data_integration_cleaning

December 7, 2017

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0.1 Data Sources

We used **three** primary sources for our project. For all sources, we gathered data for the years **2006 - 2016**. Observational unit for study was **Metropolitan Statistical Area (MSA).** An MSA is defined to be a geographical area with high population density.

0.1.1 1. FBI Uniform Crime Reporting (UCR) Program

We **automated** the extraction murders and man-slaughter data from the FBI database for the years 2006 - 2017.**Table 1** lists the features provided in the FBI database.

** Table 1: List of Crime Variables from FBI **

Name
Violent Crime
Murder + Non-negligent Manslaughter
Forcible Rape
Robbery
Aggravated Assault
Property Crime
Burglary
Larceny-theft
Motor Vehicle Theft
Population of MSA
Population of Largest city within MSA

The crime variables listed in Table 1 were available in three separate forms: Number for entire MSA, Number within the largest city of the MSA, and the number across the MSA per 100,000 individuals (a rate).

URL: https://ucr.fbi.gov/ucr-publications

0.1.2 2. United States Census Bureau (UCSB)

We obtained demographic data for each MSA from the USCB. We used our EDA (Exploratory Data Analysis), intuition, and the provided Glaeser paper to identify the features in scope. **Table 2** list the names, definitions, and table numbers for which we got census data.

** Table 2: Census Features Pulled for our analysis **

Feature Name	Feature Definition	USCB Table Number
white	% of White people	B02001
black	% of Black people	B02001
asian	% of Asian people	B02001
unemp_16_ovr	% Unemployed (age 16 years and over)	S2301
unemp_16_19	% Unemployed (age 16-19)	S2301
unemp_female	% Unemployed Female	S2301
median age	Median Age	S0101
sex_ratio	Number of Males per 100 females	S0101
male_pop	% Male Population	S0101
female_pop	% Female Population	S0101
pop_15_19	% of Population age 15-19	S0101
pop_20_24	% of Population age 20-24	S0101
male_pop_20_24	% Male Population age 20-24	S0101
married_house	% of Households with married couples	B09005
female_house	% of Single Households led by female	B09005
male_house	% of Single Households led by male	B09005
no_hs_18_24	% of 18-24 year olds with no high school	S1501
hs_18_24	% of 18-24 year olds with high school	S1501
no_9th_25_ovr	% of age 25 and over with less than 9th grade	S1501
no_hs_25_ovr	% of age 25 and over with no high school	S1501
hs_25_ovr	% of age 25 and over with high school	S1501
gini	Gini Index	B19083
under_18_pov	poverty_rate among 18 and under	S1701
18_64_pov	poverty_rate among 18-64 years	S1701
male_pov	povery_rate among males	S1701
female_pov	poverty_rate among females	S1701

We selected these variables because data were widely available (by year and by MSA) and we wanted to try to collect a range of economic, gender, racial, and age features to get a diverse array of variables about an MSA.

URL: https://factfinder.census.gov/

0.1.3 3. Bureau of Economic Analysis (BEA)

The data on income from UCSB were mostly missing and thus unusable. Instead, we looked to the BEA which provided **real per-capita GDP**, that measures an MSA aggregate economic activity. The reason we chose real per-capita GDP are two-fold. Per-capita GDP is better than GDP for our purposes because it adjusts for population. Otherwise, larger MSA will always have larger GDP due to more people and resources. Secondly, real per capita GDP was chosen to control for inflation. Our GDP measure is in 2005 dollars for all years so that comparisons between years is due to actual changes rather than inflation

URL: https://www.bea.gov/iTable/iTable.cfm?ReqID=70#reqid=70&step=1&isuri=1&7003=1000&7004=naics&7035=1&7005=1&7006=xx&7001=21000&7036=-1&7002=2&7090=70&7007=-1&7093=levels

0.2 Data Integration & Merging

Listed below are the gaps that we've identified in the extracted data, alongside the design decisions we made for re-formatting

Crime Data (FBI Uniform Crime Reporting Program):

- Some MSA had crime statistics within multiple cities while the others only had one. We decided to define our city features as those that come from the largest city (by population) so that each MSA had one set of city statistics
- Not all MSA had 100% reporting rate of data. For those MSAs that did not have 100% reporting, an estimated total was reported. We used the estimated total rather than the actual variables so that all of our data represented the entire MSA (either actual or estimated).
- Crime data did not have a numeric ID for MSA. We initially considered using a cross-walk to translate the MSA descriptions to IDs but decided otherwise since IDs changed over time. MSA desciptions were a concatenation of the key cities followed by the state name. There were instances where an MSA was part of multiple states. We also observed that MSA names change over time. For accurate and unique identification, we created a unique **join_key** for each MSA. To create the join key, we extracted the first city name from the MSA description and concantenated it with the state abbreviation (which was also a part of the MSA description). We then used this **join_key along with year to merge the three data sets** to create one complete data frame for subsequent analysis.

