Assignment 4

March 22, 2020

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*You are currently looking at **version 1.1** of this notebook. To download notebooks and datafiles, as well as get help on Jupyter notebooks in the Coursera platform, visit the Jupyter Notebook FAQ course resource.*

```
In [ ]: import pandas as pd
        import numpy as np
        from scipy.stats import ttest_ind
```

0.1 Hypothesis Testing

This assignment requires more individual learning than previous assignments - you are encouraged to check out the pandas documentation to find functions or methods you might not have used yet, or ask questions on Stack Overflow and tag them as pandas and python related. And of course, the discussion forums are open for interaction with your peers and the course staff.

Definitions: * A *quarter* is a specific three month period, Q1 is January through March, Q2 is April through June, Q3 is July through September, Q4 is October through December. * A *recession* is defined as starting with two consecutive quarters of GDP decline, and ending with two consecutive quarters of GDP growth. * A *recession bottom* is the quarter within a recession which had the lowest GDP. * A *university town* is a city which has a high percentage of university students compared to the total population of the city.

Hypothesis: University towns have their mean housing prices less effected by recessions. Run a t-test to compare the ratio of the mean price of houses in university towns the quarter before the recession starts compared to the recession bottom. (`price_ratio=quarter_before_recession/recession_bottom`)

The following data files are available for this assignment: * From the Zillow research data site there is housing data for the United States. In particular the datafile for all homes at a city level, `City_Zhvi_AllHomes.csv`, has median home sale prices at a fine grained level. * From the Wikipedia page on college towns is a list of university towns in the United States which has been copy and pasted into the file `university_towns.txt`. * From Bureau of Economic Analysis, US Department of Commerce, the GDP over time of the United States in current dollars (use the chained value in 2009 dollars), in quarterly intervals, in the file `gdplev.xls`. For this assignment, only look at GDP data from the first quarter of 2000 onward.

Each function in this assignment below is worth 10%, with the exception of `run_ttest()`, which is worth 50%.

```python
In [ ]: # Use this dictionary to map state names to two letter acronyms
        states = {'OH': 'Ohio', 'KY': 'Kentucky', 'AS': 'American Samoa', 'NV': 'Nevada', 'WY':

In [1]: def get_list_of_university_towns():
            import pandas as pd
            import numpy as np
            df = pd.read_csv('university_towns.txt',sep=';', header = None, names=['RegionName'
            df = df.replace(r'\n',' ', regex=True)
            df['State'] = df.loc[df['RegionName'].str.endswith('[edit]')]
            df['State'] = df['State'].fillna(method='ffill')
            df['State'] = df['State'].str.slice_replace(start=-6)
            df["RegionName"] = df["RegionName"].map(lambda x:x.split("(")[0].strip())
            df = df[~df['RegionName'].str.endswith(('[edit]'))]
            df = df[['State','RegionName']]
            return df
        get_list_of_university_towns()
```

```
Out[1]:          State                  RegionName
        1        Alabama                   Auburn
        2        Alabama                 Florence
        3        Alabama              Jacksonville
        4        Alabama                Livingston
        5        Alabama                Montevallo
        6        Alabama                     Troy
        7        Alabama                Tuscaloosa
        8        Alabama                  Tuskegee
        10        Alaska                 Fairbanks
        12       Arizona                 Flagstaff
        13       Arizona                    Tempe
        14       Arizona                   Tucson
        16      Arkansas               Arkadelphia
        17      Arkansas                   Conway
        18      Arkansas              Fayetteville
        19      Arkansas                 Jonesboro
        20      Arkansas                 Magnolia
        21      Arkansas                Monticello
        22      Arkansas               Russellville
        23      Arkansas                   Searcy
        25    California                   Angwin
        26    California                   Arcata
        27    California                 Berkeley
        28    California                    Chico
        29    California                Claremont
        30    California                   Cotati
        31    California                    Davis
        32    California                   Irvine
        33    California                Isla Vista
        34    California  University Park, Los Angeles
```

```
..                ...                              ...
533        Virginia                            Wise
534        Virginia                      Chesapeake
536      Washington                      Bellingham
537      Washington                          Cheney
538      Washington                      Ellensburg
539      Washington                         Pullman
540      Washington  University District, Seattle
542  West Virginia                          Athens
543  West Virginia                      Buckhannon
544  West Virginia                        Fairmont
545  West Virginia                       Glenville
546  West Virginia                      Huntington
547  West Virginia                      Montgomery
548  West Virginia                      Morgantown
549  West Virginia                    Shepherdstown
550  West Virginia                     West Liberty
552       Wisconsin                        Appleton
553       Wisconsin                      Eau Claire
554       Wisconsin                       Green Bay
555       Wisconsin                       La Crosse
556       Wisconsin                         Madison
557       Wisconsin                       Menomonie
558       Wisconsin                       Milwaukee
559       Wisconsin                         Oshkosh
560       Wisconsin                     Platteville
561       Wisconsin                     River Falls
562       Wisconsin                   Stevens Point
563       Wisconsin                        Waukesha
564       Wisconsin                      Whitewater
566         Wyoming                         Laramie

[517 rows x 2 columns]
```

```python
In [2]: def get_recession_start():
            '''Returns the year and quarter of the recession start time as a
            string value in a format such as 2005q3'''
            import pandas as pd
            import numpy as np
            df = pd.read_excel('gdplev.xls',skiprows=7,usecols= {'Unnamed: 4', 'Unnamed: 6'})
        #     df.reset_index()
            df = df.loc[212:]
            df = df.rename(columns = {'Unnamed: 4':'Quarter',
                                      'Unnamed: 6':'GDP'})
            df = df.set_index('Quarter')
            df['change'] = df.diff()
            start = (df.change<0) & (df.change.shift(-1)<0)
            return start.idxmax()
```

```
        get_recession_start()

Out[2]: '2008q3'

In [3]: def get_recession_end():
            '''Returns the year and quarter of the recession end time as a
            string value in a format such as 2005q3'''
            import pandas as pd
            import numpy as np
            df = pd.read_excel('gdplev.xls',skiprows=7,usecols= {'Unnamed: 4', 'Unnamed: 6'})
        #    where recession start
            df = df.loc[246:]

            df = df.rename(columns = {'Unnamed: 4':'Quarter',
                                      'Unnamed: 6':'GDP'})
        #    start = get_recession_start()
        #    df = df[(df['Quarter'] >= start)
            df = df.set_index('Quarter')
        #    df.reset_index()
            df['change'] = df.diff()
            end = (df.change>0) & (df.change.shift(1)>0)
            return end.idxmax()
        get_recession_end()

Out[3]: '2009q4'

In [4]: def get_recession_bottom():
            import pandas as pd
            df = pd.read_excel('gdplev.xls',skiprows=7,usecols= {'Unnamed: 4', 'Unnamed: 6'})
            df = df.rename(columns = {'Unnamed: 4':'Quarter',
                                      'Unnamed: 6':'GDP'})
            start = get_recession_start()
            end = get_recession_end()
            df = df[(df['Quarter'] >= start) & (df['Quarter'] <= end)]
            df = df.set_index('Quarter')
            bottom = df.idxmin()
            return bottom.iloc[0]
        get_recession_bottom()

Out[4]: '2009q2'

In [5]: def convert_housing_data_to_quarters():
            import pandas as pd
            '''Converts the housing data to quarters and returns it as mean
            values in a dataframe. This dataframe should be a dataframe with
            columns for 2000q1 through 2016q3, and should have a multi-index
            in the shape of ["State","RegionName"].

            Note: Quarters are defined in the assignment description, they are
```

