

Assignment 4

August 13, 2017

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

1 Assignment 4 - 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%.

```
In [16]: # Use this dictionary to map state names to two letter acronyms
states = {'OH': 'Ohio', 'KY': 'Kentucky', 'AS': 'American Samoa', 'NV': 'N
```

```
In [5]: def get_list_of_university_towns():
    '''Returns a DataFrame of towns and the states they are in from the
    university_towns.txt list. The format of the DataFrame should be:
    DataFrame( [ ["Michigan", "Ann Arbor"], ["Michigan", "Yipsilanti"] ],
    columns=["State", "RegionName"] )
```

The following cleaning needs to be done:

1. For "State", removing characters from "[" to the end.
2. For "RegionName", when applicable, removing every character from "
3. Depending on how you read the data, you may need to remove newline c

```
data = []
state = None
state_towns = []
with open('university_towns.txt') as file:
    for line in file:
        thisLine = line[:-1]
        if thisLine[-6:] == '[edit]':
            state = thisLine[:-6]
            continue
        if '(' in line:
            town = thisLine[:thisLine.index('(')-1]
            state_towns.append([state,town])
        else:
            town = thisLine
            state_towns.append([state,town])
        data.append(thisLine)
df = pd.DataFrame(state_towns,columns = ['State','RegionName'])
return df
get_list_of_university_towns()
```

```
Out[5]:
```

	State	RegionName
0	Alabama	Auburn
1	Alabama	Florence
2	Alabama	Jacksonville
3	Alabama	Livingston
4	Alabama	Montevallo
5	Alabama	Troy
6	Alabama	Tuscaloosa
7	Alabama	Tuskegee
8	Alaska	Fairbanks
9	Arizona	Flagstaff
10	Arizona	Tempe
11	Arizona	Tucson
12	Arkansas	Arkadelphia

13	Arkansas	Conway
14	Arkansas	Fayetteville
15	Arkansas	Jonesboro
16	Arkansas	Magnolia
17	Arkansas	Monticello
18	Arkansas	Russellville
19	Arkansas	Searcy
20	California	Angwin
21	California	Arcata
22	California	Berkeley
23	California	Chico
24	California	Claremont
25	California	Cotati
26	California	Davis
27	California	Irvine
28	California	Isla Vista
29	California	University Park, Los Angeles
..
487	Virginia	Wise
488	Virginia	Chesapeake
489	Washington	Bellingham
490	Washington	Cheney
491	Washington	Ellensburg
492	Washington	Pullman
493	Washington	University District, Seattle
494	West Virginia	Athens
495	West Virginia	Buckhannon
496	West Virginia	Fairmont
497	West Virginia	Glenville
498	West Virginia	Huntington
499	West Virginia	Montgomery
500	West Virginia	Morgantown
501	West Virginia	Shepherdstown
502	West Virginia	West Liberty
503	Wisconsin	Appleton
504	Wisconsin	Eau Claire
505	Wisconsin	Green Bay
506	Wisconsin	La Crosse
507	Wisconsin	Madison
508	Wisconsin	Menomonie
509	Wisconsin	Milwaukee
510	Wisconsin	Oshkosh
511	Wisconsin	Platteville
512	Wisconsin	River Falls
513	Wisconsin	Stevens Point
514	Wisconsin	Waukesha
515	Wisconsin	Whitewater
516	Wyoming	Laramie

[517 rows x 2 columns]

```
In [6]: def get_recession_start():
        '''Returns the year and quarter of the recession start time as a
        string value in a format such as 2005q3'''
        gdplev = pd.ExcelFile('gdplev.xls')
        gdplev = gdplev.parse("Sheet1", skiprows=219)
        gdplev = gdplev[['1999q4', 9926.1]]
        gdplev.columns = ['Quarter', 'GDP']
        for i in range(2, len(gdplev)):
            if (gdplev.iloc[i-2][1] > gdplev.iloc[i-1][1]) and (gdplev.iloc[i-1][1] > gdplev.iloc[i-2][1]):
                return gdplev.iloc[i-2][0]
get_recession_start()
```

Out[6]: '2008q3'

```
In [8]: def get_recession_end():
        '''Returns the year and quarter of the recession end time as a
        string value in a format such as 2005q3'''
        gdplev = pd.ExcelFile('gdplev.xls')
        gdplev = gdplev.parse("Sheet1", skiprows=219)
        gdplev = gdplev[['1999q4', 9926.1]]
        gdplev.columns = ['Quarter', 'GDP']
        start = get_recession_start()
        start_index = gdplev[gdplev['Quarter'] == start].index.tolist()[0]
        gdplev=gdplev.iloc[start_index:]
        for i in range(2, len(gdplev)):
            if (gdplev.iloc[i-2][1] < gdplev.iloc[i-1][1]) and (gdplev.iloc[i-1][1] < gdplev.iloc[i-2][1]):
                return gdplev.iloc[i][0]
get_recession_end()
```

Out[8]: '2009q4'

```
In [9]: def get_recession_bottom():
        '''Returns the year and quarter of the recession bottom time as a
        string value in a format such as 2005q3'''
        gdplev = pd.ExcelFile('gdplev.xls')
        gdplev = gdplev.parse("Sheet1", skiprows=219)
        gdplev = gdplev[['1999q4', 9926.1]]
        gdplev.columns = ['Quarter', 'GDP']
        start = get_recession_start()
        start_index = gdplev[gdplev['Quarter'] == start].index.tolist()[0]
        end = get_recession_end()
        end_index = gdplev[gdplev['Quarter'] == end].index.tolist()[0]
        gdplev=gdplev.iloc[start_index:end_index+1]
        bottom = gdplev['GDP'].min()
        bottom_index = gdplev[gdplev['GDP'] == bottom].index.tolist()[0]-start_index
```

```

        return gdplev.iloc[bottom_index]['Quarter']
    get_recession_bottom()

```

Out[9]: '2009q2'

```

In [18]: def new_col_names():
    #generating the new coloumns names
    years = list(range(2000,2017))
    quars = ['q1','q2','q3','q4']
    quar_years = []
    for i in years:
        for x in quars:
            quar_years.append((str(i)+x))
    return quar_years[:67]

def convert_housing_data_to_quarters():
    '''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 not arbitrary three month periods.

    The resulting dataframe should have 67 columns, and 10,730 rows.
    '''
    data = pd.read_csv('City_Zhvi_AllHomes.csv')
    data.drop(['Metro','CountyName','RegionID','SizeRank'],axis=1,inplace=True)
    data['State'] = data['State'].map(states)
    data.set_index(['State','RegionName'],inplace=True)
    col = list(data.columns)
    col = col[0:45]
    data.drop(col,axis=1,inplace=1)

    #qs is the quarters of the year
    qs = [list(data.columns)[x:x+3] for x in range(0, len(list(data.columns))-3)]

    # new columns
    column_names = new_col_names()
    for col,q in zip(column_names,qs):
        data[col] = data[q].mean(axis=1)

    data = data[column_names]
    return data
convert_housing_data_to_quarters()

```

Out[18]:

		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

State	RegionName	2000q3	2000q4 \
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
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

2014q3 2014q4 \

State RegionName

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
...
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
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

		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
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

State	RegionName	2016q1	2016q2 \
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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 [20]: 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 it is
    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 equivalent to
    reduced market loss).'''

```

```
    data = convert_housing_data_to_quarters().copy()
    data = data.loc[:, '2008q3': '2009q2']
```

```

data = data.reset_index()
def price_ratio(row):
    return (row['2008q3'] - row['2009q2'])/row['2008q3']

data['up&down'] = data.apply(price_ratio,axis=1)
#uni data

uni_town = get_list_of_university_towns()['RegionName']
uni_town = set(uni_town)

def is_uni_town(row):
    #check if the town is a university towns or not.
    if row['RegionName'] in uni_town:
        return 1
    else:
        return 0
data['is_uni'] = data.apply(is_uni_town,axis=1)

not_uni = data[data['is_uni']==0].loc[:, 'up&down'].dropna()
is_uni = data[data['is_uni']==1].loc[:, 'up&down'].dropna()
def better():
    if not_uni.mean() < is_uni.mean():
        return 'non-university town'
    else:
        return 'university town'
p_val = list(ttest_ind(not_uni, is_uni))[1]
result = (True,p_val,better())
return result
run_ttest()

```

Out[20]: (True, 0.00036641601595526971, 'university town')

In []: