

# Migration, Transit, and Their Impacts on Local Regions

Study of New York Metro Area (NYCSA)

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## Introduction

Moving to another city or to the suburbs? This is a question about the two types of migration: inter-regional and intra-regional migration. The first one refers to long-distance moving that is more commonly discussed and generally associated with the relocation choices of jobs. The second one is rather relatively short-distance mobility that is more often seen in the real world and associated with the commuting choices between job and life. Intra-regional migration takes up the majority of relocation activities because the traditional relationship between living and working limits the level of mobility for each individual. Particularly during today's COVID-19 pandemic, the exodus from cities becomes trendier for many individuals and families, and there's increasing uncertainty about the future workstyle, which potentially further increases the intra-regional migration activities.

## Research Questions

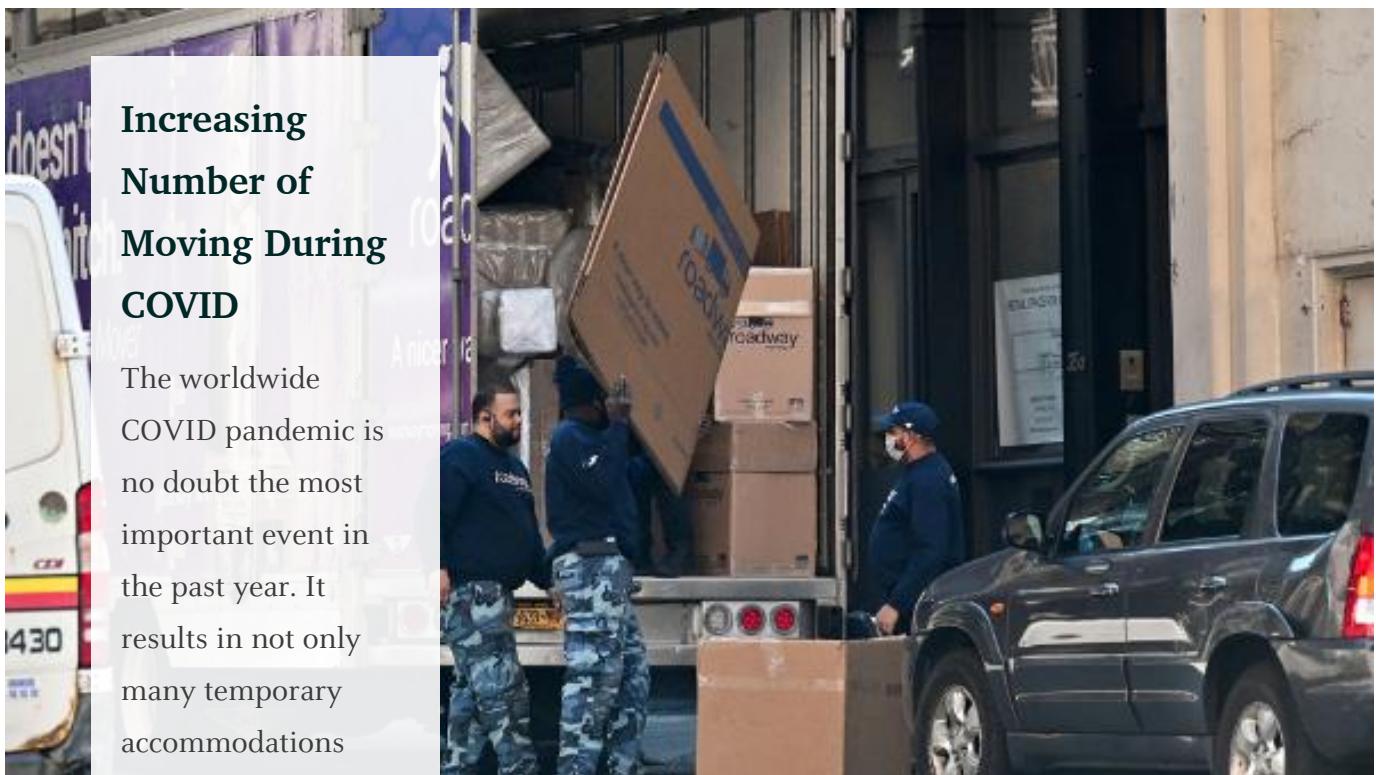
This project is particularly concerned about intra-regional migration, transit, and their impacts on local economic and housing conditions.

*Specifically, the first research question the project is to explore is the relationship between intra-regional migration and regional transit infrastructure is. The second question is how migration and transit affect and are impacted by local demographics, economic, and housing conditions.*

We hope the findings from this project will provide policy implications for the planners and the policymakers to better respond and manage future migration activities. As mobility grows, they could actively use transportation networks as a tool to manage migration and prevent people from leaving.



## Background



## Increasing Number of Moving During COVID

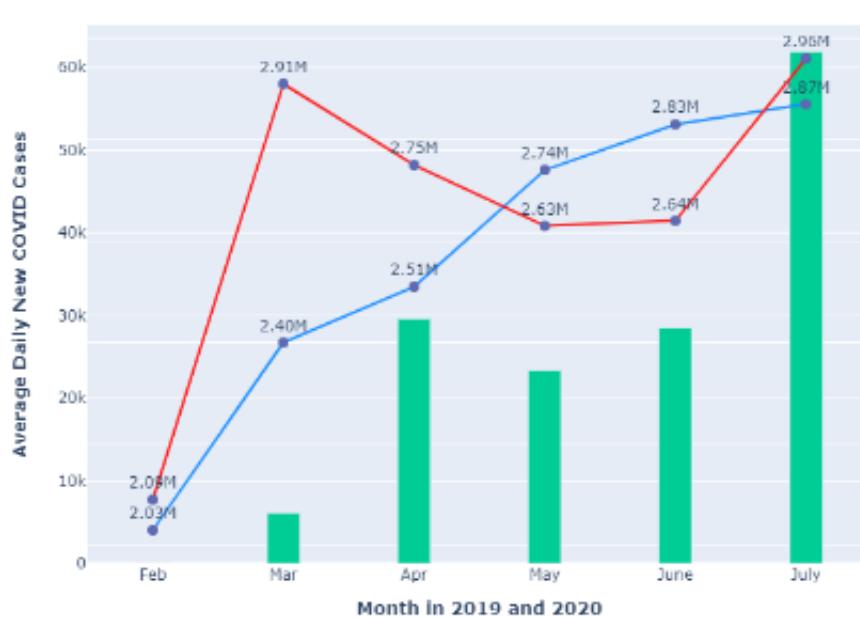
The worldwide COVID pandemic is no doubt the most important event in the past year. It results in not only many temporary accommodations such as the shutdown of many businesses and, more devastatingly, some structural changes such as the transition to work from home. Moving is one of the most trends seen amid the pandemic. No requirement of physical presence on the job sites, concerns about widespread of the virus in dense urban cores, limited transportation options, and many other factors make staying in mega-

metro less economic and comfortable.

*Photo:*

<https://wjla.com/news/nation-world/covid-19-pandemic-crime-worries-appear-to-fuel-exodus-from-us-cities>

The National Number of Moving in 2019 and 2020



## Moving Population 2019 vs COVID

As the chart below illustrates, at the beginning of the COVID cases surge, the US saw a significant jump in moving. The relatively higher moving activity is seen for the early months when the pandemic was uncertain.

\*Data was acquired from MyMove.com (Bowman, 2021)

### Top 5 States for Net Gain and Top 5 States for Net Loss of Moving



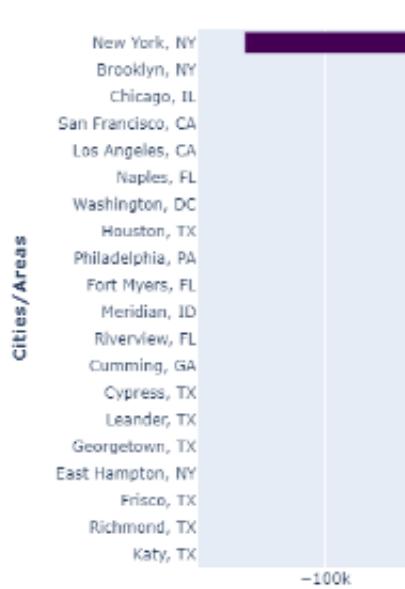
## Top List of Net Moving by State

Each place responded to the moving trend differently. The traditional major metros such as New York and California were suffering the big outflow of moving, while the growing metro regions such as many Texas gained the migration inflows. The following graph shows the top 5 states with inflow and outflow in this COVID moving trend.



*\*Data was acquired from MyMove.com (Bowman, 2021)*

### Top 5 Cities/Areas for Net Gain and Top 5 Cities/Areas for Net Loss of Moving



## Top List of Net Moving by City

Likewise, the mega metros such as New York City and Los Angeles lost residents in many times of other metros, while many Texas's cities welcomed the people in, as the figure below presents.



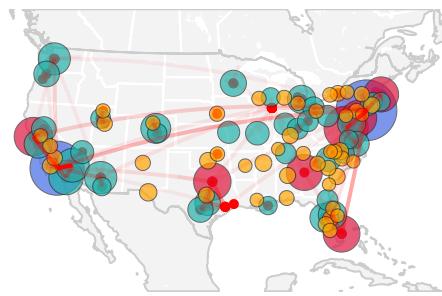
*\*Data was acquired from MyMove.com (Bowman, 2021)*



## Overall U.S. Migration Characteristics

***"Hot Spots" of Migration Outflow.*** Migration is ongoing of the population moving either across the states or within the same regions. Aligned with what is observed during the pandemic time, mega-metro regions such as New York and Los Angeles lost the most people in terms of migration outflow. In addition, the major outflow paths are usually associated with the trips between those top metros. There are generally two types of migration outflow paths: the moving between metros and the moving of smaller metros to larger ones.

0 Metro with Most Migration Outflow in 2018 and Major Migration Flows in the US



Data was acquired from US Census; data is visualized by Plotly.Express.

## Transit and

### Migration

New York Metro Area also has the most extensive transit network in the country with the largest daily commuter population (NYC Planning, 2019). What does this mean for migration? Will be ease of commute encourage people to move away from the city center? Or does the agglomeration and accessibility of the city retain some population? We are curious about the role of the rail system on migration.

*Photo:*

<https://www.tripsavvy.com/mini-guide-to-nyc-penn-station-2286764>



## Transit, migration, and Housing and Economic Characteristics

Considering the migration trend in the New York Metro Area and the potential impact of transit networks in attracting migration,

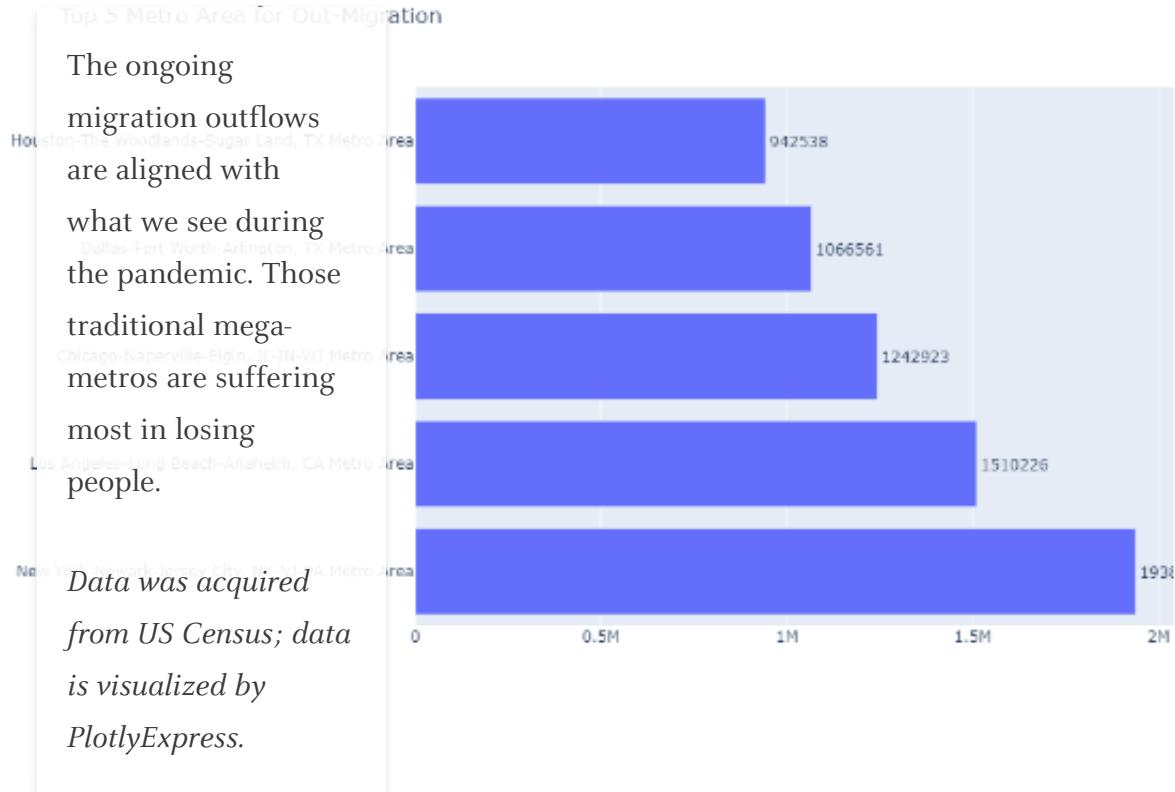
we are curious to explore the impacts of the incoming population to a county on its housing and economic factors. We ask questions such as does the economy grow with more migration? Is there a decrease in housing affordability in places with high migration and a high transit density?

*Photo:*

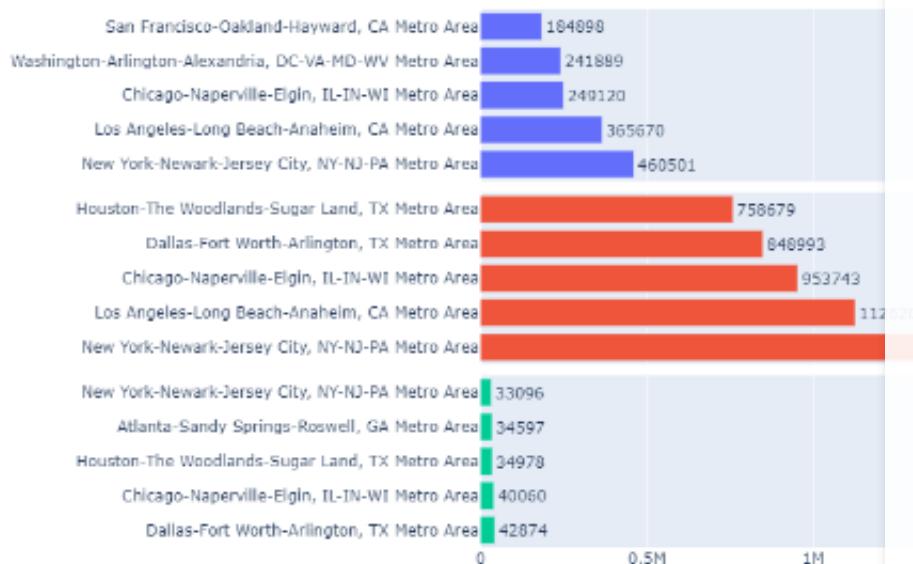
<https://www.politico.com/states/new-jersey/story/2017/12/20/murphy-light-on->



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### Top 5 Metro Area for Out-Migration



### Majority of Intra-Regional Moving

The majority of migration is intra-regional moving instead of inter-regional moving – people are more willing to move within the same metro than relocating themselves to far-away places.

*Data was acquired from US Census; data is visualized by PlotlyExpress.*



## Method

### Data Sources

There are mainly two types of data we are engaging with. The first one is geo-data (mainly SHP and JSON files) that contains geographic coordinators that we can use to map the data. The second one is various census-related data (dominantly CSV files) that we work with to process the findings.

In addition, those data are grouped into seven topics:

- ***Base maps of County and Metro Borders:*** The coordinators for the county borders and metro regions are collected in these datasets, which are used as the “structure” to match with other non-geo-data so that we can visualize and map the findings. [[US Census Geography Division](#)]
- ***Moving Trend During the COVID Pandemic:*** The findings from the existing research of MyMove are re-visualized. [[MyMove.com](#)]
- ***Transportation Network Data:*** The data of all railway transit lines and stations in NYCSA are collected and processed to present the relationship between migration trend and transit station density on the county level. [MTA Metro-North and Long Island Railroads: [UC Berkeley Library GEODATA](#)] & [New Jersey Transit: [NJKIN Open Data](#)]
- ***Migration Data:*** The data of migration flows are collected from the US Census’s American Community Survey 5-Year Data, combined with geo-data, to present migration patterns in the region. [[County Migration Flow](#)] & [[Metro Migration Flow](#)]
- ***Demographics Data:*** The data of key demographics metrics for 2014 and 2018 are collected from US Census’s American Community Survey 5-Year Data to represent the demographics aspects of changes across NYCSA. [[US Census, Population and People](#)]
- ***Economic Data:*** The data of key economic metrics for 2014 and 2018 are collected from US Bureau of Economic Analysis to represent the key economic indicators. [[US Bureau of Economic Analysis](#)]
- ***Housing Data:*** The data of key housing metrics for 2014 and 2018 are collected from the US Census’s American Community Survey 5-Year Data to represent the housing aspects of changes. across NYCSA. [[US Census, Housing Characteristics](#)]

## Analytical Procedures

***Selection for Study Area and Scale of Study:*** The project starts with the overall migration trend at the national level both in today’s pandemic time period and in previous years (2014&2018). Due to the limited access to the moving data during the COVID time, the findings from the existing research of MyMove are reproduced and re-visualized to respond to present a current moving condition due to COVID.

Migration outflows and inflows on both county and metro levels in 2014 and 2018 are collected from US Census's American Community Survey 5-Year Data, combined with geo-data, to present migration patterns in the region. Based on the high-level migration study, New York Metro Area (NYCSA) is found to be one of the largest migration hubs. Also, NYCSA has several busiest and most comprehensive transit networks in the US. Therefore, NYCSA at the county level is selected to be this project's study area.

***Planning of Research Process:*** The research is divided into two parts (responding to two research questions) and four steps. The first step is to explore the migration inflow and outflow and transit network analysis within the region. The second step to perform the correlation and regression tests to understand the underlining relationship between migration and transit. The third step, which is to present and compare the demographics, economic, and housing indicators in 2014 and 2018, starts to answer the second research question of how transit and migration affect the local conditions. The very last step is to perform correlation and regression tests among migration flows, transit density, and the changes of all key metrics to conclude the findings of the relationship.

***Analysis of Intra-Regional Migration and Transit:*** Zooming into the NYCSA and focusing on the year 2018, both data analyses adopt county-level data. For transit data, the transit density is calculated by dividing transit station(s) in each county by the county's land area. For migration pattern in the region, the two-direction flows – inflow and outflow – are both calculated and mapped spatially to present how population moves around.

***Analysis of Demographics, Economic, Housing Metrics:*** Demographics, economic, and housing aspects are selected to represent the local condition in a relatively comprehensive way. Under each category, several metrics are further selected for the study.

- **For demographics metrics**, the number of railway commuters, total population, median age, education attainment, the number of work-at-home workers are selected. Each data in 2014 and 2018 are

collected and processed to understand who are potentially in the migration group and what demographic characteristics change after the migration happens.

- **For economics metrics**, GDP, real income, and the number of jobs are selected. The data in 2014 and 2018 are collected to understand both city level and individual level are affected by the migration flows.
- **For housing metrics**, the values and the number of owned units, the rent and the number of rental units, and the burdens of housing units for each category are selected. The 2014 and 2018 data are collected to represent the housing aspects of changes. Particularly, the affordability analysis is the focus: affordable housing units as "Selected Monthly Owner Costs as a Percentage of Household Income (SMOCAP) less than 30 percent" ([U.S. Census Bureau](#)). By this standard, the SMOCAP columns in 2014 and 2018 are combined to calculate the change of total percentage of housing units with SMOCAP less than 30 percent in each county. The same procedure is repeated to measure housing affordability change for rental housing units

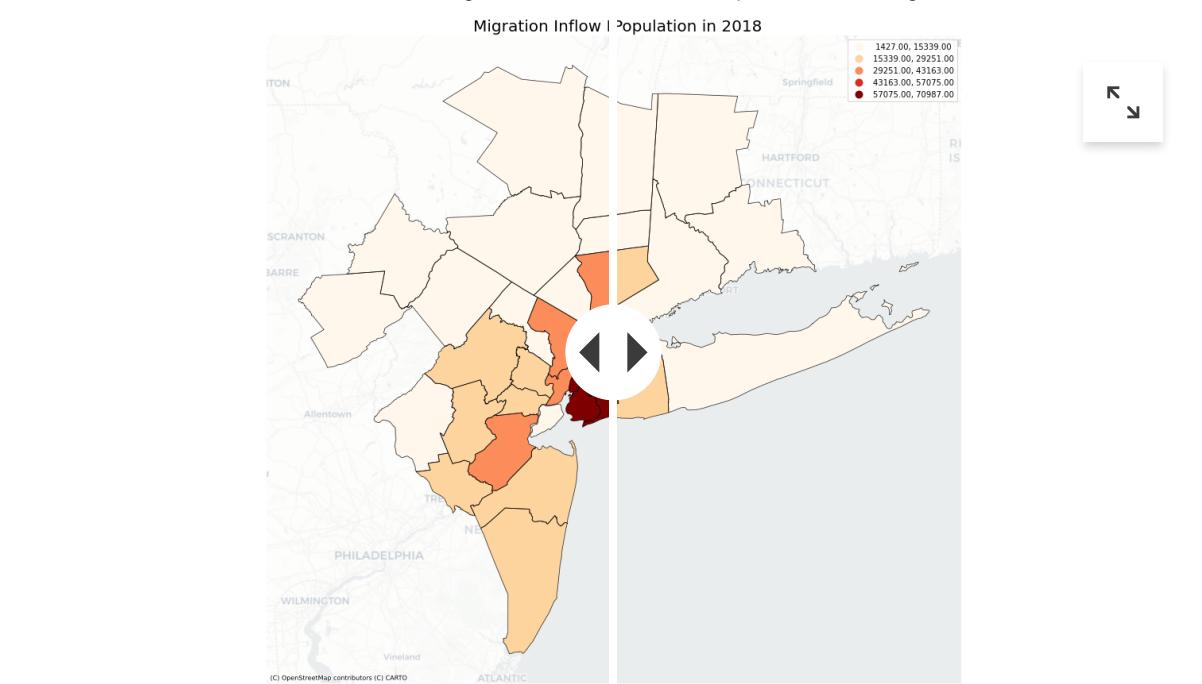


## Results

### Migration Analysis

In general, the migration of either inflow or outflow is more frequent in the areas that close to Manhattan than the far-away regions. Also, the migration is usually in positive numbers – meaning the outflows usually outweigh the inflows in most of the regions and indicating negative population growth. Particularly, the outflows are more concentrated in Manhattan, while the inflows are more spread out. The following graphs are in the comparison between the inflows and the outflows in NYCSA.

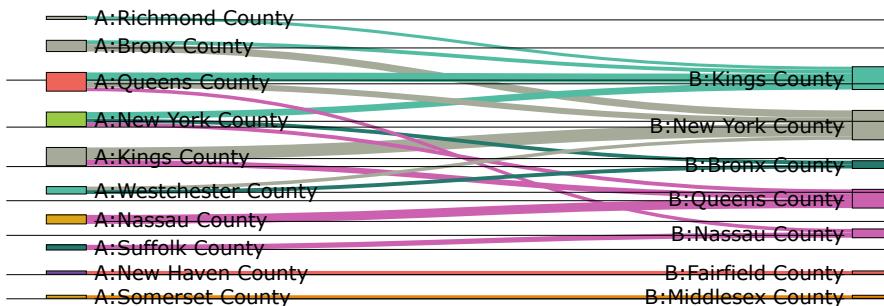
## Migration, Transit, and Their Impacts on Local Regions



Data was acquired from US Census; data was visualized by Matplotlib.

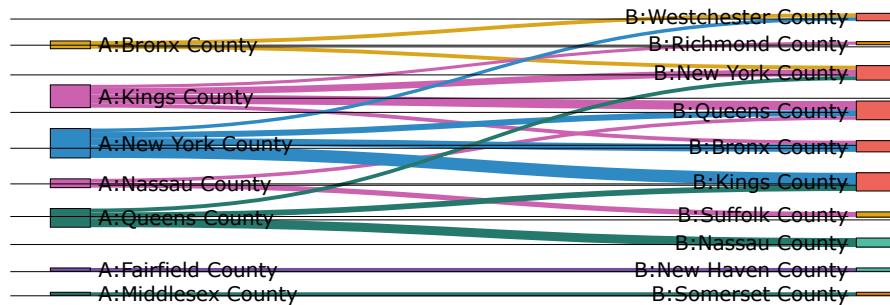
The following two interactive Sankey diagrams illustrate the inflows and the outflows of migration within NYCSA. New York City (its five counties) is on the top list for both inflow and outflow, indicating its high mobility and sorting effects. Notably, the outflows are usually larger than the inflows; this more likely leads to the population decreases if there's also a small portion of cross-regional or cross-countries migration.

### Top County to County Migration Inflows (B to A) in NY Metro (Inflow>5000 pec)



Data was acquired from US Census; data was visualized by Plotly.Express.

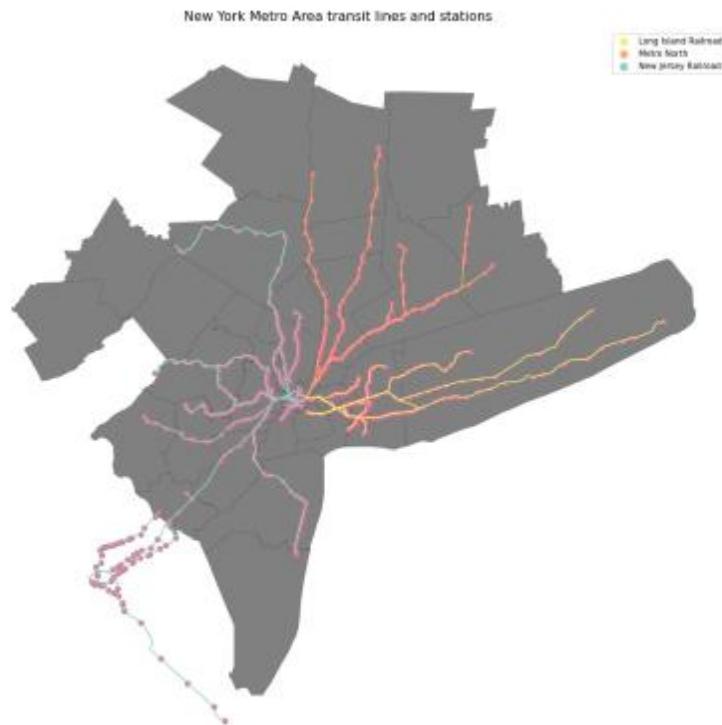
### Top County to County Migration Outflows (A to B) in NY Metro (Outflow>5000)



Data was acquired from US Census; data was visualized by Plotly.Express.

