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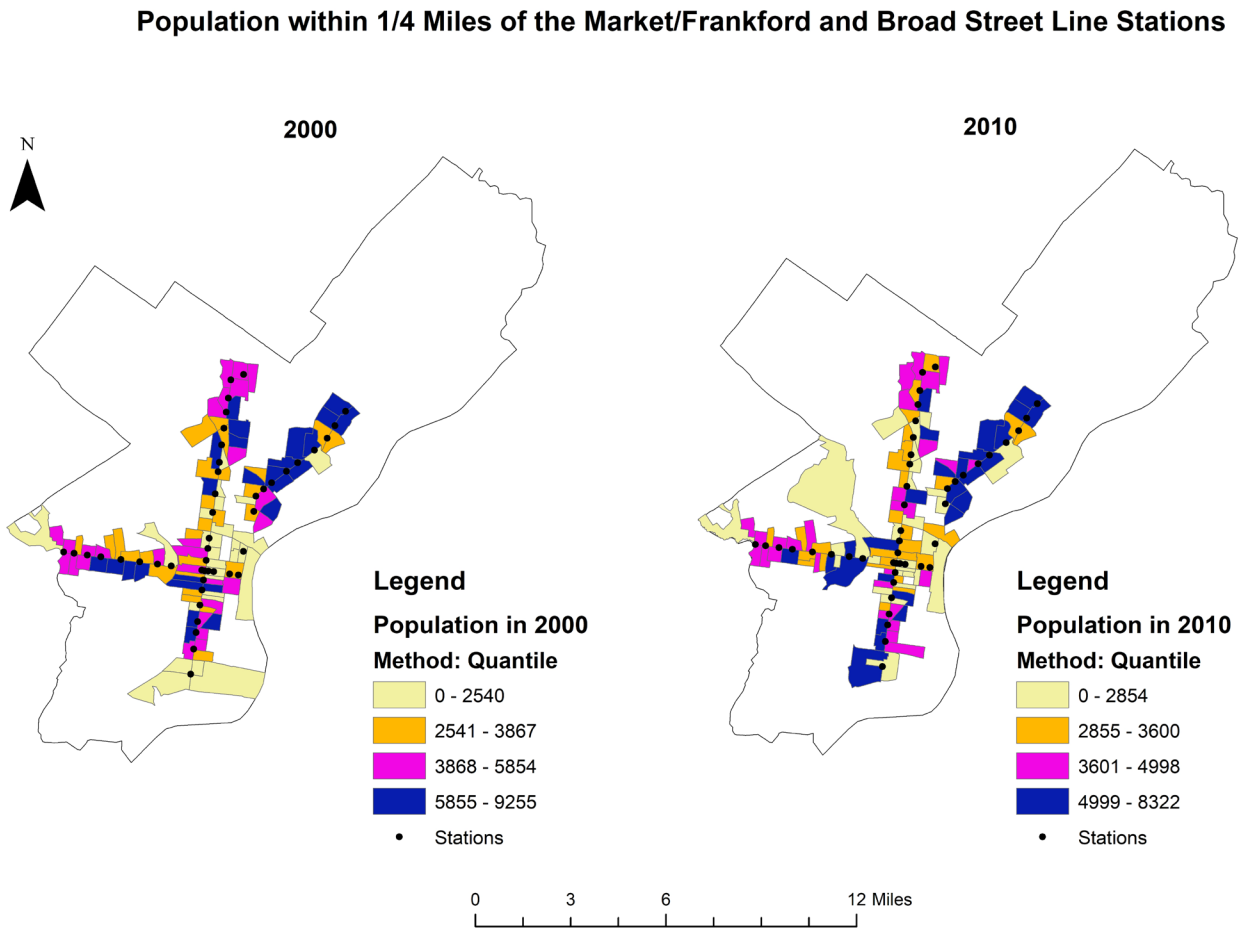
[Philadelphia TOD Analysis]

I.Demographic, social and economic characteristics of the areas around stations on the SEPTA Market/Frankford and Broad Street Lines between 2000 and 2010

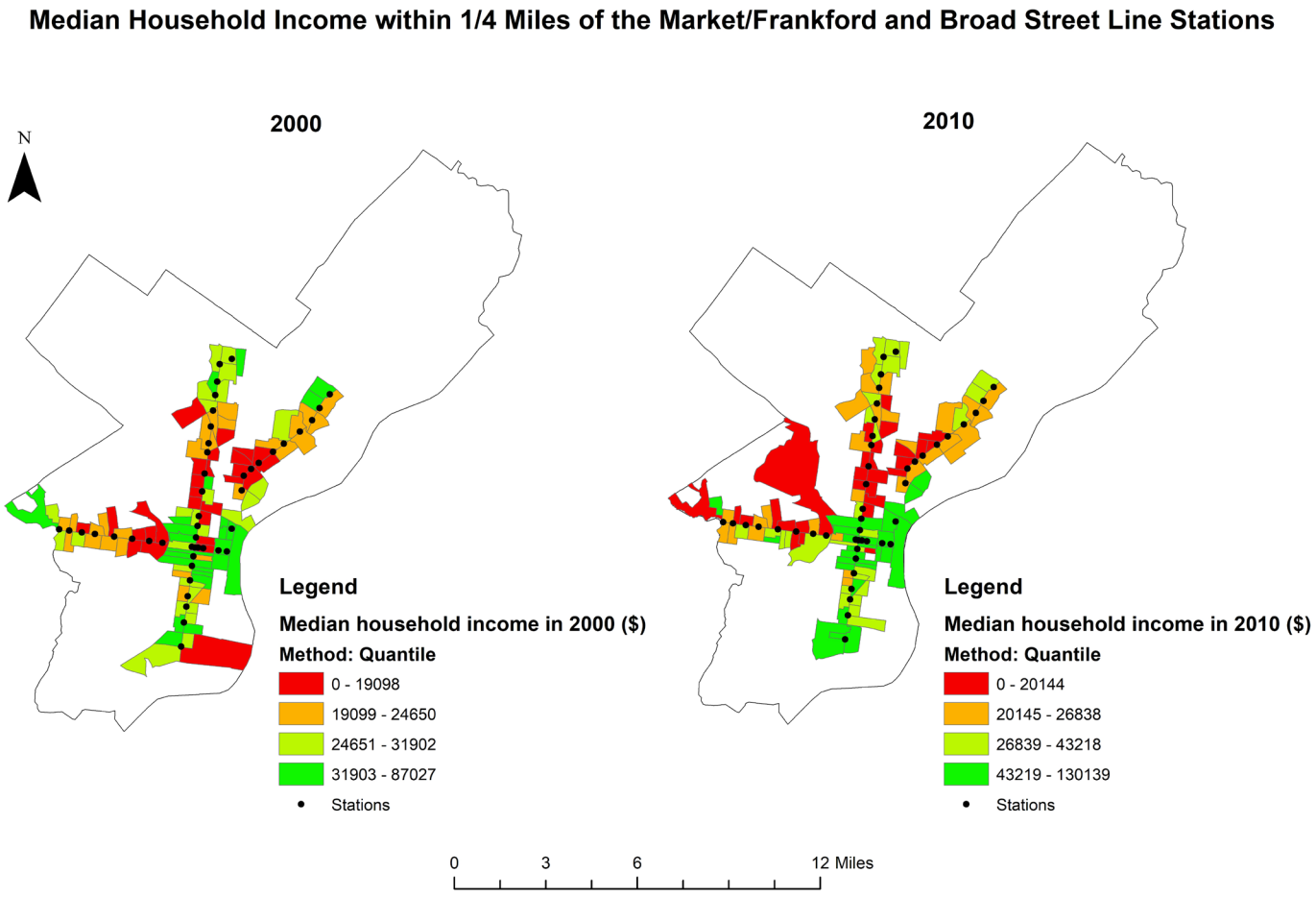
From census tracts of 2000 and 2010, I chose: 1) Population, 2) Median household income, 3) Percent of white residents, 4) Percent of residents with a bachelor degree.

1. Population



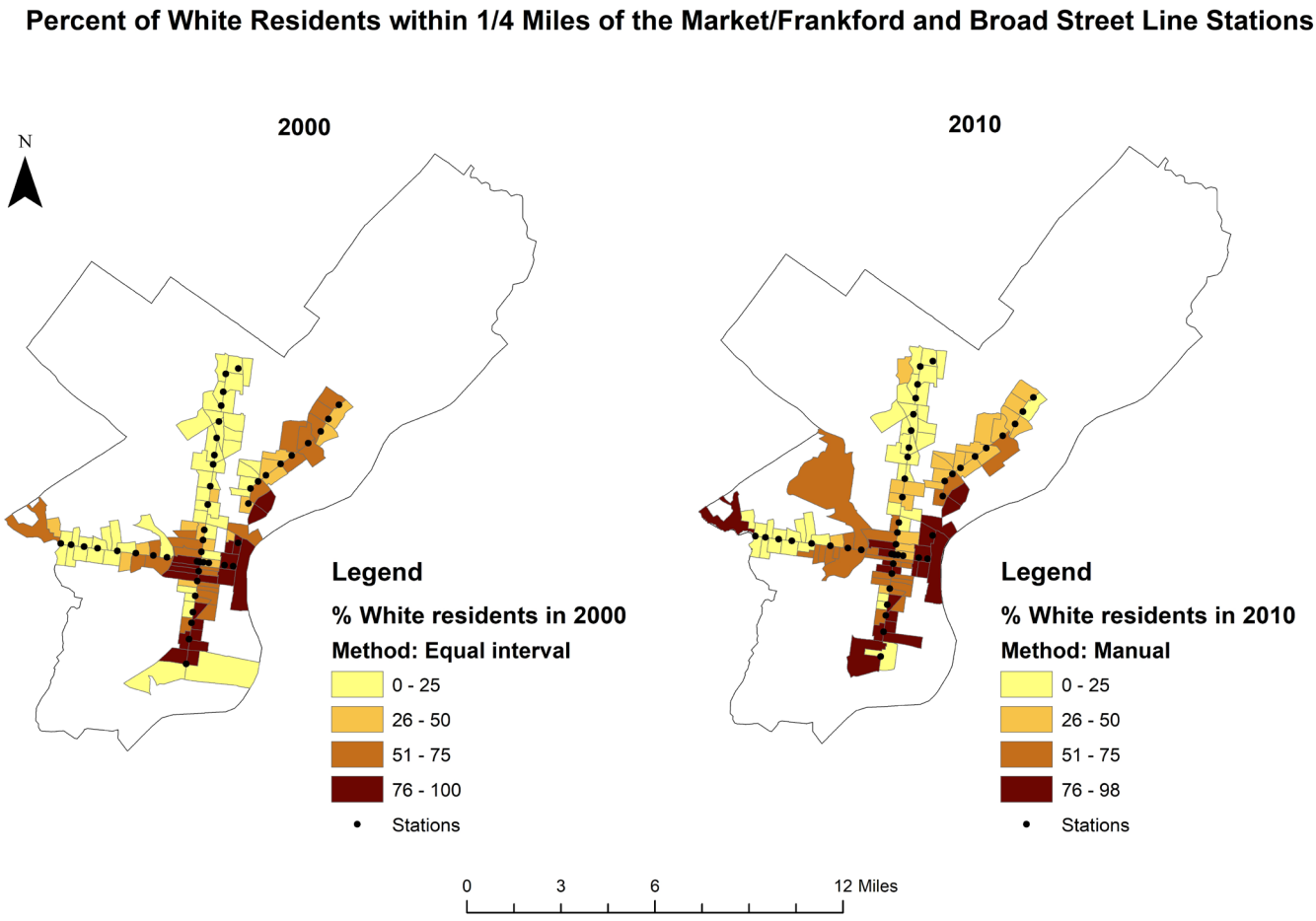
The total number of census tracts in Philadelphia change: there are 107 tracts in 2000 and 111 tracts in 2010. Some tracts are changed in size and shape as well. The population within 1.4-mile of the two metro lines also changes. From the choropleth map, using quantile can show the relative standing of a tract in terms of population, and the darker the tract, the more people. The tracts in the northeast always remain relatively most populous along the metro lines, and tracts in the easternmost and westernmost remain relatively least populous between 2000 and 2010. South became more populous from 2000 to 2010. From quantile classification, the median of population per tract within 1.4-mile of the metro lines decreases from 3867 to 3600.

2. Median household income



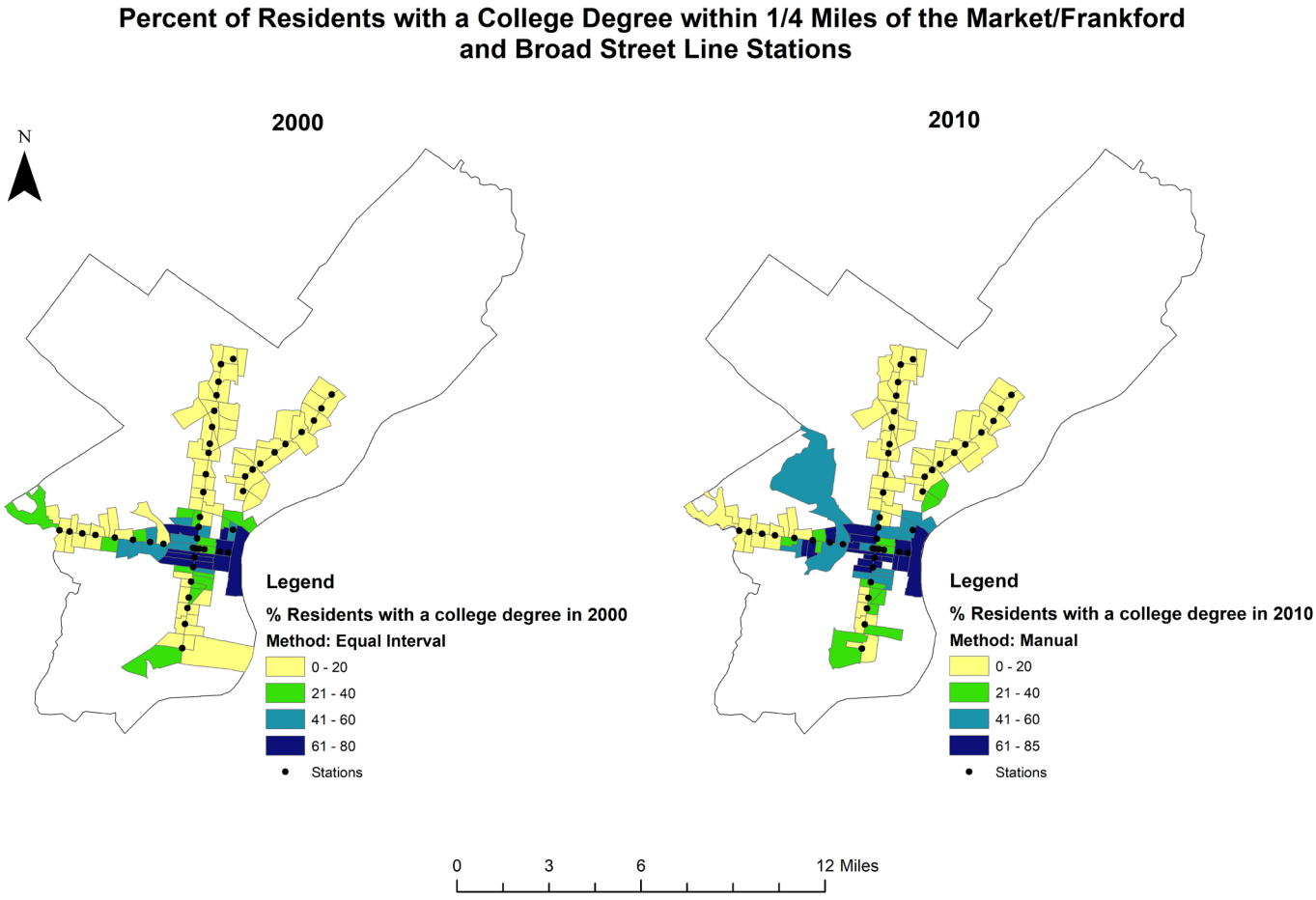
Median household income is a key economic characteristic which quantifies the economic level for each household. I still use quantile to show the economic standing of each tract, and I apply green to red color to highlight the household income level from common sense: the greener, the richer; the redder, the poorer, where the local government might pay more attention on. Visually, from 2000 to 2010, the pattern doesn't change greatly: most tracts in center city along the metro lines always have relatively higher median household income. While most tracts in northeast, north and west have relatively low median household income, as they are in the bottom 25% of all census tracts with median household income. From 2000 to 2010, especially, the condition exacerbates in west, north-east and several tracts in south as well, From quantile, the median of median household income per tract within 1.4-mile of the metro lines increases from $24,650 to $26,838.

3. Percent of white population



Percent of white population is a key demographic characteristic which indicates the scale of white population. In the census tracts within 1/4-mile of the metro lines, in 2000, the percent ranges from 0% to 100%, while in 2010, it ranges from 0% to about 98%; the difference is small. Because percent is straightforward to see the proportion of white population, and I would like to know which tracts have more percent of white people, I directly applied equal interval for 2000 data, and for 2010 data, I manually adjusted 4 intervals with 25% as much as possible to be consistent with 2000 data. The browner, the higher precent of white residents. From the maps, tracts in the east and south always have relatively higher percent of white residents, but the percent always remain the lowest in the north between 2000 and 2010. But from 2000 to 2010, the percent of white residents in tracts gradually increased in the west and north, while decreased in northeast.

4. Percent of residents with a college degree



Percent of residents with a college degree measures the education level of a census tract. In the census tracts within 1/4-mile of the metro lines, in 2000, the percent ranges from 0% to 80%, and in 2010, it ranges from 0% to 85%. Similar to the percent of white residents, the difference between 2000 and 2010 is small, so I still applied equal interval for 2000 data, and for 2010 data, I manually adjusted 4 intervals with 20% as much as possible to be consistent with 2000 data as well. The darker, the higher precent of residents with a college degree (i.e. better educated). From the maps, tracts with over 60% of residents with a college degree concentrate in center city, but especially in north and northwest, no more 20% of residents have a college degree between 2000 and 2010. But from 2000 to 2010, the percent in tracts in south increased, which indicates the proportion of people with a college degree improved in the south.

5. Tables comparing the 2000 and 2010 characteristics of Market/Frankford and Broad Street Line station areas

Table 1. All Philadelphia tracts

Population			
	2000	2010	Change
Max. in tracts	10479	8322	-20.6%
Sum	1512319	1526006	+0.9%
Mean	3979.8	3974	-0.1%
Median household income ($)			
	2000	2010	Change
Max. in tracts	200001	130139	-34.9%
Sum	12164705	14441022	+18.7%
Mean	32012.4	37606.8	+17.5%
Percent of white residents (%)			
	2000	2010	Change
Max. in tracts	100	100	0%
Mean	44.9	43.1	-1.8%
Percent of residents with a college degree (%)			
	2000	2010	Change
Max. in tracts	92	91.6	-0.4%
Mean	18.6	23.7	+5.1%

Table 2. Transit 1/4-mile buffer tracts

Population			
	2000	2010	Change
Max. in tracts	9255	8322	-10.1%
Sum	437146	433109	-0.9%
Mean	4085.5	3901.9	-4.5%
Median household income ($)			
	2000	2010	Change
Max. in tracts	87027	130139	+49.5%
Sum	2786661	3669475	+31.7%
Mean	26043.6	33058.3	+26.9%
Percent of white residents (%)			
	2000	2010	Change
Max. in tracts	100	97.7	-2.3%
Mean	39.5	41.5	+2%
Location quotient	0.9	1.0	+0.1
Percent of residents with a college degree (%)			
	2000	2010	Change
Max. in tracts	80	85.4	5.4%
Mean	21	27.1	+6.1%
Location quotient	1.1	1.1	0

*How did I calculate "location quotient" here?

A location quotients is the ratio of two percentages: the numerator refers to a specific geography (i.e. a neighborhood) and the denominator refers to a parent geography (i.e. the whole city). The numerator of the location quotient is the percent data from tracts in the buffer (e.g. the mean of the percent of white residents of tracts in the buffer), and the denominator is the percent data from all Philadelphia tracts (e.g. the mean of the percent of white residents in all Philadelphia tracts).

Comparing all Philadelphia tracts and the two metro line areas, between 2000 and 2010, both have increase in the mean of median houshold income and percent of residents with a college degree, which means both geography benefit from increasing education level and economic level. However, although the population of Philadelphia increased 0.9% from 2000 to 2010, the population around the transit station area decreased by 0.9%, and for both geography, the average population per tract decreased. The average percent of white residents in each tract in Philadelphia decreased by 1.8%, but increased 2% around the transit area. The location quotient of percent of white residents increased 0.1: to 2010, the transit station area has the same concentration of white residents compared to the city as a whole.

Table 3. Market/Frankford buffer tracts

Population			
	2000	2010	Change
Max. in tracts	9159	8322	-9.1%
Sum	236204	248540	+5.2%
Mean	4217.9	4074.4	-3.4%
Median household income ($)			
	2000	2010	Change
Max. in tracts	87027	130139	+49.5%
Sum	1451865	2058782	+41.8%
Mean	25926.2	33750.5	+30.2%
Percent of white residents (%)			
	2000	2010	Change
Max. in tracts	95	93.5	-1.5%
Mean	44.7	46.2	+1.5%
Location quotient	1.0	1.1	+0.1
Percent of residents with a college degree (%)			
	2000	2010	Change
Max. in tracts	80	85.4	+5.4%
Mean	25.3	32.1	+6.8%
Location quotient	1.4	1.4	0

Table 4. Broad Street Line buffer tracts

Population			
	2000	2010	Change
Max. in tracts	9255	6195	-33.1%
Sum	232075	214877	-7.4%
Mean	3867.9	3581.3	-7.4%
Median household income ($)			
	2000	2010	Change
Max. in tracts	44080	90156	+104.5%
Sum	1594574	2075965	+30.2%
Mean	26576.2	34599.4	+30.2%
Percent of white residents (%)			
	2000	2010	Change
Max. in tracts	100	97.7	-2.3%
Mean	38.4	41	+2.6%
Location quotient	0.9	1.0	+0.1
Percent of residents with a college degree (%)			
	2000	2010	Change
Max. in tracts	80	85.4	+5.4%
Mean	22.1	28.2	+6.1%
Location quotient	1.2	1.2	0

*How did I calculate "location quotient" here?

The numerator of the location quotient for each of the two transit lines is the percent data from tracts in the buffer (e.g. the mean of the percent of white residents of tracts in the Broad Street Line buffer), and the denominator is STILL the percent data from all Philadelphia tracts (e.g. the mean of the percent of white residents in all Philadelphia tracts).

Comparing the two transit lines, both transit areas have about 30% increase in the average median household income in tracts. The percent of white residents, and residents with a college degree also increase from 2000 and 2010. Therefore, both transit areas have demonstrated an improvement in economic level and education level, and there is a increasing proportion of white population. However, the average population in each tract in both transit areas decreased. But for total population, Market/Frankfod Line station area has 5.2% increase from 2000 to 2010, while Broad Street Line station area has 7.4% decrease in total population. Overall, Market/Frankfod Line station area is more populous than Broad Street Line station area. At this point, TOD might be more conspicuous in effect in Market/Frankfod Line station area with the emphasis of population.

II. Characteristics of parcels within 1/4-mile of the Broad Street Line

The parcel data I used for this assignment is from OpenDataPhilly (https://www.opendataphilly.org/dataset/property-parcels) with total 32,255 parcels in Philadelphia.

1. Summary table

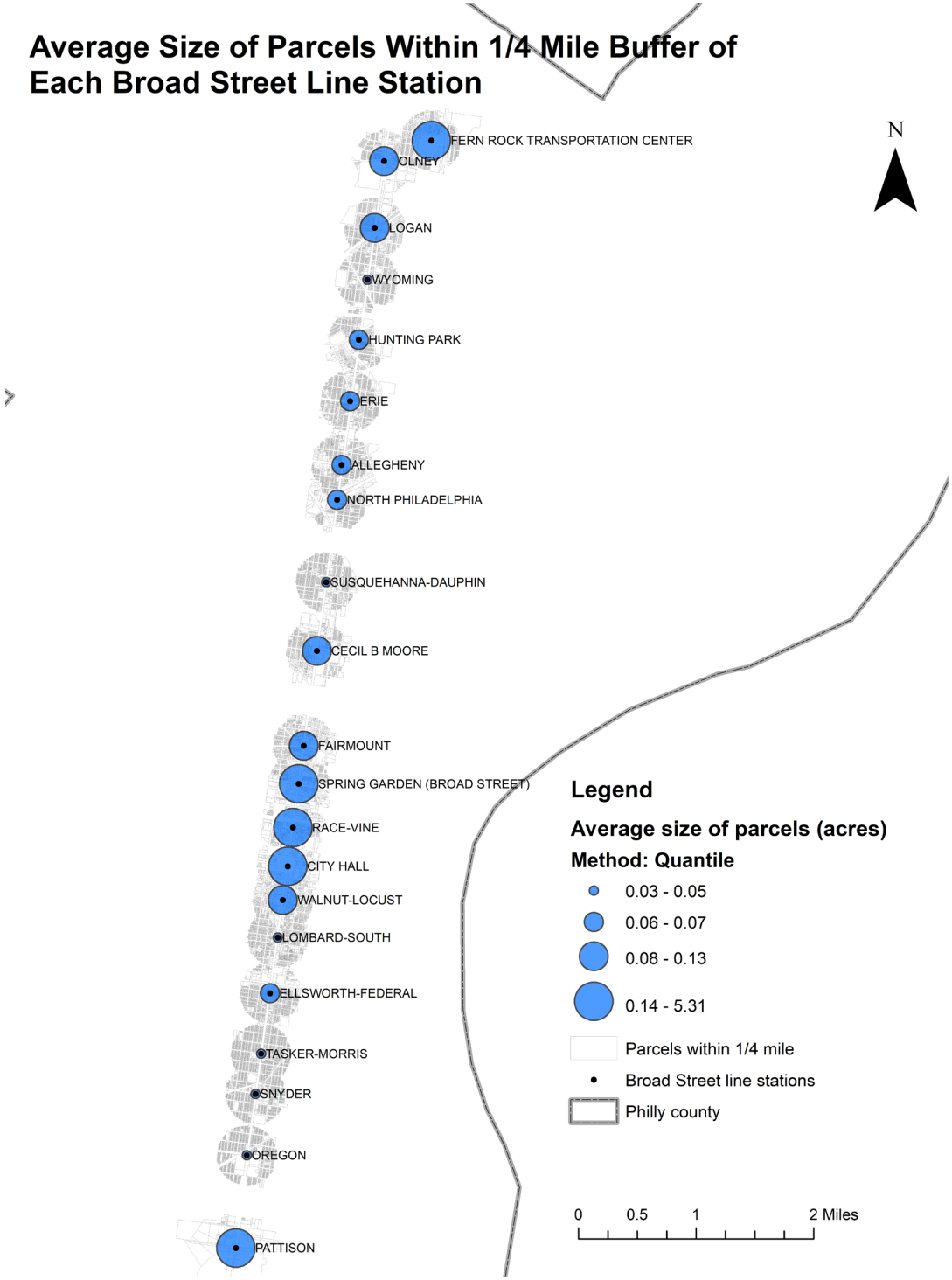
	Station	Average size of parcels (acres)	Total land area (acres)	Total number of parcels
1	FERN ROCK TRANSPORTATION CENTER	0.15	182.91	1198
2	OLNEY	0.12	105.06	888
3	LOGAN	0.08	108.91	1401
4	WYOMING	0.05	88.88	1961
5	HUNTING PARK	0.06	86.92	1377
6	ERIE	0.05	110.19	2081
7	ALLEGHENY	0.07	120.40	1780
8	NORTH PHILADELPHIA	0.06	107.64	1711
9	SUSQUEHANNA-DAUPHIN	0.04	102.88	2498
10	CECIL B MOORE	0.13	151.82	1202
11	FAIRMOUNT	0.08	121.32	1446
12	SPRING GARDEN (BROAD STREET)	0.16	143.34	904
13	RACE-VINE	0.18	143.38	790
14	CITY HALL	0.32	180.47	571
15	WALNUT-LOCUST	0.10	139.66	1397
16	LOMBARD-SOUTH	0.04	119.30	2775
17	ELLSWORTH-FEDERAL	0.06	125.82	2051
18	TASKER-MORRIS	0.03	92.96	3407
19	SNYDER	0.03	89.36	2863
20	OREGON	0.03	84.17	2615
21	PATTISON	5.31	483.44	91

The Broad Street Line runs through north-south of Philadelphia with a total of 21 stations.

According to the statistics from the summary table, Pattison station area has the largest average size of parcels and the total land area. Tasker-Morris station area covers the largest number of parcels.

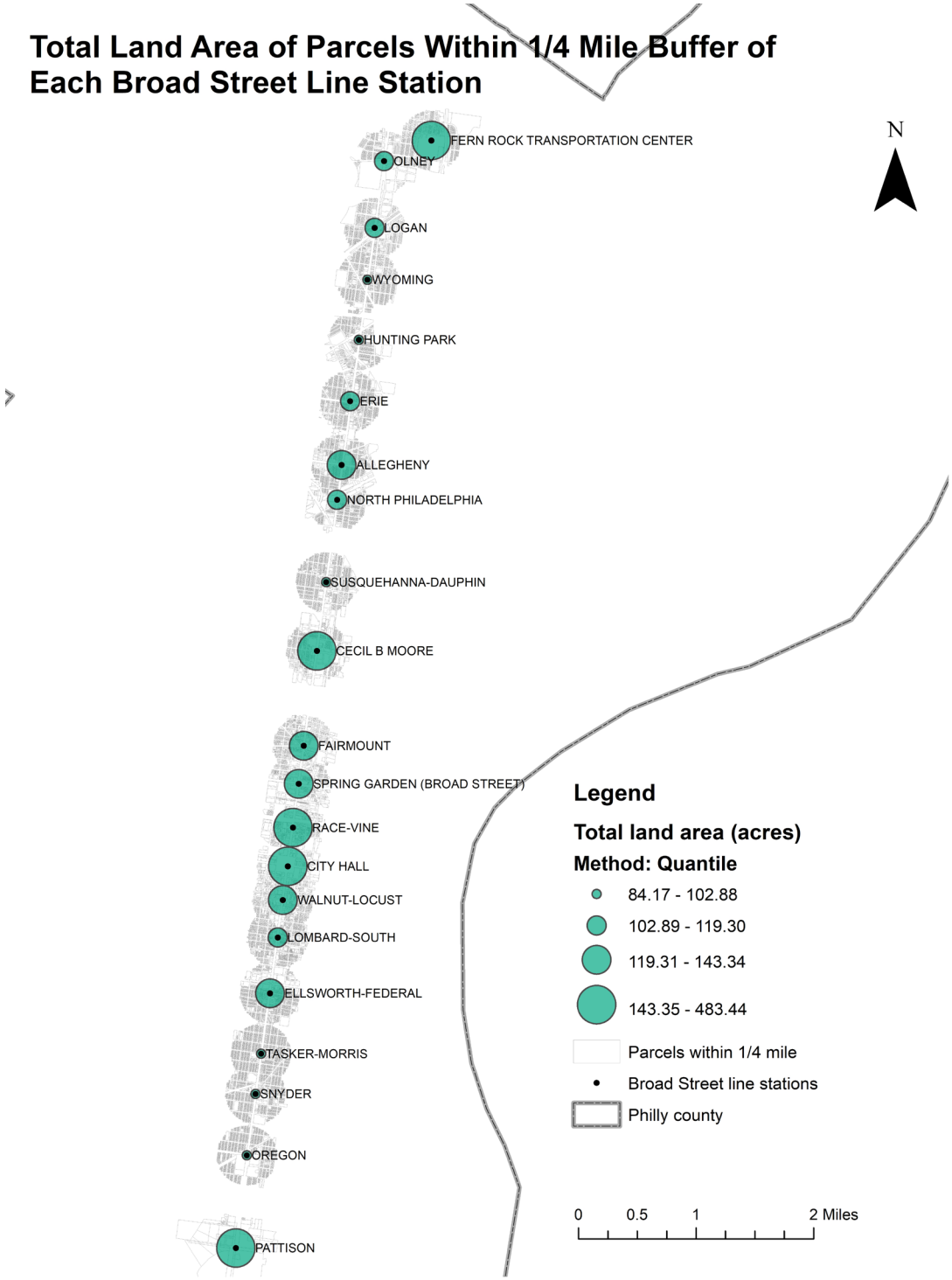
2. Graduated symbol maps

2.1. Average parcel size within 1/4-mile of each Broad Street Line station



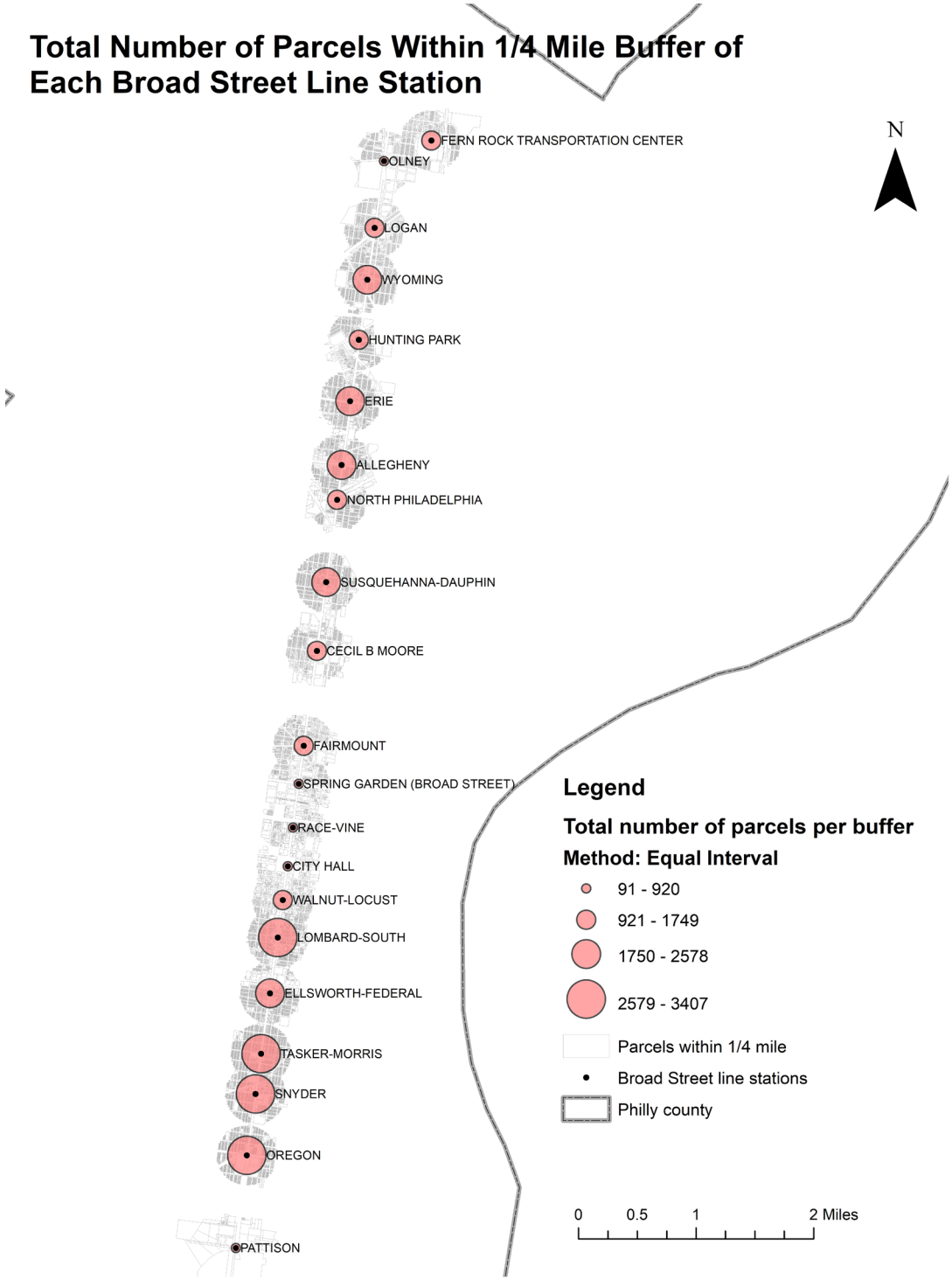
The median of the average parcel size within each 1/4-mile buffer is 0.07 acre. The stations including Fern Rock Transportation Center, Spring Garden, Race-Vine, City Hall and Pattison are ranked in the top 25% average parcel size.

2.2. Total acreage of parcels within 1/4-mile of each Broad Street Line station



The median of the total acreage of parcels within each 1/4-mile buffer is 119.3 acres. Compared with other stations, Fern Rock Transportation Center, Race-Vine, City Hall and Pattison which have relatively large parcel size are still ranked in the top 25% total land area. In addition, Cecil B Moore station is also included in the top 25% standing.

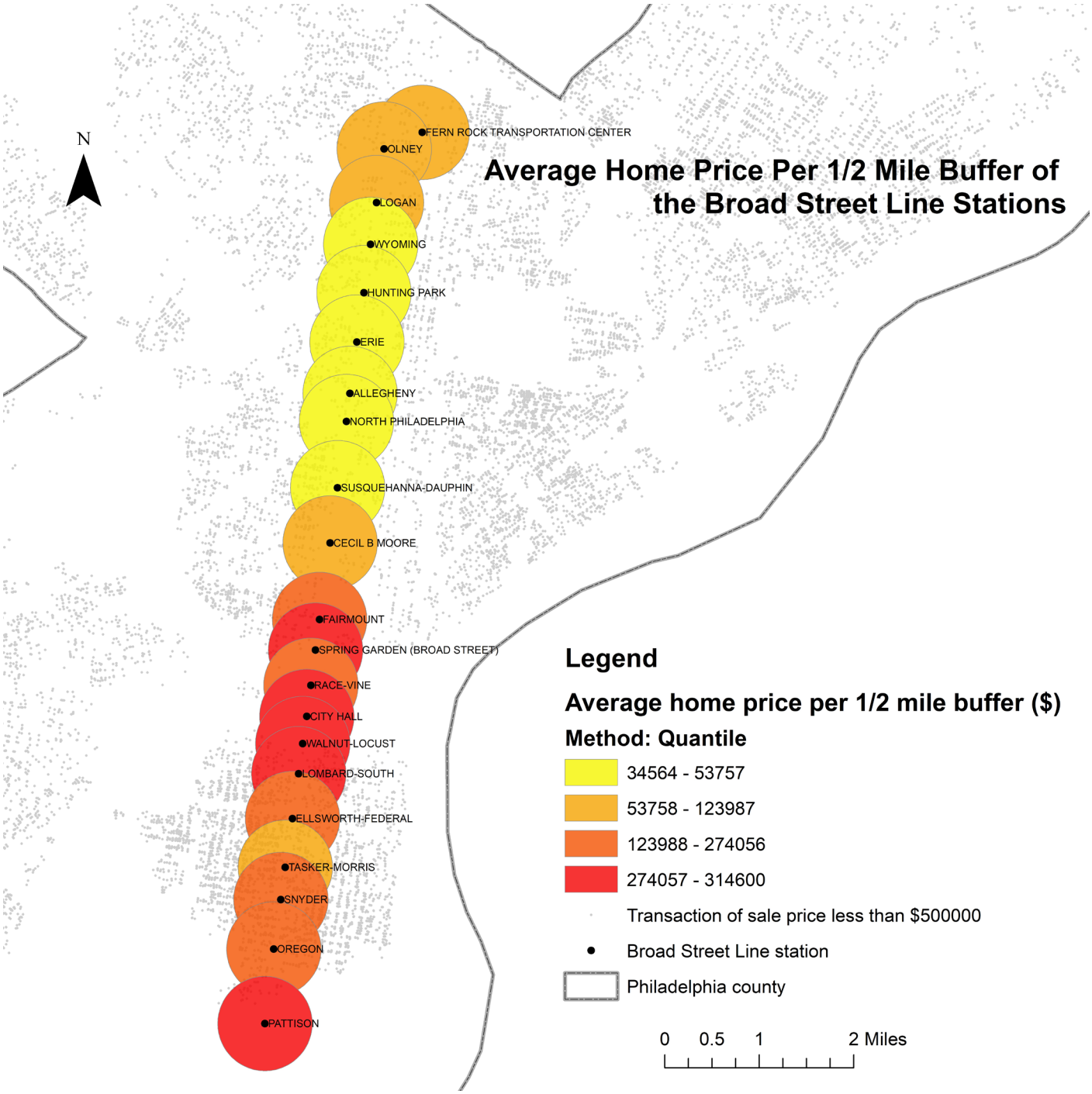
2.3. Total number of parcels within 1/4-mile of each Broad Street Line station



Lombard-South, Tasker-Morris, Snyder and Oregan stations have more parcels in the buffer compared with other stations. While stations including Pattison, City Hall, Race-Vine which have more total land area and average parcel size have the smallest numbers of parcels here.

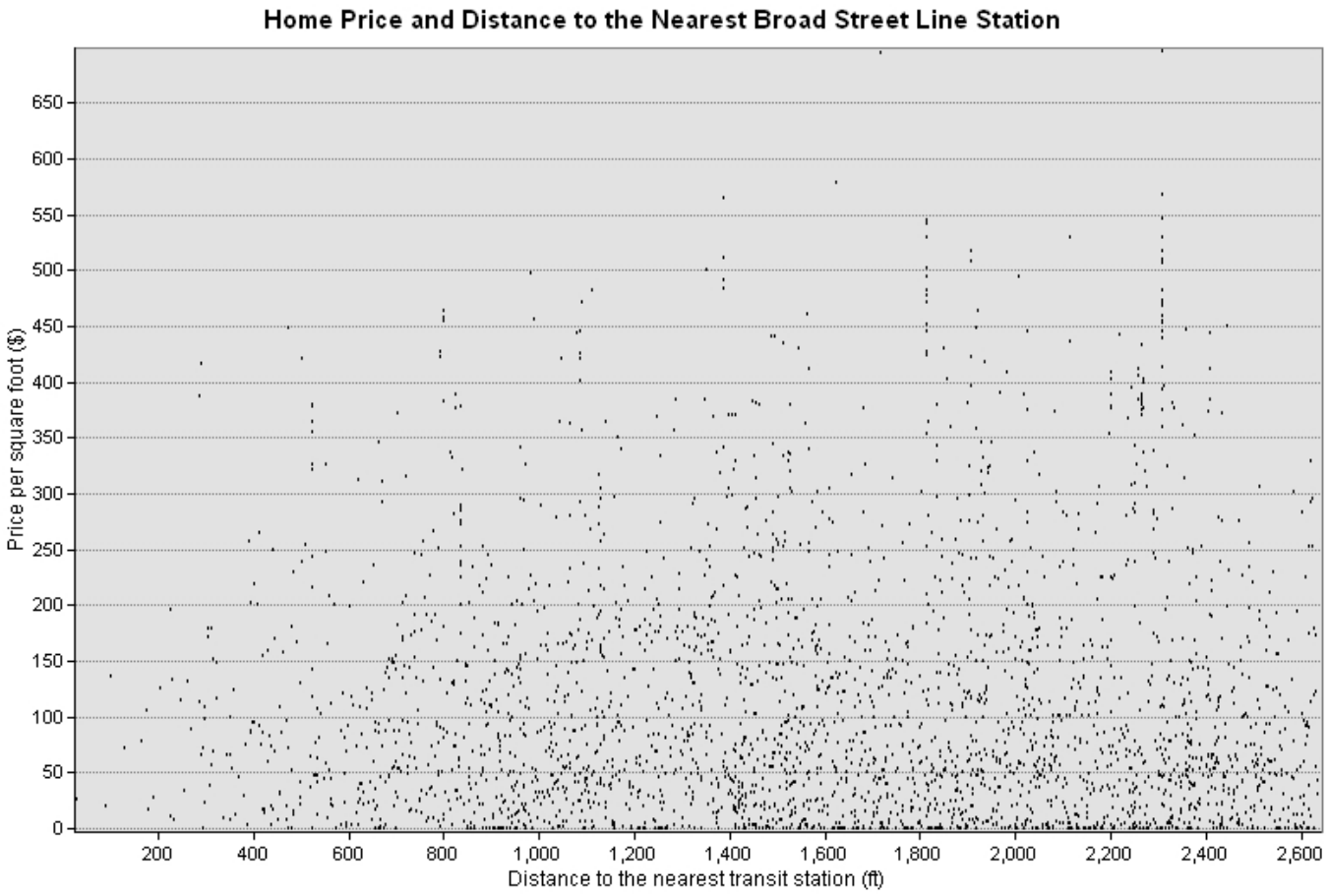
III. Statistical relationship between home price and distance to transit

1. Average home price per 1/2-mile of the Broad Street Line stations



The median of the average home price within each 1/2-mile buffer is $123,987. According to the statistics, the transit areas with top 3 highest average home price are City Hall, Walnut-Locust, Lombard-South stations. From the map, high home price also tends to concentrate closet to the center city. The home price is relatively low, remaining at the bottom 25% of home price standing in the north of the city.

2. Scattorplot of home price V.S. distance to its nearest Broad Street Line



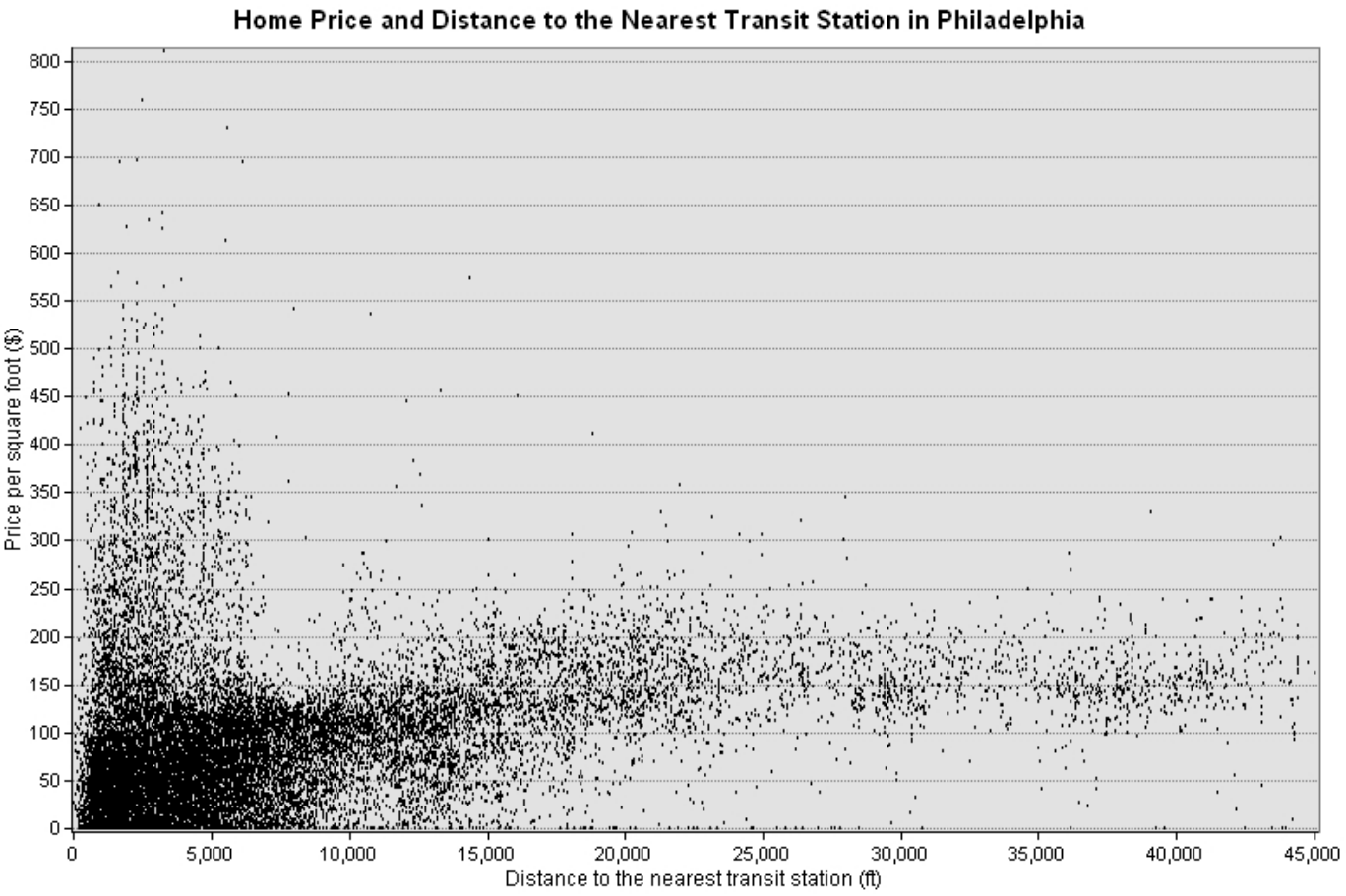
After removing outliers (I limited the price per square foot to be smaller than $700), there are 2826 transaction points in total for Broad Street Line area, so I used the 2826 data points for the scatterplot and ordinary least squares regression (OLS). Normally, we assume that if it is close to a transit station, the home price per square foot tend to be higher. But from the scatterplot, visually, it is hard to see there is an inverse relationship between price and distance. Therefore, I ran the OLS regression to build a regression model to examine the relationship mathematically:

OLS Diagnostics

Input Features:	BroadStreet_ptop_remove	Dependent Variable:	PRICE_SQFT
Number of Observations:	2826	Akaike's Information Criterion (AICc) [d]:	34694.077495
Multiple R-Squared [d]:	0.000131	Adjusted R-Squared [d]:	-0.000223

From OLS diagnotics, the multiple R-squared value is 0.000131 which is extremely small. To interpret, 0.0131% of the variation can be explained by the model. So the statistical relationship is very weak for price and distance to the nearest Broad Street Line station. From previous result of population in comparing the two lines, I think Broad Street Line does have opportunities and room to develop and improve TOD by attracting more population and having more residential space with a walking distance to transit stations.

3. Scattorplot of home price V.S. distance to its nearest station



Now we are taking all sale data (home price less than $500,000 selection at the beginning) to see the relationship between price and distance to the nearest transit station (take both Broad Street Line and Market/Frankford Line). After removing outliers (I limited the price per square foot to be smaller than $850), there are 21573 data points in total for the city. I also ran the OLS regression to check the statistical relationship. Visually from the scatterplot, it is also hard to see a conspicuous relationship between distance and price, I could only see some inverse relationship between price and distance is only obvious from 0 to 6000 feet.

OLS Diagnostics

Input Features:	Philly_ptop_removeoutli	Dependent Variable:	PRICE_SQFT
Number of Observations:	21573	Akaike's Information Criterion (AICc) [d]:	249549.308629
Multiple R-Squared [d]:	0.052610	Adjusted R-Squared [d]:	0.052566

From OLS diagnotics, the multiple R-squared value is 0.053 which is still small but more than Broad Street case. To interpret, 5.3% of the variation can be explained by the model. The statistical relationship is still very weak for price and distance to the nearest station in Philadelphia. At least from the analysis of Broad Street Line and Market/Frankford Line, Philadelphia should consider TOD to improve density around transit stations and increase the public ridership with a mix of business, residential and leisure area in a walking distance to public transit.

Furthermore, Philadelphia should consider TOD because of the disparity of median household income along transit station areas from my previous analysis. According to "Transit Oriented Development Increases Value and Affordability" from Planetizen, the article points out that, although home values near transit stations outperform the national market, they are also more affordable to residents[1]. Although normally, the average home value in TODs is higher, households that live in TODs spend the lowest percentage of their income on housing and transportation, which provide them with extra disposable income. In addition, for TOD, it should also be dense enough and walkable. The article also points out that two-thirds[2] of all rail stations across the United States are not TODs because they are not dense enough or not considered to be walkable. Hence, Philadelphia should consider TOD to relieve the pressure of household income in housing and transportation, and increase the density and dynamics around transit stations.

Works & Data Cited

1. 1 & 2: Litman, Todd. "Transit Oriented Development Increases Value and Affordability". *Planetizen*, 20 Dec, 2014. <https://www.planetizen.com/node/72929>
2. Cover photo: Google
3. Philadelphia parcel data: OpenDataPhilly <https://www.opendataphilly.org/dataset/property-parcels>

Coordinate system of map deliverables

Projected coordinate system: NAD_1983_StatePlane_Pennsylvania_South_FIPS_3702_Feet
Geographic coordinate system: GCS_North_American_1983