Notebook 4

Project:" Intra-Regional Migration and Transportation in New York Metro Area"

Due to the large data our team is working with, there are a total of four notebooks submitted for this midterm (two from each team member)

I also outlined the notebook into the Table of Content

Research Questions

- **Q1: On the county level, did housing costs change between 2014 and 2018? If so, what county experience increase in housing price? And what county experience decrease in housing price?**
  - **Expected Exploration:**
    - We expect to explore and analyze the housing value data in New York Metro Region on the county level in 2014 and 2018. We expect to compare the housing value between the two years on the county level to find out changes in housing value. We hope to capture the geographic shift of housing value if there was any change.
    - We expect to create maps and charts to visually represent our findings of housing value comparison in 2014 and 2018.
- **Q2: On the county level, did housing affordability change bewteen 2014 and 2018? If so, what county experience increase in housing afforability? And what county experience decrease in housing affordability?**
  - **Expected Exploration:**
    - We expect to capture changes of housing affordability in the New York Metro Area on the county level between 2014 and 2018 by exploring and analyzing the housing affordability data.
    - We expect to create maps and charts to visually represent our findings of housing affordability comparison in 2014 and 2018.
- **Purpose of this notebook:** I conducted data exploration and analysis of the New York Metro Area housing affordability and value data in 2014 and 2018. I used the ACS 5-year data from 2010 to 2014, and from 2014 to 2018. I created bar graphs with plotly.express to compare housing values and affordability in counties across NYMA between 2014 and 2018.

Data sources

1. 2010-2014 5-Years ACS: https://www.census.gov/acs/www/data/data-tables-and-tools/data-profiles/2014/ (https://www.census.gov/acs/www/data/data-tables-and-tools/data-profiles/2014/)
2. 2014-2018 5-Years ACS: https://www.census.gov/acs/www/data/data-tables-and-tools/data-profiles/2018/ (https://www.census.gov/acs/www/data/data-tables-and-tools/data-profiles/2018/)

Importing libraries

In [1]:
```
#import libraries
import pandas as pd
import geopandas as gpd
import matplotlib.pyplot as plt
import plotly.express as px
```

Data Exploration of Housing Affordability in 2014 and 2018

Data exploration of 2014 housing affordability data

In [66]:
```
#use .read_csv command to import 2014 ACS survey housing affordability data
hao2014 = pd.read_csv('hao2014.csv')
```

In [67]:
```
#look at the frist 5 rows of the dataset
hao2014.head()
```

Out[67]:

	GEO_ID	NAME	FIPS	DP04_0079E	DP04_0080E	DP04_0080PE	DP04_0081E	DP04_0081PE	DP04_0082E	DP04_0082PE	DP04_0083E	DP04_0083PE	DP04
0	id	Geographic Area Name	FIPS	Estimate!!VALUE!!Owner-occupied units	ooh value<$50,000	%ooh value<$50,000	ooh value $50,000 to 99,999	%ooh value $50,000 to 99,999	ooh value $100,000 to 149,999	%ooh value $100,000 to 149,999	ooh value $150,000 to 199,999	% ooh value $150,000 to 199,999	oo $200
1	0500000US09001	Fairfield County, Connecticut	9001	228331	4664	2	4247	1.9	7431	3.3	14232	6.2	
2	0500000US09005	Litchfield County, Connecticut	9005	58127	1248	2.1	1696	2.9	5991	10.3	10115	17.4	
3	0500000US09009	New Haven County, Connecticut	9009	206556	5668	2.7	8206	4	21721	10.5	34629	16.8	
4	0500000US34003	Bergen County, New Jersey	34003	217432	4207	1.9	1989	0.9	3260	1.5	5135	2.4	

In [4]:
```
#drop the first row (row 0)
hao2014 = hao2014.drop([0])
```

In [5]:
```
#check datatypes and columns
hao2014.dtypes
```

Out[5]:
```
GEO_ID         object
NAME           object
FIPS           object
DP04_0079E     object
DP04_0080E     object
                ...
DP04_0139E     object
DP04_0139PE    object
DP04_0140E     object
DP04_0140PE    object
DP04_0141E     object
Length: 116, dtype: object
```

In [6]:
```
#convert FIPS from object to integer so that I can merge the 2014 housing affordability dataframe with county boundary dataframe
hao2014['FIPS'] = hao2014['FIPS'].astype(str).astype(int)
hao2014.dtypes
```

Out[6]:
```
GEO_ID         object
NAME           object
FIPS            int64
DP04_0079E     object
DP04_0080E     object
                ...
DP04_0139E     object
DP04_0139PE    object
DP04_0140E     object
DP04_0140PE    object
DP04_0141E     object
Length: 116, dtype: object
```

Data exploration of 2018 housing afforability data

In [7]:
```
#import 2018 ACS survey housing affordability data
hao2018 = pd.read_csv('hao2018.csv')
```

In [8]:
```
#looking at the first 5 rows of the dataframe
hao2018.head()
```

Out[8]:

	GEO_ID	NAME	FIPS	DP04_0080E	DP04_0081E	DP04_0081PE	DP04_0082E	DP04_0082PE	DP04_0083E	DP04_0083PE	...	DP04_0138PE	DP04_0139E	D
0	id	Geographic Area Name	FIPS	Estimate!!VALUE!!Owner-occupied units	ooh value<$50,000	%ooh value<$50,000	ooh value $50,000 to 99,999	%ooh value $50,000 to 99,999	ooh value $100,000 to 149,999	%ooh value $100,000 to 149,999	...	% GRAPI 15.0 to 19.9 percent	GRAPI 20.0 to 24.9 percent	%
1	0500000US09001	Fairfield County, Connecticut	9001	229169	4667	2	4269	1.9	7458	3.3	...	10.7	12366	
2	0500000US09005	Litchfield County, Connecticut	9005	57079	1214	2.1	2103	3.7	7068	12.4	...	10.8	2207	
3	0500000US09009	New Haven County, Connecticut	9009	204295	4853	2.4	10039	4.9	22849	11.2	...	11.1	14309	
4	0500000US34003	Bergen County, New Jersey	34003	217881	3109	1.4	1961	0.9	3082	1.4	...	13.1	14784	

5 rows × 112 columns

In [9]:
```
#drop the first row (row 0)
hao2018 = hao2018.drop([0])
```

In [10]:
```
#check datatypes
hao2018.dtypes
```

Out[10]:
```
GEO_ID         object
NAME           object
FIPS           object
DP04_0080E     object
DP04_0081E     object
                ...
DP04_0141E     object
DP04_0141PE    object
DP04_0142E     object
DP04_0142PE    object
DP04_0143E     object
Length: 112, dtype: object
```

In [11]:
```
#convert FIPS from object to integer so that I can merge the 2018 housing affordability dataframe with county boundary dataframe
hao2018['FIPS'] = hao2018['FIPS'].astype(str).astype(int)
hao2018.dtypes
```

Out[11]:
```
GEO_ID         object
NAME           object
FIPS            int64
DP04_0080E     object
DP04_0081E     object
                ...
DP04_0141E     object
DP04_0141PE    object
DP04_0142E     object
DP04_0142PE    object
DP04_0143E     object
Length: 112, dtype: object
```

Data analysis of the housing affordability data in 2014 and 2018

In [28]:
```
#import county boundary data set
tracts=gpd.read_file('NYMRcb/county.shp')
tracts.head()
```

Out[28]:

	cartodb_id	statefp	countyfp	geoid	name	subregid	atotal	aland	pop_10e	pop_10m	...	cr_oth_e	cr_oth_m	cr_oth_c	cr_hom_e	cr_hom_m	cr_hom_c	isc
0	1	09	001	09001	Fairfield County, Connecticut	CT	836.91795	624.96958	916829	0	...	344	363.225722	64.187765	0	0.000000	0.000000	
1	10	34	025	34025	Monmouth County, New Jersey	ONJ	665.31546	468.40775	630380	0	...	0	0.000000	0.000000	0	0.000000	0.000000	
2	25	36	081	36081	Queens County, New York	NYC	178.03032	108.76805	2230722	0	...	9887	1864.166774	11.461840	35072	3689.568791	6.395127	
3	2	09	005	09005	Litchfield County, Connecticut	CT	944.55528	920.56844	189927	0	...	0	0.000000	0.000000	0	0.000000	0.000000	
4	19	36	027	36027	Dutchess County, New York	MHV	825.34308	795.63519	297488	0	...	77	132.008047	104.218251	0	0.000000	0.000000	

5 rows × 222 columns

In [46]:
```
#convert the data type of columns in 2018 housing affordability dataframe from object to integers for mapping
tracts2018["DP04_0111E_y"] =tracts2018["DP04_0111E_y"].astype(str).astype(int)
tracts2018["DP04_0111PE_y"] =tracts2018["DP04_0111PE_y"].astype(float).astype(int)
tracts2018["DP04_0112E_y"] =tracts2018["DP04_0112E_y"].astype(str).astype(int)
tracts2018["DP04_0112PE_y"] =tracts2018["DP04_0112PE_y"].astype(float).astype(int)
tracts2018["DP04_0113E_y"] =tracts2018["DP04_0113E_y"].astype(float).astype(int)
tracts2018["DP04_0113PE_y"] =tracts2018["DP04_0113PE_y"].astype(float).astype(int)
tracts2018["DP04_0114E_y"] =tracts2018["DP04_0114E_y"].astype(float).astype(int)
tracts2018["DP04_0114PE"] =tracts2018["DP04_0114PE"].astype(float).astype(int)
tracts2018["DP04_0115E_y"] =tracts2018["DP04_0115E_y"].astype(float).astype(int)
tracts2018["DP04_0115PE"] =tracts2018["DP04_0115PE"].astype(float).astype(int)
tracts2018["DP04_0116E_y"] =tracts2018["DP04_0116E_y"].astype(float).astype(int)
```

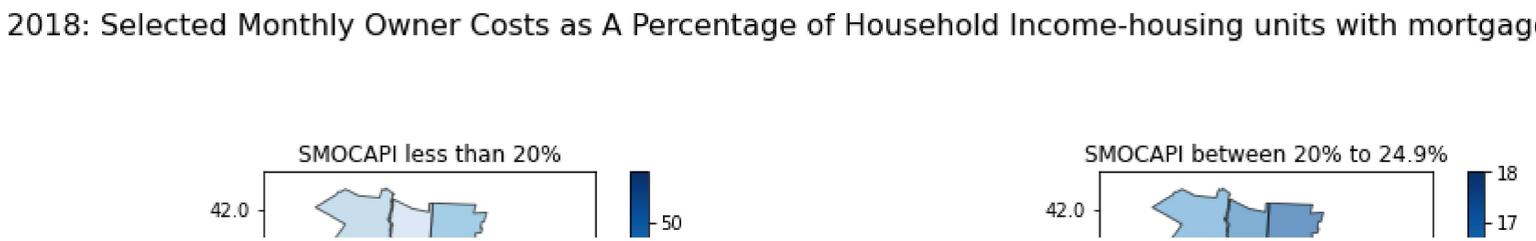
Mapping 2014 and 2018 housing affordability in NYMA

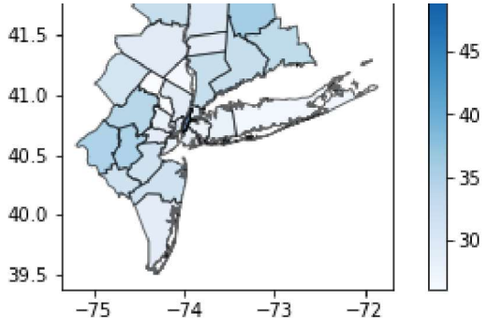
In [47]:

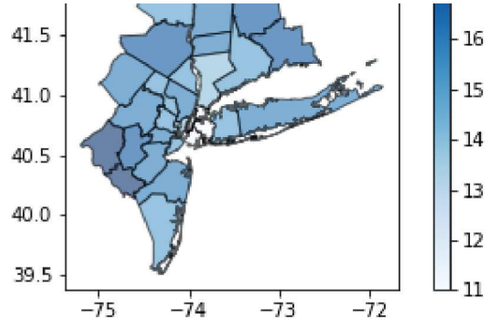
```
#plot 2018 SMOCAPI across counties in the NYMA region on the map

fig, axs = plt.subplots(nrows=3, ncols=2, figsize=(15, 12))
(ax1, ax2), (ax3, ax4),(ax5, ax6) = axs


tracts2018.plot(
    figsize=(15, 12),
    cmap='Blues',
    column='DP04_0111PE_y',
    legend = True,
    edgecolor="Black",
    alpha=0.6,
    ax=ax1,
)
ax1.set_title("SMOCAPI less than 20%")

tracts2018.plot(
    figsize=(15, 12),
    cmap='Blues',
    column='DP04_0112PE_y',
    legend = True,
    edgecolor="Black",
    alpha=0.6,
    ax=ax2,
)
ax2.set_title("SMOCAPI between 20% to 24.9%")

tracts2018.plot(
    figsize=(15, 12),
    cmap='Blues',
    column='DP04_0113PE_y',
    legend = True,
    edgecolor="Black",
    alpha=0.6,
    ax=ax3,
)
ax3.set_title("SMOCAPI between 25% to 29.9%")

tracts2018.plot(
    figsize=(15, 12),
    cmap='Blues',
```

```
    column='DP04_0114PE',
    legend = True,
    ax=ax4,
    edgecolor="Black",
    alpha=0.6
)
ax4.set_title("SMOCAPI between 30% to 34.9%")

tracts2018.plot(
    figsize=(15, 12),
    cmap='Blues',
    column='DP04_0115PE',
    legend = True,
    ax=ax5,
    edgecolor="Black",
    alpha=0.6
)
ax5.set_title("SMOCAPI greater than 35%")

tracts2018.plot(
    figsize=(15, 12),
    cmap='Blues',
    column='DP04_0116E_y',
    legend = True,
    ax=ax6,
    edgecolor="Black",
    alpha=0.6
)
ax6.set_title("SMOCAPI not computed")


fig.suptitle('2018: Selected Monthly Owner Costs as A Percentage of Household Income-housing units with mortgage', fontsize=16)
```

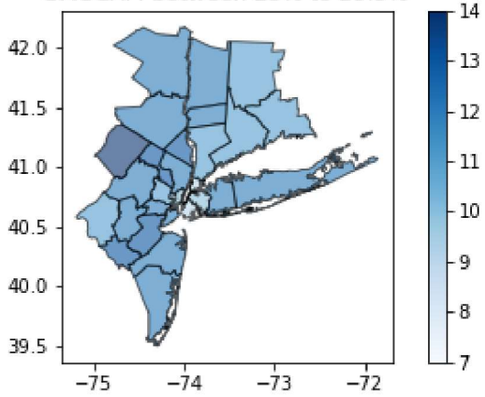
Out[47]: Text(0.5, 0.98, '2018: Selected Monthly Owner Costs as A Percentage of Household Income-housing units with mortgage')



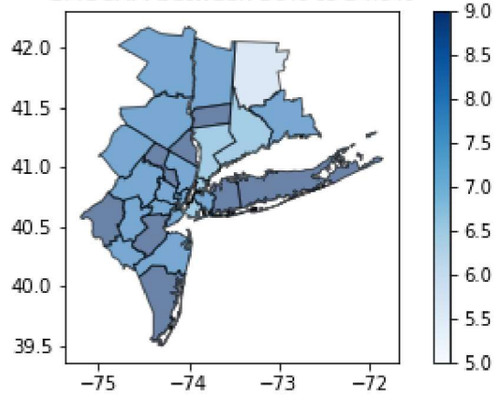




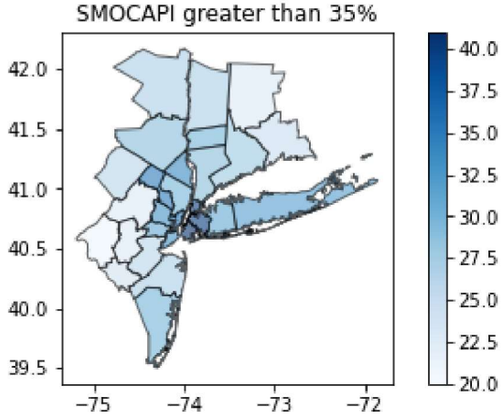
SMOCAPI between 25% to 29.9%



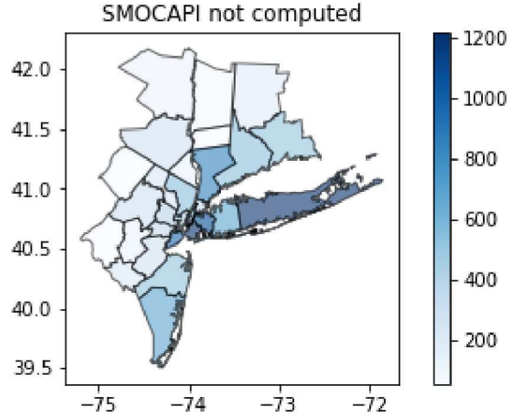
SMOCAPI between 30% to 34.9%



SMOCAPI greater than 35%



SMOCAPI not computed



In [45]:
```
#merge the county boundary dataframe wiht 2018 housing affordability dataframe on FIPS
tracts2018=tracts.merge(hao2018,on="FIPS")
pd.set_option('display.max_columns', None)
tracts2018.head()
```

Out[45]:

	cartodb_id	statefp	countyfp	geoid	name	subregid	atotal	aland	pop_10e	pop_10m	pop_10c	pop_19e	pop_19m	pop_19c	pop_1019e	pop_1019m	pop_1019c	p
0	1	09	001	09001	Fairfield County, Connecticut	CT	836.91795	624.96958	916829	0	0	943332	0	0	26503	0	0	
1	10	34	025	34025	Monmouth County, New Jersey	ONJ	665.31546	468.40775	630380	0	0	618795	0	0	-11585	0	0	
2	25	36	081	36081	Queens County, New York	NYC	178.03032	108.76805	2230722	0	0	2253858	0	0	23136	0	0	
3	2	09	005	09005	Litchfield County, Connecticut	CT	944.55528	920.56844	189927	0	0	180333	0	0	-9594	0	0	
4	19	36	027	36027	Dutchess County, New York	MHV	825.34308	795.63519	297488	0	0	294218	0	0	-3270	0	0	

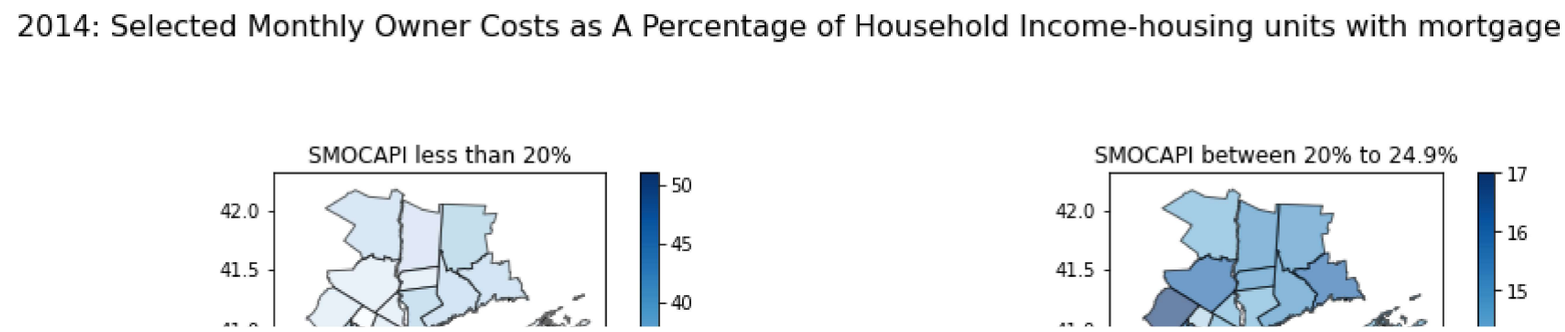
In [46]:
```
#convert the data type of columns in 2018 housing affordability dataframe from object to integers for mapping
tracts2018["DP04_0111E_y"] =tracts2018["DP04_0111E_y"].astype(str).astype(int)
tracts2018["DP04_0111PE_y"] =tracts2018["DP04_0111PE_y"].astype(float).astype(int)
tracts2018["DP04_0112E_y"] =tracts2018["DP04_0112E_y"].astype(str).astype(int)
tracts2018["DP04_0112PE_y"] =tracts2018["DP04_0112PE_y"].astype(float).astype(int)
tracts2018["DP04_0113E_y"] =tracts2018["DP04_0113E_y"].astype(float).astype(int)
tracts2018["DP04_0113PE_y"] =tracts2018["DP04_0113PE_y"].astype(float).astype(int)
tracts2018["DP04_0114E_y"] =tracts2018["DP04_0114E_y"].astype(float).astype(int)
tracts2018["DP04_0114PE"] =tracts2018["DP04_0114PE"].astype(float).astype(int)
tracts2018["DP04_0115E_y"] =tracts2018["DP04_0115E_y"].astype(float).astype(int)
tracts2018["DP04_0115PE"] =tracts2018["DP04_0115PE"].astype(float).astype(int)
tracts2018["DP04_0116E_y"] =tracts2018["DP04_0116E_y"].astype(float).astype(int)
```

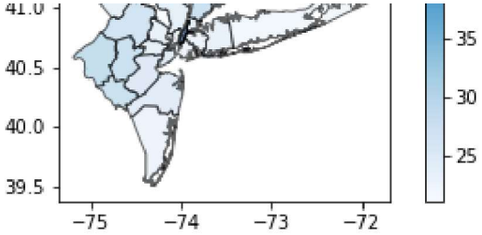
In [44]:

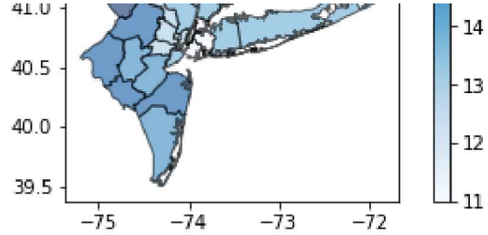
```
#plot 2014 SMOCAPI across counties in the NYMA region on the map
fig, axs = plt.subplots(nrows=3, ncols=2, figsize=(15, 12)) #3 rows and 2 columns
(ax1, ax2), (ax3, ax4),(ax5, ax6) = axs

tracts.plot(
    figsize=(15,12),
    cmap='Blues',
    ax=ax1,
    column= 'DP04_0109PE',
    legend = True,
    edgecolor="Black",
    alpha=0.6
    )
ax1.set_title("SMOCAPI less than 20%")

tracts.plot(
    figsize=(15, 12),
     ax=ax2,
    cmap='Blues',
    column='DP04_0110PE',
    legend = True,
    edgecolor="Black",
    alpha=0.6
    )
ax2.set_title("SMOCAPI between 20% to 24.9%")

tracts.plot(
    figsize=(15, 12),
    cmap='Blues',
    column='DP04_0111PE',
    legend = True,
    ax=ax3,
    edgecolor="Black",
    alpha=0.6
)
ax3.set_title("SMOCAPI between 25% to 29.99%")

tracts.plot(
    figsize=(15, 12),
    cmap='Blues',
    column='DP04_0112PE',
    legend = True,
```

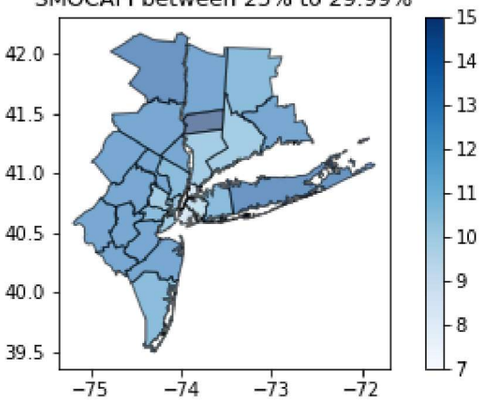
```
    ax=ax4,
    edgecolor="Black",
    alpha=0.6
)
ax4.set_title("SMOCAPI between 30% to 34.99%")

tracts.plot(
    figsize=(15, 12),
    cmap='Blues',
    column='DP04_0113PE',
    legend = True,
    ax=ax5,
    edgecolor="Black",
    alpha=0.6
)
ax5.set_title("SMOCAPI greater than 35%")

tracts.plot(
    figsize=(15, 12),
    cmap='Blues',
    column='DP04_0114E',
    legend = True,
    ax=ax6,
     edgecolor="Black",
    alpha=0.6
)
ax6.set_title("SMOCAPI not computed")


fig.suptitle('2014: Selected Monthly Owner Costs as A Percentage of Household Income-housing units with mortgage', fontsize=16)
```

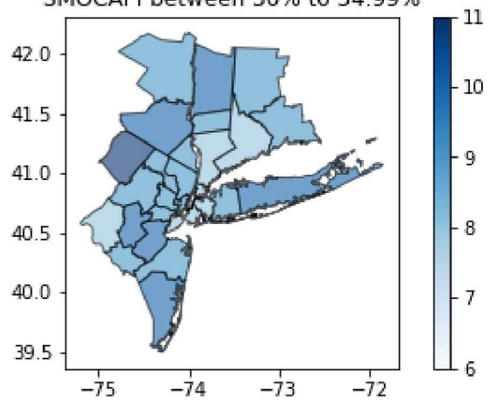
Out[44]: Text(0.5, 0.98, '2014: Selected Monthly Owner Costs as A Percentage of Household Income-housing units with mortgage')

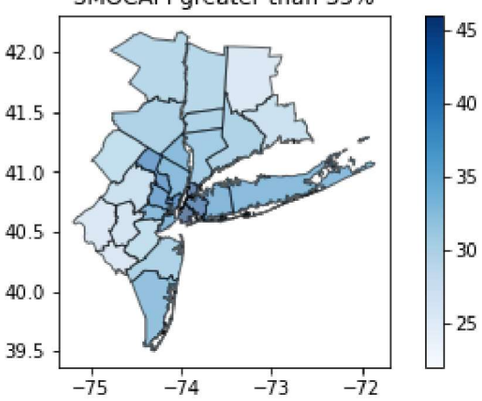


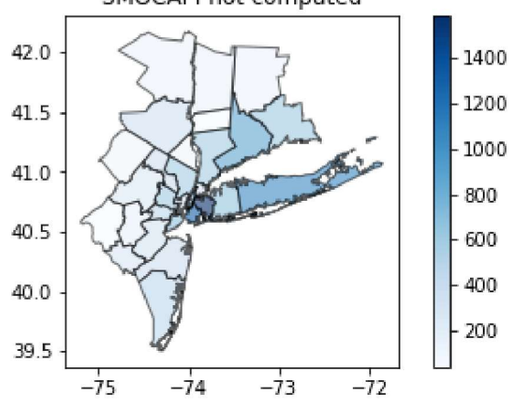












Comparing housing affordability in 2014 and 2018 with Plotly.Express

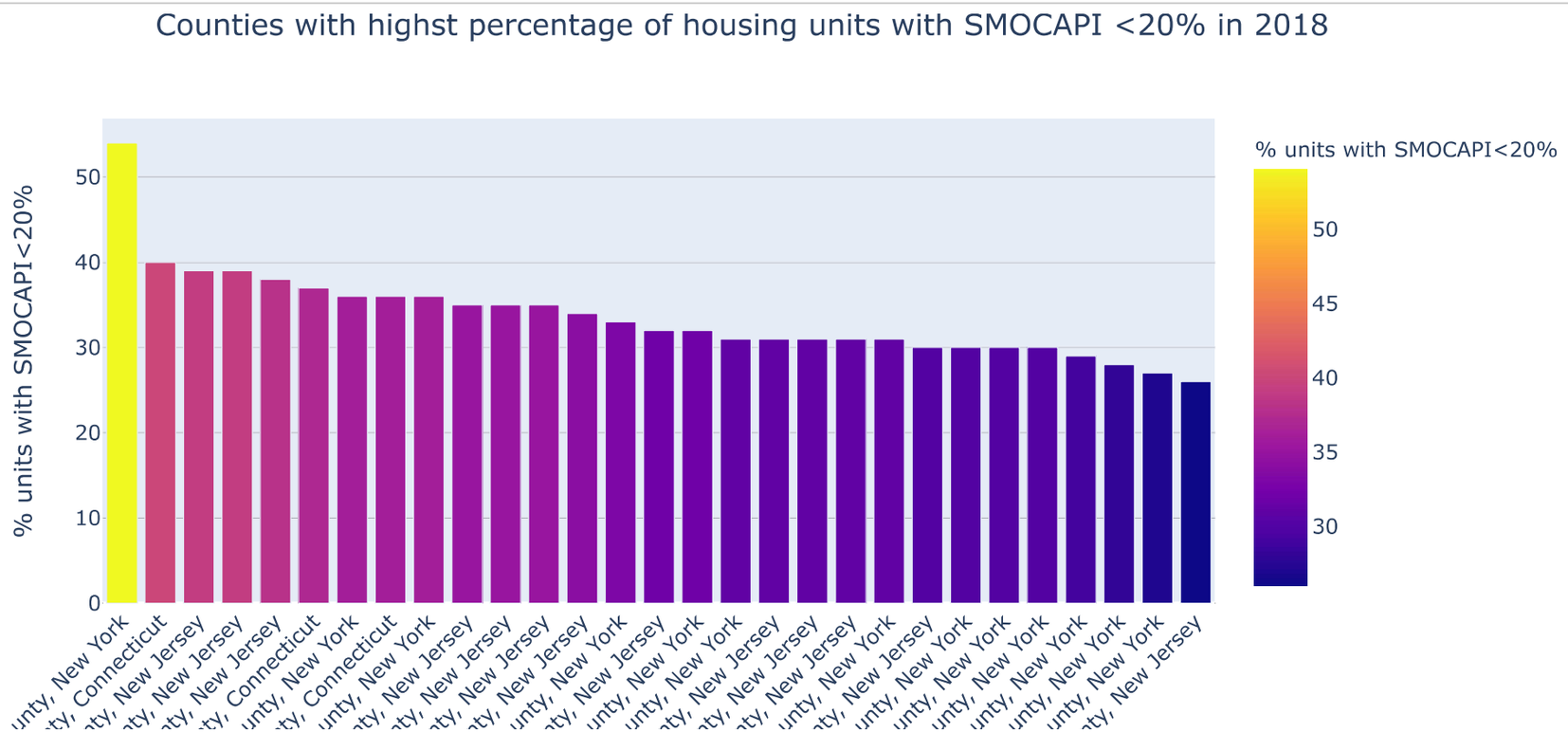
In [48]:
```
#US Census Bureau defined housing units with less than 20% SMOCAPI as affordable.
#create a new dataframe "SMOCAPI2018 by sorting the 2018housing units with less than 20% SMOCAPI
SMOCAPI2018=tracts2018.sort_values(by=['DP04_0111PE_y'], ascending=False)
SMOCAPI2018
```