Census Data:

We created custom tables at the M.S.A level from the census database and extracted the files in Excel format. These files were merged into a census dataframe, which was later joined back to the Crime Dataset

- Around 4% of MSA descriptions differed from what we obtained from the FBI Database. These cases were manually updated.

```
In [1]: import pandas as pd
        import urllib
        import numpy as np
        import matplotlib
        from matplotlib import pyplot as plt
        %matplotlib inline
        import warnings
        warnings.filterwarnings('ignore')
```

```
In [2]: """
        Function
        ---------------
        split_MSA

        This method takes in a dataframe with MSA and splits into a city_key (largest city)
        and state_key. This will help facilitate MSA merging

        Returns dataframe with these two additional features
```

```
"""
def split_MSA(df):
    df['MSA'] = df['MSA'].str.replace('Metro Area', '')
    # Need to manually fix how this MSA is written
    df.loc[df['MSA'].str.contains("Texarkana"), "MSA"] = "Texarkana, AR-TX"

    #Grab Everything before comma
    df['city_key'] = df['MSA'].str.split(",").str[0]
    # Then grab everything before first hyphen if it has it
    df['city_key'] = df['city_key'].str.split("-").str[0].str.strip()
    # State will be everying after comma
    df['state_key']=df['MSA'].str.split(",").str[1].str.strip()
    return(df)

"""
Function
--------
append_df

This function appends two dataframes

Parameters:
    input - dataframe to be appended
    output - dataframe to be appended onto

Returns a single dataframe
"""
def append_df(input,output):
    if output.empty:
        output=input.copy()
    else:
        output=pd.concat([output,input])
        output.reset_index(drop='Index',inplace=True)
    return(output)

'''
Function
-----------
var_thresh

This function takes in a dataframe and keeps only those varaibles that have a pct
non-missing that is above that threshold
'''
def var_thresh(df, thresh=0.65):
    return(df.loc[:, pd.notnull(df).sum() > len (df) *thresh])

'''
Function
```

```
---------
slim_df

This function takes in a list of variables to keep
on the the given df. It keep the variables + geography
then renames to MSA and drops the first row of variable descriptions
'''
def slim_df(df, var_list):
    var_list.append('GEO.display-label')
    df = df.loc[:, var_list]
    # Get rid of Micro Areas
    df = df.loc[~df['GEO.display-label'].str.contains("Micro Area"), :]

    df = df.rename(index=str, columns={'GEO.display-label': 'MSA'})
    df['MSA'] = df["MSA"].astype(str)
    # Drop first row of var descriptions
    df = df.loc[df.MSA != "Geography", :]
    # Split MSA into city-state key
    return(split_MSA(df))

'''
Function
---------
match_crime

This function will take in a dataframe and make changes to MSA
in order to match crime data
'''
def match_crime(df):
    df.loc[df['MSA'].str.contains('Crestview'),'city_key']='Crestview'
    df.loc[df['MSA'].str.contains('Sarasota'),'city_key']='North Port'
    df.loc[df['MSA'].str.contains('Louisville'),'city_key']='Louisville'
    df.loc[df['MSA'].str.contains('Santa Maria'),'city_key']='Santa Maria'
    df.loc[df['MSA'].str.contains('Weirton'),'city_key']='Weirton'
    df.loc[df['MSA'].str.contains('San Germán'),'city_key']='San German'
    df.loc[df['MSA'].str.contains('Mayagüez'),'city_key']='Mayaguez'
    df.loc[df['MSA'].str.contains('Honolulu'),'city_key']='Urban Honolulu'

    #State
    df.loc[df['MSA'].str.contains('Worcester'),'state_key']='MA-CT'
    df.loc[df['MSA'].str.contains('Myrtle Beach'),'state_key']='SC-NC'
    df.loc[df['MSA'].str.contains('Salisbury'),'state_key']='MD-DE'
    df.loc[df['MSA'].str.contains('Weirton'),'state_key']='WV-OH'
    return(df)

'''
Function
--------
```

```
get_file_name

Get the appropriate file name giving year and table code

'''
def get_file_name(year, table_code):
    if year == 2006:
        mid = 'EST'
    else:
        mid = '1YR'
    return('ACS_'+str(year)[2:]+"_%s_" %mid + table_code)

'''
Function
--------
convert_to_int

This function takes in a dataframe and list of vars to convert to int
'''
def convert_to_int(df, int_vars):
    df[int_vars] = df[int_vars].astype(int)
    return(df)
'''
Function
----------
create_proportions

This function will take in a list of variables and a single total variable
It then creates proportions by dividing each of the variables in the list by the total
to create a proportion
'''
def create_proportions(df,num_list, total_var):
    df.loc[:, num_list] = df[num_list].apply(lambda x: x / df[total_var])
    del df[total_var]
    return(df)

"""
function
-----------
fbi_url_generator

This function pulls violent crime spreadsheets from FBI UCR website
for a given year

It takes in the year of interest and outputs a url string
"""
def fbi_url_generator(year):
    if 2006 <= year <= 2009:
```

```
            return('https://www2.fbi.gov/ucr/cius%i/data/documents/'%year +str(year)[2:]+'
        else:
            if 2010 <= year <= 2011:
                end = '/tables/table-6/output.xls'
            elif 2012 <= year <= 2013:
                end = '/tables/6tabledatadecpdf/table-6/output.xls'
            elif 2014 <= year <= 2015:
                if year == 2014:
                    mid = 'Table_6_Crime_in_the_United_States_by_Metropolitan_Statistical_
                else:
                    mid = 'table_6_crime_in_the_united_states_by_metropolitan_statistical_
                end = '/tables/table-6/%s' %mid
            elif year == 2016:
                end ='/tables/table-4/table-4/output.xls'
            hostname = 'https://ucr.fbi.gov/crime-in-the-u.s/%i/crime-in-the-u.s.-%i' %(yea
            return(hostname + end)
```

In [3]:
```
######################
# Employment Data
######################
emp_all = pd.DataFrame()
for year in range(2006, 2017):
    f = get_file_name(2006, 'S2301')
    employ = pd.read_csv("data/employ/%s.csv" %f, encoding='Latin-1')

    # Grab Unemployment
    un = [v for v in employ.columns if "HC04" in v and "EST" in v]
    employ = slim_df(employ, un)

    employ = employ.loc[:, ["MSA", "city_key", "state_key",
                            "HC04_EST_VC01", "HC04_EST_VC03",
                           'HC04_EST_VC24']]
    employ['year'] = year
    emp_all = append_df(employ, emp_all)

# Process Final DataFrame
emp_all = emp_all.sort_values(['city_key', 'state_key', 'year'])
emp_all = match_crime(emp_all)
del emp_all['MSA']
emp_all = emp_all.rename(index=str,
                         columns={'HC04_EST_VC01': 'unemp_16_ovr',
                                  'HC04_EST_VC03': 'unemp_16_19',
                                  'HC04_EST_VC24': 'unemp_female'})
#emp_all.head()
```

In [4]:
```
############
# Age Data
```

```
        ############
        age_all = pd.DataFrame()
        for year in range(2006, 2017):
            f = get_file_name(year, 'S0101')
            age = pd.read_csv("data/age/%s.csv" %f, encoding='Latin-1')
            age = slim_df(age, [v for v in age.columns if "EST" in v])
            age = age.replace("(X)", np.nan)

            age = age.loc[:, ['MSA','city_key','state_key',
                              'HC01_EST_VC33','HC01_EST_VC34',
                              'HC01_EST_VC01', 'HC02_EST_VC01',
                              'HC03_EST_VC01', 'HC01_EST_VC06',
                              'HC01_EST_VC07', 'HC02_EST_VC07']]
            age['year'] = year
            age_all = append_df(age, age_all)


        # Process Final DataFrame
        age_all = age_all.sort_values(['city_key', 'state_key', 'year'])
        age_all = age_all.rename(index=str,
                                 columns={'HC01_EST_VC33':'median_age',
                                        'HC01_EST_VC34': 'sex_ratio',
                                        'HC01_EST_VC01': 'total_pop',
                                        'HC02_EST_VC01': 'male_pop',
                                        'HC03_EST_VC01': 'female_pop',
                                        'HC01_EST_VC06': 'pop_15_19',
                                        'HC01_EST_VC07': 'pop_20_24',
                                        'HC02_EST_VC07': 'male_pop_20_24'})

        # Convert to Int and Get Proportions
        age_all = convert_to_int(age_all, ['total_pop', 'male_pop', 'female_pop'])
        age_all = create_proportions(age_all, ['male_pop', 'female_pop'], 'total_pop')
        # Match Crime Data and then get rid of MSA
        age_all = match_crime(age_all)
        del age_all['MSA']
        #age_all.head()
```

