



CJUS 6171/DSBA 6010 Geospatial Analytics and Crime

Light Rail Opening's Impact On Crime in Charlotte, NC

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1. Introduction

Public Transport in the form of light rail is a convenient and cheaper way to commute. But when more people start using the light rail, more security is to be deployed to ensure the safety of the commuters. It is perceived that more thefts happen when the size of passengers is in either extremes – during the peak hours and the wee hours.

Criminologists have called transit stations crime attractors and fear generators because they can generate crime and disorder by producing crowds. But in addition to crime occurring at the station, some have argued that mass transit systems have the potential of exporting crime from one area to the other. A study showed that station crime was strongly related to ridership. Less serious crime (e.g., vandalism) was higher in stations located in dense neighborhoods with higher proportions of youth. Researchers identified that crime at open spaces are spontaneous with less planning and the offender has a physiological understanding of the surrounding. In examining the environment of Chicago railway stations, researchers found that the bulk of robberies were not concentrated immediately at the station, but about 1 to 1½ blocks away.

According to the American Public Transportation Association, Charlotte light rail is the 18th-largest based on weekday ridership. The Charlotte Area Transit System (CATS) - Lynx Blue line is one of the only two light rail systems in the entire nation to show double-digit growth in ridership from the previous year. In 2007 when the Blue Line was introduced, CATS expected the Blue Line to average about 9,100 weekday trips. Ridership numbers came in about 50% higher than that, and by 2015, that number was up to more than 15,000 weekday trips. In 2019, the average weekday ridership is around 27,500 — and CATS projects more than 7 million total riders by the end of the current fiscal year, a new record.

The light rail offers a nearly 19-mile path from UNC Charlotte southwest across the city to near the South Carolina line. In a car at rush hour, that trip could take nearly two hours. On the train, it's less than half of that. Using the light rail has a clear advantage but is it safe? In this project we would like to compare how the crime rate has changed along the rail route after the inauguration of the Blue Line.

2. Literature Review

2.1 Theories on how public transportation influence the crime. Amount? Type?

Billings, S., Leland, S., & Swindell, D. (2011)

The paper offers an overview of how criminals may use the light rail for their crimes. Rail transit may improve the mobility of criminals and may increase crime because the presence of a rail station undermines an area's defensible space thus decreasing safety in the immediate neighborhood. Some scholars investigating the transit and crime linkage as part of this larger debate note that transit-oriented investments breed crime by linking central city crime with

outlying areas, providing gangs a means of access and territorial control, as well as serving as a conduit for bringing drugs into suburban communities.

The rail transit stops provide cover for potential offenders because riders stand around and this is not thought of as a suspicious activity. Stations provide easy exit and entry for criminals. Finally, potential targets of criminals typically live away from the area and may not be familiar with the surroundings.

2.2 Previous studies on the topic. Why we are different? Consider the crime type?

Liggett, Robin, et al. "Journeys to Crime: Assessing the Effects of a Light Rail Line on Crime in the Neighborhoods."

The focus of the study was along the Green Transit line in Los Angeles, CA.

In this research work, to identify long-term trends, the crime series data sets were first adjusted for quarterly (seasonal) variation. To control for other factors influencing crime rates, station neighborhood trends were also compared to county crime trends during the same period.

The research concludes that no evidence was found to confirm that this transit line opened a new platform for committing crime, and has not transported crime from the inner city to the suburbs. Overall, most station neighborhoods have either experienced no change or have witnessed a reduction in crime after the introduction of the Green Line.

Although the study focuses on crimes along the light rail, different categories of crime weren't individually studied which would help on taking relevant measures that are crime type specific. However, this research work helps us to understand the different aspects when studying crime along the light rail.

Piza, Eric L., and Kennedy. Transit Stops, Robbery, and Routine Activities: Examining Street Robbery in the Newark, NJ Subway Environment.

The study was to find if a relationship exists between street robbery around the Newark, NJ Subways. Robbery was the fourth most frequently occurring crime, and the second most frequently occurring violent crime, behind assaults with hands or feet.

To discover the concentration of street robbery, ArcView's calculate density function was used. In order to determine the proportion of robberies occurring around transit stops, 2 sets of buffers around the subway stops were created in ArcView.

The research found that around 11% & 25% of the robberies occurred within the 1300 & 2600 feet buffer around the subway stations respectively.

During the peak hours, around 15% & 30% of the robberies occurred within the 1300 & 2600 feet buffer around the subway stations respectively.

Having over 20% of street robberies cluster around the Newark city subway is a substantial finding.

This research helps us to understand a specific crime type - Robberies that is more common in public transports. But our study focuses on crime changes before and after the inception of the light rail. Additionally, a generic buffer of 1300ft and 2600ft are a good way to

study the crime changes but different stations will have different rate of busyness around and following a specific buffer may not be ideal.

(Clarke, Belanger, & Eastman, 1996)

The study was about the New York city subway system. The study found that the rates of robbery are highest for those stations with the fewest passengers. This was obtained by plotting robbery rates for each station against their daily passenger densities thus obtaining a log-linear distribution.

To examine whether a late-night/early-hours effect existed independent of density, a regression analysis using a log transformation of the adjusted hourly robbery rates was done. The analysis confirmed that a late-night/early-hours effect existed. This indicated that a low passenger densities during the late/early hours have a greater risk of crime occurrence.

The study offers a good preliminary understanding of crimes along one of the earliest subway systems. However we would like to study more about the current trends in crime when we have advanced and faster light rails.

Information from other works:

- Billings, S., Leland, S., & Swindell, D. (2011):

It is identified that the light rail does not actually increase crime around stations. Instead, we see a decrease in property crimes once the station locations are announced, which remains relatively stable after the light rail begins operating.

- Ihlanfeldt, K. (2003):

Using a unique panel of neighborhood crime data for Atlanta, the results from estimating fixed effects and random effects models show that transit's impact on crime depends on certain characteristics of the neighborhood. The mix of these characteristics found within central city neighborhoods has resulted in transit increasing crime there, whereas in the suburbs crime has been reduced by transit.

3. Methodology

3.1 Data Collection

The panel crime data from 2005 to 2016 is provided by the advisor, Dr. Shanon Reid. We mainly used X/Y coordinate, location type, incident date and crime type in the dataset. For light rail transit area information, we retrieved the dataset for LYNX Blue Line Route, LYNX Blue Line Stations and Transit Station Areas from Charlotte Open Data Portal (<http://data.charlottenc.gov/>). We used the transit station areas as a buffer zone to spatial join the crime around each light rail station. The only missing transit station area in the dataset is around the stations in uptown, which include 9th Street Station, 7th Street Station, CTC Station and 3rd Street Station. Considering that the stations are close in uptown (Figure 1), a buffer area covering the whole uptown is added into the dataset for these stations.

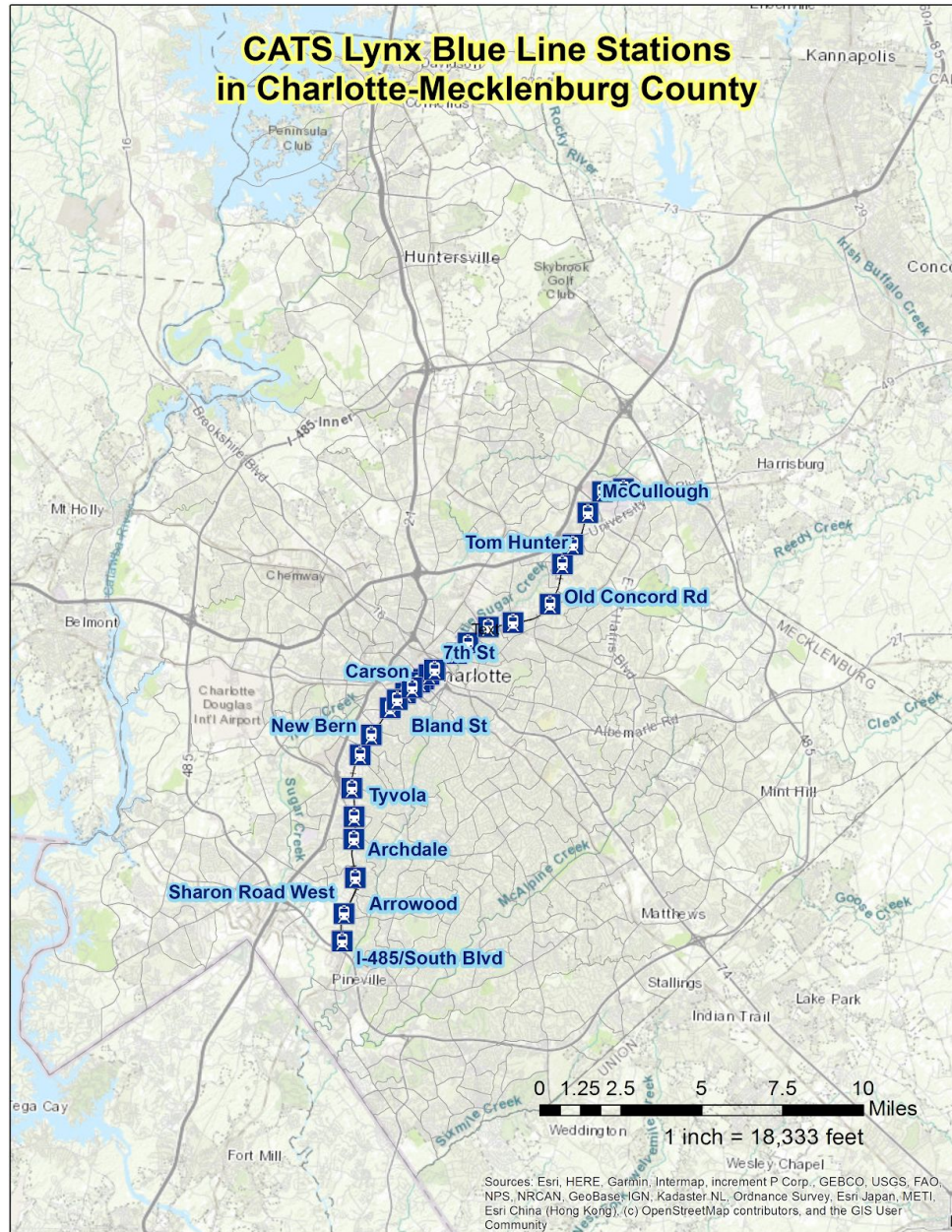


Figure 1. LYNX Blue Line stations map.

3.2 Experiment Design and Tools

Since the Blue Line opened in 2007, we chose to compare the crime happened in 2006 and 2008 to investigate the impact of light rail on crime in the neighborhoods close to the transit stations.

Below are the steps of the experiment:

Step 1. Use the transit station areas as a buffer zone.

Step 2. Spatial join the buffer zone and all outdoor crime in 06 and 08 separately. Get incident06_study and incident08_study.

Step 3. Compare the number of total crime in incident06_study and incident08_study. Use paired t-test to determine if the difference is statistically significant.

Step 4. Count the number of each crime type in 2006 and 2008 separately. Find the crime types that increased or decreased the most in two years.

Step 5. Compare these specific crime type counts in 2006 and 2008. Find the station-wise changes of these crime types.

The tools used in the study are ArcMap 10.6.1 and SAS Enterprise Guide 71 64-bit.

4. Results

A selection of demographic characteristics around the transit areas by census tract was shown in the maps below (Figure 2, 3 and 4). The light rail mainly travels through the medium populated, highly unemployed and less wealthy areas.

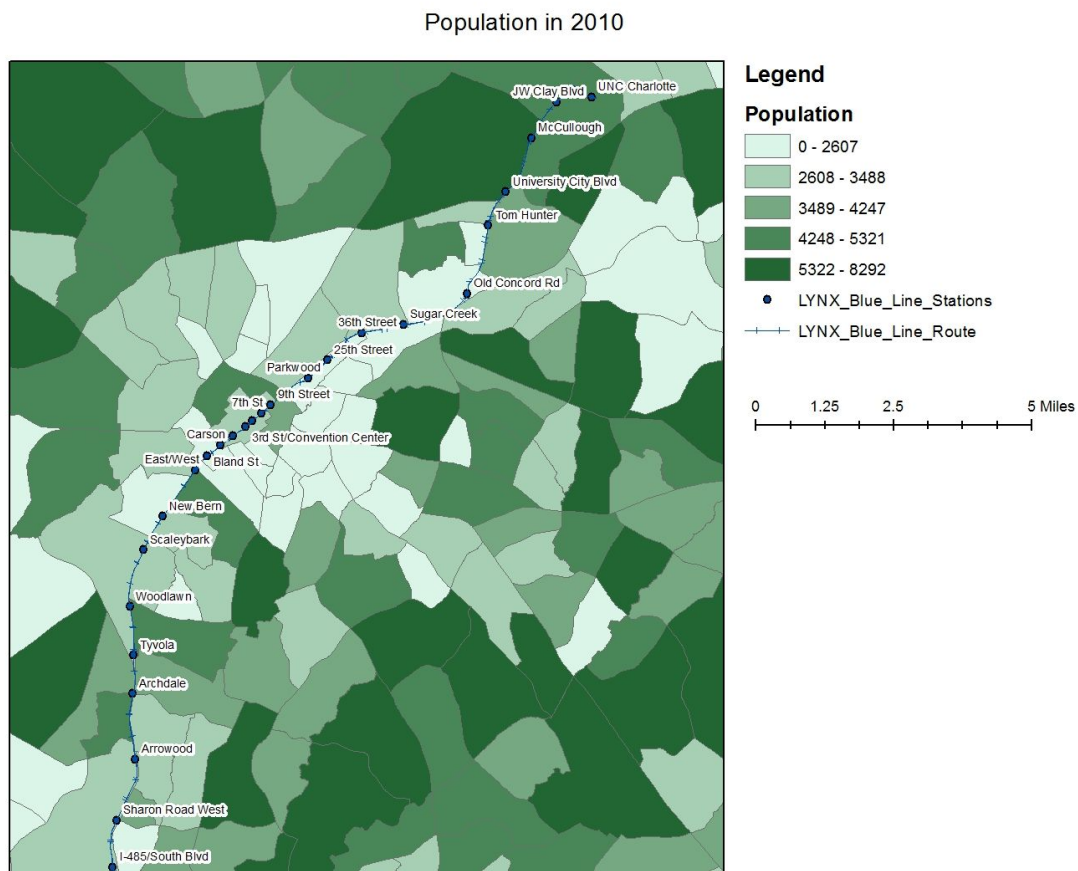


Figure 2. Population density map along Lynx Blue Line stations by census tract in 2010

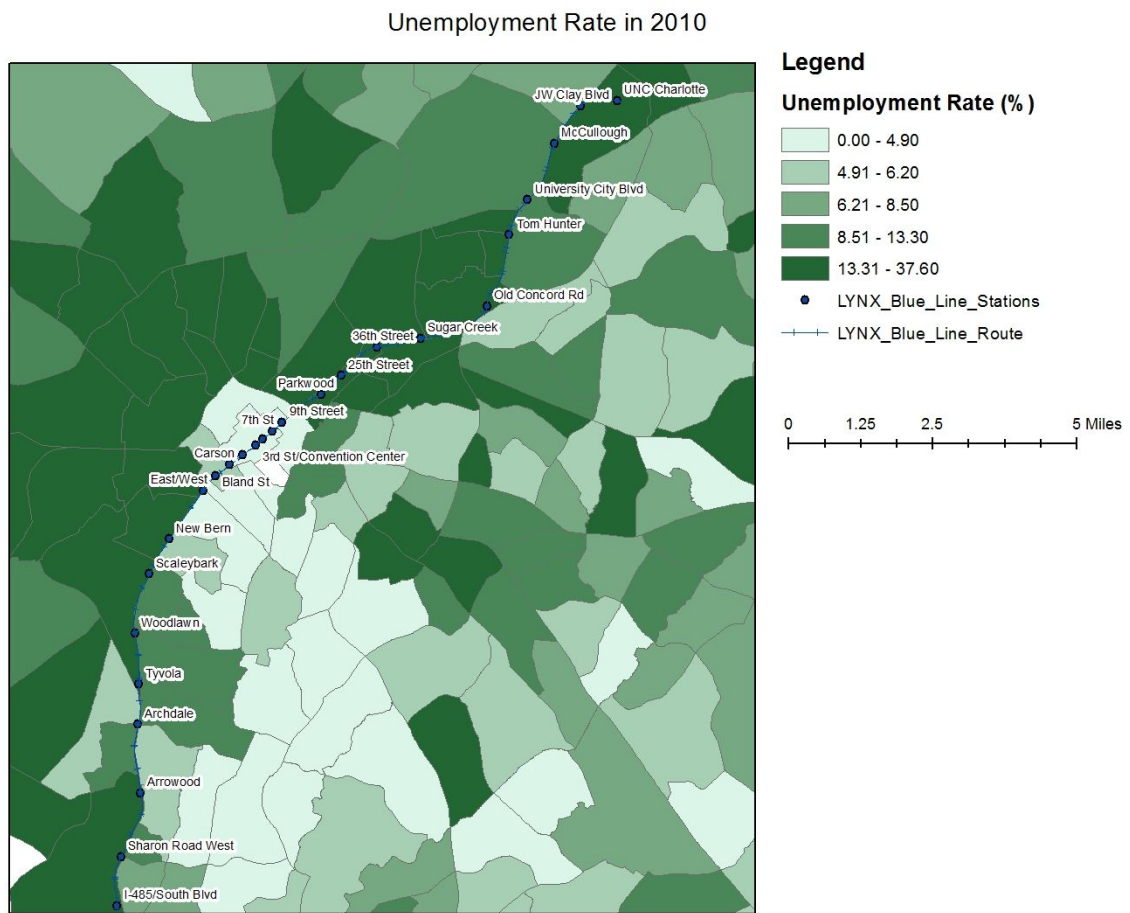


Figure 3. Unemployment rate map along Lynx Blue Line stations by census tract in 2010

Median Household Income in 2010

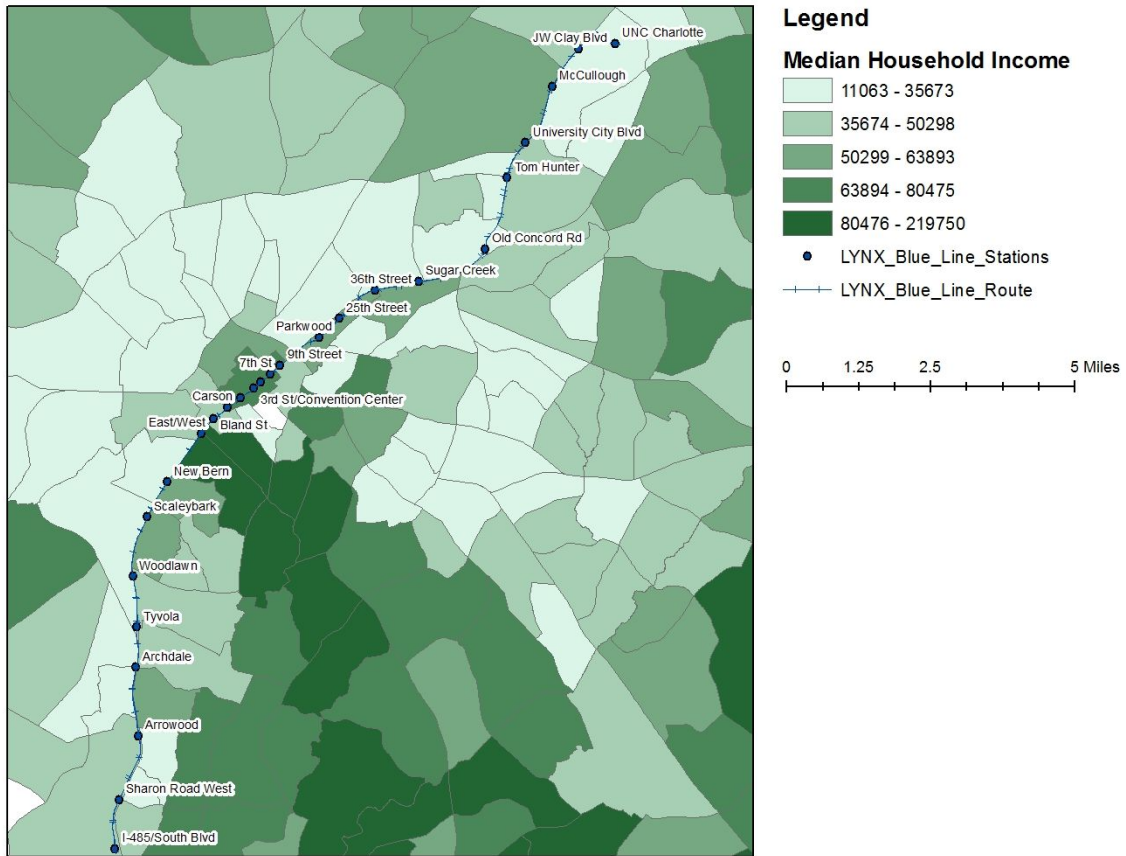


Figure 4. Median household income map along Lynx Blue Line stations by census tract in 2010

The total crime distribution seems not to change from 2006 to 2008 (Figure 5). JW Clay transit station area, uptown area, New Bern and Sharon Rd West area experience the most amount of crime in both years. Parkwood station and 25th Street station areas remain safer compared to the other stations.

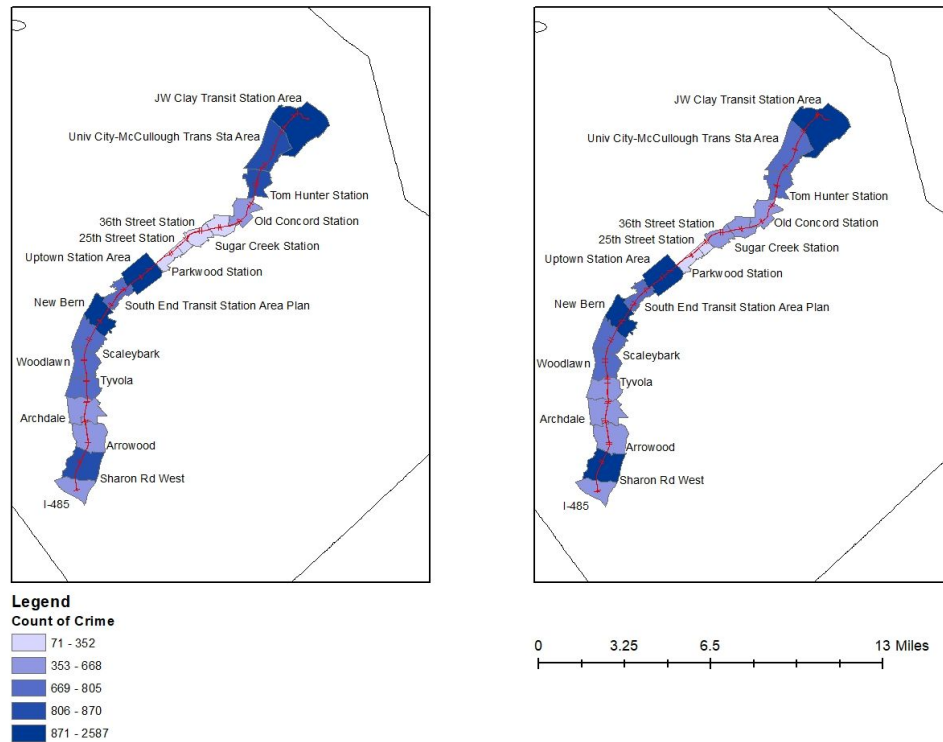


Figure 5. Total crime count along the light rail stations (left: 2006 data; right: 2008 data)

As for the non-indoor crime count changes, 36th Street station, Arrowwood and Sugar Creek Station saw the most increases, whereas Tom Hunter Station and University City-McCullough transit station area saw the most decreases (Figure 6 and 7).

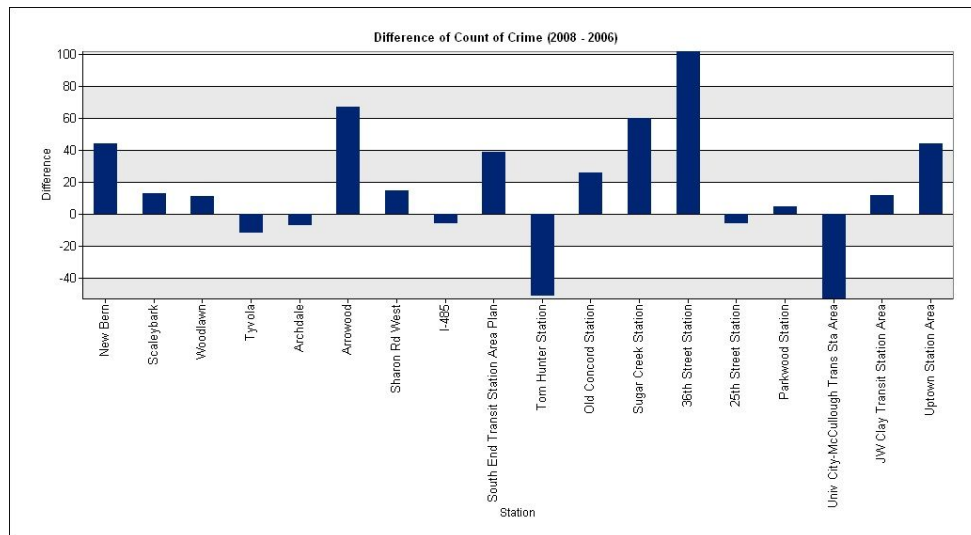


Figure 6. Bar chart of differences of non-indoor crime count (2008 crime count minus 2006 crime count) for each station

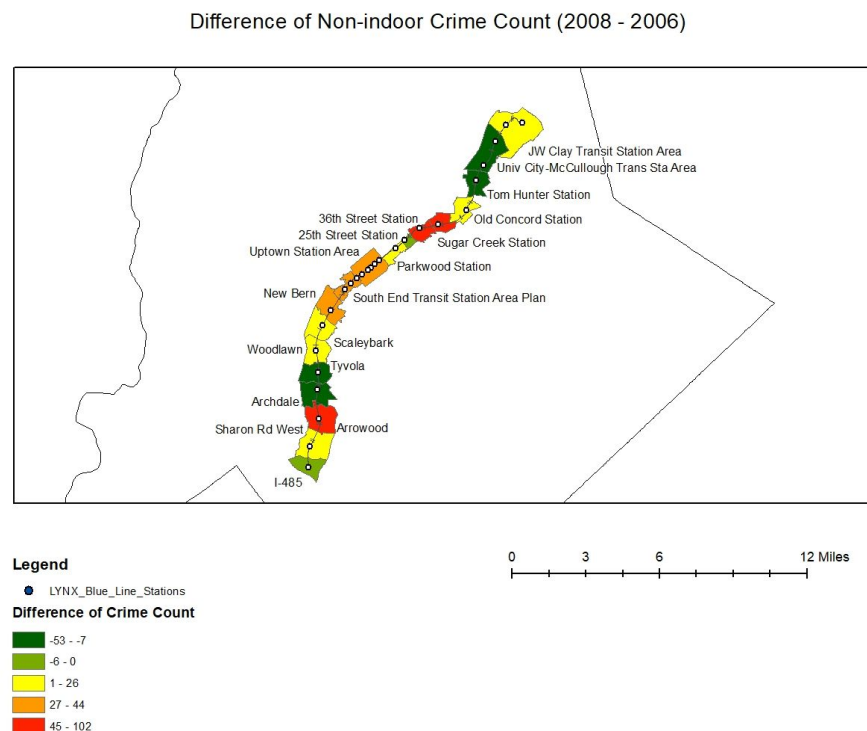


Figure 7. Map of differences of non-indoor crime count (2008 crime count minus 2006 crime count) for each station

A paired t-test was conducted in SAS Enterprise Guide to determine if the difference between non-indoor crime count in 2006 and 2008 is statistically significant. The result is shown in Figure 8. Although the 95% confidence interval contains 0, the mean difference is still positive. That indicates that the non-indoor crime count in 2008 is statistically significant and slightly higher than in 2006.

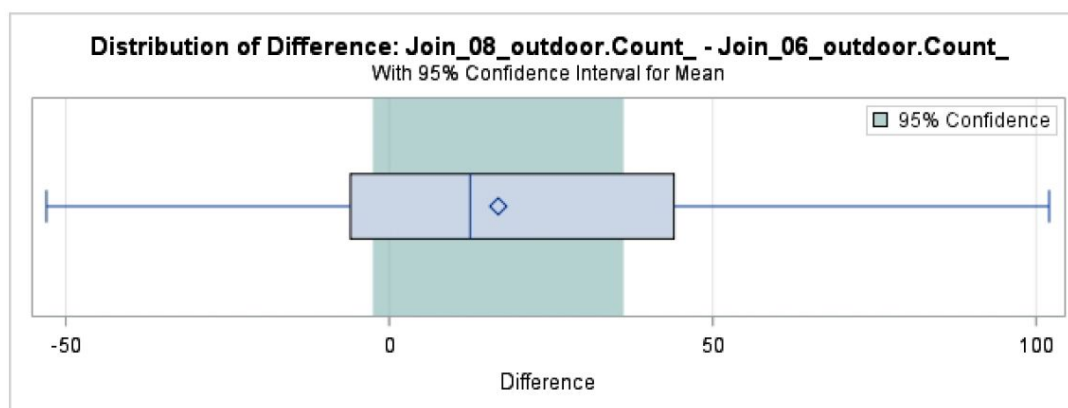


Figure 8. Paired t-test of 2006 non-indoor crime count in transit station areas vs 2008 non-indoor crime count in transit station areas result.

The most common crime types in 2006 in the light rail transit areas are theft from motor vehicle, motor vehicle theft, damage/vandalism of property, all other thefts and simple assault (Figure 9). The most common crime types in 2008 in the same areas are theft from motor vehicle, damage/vandalism of property, motor vehicle theft, drug/narcotic violations and all other thefts (Figure 10).

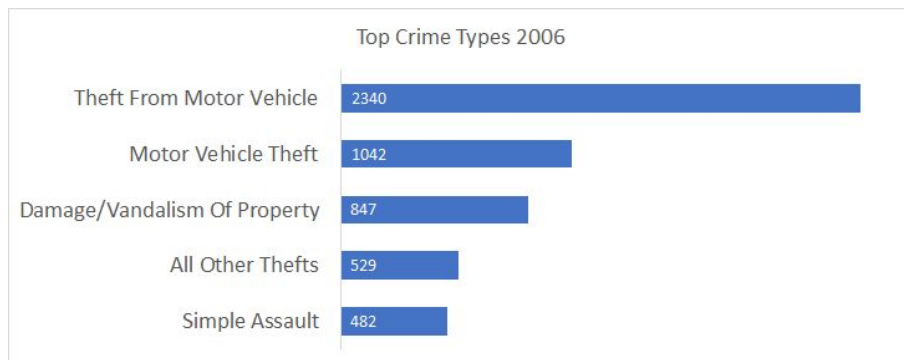


Figure 9. Top crime types in 2006 in terms of counts in light rail transit areas

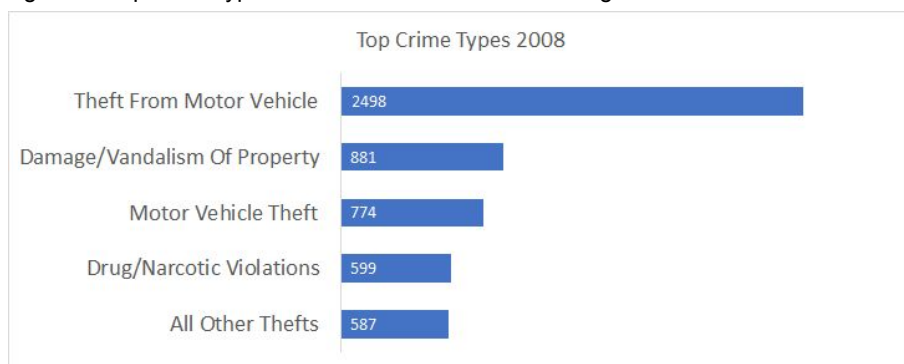


Figure 10. Top crime types in 2008 in terms of counts in light rail transit areas

Compared to the crime count in 2006, drug equipment violations, theft from motor vehicle and drug/narcotic violations saw the most increase in number, whereas motor vehicle theft, robbery and burglary/B&E decreased the most (Figure 11). We are going to have a closer look at each of the crime types and their changes regarding each station.

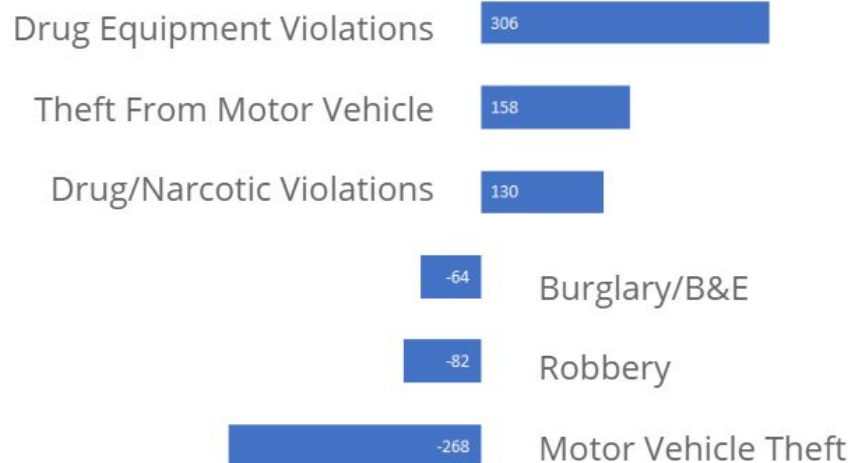


Figure 11. Top Crime Count Changes in 2008 Compared to 2006. Numbers show the amount changed.

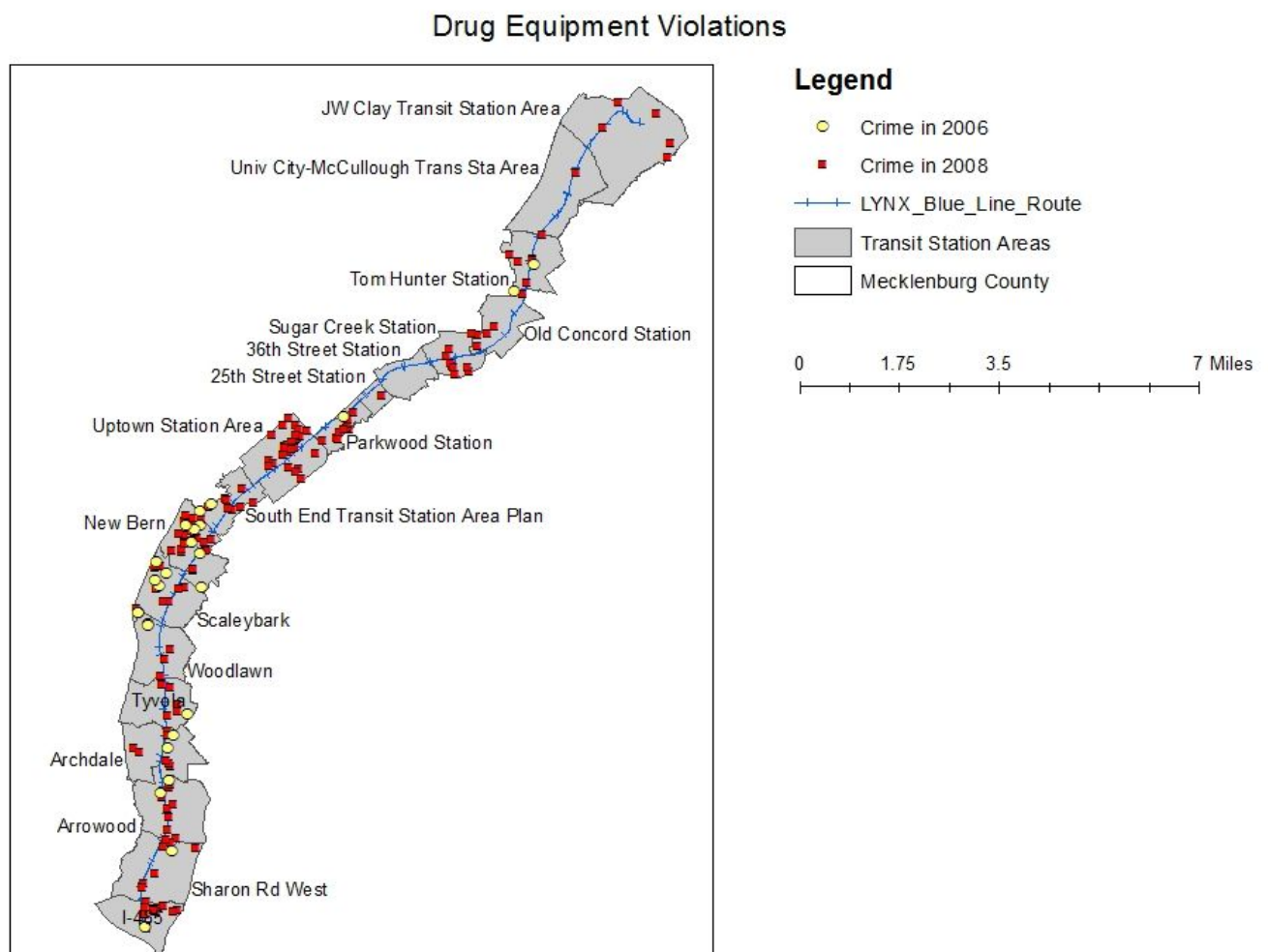


Figure 12. Drug equipment violations in 2006 and 2008 in light rail transit areas

Drug equipment violations used to happen mostly in New Bern and Scaleybark areas in 2006 as shown in Figure 12. After the opening of the light rail, it happened along the light rail route across Charlotte. This might indicate that the drug dealers use light rail to transport the equipment.

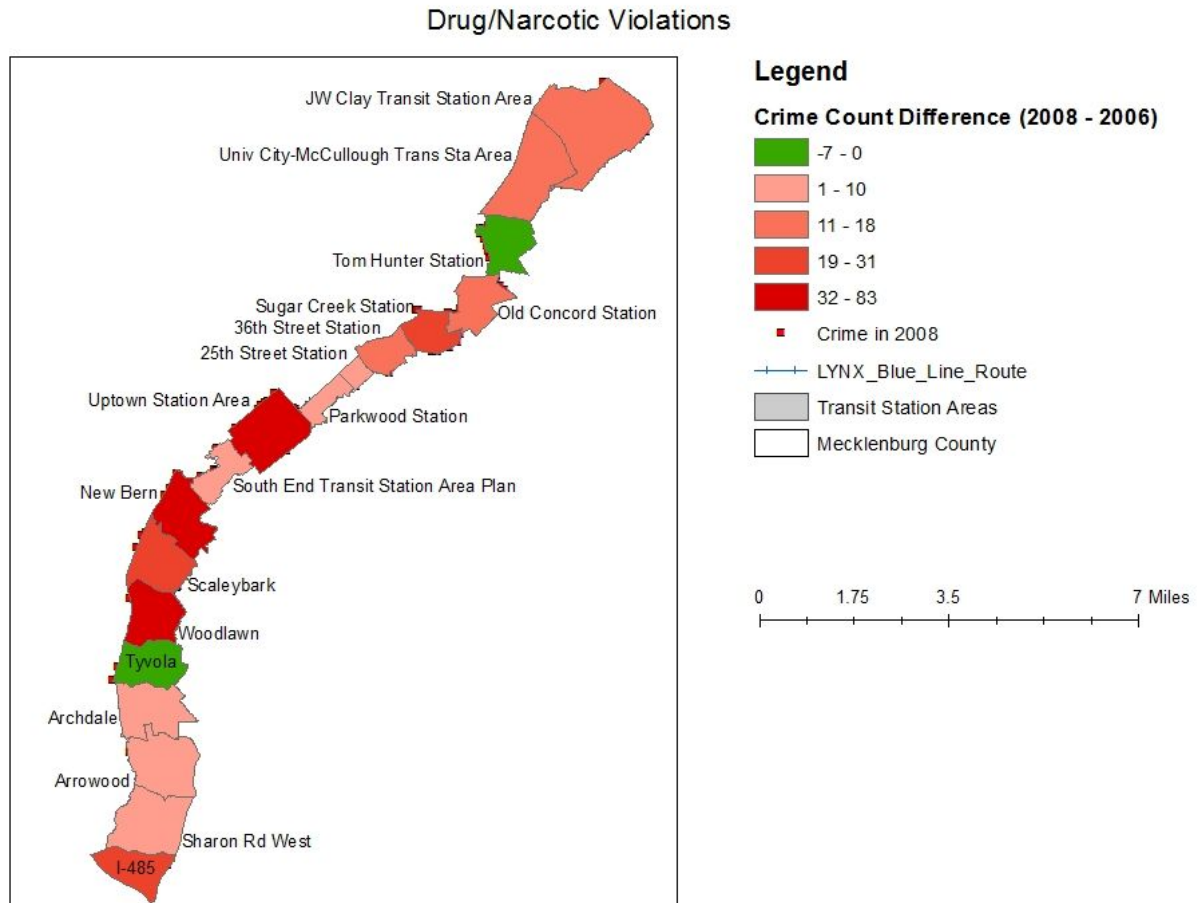


Figure 13. Drug/Narcotic violations count difference (crime count in 2008 minus crime count in 2006) in light rail transit areas

Most of the stations encountered an increase in drug/narcotic violations after the light rail opening, even for those stations which were not open in 2007 (Figure 13). Only two stations (Tom Hunter Station and Tyvola) saw a decrease in the crime. The most severe increases are spotted in uptown area, New Bern and Woodlawn. It seems that not only the drug equipment violation increased in the light rail transit areas, but also the drug/narcotic violation.

Theft From Motor Vehicles

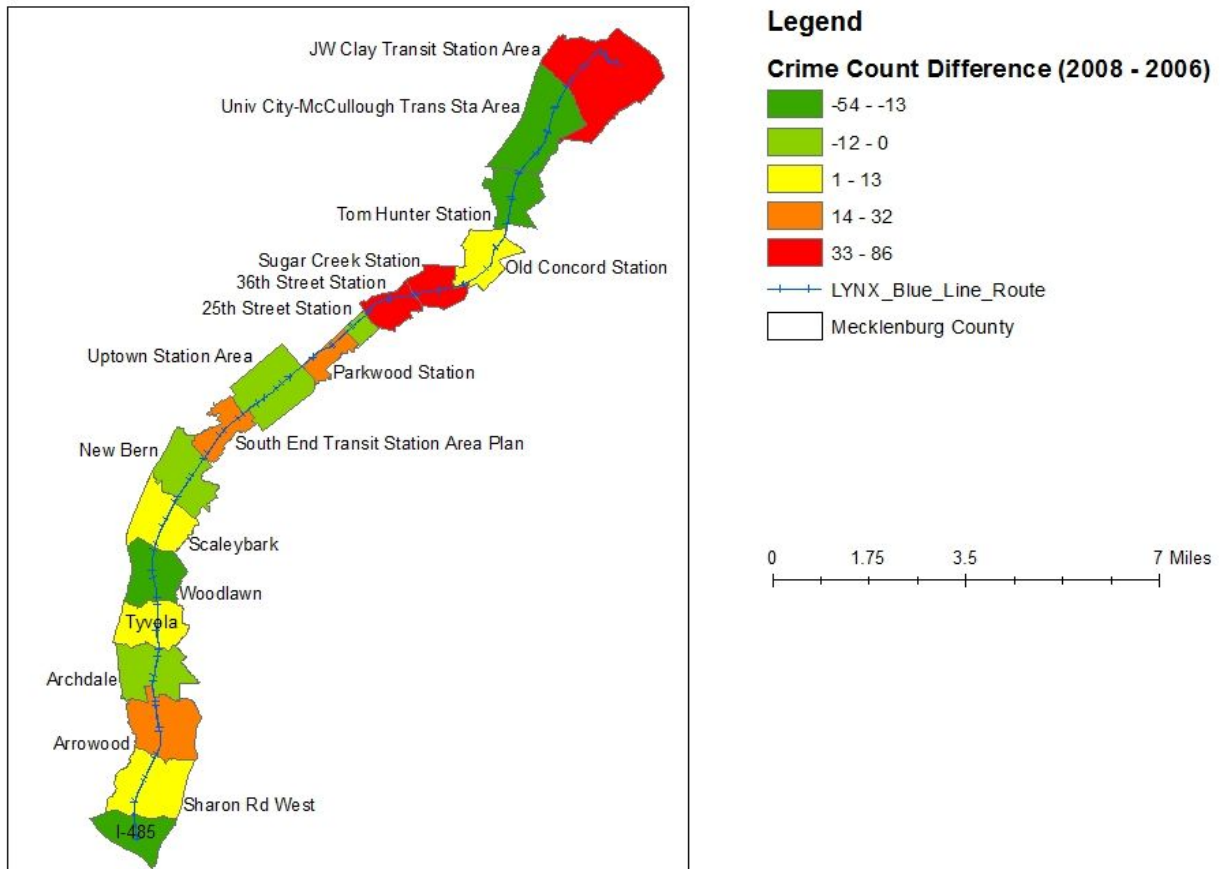


Figure 14. Theft from motor vehicles count difference (crime count in 2008 minus crime count in 2006) in light rail transit areas

The largest increase in theft from motor vehicles happened in JW Clay Transit Station area, Sugar Creek Station and 36th Street Station (Figure 14). Both JW Clay Transit Station area and Sugar Creek Station are next to multi-story parking decks. 36th Street Station is next to the NoDa, the city's art and entertainment district with many restaurants and bars.

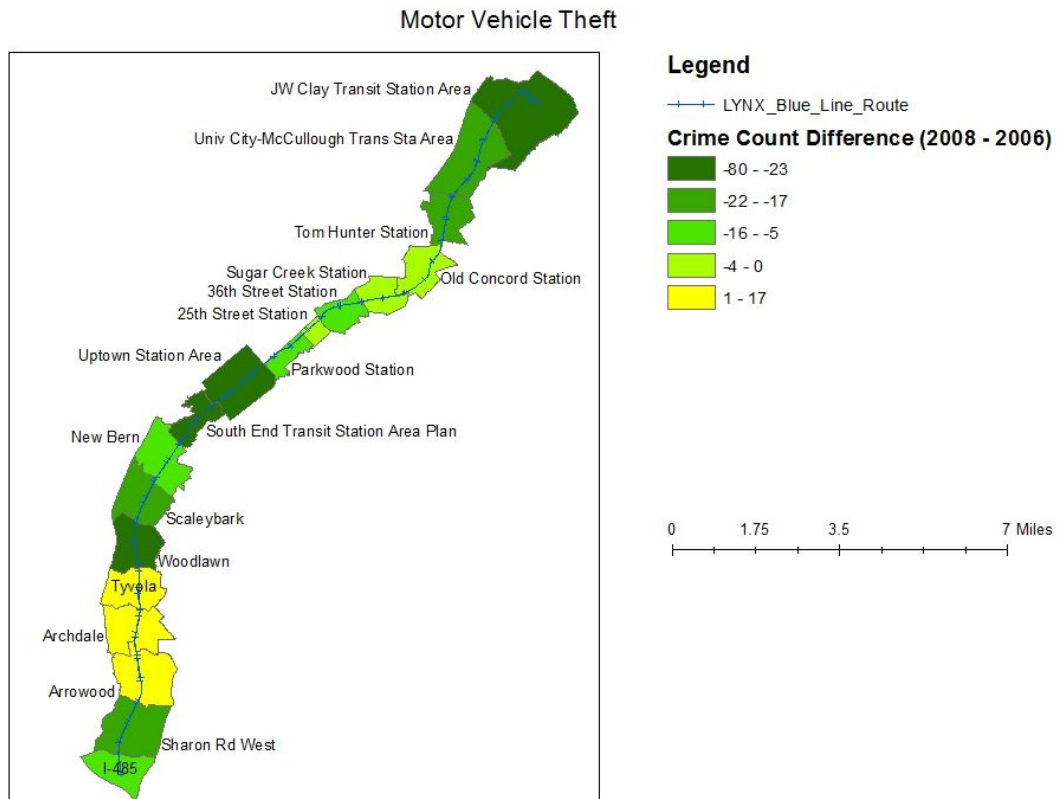


Figure 15. Motor vehicle theft count difference (crime count in 2008 minus crime count in 2006) in light rail transit areas

On the contrary to theft from motor vehicles, motor vehicle theft counts dropped in 2008 compared to 2006, mostly seen in JW Clay Transit Station Area, uptown area, South End Transit Station Area and Woodlawn (Figure 15).

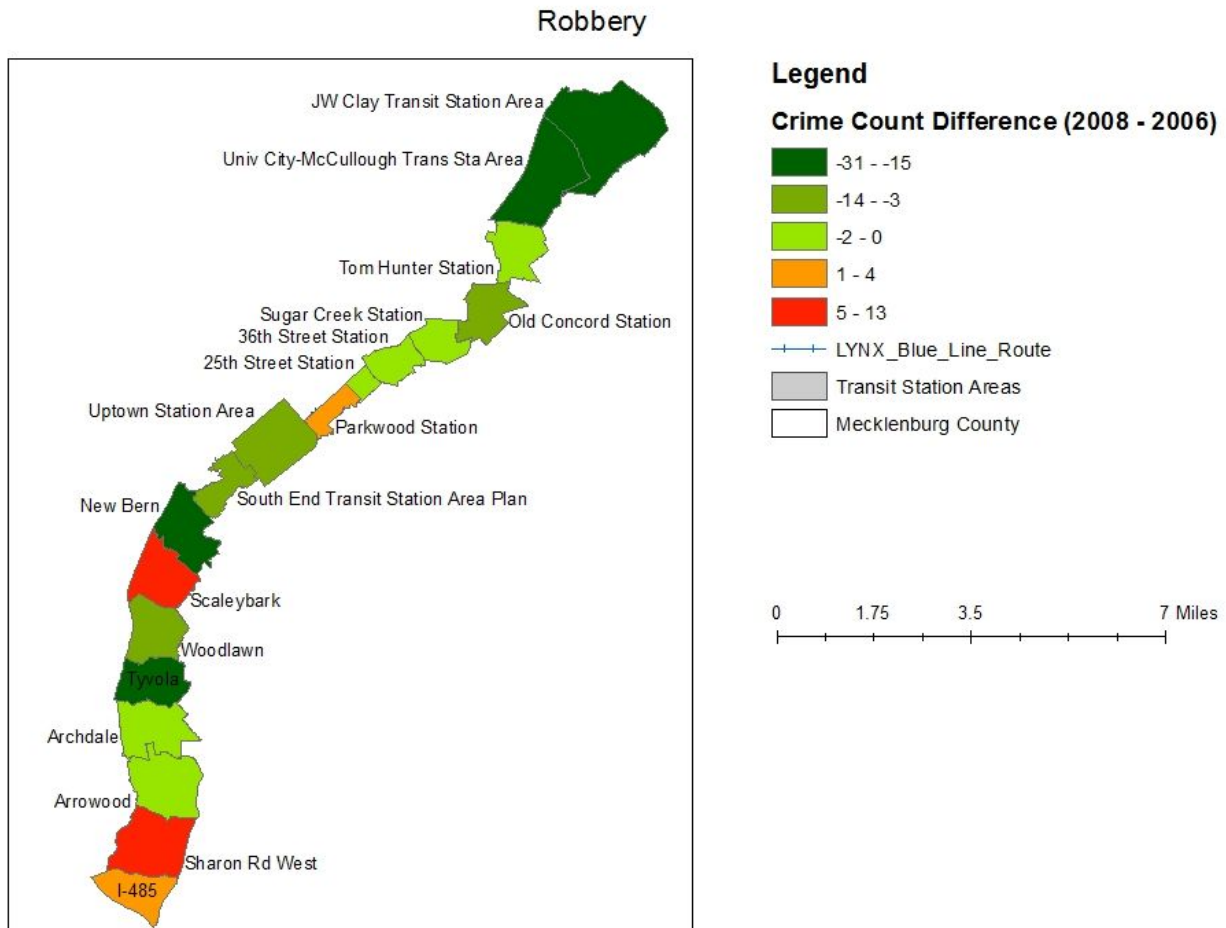


Figure 16. Robbery count difference (crime count in 2008 minus crime count in 2006) in light rail transit areas

Robbery dropped largely in university area, New Bern and Tyvola, but increased in Scaleybark and Sharon Rd West (Figure 16). Scaleybark station is next to a piece of unused land and parking lot on the one side, and auto stores on the other side (Figure 17). Sharon Rd West is in the industry area, next to a parking lot and gas station (Figure 18). Scaleybark and Sharon Rd West are both located in an area with less traffic, and that makes the people around these areas more vulnerable. This finding is in accordance with the results of a study on New York subway stations (Clarke, Belanger, and Eastman, 1996). The researchers found that the number of platform robberies was inversely correlated with passenger density at these stations.

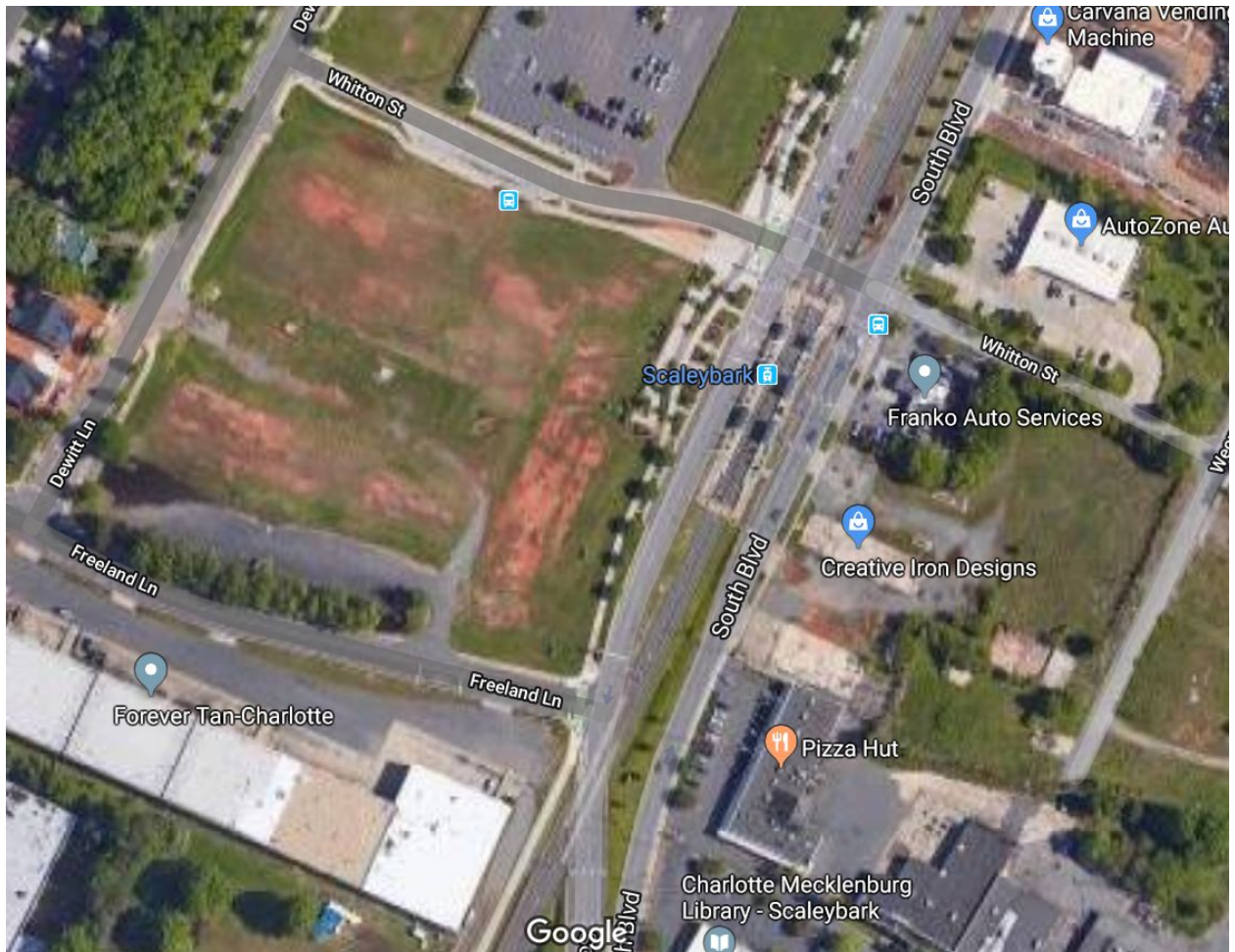


Figure 17. Surroundings of Scaleybank Station (source: Google Maps)

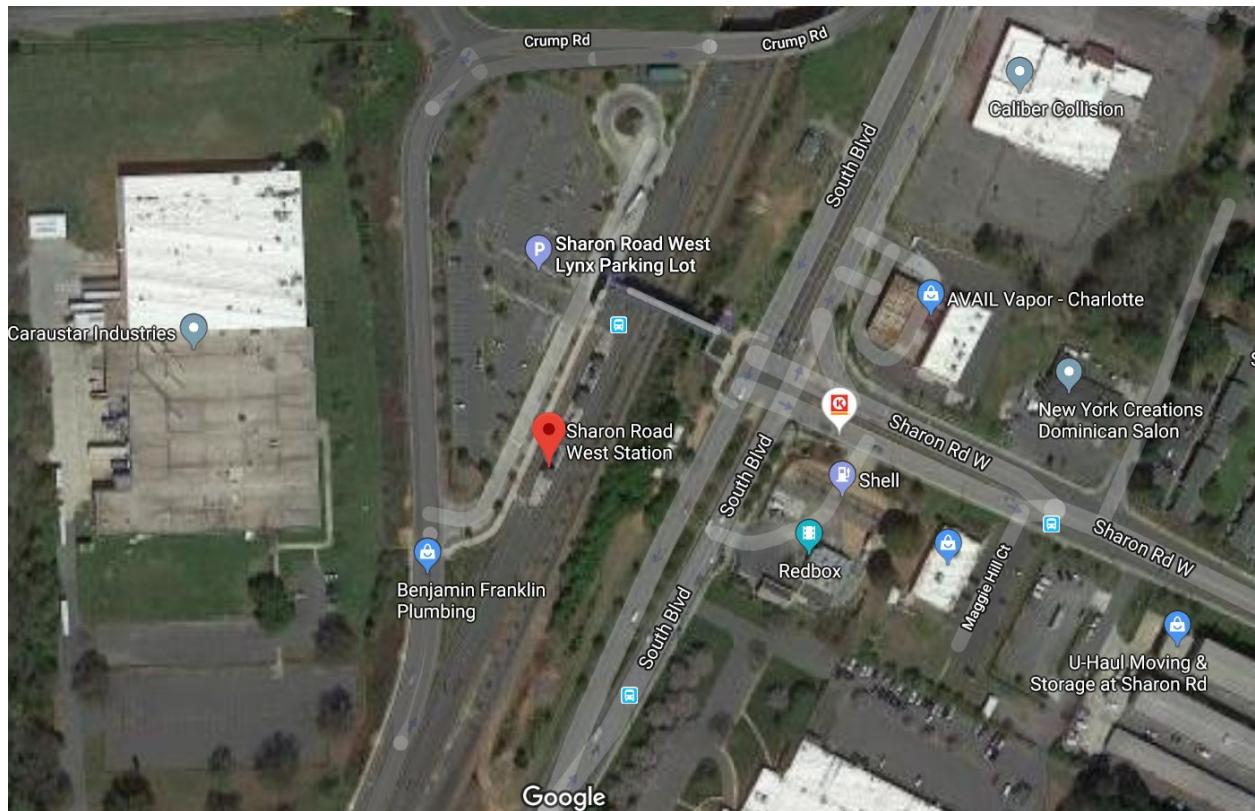


Figure 18. Surroundings of Sharon Road West Station (source: Google Maps)

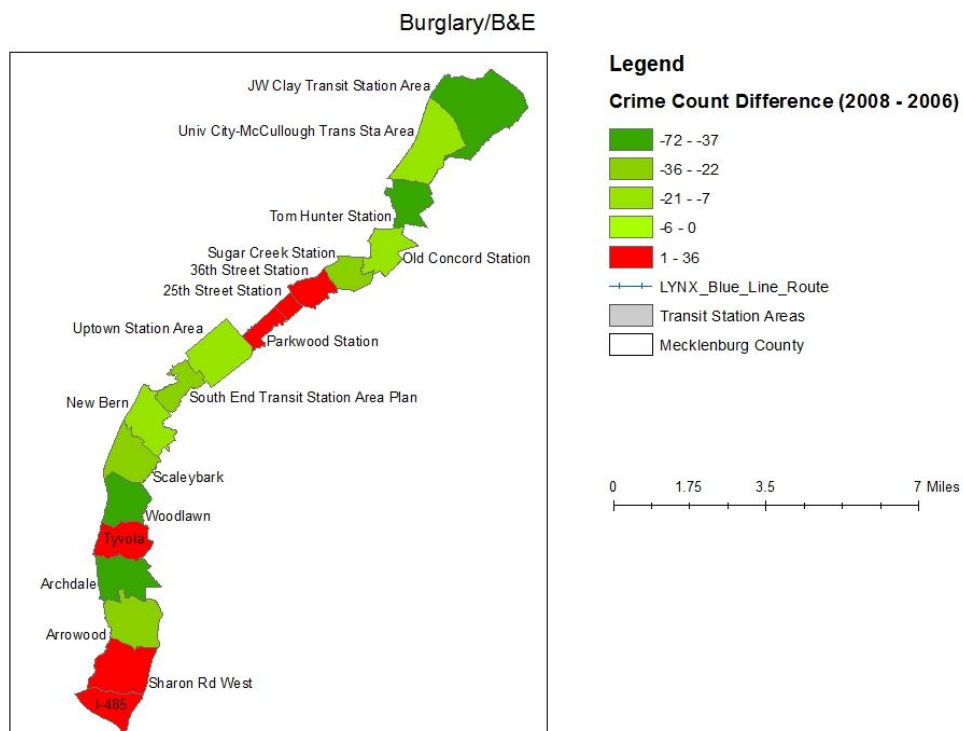


Figure 19. Burglary/B&E count difference (crime count in 2008 minus crime count in 2006) in light rail transit areas.

There were far less burglary or break & entering in JW Clay Transit Station area, Tom Hunter Station, Woodlawn and Archdale (Figure 19). Still, there were increases in 36th Street Station to Parkwood Station, Tyvola, Sharon Rd West and I-485 Station. Tyvola Station is next to several financial related institutions, such as banks, ATMS, pawn stores, as well as a shopping center (Figure 20).

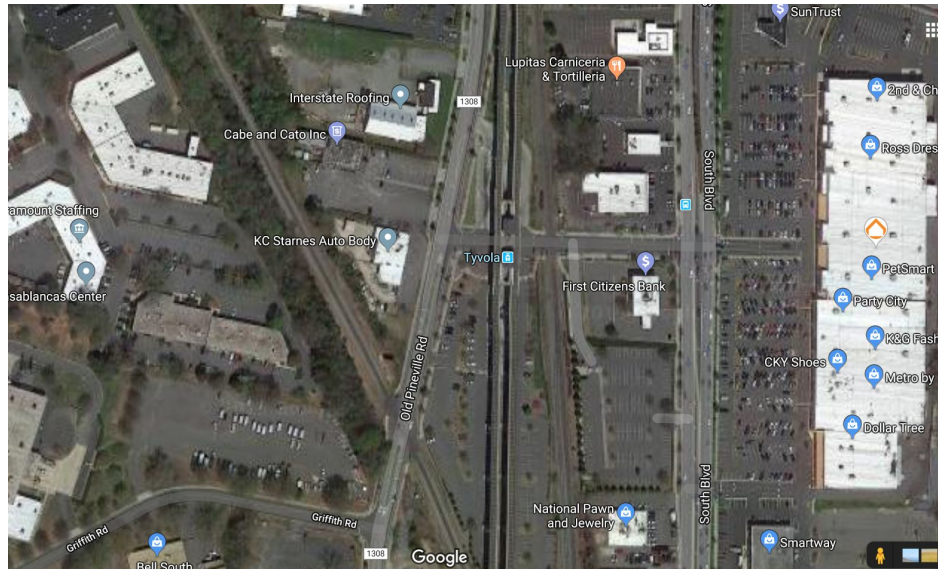


Figure 20. Surroundings of Tyvola Station (source: Google Maps)

5. Conclusion

The construction and opening of crime is commonly linked to the change of crime in the neighborhoods around the transit stations. In this study, we compared the crime type counts around the stations before and after the opening of the Lynx Blue Line in Charlotte, North Carolina. The results shows three conclusions:

1. Light rail brings change to the most common crime types in the transit areas;
2. Light rail has different impact on different types of crime. For example, drug related crimes increased by motor vehicle theft decreased after the opening of the light rail;
3. Light rail has different impact on different transit station areas. For example, 36th Street station, Arrowood and Sugar Creek Station had increases in total non-indoor crime counts, whereas Tom Hunter Station and University City-McCullough transit station area saw decreases.

Based on the findings, we suggest the authorities increasing the force on preventing drug related crime along the Lynx Blue Line stations, which is the most increased crime after the opening of the light rail. As for the mostly happened crime, theft from motor vehicles, we suggest more security in the parking lots and especially, parking decks, next to the transit stations. More attention should be paid to stations next to vacant lots or in the industrial area, such as Arrowood, Scaleybark and Sharon Road West. Station and parking lot design eliminating the hiding spots and increasing the visibility via sufficient lighting should create “defensible space” (Newman 1972), such that passengers could feel safer using the light rail.

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