Out[48]:

	cartodb_id	statefp	countyfp	geoid	name	subregid	atotal	aland	pop_10e	pop_10m	pop_10c	pop_19e	pop_19m	pop_19c	pop_1019e	pop_1019m	pop_10
25	22	36	061	36061	New York County, New York	NYC	33.68056	22.65581	1585873	0	0	1628706	0	0	42833	0	
3	2	09	005	09005	Litchfield County, Connecticut	CT	944.55528	920.56844	189927	0	0	180333	0	0	-9594	0	
27	7	34	019	34019	Hunterdon County, New Jersey	ONJ	437.44525	427.83451	128349	0	0	124371	0	0	-3978	0	
					Somerset												

In [59]:

```
#plot it
fig2=px.bar(
     SMOCAPI2018,
      x='name',
      y='DP04_0111PE_y',
    color='DP04_0111PE_y',
    labels={"DP04_0111PE_y": "Percent of housing units with SMOCAPI<20%", #change labels of x and y axis, and legend
        "name": "Counties",
        "DP04_0111PE_y": "% units with SMOCAPI<20%"
                }
)
fig2.update_layout(xaxis_tickangle=-45,title={
        'text': "Counties with highst percentage of housing units with SMOCAPI <20% in 2018", #add title
        'y':1,#change position of the title
        'x':0.5,
        'xanchor': 'center',
        'yanchor': 'top'}
)
```



Counties

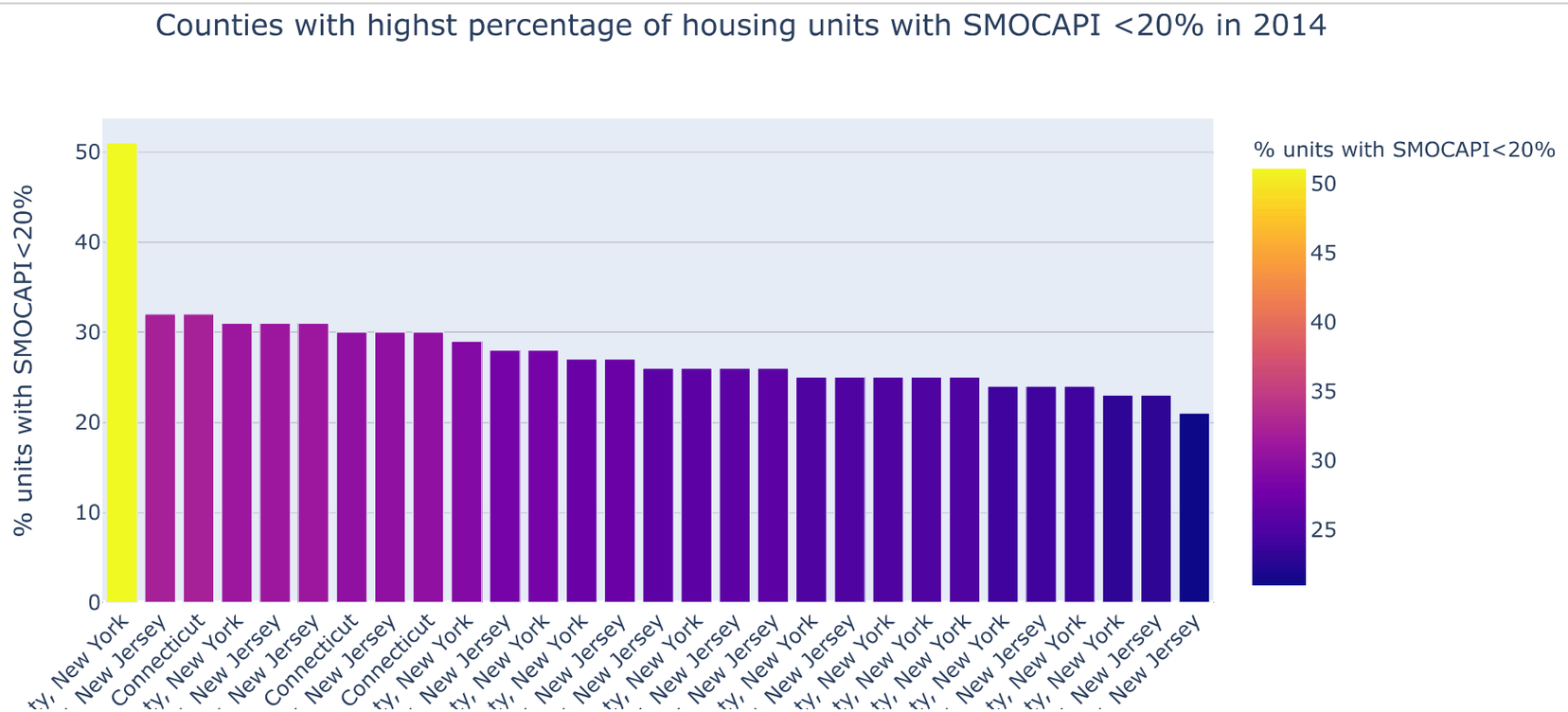
In [51]:
```
#create a new dataframe "SMOCAPI2014" by sorting the 2014 housing units with less than 20% SMOCAPI
SMOCAPI2014=tracts.sort_values(by=['DP04_0109PE'], ascending=False)
SMOCAPI2014
```

Out[51]:

	cartodb_id	statefp	countyfp	geoid	name	subregid	atotal	aland	pop_10e	pop_10m	pop_10c	pop_19e	pop_19m	pop_19c	pop_1019e	pop_1019m	pop_10
25	22	36	061	36061	New York County, New York	NYC	33.68056	22.65581	1585873	0	0	1628706	0	0	42833	0	
27	7	34	019	34019	Hunterdon County, New Jersey	ONJ	437.44525	427.83451	128349	0	0	124371	0	0	-3978	0	
3	2	09	005	09005	Litchfield County, Connecticut	CT	944.55528	920.56844	189927	0	0	180333	0	0	-9594	0	
21	31	36	119	36119	Westchester County,	LHV	499.99194	430.51583	949113	0	0	967506	0	0	18393	0	

In [52]:

```
#plot it
fig2=px.bar(
     SMOCAPI2014,
      x='name',
      y='DP04_0109PE',
    color='DP04_0109PE',
    labels={"DP04_0109PE": "Percent of housing units with SMOCAPI<20%", #change labels of x and y axis, and legend
        "name": "Counties",
        "DP04_0109PE": "% units with SMOCAPI<20%"
                }
)
fig2.update_layout(xaxis_tickangle=-45,title={
        'text': "Counties with highst percentage of housing units with SMOCAPI <20% in 2014", #add title
        'y':1,#change position of the title
        'x':0.5,
        'xanchor': 'center',
        'yanchor': 'top'},
)
```



In [53]:

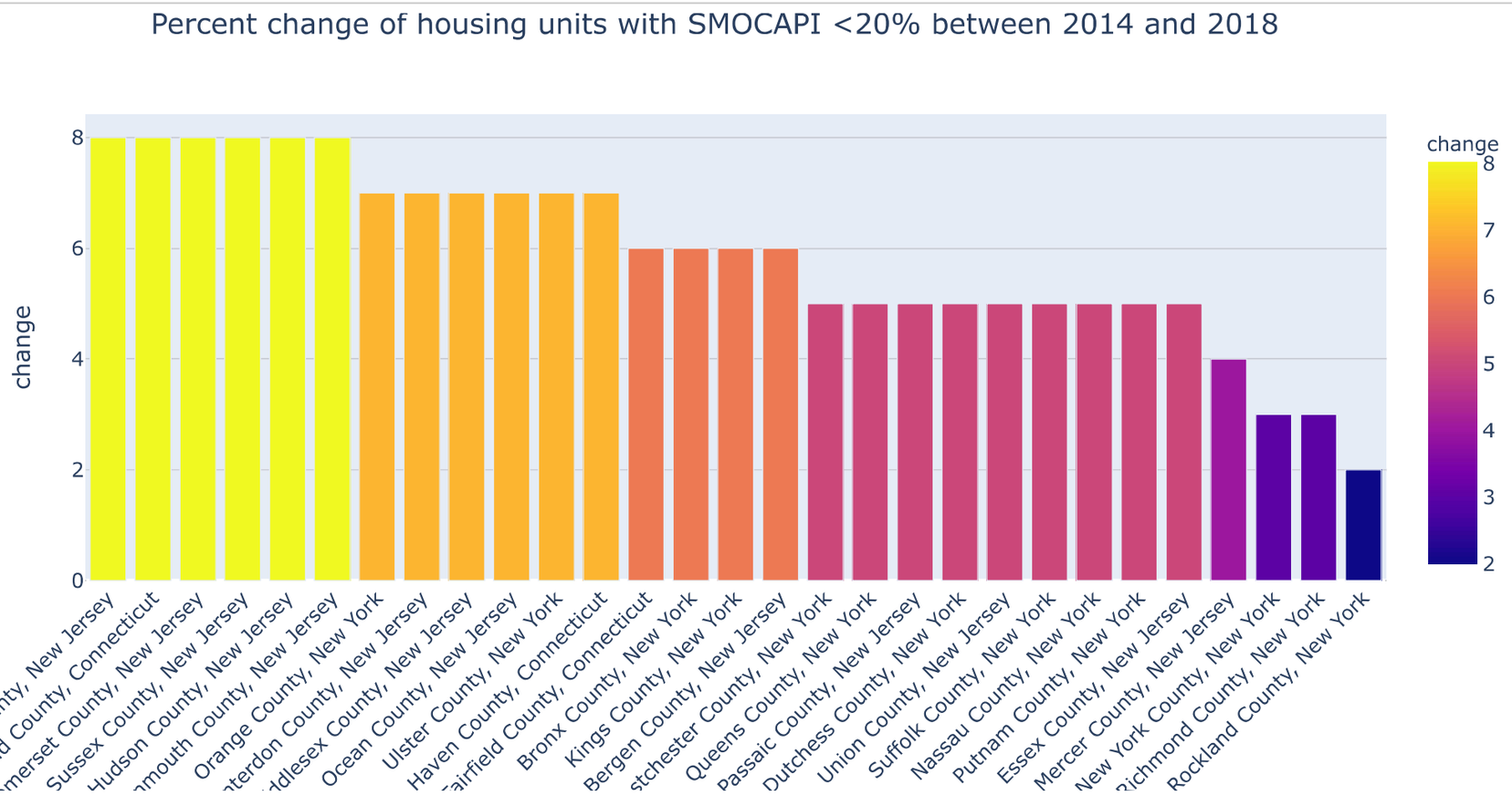
```
#I want to measure the change between 2014 and 2018 housing units with SMOCAPI<20% across counties in NYMA
tracts2018["change"]=SMOCAPI2018['DP04_0111PE_y']-SMOCAPI2014['DP04_0109PE'] #create new category "change" and calculate it by dividing.
tracts2018
tracts2018=tracts2018.sort_values(by=['change'], ascending=False)
tracts2018
```

Out[53]:

	cartodb_id	statefp	countyfp	geoid	name	subregid	atotal	aland	pop_10e	pop_10m	pop_10c	pop_19e	pop_19m	pop_19c	pop_1019e	pop_1019m	pop_10
14	11	34	027	34027	Morris County, New Jersey	INJ	481.65515	460.30071	492276	0	0	491845	0	0	-431	0	
3	2	09	005	09005	Litchfield County, Connecticut	CT	944.55528	920.56844	189927	0	0	180333	0	0	-9594	0	
23	14	34	035	34035	Somerset County, New Jersey	INJ	304.81309	301.77125	323444	0	0	328934	0	0	5490	0	

In [54]:

