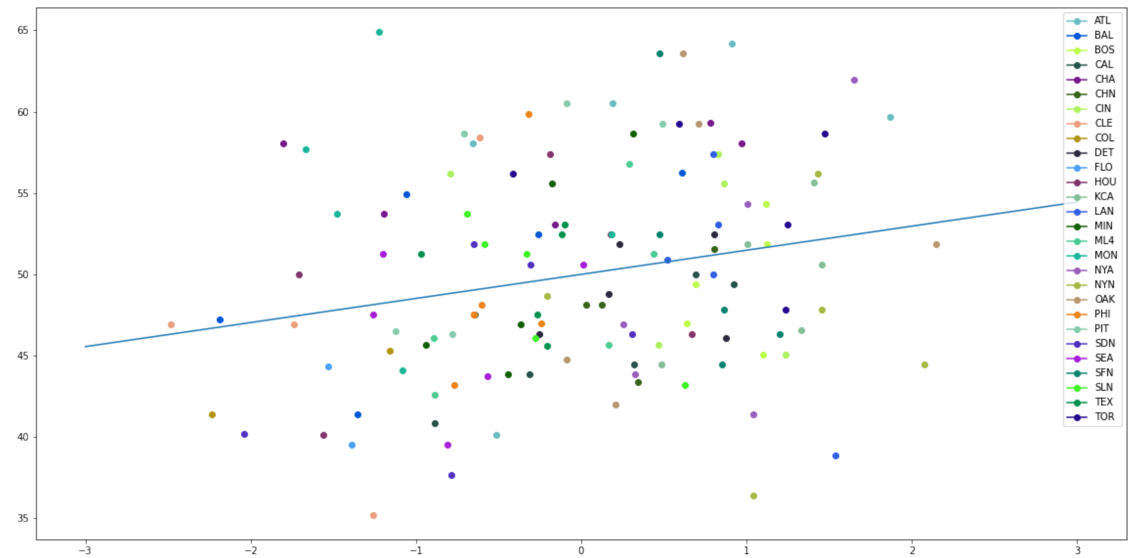
```
group5 = grouped.get_group('2010-2015')
```

[24]:

```
#Group1
team_list = group1['teamID']
plot_table=group1.drop(columns=['yearID','categories'])
plot_table.index=range(1,135)
plot_table


plot_table
dict_team={}
plt.figure(figsize=(20,10))
for i, row in plot_table.iterrows():
    team_name = row['teamID']

    if team_name in dict_team:
        plt.
 ↪plot(row['standardized_payroll'],row['winning_per'],marker='o',color=dict_team[team_name])

    else:
        a=np.random.rand(3,)
        plt.
 ↪plot(row['standardized_payroll'],row['winning_per'],marker='o',label=row['teamID'],color=a)
        dict_team[team_name]=a
line=np.polyfit(plot_table['standardized_payroll'],plot_table['winning_per'],1)
p = np.poly1d(line)
xp=np.linspace(-3, 3, 10)
yp=p(xp)
plt.plot(xp,yp)

plt.legend()
group1
```

[24]:

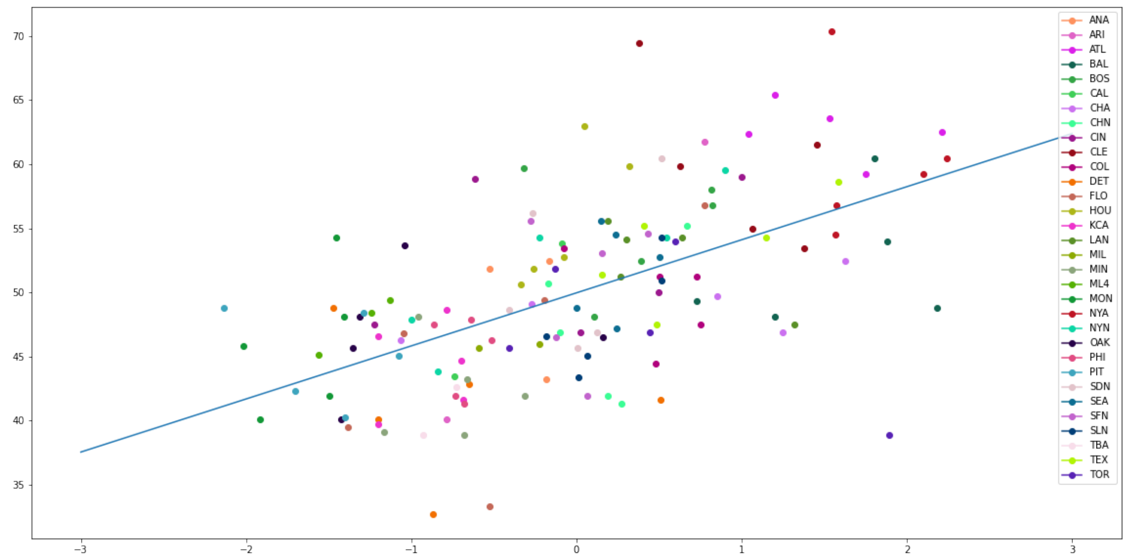
```
     teamID  yearID  winning_per  standardized_payroll categories
50      ATL    1990    40.123457             -0.513311  1990-1994
51      ATL    1991    58.024691             -0.656737  1990-1994
52      ATL    1992    60.493827              0.190807  1990-1994
53      ATL    1993    64.197531              0.908389  1990-1994
54      ATL    1994    59.649123              1.869895  1990-1994
…        …     …            …                   …          …
2639    TOR    1990    53.086420              1.247239  1990-1994
2640    TOR    1991    56.172840             -0.412027  1990-1994
2641    TOR    1992    59.259259              0.591159  1990-1994
2642    TOR    1993    58.641975              1.474949  1990-1994
2643    TOR    1994    47.826087              1.233851  1990-1994

[134 rows x 5 columns]
```