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```
        not arbitrary three month periods.

        The resulting dataframe should have 67 columns, and 10,730 rows.
        '''
        hdf = pd.read_csv('City_Zhvi_AllHomes.csv')
        states = {'OH': 'Ohio', 'KY': 'Kentucky', 'AS': 'American Samoa', 'NV': 'Nevada', 'W
        hdf['State'] = hdf['State'].map(states)

        hdf = hdf.drop(['RegionID','Metro','CountyName','SizeRank'],axis =1)
        hdf = hdf.set_index(['State','RegionName'])
        hdf = hdf.groupby(pd.PeriodIndex(hdf.columns, freq='Q'), axis=1).mean()
        hdf = hdf.loc[:, '2000q1':'2016q3']
        hdf.columns = hdf.columns.format()
        return hdf
convert_housing_data_to_quarters()
```

```
Out[5]:                                                      2000Q1        2000Q2  \
        State                 RegionName
        New York              New York                          NaN           NaN
        California            Los Angeles              2.070667e+05  2.144667e+05
        Illinois              Chicago                  1.384000e+05  1.436333e+05
        Pennsylvania          Philadelphia             5.300000e+04  5.363333e+04
        Arizona               Phoenix                  1.118333e+05  1.143667e+05
        Nevada                Las Vegas                1.326000e+05  1.343667e+05
        California            San Diego                2.229000e+05  2.343667e+05
        Texas                 Dallas                   8.446667e+04  8.386667e+04
        California            San Jose                 3.742667e+05  4.065667e+05
        Florida               Jacksonville             8.860000e+04  8.970000e+04
        California            San Francisco            4.305000e+05  4.644667e+05
        Texas                 Austin                   1.429667e+05  1.452667e+05
        Michigan              Detroit                  6.616667e+04  6.830000e+04
        Ohio                  Columbus                 9.436667e+04  9.583333e+04
        Tennessee             Memphis                  7.250000e+04  7.320000e+04
        North Carolina        Charlotte                1.269333e+05  1.283667e+05
        Texas                 El Paso                  7.626667e+04  7.686667e+04
        Massachusetts         Boston                   2.069333e+05  2.191667e+05
        Washington            Seattle                  2.486000e+05  2.556000e+05
        Maryland              Baltimore                5.966667e+04  5.950000e+04
        Colorado              Denver                   1.622333e+05  1.678333e+05
        District of Columbia  Washington               1.377667e+05  1.442000e+05
        Tennessee             Nashville                1.138333e+05  1.152667e+05
        Wisconsin             Milwaukee                7.803333e+04  7.906667e+04
        Arizona               Tucson                   1.018333e+05  1.029667e+05
        Oregon                Portland                 1.528000e+05  1.547667e+05
        Oklahoma              Oklahoma City            7.643333e+04  7.750000e+04
        Nebraska              Omaha                    1.128000e+05  1.141000e+05
        New Mexico            Albuquerque              1.258667e+05  1.267000e+05
        California            Fresno                   9.410000e+04  9.526667e+04
```

		...	...
Texas	Granite Shoals	NaN	NaN
Maryland	Piney Point	1.556667e+05	1.551667e+05
Wisconsin	Maribel	NaN	NaN
Idaho	Middleton	1.060667e+05	1.043333e+05
Colorado	Bennett	1.329000e+05	1.358333e+05
New Hampshire	East Hampstead	1.618333e+05	1.691000e+05
Missouri	Garden City	NaN	NaN
Arkansas	Mountainburg	5.716667e+04	6.433333e+04
Wisconsin	Oostburg	1.072667e+05	1.081000e+05
California	Twin Peaks	9.736667e+04	1.001667e+05
New York	Upper Brookville	1.230967e+06	1.230967e+06
Hawaii	Volcano	9.870000e+04	1.053667e+05
South Carolina	Wedgefield	NaN	NaN
Michigan	Williamston	1.591667e+05	1.613000e+05
Arkansas	Decatur	6.360000e+04	6.440000e+04
Tennessee	Briceville	4.000000e+04	4.173333e+04
Indiana	Edgewood	9.170000e+04	9.186667e+04
Tennessee	Palmyra	NaN	NaN
Maryland	Saint Inigoes	1.480667e+05	1.476000e+05
Indiana	Marysville	NaN	NaN
California	Forest Falls	1.135333e+05	1.144000e+05
Missouri	Bois D Arc	1.078000e+05	1.069667e+05
Virginia	Henrico	1.285667e+05	1.307667e+05
New Jersey	Diamond Beach	1.739667e+05	1.831000e+05
Tennessee	Gruetli Laager	3.540000e+04	3.546667e+04
Wisconsin	Town of Wrightstown	1.017667e+05	1.054000e+05
New York	Urbana	7.920000e+04	8.166667e+04
Wisconsin	New Denmark	1.145667e+05	1.192667e+05
California	Angels	1.510000e+05	1.559000e+05
Wisconsin	Holland	1.510333e+05	1.505000e+05

		2000Q3	2000Q4 \
State	RegionName		
New York	New York	NaN	NaN
California	Los Angeles	2.209667e+05	2.261667e+05
Illinois	Chicago	1.478667e+05	1.521333e+05
Pennsylvania	Philadelphia	5.413333e+04	5.470000e+04
Arizona	Phoenix	1.160000e+05	1.174000e+05
Nevada	Las Vegas	1.354000e+05	1.370000e+05
California	San Diego	2.454333e+05	2.560333e+05
Texas	Dallas	8.486667e+04	8.783333e+04
California	San Jose	4.318667e+05	4.555000e+05
Florida	Jacksonville	9.170000e+04	9.310000e+04
California	San Francisco	4.835333e+05	4.930000e+05
Texas	Austin	1.494667e+05	1.557333e+05
Michigan	Detroit	6.676667e+04	6.703333e+04
Ohio	Columbus	9.713333e+04	9.826667e+04

Tennessee	Memphis	7.386667e+04	7.400000e+04
North Carolina	Charlotte	1.302000e+05	1.315667e+05
Texas	El Paso	7.673333e+04	7.730000e+04
Massachusetts	Boston	2.331000e+05	2.425000e+05
Washington	Seattle	2.625333e+05	2.674000e+05
Maryland	Baltimore	5.883333e+04	5.950000e+04
Colorado	Denver	1.743333e+05	1.803333e+05
District of Columbia	Washington	1.487000e+05	1.477000e+05
Tennessee	Nashville	1.158667e+05	1.169333e+05
