INVESTIGATING THE RELATIONSHIP BETWEEN CRIME AND PUBLIC TRANSIT IN CHICAGO

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Introduction

Crime rates tend to be related with modern public transit systems. Evidence shows that in the United States, overall crime rates are twice as high in Metropolitan Statistical Areas as in rural areas. In MSAs, theft is 135%, murder is 53%, and robbery is 800% more frequent than in rural areas[1]. One main theory claim that the densely populated areas encourage crime by lowering transportation costs to committing crime[2]. And public transit plays an important role in lowering such cost and thus facilitating traveling between dense city areas.

Popular opinions and public safety professionals tend to espouse this opinion. In addition, researches into the relationships between crimes and public transit in recent years have confirmed such belief. In 2015, a research scoping at temporary maintenance-related closed transit stations in Washington, DC shows that a closed station leads to 5% decrease in crimes in the vicinity of stations[3]. And a research looking at rail transit stations in Atlanta concludes that rail stations have a statistically significant effect on neighborhood crime, with neighborhoods closer to poor people more likely to experience an increase in crime from transit access[4].

Our research investigates the public transit stations in Chicago and aims at determining if there are any relationships between transit accessibility and crime rates. We constructed regression models between transit station accessibility and crime rates in its surrounding neighborhoods. And we controlled for the demographic, socio-economic information in these neighborhoods. With the

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[1] "U.S. Census," 2012.

[2] Edward L. Glaeser and Bruce Sacerdote, "Why Is There More Crime in Cities?," *Journal of Political Economy* 107, no. S6 (1999).

[3] David C. Phillips and Danielle Sandler, "Does Public Transit Spread Crime? Evidence from Temporary Rail Station Closures," *Regional Science and Urban Economics* 52 (2015): 13–26.

[4] Keith R. Ihlanfeldt, "Rail Transit and Neighborhood Crime: The Case of Atlanta, Georgia," *Southern Economic Journal* 70, no. 2 (2003): 273–94.

interpretation of the regression outcomes, we expect to hopefully come up with some policy implications for decision makers to achieve crime preventions via increasing the transportation costs for potential perpetrators. For instance, we may allocate police resources to certain defined areas and targeting multiple connected locations on the same lines and so on.

Finally, we find that public transit accessibility density does not have statistical correlation to the total crime data in Chicago but has statistical correlation to the crime subcategories we examined. More specifically, while railway transit accessibility density has correlation to violent crime and property crime, bus transit accessibility density has statistical correlation to property crime and sex and drug crime.

Methodology

Case and Unit of Analysis

In this study, we choose Chicago as our case because it is one of the largest cities in America with extremely high crime rate and large public transit network. And our unit of analysis is census tracts. There are 866 census tracts in Chicago, so the sample size is large enough and it is convenient to get access to census data which we need for generating control variables.

Dependent Variables: Crime Rate

Considering the research objective and categorized method from the Bureau of Justice Statistics, three types of crime are indirectly selected from all criminal records, which are property crime, violent crime, and sex and drug crime[5]. Based on instructions from the office of Justice program, all three types are composed of multiple criminal types from the criminal records in the acquired dataset. More specifically, we set property crime as a combination of "theft", "motor vehicle theft", "criminal trespass", "deceptive practice", and "burglary". And violent crime consists of "criminal damage", "assault", "battery", "homicide", "robbery", and "criminal damage". And sex and drug crime are composed of "narcotics", "obscenity", "other narcotic violation", "crim sexual assault", "prostitution", "public indecency", and "sex offense".

We collected crime data[6] extracted from Chicago Police Department's CLEAR (Citizen Law Enforcement Analysis and Reporting) system via Chicago Data Portal and then grouped them into three categories we mentioned above. For each census tract, we measure crime rate by

[5] MotivanMark. 2019. Immigration, Citizenship, and the Federal Justice System, 1998-2018. Bureau of Justice Statistics.

[6] URL: https://data.cityofchicago.org/api/views/kf95-mnd6/rows.csv?accessType=DOWNLOAD

counting the numbers of three types of crimes happened within the tract and dividing them by total population. As shown in the results, Property Crime and Sex&Drug Crime have very similar spatial distribution pattern which is quite different from the pattern of violent crime.

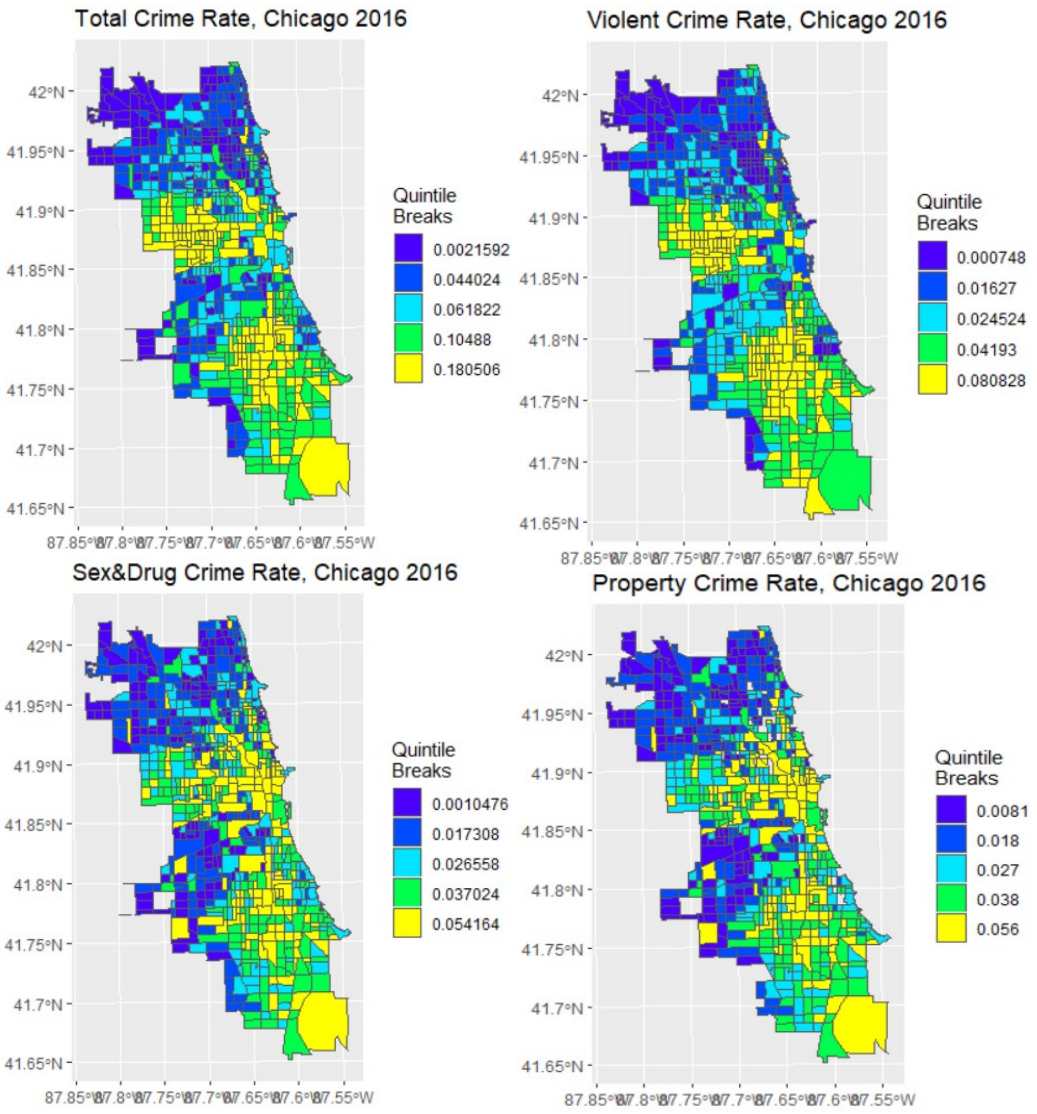

Figure 1 Chicago Crime Rate by Tracts

Measuring Public Transit Accessibility

The first step in measuring the public transit accessibility is to define what it is. In the context of urban economics and geography, accessibility is characterized as the facilitation in accessing a specific area or location[7]. In this study, for the measure of public transit accessibility, we use the cumulative opportunity measure, which counts the number of places that are reachable from a given location by taking public transit[8]. We didn't use more sophisticated measure because of the limited data we have access to.