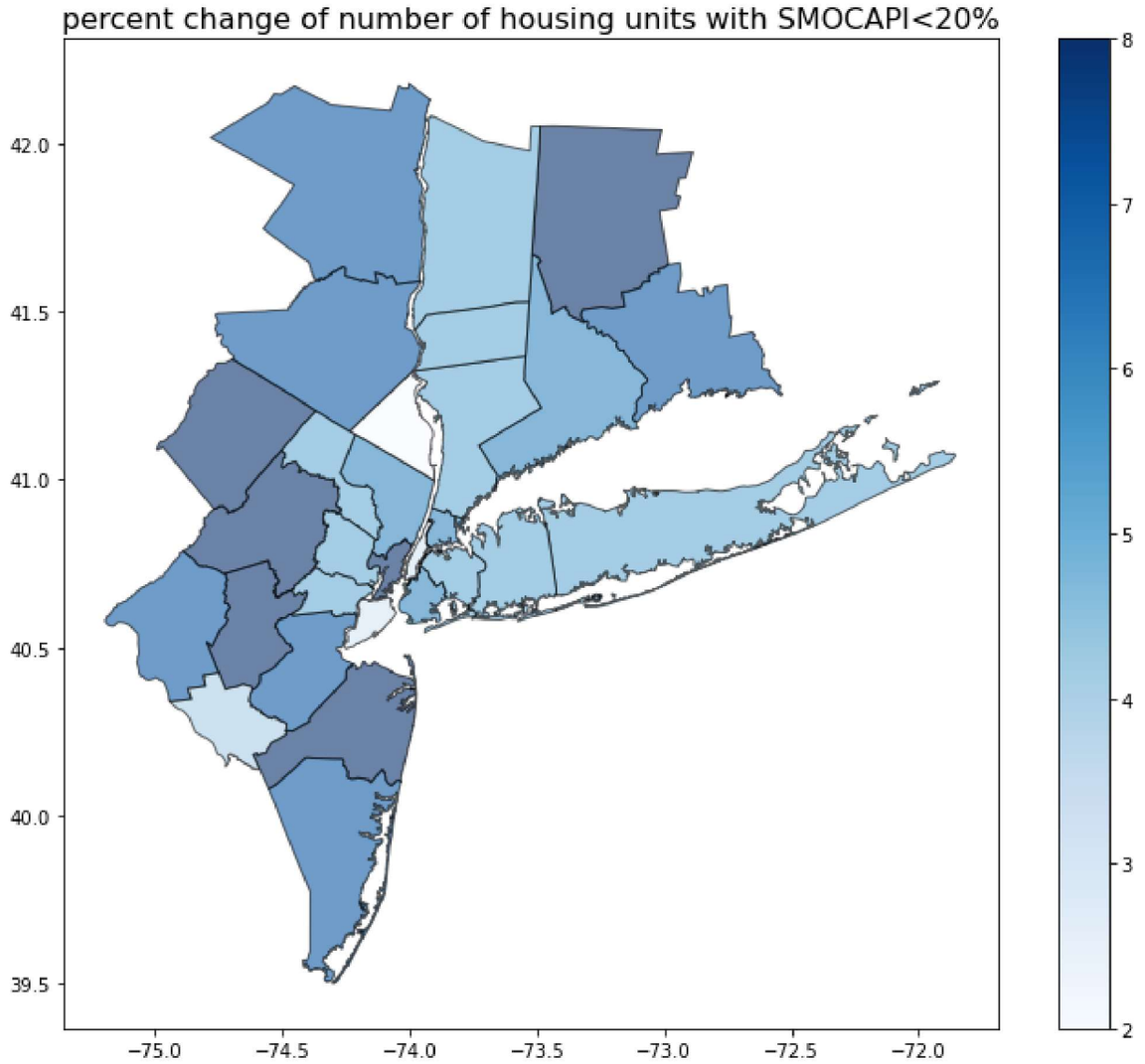
```
# Plot the change between the number of housing units with SMOCAPI<20% in 2014 and 2018
fig3=px.bar(
     tracts2018,
      x='name',
      y='change',
    color='change'
)
fig3.update_layout(xaxis_tickangle=-45,title={
        'text': "Percent change of housing units with SMOCAPI <20% between 2014 and 2018", #add title
        'y':1,#change position of the title
        'x':0.5,
        'xanchor': 'center',
        'yanchor': 'top'},
)
```




name

In [69]:
```
#plot it on the map
fig3=tracts2018.plot(figsize=(12,10),
    cmap='Blues',
    column='change',
    legend = True,
    edgecolor="Black",
    alpha=0.6)

plt.title('percent change of number of housing units with SMOCAPI<20%',fontsize=16)
```

Out[69]:
```
Text(0.5, 1.0, 'percent change of number of housing units with SMOCAPI<20%')
```



Conclusion

From the data exploration and analysis of housing affordability of owner occupied housing units with mortgage in NYMA, there is an overall increase in housing afforability in NYMA counties, ranging from two to eight percent. The highest increase is in counties further away from New York County (NYC), but also in Hudson County, which is located across from New York Conty.

Next step of the affordability analysis will be focused on the relationship between migration, housing affordability, and transit density on the county level.

Data exploration and analysis of housing value in 2014 and 2018

Data exploration

In [12]:
```
#importing 2014 and 2018 housing value data from ACS survey
value2014 = pd.read_csv('Book1.csv')
```

In [13]:
```
#looking at first 5 rows of the dataframe
value2014.head()
```

Out[13]:

	Value	Name	count1	year1	count2	year2	FIPS	change
0	Less than $50k	Fairfield County, Connecticut	4664	2014	4667	2018	901	0.000643
1	Less than $50k	Litchfield County, Connecticut	1248	2014	1214	2018	905	-0.027244
2	Less than $50k	New Haven County, Connecticut	5668	2014	4853	2018	909	-0.143790
3	Less than $50k	Bergen County, New Jersey	4207	2014	3109	2018	34003	-0.260994
4	Less than $50k	Essex County, New Jersey	2951	2014	3318	2018	34013	0.124365

In [14]:
```
#Check data types
value2014.dtypes
```

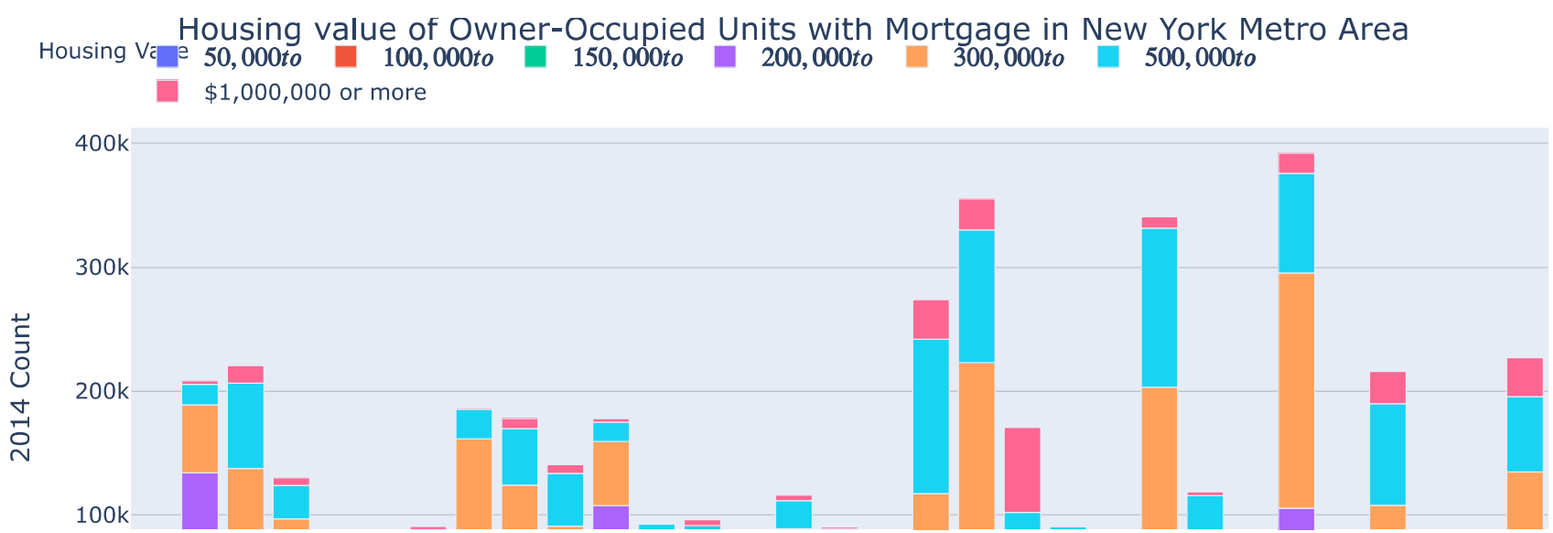
Out[14]:
```
Value      object
Name       object
count1      int64
year1       int64
count2      int64
year2       int64
FIPS        int64
change    float64
dtype: object
```

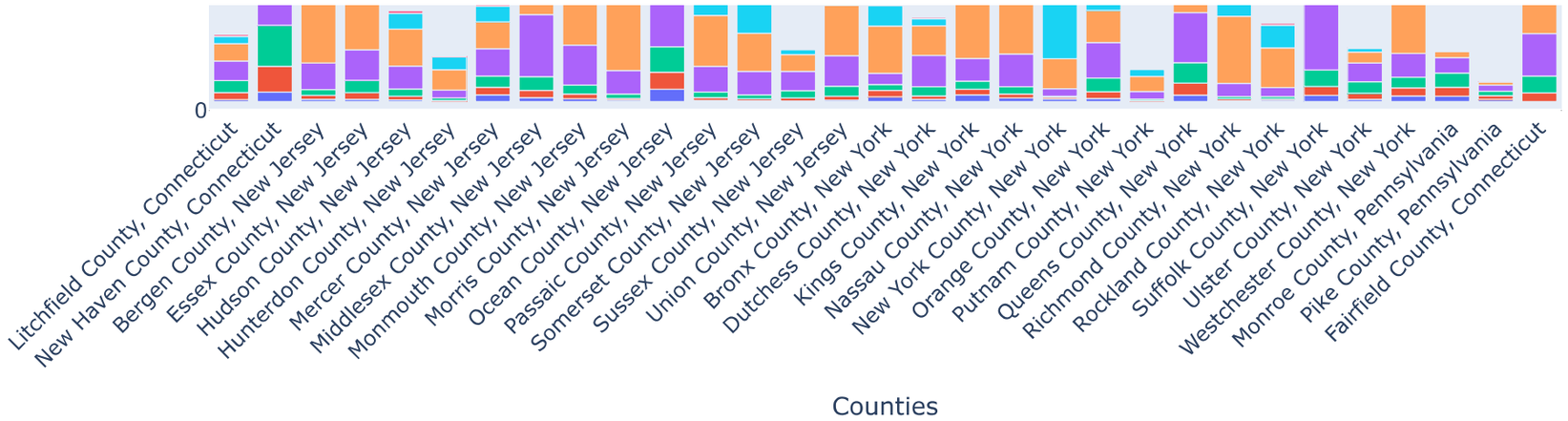
In [15]:
```
1 list(value2014)
```

Out[15]:
```
['Value', 'Name', 'count1', 'year1', 'count2', 'year2', 'FIPS', 'change']
```

In [16]:

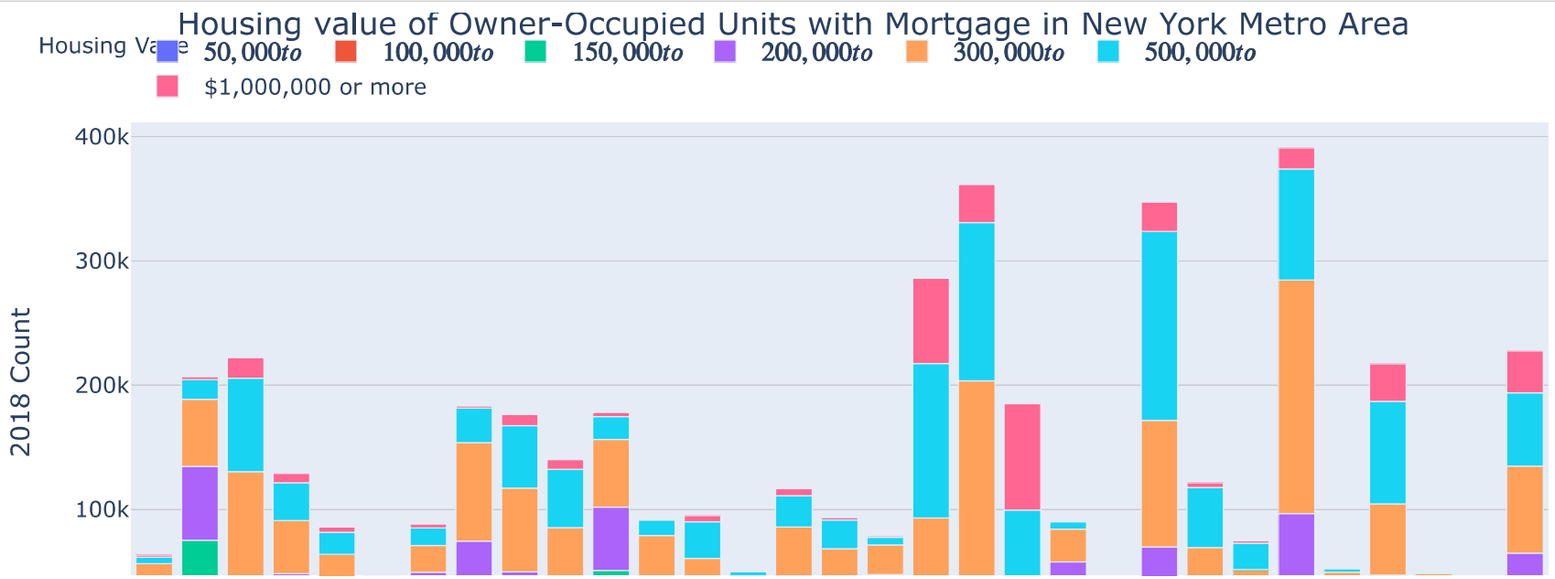
```
#Use plotly.express to create stacked bar chart of housing values in 2014 across counties in NYMA
Count = value2014.query("Value == ['Less than $50,000','$50,000 to $99,999','$100,000 to $149,999','$150,000 to $199,999','$200,000 to $299,999',
fig=px.bar(Count,
      x='Name',
      y='count1',
      color='Value',
      labels={"count1": "2014 Count", #change labels of x and y axis, and legend
              "Name": "Counties",
              "Value": "Housing Vaue"
                 })

fig.update_layout(xaxis_tickangle=-45,
      title={
        'text': "Housing value of Owner-Occupied Units with Mortgage in New York Metro Area",
        'y':1,#change position of the title
        'x':0.5,
        'xanchor': 'center',
        'yanchor': 'top'},
    legend=dict(
    orientation="h", #change the orientation of legend to horizontal
    yanchor="bottom",#change the position of the legend
    y=1.02,
    xanchor="right",
    x=.8))
```




0
Litchfield County, Connecticut
New Haven County, Connecticut
Bergen County, New Jersey
Essex County, New Jersey
Hudson County, New Jersey
Hunterdon County, New Jersey
Mercer County, New Jersey
Middlesex County, New Jersey
Monmouth County, New Jersey
Morris County, New Jersey
Ocean County, New Jersey
Passaic County, New Jersey
Somerset County, New Jersey
Sussex County, New Jersey
Union County, New Jersey
Bronx County, New York
Dutchess County, New York
Kings County, New York
Nassau County, New York
New York County, New York
Orange County, New York
Putnam County, New York
Queens County, New York
Richmond County, New York
Rockland County, New York
Suffolk County, New York
Ulster County, New York
Westchester County, New York
Monroe County, Pennsylvania
Pike County, Pennsylvania
Fairfield County, Connecticut
Counties

In [17]:

```
#Use plotly.express to create stacked bar chart of housing values in 2018 across counties in NYMA
Count = value2014.query("Value == ['Less than $50,000','$50,000 to $99,999','$100,000 to $149,999','$150,000 to $199,999','$200,000 to $299,999',
fig=px.bar(Count,
      x='Name',
      y='count2',
      color='Value',
      labels={"count2": "2018 Count", #change labels of x and y axis, and legend
        "Name": "Counties",
        "Value": "Housing Vaue"
                })
fig.update_layout(xaxis_tickangle=-45,
      title={
        'text': "Housing value of Owner-Occupied Units with Mortgage in New York Metro Area", #add title
        'y':1,#change position of the title
        'x':0.5,
        'xanchor': 'center',
        'yanchor': 'top'},
    legend=dict(
    orientation="h", #change the orientation of legend to horizontal
    yanchor="bottom", #change the position of the legend
    y=1.02,
    xanchor="right",
    x=.8))
```



Data analysis

In [18]:
```
#I want to measure the change between 2014 and 2018 housing values across value categories and counties in NYMA
value2014["change"]=1-value2014["count1"] / value2014['count2'] #create new category "change" and calculate it by dividing.
value2014
```

Out[18]:

	Value	Name	count1	year1	count2	year2	FIPS	change
0	Less than $50k	Fairfield County, Connecticut	4664	2014	4667	2018	901	0.000643
1	Less than $50k	Litchfield County, Connecticut	1248	2014	1214	2018	905	-0.028007
2	Less than $50k	New Haven County, Connecticut	5668	2014	4853	2018	909	-0.167937
3	Less than $50k	Bergen County, New Jersey	4207	2014	3109	2018	34003	-0.353168
4	Less than $50k	Essex County, New Jersey	2951	2014	3318	2018	34013	0.110609
...	...	...	...	...	...	...	...	...
243	$1,000,000 or more	Suffolk County, New York	16345	2014	17122	2018	36103	0.045380
244	$1,000,000 or more	Ulster County, New York	654	2014	644	2018	36111	-0.015528
245	$1,000,000 or more	Westchester County, New York	26146	2014	30215	2018	36119	0.134668
246	$1,000,000 or more	Monroe County, Pennsylvania	234	2014	288	2018	42089	0.187500
247	$1,000,000 or more	Pike County, Pennsylvania	127	2014	154	2018	42103	0.175325

248 rows × 8 columns

In [19]:
```
#Group the data by counties and sort the change from high to low.
value2014.groupby("Name").change.describe().sort_values(by=["max"], ascending=False)
```

Out[19]:

Name	count	mean	std	min	25%	50%	75%	max
Queens County, New York	8.0	-0.060666	0.307060	-0.335936	-0.204030	-0.187760	-0.059962	0.615275
Kings County, New York	8.0	-0.114528	0.318828	-0.549690	-0.289721	-0.139874	-0.029574	0.537062
New York County, New York	8.0	0.078289	0.236347	-0.231081	-0.040876	0.050689	0.213129	0.488702
Hudson County, New Jersey	8.0	-0.022560	0.289129	-0.467949	-0.178367	-0.077004	0.186272	0.419011
Putnam County, New York	8.0	0.025068	0.214129	-0.385542	-0.034432	0.027030	0.123258	0.327152
Richmond County, New York	8.0	-0.145303	0.277094	-0.592530	-0.268459	-0.191407	-0.030002	0.256929
Bronx County, New York	8.0	0.020338	0.194725	-0.262523	-0.071438	-0.006813	0.190398	0.252080
Orange County, New York	8.0	0.048049	0.130903	-0.132379	-0.044616	0.050117	0.120501	0.236685
Middlesex County, New Jersey	8.0	-0.053399	0.162053	-0.240747	-0.146051	-0.098415	0.025496	0.219672
Sussex County, New Jersey	8.0	-0.003837	0.160242	-0.265269	-0.089668	-0.012803	0.083261	0.215894
Hunterdon County, New Jersey	8.0	-0.042437	0.194861	-0.364238	-0.149707	-0.022129	0.064869	0.212291
Union County, New Jersey	8.0	-0.008484	0.119621	-0.161146	-0.089204	-0.007508	0.036574	0.205255
Ulster County, New York	8.0	-0.004265	0.114335	-0.170343	-0.068496	-0.026111	0.058993	0.201677
Essex County, New Jersey	8.0	0.021700	0.108704	-0.112352	-0.051880	-0.012255	0.111991	0.199550
Litchfield County, Connecticut	8.0	0.000274	0.110565	-0.116083	-0.058772	-0.037890	0.017089	0.193533
Monroe County, Pennsylvania	8.0	-0.018964	0.187117	-0.287285	-0.139602	-0.032530	0.165834	0.190233
Dutchess County, New York	8.0	-0.018469	0.134866	-0.241211	-0.075629	-0.001611	0.057435	0.188390
New Haven County, Connecticut	8.0	-0.028158	0.119470	-0.195061	-0.075868	-0.029908	0.020419	0.182588
Nassau County, New York	8.0	-0.075142	0.170222	-0.315291	-0.181699	-0.092965	-0.012186	0.180394
Pike County, Pennsylvania	8.0	0.057608	0.094271	-0.050357	-0.008075	0.026583	0.155893	0.175325
Ocean County, New Jersey	8.0	-0.003031	0.129945	-0.241412	-0.060680	-0.000826	0.074850	0.160643
Rockland County, New York	8.0	0.030561	0.100183	-0.146927	-0.033111	0.061009	0.101173	0.144949
Mercer County, New Jersey	8.0	-0.003980	0.087183	-0.126740	-0.057703	-0.027418	0.059464	0.143957

Name	count	mean	std	min	25%	50%	75%	max
Westchester County, New York	8.0	-0.017474	0.110854	-0.211277	-0.061018	-0.023231	0.033869	0.134668
Passaic County, New Jersey	8.0	-0.004303	0.117521	-0.224442	-0.069425	0.013405	0.081418	0.132394
Bergen County, New Jersey	8.0	-0.050444	0.144817	-0.353168	-0.070131	-0.047989	0.011039	0.130112
Somerset County, New Jersey	8.0	-0.059840	0.108936	-0.233514	-0.102659	-0.087859	0.005980	0.116162
Monmouth County, New Jersey	8.0	-0.049199	0.131232	-0.289545	-0.096247	-0.036004	0.028806	0.111982
Morris County, New Jersey	8.0	-0.062582	0.166591	-0.369138	-0.126799	-0.059538	0.090541	0.107363
Suffolk County, New York	8.0	-0.075940	0.121239	-0.286786	-0.130395	-0.090300	0.003116	0.100328
Fairfield County, Connecticut	8.0	0.006456	0.029202	-0.030190	-0.000858	0.002337	0.004201	0.072844

In [20]:
```
#create a new dataframe "top5change" to look at the top 5 counties across value categories that experienced most changes in the number of housing
top10change=value2014.sort_values(by=['change'], ascending=False).head(10)
top10change
```

Out[20]:

	Value	Name	count1	year1	count2	year2	FIPS	change
240	$1,000,000 or more	Queens County, New York	9148	2014	23778	2018	36081	0.615275
235	$1,000,000 or more	Kings County, New York	31789	2014	68668	2018	34047	0.537062
82	$100,000 to 149,999$	New York County, New York	1335	2014	2611	2018	36061	0.488702
222	$1,000,000 or more	Hudson County, New Jersey	2396	2014	4124	2018	34017	0.419011
239	$1,000,000 or more	Putnam County, New York	508	2014	755	2018	36079	0.327152
191	$500,000 to 999,999$	Hudson County, New Jersey	13174	2014	17757	2018	34017	0.258095
210	$500,000 to 999,999$	Richmond County, New York	35978	2014	48418	2018	36085	0.256929
202	$500,000 to 999,999$	Bronx County, New York	17259	2014	23076	2018	36005	0.252080
16	Less than $50k	Bronx County, New York	9040	2014	12067	2018	36005	0.250849
113	$150,000 to 199,999$	New York County, New York	1050	2014	1398	2018	36061	0.248927

In [21]:
```
#create new dataframe topchange to see all the changes between 2014 and 2018 housing units count in each county and each value category
topchange=value2014.sort_values(by=['change'], ascending=False)
topchange
```

Out[21]:

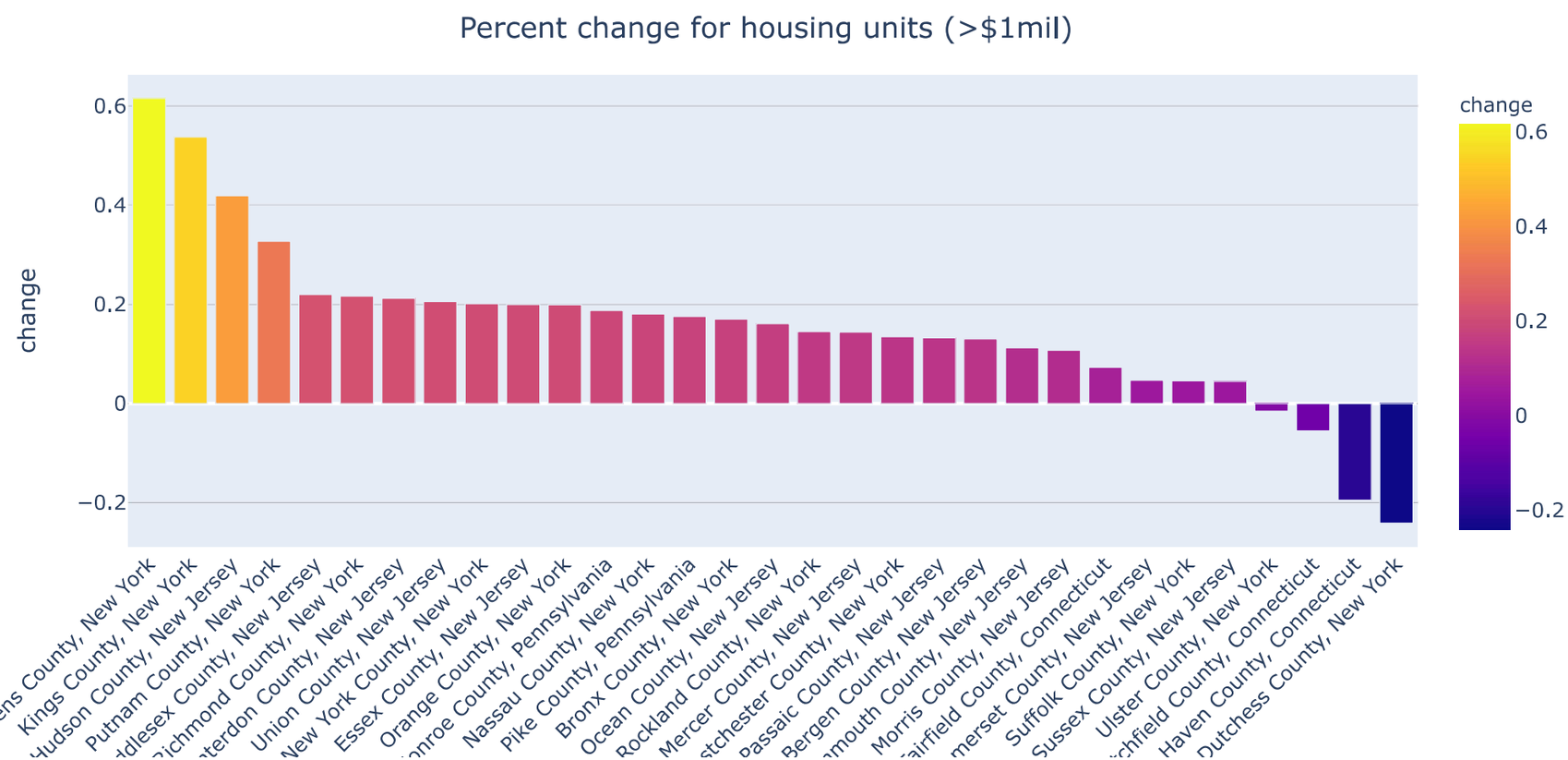
	Value	Name	count1	year1	count2	year2	FIPS	change
240	$1,000,000 or more	Queens County, New York	9148	2014	23778	2018	36081	0.615275
235	$1,000,000 or more	Kings County, New York	31789	2014	68668	2018	34047	0.537062
82	$100,000 to 149,999$	New York County, New York	1335	2014	2611	2018	36061	0.488702
222	$1,000,000 or more	Hudson County, New Jersey	2396	2014	4124	2018	34017	0.419011
239	$1,000,000 or more	Putnam County, New York	508	2014	755	2018	36079	0.327152
...	...	...	...	...	...	...	...	...
10	Less than $50k	Morris County, New Jersey	2511	2014	1834	2018	34027	-0.369138
53	$50,000 to 99,999$	Putnam County, New York	345	2014	249	2018	36079	-0.385542
36	$50,000 to 99,999$	Hudson County, New Jersey	1603	2014	1092	2018	34017	-0.467949
49	$50,000 to 99,999$	Kings County, New York	5754	2014	3713	2018	34047	-0.549690
117	$150,000 to 199,999$	Richmond County, New York	1876	2014	1178	2018	36085	-0.592530

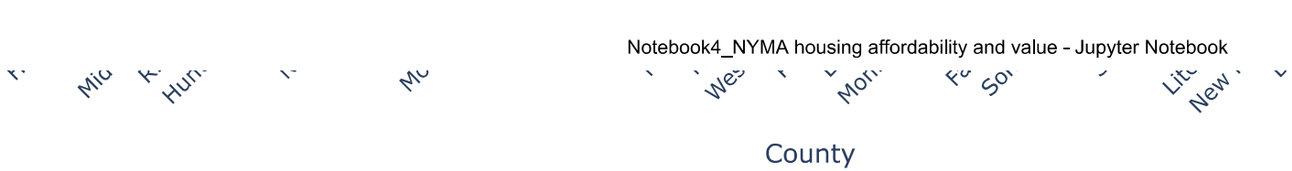
248 rows × 8 columns

Present the housing price change on the county level

In [22]:

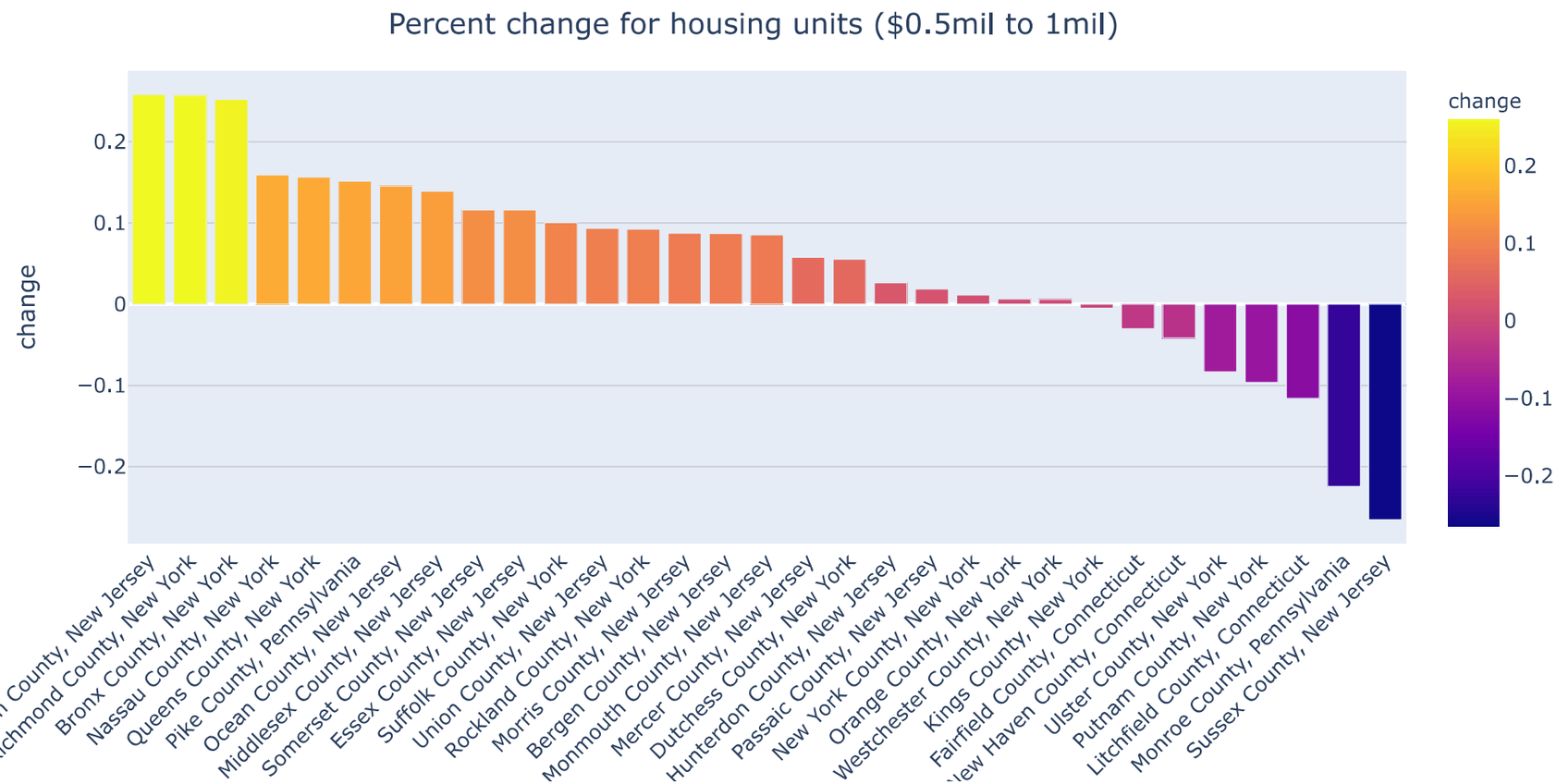
```
#I want to see the change of housing units in the value category "$1,000,000 or more"
temp = topchange.query("Value == ['$1,000,000 or more']")
fig5 = px.bar(temp,
      x='Name',
      y='change',
      color='change',
      labels={'Name':'County'})
fig5.update_layout(xaxis_tickangle=-45,title={
        'text': "Percent change for housing units (>$1mil)", #add title
        'y':0.95,#change position of the title
        'x':0.5,
        'xanchor': 'center',
        'yanchor': 'top'})
fig5
```




County

In [23]:

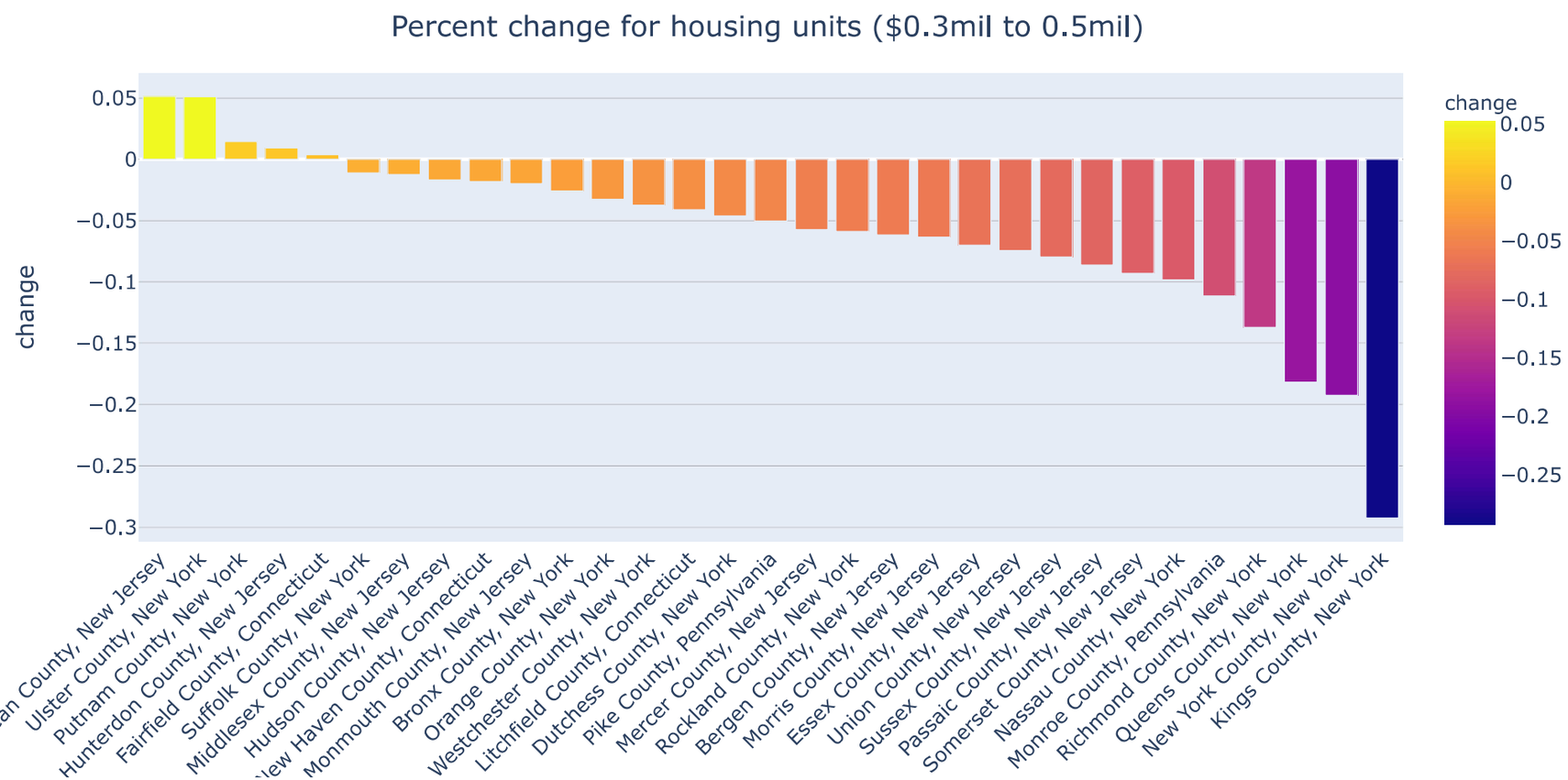
```
#I want to see the change of housing units in the value category "$500,000 to $999,999"
temp2 = topchange.query("Value == ['$500,000 to $999,999']")
fig6 = px.bar(temp2,
      x='Name',
      y='change',
      color='change',
      labels={'Name':'County'})
fig6.update_layout(xaxis_tickangle=-45,title={
        'text': "Percent change for housing units ($0.5mil to 1mil)", #add title
        'y':0.95,#change position of the title
        'x':0.5,
        'xanchor': 'center',
        'yanchor': 'top'})
fig6
```




N
County

In [24]:

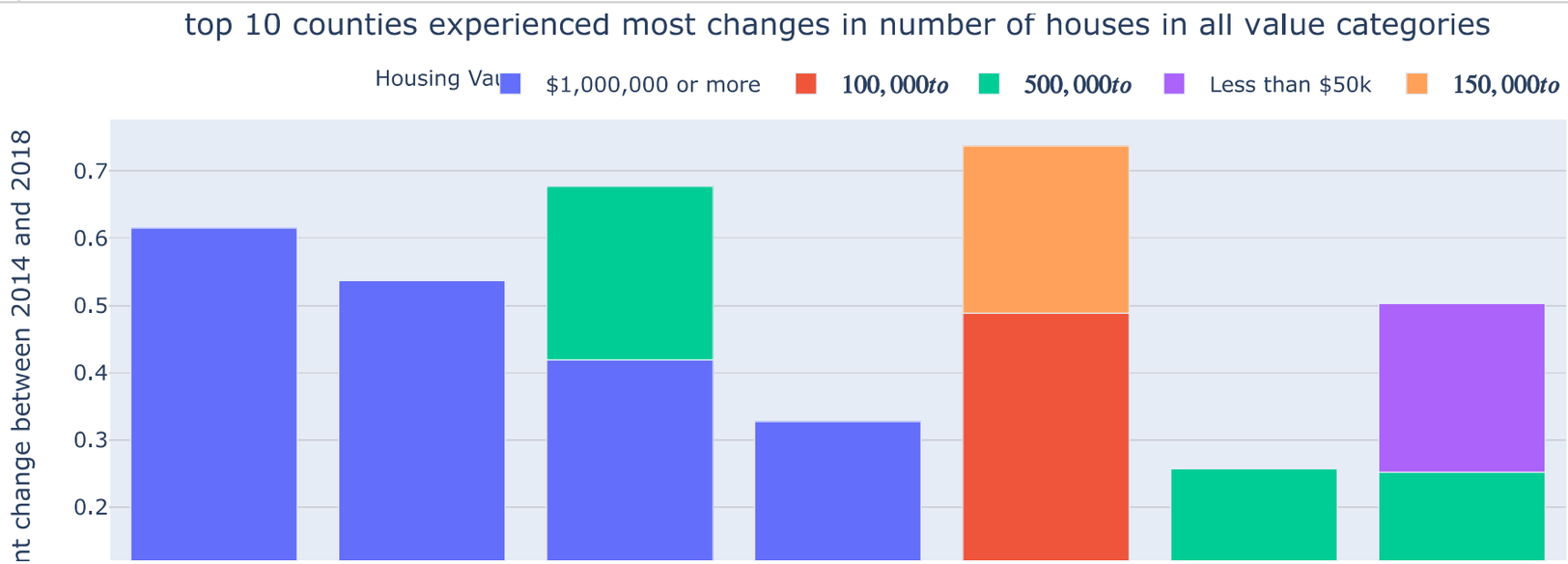
```
#I want to see the change of housing units in the value category "$300,000 to $499,999"
temp3 = topchange.query("Value == ['$300,000 to $499,999']")
fig7 = px.bar(temp3,
      x='Name',
      y='change',
      color='change',
      labels={'Name':'County'})
fig7.update_layout(xaxis_tickangle=-45,title={
        'text': "Percent change for housing units ($0.3mil to 0.5mil)", #add title
        'y':0.95,#change position of the title
        'x':0.5,
        'xanchor': 'center',
        'yanchor': 'top'})
fig7
```

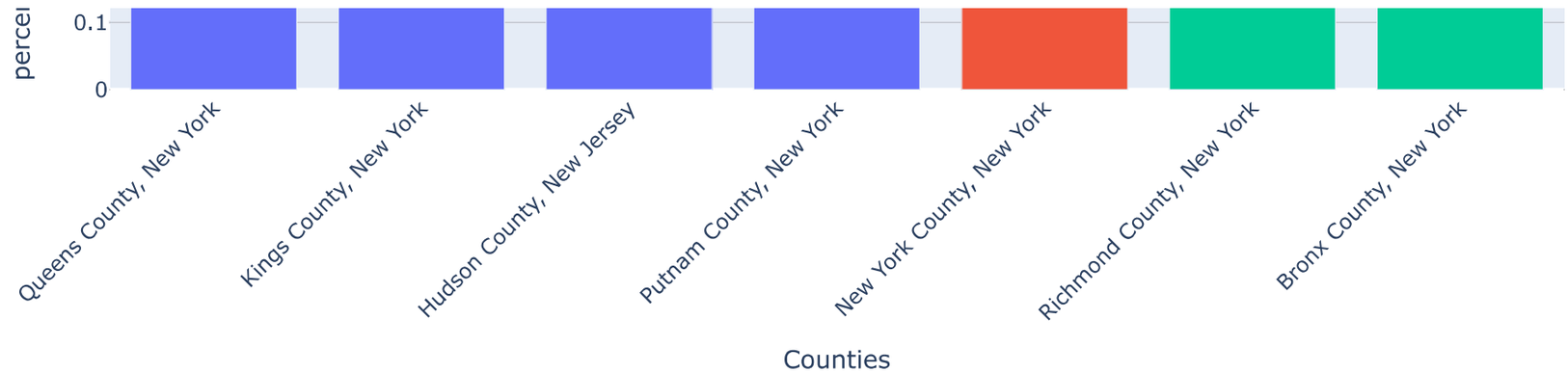


County

In [64]:

```
#create interactive bar graphs for the top 10 counties and distinguish the value categories
fig2=px.bar(
      top10change,
      x='Name',
      y='change',
      color='Value',
      labels={"change": "percent change between 2014 and 2018", #change labels of x and y axis, and legend
        "Name": "Counties",
        "Value": "Housing Vaue"
                }
)
fig2.update_layout(xaxis_tickangle=-45,title={
        'text': "top 10 counties experienced most changes in number of houses in all value categories", #add title
        'y':1,#change position of the title
        'x':0.5,
        'xanchor': 'center',
        'yanchor': 'top'},
    legend=dict(
    orientation="h",
    yanchor="bottom",
    y=1.02,
    xanchor="right",
    x=1
))
```





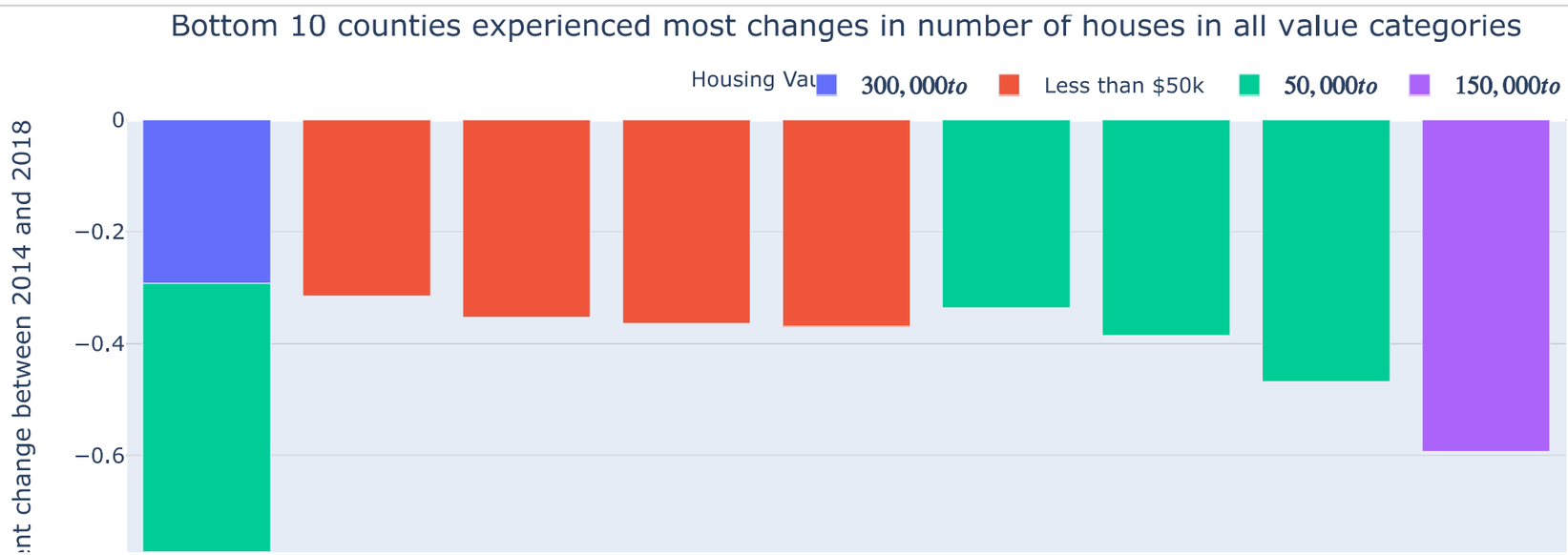
In [26]:
```
#look at the counties with decline in housing units within each value category
bottomchange=value2014.sort_values(by=['change'], ascending=False).tail(10)
bottomchange
```

Out[26]:

	Value	Name	count1	year1	count2	year2	FIPS	change
173	$300,000 to 499,999$	Kings County, New York	73130	2014	56586	2018	34047	-0.292369
19	Less than $50k	Nassau County, New York	6950	2014	5284	2018	36059	-0.315291
54	$50,000 to 99,999$	Queens County, New York	5647	2014	4227	2018	36081	-0.335936
3	Less than $50k	Bergen County, New Jersey	4207	2014	3109	2018	34003	-0.353168
6	Less than $50k	Hunterdon County, New Jersey	618	2014	453	2018	34019	-0.364238
10	Less than $50k	Morris County, New Jersey	2511	2014	1834	2018	34027	-0.369138
53	$50,000 to 99,999$	Putnam County, New York	345	2014	249	2018	36079	-0.385542
36	$50,000 to 99,999$	Hudson County, New Jersey	1603	2014	1092	2018	34017	-0.467949
49	$50,000 to 99,999$	Kings County, New York	5754	2014	3713	2018	34047	-0.549690
117	$150,000 to 199,999$	Richmond County, New York	1876	2014	1178	2018	36085	-0.592530

In [27]:

```
#create interactive bar graphs for the botton 10 counties and distinguish the value categories
fig2=px.bar(
      bottomchange,
      x='Name',
      y='change',
      color='Value',
      labels={"change": "percent change between 2014 and 2018", #change labels of x and y axis, and legend
        "Name": "Counties",
        "Value": "Housing Vaue"
                }
)
fig2.update_layout(xaxis_tickangle=-45,title={
        'text': "Bottom 10 counties experienced most changes in number of houses in all value categories", #add title
        'y':1,#change position of the title
        'x':0.5,
        'xanchor': 'center',
        'yanchor': 'top'},
    legend=dict(
    orientation="h",
    yanchor="bottom",
    y=1.02,
    xanchor="right",
    x=1
))
```



Map the changes of housing price in NYMA between 2014 and 2018

In [28]:
```
#import county boundary data set
tracts=gpd.read_file('NYMRcb/county.shp')
tracts.head()
```

Out[28]:

	cartodb_id	statefp	countyfp	geoid	name	subregid	atotal	aland	pop_10e	pop_10m	...	cr_oth_e	cr_oth_m	cr_oth_c	cr_hom_e	cr_hom_m	cr_hom_c	isc
0	1	09	001	09001	Fairfield County, Connecticut	CT	836.91795	624.96958	916829	0	...	344	363.225722	64.187765	0	0.000000	0.000000	
1	10	34	025	34025	Monmouth County, New Jersey	ONJ	665.31546	468.40775	630380	0	...	0	0.000000	0.000000	0	0.000000	0.000000	
2	25	36	081	36081	Queens County, New York	NYC	178.03032	108.76805	2230722	0	...	9887	1864.166774	11.461840	35072	3689.568791	6.395127	
3	2	09	005	09005	Litchfield County, Connecticut	CT	944.55528	920.56844	189927	0	...	0	0.000000	0.000000	0	0.000000	0.000000	
4	19	36	027	36027	Dutchess County, New York	MHV	825.34308	795.63519	297488	0	...	77	132.008047	104.218251	0	0.000000	0.000000	

5 rows × 222 columns

In [29]:
```
#looking at datatypes
tracts.dtypes
```

Out[29]:
```
cartodb_id       int64
statefp         object
countyfp        object
geoid           object
name            object
                ...
cr_hom_c       float64
iscommap         int64
iscomnycre       int64
iscomnycwo       int64
geometry      geometry
Length: 222, dtype: object
```

In [30]:
```
#I knew I need to drop row 7 and 32 from the previous analysis because they contain different geographic region than other rows.
tracts = tracts.drop(7)
```

In [31]:
```
tracts = tracts.drop([32])
```

In [32]:
```
# create new column "FIPS" by combining the "statefp" column anhd "countyfp" column
tracts["FIPS"]=tracts["statefp"]+tracts["countyfp"]
```

In [33]:
```
#convert FIPS from object to integer to merge this dataframe with housing affordability dataframe later
tracts["FIPS"] = tracts["FIPS"].astype(str).astype(int)
```

In [34]:
```
1 tracts.head()
```

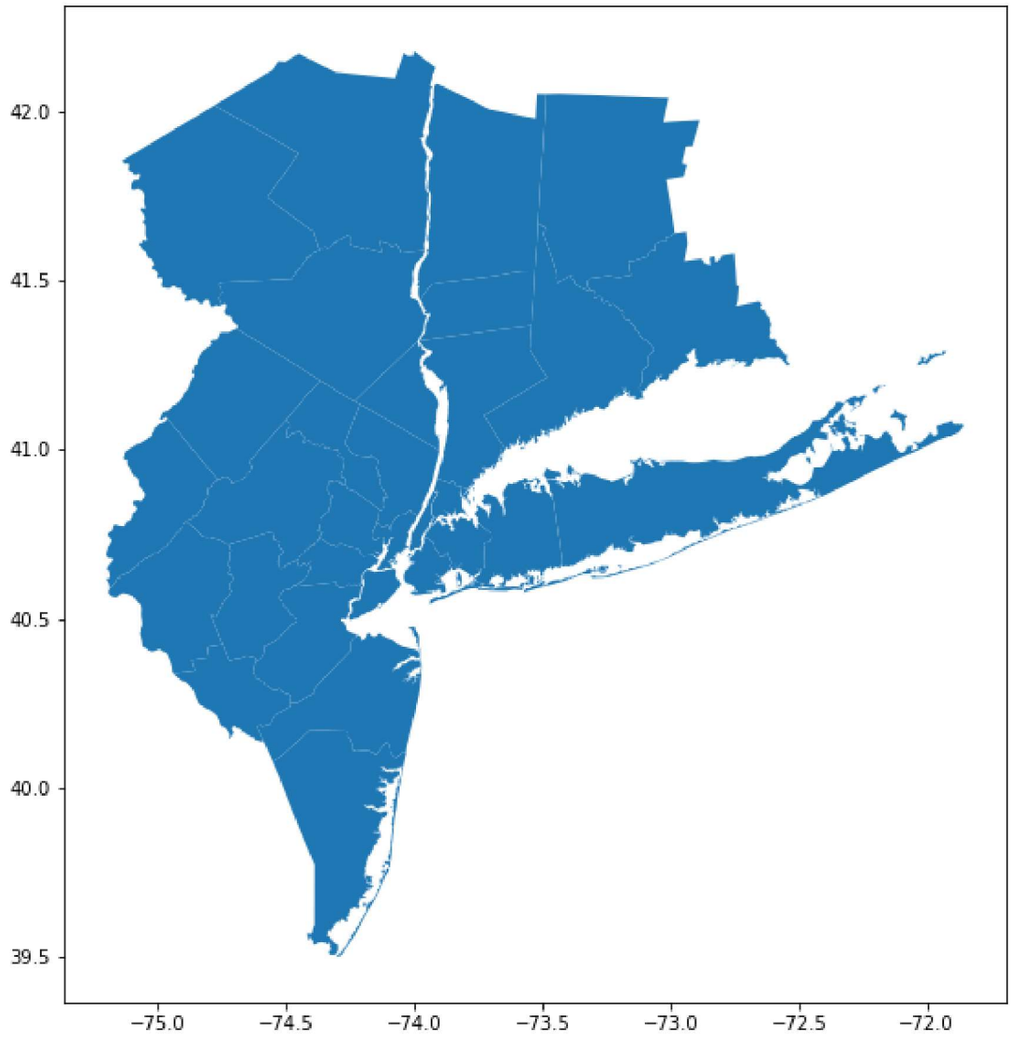
Out[34]:

	cartodb_id	statefp	countyfp	geoid	name	subregid	atotal	aland	pop_10e	pop_10m	...	cr_oth_m	cr_oth_c	cr_hom_e	cr_hom_m	cr_hom_c	iscommap	is
0	1	09	001	09001	Fairfield County, Connecticut	CT	836.91795	624.96958	916829	0	...	363.225722	64.187765	0	0.000000	0.000000	0	
1	10	34	025	34025	Monmouth County, New Jersey	ONJ	665.31546	468.40775	630380	0	...	0.000000	0.000000	0	0.000000	0.000000	0	
2	25	36	081	36081	Queens County, New York	NYC	178.03032	108.76805	2230722	0	...	1864.166774	11.461840	35072	3689.568791	6.395127	0	
3	2	09	005	09005	Litchfield County, Connecticut	CT	944.55528	920.56844	189927	0	...	0.000000	0.000000	0	0.000000	0.000000	0	
4	19	36	027	36027	Dutchess County, New York	MHV	825.34308	795.63519	297488	0	...	132.008047	104.218251	0	0.000000	0.000000	0	

5 rows × 223 columns

In [35]:
```
#plot the county boundary
tracts.plot(figsize=(12,10))
```

Out[35]: <matplotlib.axes._subplots.AxesSubplot at 0x7f8f8513fd00>



In [36]:
```
#map changing of housing units in the value category of more than $1,000,000 by merging the dataframe with county boundary dataframe
cbtop1m=tracts.merge(temp,on="FIPS")
cbtop1m.head()
```

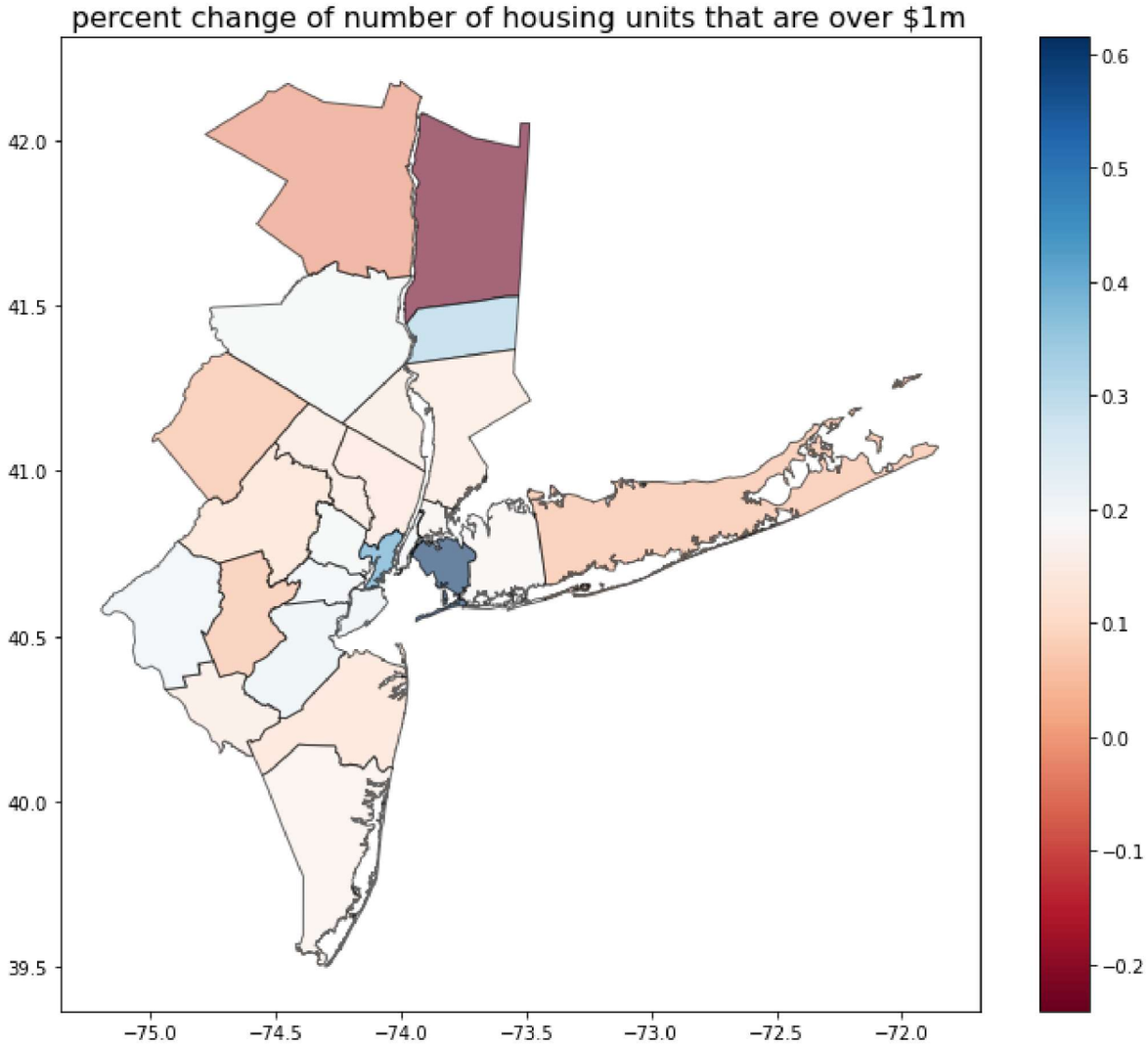
Out[36]:

	cartodb_id	statefp	countyfp	geoid	name	subregid	atotal	aland	pop_10e	pop_10m	...	iscomnycwo	geometry	FIPS	Value	Name	count1	year1
0	10	34	025	34025	Monmouth County, New Jersey	ONJ	665.31546	468.40775	630380	0	...	1	MULTIPOLYGON (((-73.99367 40.23651, -73.99377 ...	34025	$1,000,000 or more	Monmouth County, New Jersey	8041	2014
1	25	36	081	36081	Queens County, New York	NYC	178.03032	108.76805	2230722	0	...	1	MULTIPOLYGON (((-73.83039 40.60801, -73.83033 ...	36081	$1,000,000 or more	Queens County, New York	9148	2014
2	19	36	027	36027	Dutchess County, New York	MHV	825.34308	795.63519	297488	0	...	1	POLYGON ((-73.48731 42.04964, -73.48731 42.049...	36027	$1,000,000 or more	Dutchess County, New York	1271	2014
3	27	36	087	36087	Rockland County, New York	LHV	199.33864	173.50381	311687	0	...	1	POLYGON ((-73.90268 40.99730, -73.90268 40.997...	36087	$1,000,000 or more	Rockland County, New York	1693	2014
4	21	36	059	36059	Nassau County, New York	LI	453.47308	284.80991	1339532	0	...	1	MULTIPOLYGON (((-73.61637 40.59684, -73.61620 ...	36059	$1,000,000 or more	Nassau County, New York	24957	2014