Wisconsin	Milwaukee	8.103333e+04	8.233333e+04
Arizona	Tucson	1.044667e+05	1.056667e+05
Oregon	Portland	1.565667e+05	1.574667e+05
Oklahoma	Oklahoma City	7.856667e+04	7.916667e+04
Nebraska	Omaha	1.167333e+05	1.189000e+05
New Mexico	Albuquerque	1.264333e+05	1.267333e+05
California	Fresno	9.646667e+04	9.823333e+04
...		...	...
Texas	Granite Shoals	NaN	NaN
Maryland	Piney Point	1.584667e+05	1.637000e+05
Wisconsin	Maribel	NaN	NaN
Idaho	Middleton	1.019000e+05	1.041667e+05
Colorado	Bennett	1.398000e+05	1.446667e+05
New Hampshire	East Hampstead	1.739667e+05	1.805000e+05
Missouri	Garden City	NaN	NaN
Arkansas	Mountainburg	6.783333e+04	6.900000e+04
Wisconsin	Oostburg	1.124333e+05	1.155000e+05
California	Twin Peaks	1.013333e+05	1.017000e+05
New York	Upper Brookville	1.237700e+06	1.261567e+06
Hawaii	Volcano	1.146667e+05	1.247667e+05
South Carolina	Wedgefield	NaN	NaN
Michigan	Williamston	1.643000e+05	1.662000e+05
Arkansas	Decatur	6.566667e+04	6.673333e+04
Tennessee	Briceville	4.366667e+04	4.490000e+04
Indiana	Edgewood	9.293333e+04	9.490000e+04
Tennessee	Palmyra	NaN	NaN
Maryland	Saint Inigoes	1.572333e+05	1.633667e+05
Indiana	Marysville	NaN	NaN
California	Forest Falls	1.141667e+05	1.111333e+05
Missouri	Bois D Arc	1.071000e+05	1.081000e+05
Virginia	Henrico	1.322667e+05	1.332667e+05
New Jersey	Diamond Beach	1.889667e+05	1.931333e+05
Tennessee	Gruetli Laager	3.666667e+04	3.730000e+04
Wisconsin	Town of Wrightstown	1.113667e+05	1.148667e+05
New York	Urbana	9.170000e+04	9.836667e+04
Wisconsin	New Denmark	1.260667e+05	1.319667e+05
California	Angels	1.581000e+05	1.674667e+05
Wisconsin	Holland	1.532333e+05	1.558333e+05

		2001Q1	2001Q2 \
State	RegionName		
New York	New York	NaN	NaN
California	Los Angeles	2.330000e+05	2.391000e+05
Illinois	Chicago	1.569333e+05	1.618000e+05
Pennsylvania	Philadelphia	5.533333e+04	5.553333e+04
Arizona	Phoenix	1.196000e+05	1.215667e+05
Nevada	Las Vegas	1.395333e+05	1.417333e+05
California	San Diego	2.672000e+05	2.762667e+05
Texas	Dallas	8.973333e+04	8.930000e+04
California	San Jose	4.706667e+05	4.702000e+05
Florida	Jacksonville	9.440000e+04	9.560000e+04
California	San Francisco	4.940667e+05	4.961333e+05
Texas	Austin	1.612333e+05	1.607333e+05
Michigan	Detroit	6.750000e+04	6.836667e+04
Ohio	Columbus	9.940000e+04	1.002667e+05
Tennessee	Memphis	7.416667e+04	7.493333e+04
North Carolina	Charlotte	1.329333e+05	1.332000e+05
Texas	El Paso	7.823333e+04	7.830000e+04
Massachusetts	Boston	2.496000e+05	2.570667e+05
Washington	Seattle	2.710000e+05	2.724333e+05
Maryland	Baltimore	5.956667e+04	6.013333e+04
Colorado	Denver	1.865000e+05	1.925333e+05
District of Columbia	Washington	1.497667e+05	1.551333e+05
Tennessee	Nashville	1.180333e+05	1.191667e+05
Wisconsin	Milwaukee	8.403333e+04	8.556667e+04
Arizona	Tucson	1.072000e+05	1.087667e+05
Oregon	Portland	1.599000e+05	1.618000e+05
Oklahoma	Oklahoma City	7.983333e+04	8.040000e+04
Nebraska	Omaha	1.208667e+05	1.197667e+05
New Mexico	Albuquerque	1.271000e+05	1.277333e+05
California	Fresno	1.005667e+05	1.035667e+05
...		...	...
Texas	Granite Shoals	NaN	NaN
Maryland	Piney Point	1.634000e+05	1.648333e+05
Wisconsin	Maribel	NaN	NaN
Idaho	Middleton	1.061667e+05	1.083667e+05
Colorado	Bennett	1.483000e+05	1.521000e+05
New Hampshire	East Hampstead	1.909000e+05	1.950667e+05
Missouri	Garden City	NaN	NaN
Arkansas	Mountainburg	6.866667e+04	6.386667e+04
Wisconsin	Oostburg	1.191000e+05	1.204333e+05
California	Twin Peaks	1.040000e+05	1.076667e+05
New York	Upper Brookville	1.295167e+06	1.340033e+06
Hawaii	Volcano	1.181333e+05	1.194000e+05
South Carolina	Wedgefield	NaN	NaN
Michigan	Williamston	1.664333e+05	1.686333e+05
Arkansas	Decatur	6.720000e+04	6.770000e+04

Tennessee	Briceville	4.480000e+04	4.530000e+04
Indiana	Edgewood	9.893333e+04	1.000667e+05
Tennessee	Palmyra	NaN	NaN
Maryland	Saint Inigoes	1.642333e+05	1.682000e+05
Indiana	Marysville	NaN	NaN
California	Forest Falls	1.134333e+05	1.130000e+05
Missouri	Bois D Arc	1.107000e+05	1.136667e+05
Virginia	Henrico	1.352333e+05	1.367333e+05
New Jersey	Diamond Beach	1.944000e+05	2.102667e+05
Tennessee	Gruetli Laager	3.773333e+04	3.790000e+04
Wisconsin	Town of Wrightstown	1.259667e+05	1.299000e+05
New York	Urbana	9.486667e+04	9.853333e+04
Wisconsin	New Denmark	1.438000e+05	1.469667e+05
California	Angels	1.768333e+05	1.837667e+05
Wisconsin	Holland	1.618667e+05	1.657333e+05

		2001Q3	2001Q4 \
State	RegionName		
New York	New York	NaN	NaN
California	Los Angeles	2.450667e+05	2.530333e+05
Illinois	Chicago	1.664000e+05	1.704333e+05
Pennsylvania	Philadelphia	5.626667e+04	5.753333e+04
Arizona	Phoenix	1.227000e+05	1.243000e+05
Nevada	Las Vegas	1.433667e+05	1.461333e+05
California	San Diego	2.845000e+05	2.919333e+05
Texas	Dallas	8.906667e+04	9.090000e+04
California	San Jose	4.568000e+05	4.455667e+05
Florida	Jacksonville	9.706667e+04	9.906667e+04
California	San Francisco	5.041000e+05	5.134000e+05
Texas	Austin	1.595333e+05	1.600333e+05
Michigan	Detroit	6.926667e+04	6.996667e+04
Ohio	Columbus	1.010667e+05	1.022000e+05
Tennessee	Memphis	7.550000e+04	7.606667e+04
North Carolina	Charlotte	1.328000e+05	1.331000e+05
Texas	El Paso	7.743333e+04	7.680000e+04
Massachusetts	Boston	2.669333e+05	2.749667e+05
Washington	Seattle	2.741667e+05	2.781667e+05
Maryland	Baltimore	6.210000e+04	6.340000e+04
Colorado	Denver	1.964000e+05	1.991000e+05
District of Columbia	Washington	1.646333e+05	1.725333e+05
Tennessee	Nashville	1.201000e+05	1.208000e+05
Wisconsin	Milwaukee	8.706667e+04	8.840000e+04
Arizona	Tucson	1.105667e+05	1.128000e+05
Oregon	Portland	1.642667e+05	1.677667e+05
Oklahoma	Oklahoma City	8.113333e+04	8.173333e+04
Nebraska	Omaha	1.178667e+05	1.174000e+05
New Mexico	Albuquerque	1.285667e+05	1.299000e+05
California	Fresno	1.072333e+05	1.103000e+05

		...	...
Texas	Granite Shoals	NaN	NaN
Maryland	Piney Point	1.647000e+05	1.679000e+05
Wisconsin	Maribel	NaN	NaN
Idaho	Middleton	1.110333e+05	1.112333e+05
Colorado	Bennett	1.542333e+05	1.562000e+05
New Hampshire	East Hampstead	1.992667e+05	2.074000e+05
Missouri	Garden City	NaN	NaN
Arkansas	Mountainburg	6.376667e+04	6.546667e+04
Wisconsin	Oostburg	1.203667e+05	1.196333e+05
California	Twin Peaks	1.098333e+05	1.111333e+05
New York	Upper Brookville	1.403667e+06	1.481933e+06
Hawaii	Volcano	1.232667e+05	1.211667e+05
South Carolina	Wedgefield	NaN	NaN
Michigan	Williamston	1.716667e+05	1.750333e+05
Arkansas	Decatur	6.650000e+04	6.540000e+04
Tennessee	Briceville	4.463333e+04	4.370000e+04
Indiana	Edgewood	1.008333e+05	1.010000e+05
Tennessee	Palmyra	NaN	NaN
Maryland	Saint Inigoes	1.665000e+05	1.653333e+05
Indiana	Marysville	NaN	NaN
California	Forest Falls	1.130333e+05	1.151667e+05
Missouri	Bois D Arc	1.126333e+05	1.127333e+05
Virginia	Henrico	1.386000e+05	1.413333e+05
New Jersey	Diamond Beach	2.302667e+05	2.486667e+05
Tennessee	Gruetli Laager	3.936667e+04	4.040000e+04
Wisconsin	Town of Wrightstown	1.299000e+05	1.294333e+05
New York	Urbana	1.029667e+05	9.803333e+04
Wisconsin	New Denmark	1.483667e+05	1.491667e+05
California	Angels	1.902333e+05	1.845667e+05
Wisconsin	Holland	1.680333e+05	1.674000e+05

		2002Q1	2002Q2 \
State	RegionName		
New York	New York	NaN	NaN
California	Los Angeles	2.619667e+05	2.727000e+05
Illinois	Chicago	1.755000e+05	1.775667e+05
Pennsylvania	Philadelphia	5.913333e+04	6.073333e+04
Arizona	Phoenix	1.265333e+05	1.283667e+05
Nevada	Las Vegas	1.493333e+05	1.509333e+05
California	San Diego	3.012333e+05	3.128667e+05
Texas	Dallas	9.256667e+04	9.380000e+04
California	San Jose	4.414333e+05	4.577667e+05
Florida	Jacksonville	1.012333e+05	1.034333e+05
California	San Francisco	5.204333e+05	5.381667e+05
Texas	Austin	1.589667e+05	1.575000e+05
Michigan	Detroit	7.100000e+04	7.233333e+04
Ohio	Columbus	1.034000e+05	1.048000e+05

Tennessee	Memphis	7.633333e+04	7.676667e+04
North Carolina	Charlotte	1.343667e+05	1.353667e+05
Texas	El Paso	7.660000e+04	7.640000e+04
Massachusetts	Boston	2.825000e+05	2.893000e+05
Washington	Seattle	2.805000e+05	2.846000e+05
Maryland	Baltimore	6.366667e+04	6.490000e+04
Colorado	Denver	2.012333e+05	2.024333e+05
District of Columbia	Washington	1.805000e+05	1.933000e+05
Tennessee	Nashville	1.215667e+05	1.226333e+05
Wisconsin	Milwaukee	8.953333e+04	9.136667e+04
Arizona	Tucson	1.150000e+05	1.172000e+05
Oregon	Portland	1.707667e+05	1.741333e+05
Oklahoma	Oklahoma City	8.260000e+04	8.343333e+04
Nebraska	Omaha	1.180667e+05	1.176333e+05
New Mexico	Albuquerque	1.310667e+05	1.321000e+05
California	Fresno	1.140333e+05	1.185333e+05
...		...	...
Texas	Granite Shoals	NaN	NaN
Maryland	Piney Point	1.782667e+05	1.812000e+05
Wisconsin	Maribel	NaN	NaN
Idaho	Middleton	1.141000e+05	1.141667e+05
Colorado	Bennett	1.587333e+05	1.606333e+05
New Hampshire	East Hampstead	2.123000e+05	2.122333e+05
Missouri	Garden City	NaN	NaN
Arkansas	Mountainburg	6.533333e+04	6.600000e+04
Wisconsin	Oostburg	1.198667e+05	1.185667e+05
California	Twin Peaks	1.132000e+05	1.166000e+05
New York	Upper Brookville	1.536167e+06	1.562033e+06
Hawaii	Volcano	1.233000e+05	1.169000e+05
South Carolina	Wedgefield	NaN	NaN
Michigan	Williamston	1.786667e+05	1.793333e+05
Arkansas	Decatur	6.460000e+04	6.490000e+04
Tennessee	Briceville	4.446667e+04	4.340000e+04
Indiana	Edgewood	1.021667e+05	1.017667e+05
Tennessee	Palmyra	NaN	NaN
Maryland	Saint Inigoes	1.673000e+05	1.688000e+05
Indiana	Marysville	NaN	NaN
California	Forest Falls	1.187000e+05	1.250667e+05
Missouri	Bois D Arc	1.130667e+05	1.154000e+05
Virginia	Henrico	1.435333e+05	1.461333e+05
New Jersey	Diamond Beach	2.599333e+05	2.656333e+05
Tennessee	Gruetli Laager	4.156667e+04	4.163333e+04
Wisconsin	Town of Wrightstown	1.319000e+05	1.342000e+05
New York	Urbana	9.396667e+04	9.460000e+04
Wisconsin	New Denmark	1.531333e+05	1.567333e+05
California	Angels	1.840333e+05	1.861333e+05
Wisconsin	Holland	1.657667e+05	1.619667e+05

State	RegionName	...	2014Q2 \
New York	New York	...	5.154667e+05
California	Los Angeles	...	4.980333e+05
Illinois	Chicago	...	1.926333e+05
Pennsylvania	Philadelphia	...	1.137333e+05
Arizona	Phoenix	...	1.642667e+05
Nevada	Las Vegas	...	1.700667e+05
California	San Diego	...	4.802000e+05
Texas	Dallas	...	1.066333e+05
California	San Jose	...	6.794000e+05
Florida	Jacksonville	...	1.207667e+05
California	San Francisco	...	9.269333e+05
Texas	Austin	...	2.488667e+05
Michigan	Detroit	...	3.730000e+04
Ohio	Columbus	...	1.031333e+05
Tennessee	Memphis	...	6.810000e+04
North Carolina	Charlotte	...	1.494667e+05
Texas	El Paso	...	1.118000e+05
Massachusetts	Boston	...	4.266667e+05
Washington	Seattle	...	4.418000e+05
Maryland	Baltimore	...	1.092333e+05
Colorado	Denver	...	2.708667e+05
District of Columbia	Washington	...	4.469333e+05
Tennessee	Nashville	...	1.607000e+05
Wisconsin	Milwaukee	...	9.216667e+04
Arizona	Tucson	...	1.424667e+05
Oregon	Portland	...	2.822333e+05
Oklahoma	Oklahoma City	...	1.180333e+05
Nebraska	Omaha	...	1.301000e+05
New Mexico	Albuquerque	...	1.632667e+05
California	Fresno	...	1.696333e+05
...		...	...
Texas	Granite Shoals	...	1.169667e+05
Maryland	Piney Point	...	2.964000e+05
Wisconsin	Maribel	...	1.306000e+05
Idaho	Middleton	...	1.443667e+05
Colorado	Bennett	...	1.514667e+05
New Hampshire	East Hampstead	...	2.495000e+05
Missouri	Garden City	...	1.055000e+05
Arkansas	Mountainburg	...	8.160000e+04
Wisconsin	Oostburg	...	1.295667e+05
California	Twin Peaks	...	1.501000e+05
New York	Upper Brookville	...	1.780633e+06
Hawaii	Volcano	...	2.064667e+05
South Carolina	Wedgefield	...	7.436667e+04
Michigan	Williamston	...	1.657000e+05
Arkansas	Decatur	...	8.966667e+04

State	RegionName		
Tennessee	Briceville	...	5.623333e+04
Indiana	Edgewood	...	9.213333e+04
Tennessee	Palmyra	...	1.227667e+05
Maryland	Saint Inigoes	...	2.822333e+05
Indiana	Marysville	...	1.166000e+05
California	Forest Falls	...	1.653667e+05
Missouri	Bois D Arc	...	1.375667e+05
Virginia	Henrico	...	2.016333e+05
New Jersey	Diamond Beach	...	3.818000e+05
Tennessee	Gruetli Laager	...	5.556667e+04
Wisconsin	Town of Wrightstown	...	1.448667e+05
New York	Urbana	...	1.321333e+05
Wisconsin	New Denmark	...	1.745667e+05
California	Angels	...	2.444667e+05
Wisconsin	Holland	...	2.012667e+05

State	RegionName	2014Q3	2014Q4 \
New York	New York	5.228000e+05	5.280667e+05
California	Los Angeles	5.090667e+05	5.188667e+05
Illinois	Chicago	1.957667e+05	2.012667e+05
Pennsylvania	Philadelphia	1.153000e+05	1.156667e+05
Arizona	Phoenix	1.653667e+05	1.685000e+05
Nevada	Las Vegas	1.734000e+05	1.754667e+05
California	San Diego	4.890333e+05	4.964333e+05
Texas	Dallas	1.089000e+05	1.115333e+05
California	San Jose	6.970333e+05	7.149333e+05
Florida	Jacksonville	1.217333e+05	1.231667e+05
California	San Francisco	9.545333e+05	9.687667e+05
Texas	Austin	2.528000e+05	2.581333e+05
Michigan	Detroit	3.710000e+04	3.713333e+04
Ohio	Columbus	1.045000e+05	1.064333e+05
Tennessee	Memphis	6.910000e+04	7.116667e+04
North Carolina	Charlotte	1.506333e+05	1.527333e+05
Texas	El Paso	1.117333e+05	1.117667e+05
Massachusetts	Boston	4.314333e+05	4.407333e+05
Washington	Seattle	4.515000e+05	4.591667e+05
Maryland	Baltimore	1.095333e+05	1.073667e+05
Colorado	Denver	2.775000e+05	2.872333e+05
District of Columbia	Washington	4.530000e+05	4.603000e+05
Tennessee	Nashville	1.623000e+05	1.669000e+05
Wisconsin	Milwaukee	9.216667e+04	9.196667e+04
Arizona	Tucson	1.434333e+05	1.442333e+05
Oregon	Portland	2.872667e+05	2.955333e+05
Oklahoma	Oklahoma City	1.189667e+05	1.201000e+05
Nebraska	Omaha	1.303000e+05	1.325000e+05
New Mexico	Albuquerque	1.640000e+05	1.648000e+05
California	Fresno	1.736000e+05	1.781333e+05

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...                                                  ...          ...
Texas            Granite Shoals       1.175333e+05  1.175333e+05
Maryland         Piney Point          3.090000e+05  3.092333e+05
Wisconsin        Maribel              1.289667e+05  1.296333e+05
Idaho            Middleton            1.457000e+05  1.462333e+05
Colorado         Bennett              1.620667e+05  1.714000e+05
New Hampshire    East Hampstead       2.521000e+05  2.557333e+05
Missouri         Garden City          1.043000e+05  1.047667e+05
Arkansas         Mountainburg         8.506667e+04  8.846667e+04
Wisconsin        Oostburg             1.279333e+05  1.274333e+05
California       Twin Peaks           1.475333e+05  1.460667e+05
New York         Upper Brookville     1.749233e+06  1.729467e+06
Hawaii           Volcano              2.276333e+05  2.332000e+05
South Carolina   Wedgefield           7.026667e+04  7.206667e+04
Michigan         Williamston          1.689333e+05  1.708667e+05
Arkansas         Decatur              9.256667e+04  9.470000e+04
Tennessee        Briceville           5.423333e+04  5.260000e+04
Indiana          Edgewood             9.406667e+04  9.466667e+04
Tennessee        Palmyra              1.269333e+05  1.262333e+05
Maryland         Saint Inigoes        2.884333e+05  2.869667e+05
Indiana          Marysville           1.151000e+05  1.165000e+05
California       Forest Falls         1.675000e+05  1.771000e+05
Missouri         Bois D Arc           1.375667e+05  1.404000e+05
Virginia         Henrico              2.040000e+05  2.059000e+05
New Jersey       Diamond Beach        3.878667e+05  3.876667e+05
Tennessee        Gruetli Laager       5.636667e+04  5.713333e+04
Wisconsin        Town of Wrightstown  1.468667e+05  1.492333e+05
New York         Urbana               1.370333e+05  1.400667e+05
Wisconsin        New Denmark          1.811667e+05  1.861667e+05
California       Angels               2.540667e+05  2.599333e+05
Wisconsin        Holland              2.015667e+05  2.012667e+05

                                            2015Q1        2015Q2  \
State            RegionName
New York         New York             5.322667e+05  5.408000e+05
California       Los Angeles          5.288000e+05  5.381667e+05
Illinois         Chicago              2.010667e+05  2.060333e+05
Pennsylvania     Philadelphia         1.162000e+05  1.179667e+05
Arizona          Phoenix              1.715333e+05  1.741667e+05
Nevada           Las Vegas            1.775000e+05  1.816000e+05
California       San Diego            5.033667e+05  5.120667e+05
Texas            Dallas               1.137000e+05  1.211333e+05
California       San Jose             7.314333e+05  7.567333e+05
Florida          Jacksonville         1.241667e+05  1.269000e+05
California       San Francisco        1.000733e+06  1.060800e+06
Texas            Austin               2.665000e+05  2.750333e+05
Michigan         Detroit              3.620000e+04  3.583333e+04
Ohio             Columbus             1.078667e+05  1.094333e+05
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Tennessee             Memphis               7.053333e+04   6.870000e+04
North Carolina        Charlotte             1.551667e+05   1.579000e+05
Texas                 El Paso               1.115000e+05   1.113000e+05
Massachusetts         Boston                4.485000e+05   4.553667e+05
Washington            Seattle               4.679333e+05   4.933667e+05
Maryland              Baltimore             1.080667e+05   1.114333e+05
Colorado              Denver                2.976333e+05   3.103667e+05
District of Columbia  Washington            4.661667e+05   4.810667e+05
Tennessee             Nashville             1.714667e+05   1.762667e+05
Wisconsin             Milwaukee             9.333333e+04   9.410000e+04
Arizona               Tucson                1.441667e+05   1.451333e+05
Oregon                Portland              3.019333e+05   3.119000e+05
Oklahoma              Oklahoma City         1.208000e+05   1.223667e+05
Nebraska              Omaha                 1.330667e+05   1.344667e+05
New Mexico            Albuquerque           1.651667e+05   1.659000e+05
California            Fresno                1.804667e+05   1.820333e+05
...                                                ...            ...
Texas                 Granite Shoals        1.171667e+05   1.191000e+05
Maryland              Piney Point           3.095667e+05   3.017000e+05
Wisconsin             Maribel               1.312667e+05   1.301333e+05
Idaho                 Middleton             1.461667e+05   1.477333e+05
Colorado              Bennett               1.780333e+05   1.844333e+05
New Hampshire         East Hampstead        2.587333e+05   2.613667e+05
Missouri              Garden City           1.060333e+05   9.606667e+04
Arkansas              Mountainburg          8.903333e+04   8.556667e+04
Wisconsin             Oostburg              1.270667e+05   1.274000e+05
California            Twin Peaks            1.435000e+05   1.523000e+05
New York              Upper Brookville      1.749867e+06   1.789600e+06
Hawaii                Volcano               2.346333e+05   2.323667e+05
South Carolina        Wedgefield            7.570000e+04   7.206667e+04
Michigan              Williamston           1.744333e+05   1.758667e+05
Arkansas              Decatur               9.350000e+04   9.490000e+04
Tennessee             Briceville            4.963333e+04   4.590000e+04
Indiana               Edgewood              9.586667e+04   9.433333e+04
Tennessee             Palmyra               1.223000e+05   1.204667e+05
Maryland              Saint Inigoes         2.847000e+05   2.807667e+05
Indiana               Marysville            1.118667e+05   1.118000e+05
California            Forest Falls          1.765333e+05   1.818000e+05
Missouri              Bois D Arc            1.450333e+05   1.475667e+05
Virginia              Henrico               2.065667e+05   2.104333e+05
New Jersey            Diamond Beach         3.931667e+05   3.980000e+05
Tennessee             Gruetli Laager        5.890000e+04   6.536667e+04
Wisconsin             Town of Wrightstown   1.486667e+05   1.493333e+05
New York              Urbana                1.417000e+05   1.378667e+05
Wisconsin             New Denmark           1.876000e+05   1.886667e+05
California            Angels                2.601000e+05   2.506333e+05
Wisconsin             Holland               2.060000e+05   2.076000e+05
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		2015Q3	2015Q4 \
State	RegionName		
New York	New York	5.572000e+05	5.728333e+05
California	Los Angeles	5.472667e+05	5.577333e+05
Illinois	Chicago	2.083000e+05	2.079000e+05
Pennsylvania	Philadelphia	1.212333e+05	1.222000e+05
Arizona	Phoenix	1.790667e+05	1.838333e+05
Nevada	Las Vegas	1.867667e+05	1.906333e+05
California	San Diego	5.197667e+05	5.254667e+05
Texas	Dallas	1.285667e+05	1.346000e+05
California	San Jose	7.764000e+05	7.891333e+05
Florida	Jacksonville	1.301333e+05	1.320000e+05
California	San Francisco	1.095100e+06	1.105467e+06
Texas	Austin	2.816333e+05	2.872333e+05
Michigan	Detroit	3.706667e+04	3.836667e+04
Ohio	Columbus	1.115667e+05	1.150000e+05
Tennessee	Memphis	6.866667e+04	6.953333e+04
North Carolina	Charlotte	1.601667e+05	1.628667e+05
Texas	El Paso	1.110667e+05	1.102667e+05
Massachusetts	Boston	4.639667e+05	4.716333e+05
Washington	Seattle	5.142667e+05	5.334667e+05
Maryland	Baltimore	1.139667e+05	1.139000e+05
Colorado	Denver	3.205000e+05	3.301000e+05
District of Columbia	Washington	4.934000e+05	5.009000e+05
Tennessee	Nashville	1.818000e+05	1.892000e+05
Wisconsin	Milwaukee	9.413333e+04	9.456667e+04
Arizona	Tucson	1.466000e+05	1.481667e+05
Oregon	Portland	3.257333e+05	3.430667e+05
Oklahoma	Oklahoma City	1.247000e+05	1.271000e+05
Nebraska	Omaha	1.367333e+05	1.400667e+05
New Mexico	Albuquerque	1.665333e+05	1.673333e+05
California	Fresno	1.857000e+05	1.874667e+05
...		...	...
Texas	Granite Shoals	1.216000e+05	1.280000e+05
Maryland	Piney Point	3.052333e+05	3.099667e+05
Wisconsin	Maribel	1.297333e+05	1.293000e+05
Idaho	Middleton	1.482000e+05	1.511333e+05
Colorado	Bennett	1.916667e+05	1.958000e+05
New Hampshire	East Hampstead	2.616000e+05	2.688000e+05
Missouri	Garden City	9.930000e+04	1.034333e+05
Arkansas	Mountainburg	8.370000e+04	9.043333e+04
Wisconsin	Oostburg	1.303333e+05	1.320333e+05
California	Twin Peaks	1.552667e+05	1.591667e+05
New York	Upper Brookville	1.777267e+06	1.834367e+06
Hawaii	Volcano	2.249667e+05	2.324333e+05
South Carolina	Wedgefield	7.033333e+04	6.903333e+04
Michigan	Williamston	1.794667e+05	1.823000e+05
Arkansas	Decatur	9.543333e+04	9.700000e+04

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Tennessee            Briceville             4.793333e+04  4.360000e+04
Indiana              Edgewood               9.663333e+04  9.996667e+04
Tennessee            Palmyra                1.198000e+05  1.258000e+05
Maryland             Saint Inigoes          2.778333e+05  2.768333e+05
Indiana              Marysville             1.156667e+05  1.201667e+05
California           Forest Falls           1.911667e+05  1.987333e+05
Missouri             Bois D Arc             1.463000e+05  1.494333e+05
Virginia             Henrico                2.121000e+05  2.139667e+05
New Jersey           Diamond Beach          3.992333e+05  4.004333e+05
Tennessee            Gruetli Laager         6.950000e+04  7.170000e+04
Wisconsin            Town of Wrightstown    1.498667e+05  1.499333e+05
New York             Urbana                 1.364667e+05  1.361667e+05