Two main transit systems in Chicago, bus and "L"(rail), are included in this study. We collected bus stops data[9] and "L" rail stations data[10] provided by Chicago Transit Authority via the Chicago Data Portal. Before we measure the public transit accessibility for each census tract, we first need to measure the accessibility for each stops and stations. Based on the data we have, we count the number of census tracts that are attachable from each stop or station by taking bus or rail. In view of frequency's impacts on accessibility, for those tracts that are attachable from a certain stop by multiple routes, we count the number by log-transforming the number of routes and plus one. Then, we assess the accessibility of each tract by summing the accessibility of stops or stations within 3000 feet buffer of it and normalizing by area. For those tracts having no rail station within their 3000 feet buffer, a larger buffer (4500 feet) is used and the accessibility would be divided by 2.25. Finally, we have 789 valid samples.

[7] Mavoa, S, K Witten, T McCreanor, and D O'Sullivan. 2012. "GIS based destination accessibility via public transit and walking in Auckland, New Zealand." Journal of Transport Geography. 15-22.

[8] Geurs, K, and B van Wee. 2004. "Accessibility evaluation of land-use and transport strategies: Review and research directions." Journal of Transport Geography 127-140.

[9] URL: https://data.cityofchicago.org/d/hvnx-qtky?category=Transportation&view_name=CTA-Bus-Stops

