hypothisis

April 14, 2020

```
In [1]: import pandas as pd
        import numpy as np
        from scipy.stats import ttest_ind
```

0.1 Hypothesis Testing

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 [ ]: # 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

                                    2

```
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'})
```

3

```python
#     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'

```python
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'

```python
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
            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]:

State	RegionName	2000Q1	2000Q2 \
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

State	RegionName		
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

State	RegionName	2001Q3	2001Q4 \
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

State	RegionName		
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

		...	2014Q2 \
State	RegionName	...	
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

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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
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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

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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
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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
...                                              ...           ...
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
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State	RegionName		
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
```

```python
        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 [ ]: