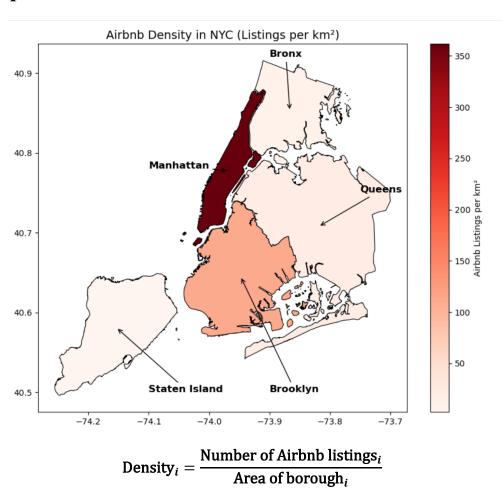
## Report 2

#### **Effect of Short-Term Rental on Long-Term Housing Market**

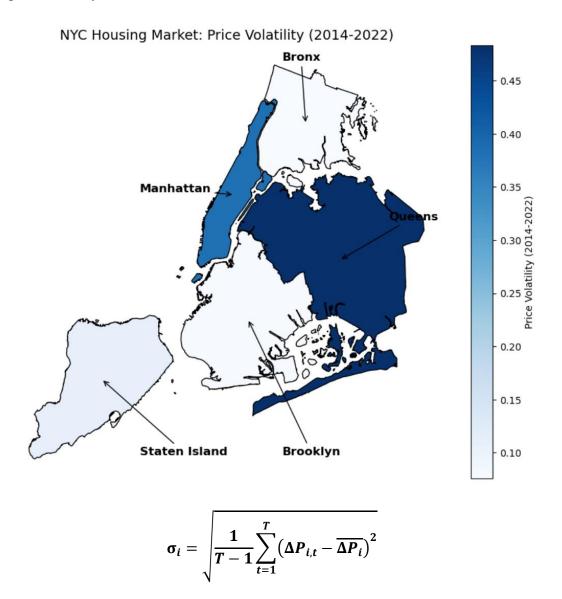
The study examines whether short-term rentals, such as Airbnb, affect housing market in New York City. It combines Airbnb data (*AB\_NYC\_2019.csv*) on neighborhood listings and prices with housing data (*NewYorkHousing.csv*) on property prices and size. The key outcome is housing price, with short term rental (STR) density as the main variable of interest.

### **Map Visualization**



This map illustrates the Airbnb density per km<sup>2</sup> in New York City. In the supply and demand theory in Economics, if a house is used as short term rental, it is no longer in the on-sale housing market. A decrease in overall supply of housing market will lead to increase in price. We use this map as a base to other maps to see if higher density led to a higher volatility and price growth rate. We also use that data to perform future linear

regression analysis.



where

 $\triangle P_{i,t}$ : annual percentage change in median housing price for borough *i* in year *t*;

 $\overline{\Delta P_i}$ : mean annual price change across all years for borough i;

T: total number of years in the analysis.

This map shows the price volatility (standard deviation) in different boroughs of New York City. We observe that Queens has the highest volatility, followed by Manhattan, while Manhattan have the higher STR density in previous map. This provides suggestions on testing significance between STR density and price volatility in further linear regression models.

# **Regression Table**

OLS Regression Results: STR Density and Housing Price

C(city)[T.Brooklyn] -83182.917  C(city)[T.Manhattan] 30569.601*  C(city)[T.Queens] 84453.663*  C(city)[T.Staten Island] 58978.74*  CAGR -863066.447* 36254.436*  CAGR -863066.447* 36254.436*  C(27331.27) (39134.974) (43655.630) (60879.686*  STR_density_per_km2 3326.348** 4387.310** 4311.132** 4794.358**  C(201.722) (202.576) (204.244) (248.717*  Volatility_Weighted_Change 96277.967** 60696.314**  C(18152.506) (18386.566) (18420.752*)  bed 18858.938 23928.590* 26604.750*  C(12186.486) (12330.660) (12356.300*  Observations 4288 3872 3872 3872 3872  R2 0.060 0.206 0.212 0.211  Adjusted R2 0.059 0.205 0.211 0.21		Dependent variable: price			
C(city)[T.Brooklyn]         -83182.917           C(city)[T.Manhattan]         30569.601**           C(city)[T.Queens]         84453.663**           C(city)[T.Staten Island]         58978.74*           C(city)[T.Staten Island]         58978.74*           CAGR         -863066.447*         36254.436*           CAGR         -863066.447*         36254.436*           Intercept         657573.723***         -209802.272***         298386.406***         -296130.199**           STR_density_per_km2         3326.348***         4387.310***         4311.132***         4794.356**           STR_density_weighted_Change         96277.967***         60696.314**         (18249.983)         (16599.461           bath         312930.027***         311963.196***         308123.587**           (18152.506)         (18386.566)         (18420.752           bed         18858.938         23928.590*         26604.750           (12186.486)         (1230.660)         (12356.30           Observations         4288         3872         3872         387           Adjusted R²         0.059         0.205         0.211         0.21         0.21		Baseline	Property Controls	Market Trends	Full Model
C(city)[T.Manhattan]       30569.601**         C(city)[T.Queens]       84453.663**         C(city)[T.Staten Island]       58978.74*         C(city)[T.Staten Island]       58978.74*         CAGR       -863066.447*       -36254.36*         (A50457.251)       (14143.483         Intercept       657573.723***       -209802.272***       -298386.406***       -296130.199**         STR_density_per_km2       3326.348***       4387.310***       4311.132***       4794.358**         STR_density_weighted_Change       96277.967***       60696.314**         Volatility_Weighted_Change       96277.967***       60696.314**         bath       312930.027***       311963.196***       308123.587**         (18152.506)       (18386.566)       (18420.752         bed       18858.938       23928.590*       26604.750         (12186.486)       (12330.660)       (12356.30)         Observations       4288       3872       3872       387         R2       0.060       0.206       0.212       0.21         Adjusted R2       0.059       0.205       0.211       0.21		(1)	(2)	(3)	(4)
C(city)[T.Manhattan]       30569.601**         C(city)[T.Queens]       84453.663**         C(city)[T.Staten Island]       58978.74*         C(city)[T.Staten Island]       58978.74*         CAGR       -863066.447*       -36254.436*         CAGR       -863066.447*       -296130.199**         (21273.127)       (39134.974)       (43655.630)       (60879.686         STR_density_per_km2       3326.348***       4387.310***       4311.132***       4794.358**         Volatility_Weighted_Change       96277.967***       60696.314**         bath       312930.027***       311963.196***       308123.587**         bed       18858.938       23928.590*       26604.750         (18152.506)       (18386.566)       (18420.752         Observations       4288       3872       3872       387         Adjusted R²       0.059       0.205       0.211       0.21	C(city)[T.Brooklyn]				-83182.917*
(11252.752         C(city)[T.Queens]       84453.663**         (27343.053)         C(city)[T.Staten Island]       58978.74*         (53334.122         CAGR       -863066.447*       -36254.436*         (450457.251)       (14143.483)         Intercept       657573.723***       -209802.272***       -298386.406***       -296130.199**         STR_density_per_km2       3326.348***       4387.310***       4311.132***       4794.358**         Volatility_Weighted_Change       96277.967***       60696.314**       (248.717         Volatility_Weighted_Change       18152.506       (18386.566)       (18420.752)         bed       18858.938       23928.590*       26604.750         (12186.486)       (12330.660)       (12356.30)         Observations       4288       3872       3872       3872         Adjusted R²       0.059       0.205       0.211       0.21					(43796.073)
C(city)[T.Queens]       84453.663**         C(city)[T.Staten Island]       58978.74*         C(city)[T.Staten Island]       (53334.122         CAGR       -863066.447*       -36254.436*         Intercept       657573.723***       -209802.272***       -298386.406***       -296130.199**         STR_density_per_km2       3326.348***       4387.310***       4311.132***       4794.358**         Volatility_Weighted_Change       (201.722)       (202.576)       (204.244)       (248.717         Volatility_Weighted_Change       96277.967***       60696.314**         bath       312930.027***       311963.196***       308123.587**         (18152.506)       (18386.566)       (18420.752         bed       18858.938       23928.590*       26604.750         (12186.486)       (12330.660)       (12356.30)         Observations       4288       3872       3872       387         Adjusted R²       0.059       0.205       0.211       0.21	C(city)[T.Manhattan]				30569.601***
C(city)[T.Staten Island] 58978.74  C(city)[T.Staten Island] 58978.74  CAGR -863066.447* -36254.436*  (450457.251) (14143.483  Intercept 657573.723*** -209802.272*** -298386.406*** -296130.199**  (21273.127) (39134.974) (43655.630) (60879.686  STR_density_per_km2 3326.348*** 4387.310*** 4311.132*** 4794.358**  (201.722) (202.576) (204.244) (248.717  Volatility_Weighted_Change 96277.967*** 60696.314**  (18249.983) (16599.461  bath 312930.027*** 311963.196*** 308123.587**  (18152.506) (18386.566) (18386.566)  (102336.600) (12356.300**  Observations 4288 3872 3872 3872 387  R <sup>2</sup> 0.060 0.206 0.216 0.212 0.21  Adjusted R <sup>2</sup> 0.059 0.205 0.211 0.21					(11252.755)
C(city)[T.Staten Island]       58978.749         CAGR       -863066.447*       -36254.436*         Intercept       657573.723***       -209802.272***       -298386.406***       -296130.199**         STR_density_per_km2       3326.348***       4387.310***       4311.132***       4794.358**         STR_density_Weighted_Change       (201.722)       (202.576)       (204.244)       (248.717         Volatility_Weighted_Change       96277.967***       60696.314**       (18249.983)       (16599.461         bath       312930.027***       311963.196***       308123.587**         class to the complex of	C(city)[T.Queens]				84453.663***
CAGR -863066.447* -36254.436*  (450457.251) (14143.483*  Intercept 657573.723*** -209802.272*** -298386.406*** -296130.199**  (21273.127) (39134.974) (43655.630) (60879.686*  STR_density_per_km2 3326.348*** 4387.310*** 4311.132*** 4794.358**  (201.722) (202.576) (204.244) (248.717*  Volatility_Weighted_Change 96277.967*** 60696.314**  (18249.983) (16599.461*  bath 312930.027*** 311963.196*** 308123.587**  (18152.506) (18386.566) (18420.752*)  bed 18858.938 23928.590* 26604.750*  (12186.486) (12330.660) (12356.30*)  Observations 4288 3872 3872 3872 3878*  R <sup>2</sup> 0.060 0.206 0.212 0.214  Adjusted R <sup>2</sup> 0.059 0.205 0.211 0.215*					(27343.053)
CAGR       -863066.447*       -36254.436*         Intercept       657573.723****       -209802.272****       -298386.406****       -296130.199**         Intercept       657573.723****       -209802.272****       -298386.406****       -296130.199***         STR_density_per_km2       3326.348****       4387.310****       4311.132****       4794.358**         STR_density_weighted_Change       96277.967***       60696.314**       60696.314**         Volatility_Weighted_Change       96277.967***       60696.314**       18249.983)       (16599.461         bath       312930.027***       311963.196***       308123.587**         (18152.506)       (18386.566)       (18420.752         bed       18858.938       23928.590*       26604.750         (12186.486)       (12330.660)       (12356.30**         Observations       4288       3872       3872       3872       387         Adjusted R²       0.059       0.206       0.212       0.21       0.21	C(city)[T.Staten Island]				58978.749
Marcept   Marc					(53334.122)
Intercept 657573.723*** -209802.272*** -298386.406*** -296130.199**	CAGR			-863066.447*	-36254.436**
Canon   Cano				(450457.251)	(14143.483)
STR_density_per_km2         3326.348****         4387.310****         4311.132****         4794.358**           Volatility_Weighted_Change         (201.722)         (202.576)         (204.244)         (248.717           Volatility_Weighted_Change         96277.967****         60696.314***         60696.314**           bath         312930.027****         311963.196****         308123.587**           bed         18858.938         23928.590*         26604.750           Change         (12186.486)         (12330.660)         (12356.30*)           Observations         4288         3872         3872         387           Adjusted R²         0.059         0.205         0.211         0.21	Intercept	657573.723***	-209802.272***	-298386.406***	-296130.199**
(201.722)       (202.576)       (204.244)       (248.717         Volatility_Weighted_Change       96277.967****       60696.314***         bath       312930.027****       311963.196****       308123.587**         (18152.506)       (18386.566)       (18420.752         bed       18858.938       23928.590*       26604.750         (12186.486)       (12330.660)       (12356.30*         Observations       4288       3872       3872       387         R2       0.060       0.206       0.212       0.21         Adjusted R2       0.059       0.205       0.211       0.21		(21273.127)	(39134.974)	(43655.630)	(60879.686)
Volatility_Weighted_Change         96277.967***         60696.314**           bath         312930.027***         311963.196***         308123.587**           bed         18858.938         23928.590*         26604.750           (12186.486)         (12330.660)         (12356.30*)           Observations         4288         3872         3872         387           R2         0.060         0.206         0.212         0.21           Adjusted R2         0.059         0.205         0.211         0.21	STR_density_per_km2	3326.348***	4387.310***	4311.132***	4794.358***
beth 312930.027*** 311963.196*** 308123.587**  (18152.506) (18386.566) (18420.752  bed 18858.938 23928.590* 26604.750  (12186.486) (12330.660) (12356.30*  Observations 4288 3872 3872 3872  R <sup>2</sup> 0.060 0.206 0.212 0.21  Adjusted R <sup>2</sup> 0.059 0.205 0.211 0.21		(201.722)	(202.576)	(204.244)	(248.717
beth 312930.027*** 311963.196*** 308123.587**  (18152.506) (18386.566) (18420.752  bed 18858.938 23928.590* 26604.750  (12186.486) (12330.660) (12356.30*  Observations 4288 3872 3872 3872  R <sup>2</sup> 0.060 0.206 0.212 0.21  Adjusted R <sup>2</sup> 0.059 0.205 0.211 0.21	Volatility_Weighted_Change			96277.967***	60696.314**
bed 18858.938 23928.590* 26604.750* (12186.486) (12330.660) (12356.30*  Observations 4288 3872 3872 387  R <sup>2</sup> 0.060 0.206 0.212 0.21  Adjusted R <sup>2</sup> 0.059 0.205 0.211 0.21				(18249.983)	(16599.461
bed 18858.938 23928.590* 26604.750 (12186.486) (12330.660) (12356.30*)  Observations 4288 3872 3872 3872  R <sup>2</sup> 0.060 0.206 0.212 0.21  Adjusted R <sup>2</sup> 0.059 0.205 0.211 0.21	bath		312930.027***	311963.196***	308123.587***
(12186.486)         (12330.660)         (12356.30°           Observations         4288         3872         3872         387           R <sup>2</sup> 0.060         0.206         0.212         0.21           Adjusted R <sup>2</sup> 0.059         0.205         0.211         0.21			(18152.506)	(18386.566)	(18420.752)
(12186.486)         (12330.660)         (12356.30°           Observations         4288         3872         3872         387           R <sup>2</sup> 0.060         0.206         0.212         0.21           Adjusted R <sup>2</sup> 0.059         0.205         0.211         0.21					
Observations     4288     3872     3872     3872       R <sup>2</sup> 0.060     0.206     0.212     0.21       Adjusted R <sup>2</sup> 0.059     0.205     0.211     0.21	bed		18858.938	23928.590*	26604.750 <sup>*</sup>
R2       0.060       0.206       0.212       0.21         Adjusted R2       0.059       0.205       0.211       0.21			(12186.486)	(12330.660)	(12356.301
Adjusted R <sup>2</sup> 0.059 0.205 0.211 0.21	Observations	4288	3872	3872	387
	R <sup>2</sup>	0.060	0.206	0.212	0.21
	Adjusted R <sup>2</sup>	0.059	0.205	0.211	0.21
		1047659.720 (df=4286)	984098.215 (df=3868)	980806.387 (df=3866)	979930.101 (df=3865
F Statistic 271.912*** (df=1; 4286) 334.618*** (df=3; 3868) 207.722*** (df=5; 3866) 174.731*** (df=6; 3865)	F Statistic	271.912*** (df=1; 4286)	334.618*** (df=3; 3868)	207.722*** (df=5; 3866)	174.731*** (df=6; 3865

Model 1 establish a base relationship between housing price and STR density per  $\rm km^2$ , and it shows a high significance to the housing price with p < 0.01. Model 2 incorporate housing statistics like number of beds and number of bathrooms. STR density remains significant indicates that STR density correlates with housing price even when controlling some house attributes. Model 3 add compound annual growth rate (CAGR) and price volatility, and it shows that both CAGR and volatility shows a

significance to housing prices. Finally, model 4 introduces dummy variables, and use Bronx as the base. We observe that STR density is still significant to housing price. Manhattan and Queens have significantly higher price than the Bronx, while Staten Island don't.

Generally, even we introducing control variables and dummy variables, there is still a high significance between STR density and housing price, with a p value smaller than 0.01. This implies that short term rentals density difference has a relationship with housing price change, which fit our main research topic.

## **Next Step**

Fitting more linear regression models using different response variables, such as CAGR or volatility, to further investigate the relationship between them and STR density.

Then, apply same models to different cities to prove the universality.