

The Effects of Proximity to Public Transportation and Property Tax Within Mecklenburg County

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GEOG 370

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December 4th, 2024

Introduction:

Public transportation systems have long been recognized as a catalyst for urban development, influencing property values and shaping economic landscapes. The Charlotte Area Transit System (CATS) in Mecklenburg County, North Carolina, serves as a case study for examining these effects in a growing metropolitan area. This project aims to understand the relationship between proximity to public transit infrastructure and property values over time, as well as the potential implications for urban planning and revenue generation. The main objective is to evaluate how public transit access impacts property values and property tax revenues, particularly in areas within proximity to transit stations, and to identify the broader factors influencing these relationships.

Existing studies highlight the dual role of public transportation systems in driving economic development and improving accessibility. These studies have shown that transit-oriented development often leads to higher property values in areas with close access to public transportation. For example, Debrezion et al. (2007) conducted a meta-analysis of the relationship between property values and railway proximity, finding significant positive effects on residential and commercial property values near transit stations.¹ Similarly, Nelson (1999) observed that the development of light rail systems in the United States resulted in increased property values and spurred mixed-use developments around transit hubs.² However, these benefits are not universal. Gibbons and Machin (2005) examined the London Underground and found that while accessibility positively influenced property values, the effects varied across neighborhoods depending on income levels and existing infrastructure.³ This suggests that localized factors, such as zoning laws, housing characteristics, and socioeconomic diversity, also play a crucial role.

Because of this, understanding how transit infrastructure affects property values and tax revenues is essential for informed urban planning and policy decisions. The findings can inform future transit-oriented developments, highlight areas for equitable urban growth, and provide insights into optimizing municipal revenue streams. This project will also contribute to the broader implications by examining how localized factors, such as zoning laws and building functions, mediate the relationship between transit access and property values. This project on the CATS system aims to provide actionable insights into urban development strategies while contributing to the growing body of research on transit-induced property value changes.

Methods:

Our first approach to understanding the correlation between property value and distance to public transportation stations was the implementation of a linear regression model. The necessary data came from open sources through Mecklenburg County and the City of Charlotte.⁴ The property data came from the Mecklenburg County Parcel Data Archive.⁵ This archive

¹Ghebregeziabher Debrezion, Eric Pels, and Piet Rietveld, "The Impact of Railway Stations on Residential and Commercial Property Value: A Meta-Analysis," *The Journal of Real Estate Finance and Economics* 35, no. 2 (June 19, 2007): 161–80, <https://doi.org/10.1007/s11146-007-9032-z>.

²Arthur Nelson, "Transit Stations and Commercial Property Values: A Case Study with Policy and Land-Use Implications," *Journal of Public Transportation* 2, no. 3 (September 1999): 77–95, <https://doi.org/10.5038/2375-0901.2.3.4>.

³ Stephen Gibbons and Stephen Machin, "Valuing Rail Access Using Transport Innovations," *Journal of Urban Economics* 57, no. 1 (January 2005): 148–69, <https://doi.org/10.1016/j.jue.2004.10.002>.

⁴ Charlotte NC (IT) - City of Charlotte. *LYNX Blue Line Route*. January 6, 2022. Dataset. data.charlottenc.gov/datasets/ba37d75c37034c53abeb5f4cbc502e63_0/explore.

⁵ Charlotte NC (IT) - City of Charlotte. *LYNX Blue Line Stations*. April 4, 2022. Dataset. data.charlottenc.gov/datasets/7824c64dbdd4464d83f26cf4f5e42f11_0/explore.

⁶ Charlotte NC (IT) - City of Charlotte. *LYNX Gold Line Route*. January 6, 2022. Dataset. data.charlottenc.gov/datasets/ba06e34952194815b7bf3f984180a45f_0/explore.

⁷ Charlotte NC (IT) - City of Charlotte. *LYNX Gold Line Stops*. January 6, 2022. Dataset. data.charlottenc.gov/datasets/df51b046bb5442ff9a1e1d45bbcd6737_0/explore.

⁸ Charlotte NC (IT) - City of Charlotte. *Bus Stops With Frequency HLT*. January 17, 2022. Dataset. data.charlottenc.gov/datasets/757ac30f21fb4f128e4a724ba932ea0e_16/explore.

⁹ *Parcel Look Up*. data.charlottenc.gov/datasets/charlotte/parcel-look-up/about.

included tax data from 2001-2023 which included assessed property values, location, and non-spatial property variables. This analysis used the most recent tax data available which was from 2023. Additionally, the City of Charlotte Open Data Portal was utilized to map the bus, light rail, and trolley stations as well as the routes that these public transit forms use.¹⁰ The light rail data included stations that have not been constructed, however, these stations were not included in this analysis to provide the most relevant analysis. All of these datasets are vector shapefiles and were imported and modified in QGIS. All layers were set to WGS 84 / UTM zone 17 N (EPSG:32617) which sets the units into meters and allows for accurate distance measurements.

After the data was imported and the CRS was applied to all layers, the tax data was normalized to allow comparison between different properties. The tax data included the assessed value of a given property, which is what property tax rates are based on, as well as the heated square footage of each property. A new column was created in this dataset for the price per square foot by dividing the assessed value by the heated square footage.

A new layer was created that merged all of the public transportation stations across Mecklenburg County. This layer was created to run a “Distance to Nearest Hub (line to hub)” vector analysis tool to find the distances to each station from the center of each property.¹¹ This vector analysis tool finds the shortest distance to the closest hub from any given property on the map “as the crow flies.” This tool creates a new layer that includes all of the attributes from the tax data layer, including the new column of normalized property value, and includes the distance, in meters, for each property. This layer was exported and saved as a CSV file for further data cleaning and regression analysis.

The data analysis program R Studio was used to perform data cleaning and linear regression. Two external R packages, ggplot2, and tidyverse, were used to assist in data analysis. Outliers and “NA” data were omitted from the regression analysis. A linear regression analysis was performed by comparing the distance to the nearest hub and price per square foot. A multiple linear analysis was also performed by using variables already available from the tax data. The additional variables used in the multiple linear regression include number of bedrooms, number of bathrooms, year built, number of stories, and zoning.

Our second approach focused on analyzing the growth of property taxes over time in areas surrounding the CATS stations. This approach utilized the same datasets and sources as the previous method, as well as the same projection, with the only significant difference being the data format. Property taxes were calculated by taking the total property value and multiplying it by the county tax rate, represented by the equation $y=(100x)\times 0.4831$.¹² These calculations were performed in Excel for all tax-related datasets and later joined to their corresponding shapefiles to ensure the tax rate remained consistent across multiple municipalities. However, tax exemptions for properties such as churches and universities were not included in the analysis. Datasets from 2002, 2009, 2020, and 2023 were chosen to illustrate property tax growth during key periods: 2002 as one of the earliest datasets available, 2009 to account for lagging effects following the Lynx Blue Line’s completion and the peak of the Great Recession, 2020 to capture the impact of the COVID-19 pandemic, and 2023 as the most recent complete dataset.

¹⁰ City of Charlotte Open Data Portal. *Bus Routes*. City of Charlotte, 6 Jan. 2022, data.charlottenc.gov/datasets/charlotte::bus-routes-1/explore?location=35.218987%2C-80.869941%2C11.83.

¹¹ Bradley, Tobin. *Open Mapping - Data*. maps.mecknc.gov/openmapping/data.html.

¹² “Tax Rates,” Tax Rates | Office of the Tax Collector, accessed December 3, 2024, <https://tax.mecknc.gov/tax-rates>.

Cleanup was required for the 2002, 2009, and 2020 datasets¹³ due to errors detected using the 'Check Validity' function in QGIS, which were resolved with the 'Fix Geometries' function. Afterward, two new layers were created to place buffers around the CATS stations, with distances of 0.25 miles and 0.5 miles representing typical walking distances to a station.¹⁴ The buffers were dissolved to remove overlaps, and the 'Intersection' and 'Difference' functions were applied to the tax datasets and buffers, resulting in distinct target zones for each analyzed year: the entire county, areas within 0.25 miles of a station, areas within 0.5 miles of a station, and areas outside the buffer zones. Finally, the 'Basic Statistics for Fields' function was used to calculate the interquartile range (IQR) and mean property tax data for each target zone. This data was then imported into Excel to create both graphs and tables showing the rate of change and growth of the property tax within each target zone.

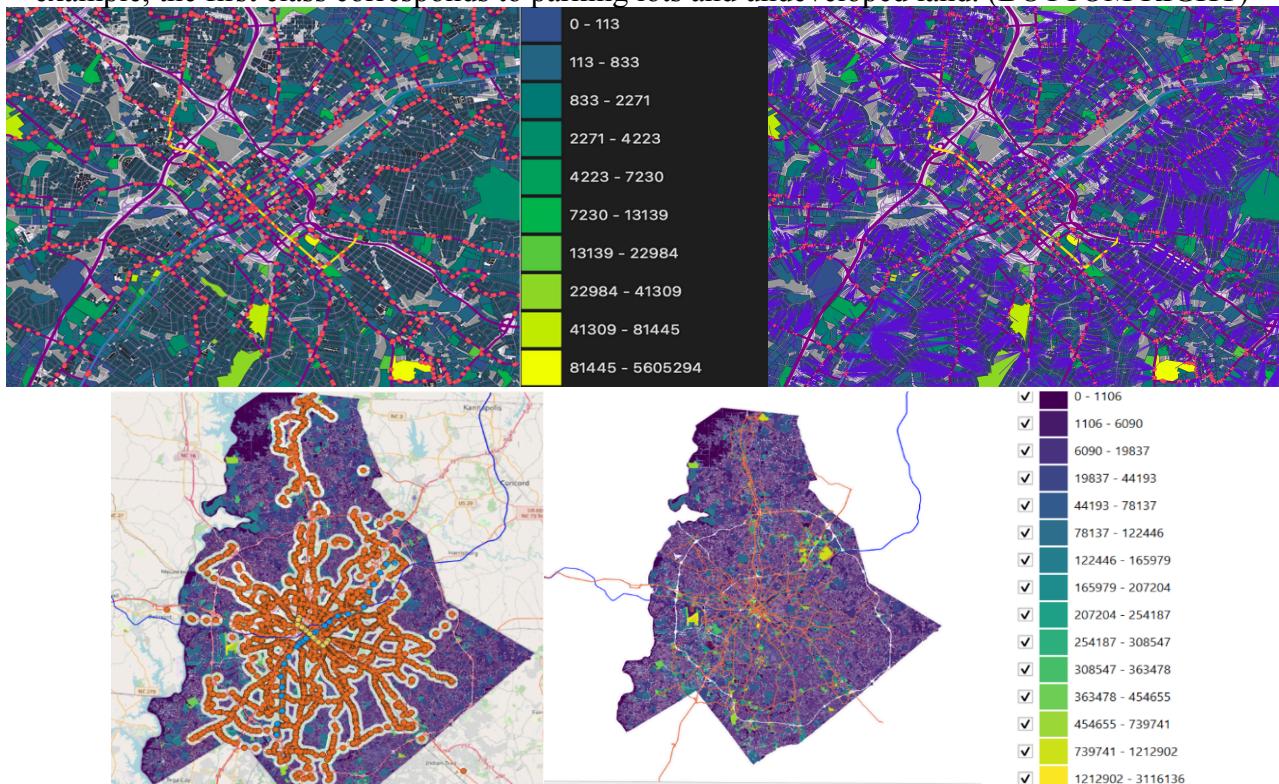
Results:

Map 1. Normalized property value data was visualized using Natural Breaks (Jenks) classification with 10 different classes. Each class represents the price per square foot in USD. Properties that were not categorized were visualized using a single symbol categorization with a gray fill. (TOP LEFT)

Map 2. Distance to Nearest Hub visualized using purple vector lines overlaid on the normalized property value map. (TOP RIGHT)

Map 3. Visualization of the various target zones for the buffer analysis (BOTTOM LEFT)

Map 4. Illustrates property tax values using the Natural Breaks (Jenks) classification method, divided into 15 categories. Each category represents a specific property type's tax value. For example, the first class corresponds to parking lots and undeveloped land. (BOTTOM RIGHT)



¹³ Mecklenburg County, NC - OpenMapping/Parcel Data Archive. 24 Feb. 2023, Zipped Shapefile mecklenburgcounty.hosted-by-files.com/OpenMapping/Parcel%20Data%20Archive.

¹⁴ Tamara Redmon, "Pedestrians and Transit - Safety: Federal Highway Administration," Federal Highway Administration, January 31, 2013, https://safety.fhwa.dot.gov/ped_bike/ped_transit/ped_transguide/ch4.cfm.

Figure 1. Distance to Nearest Hub and normalized property value scatter plot

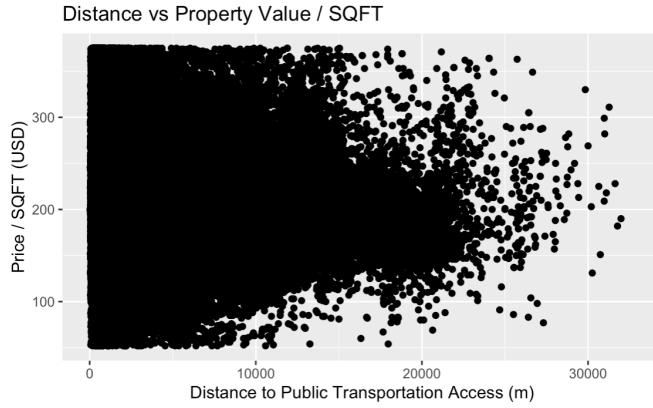


Figure 2. Linear Regression Results

Multiple R-squared: 0.01931, Adjusted R-squared: 0.0193
 F-statistic: 6785 on 1 and 344689 DF, p-value: < 2.2e-16

Figure 3. Multiple Regression Results

Multiple R-squared: 0.1029, Adjusted R-squared: 0.1028
 F-statistic: 1362 on 29 and 344589 DF, p-value: < 2.2e-16

Figure 4. Growth of IQR and Mean

IQR	Full County	Half Mile	Quarter Mile	Outside Buffer
2002	\$637.21	\$615.95	\$681.65	\$659.43
2009	\$637.21	\$660.40	\$827.55	\$571.51
2020	\$1,109.20	\$1,324.66	\$1,689.88	\$913.06
2023	\$1,434.32	\$1,676.36	\$2,124.67	\$1,185.53
	125.09%	172.16%	211.69%	79.78%
MEAN	Full County	Half Mile	Quarter Mile	Outside Buffer
2002	\$2,161.84	\$2,803.47	\$3,563.80	\$1,486.71
2009	\$3,273.40	\$4,435.41	\$5,848.94	\$2,655.41
2020	\$6,039.15	\$8,567.96	\$11,454.23	\$3,718.15
2023	\$9,501.00	\$13,572.91	\$18,188.93	\$7,511.84
x	339.49%	384.15%	410.38%	405.27%

Discussion:

The results of our first approach to understanding the effect of proximity to public transportation stations and property value showed that distance is related to property value but there is not a direct correlation. Similar results were found in the multiple linear regression with a more significant adjusted r-squared value, however, not significant enough to justify a correlation. This lack of correlation is not surprising considering the scope of this project. Many factors are influencing property value that were not measured in this study. Other variables such

as school district, crime rates, and distance to green spaces play a role in property value. Additionally, this analysis covers the entire county of Mecklenburg creating a wider variability of data making linear analysis a less-than-ideal fit for finding a correlation between property value and distance to public transportation stations.

The second approach yielded more positive results, with areas within a quarter-mile of CATS stations experiencing around five percent higher property value growth than areas outside the buffer. However, the outside buffer target area showed the second-highest growth in mean property value, likely due to suburban expansion and the rise in single-family housing prices, which are predominantly located outside the buffer. This is supported by both the IQR, which showed minimal variability in growth and the categorization of parcels, with 127,866 out of 267,378 single-family parcels located outside the buffer.

Limitations of this methodology include distance measurement and property exclusions. The use of "as the crow flies" distance measurement does not accurately reflect the actual distance required to walk, bike, or drive to a public transportation station. While a network analysis would have been more accurate, it was not feasible due to limited processing power. Attempts to use the '*Open Route Services*' to address this were unsuccessful due to API limits.

As previously mentioned, some properties were excluded from the regression analyses due to missing data. Specifically, 52,622 out of the 437,444 total properties lacked information such as heated square footage and/or assessed value. The inclusion of heated square footage helped narrow the focus of the tax data to residential and commercial properties, as properties without heated areas would not fall into these categories. This refinement is better aligned with our thesis, which focuses on property taxes applied to residential and commercial properties. Furthermore, any potential issues arising from the use of heated square footage were addressed in the second approach, which utilized the absolute property value regardless of whether the property was heated. This dual perspective enables the analysis to capture both variances, providing a deeper understanding of the impact of public transportation on property values.

The findings indicate that public transportation's impact on property values is limited but present. While the correlation analysis revealed little connection between the two, the time analysis showed a slight increase in property value growth over time. This counters the issue of wholesale value in areas like downtown Charlotte but does not eliminate the influence of desirability factors, such as proximity to malls or workplaces, often found near the city center. This creates a "chicken or egg" dilemma: is property value growth driven by transit availability, or were these regions already the most desirable?

To address this question, future research could implement year-by-year longitudinal studies, comparing property values before and after transit development and conducting geospatial analyses of property value changes at varying distances from transit stations. By incorporating data from city records not available online and controlling for external variables such as crime rates, zoning, and school quality, researchers could better isolate the role of public transportation. Surveys of residents and developers could also provide direct insights into decision-making processes, helping disentangle the causal relationship between transit and property tax growth. Such research would be particularly valuable as Mecklenburg County develops new light-rail lines, such as the Red and Silver lines. Furthermore, exploring zoning subgroups and additional factors like green space and crime rates could deepen our understanding of the many elements influencing property values. Ultimately, while public transportation plays a role, it is just one piece of a city's complex puzzle.

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