Wisconsin            New Denmark            1.884333e+05  1.889333e+05
California           Angels                 2.635000e+05  2.795000e+05
Wisconsin            Holland                2.128667e+05  2.178333e+05

                                              2016Q1        2016Q2  \
State                RegionName
New York             New York               5.828667e+05  5.916333e+05
California           Los Angeles            5.660333e+05  5.774667e+05
Illinois             Chicago                2.060667e+05  2.082000e+05
Pennsylvania         Philadelphia           1.234333e+05  1.269333e+05
Arizona              Phoenix                1.879000e+05  1.914333e+05
Nevada               Las Vegas              1.946000e+05  1.972000e+05
California           San Diego              5.293333e+05  5.362333e+05
Texas                Dallas                 1.405000e+05  1.446000e+05
California           San Jose               8.036000e+05  8.189333e+05
Florida              Jacksonville           1.339667e+05  1.372000e+05
California           San Francisco          1.121767e+06  1.119267e+06
Texas                Austin                 2.935000e+05  3.014333e+05
Michigan             Detroit                3.796667e+04  3.746667e+04
Ohio                 Columbus               1.167000e+05  1.182000e+05
Tennessee            Memphis                7.090000e+04  7.416667e+04
North Carolina       Charlotte              1.664667e+05  1.694333e+05
Texas                El Paso                1.106667e+05  1.114667e+05
Massachusetts        Boston                 4.826000e+05  4.903667e+05
Washington           Seattle                5.517333e+05  5.755333e+05
Maryland             Baltimore              1.146667e+05  1.147333e+05
Colorado             Denver                 3.355667e+05  3.427667e+05
District of Columbia Washington             5.041000e+05  5.058000e+05
Tennessee            Nashville              1.950667e+05  2.003667e+05
Wisconsin            Milwaukee              9.466667e+04  9.636667e+04
Arizona              Tucson                 1.495333e+05  1.511667e+05
Oregon               Portland               3.560000e+05  3.698000e+05
Oklahoma             Oklahoma City          1.279000e+05  1.293000e+05
Nebraska             Omaha                  1.416333e+05  1.426667e+05
New Mexico           Albuquerque            1.691000e+05  1.706333e+05
California           Fresno                 1.890333e+05  1.927333e+05
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...			
Texas	Granite Shoals	1.337667e+05	1.400667e+05
Maryland	Piney Point	3.195000e+05	3.241667e+05
Wisconsin	Maribel	1.278333e+05	1.292667e+05
Idaho	Middleton	1.539000e+05	1.571667e+05
Colorado	Bennett	1.997667e+05	2.074667e+05
New Hampshire	East Hampstead	2.725333e+05	2.778000e+05
Missouri	Garden City	1.062667e+05	1.116667e+05
Arkansas	Mountainburg	9.833333e+04	1.019000e+05
Wisconsin	Oostburg	1.327667e+05	1.341000e+05
California	Twin Peaks	1.641667e+05	1.679667e+05
New York	Upper Brookville	1.904500e+06	1.944067e+06
Hawaii	Volcano	2.420667e+05	2.489667e+05
South Carolina	Wedgefield	6.886667e+04	7.426667e+04
Michigan	Williamston	1.814667e+05	1.824000e+05
Arkansas	Decatur	9.650000e+04	9.663333e+04
Tennessee	Briceville	4.080000e+04	4.180000e+04
Indiana	Edgewood	9.943333e+04	9.996667e+04
Tennessee	Palmyra	1.276667e+05	1.328667e+05
Maryland	Saint Inigoes	2.793333e+05	2.826333e+05
Indiana	Marysville	1.282333e+05	1.232333e+05
California	Forest Falls	1.886333e+05	1.898667e+05
Missouri	Bois D Arc	1.468667e+05	1.437667e+05
Virginia	Henrico	2.160333e+05	2.162000e+05
New Jersey	Diamond Beach	4.045333e+05	4.039000e+05
Tennessee	Gruetli Laager	7.533333e+04	7.646667e+04
Wisconsin	Town of Wrightstown	1.498333e+05	1.512667e+05
New York	Urbana	1.389667e+05	1.442000e+05
Wisconsin	New Denmark	1.910667e+05	1.928333e+05
California	Angels	2.765333e+05	2.716000e+05
Wisconsin	Holland	2.219667e+05	2.280333e+05

		2016Q3
State	RegionName	
New York	New York	587200.0
California	Los Angeles	584050.0
Illinois	Chicago	212000.0
Pennsylvania	Philadelphia	128700.0
Arizona	Phoenix	195200.0
Nevada	Las Vegas	199950.0
California	San Diego	539750.0
Texas	Dallas	149300.0
California	San Jose	822200.0
Florida	Jacksonville	139900.0
California	San Francisco	1106400.0
Texas	Austin	304450.0
Michigan	Detroit	37900.0
Ohio	Columbus	120100.0

Tennessee	Memphis	75900.0
North Carolina	Charlotte	172400.0
Texas	El Paso	112200.0
Massachusetts	Boston	501700.0
Washington	Seattle	589700.0
Maryland	Baltimore	115150.0
Colorado	Denver	351550.0
District of Columbia	Washington	516250.0
Tennessee	Nashville	206100.0
Wisconsin	Milwaukee	98850.0
Arizona	Tucson	152700.0
Oregon	Portland	387050.0
Oklahoma	Oklahoma City	130300.0
Nebraska	Omaha	143450.0
New Mexico	Albuquerque	171900.0
California	Fresno	196450.0
...		...
Texas	Granite Shoals	146450.0
Maryland	Piney Point	324600.0
Wisconsin	Maribel	134200.0
Idaho	Middleton	160750.0
Colorado	Bennett	212600.0
New Hampshire	East Hampstead	282450.0
Missouri	Garden City	113600.0
Arkansas	Mountainburg	103400.0
Wisconsin	Oostburg	136350.0
California	Twin Peaks	173500.0
New York	Upper Brookville	1968800.0
Hawaii	Volcano	247850.0
South Carolina	Wedgefield	80700.0
Michigan	Williamston	183000.0
Arkansas	Decatur	96850.0
Tennessee	Briceville	40850.0
Indiana	Edgewood	100950.0
Tennessee	Palmyra	137750.0
Maryland	Saint Inigoes	281400.0
Indiana	Marysville	124200.0
California	Forest Falls	186650.0
Missouri	Bois D Arc	144000.0
Virginia	Henrico	220150.0
New Jersey	Diamond Beach	399000.0
Tennessee	Gruetli Laager	77500.0
Wisconsin	Town of Wrightstown	155000.0
New York	Urbana	143000.0
Wisconsin	New Denmark	197600.0
California	Angels	269950.0
Wisconsin	Holland	234950.0