In [5]:
```
        ###############
        # Income Data
        ###############
        inc_all = pd.DataFrame()
        for year in range(2006, 2017):
            f = get_file_name(year, 'B19001F')
            inc = pd.read_csv("data/house_income/%s.csv" %f, encoding='Latin-1')
            # Keep only the estimates
            inc = slim_df(inc, [v for v in inc.columns if "HD01" in v])
            inc['year'] = year
            inc_all = append_df(inc, inc_all)
```

```
        # Proccess Final Data Frame
        inc_all =  inc_all.rename(index=str,
                                  columns={'HD01_VD01':'total',
                                           'HD01_VD02': 'inc_lt10',
                                           'HD01_VD03': 'inc_10_15',
                                           'HD01_VD04': 'inc_15_19',
                                           'HD01_VD05': 'inc_20_24',
                                           'HD01_VD06': 'inc_25_29',
                                           'HD01_VD07': 'inc_30_34',
                                           'HD01_VD08': 'inc_35_39',
                                           'HD01_VD09': 'inc_40_44',
                                           'HD01_VD10': 'inc_45_49',
                                           'HD01_VD11': 'inc_50_59',
                                           'HD01_VD12': 'inc_60_74',
                                           'HD01_VD13':'inc_75_99',
                                           'HD01_VD14':'inc_100_124',
                                           'HD01_VD15':'inc_125_149',
                                           'HD01_VD16':'inc_150_199',
                                           'HD01_VD17':'inc_gt_200'})

        numeric_vars =  [v for v in inc_all.columns if "inc" in v]
        inc_all = convert_to_int(inc_all, numeric_vars)
        inc_all['total'] = inc_all['total'].astype(int)
        # Get propotion of each imcome bracket by dividing by total
        inc_all = create_proportions(inc_all, numeric_vars, "total")
        # Match Crime data and Get rid of MSA
        inc_all = match_crime(inc_all)
        del inc_all['MSA']
        #inc_all.head()

In [6]: ###############
        # GINI INDEX
        ###############
        gini_all = pd.DataFrame()
        for year in range(2006, 2017):
            f = get_file_name(year, 'B19083')
            gini = pd.read_csv("data/gini/%s.csv" %f, encoding='Latin-1')
            # Don't need micro areas
            gini = slim_df(gini, ["HD01_VD01"])
            gini['year'] = year
            gini_all = append_df(gini, gini_all)

        # Clean Final Dataframes
        gini_all = gini_all.rename(index=str,
                                   columns={"HD01_VD01":"gini"})
        gini_all['gini'] = gini_all['gini'].astype(float)
        gini_all = match_crime(gini_all)
```

```
        del gini_all['MSA']
        #gini_all.head()

In [7]: #################
        # Poverty Data
        #################
        pov_all = pd.DataFrame()
        for year in range(2006, 2017):
            f = get_file_name(year, 'S1701')
            pov = pd.read_csv("data/poverty/%s.csv" %f, encoding='Latin-1')
            pov = slim_df(pov, ['HC03_EST_VC03', 'HC03_EST_VC05',
                                'HC03_EST_VC08', 'HC03_EST_VC09'])
            pov['year'] = year
            pov_all = append_df(pov, pov_all)
        # Clean Final DataFrame
        pov_all = pov_all.rename(index=str,
                                 columns={'HC03_EST_VC03': 'under_18_pov',
                                          'HC03_EST_VC05':'18_64_pov',
                                          'HC03_EST_VC08':'male_pov',
                                          'HC03_EST_VC09':'female_pov'})
        pov_all = match_crime(pov_all)
        del pov_all['MSA']
        #pov_all.head()

In [8]: ##################################
        # Head of Household Information
        ##################################
        house_all = pd.DataFrame()
        for year in range(2006, 2017):
            f = get_file_name(year, 'B09005')
            house = pd.read_csv("data/house_head/%s.csv" %f, encoding='Latin-1')
            house = slim_df(house, [v for v in house.columns if "HD01" in v])
            house = house.loc[:, ["MSA", "city_key", "state_key",
                                  "HD01_VD01", "HD01_VD03", "HD01_VD05",
                                  "HD01_VD06"]]
            house['year'] = year
            house_all = append_df(house, house_all)

        # Clean Entire DataFrame
        house_all = house_all.rename(index=str,
                                     columns={'HD01_VD01': 'total',
                                              'HD01_VD03': 'married_house',
                                              'HD01_VD05': 'female_house',
                                              'HD01_VD06': 'male_house'})

        house_all = convert_to_int(house_all,
                                   ['total', 'married_house', 'female_house', 'male_house'])
        house_all = create_proportions(house_all,
```

```
                                    ['married_house', 'female_house',
                                                'male_house'],
                                    'total')
        house_all = match_crime(house_all)
        del house_all['MSA']
        #house_all.head()

In [9]: ##################
        # Education Data
        ##################
        edu_all = pd.DataFrame()
        for year in range(2006,2017):
            f = get_file_name(year, 'S1501')
            edu = pd.read_csv("data/education/%s.csv" %f, encoding='Latin-1')
            if 2015 <= year <= 2016:
                edu = slim_df(edu, ['HC02_EST_VC03', 'HC02_EST_VC04',
                                    'HC02_EST_VC09','HC02_EST_VC10', 'HC02_EST_VC11'])
            elif 2010 <= year <= 2014:
                edu = slim_df(edu,['HC01_EST_VC02', 'HC01_EST_VC03',
                                   'HC01_EST_VC08','HC01_EST_VC09', 'HC01_EST_VC10'])
            else:
                edu = slim_df(edu, ['HC01_EST_VC02', 'HC01_EST_VC03',
                                    'HC01_EST_VC07','HC01_EST_VC08', 'HC01_EST_VC09'])

            edu['year'] = year
            edu.columns=['no_hs_18_24','hs_18_24','no_9th_25_ovr','no_hs_25_ovr',
                         'hs_25_ovr','MSA','city_key','state_key','year']
            edu_all = append_df(edu, edu_all)

        #Trim Final Dataframe
        edu_all = match_crime(edu_all)
        del edu_all['MSA']
        #edu_all.head()

In [10]: #############
         # Race Data
         #############
         race_all = pd.DataFrame()
         for year in range(2006, 2017):
             f = get_file_name(year, 'B02001')
             race = pd.read_csv("data/race/%s.csv" %f, encoding='Latin-1')
             race = slim_df(race, [v for v in race.columns if "HD01" in v])
             race = race.loc[:, ['MSA', 'city_key', 'state_key',
                                 'HD01_VD01','HD01_VD02',
                                 'HD01_VD03', 'HD01_VD05']]

             race['year'] = year
             race_all = append_df(race, race_all)
```

```
        # Proccess Final Data Frame
        race_all =  race_all.rename(index=str,
                                    columns={'HD01_VD01':'total',
                                             'HD01_VD02': 'white',
                                             'HD01_VD03': 'black',
                                             'HD01_VD05': 'asian'})

        race_all = convert_to_int(race_all, ['total', 'white','black','asian'] )
        race_all = create_proportions(race_all, ['white', 'black', 'asian'], 'total')
        # Match Crime Data
        race_all = match_crime(race_all)
        del race_all['MSA']
        #race_all.head()
```

In [11]:
```
        # Bring Everything Together
        census_df = race_all.copy()

        merge_df = lambda df: census_df.merge(df,
                                              how='outer',
                                              on=['city_key','state_key','year'],
                                              indicator=True)

        str_list = ['Employment', 'Age', 'Head of House','Education', 'Gini', 'Poverty']
        df_list = [emp_all, age_all, house_all, edu_all, gini_all, pov_all]

        for i, df in enumerate(df_list):
            census_df = merge_df(df)
            #print("%s Merge Stats" %str_list[i])
            #print(census_df['_merge'].value_counts())
            del census_df['_merge']

        '''

        Household had ones where it looks like there may be mismatches but code below checked

        Code to check merges
        names = census_df.loc[census_df._merge != "both", ['city_key', 'state_key', '_merge']
        names = names.sort_values['city_key', 'state_key']
        names = names.drop_duplicates()
        print(names.shape[0])
        names.head(50)
        '''
```

Out[11]:
```
'\n\nHousehold had ones where it looks like there may be mismatches but code below ch
```

In [12]:
```
        ######################
        # Bring in BEA Data
```

```
        ######################
        bea_gdp = pd.read_csv("data/BEA_real_GDP_pc.csv",skiprows=[0,1,2], header=1)
        del bea_gdp['Fips']
        bea_gdp= bea_gdp.iloc[1:, :].rename(index=str, columns={"Area": 'MSA'})
        bea_gdp = pd.melt(bea_gdp, id_vars=["MSA"], var_name='year', value_name='real_pc_gdp')
        bea_gdp = bea_gdp.loc[bea_gdp.MSA.notnull(), :]
        bea_gdp['year'] = bea_gdp['year'].astype(int)
        bea_gdp = bea_gdp.loc[bea_gdp.year >= 2006, :]

        # Get rid of MSA in paranthesis
        bea_gdp['MSA'] = bea_gdp['MSA'].str.replace(r"\(.*\)","")
        bea_gdp = split_MSA(bea_gdp)
        # Need to manually fix this one so it will merge
        bea_gdp.loc[bea_gdp.city_key.str.contains("Louisville"), 'city_key'] = 'Louisville'

        del bea_gdp['MSA']
```

In [13]:
```
        census_df = merge_df(bea_gdp)
        del census_df["_merge"]
```

In [14]:
```
        # Check to make sure that there were no typos
        #names = census_df.loc[census_df._merge != "both", ['city_key', 'state_key', '_merge']
        #names = names.drop_duplicates()
        #print(names.shape[0])
        #del census_df["_merge"]
```

In [15]:
```
        # THIS CODE ONLY NEEDS TO BE RUN ONCE TO BRING IN ALL OF THE EXCEL FILES
        version='Mozilla/5.0 (X11; Linux x86_64) AppleWebKit/537.36 (KHTML, like Gecko) Chrome
        test=urllib.request.URLopener()
        test.addheader('User-Agent',version)
        for year in range(2006, 2017):
            #print("Pulling: %i" %year)
            test.retrieve(url=fbi_url_generator(year),filename='crime_%i.xls' %year)
```

In [16]:
```
        df_allyears = pd.DataFrame()
        for year in range(2006, 2017):
            df = pd.read_excel("crime_%i.xls" %year,skiprows=[0,1],header=1)

            #######
            # NOTE - misc column has msa population, city population and estimate percentage
            ######
            df=df.iloc[:,0:12]
            df.columns=['MSA', 'counties','misc', 'violent_crime','mur_mans',
                        'rape', 'robbery','assault', 'property', 'burglary',
                        'larceny','mv_theft']

            df['counties'].replace(' ',np.nan, inplace=True)

            # Drop footnotes
```

```
footnotes = df['MSA'].str[0].str.isdigit().fillna(False)
df = df.loc[~footnotes, :]

#Drop blank rows
df = df.dropna(how='all')

# Get rid of numbers in MSA
df['MSA'] = df['MSA'].str.replace('\d+', '')
# Set empty columns to NaN for MSA
df['MSA'] = df['MSA'].replace(' ', np.nan, regex=False)

# Sometimes city  names get put in MSA column
# Messes up carry forward
df.loc[df['MSA'].str.contains("City of").fillna(False), "MSA"] = np.nan

# Carry MSA name forward to fill in for all cells
df.loc[:,'MSA'] = df.loc[:, 'MSA'].fillna(method='ffill')

###############
# POPULATION - grab population and fill in for all MSA
###############
pop_row = df.counties.isnull()
pop = df.loc[pop_row, ["MSA", 'misc']]
pop = pop.rename(index=str, columns={'misc': 'msa_pop'})

# Merge population back in
df = df.loc[~pop_row, :]
df = df.merge(pop, how='outer', on='MSA')

#################
# Descriptions - don't need county descriptions
#################
df = df.loc[df.counties.str.contains("Includes") == False, :]


##########################################
# GOING LONG TO WIDE FOR CRIME VARIABLES
##########################################
crime_vars = ['violent_crime','mur_mans', 'rape', 'robbery',
              'assault', 'property', 'burglary', 'larceny','mv_theft']

#########
# CITIES
#########
city_vars = ['MSA', 'counties', 'misc'] + crime_vars
# Split data Frame
cities = df.counties.str.contains("City")
city_df = df.loc[cities, city_vars]
```

```
city_df = city_df.rename(index=str, columns={'misc': 'city_pop'})

# Grab largest city for each MSA and merge back on
city_df = city_df.sort_values(['MSA','city_pop'], ascending=False)
large_city = city_df.groupby('MSA').first().reset_index()

# Rename crime variables to denote city only crime
large_city.columns = ['MSA', 'counties', 'city_pop'] + ['city_' + i for i in crime
large_city = large_city.rename(index=str,
                               columns={'counties':'largest_city'})
# Get rid of "City of"
large_city.loc[:,'largest_city'] = large_city.loc[:,
                                                  'largest_city'].str.replace('Ci
                                                                              '')


# Merge back to main dataframe
df = df.loc[~cities, ]
df = df.merge(large_city, how='outer', on='MSA')

################
# CRIME RATE
################
rates = df.counties.str.contains("Rate per")
rate_vars = ['MSA'] + crime_vars
rates_df = df.loc[rates, rate_vars]
rates_df.columns = ['MSA'] + ['rate_' + i for i in crime_vars]

df = df.loc[~rates, :]
df = df.merge(rates_df, how='outer', on='MSA')

########################
# MSA-WIDE CRIME STATS
########################

# If the entire MSA reported then there is just one row of numbers
# If the entire MSA did not report, then there are two rows
        # first row is areas that reported
        # second report is an estimated total
# We are going to grab the estimates total so our data
# reflects all areas for all MSA

# Create Flag for those that do not have complete coverage
# and are thus estimates
mins = df.groupby('MSA').misc.min().reset_index()
mins.columns = ['MSA', 'min_coverage']
df = df.merge(mins, how='outer', on='MSA')
df['estimate'] = 0
df.loc[df.min_coverage < 1, 'estimate'] = 1
```

```
            del df['min_coverage']

            # Now only keeping rows with coverage = 1
            # will either be all area or the estimate for all area
            df = df.loc[df.misc == 1, :]

            # Now no longer need coverage or whether its estimate or not
            del df['misc']
            del df['counties']

            df['year'] = year

            # Append to existing Frame
            df_allyears = append_df(df, df_allyears)
```

```
In [17]: df_allyears = df_allyears.sort_values(["MSA", 'year'])
```

```
In [18]: #Generate the city
         df_allyears['city_key'] = df_allyears['MSA'].str.replace(' M.S.A.','').str.split(",")
         df_allyears['city_key'] = df_allyears['city_key'].str.split("-").str[0].str.strip()
         df_allyears['state_key']=df_allyears['MSA'].str.replace(' M.S.A.',
                                                                 '').str.split(",").str[1].str
```

```
In [19]: ##Cleanse Crime Data
         df_allyears=df_allyears[~df_allyears['MSA'].str.contains(' M.D.')]
         df_allyears.loc[df_allyears['state_key']=='Puerto Rico','state_key']='PR'
         df_allyears.loc[df_allyears['MSA'].str.contains('Texarkana'),'state_key']='AR-TX'
         df_allyears.loc[df_allyears['city_key']=='Worcester','state_key']='MA-CT'
         df_allyears.loc[df_allyears['city_key']=='Steubenville','city_key']='Weirton'
         df_allyears.loc[df_allyears['city_key']=='Steubenville','state_key']='WV-OH'
         df_allyears.loc[df_allyears['city_key']=='Honolulu','city_key']='Urban Honolulu'
         df_allyears.loc[df_allyears['MSA'].str.contains('Scranton'),'city_key']='Scranton'
         df_allyears.loc[df_allyears['MSA'].str.contains('Sarasota'),'city_key']='North Port'
         df_allyears.loc[df_allyears['MSA'].str.contains('Santa Maria'),'city_key']='Santa Mar
         df_allyears.loc[df_allyears['MSA'].str.contains('Salisbury'),'state_key']='MD-DE'
         df_allyears.loc[df_allyears['MSA'].str.contains('Sacramento'),'city_key']='Sacramento
         df_allyears.loc[df_allyears['MSA'].str.contains('Myrtle Beach'),'state_key']='SC-NC'
         df_allyears.loc[df_allyears['MSA'].str.contains('Louisville'),'city_key']='Louisville
         df_allyears.loc[df_allyears['MSA'].str.contains('Homosassa'),'city_key']='Homosassa Sp
         df_allyears.loc[df_allyears['MSA'].str.contains('Crestview'),'city_key']='Crestview'
```

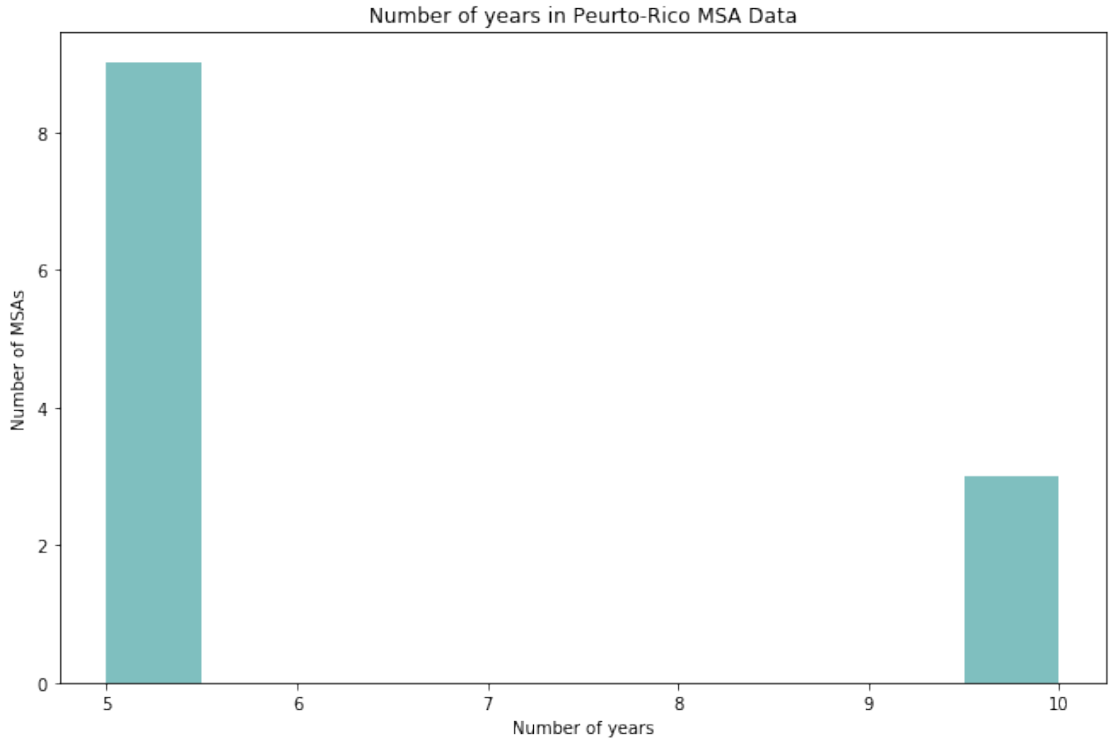
```
In [20]: #Merge Crime and census data
         final_df = df_allyears.merge(census_df, how='left', on=['city_key','state_key','year']
```

```
In [21]: # Look at final Cleaning of data-types
         float_cols = final_df.columns.difference(["MSA", "city_key", "state_key","year", "larg
         for v in float_cols:
             try:
```

```
            final_df[v] = final_df[v].astype(float)
        except:
            continue
    # Assault Rate Needs to be fixed
    # One Value is missing
    final_df.loc[final_df.rate_assault == " ", 'rate_assault'] = np.nan
    final_df["rate_assault"] = final_df["rate_assault"].astype(float)
```

PUERTO RICO CELL

In [22]:
```
#Find the number of years within each MSA in Puerto Rico
pr_msa=final_df[final_df['state_key'].str.contains("PR")].groupby('MSA').count().iloc
fig, ax = plt.subplots(1,1, figsize=(11,7))
ax.hist(pr_msa, color='teal',alpha=0.5)
ax.set_title('Number of years in Peurto-Rico MSA Data')
ax.set_xlabel('Number of years')
ax.set_ylabel('Number of MSAs');
```



In [23]:
```
#Exclude any PR data
final_df = final_df.loc[~final_df['state_key'].str.contains("PR"), :]
```

In [24]:
```
#Create a join key
final_df['join_key'] = final_df['city_key'].str.cat(final_df['state_key'],sep='-')
#Add columns for OHE
```

```
        final_df['year_ohe'] = final_df['year']
        final_df['state_ohe'] = final_df['state_key']
        final_df['join_ohe'] = final_df['join_key']
        #One hot encode join key, state key and year
        #Not dropping one column since year has missing values
        final_df = pd.get_dummies(final_df,prefix='year',columns=['year_ohe'])
        final_df = pd.get_dummies(final_df,prefix=['MSA','state'],columns=['join_ohe','state_
```

In [25]:
```
final_df.to_json('output/final.json')
```