[10] URL: https://data.cityofchicago.org/download/vmyy-m9qj/application%2Fzip

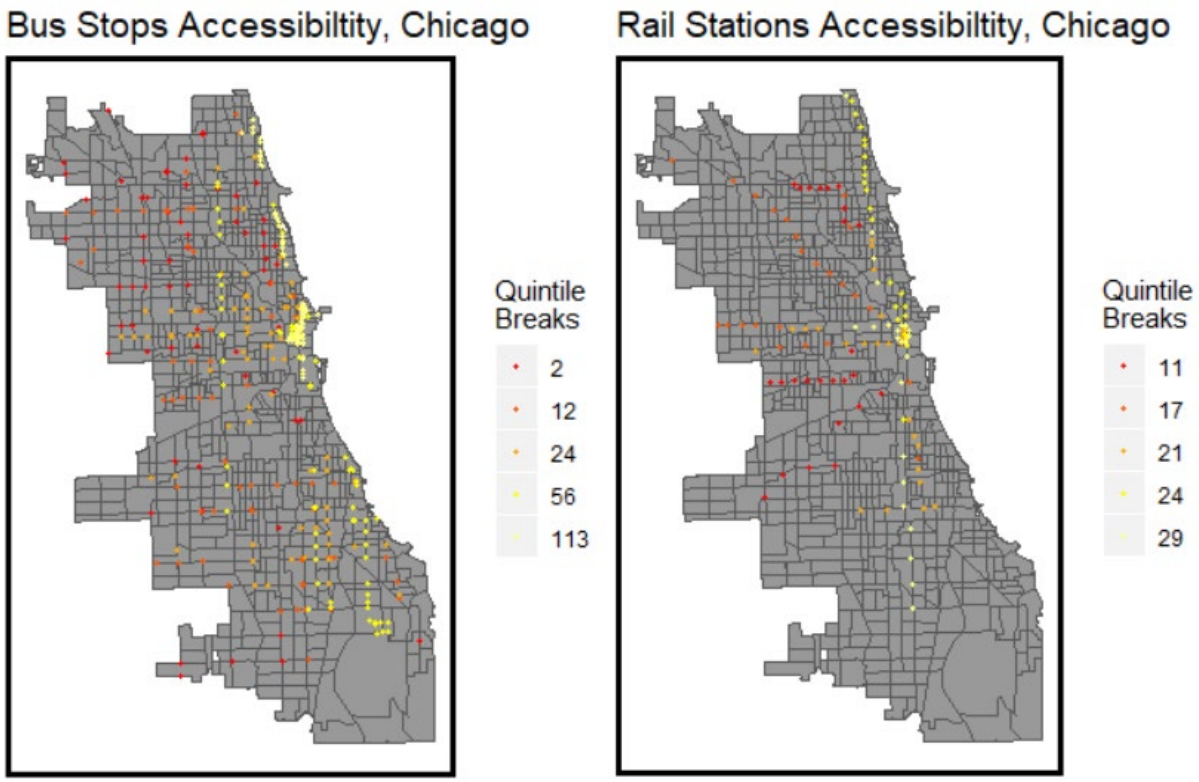

Figure 2 Chicago Public Transit Stations Accessibility

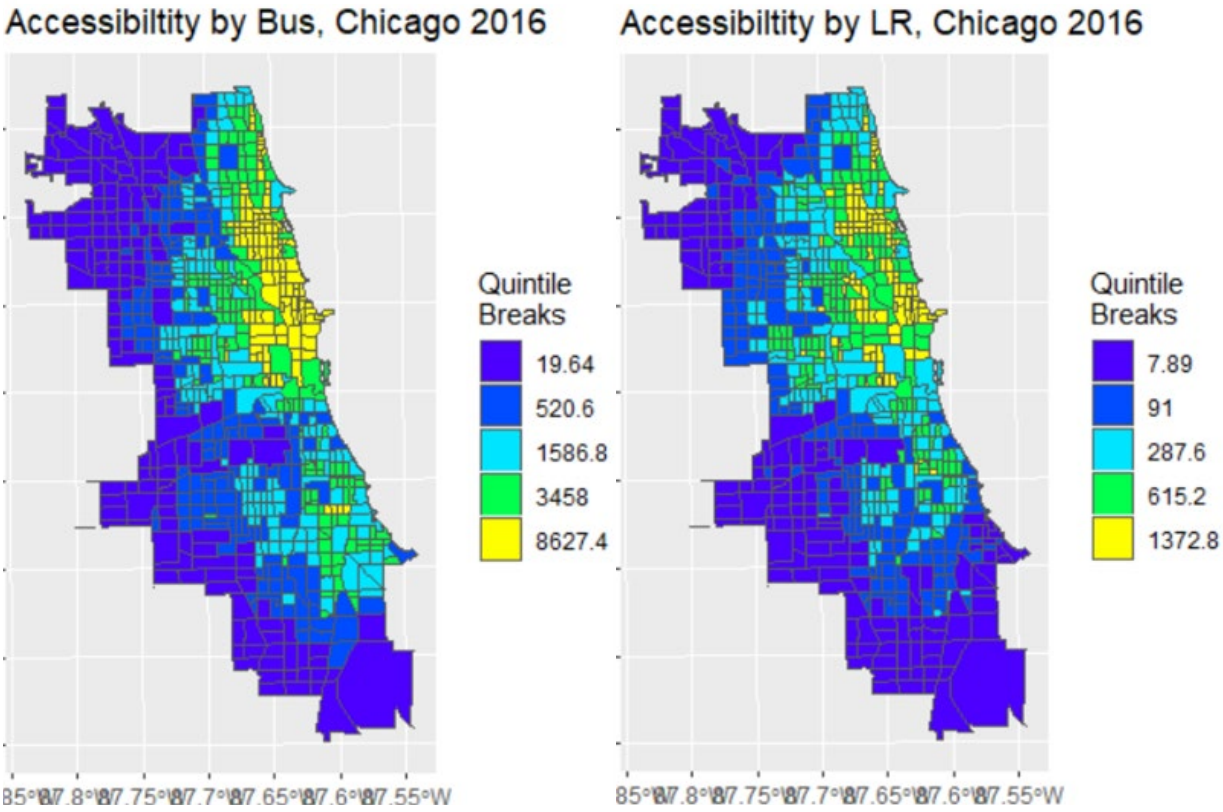

Figure 3 Chicago Public Transit Accessibility by Census Tract

Control Variables: Socio-demographic characteristics

During our research phase for finding the primary social factors of causing crimes in metropolitan areas in the United States, we find that crimes are caused by numerous social and economic factors and the interrelation between factors is complex. According to the crime data from the Bureau of Justice, urban areas with high unemployment rate and poverty rate tend to have higher crate rates. Thus, we assume age, educational level, and employment have direct correlation to crime rates. For our research, we will only use sex, age, educational level, employment, and poverty as the elements for our analysis. All our data are 5-year estimates from the ACS database. More specifically, we will use the 2016 estimates for our crime and public transit accessibility density analysis.

Statistical Methodology

Multiple linear regression (MLR) is a widely used statistical technique to model the relationship between dependent variable and more than one explanatory variables. Scatterplots depicting the relationship between crime rate and independent variables were skewed, suggesting a non-linear relationship. Therefore, all variables have been log-transformed in our regression models. Another reason for using logged values is that coefficients hence can be interpreted as elasticities and can be compared with each other.

Findings

Regression Results

Table 1 Multi Linear Model Regression Results

Variable	Model1 Total Crime Coefficient	Model2 Violent Crime Coefficient	Model1 Property Crime Coefficient	Model1 Sex&Drug Crime Coefficient
(Intercept)	1.062896	-1.202619	-0.382843	-1.979448
log(bus_accessiblity)	0.04311	0.045485	0.061762*	-0.021699
log(rail_accessibility)	-0.037268	-0.065002*	-0.07149*	0.158106**
log(poverty_rate+1)	0.378474***	0.536531***	0.267965***	0.482624***
log(employment_rate + 1)	-0.448065***	-0.446411**	-0.373191**	-0.42721.
log(high_school_18_24 +1)	-0.001122	0.015558	-0.006742	0.005624
log(bachelor_18_24 + 1)	-0.097723***	-0.118925***	-0.063238**	-0.186732***
log(high_school_25_34 + 1)	-0.018113	0.038543	0.183707	-0.547523
log(bachelor_25_34 + 1)	-0.114624**	-0.116415**	-0.062539.	-0.227346***
log(high_school35_44 + 1)	0.685701***	0.669682***	0.764294***	0.730963*
log(bachelor35_44 + 1)	-0.06076.	-0.055077	-0.065464.	-0.117103*
log(high_school45_64 + 1)	0.603945***	0.538123**	0.553133**	0.983201***
log(bachelor45_64 + 1)	-0.090833*	-0.126705**	0.005008	-0.325972***
log(male_ratio + 1)	-0.654465**	-0.671147**	-0.632141*	-0.468647
log(`0_9` + 1)	-0.094824	-0.02431	-0.226244**	-0.032642
log(`10_19` + 1)	-0.216947**	-0.164263*	-0.262415***	-0.174177
log(`20_29` + 1)	0.11874	0.211573.	0.01931	0.158949
log(`30_39` + 1)	0.061647	0.088634	0.132016	-0.337203*
log(`40_49` + 1)	0.097427	0.180966*	0.050844	0.128298
log(`50_59` + 1)	-0.052463	0.046776	-0.178837*	0.168268
log(`60over` + 1)	-0.067384	-0.009023	-0.119301	-0.079056

*p < .10; **p < .05; ***p < .01

The regression model result does not show any statistical correlation between total crime in Chicago and public transit accessibility density, no matter in the bus system or the rail system. Whereas, specific demographic data we choose as the controlling groups manifest statistical correlation and strongly associated with the total crime rate in the geography.

As for violent crime, the regression model shows the correlation between violent crime and rail type public transit statistically. When a 100% increase in the accessibility density of rail public transit, violent crime associated with decreasing 0.65%. Eleven variables are statistically correlation with the violent crime rate.

The property crime has a statistical correlation with public transit, but it has a different relationship with a different type. Bus accessibility density has a positive relationship with property crime. And increasing 100%, bus accessibility density could associate with property crime increase 6.17%. Rail accessibility density has a negative relation to property crime. And it is increasing 100% bus accessibility density associated with property crime decreasing 7.15%. Considering the result of the property crime model, we assume criminals prefer taking the bus to commit theft, illegal trespass, or other types of property crime. Rail transit, on the other hand, has more reliable security and passenger-check procedure before or on the trip than the bus, which avoiding is committing a crime.