[25]:
```
#Group2
team_list = group2['teamID']
plot_table=group2.drop(columns=['yearID','categories'])
plot_table.index=range(1,len(plot_table)+1)
plot_table


plot_table
dict_team={}
plt.figure(figsize=(20,10))
for i, row in plot_table.iterrows():
    team_name = row['teamID']

    if team_name in dict_team:
        plt.
 ↪plot(row['standardized_payroll'],row['winning_per'],marker='o',color=dict_team[team_name])

    else:
        a=np.random.rand(3,)
        plt.
 ↪plot(row['standardized_payroll'],row['winning_per'],marker='o',label=row['teamID'],color=a)
        dict_team[team_name]=a
line=np.polyfit(plot_table['standardized_payroll'],plot_table['winning_per'],1)
p = np.poly1d(line)
xp=np.linspace(-3, 3, 10)
yp=p(xp)
plt.plot(xp,yp)
```

```
plt.legend()
```

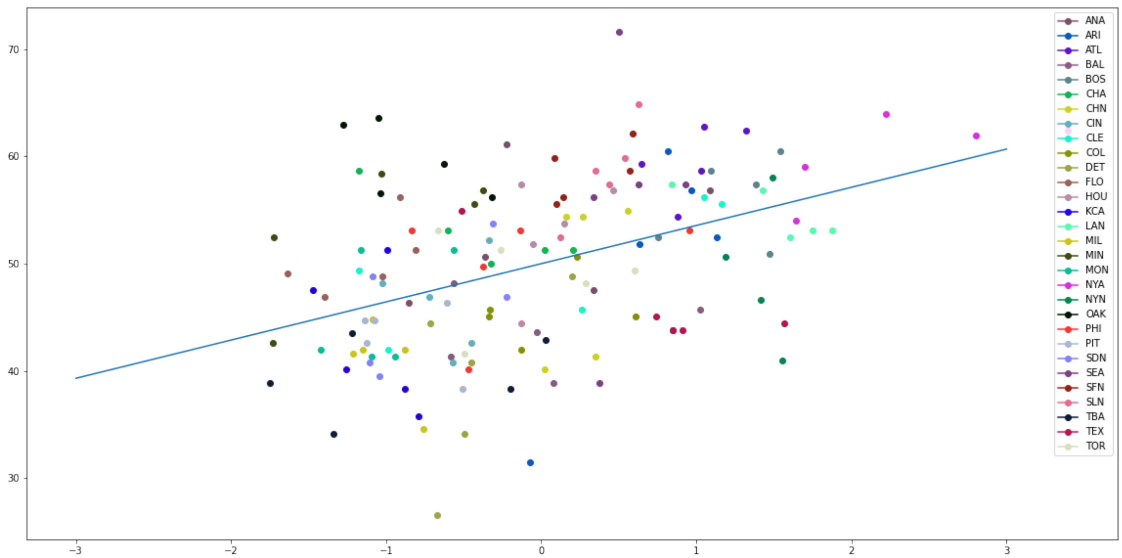
[25]: <matplotlib.legend.Legend at 0x7fc6bee58760>



[26]:
```
#Group2
team_list = group3['teamID']
plot_table=group3.drop(columns=['yearID','categories'])
plot_table.index=range(1,len(plot_table)+1)
plot_table


plot_table
dict_team={}
plt.figure(figsize=(20,10))
for i, row in plot_table.iterrows():
    team_name = row['teamID']

    if team_name in dict_team:
        plt.
 ↪plot(row['standardized_payroll'],row['winning_per'],marker='o',color=dict_team[team_name])

    else:
        a=np.random.rand(3,)
        plt.
 ↪plot(row['standardized_payroll'],row['winning_per'],marker='o',label=row['teamID'],color=a)
        dict_team[team_name]=a
line=np.polyfit(plot_table['standardized_payroll'],plot_table['winning_per'],1)
```

```
p = np.poly1d(line)
xp=np.linspace(-3, 3, 10)
yp=p(xp)
plt.plot(xp,yp)

plt.legend()
```