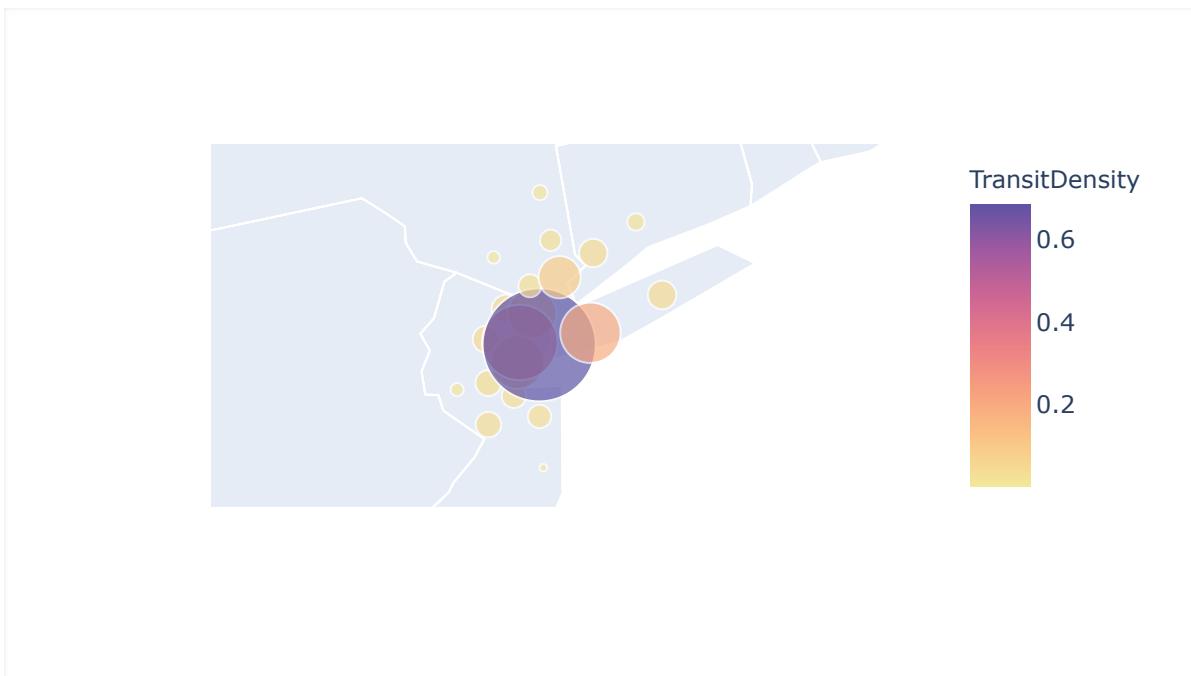
## Transit Analysis

As the following map illustrates, there are three major regional transit systems in NYCSA that serve the commuter population, including New Jersey Railroads, Metro-North Railroads, and Long Island Railroads. The network is very center-oriented: they mainly connect the surrounding counties in four states into the urban core – Manhattan.



Data from NJGIN Open Data, UC Berkely Library GEODATA, data is visualized by matplotlib

Transit accessibility is measured by calculating transit density – the number of the station in each county divided by the land areas. The density is illustrated in the following interactive map. The counties near New York City have higher transit density than counties further away, with Hudson County, NJ being the county in NYSCA with the highest transit density (0.69 stations per square mile).



Data from NJGIN Open Data, UC Berkely Library GEODATA, data is visualized by Plotly.Express

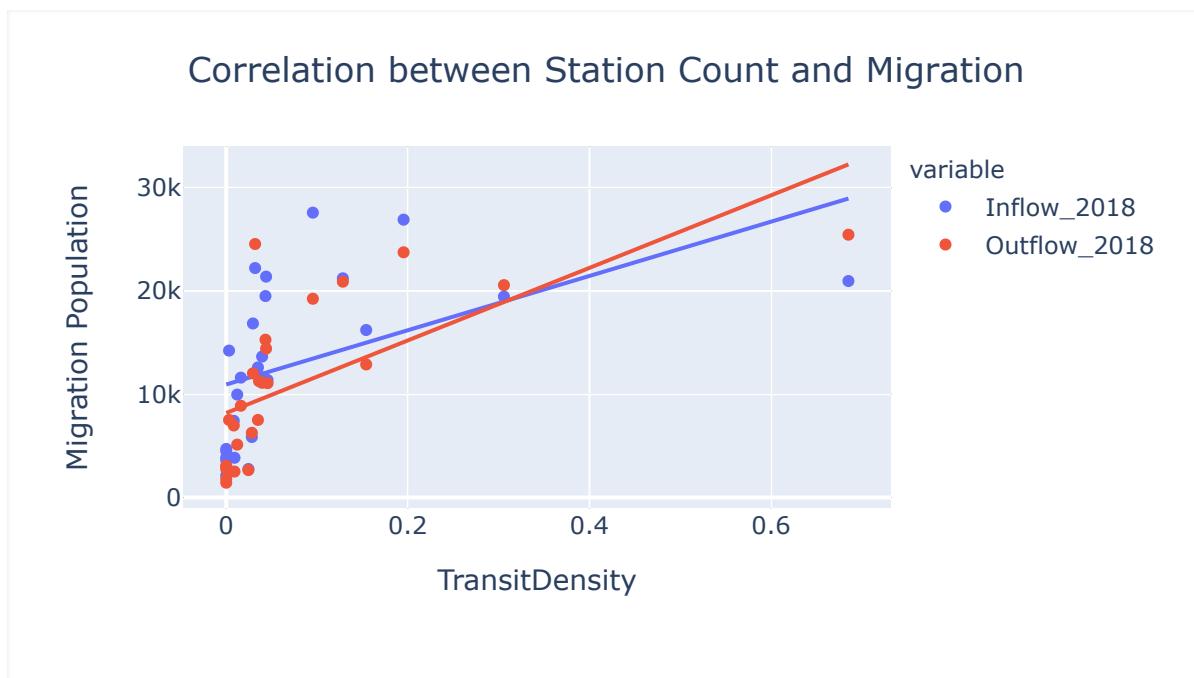
The standard deviation ellipse shows the spatial spread of points on the map. The maximum spread of transit stations is roughly in the northwestern-southeastern direction, and the minimum spread of transit stations is roughly in the southwester-northeastern direction.



Data from NJGIN Open Data, UC Berkely Library GEODATA, data is visualized by Seaborn

## Relationship Between Transit and Migration

There are significant relationships between transit density and migration inflow and outflow ( $p < .05$ ). As transit density in counties increases, both migration inflow, and outflow increase. Specifically, the migration outflow has a higher correlation with transit density.



Data from NJGIN Open Data, UC Berkely Library GEODATA, data is visualized by Plotly.Express

## Demographics, Housing, and Economic Analysis

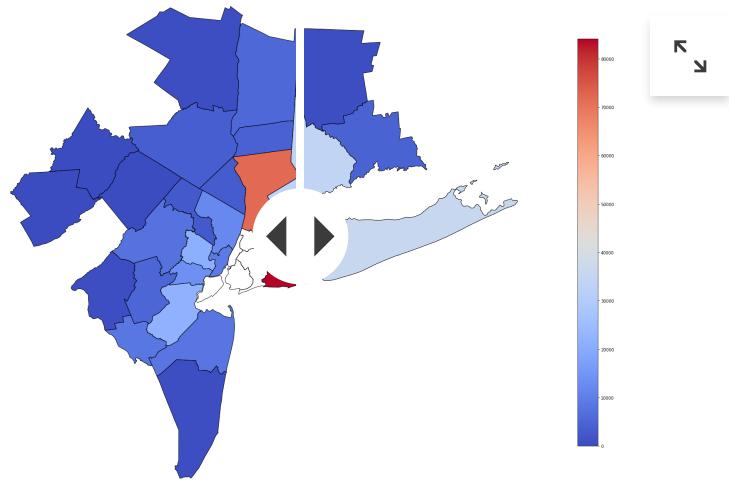
The data of key demographic, economic, and housing metrics in 2014 and 2018 were acquired and processed to explore how local conditions changed.

### Demographic Metrics

Five demographic metrics are selected in this project: total population, the number of commuters and homeworkers, age, and education level. Many populations are working from home in the north and northeastern part of the region. These counties also have larger populations and higher education levels. The commuter population is concentrated in counties in very close proximity to New York City. The counties near New York City generally have a younger population, compared to the counties further away. The following five comparisons illustrate all demographic metrics.

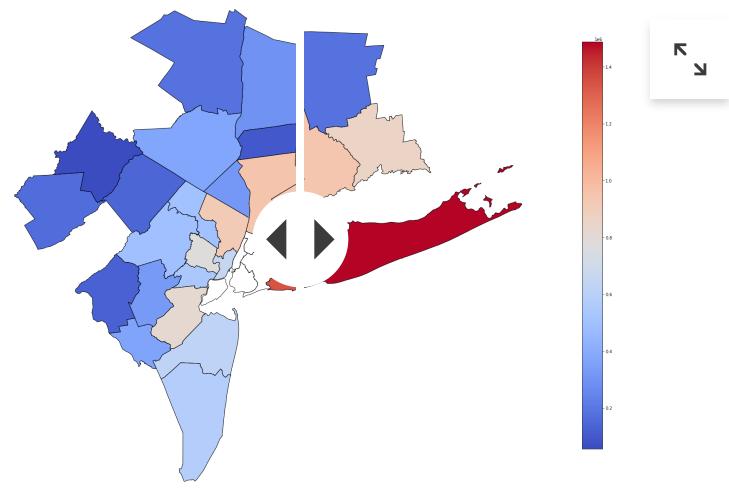
## Migration, Transit, and Their Impacts on Local Regions

Commuter20 8



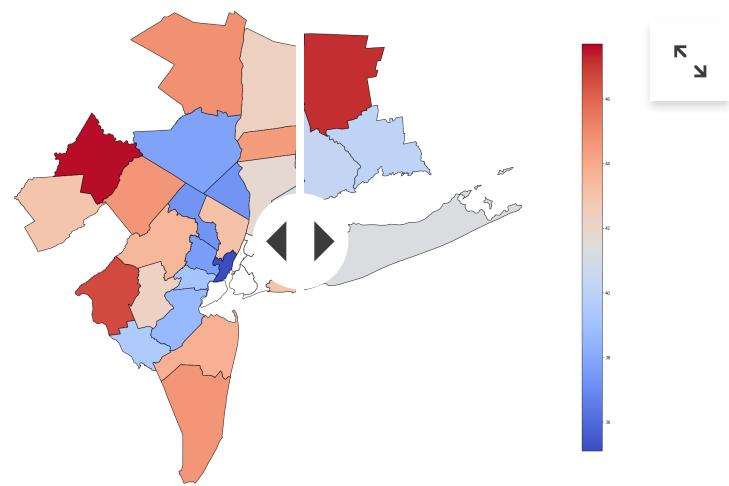
Data was acquired from US Census; data was visualized by Plotly.Express.

Population2018



Data was acquired from US Census; data was visualized by Plotly.Express.

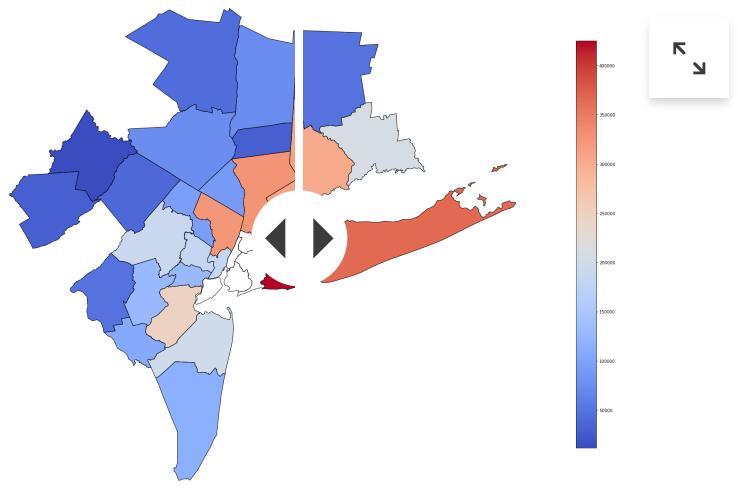
Age2014



Data was acquired from US Census; data was visualized by Plotly.Express.

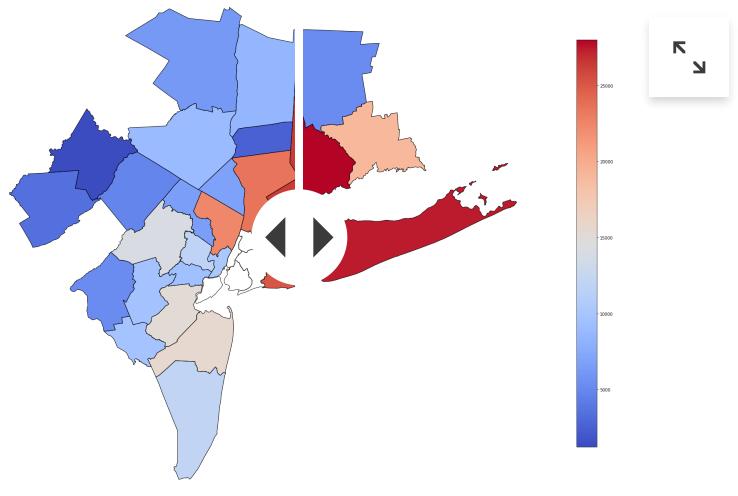
## Migration, Transit, and Their Impacts on Local Regions

Education20 8



Data was acquired from US Census; data was visualized by Plotly.Express.

Homeworker2 18



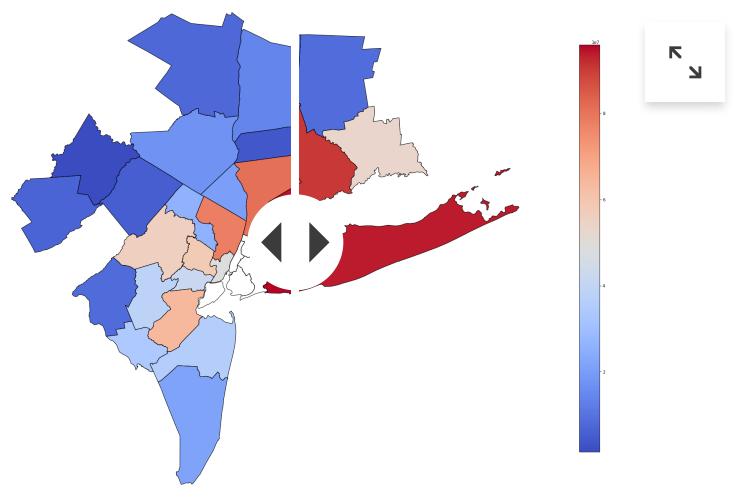
Data was acquired from US Census; data was visualized by Plotly.Express.

## Economic Metrics

Three critical economic indicators are used to evaluate the local changes: real income at the individual level and GDP and the number of jobs at the business scale. High GDP and jobs are generally located in counties near New York City. Income follows a similar pattern except that it is higher in counties further from New York City in the southwestern direction. The following three comparisons illustrate all economic metrics.

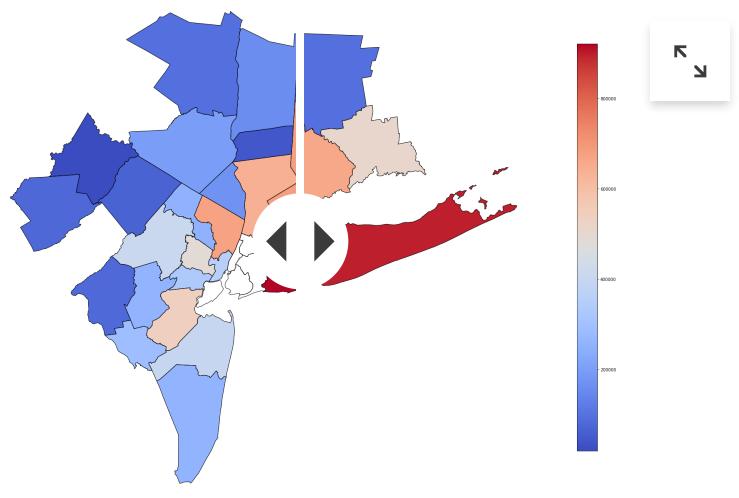
## Migration, Transit, and Their Impacts on Local Regions

GDP2014



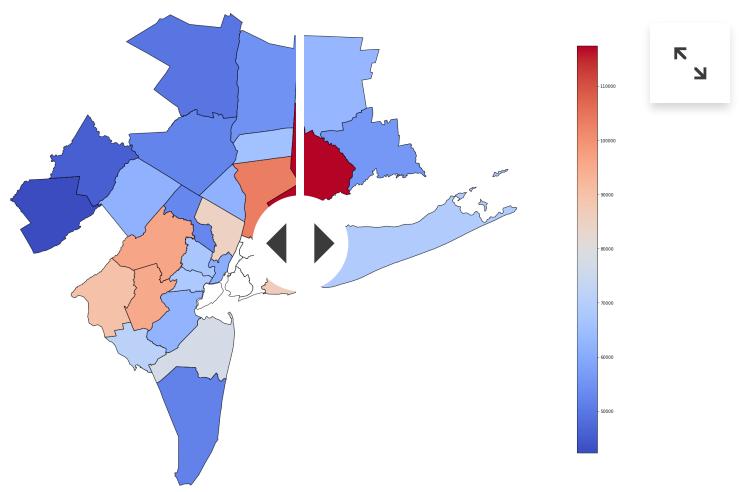
Data was acquired from US Census; data was visualized by Plotly.Express.

Job2014



Data was acquired from US Census; data was visualized by Plotly.Express.

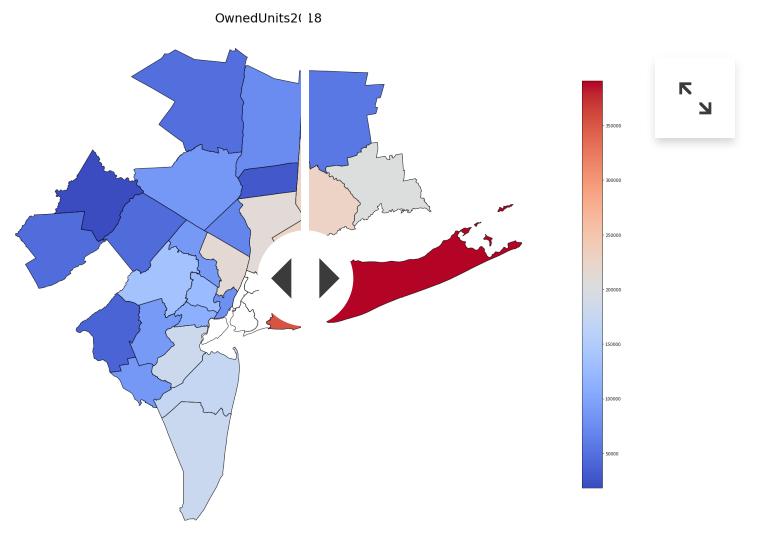
Income2011



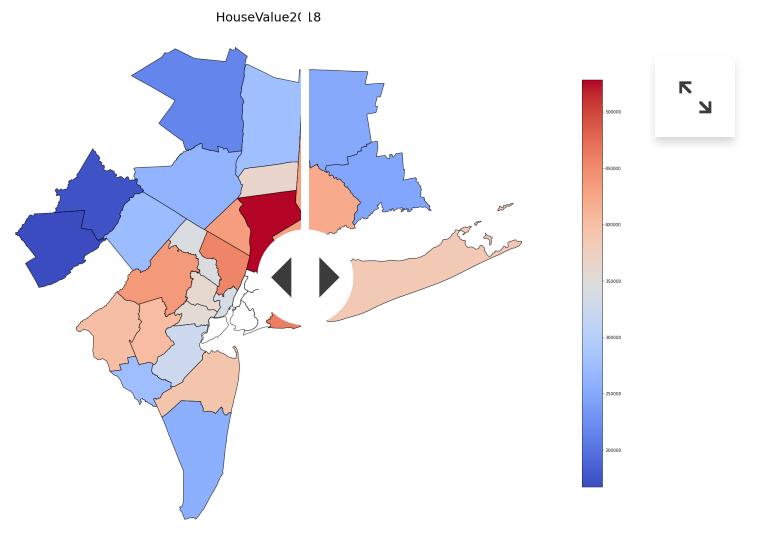
Data was acquired from US Census; data was visualized by Plotly.Express.

## Housing Metrics

A total of six metrics are selected to evaluate the housing changes in the region: the values and the number of owned units, the rent and the number of the rental units, and the affordability level for both types of units. In general, there are more owner-occupied units and rental units in counties near New York City. The housing value and rents decrease as the distance between the county and New York City increases. For owner-occupied units, they are more affordable in counties closer to New York City. However, there is no precise geographic distribution for affordable rental housing. The following six comparisons illustrate all housing metrics.



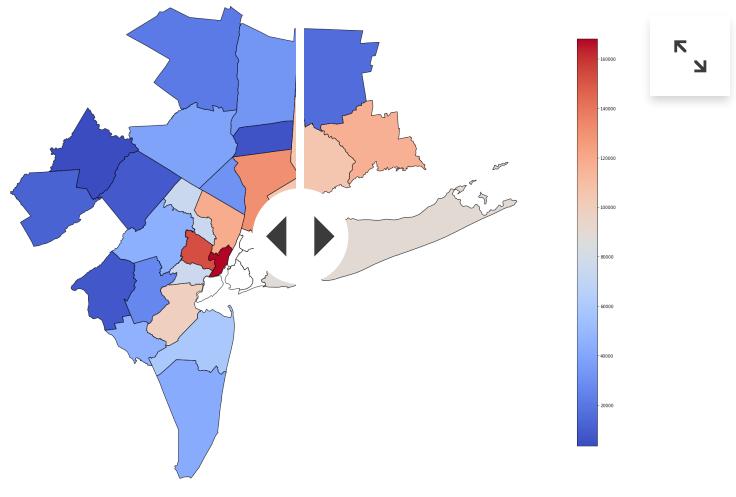
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Data was acquired from US Census; data was visualized by Plotly.Express.

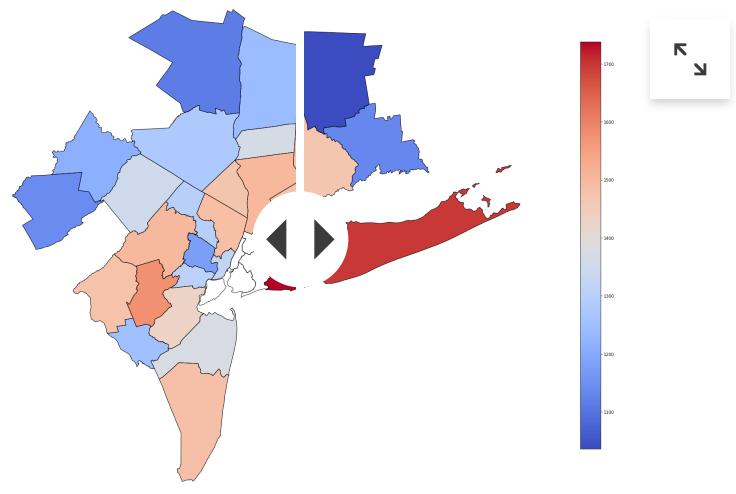
## Migration, Transit, and Their Impacts on Local Regions

RentalUnits2018



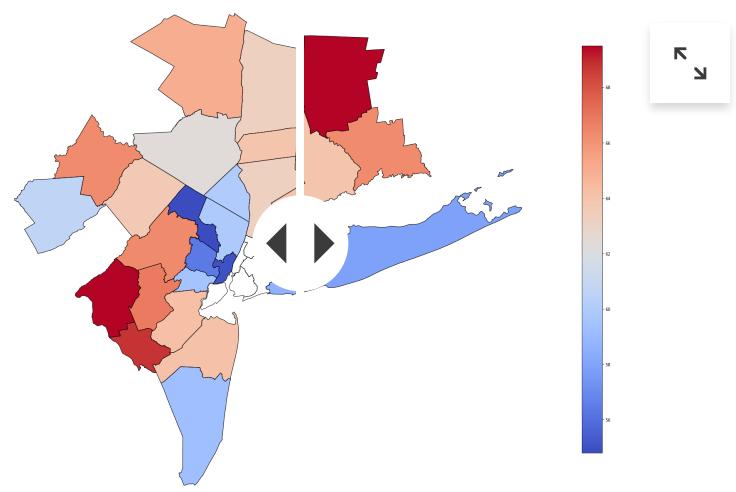
Data was acquired from US Census; data was visualized by Plotly.Express.

Rent2014

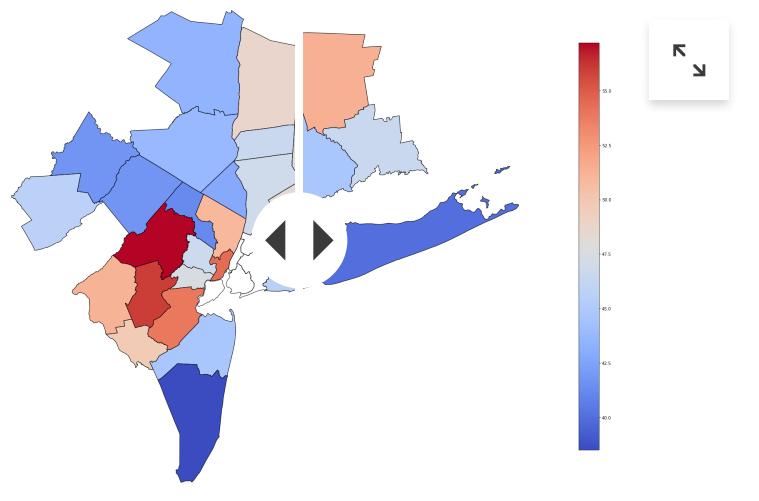


Data was acquired from US Census; data was visualized by Plotly.Express.

OwnedAffordability2018



Data was acquired from US Census; data was visualized by Plotly.Express.

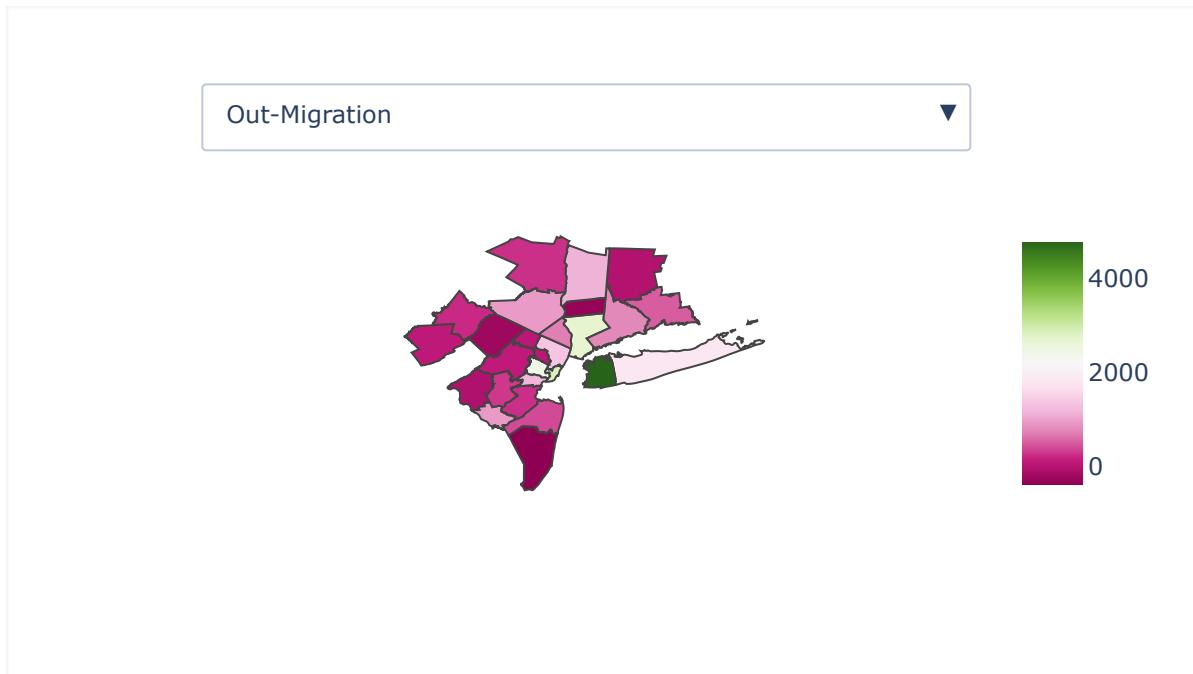


Data was acquired from US Census; data was visualized by Plotly.Express.

## Relationship Analysis

Two methods – spatial analysis and regression analysis - are used in this project to explore the relationships among the metrics. The findings are presented as follows:

### Spatial Comparison of All Metric Changes



The interactive map above illustrates that how the change of each selected metric is distributed spatially. There is no single pattern to describe the overall distributions across categories. The spatial

distribution of the changes is relatively discrete instead of gradually changed based on the proximity to the metro center of New York City.

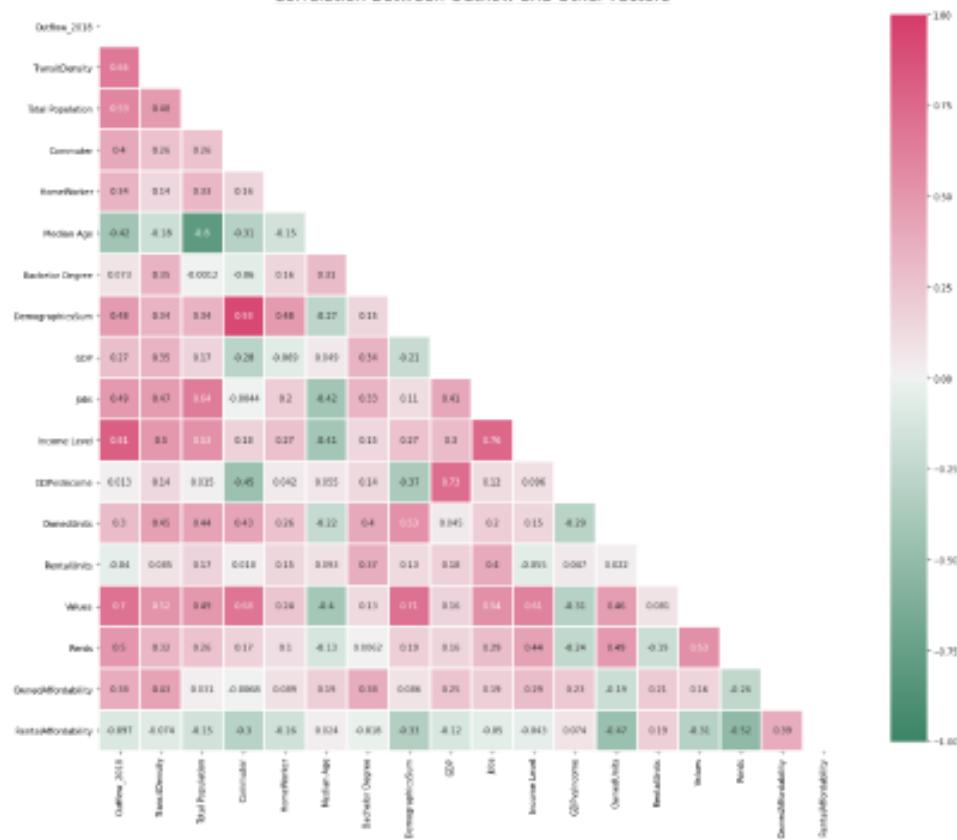
- *As for demographics*, the increased commuter populations concentrate on Metro-North and NJ Transit lines, compared to other routines. Also, Suffolk County might have a better transportation connection to NYC compared with many other more remote counties, where experienced most population decreases among all counties in the region. Surprisingly, Connecticut counties and Nassau County in Long Island, although seeing the most outflows, have increasing numbers of work-at-home workers.
- *As for economic metrics*, the growths are mostly seen in the northern portion of the region, and they are not in close proximity to NYC, potentially explaining a relatively low level of commuters. At the company and the government level, the GDP growth is widespread and spatially discretely distributed.
- *As for Housing Metrics*, all counties experienced different degrees of increase in owner-occupied housing affordability, the highest growth concentrated in the western and southwestern part of the region. Most counties have increased rental housing affordability, the counties experienced minor decrease are in the northern and southwestern parts of the region further away from New York City. Median rent increased in all counties.

### Regression Model of All Metrics

Correlation analysis is adopted in this project to explore the relationship between migration (both inflow and outflow), transit density, and various demographic, economic, and housing metrics.

### Correlation Between Outflow, Transit, and Key Local Metrics

## Correlation Between Outflow and Other Factors



Data was acquired from US Census; data was visualized by Seaborn.

Population outflow is positively related to all economic factors to different extents. The economy improves with more people moving out of a county and is represented by a high-income growth and a minor GDP increase. For housing, the number of owned units increases as more people move out of a state, and interestingly, while housing prices increase, the affordability also increases, which might be related to the increasing GDP. Conversely, there is a small decrease in the number of rental units, and while the rents grow, rental affordability decreases. This might be explained by the population inflow, which will be discussed below. The counties with a high outflow population experience a decrease in mean age, with an increase in total population and commuter population.

From the outflow population and its relationship with the indicators, we can conclude that a large population moving out does not necessarily lead to a population decrease. The age decreases as people leave means that either older people are moving out or young people are moving in. With the increasing commuter population, we can infer that many young working professionals move in than those who move

out. This is also reflected in the decreasing rental affordability and the increasing owned-housing affordability. The young working population might demand rental units, which drives up the rental price and decrease the affordability as the number of rental units remains the same. Their high-income jobs might contribute to the rising housing price and affordability.

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For migration and transit density, we observe from the correlation that a higher outflow population is related to a high transit density, which is supported by our previous analysis on the significant relationship between the two factors.

### Correlation Between Inflow, Transit, and Key Local Metrics

Population inflow shares similar correlational patterns with population outflow to transit, economic and demographic characteristics.

Population inflow to a county is positively correlated to all the economic factors. For housing, counties with large population inflow are likely to increase owner-occupied units, with the increasing housing value and affordability. There is a larger but still minor decrease in the number of rental units in counties with population inflows than outflows for rental housing. Moreover, there is also a decrease in rental affordability and an increase in rental price. There is a growth of the total population for a demographic change as more people move in and

decrease age. Counties are more likely to have more commuters with larger inflow migration populations.

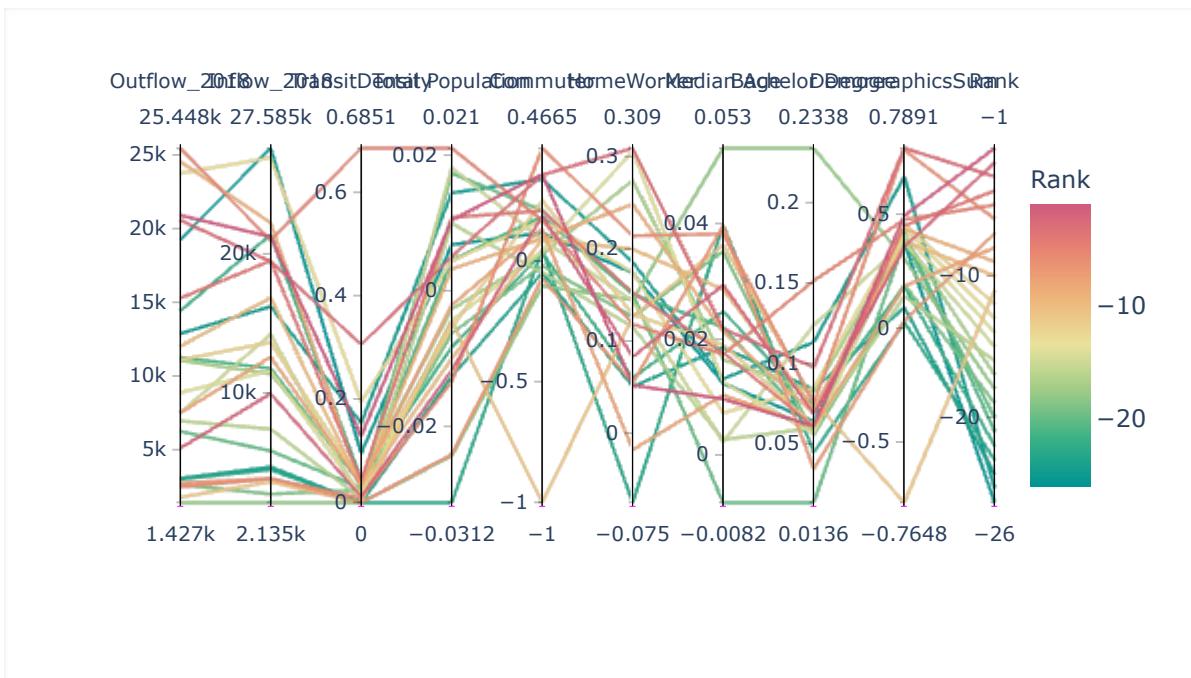
For transit density, counties can attract more people if they have a higher transit density; however, this correlation is weaker than between transit density and population outflow.

From the inflow migration analysis, we can explain some of the correlations between population out-migration and demographic changes. While people move out of a county, more people are moving in, which contributes to the general population growth. The exchange of young working population between counties in the New York Metro Area contributes to a rising rental price and a decreased rental affordability. Surprisingly, both population inflow and outflow is weakly correlated to the increase of people with Bachelor's Degrees and higher, which means that College graduates dominate the migrating population

#### Parallel Coordinates Chart of All Counties

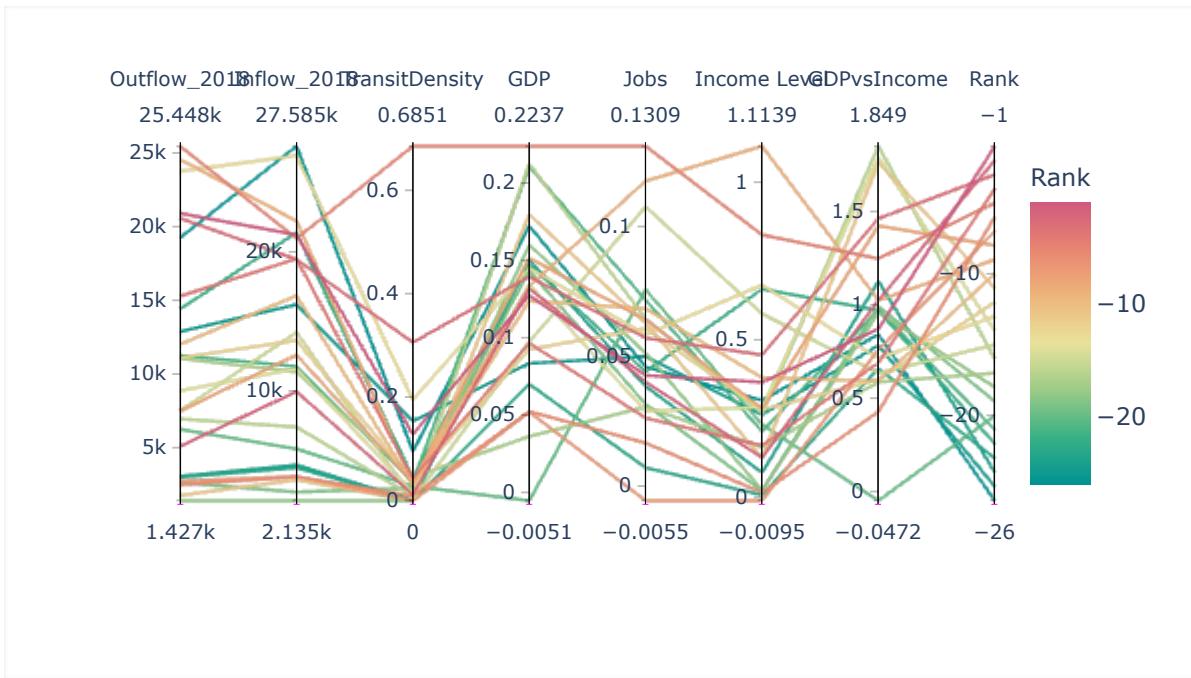
By analyzing the correlations between migration, transit density, and housing, economic and demographic characteristics of each county, we conclude that there are variable relationships between migration, transit density, and the three characteristics. However, the geographic distribution for each indicator of the characteristics remains consistent between 2014 and 2018. The following three interactive parallel coordinates charts further illustrate where all counties are in each metric.

#### *Migration Flows and Transit vs. Demographic Metrics*



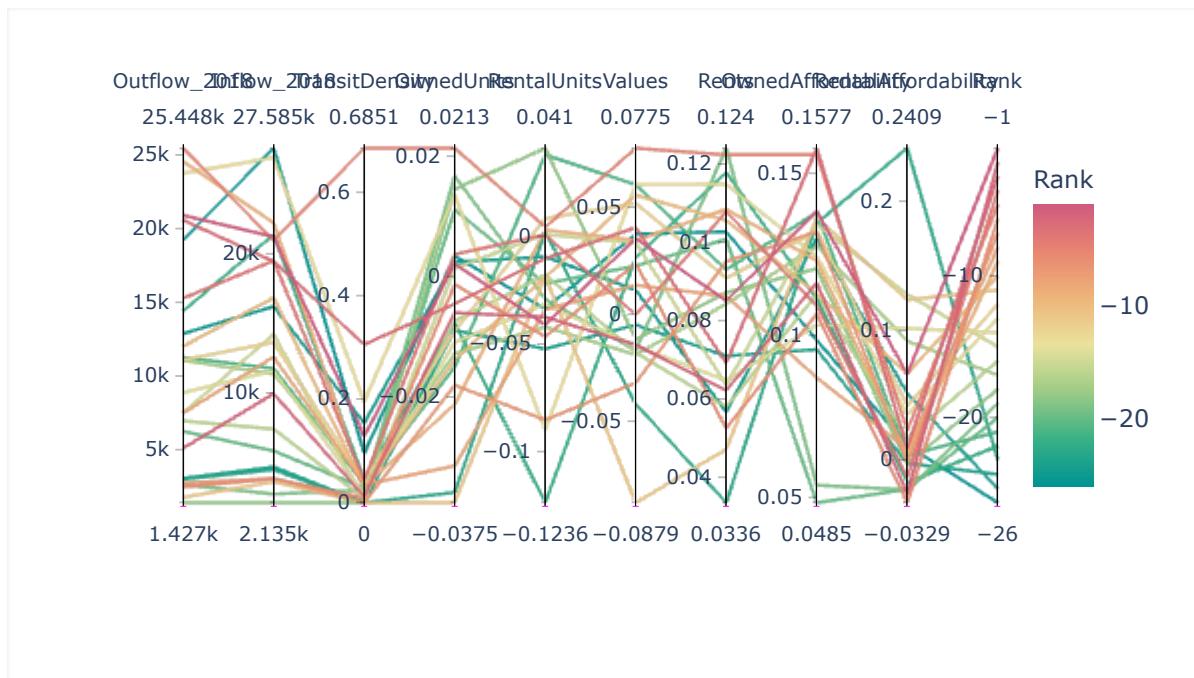
Data was acquired from US Census; data was visualized by Plotly.Express.

### *Migration Flows and Transit vs. Economic Metrics*



Data was acquired from US Census; data was visualized by Plotly.Express.

### *Migration Flows and Transit vs. Housing Metrics*



Data was acquired from US Census; data was visualized by Plotly.Express.



## Discussion and Implication

### Migration

The project reveals two general characteristics about migration. The first one is about the speed of migration. The migration is highly active throughout the metros and the counties. Especially in the context of today's pandemic, the migration options might become trendier, and the flows become more significant as well. The second characteristic is about the direction of migration. Traditional mega-states and gateway cities suffer most in terms of migration outflows – the residents of those places are more willing to relocate themselves. An active level of outflow doesn't mean a significant loss in total population because the inflows from other parts of the US or even foreign countries are likely to offset the outflows. In addition, people are more willing to have short-distance moving (intra-regional migration within the same metro area) than to relocate themselves to another region, which implies a strong moving trend from urban cores to its surrounding less-populated areas that are connected by transit. Understanding how people will move as the conditions change is fundamental to prepare for future

planning; therefore, we hope this project can provide some insights for the planners in predicting what the future the regions are facing.

## Migration and Transit

The project findings imply a strong relationship between migration and transit network – regions with higher transit density are more likely to experience high migration in and out flows. Although strong causal relation and direction cannot be confirmed, the transit network does act as an important factor affecting people's relocation choices. In today's planning context where many transit-oriented development models are concentrated, this is an important note because transit could be potentially an advantageous tool for the policy-makers and the planners to manage the amount and direction of migration, which might help explain why TOD could be a critical development model in many regions.

## The Impacts of Transit and Migration on Local Conditions

In general, transit and migration might be indicators for local demographics, economy, and housing market, which warrant the planners' attention for regional development plans.

*As for the demographic profiles*, migration is associated with many demographic changes. As migration becomes trendy, more people do take transit to become commuters (commuting people), while more people also choose to work at home (homeworkers); therefore, migration implies a change of working style. Also, the sorting effects are also realized in demographic profiles – the metro residents become younger and younger as the migration goes on, indicating the older-generation are more likely to move outside the metro regions.

Surprisingly, education level doesn't necessarily affect migration pattern, challenging the traditional view that metro requires higher education people.

*As for the economy*, migration is able to change the local market environment. Highly associated with the jump of income level,

migration facilitates the urban sorting effect – the people with higher income come into the region, while the lower-income people might leave. From the company and market perspective, migration can be a good positive contribution – increasing the available jobs and expanding GDP.

*As for the housing market,* migration, of both inflow and outflow, makes it more burdened to rent a place but less burdened when owing a place. People in the migration group are more likely to rent rather than buying a place to stay, which confirms that the rental unit inventory is decreasing while the owned units are increasing as migration speeds up. Also, migration has a significant impact on the values of all units (i.e., the rent level and housing values).

On the one hand, these impacts on the local built environment and society might help inform the planners about the policies that attract more migration; on the other hand, these findings also imply the potential outcomes that may come so that the planners can prepare for proactively.



## Contribution and Credits

### Group Collaboration

During this project, we collaborated and shared the responsibilities evenly. The project was divided by contents and topics so that we both have the equal opportunity to work on each step from data collection, processing, code-writing, and data visualization. Then, we worked together to compare and discuss each part's findings. Specifically, the primary focuses of each member are:

- Yushan Tong: Transit Analysis, Housing Analysis.
- Zhendong Long (Jayden): Migration Analysis, Economic Analysis

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