Sex and drug crime have a robust statistical correlation only with public rail transit. And increasing 100%, rail accessibility density could associate with sex and drug crime increasing 15.8%. Rail accessibility density has a positive relationship with property crime. Rail transit provides public space where the crime committed possibility could increase significantly. As a 100% increase in the poverty level, sex and drug crime associated with increasing 52.6%. No statistical correlation with employment. As a 100% increase in the poverty level, sex and drug crime associated with increasing 26.8%.

Conclusion

In general, we can conclude that public transit accessibility density does not have statistical correlation to the total crime data in Chicago but has statistical correlation to the crime subcategories we examined. More specifically, while railway transit accessibility density has correlation to violent crime and property crime, bus transit accessibility density has statistical correlation to property crime and sex and drug crime. Hence, our research has showcased that public transit accessibility density does not have a critical impact on public safety, which is in contrast with our common beliefs. Transit accessibility has stronger correlations with demographics, so it is more optimum if related public policies can build around these two components.

Discussion

According to our findings, we can clearly see that there is no statistical correlation between public transit system accessibility density and total crime. Employment, poverty and education are the more significant factors that have stronger correlation to total crime. The statistics indicates that financial hardship, lack of education and age are closely related to the total crime data. According to the 2017 Annual data provided by Chicago Police Force, Robbery, Assault, theft, burglary, and motor vehicle theft are the major crime types that appear in the city of Chicago. All of these crimes, especially motor vehicle theft, can take place in both areas with access to public transit and many areas that have limited access to public transportations. Also, suspects who committed crimes may not choose public transportations as the means to escape from the crime scene. Public transit, in general, does not have a statistical correlation to all crimes that takes place in the city of Chicago.

Although our results denote there are no statistical correlation between public transit and total crime, the results for subcategories of our choice(violent crime, property crime, sex and drug crime) are relatively different. The regression results show that violent crime is only statistically correlated to rail accessibility density; property crime is statistically correlated to both rail accessibility density and bus accessibility density; sex and drug crimes only have statistical correlation with rail accessibility density.

By interpreting the regression results, we can determine that all three crime subcategories are statistically correlated to railway accessibility density. This means that railway stations are not just public transportation hubs, they can also be the harbors for crimes and illegal activities. Crime rates tend to be higher in urban contexts when compare to rural areas, so it is more important for policy makers and law enforcers to know the relationships between different urban environments and crime. We also need to acknowledge that public transportation plays an important role in maintaining the functions and vitality of metropolitan areas. If railway accessibility is statistically correlated to crimes, it is necessary for Chicago police department to assign more police forces to patrol the areas that are close to railway stations. Besides, security checks at each stations and more surveillance cameras are also viable solutions to prevent crimes in areas that are more accessible to railway stations.

While we were searching for crime and public transportation related articles we came across the idea of crime export stations and crime import stations in David Phillips and Danielle Sandler's journal Does public transit spread crime? Evidence from temporary rail station closures. The authors have illustrated that there are railway stations that attracts and trap criminals and there

are stations that send criminals out to other locations[11]. While crime import stations will lead to more local crimes near the railway stations, crime export stations serves as a portal for criminals to conduct illegal activities elsewhere. This is a blind spot in the Chicago crime data base and thus we cannot perform any detailed analysis on this specific topic.

The focus of our research is the relationship between crimes and public transit accessibility, yet we see poverty rate, educational status, and employment rate are closely related to crime rates in Chicago. Unemployed young adults with inadequate education have the highest risk of committing crimes. We believe improving the quality of public education is crucial to the prevention of crimes. Keeping youths in school will separate them from illegal activities and provide them the means to either find a job or continue their education. People with stable income and adequate education will be less likely to commit crimes.

[11] Phillips, David C., and Danielle Sandler. "Does Public Transit Spread Crime? Evidence from Temporary Rail Station Closures." Regional Science and Urban Economics, vol. 52, 2015, pp. 13–26., doi:10.1016/j.regsciurbeco.2015.02.001.