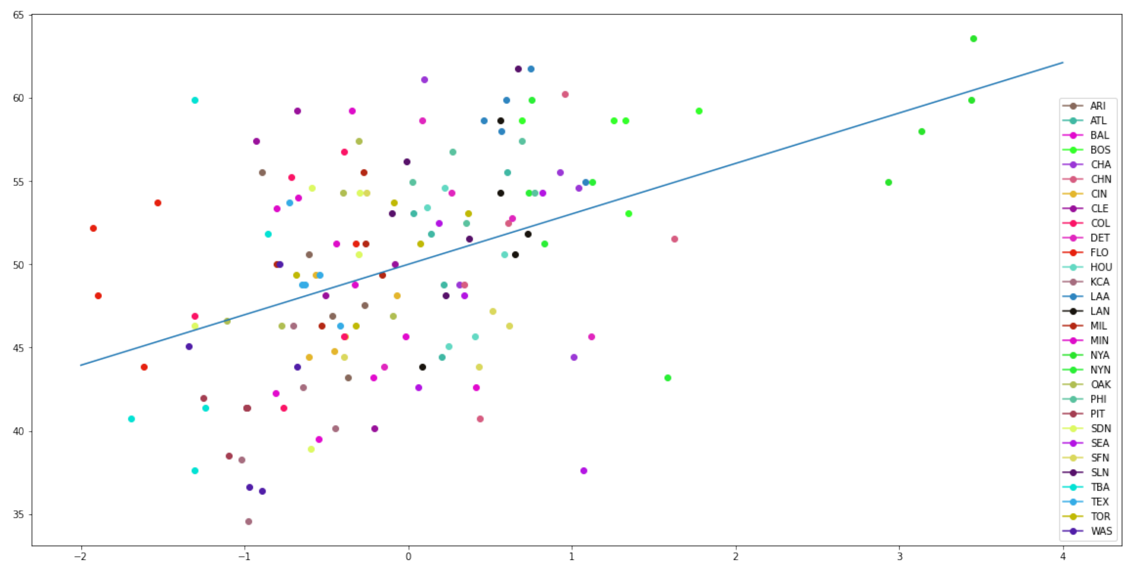
[26]: <matplotlib.legend.Legend at 0x7fc6bf83eb50>



[27]:
```
#Group4
team_list = group4['teamID']
plot_table=group4.drop(columns=['yearID','categories'])
plot_table.index=range(1,len(plot_table)+1)
plot_table


plot_table
dict_team={}
plt.figure(figsize=(20,10))
for i, row in plot_table.iterrows():
    team_name = row['teamID']

    if team_name in dict_team:
        plt.
 ↪plot(row['standardized_payroll'],row['winning_per'],marker='o',color=dict_team[team_name])

    else:
        a=np.random.rand(3,)
```

```
        plt.
↪plot(row['standardized_payroll'],row['winning_per'],marker='o',label=row['teamID'],color=a)
        dict_team[team_name]=a
line=np.polyfit(plot_table['standardized_payroll'],plot_table['winning_per'],1)
p = np.poly1d(line)
xp=np.linspace(-2, 4, 10)
yp=p(xp)
plt.plot(xp,yp)

plt.legend()
```

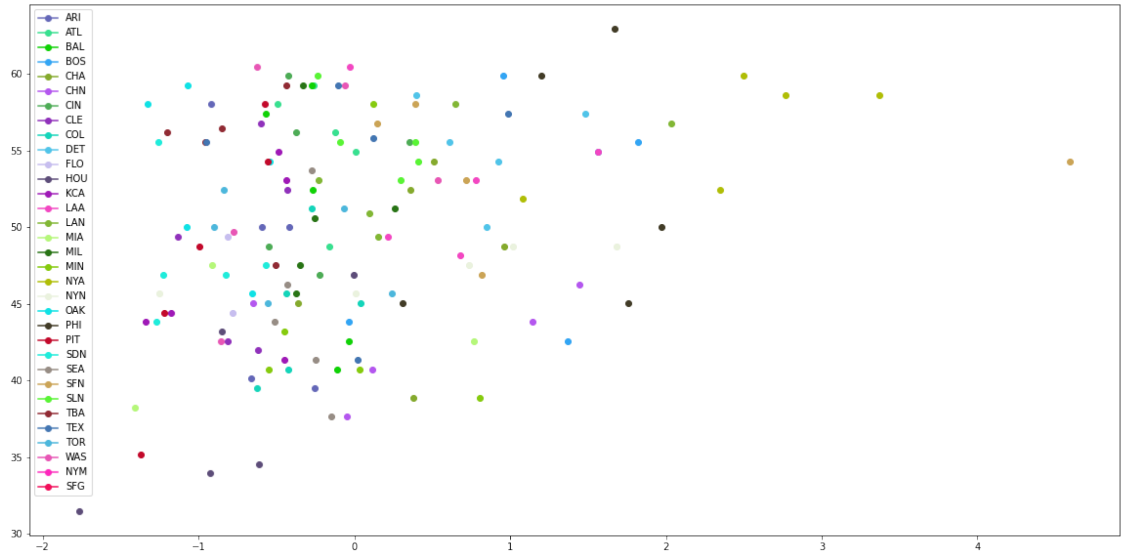
[27]: <matplotlib.legend.Legend at 0x7fc6bf9e3bb0>



[28]:
```
#Group5
team_list = group5['teamID']
plot_table=group5.drop(columns=['yearID','categories'])
plot_table.index=range(1,len(plot_table)+1)
plot_table


plot_table
dict_team={}
plt.figure(figsize=(20,10))
for i, row in plot_table.iterrows():
    team_name = row['teamID']

    if team_name in dict_team:
```

```
        plt.
↪plot(row['standardized_payroll'],row['winning_per'],marker='o',color=dict_team[team_name])

    else:
        a=np.random.rand(3,)
        plt.
↪plot(row['standardized_payroll'],row['winning_per'],marker='o',label=row['teamID'],color=a)
        dict_team[team_name]=a
# line=np.
↪polyfit(plot_table['standardized_payroll'],plot_table['winning_per'],1)
# p = np.poly1d(line)
# xp=np.linspace(-3, 3, 10)
# yp=p(xp)
# plt.plot(xp,yp)

plt.legend()
```

[28]: <matplotlib.legend.Legend at 0x7fc6c041cee0>



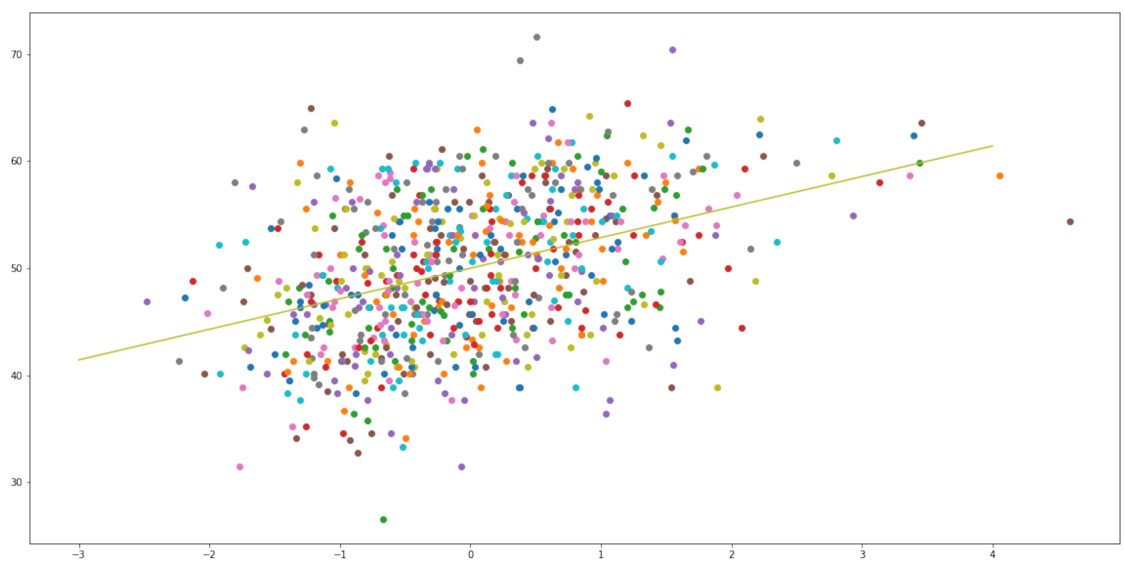
[29]:
```
# Question 3
# The plot are very similar to each other, except that the unit of the␣
↪horizontal axis changed a lot.
# By the transformation, we make the standardized_payroll close to 0 within a␣
↪much smaller range.
```

[30]:
```
group_table
```

[30]:
```
      teamID  yearID    payroll_mean  winning_percentage categories
0        ATL    1985   673045.454545                40.0        NaN
1        BAL    1985   525486.909091                51.0        NaN
2        BOS    1985   435902.400000                49.0        NaN
3        CAL    1985   515281.928571                55.0        NaN
4        CHA    1985   468865.619048                52.0        NaN
…        …       …             …                   …          …
2772     WS8    1887             NaN                36.0        NaN
2773     WS8    1888             NaN                35.0        NaN
2774     WS8    1889             NaN                32.0        NaN
2775     WS9    1891             NaN                31.0        NaN
2776     WSU    1884             NaN                41.0        NaN

[2777 rows x 5 columns]
```

[31]:
```
#Problem 7
problem7_df=problem6_df.dropna()
problem7_df
plt.figure(figsize=(20,10))
line=np.
 ↪polyfit(problem7_df['standardized_payroll'],problem7_df['winning_per'],1)
for i, row in problem7_df.iterrows():
    plt.plot(row['standardized_payroll'],row['winning_per'],'o')

p = np.poly1d(line)
xp=np.linspace(-3, 4, 10)
yp=p(xp)
plt.plot(xp,yp)
line
```

[31]:
```
array([ 2.85310865, 49.9866575 ])
```

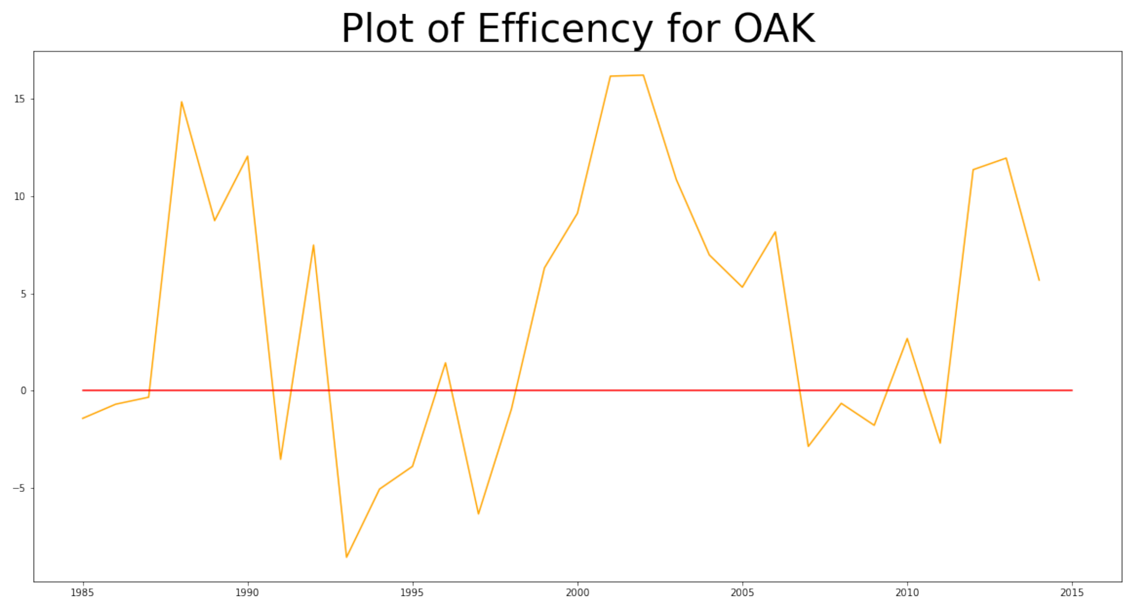


[32]:
```
#Problem 8
result['efficiency']=pd.Series(np.nan, index=result.index)
for i, row in result.iterrows():
    std_payroll = row['standardized_payroll']
    exp_win_rate=50+2.5*std_payroll
    result.loc[i,'efficiency']=row['winning_per']-exp_win_rate
```

[33]:
```
result
```

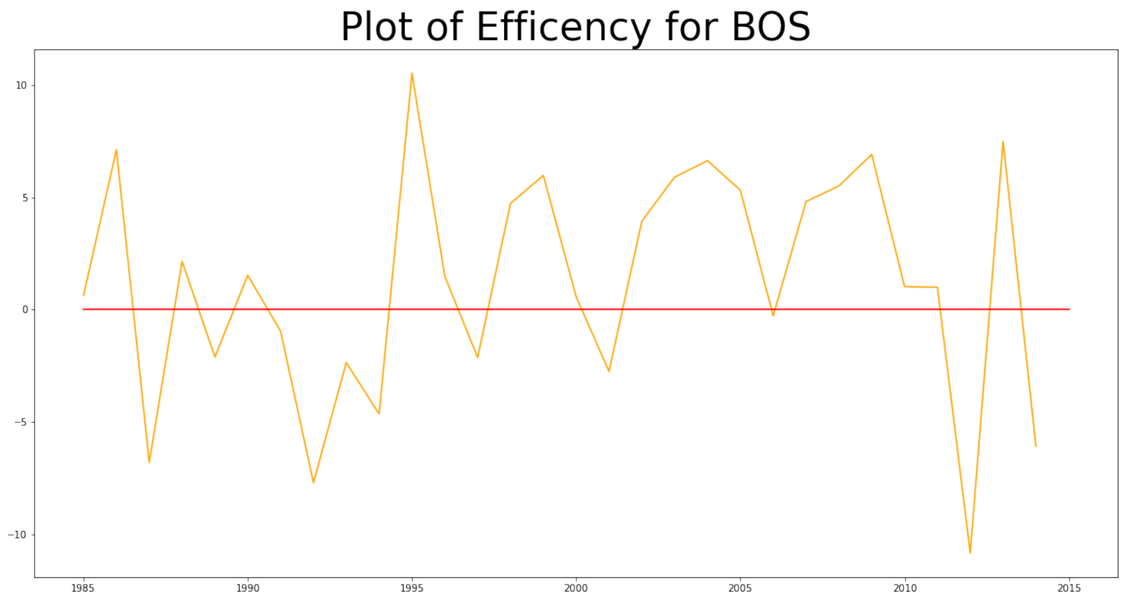
[33]:
```
     teamID  yearID  winning_per      G  total_payroll  team_payroll_mean  \
0       ALT    1884    24.000000   25.0            NaN                NaN
1       ANA    1997    51.851852  162.0     31135472.0       1.004370e+06
2       ANA    1998    52.469136  162.0     41281000.0       1.214147e+06
3       ANA    1999    43.209877  162.0     55388166.0       1.384704e+06
4       ANA    2000    50.617284  162.0     51464167.0       1.715472e+06
…       …      …             …      …            …                  …
2772    WS8    1889    32.283465  127.0            NaN                NaN
2773    WS9    1891    31.654676  139.0            NaN                NaN
2774    WSU    1884    41.228070  114.0            NaN                NaN
2775    NYM    2014          NaN    NaN     54806990.0       2.283625e+06
2776    SFG    2014          NaN    NaN    143510167.0       5.315191e+06

      standardized_payroll  efficiency
0                      NaN         NaN
1                -0.528661    3.173505
2                -0.168201    2.889640
3                -0.181448   -6.336503
4                -0.362224    1.522845
…                      …           …
2772                   NaN         NaN
2773                   NaN         NaN
2774                   NaN         NaN
2775             -0.694316         NaN
2776              0.210621         NaN

[2777 rows x 8 columns]
```

[34]:
```
# Team OAK
plt.figure(figsize=(20,10))
temp_set = result.loc[result['teamID']=='OAK']
temp_set=temp_set.dropna()
plt.plot(temp_set['yearID'],temp_set['efficiency'],color='orange')
plt.title("Plot of Efficency for OAK", fontsize=40)
plt.plot([1985,2015],[0,0],color='red')
plt.show()
```

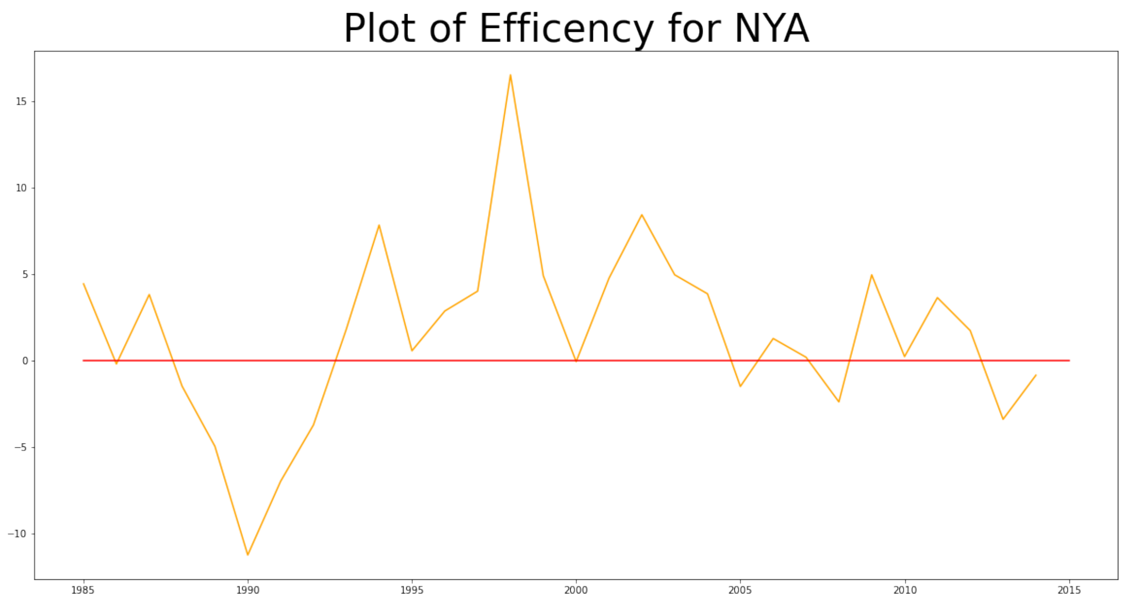


[35]:

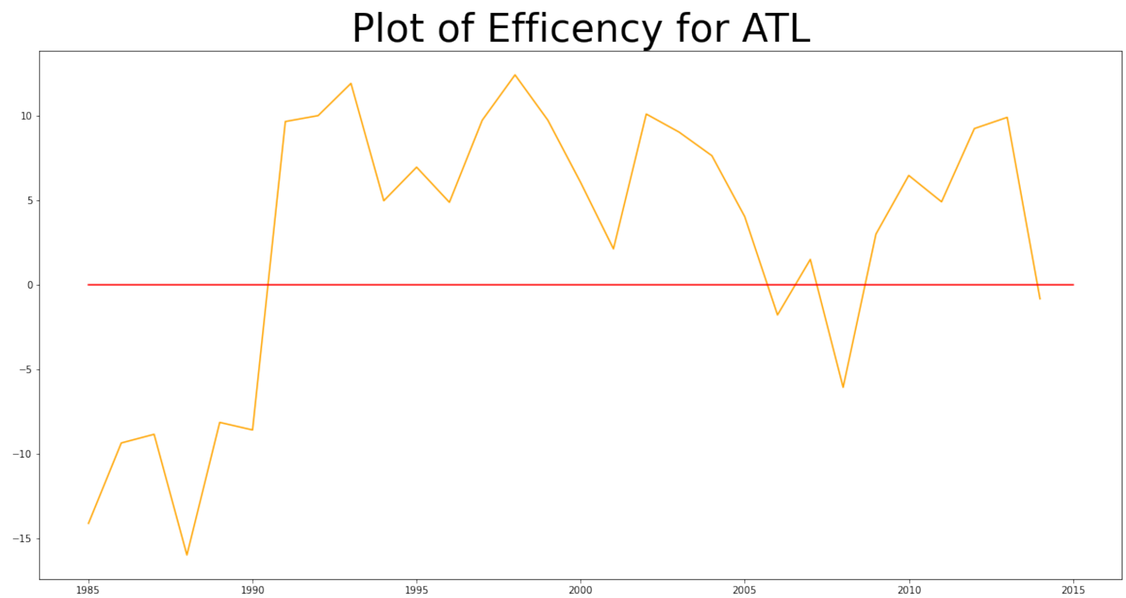
```
# Team BOS
plt.figure(figsize=(20,10))
temp_set = result.loc[result['teamID']=='BOS']
temp_set=temp_set.dropna()
plt.plot(temp_set['yearID'],temp_set['efficiency'],color='orange')
plt.title("Plot of Efficency for BOS", fontsize=40)
plt.plot([1985,2015],[0,0],color='red')
plt.show()
```



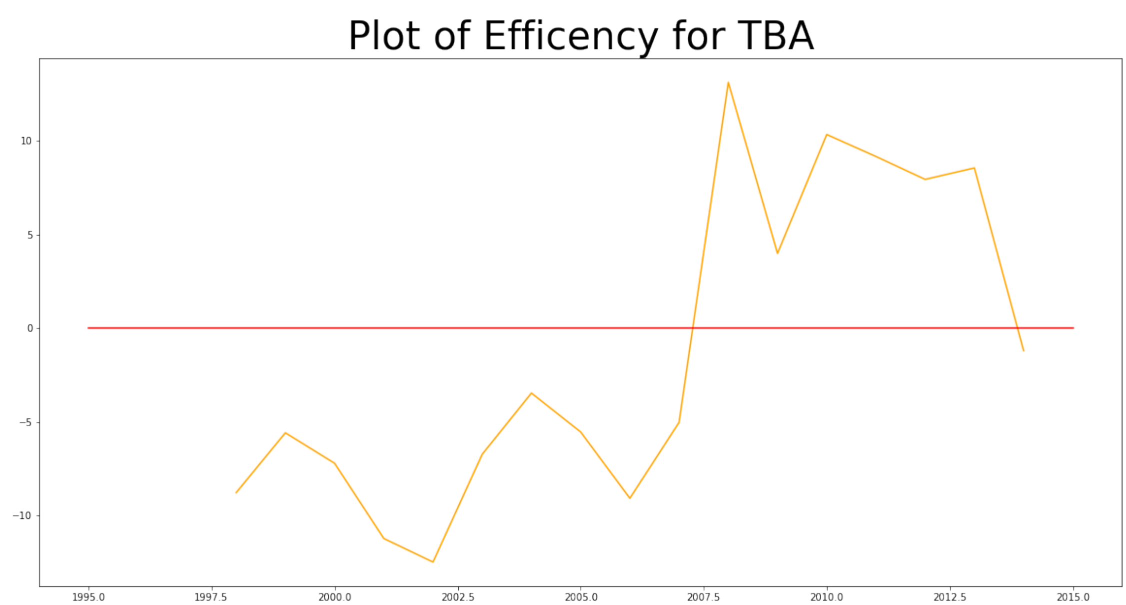
[36]:
```
# Team NYA
plt.figure(figsize=(20,10))
temp_set = result.loc[result['teamID']=='NYA']
temp_set=temp_set.dropna()
plt.plot(temp_set['yearID'],temp_set['efficiency'],color='orange')
plt.title("Plot of Efficency for NYA", fontsize=40)
plt.plot([1985,2015],[0,0],color='red')
plt.show()
```



[37]:
```
# Team ATL
plt.figure(figsize=(20,10))
temp_set = result.loc[result['teamID']=='ATL']
temp_set=temp_set.dropna()
plt.plot(temp_set['yearID'],temp_set['efficiency'],color='orange')
plt.title("Plot of Efficency for ATL", fontsize=40)
plt.plot([1985,2015],[0,0],color='red')
plt.show()
```

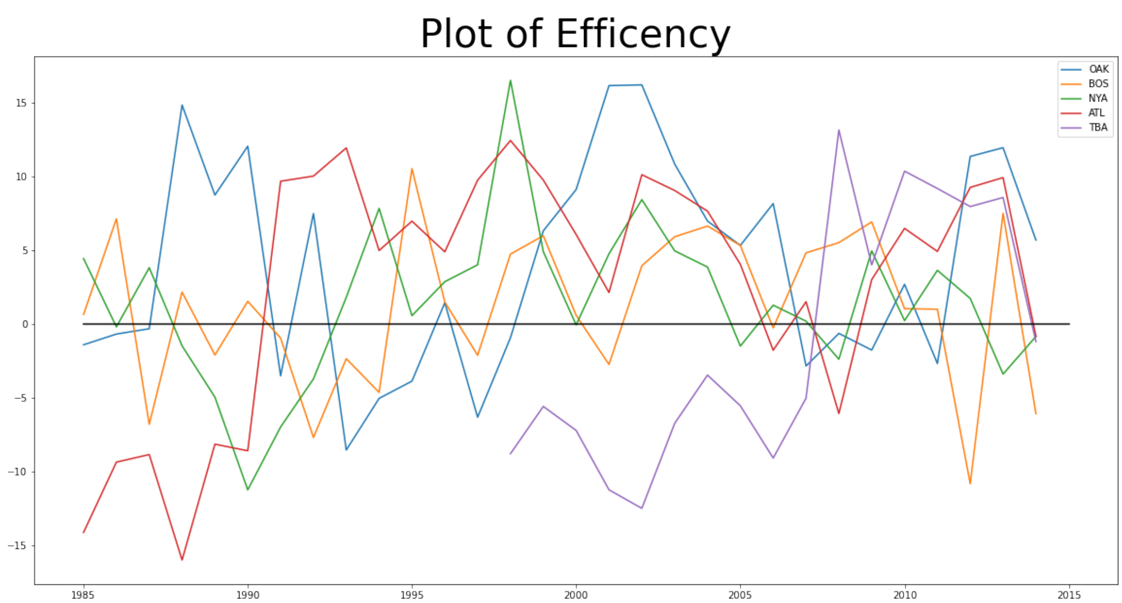


[38]:
```
# Team TBA
plt.figure(figsize=(20,10))
temp_set = result.loc[result['teamID']=='TBA']
temp_set=temp_set.dropna()
plt.plot(temp_set['yearID'],temp_set['efficiency'],color='orange')
plt.title("Plot of Efficency for TBA", fontsize=40)
plt.plot([1995,2015],[0,0],color='red')
plt.show()
```



[39]:
```
plt.figure(figsize=(20,10))
temp_set = result.loc[result['teamID']=='OAK']
temp_set=temp_set.dropna()
plt.plot(temp_set['yearID'],temp_set['efficiency'],label='OAK')
temp_set = result.loc[result['teamID']=='BOS']
temp_set=temp_set.dropna()
plt.plot(temp_set['yearID'],temp_set['efficiency'],label='BOS')
temp_set = result.loc[result['teamID']=='NYA']
temp_set=temp_set.dropna()
plt.plot(temp_set['yearID'],temp_set['efficiency'],label='NYA')
temp_set = result.loc[result['teamID']=='ATL']
temp_set=temp_set.dropna()
plt.plot(temp_set['yearID'],temp_set['efficiency'],label='ATL')
temp_set = result.loc[result['teamID']=='TBA']
temp_set=temp_set.dropna()
plt.plot(temp_set['yearID'],temp_set['efficiency'],label='TBA')
plt.title("Plot of Efficency", fontsize=40)
plt.plot([1985,2015],[0,0],color='black')

plt.legend()
```

[39]: <matplotlib.legend.Legend at 0x7fc6c2964c70>



[40]:
```
# Question 4:
# The plot is much more direct on showing whether a team's payroll is efficient␣
↪or not compared to the plot in problem 2 and 3.
```

```
# It seems from the plot that the efficiency of OAK is high on 1987 to 1992 and
1997 to 2005, and the conclusion is more persuasive than the conclusion from
problem 2 and 3.
```