5 rows × 230 columns

In [37]:
```
#plot it
figtop1m=cbtop1m.plot(figsize=(12,10),
    cmap='RdBu',
    column='change',
    legend = True,
    edgecolor='Black',
    alpha=0.6)

plt.title('percent change of number of housing units that are over $1m',fontsize=16)
```

Out[37]:
```
Text(0.5, 1.0, 'percent change of number of housing units that are over $1m')
```


percent change of number of housing units that are over $1m
42.0
41.5
41.0
40.5
40.0
39.5
−75.0
−74.5
−74.0
−73.5
−73.0
−72.5
−72.0
0.6
0.5
0.4
0.3
0.2
0.1
0.0
−0.1
−0.2

In [38]:
```
#map changing of housing units in the value category between $500,000 to $999,999 by merging the dataframe with county boundary dataframe
cbtophalf=tracts.merge(temp2,on="FIPS")
cbtop1m.head()
```

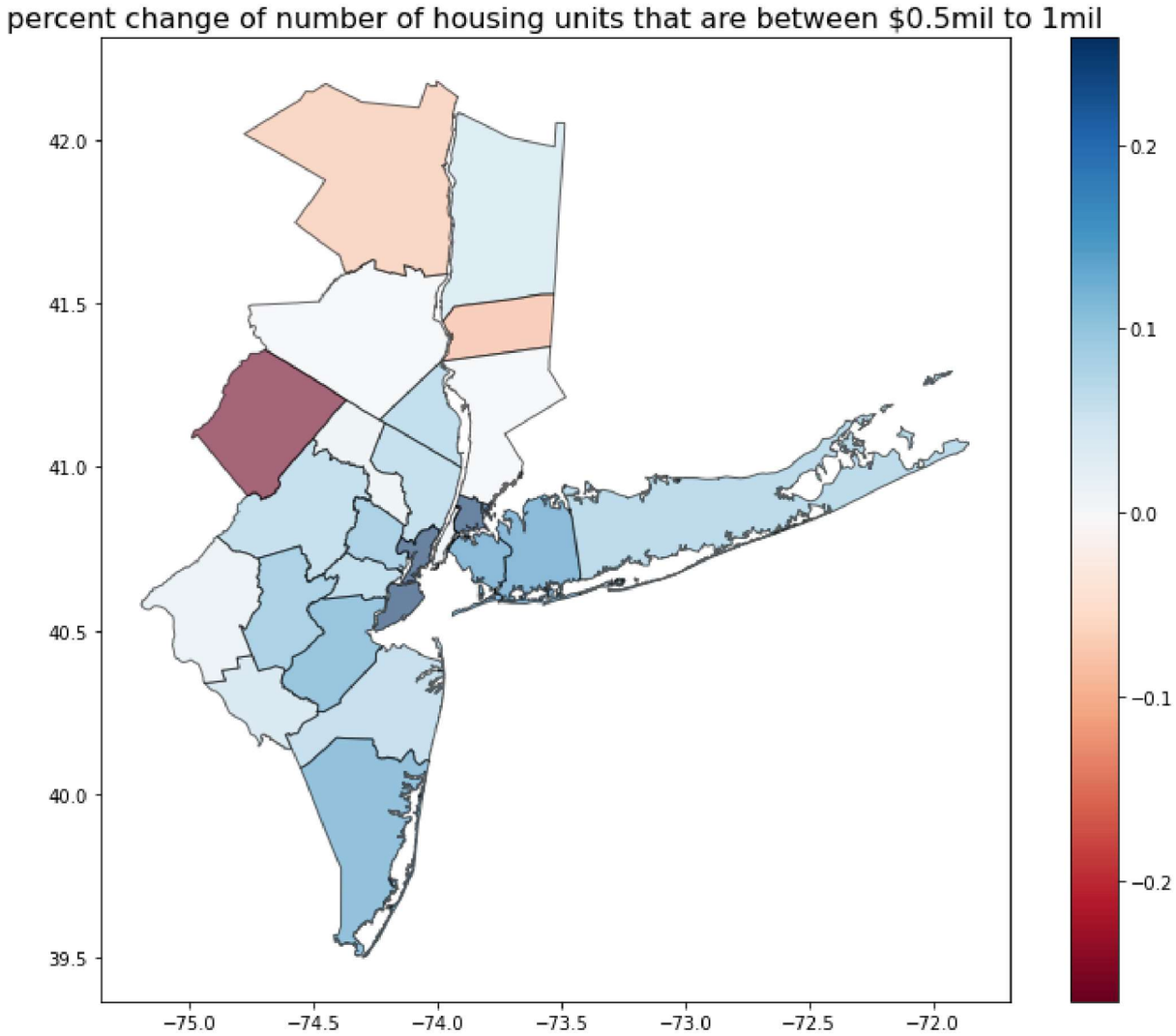
Out[38]:

	cartodb_id	statefp	countyfp	geoid	name	subregid	atotal	aland	pop_10e	pop_10m	...	iscomnycwo	geometry	FIPS	Value	Name	count1	year1
0	10	34	025	34025	Monmouth County, New Jersey	ONJ	665.31546	468.40775	630380	0	...	1	MULTIPOLYGON (((-73.99367 40.23651, -73.99377 ...	34025	$1,000,000 or more	Monmouth County, New Jersey	8041	2014
1	25	36	081	36081	Queens County, New York	NYC	178.03032	108.76805	2230722	0	...	1	MULTIPOLYGON (((-73.83039 40.60801, -73.83033 ...	36081	$1,000,000 or more	Queens County, New York	9148	2014
2	19	36	027	36027	Dutchess County, New York	MHV	825.34308	795.63519	297488	0	...	1	POLYGON ((-73.48731 42.04964, -73.48731 42.049...	36027	$1,000,000 or more	Dutchess County, New York	1271	2014
3	27	36	087	36087	Rockland County, New York	LHV	199.33864	173.50381	311687	0	...	1	POLYGON ((-73.90268 40.99730, -73.90268 40.997...	36087	$1,000,000 or more	Rockland County, New York	1693	2014
4	21	36	059	36059	Nassau County, New York	LI	453.47308	284.80991	1339532	0	...	1	MULTIPOLYGON (((-73.61637 40.59684, -73.61620 ...	36059	$1,000,000 or more	Nassau County, New York	24957	2014

5 rows × 230 columns

In [39]:
```
figtophalf=cbtophalf.plot(figsize=(12,10),
    cmap='RdBu',
    column='change',
    legend = True,
    edgecolor='Black',
    alpha=0.6)

plt.title('percent change of number of housing units that are between $0.5mil to 1mil',fontsize=16)
```

Out[39]:
```
Text(0.5, 1.0, 'percent change of number of housing units that are between $0.5mil to 1mil')
```


percent change of number of housing units that are between $0.5mil to 1mil
42.0
41.5
41.0
40.5
40.0
39.5
−75.0
−74.5
−74.0
−73.5
−73.0
−72.5
−72.0
0.2
0.1
0.0
−0.1
−0.2

In [40]:
```
cbtop3to5=tracts.merge(temp3,on="FIPS")
cbtop3to5.head()
```

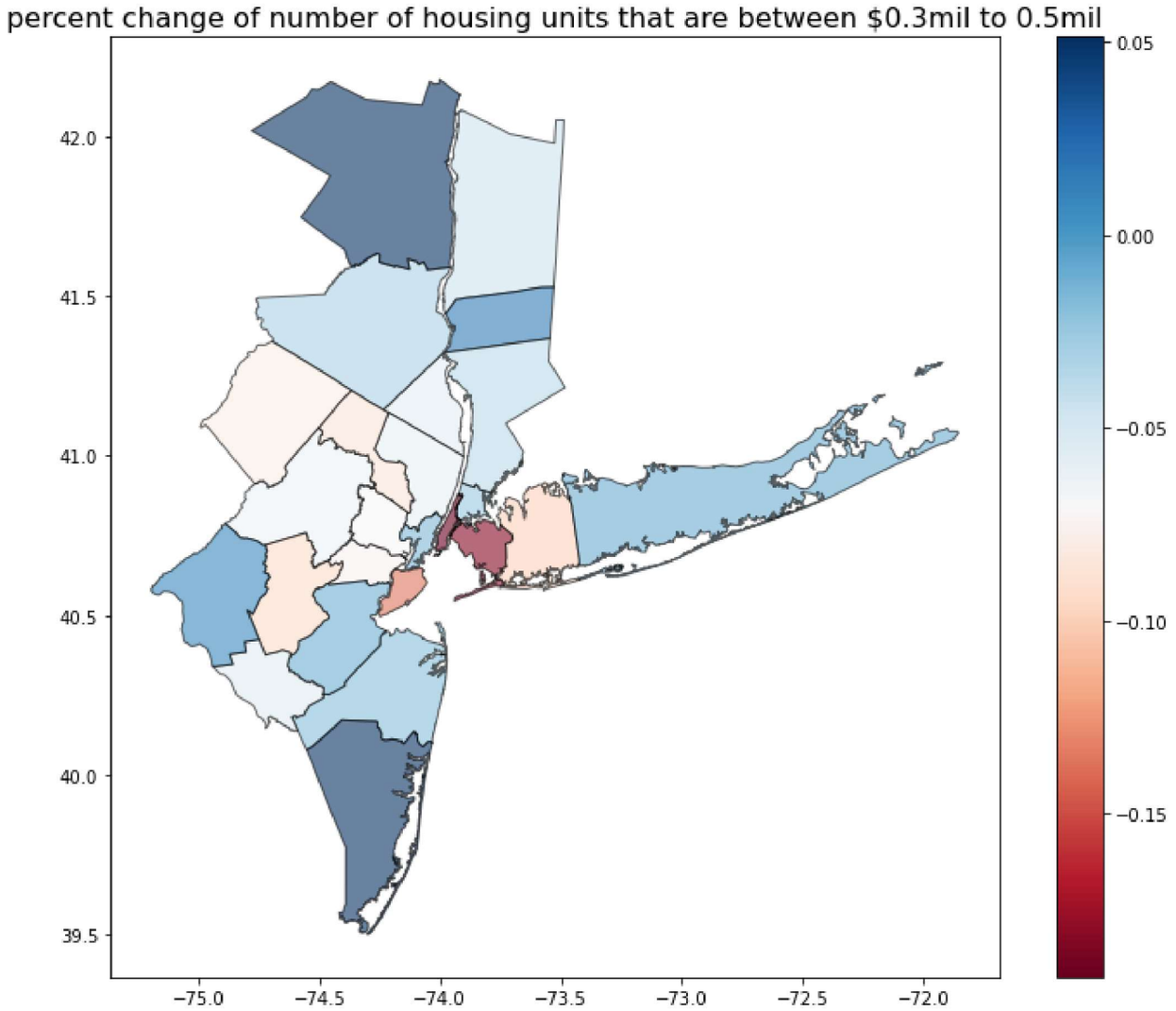
Out[40]:

	cartodb_id	statefp	countyfp	geoid	name	subregid	atotal	aland	pop_10e	pop_10m	...	iscomnycwo	geometry	FIPS	Value	Name	count1	year1	c
0	10	34	025	34025	Monmouth County, New Jersey	ONJ	665.31546	468.40775	630380	0	...	1	MULTIPOLYGON (((-73.99367 40.23651, -73.99377 ...	34025	300,000to 499,999	Monmouth County, New Jersey	68783	2014	6
1	25	36	081	36081	Queens County, New York	NYC	178.03032	108.76805	2230722	0	...	1	MULTIPOLYGON (((-73.83039 40.60801, -73.83033 ...	36081	300,000to 499,999	Queens County, New York	120386	2014	1(
2	19	36	027	36027	Dutchess County, New York	MHV	825.34308	795.63519	297488	0	...	1	POLYGON ((-73.48731 42.04964, -73.48731 42.049...	36027	300,000to 499,999	Dutchess County, New York	25104	2014	2
3	27	36	087	36087	Rockland County, New York	LHV	199.33864	173.50381	311687	0	...	1	POLYGON ((-73.90268 40.99730, -73.90268 40.997...	36087	300,000to 499,999	Rockland County, New York	33371	2014	3
4	21	36	059	36059	Nassau County, New York	LI	453.47308	284.80991	1339532	0	...	1	MULTIPOLYGON (((-73.61637 40.59684, -73.61620 ...	36059	300,000to 499,999	Nassau County, New York	175206	2014	15

5 rows × 230 columns

In [41]:
```
figtophalf=cbtop3to5.plot(figsize=(12,10),
    cmap='RdBu',
    column='change',
    legend = True,
    edgecolor='Black',
    alpha=0.6)

plt.title('percent change of number of housing units that are between $0.3mil to 0.5mil',fontsize=16)
```

Out[41]:
```
Text(0.5, 1.0, 'percent change of number of housing units that are between $0.3mil to 0.5mil')
```



Conclusion about housing price

From the data exploration and analysis of housing value in 2014 and 2018, all counties experienced some changes in housing price. For counties close to New York County (NYC), there is an increase in housing units with higher price (higher than $500,000$), $and decrease in housing units with lower price (below$ 500,000).

Specifically, counties near New York County (NYC) experienced the highest increase in housing units in the more than $1 million value category. Queens county increased more than 60%, Kings county increased 53.7%, Hudson County(across from NYC) increased 41.9%, and the further aweay Putnam County increased 32.7%.

Similar geographic pattern of increase holds true for the value category between $500,000 to 999,999$. In Hudson County, which is located across from New York County (NYC), housing units between $500,000 to 999,999$ increased 25.8%, Richmond County, which is located mainly in Staten Island (below NYC), units increased 25.7%, and in Bronx, which is above NYC, housing units increased 25.2%. In counties further away from New York County, there is also a significant but smaller increase in housing units in the $500,000 to 999,999$ value category.

For lower value categories, the housing units near New York County experienced an overall decine in number of units, ranging from minor to significant decrease. Kings County (Brooklyn) experienced 29.2% decrease in housing units within this value category, New York county itself experience 19.2% decrese, Queens County experience 18.2% decrease, and Richmond County experience 13.7% decrease. However, there are some counties nearby that experience a minor descrease as well. For counties further away from NYC, some experienced a minor decrease and some experienced a minor increase of housing units in this value category.

Conclusion on housing affordability and housing value in NYMA between 2014 and 2018

In this data exploration and analysis notebook, I conducted basic data exploration of housing affordability datasets, housing value datasets and county boundary datasets. I analyzed and mapped housing affordability anbd housing value in 2014 and 2018 across 31 counties in New York Metro Area. In the future weeks during this quarter, I will conduct more analysis on the impact of migration on housing price and affordability in NYMA.