NAMES & IDs: Bryant Liu - Jingyao Chen - A92071265 Joseph D’Angelo - A13580892 Tammy Lee - A13573330

OVERVIEW: Include 3-4 sentences summarizing your group’s project

RESEARCH QUESTION: What is your research question? (1-2 sentences)

HYPOTHESIS: What is your main hypothesis and predictions? Briefly explain why. (2-3 sentences)

BACKGROUND & PRIOR WORK: Why is this question of interest to your group? What background information led you to your hypothesis. Why is this important? Find some relevant prior work, and reference those sources. Even if you think you have a totally novel question, find the most similar prior work that you can and discuss how it relates to your project. References can be research publications, but they need not be. Blogs, GitHub repositories, company websites, etc., are all viable references if they are relevant to your project. (2-3 paragraphs, including at least 2 references)

DATASET(S): What data will you use to answer your question? Describe the dataset(s) in terms of number of observations, what kind of features it contains, etc. You must use at least one dataset containing at least approximately 1000 observations (if your data are smaller but you feel they are sufficient, email Prof. Ellis). You are welcome (and in fact recommended) to find multiple datasets! If you do so, describe each one, and briefly explain how you will combine them together. Include the source of the dataset in the description here.

DATA CLEANING: What methods did you use to analyze your data? Briefly explain what steps you had to take before you were able to use the datasets you chose to answer your question of interest.

- How 'clean' is the data? - What did you have to do to get the data into a usable format? - What pre-processing steps that were required for your methods (for example, checking data distributions and performing any transformations that may be required)

In [1]:

```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns

from pyzipcode import ZipCodeDatabase
from numpy import arange,array,ones
from scipy import stats
```

In [2]:

```
df_income = pd.read_csv('irs-zipcode.csv')

# Change column name using second row
df_income.columns = df_income.iloc[2]

# Drop 0th, 1st, nan rows; select 'Number of returns' and 'Amount' of 'Total income' columns
df_income = df_income.drop([0, 1])
df_income = df_income.rename(index=str, columns={'ZIP\ncode [1]': 'ZIP code'})
df_income = df_income.rename(index=str, columns={'Number of returns': 'Number'})
df_income = df_income.set_index('ZIP code')

# Drop na rows
df_income_selected = df_income.iloc[:, [16, 17]]
df_income_selected = df_income_selected.dropna()
df_income_selected.columns = ['Number of returns', 'Amount']

# Drop zip code 00000 and 99999
df_income_selected = df_income_selected.drop(['00000', '99999'])

# Drop all rows but the first, which is total returns and amount
df_income_selected = df_income_selected.loc[~df_income_selected.index.duplicated(keep='first')]
df_income_selected = df_income_selected.reset_index()
df_income_selected = df_income_selected.drop([0])

# Set index to be Zip Code
df_income_selected = df_income_selected.set_index('ZIP code')
df_income_selected = df_income_selected.rename(index=str, columns={'Number of returns': 'Number'})

# Remove commas so that the numbers can be converted to integers
df_income_selected['Amount'] = df_income_selected['Amount'].str.replace(',', '')
df_income_selected['Number'] = df_income_selected['Number'].str.replace(',', '')
df_income_selected['Amount'] = pd.to_numeric(df_income_selected['Amount'])
df_income_selected['Number'] = pd.to_numeric(df_income_selected['Number'])

# Make standardized wealth number by dividing amount of money by number of returns
# Then multiplying by 1000 because money is in thousands
df_income_selected['Wealth'] = df_income_selected.apply(lambda x: (x.Amount / x.Number) * 1000, axis=1)
df_income = df_income_selected
df_income.head()
```

```
/usr/local/lib/python3.7/dist-packages/IPython/core/interactiveshell.py:3049: DtypeWarning: Columns
(0) have mixed types. Specify dtype option on import or set low_memory=False.
  interactivity=interactivity, compiler=compiler, result=result)
```

Out[2]:

	Number	Amount	Wealth
ZIP code			
90001	21670	619635	28594.139363
90002	19890	563172	28314.328808
90003	27290	730810	26779.406376
90004	27810	1995586	71757.856886
90005	15850	807743	50961.703470

In [3]:

```
df_complaints = pd.read_csv('new2.csv')

# Remove all of the unimportant columns from our dataframe
df_complaints = df_complaints.drop(columns=['Date received', 'Sub-product', 'Issue', 'Sub-issue', 'Consumer complaint narrative',
                                            'Company public response', 'Company', 'State', 'Tags', 'Consumer consent provided?',
                                            'Submitted via', 'Date sent to company', 'Company response to consumer',
                                            'Timely response?', 'Consumer disputed?', 'Complaint ID'])

# Remove weird zip codes
df_complaints = df_complaints[df_complaints['ZIP code'] >= 90001]
df_complaints = df_complaints.sort_index()

# Create groups for unique zip codes and unique products
df_complaints_groups = df_complaints.groupby(['ZIP code', 'Product'])
df_complaints_2 = pd.DataFrame(columns = ['ZIP code'])

# In each group, get the length which represents
for key, item in df_complaints_groups:
    # Make new column with complaint type being the header and amount of that complaint being the type
    group_length = len(df_complaints_groups.get_group(key))
    df_complaints_2 = df_complaints_2.append({'ZIP code' : int(key[0]), key[1] : group_length}, ignore_index=True)

# Convert na to 0's for adding purposes
df_complaints_2 = df_complaints_2.fillna(int(0))

# Sum all unique zip codes to get one row per zip code
grouped_df = df_complaints_2.groupby('ZIP code').sum()

grouped_df.head()
```

```
/usr/local/lib/python3.7/dist-packages/IPython/core/interactiveshell.py:3049: DtypeWarning: Columns
(16) have mixed types. Specify dtype option on import or set low_memory=False.
  interactivity=interactivity, compiler=compiler, result=result)
```

Out[3]:

	Checking or savings account	Consumer Loan	Credit reporting	Credit reporting, credit repair services, or other personal consumer reports	Debt collection	Mortgage	Credit card or prepaid card	Student loan	Bank account or service	Payday loan, title loan, or personal loan	Vehicle loan or lease
ZIP code											
90001.0	3.0	1.0	4.0	28.0	22.0	6.0	0.0	0.0	0.0	0.0	0.0
90002.0	0.0	0.0	0.0	21.0	13.0	3.0	4.0	7.0	0.0	0.0	0.0
90003.0	3.0	0.0	0.0	40.0	9.0	4.0	1.0	1.0	1.0	0.0	0.0
90004.0	7.0	0.0	0.0	13.0	8.0	3.0	5.0	2.0	1.0	1.0	1.0
90005.0	1.0	0.0	5.0	5.0	7.0	3.0	1.0	0.0	0.0	0.0	0.0

In [4]:

```
# Convert index to string for combining purposes
grouped_df.index = grouped_df.index.astype('int')
grouped_df.index = grouped_df.index.astype('str')
df_income.index = df_income.index.astype('str')

# Combine the two dataframes and drop the rows that don't appear in both
complaints_df = pd.concat([grouped_df, df_income], axis=1, sort=False)
complaints_df = complaints_df.dropna()

# Create total complaints by adding all complaints for a zip code
complaints_df['Total Complaints'] = grouped_df.sum(axis=1)
```

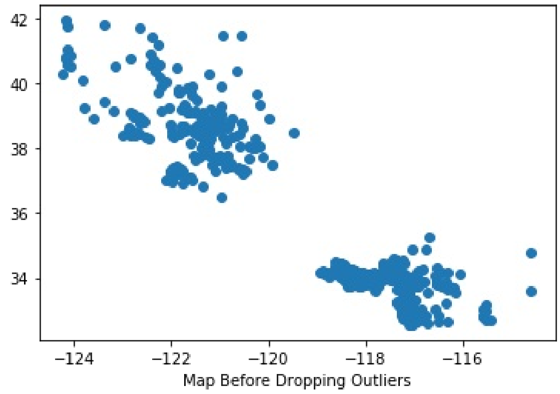
In [5]:

```
zcdb = ZipCodeDatabase()

# Iterrate over rows to add Lat and Long to dataframe
for index, row in complaints_df.iterrows():
    zipcode = zcdb[index]
    complaints_df.set_value(index,'Latitude',zipcode.latitude)
    complaints_df.set_value(index,'Longitude',zipcode.longitude)

# Plot scatter plot with Long and Lat
plt.plot(complaints_df['Longitude'], complaints_df['Latitude'],'o')
plt.xlabel("Map Before Dropping Outliers")
```

```
/usr/local/lib/python3.7/dist-packages/ipykernel_launcher.py:6: FutureWarning: set_value is deprecat
ed and will be removed in a future release. Please use .at[] or .iat[] accessors instead

/usr/local/lib/python3.7/dist-packages/ipykernel_launcher.py:7: FutureWarning: set_value is deprecat
ed and will be removed in a future release. Please use .at[] or .iat[] accessors instead
  import sys
```

Out[5]:

```
Text(0.5, 0, 'Map Before Dropping Outliers')
```

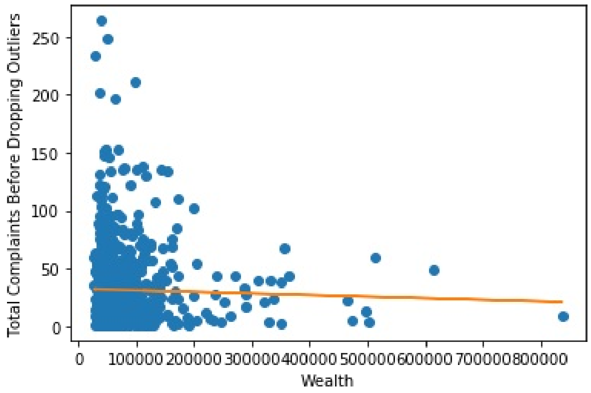


In [6]:

```
y = complaints_df['Total Complaints']
x = complaints_df['Wealth']

# Using scipy get some stats from the x and y data
slope, intercept, r_value, p_value, std_err = stats.linregress(x, y)

# Calculate line of best fit
line = slope*x+intercept

# Plot our data
plt.plot(x, y,'o', x, line)
plt.xlabel('Wealth')
plt.ylabel('Total Complaints Before Dropping Outliers')
```

Out[6]:

```
Text(0, 0.5, 'Total Complaints Before Dropping Outliers')
```



In [7]:

```
# Drop some outliers
complaints_df.drop( complaints_df[ complaints_df['Total Complaints'] < 5 ].index , inplace=True)
complaints_df.drop( complaints_df[ complaints_df['Wealth'] > 500000 ].index , inplace=True)

complaints_df.head()
```

Out[7]:

	Checking or savings account	Consumer Loan	Credit reporting	Credit reporting, credit repair services, or other personal consumer reports	Debt collection	Mortgage	Credit card or prepaid card	Student loan	Bank account or service	Payday loan, title loan, or personal loan	...	Payda loa
90001	3.0	1.0	4.0	28.0	22.0	6.0	0.0	0.0	0.0	0.0	...	0
90002	0.0	0.0	0.0	21.0	13.0	3.0	4.0	7.0	0.0	0.0	...	0
90003	3.0	0.0	0.0	40.0	9.0	4.0	1.0	1.0	1.0	0.0	...	0
90004	7.0	0.0	0.0	13.0	8.0	3.0	5.0	2.0	1.0	1.0	...	0
90005	1.0	0.0	5.0	5.0	7.0	3.0	1.0	0.0	0.0	0.0	...	0

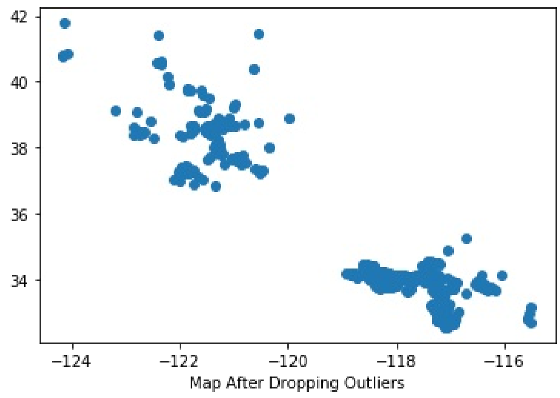
5 rows × 23 columns

In [8]:

```
# Plot again after dropping outliers
plt.plot(complaints_df['Longitude'], complaints_df['Latitude'],'o')
plt.xlabel("Map After Dropping Outliers")
```

Out[8]:

```
Text(0.5, 0, 'Map After Dropping Outliers')
```



In [9]:

```
# Shows all the complaint categories and counts the number for each one
complaints_num_df = pd.DataFrame()
column_list = complaints_df.columns.tolist()

complaints_num_df['Number of Complaints'] = complaints_df.sum().astype(int)
complaints_num_df
```

Out[9]:

	Number of Complaints
Checking or savings account	2066
Consumer Loan	50
Credit reporting	463
Credit reporting, credit repair services, or other personal consumer reports	10390
Debt collection	3909
Mortgage	2574
Credit card or prepaid card	1867
Student loan	482
Bank account or service	160
Payday loan, title loan, or personal loan	277
Vehicle loan or lease	343
Credit card	134
Money transfer, virtual currency, or money service	339
Payday loan	5
Prepaid card	9
Money transfers	5
Other financial service	5
Number	10159770
Amount	735549168
Wealth	45995785
Total Complaints	23078
Latitude	20576
Longitude	-69667

In [10]:

```
# Get rid of complaint types that have less than 1000 number of complaints
to_drop = (complaints_num_df[complaints_num_df['Number of Complaints'] < 1000].index).tolist()
complaints_df = complaints_df.drop(columns=to_drop)

complaints_df.head()
```

Out[10]:

	Checking or savings account	Credit reporting, credit repair services, or other personal consumer reports	Debt collection	Mortgage	Credit card or prepaid card	Number	Amount	Wealth	Total Complaints	Latitude
90001	3.0	28.0	22.0	6.0	0.0	21670.0	619635.0	28594.139363	64.0	33.9731
90002	0.0	21.0	13.0	3.0	4.0	19890.0	563172.0	28314.328808	48.0	33.9497
90003	3.0	40.0	9.0	4.0	1.0	27290.0	730810.0	26779.406376	59.0	33.9653
90004	7.0	13.0	8.0	3.0	5.0	27810.0	1995586.0	71757.856886	41.0	34.0762
90005	1.0	5.0	7.0	3.0	1.0	15850.0	807743.0	50961.703470	23.0	34.0585

In [11]:

```
# Create index columns for the larger complaint types.
# these were created by dividing the amount of these complaints
# by the total complaints for the zip code to get out the frequency
# that a certain zip code complains about certain things
complaints_df['Checking or savings account index'] = complaints_df['Checking or savings account'] / complaints_df['Total Complaints']
complaints_df['Credit reporting, credit repair services, or other personal consumer reports index'] = complaints_df['Credit reporting, credit repair services, or other personal consumer reports'] / complaints_df['Total Complaints']
complaints_df['Debt collection index'] = complaints_df['Debt collection'] / complaints_df['Total Complaints']
complaints_df['Mortgage index'] = complaints_df['Mortgage'] / complaints_df['Total Complaints']
complaints_df['Credit card or prepaid card index'] = complaints_df['Credit card or prepaid card'] / complaints_df['Total Complaints']

# Total complaint score = ( Total Complaints / Number of returns ) * 1000
complaints_df['Total Complaints Score'] = complaints_df['Total Complaints'] / complaints_df['Number'] * 1000

complaints_df.head()
```

Out[11]:

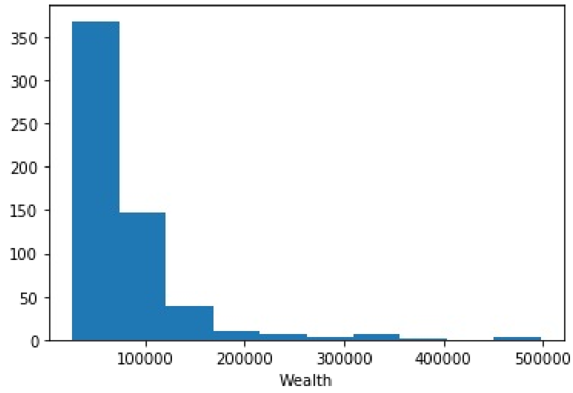
	Checking or savings account	Credit reporting, credit repair services, or other personal consumer reports	Debt collection	Mortgage	Credit card or prepaid card	Number	Amount	Wealth	Total Complaints	Latitude	Che sa ac
90001	3.0	28.0	22.0	6.0	0.0	21670.0	619635.0	28594.139363	64.0	33.9731	0.0
90002	0.0	21.0	13.0	3.0	4.0	19890.0	563172.0	28314.328808	48.0	33.9497	0.0
90003	3.0	40.0	9.0	4.0	1.0	27290.0	730810.0	26779.406376	59.0	33.9653	0.0
90004	7.0	13.0	8.0	3.0	5.0	27810.0	1995586.0	71757.856886	41.0	34.0762	0.1
90005	1.0	5.0	7.0	3.0	1.0	15850.0	807743.0	50961.703470	23.0	34.0585	0.0

In [12]:

```
plt.hist(complaints_df['Wealth'])
plt.xlabel('Wealth')
```

Out[12]:

```
Text(0.5, 0, 'Wealth')
```

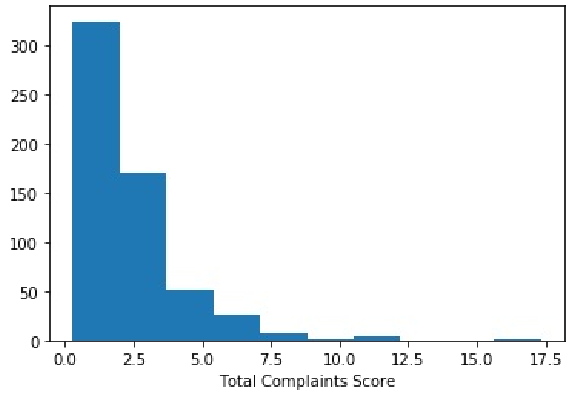


In [13]:

```
plt.hist(complaints_df['Total Complaints Score'])
plt.xlabel('Total Complaints Score')
```

Out[13]:

```
Text(0.5, 0, 'Total Complaints Score')
```

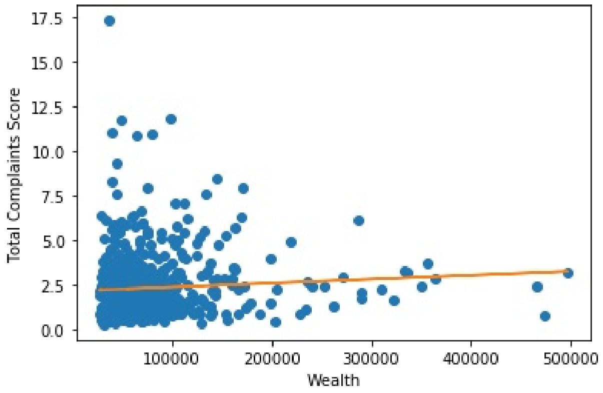


In [14]:

```
y = complaints_df['Total Complaints Score']
x = complaints_df['Wealth']

# Using scipy get some stats from the x and y data
slope, intercept, r_value_total_complaints, p_value_total_complaints, std_err = stats.linregress(x, y)

# Calculate line of best fit
line = slope*x+intercept

# Plot our data
plt.plot(x, y,'o', x, line)
plt.xlabel('Wealth')
plt.ylabel('Total Complaints Score')
```

Out[14]:

```
Text(0, 0.5, 'Total Complaints Score')
```

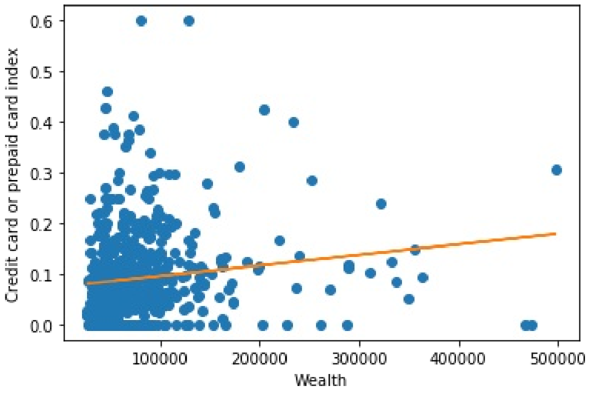


In [15]:

```
y = complaints_df['Credit card or prepaid card index']
x = complaints_df['Wealth']

# Using scipy get some stats from the x and y data
slope, intercept, r_value_account, p_value_account, std_err = stats.linregress(x, y)

# Calculate line of best fit
line = slope*x+intercept

# Plot our data
plt.plot(x, y,'o', x, line)
plt.xlabel('Wealth')
plt.ylabel('Credit card or prepaid card index')
```

Out[15]:

```
Text(0, 0.5, 'Credit card or prepaid card index')
```

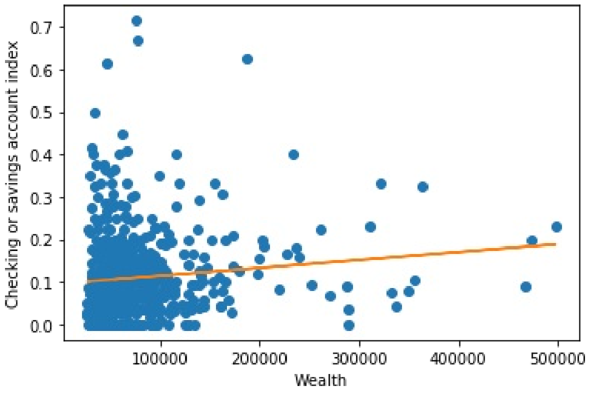


In [16]:

```
y = complaints_df['Checking or savings account index']
x = complaints_df['Wealth']

# Using scipy get some stats from the x and y data
slope, intercept, r_value_cards, p_value_cards, std_err = stats.linregress(x, y)

# Calculate line of best fit
line = slope*x+intercept

# Plot our data
plt.plot(x, y,'o', x, line)
plt.xlabel('Wealth')
plt.ylabel('Checking or savings account index')
```

Out[16]:

```
Text(0, 0.5, 'Checking or savings account index')
```

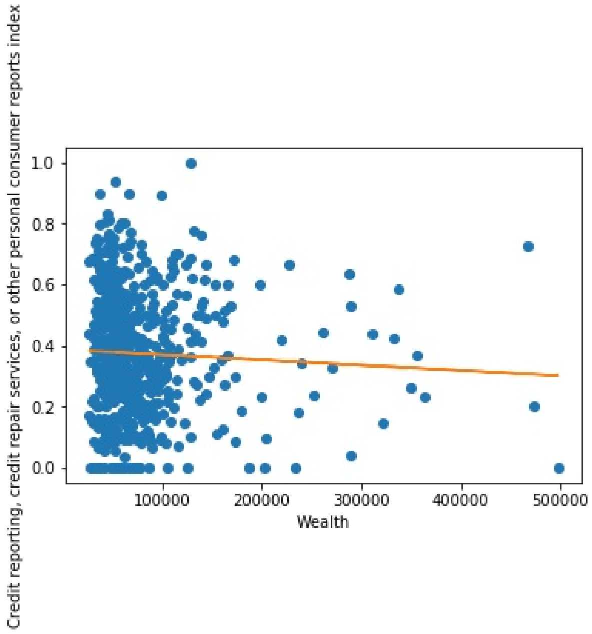


In [17]:

```
y = complaints_df['Credit reporting, credit repair services, or other personal consumer reports index']
x = complaints_df['Wealth']

# Using scipy get some stats from the x and y data
slope, intercept, r_value_credit, p_value_credit, std_err = stats.linregress(x, y)

# Calculate line of best fit
line = slope*x+intercept

# Plot our data
plt.plot(x, y,'o', x, line)
plt.xlabel('Wealth')
plt.ylabel('Credit reporting, credit repair services, or other personal consumer reports index')
```

Out[17]:

```
Text(0, 0.5, 'Credit reporting, credit repair services, or other personal consumer reports index')
```

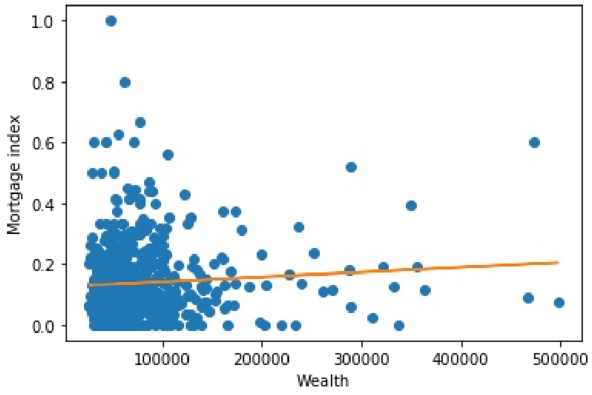


In [18]:

```
y = complaints_df['Mortgage index']
x = complaints_df['Wealth']

# Using scipy get some stats from the x and y data
slope, intercept, r_value_mortgage, p_value_mortgage, std_err = stats.linregress(x, y)

# Calculate line of best fit
line = slope*x+intercept

# Plot our data
plt.plot(x, y,'o', x, line)
plt.xlabel('Wealth')
plt.ylabel('Mortgage index')
```

Out[18]:

```
Text(0, 0.5, 'Mortgage index')
```

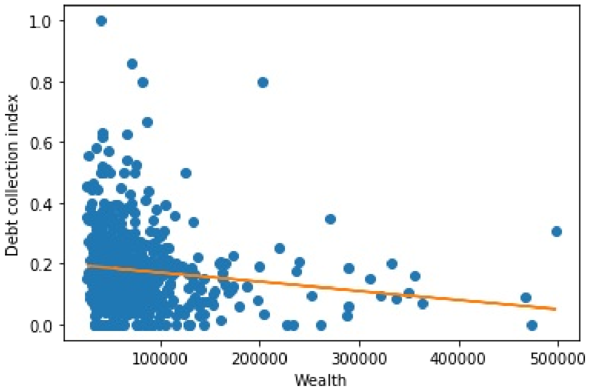


In [19]:

```
y = complaints_df['Debt collection index']
x = complaints_df['Wealth']

# Using scipy get some stats from the x and y data
slope, intercept, r_value_debt, p_value_debt, std_err = stats.linregress(x, y)

# Calculate line of best fit
line = slope*x+intercept

# Plot our data
plt.plot(x, y,'o', x, line)
plt.xlabel('Wealth')
plt.ylabel('Debt collection index')
```

Out[19]:

```
Text(0, 0.5, 'Debt collection index')
```



In [20]:

```
def check_p_val(p_val, alpha = 0.05):

    if p_val < alpha:
        return 'We have evidence to reject the null hypothesis.'
    else:
        return 'We do not have evidence to reject the null hypothesis.'

print("Total Complaints Score p-value: " + str(p_value_total_complaints))
print(check_p_val(p_value_total_complaints))
print("Credit card or prepaid card index p-value: " + str(p_value_cards))
print(check_p_val(p_value_cards))
print("Credit reporting, credit repair services, or other personal consumer reports index p-value: " + str(p_valu
e_account))
print(check_p_val(p_value_account))
print("Checking or savings account index p-value: " + str(p_value_credit))
print(check_p_val(p_value_credit))
print("Mortgage index p-value: " + str(p_value_mortgage))
print(check_p_val(p_value_mortgage))
print("Debt collection index p-value: " + str(p_value_debt))
print(check_p_val(p_value_debt))

print()

print("Total Complaints Score r-squared: " + str(r_value_total_complaints * r_value_total_complaints))
print("Credit card or prepaid card index r-squared: " + str(r_value_cards * r_value_cards))
print("Credit reporting, credit repair services, or other personal consumer reports index r-squared: " + str(r_va
lue_account * r_value_account))
print("Checking or savings account index r-squared: " + str(r_value_credit * r_value_credit))
print("Mortgage index r-squared: " + str(r_value_mortgage * r_value_mortgage))
print("Debt collection index r-squared: " + str(r_value_debt * r_value_debt))
```

```
Total Complaints Score p-value: 0.08901403095114181
We do not have evidence to reject the null hypothesis.
Credit card or prepaid card index p-value: 0.007914388111044363
We have evidence to reject the null hypothesis.
Credit reporting, credit repair services, or other personal consumer reports index p-value: 0.000888
4173629271891
We have evidence to reject the null hypothesis.
Checking or savings account index p-value: 0.2334688942785364
We do not have evidence to reject the null hypothesis.
Mortgage index p-value: 0.07170445922293184
We do not have evidence to reject the null hypothesis.
Debt collection index p-value: 0.0016364946328028076
We have evidence to reject the null hypothesis.

Total Complaints Score r-squared: 0.004944227641171785
Credit card or prepaid card index r-squared: 0.012014197743785314
Credit reporting, credit repair services, or other personal consumer reports index r-squared: 0.0187
53799687382368
Checking or savings account index r-squared: 0.0024299501748667493
Mortgage index r-squared: 0.005543382944027229
Debt collection index r-squared: 0.01685415331734389
```

DATA ANALYSIS & RESULTS: This section should include markdown text and code walking us through the following:

- EDA - What distributions do your variables take?
- Are there any outliers? - Relationship between variables? - Analysis (Note that you will likely have to do some Googling for analytical approaches not discussed in class. This is expected for this project and an important skill for a data scientist to master.)
- What approaches did you use? Why? - What were the results? - What were your interpretation of these findings.

There must be at least three appropriate data visualizationsthroughout these sections. Each visualization must included an interpretation of what is displayed *and* what should be learned from that visualization. Be sure that the appropriate type of visualization is generated given the data that you have, axes are all labeled, and the visualizations clearly communicate the point you’re trying to make.

ETHICS & PRIVACY: Briefly acknowledge and address any potential issues of ethics and privacy for the proposed project. In particular:

- Did you have permission to use this data, for this purpose? - Are there privacy concerns regarding your datasets that you need to deal with, and/or terms of use that you need to comply with? - Are there potential biases in your dataset(s), in terms of who it composes, and how it was collected, that may be problematic in terms of it allowing for equitable analysis? (For example, does your data exclude particular populations, or is it likely to reflect particular human biases in a way that could be a problem?) - Are there any other issues related to your topic area, data, and/or analyses that are potentially problematic in terms of data privacy and equitable impact? - How did you handle issues you identified? (1-2 paragraphs)

CONCLUSION & DISCUSSION: Discuss your project. Summarize your data and question. Briefly describe your analysis. Summarize your results and conclusions. Be sure to mention any limitations of your project. Discuss the impact of this work on society. (2-3 paragraphs)