```
        [10730 rows x 67 columns]

In [14]: def run_ttest():
            '''First creates new data showing the decline or growth of housing prices
            between the recession start and the recession bottom. Then runs a ttest
            comparing the university town values to the non-university towns values,
            return whether the alternative hypothesis (that the two groups are the same)
            is true or not as well as the p-value of the confidence.

            Return the tuple (different, p, better) where different=True if the t-test is
            True at a p<0.01 (we reject the null hypothesis), or different=False if
            otherwise (we cannot reject the null hypothesis). The variable p should
            be equal to the exact p value returned from scipy.stats.ttest_ind(). The
            value for better should be either "university town" or "non-university town"
            depending on which has a lower mean price ratio (which is equivilent to a
            reduced market loss).'''
            import pandas as pd
            import numpy as np
            from scipy.stats import ttest_ind
        #     house = convert_housing_data_to_quarters().loc[:, '2008Q3':'2009Q2']
        #     uni_house = get_list_of_university_towns()
        #     j = pd.merge(house, uni_house, how='outer', left_index=True, right_on=['State', '
        # #       df['univ_town'] = df['univ_town'].replace({np.NaN: False})
        #     j['price_ratio'] = (j['2009Q2'] / j['2008Q3'])
        #     get university town
            uni_town = get_list_of_university_towns()
            uni_town = uni_town[['State', 'RegionName']]
            uni_town['Uni_town'] = 1
            uni_town = uni_town.set_index(['State', 'RegionName'])

        #     get housing data
            ho_dat = convert_housing_data_to_quarters().loc[:, '2008Q3':'2009Q2']
            x = ho_dat.merge(uni_town, how='left',left_index = True, right_index = True)
            x['Uni_town'] = x['Uni_town'].replace(np.nan, 0)
            x['Change'] = x['2009Q2'] / x['2008Q3']

            ut = x[x['Uni_town'] == 1]['Change'].dropna()
            not_ut = x[x['Uni_town'] == 0]['Change'].dropna()
            t = ttest_ind(ut, not_ut)
            p = t[1]

            different = False
            if p < 0.1:
                different = True

            better = 'university town'
            if ut.mean() < not_ut.mean():
                better = 'non-university town'
```

```
            return (different, p, better)
        run_ttest()
```

Out[14]: (True, 0.0089755875407122598, 'university town')

In [ ]: