Impact of Public Transit Access on Chicago Housing Prices

By

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I hope that my findings will be able to shed more light on public transportation and housing markets that will lead to policy advancements in the near future.

ABSTRACT

This paper seeks to uncover the fiscal relationship between public transportation access, particularly the rail stations of the Chicago Transit Authority, and the Chicago housing market. In addition to determining the fiscal relationship between public transportation access and housing in Chicago, I'll analyze how crime rates at the Chicago Transit Authority (CTA) stations impact their usage. To solve these questions, I built multivariable regressions for each research question. The regression for the first research question had variables Median Home Value in USD, CTA Station Present Y/N, Cumulative Crime by Zip Code, High Crime Dummy Var, and Station & High Crime. The regression for the second research question had variables Cumulative Ridership Total, Cumulative Crime by Station, Usage/Pop Density by ¼ Mile, and Median Household Income. The data for these variables came from Social Explorer and the Chicago Data Portal. To determine the number of crimes by zip code and by ¼ mile radius of each CTA rail station, I used the geospatial software QGIS to accomplish this. The results from my first regression found that CTA rail stations will always have a positive fiscal impact on the housing market within that zip code, regardless of the number of crimes in that zip code. The second regression found that crime actually increased the number of riders per station. From a Public Policy perspective, this study reinforces the importance of public transportation access for Chicago residents and recommends two policies that will improve the efficiency of operating the Chicago Transit Authority rail system.

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Introduction

Mankind has always been a distinctly social species that, in order to survive, forms communities with others. This social characteristic found in humans caused us to eventually decide on settling in a specific location and the notion of a city was born. Cities have been, and still are, the intersecting points of various cultures, peoples, languages, and ideas. However, the appalling lack of sanitation and prevalent poverty that were faced by those who dared to venture into the ancient and medieval cities of the past caused many individuals to decide that a rural lifestyle was preferable. During the 19th century, vast improvements were made in the sanitation and infrastructure of cities. This enticed waves of people to cities in search of work and the attractions of modern life. Due to this, cities were overflowing with people and streets were clogged with congestion. City planners needed to find a way to keep the street traffic flowing and allow for citizens to travel across the city for work. In 1863, London developed the first underground train system that is still in use today. The notion of an available form of public transportation revolutionized the way that humanity saw the urban world. No longer were people forced to live in the heart of the city to enjoy its cultural benefits, but were now free to move to different neighborhoods and could travel either for pleasure or work. The popularity of the 'tube' enticed other metropolitan regions to implement their own public transportation systems. While these systems helped connected people to the city centers, they were limited in their reaches. The areas closest to reliable public transit stops were deemed more attractive for citizens while neighborhoods further away or without public transit were not. In this paper, I will specifically explore the role that public transportation has had on housing price patterns in the Chicagoland region. To accomplish this, I will use second-hand economic research that I have gathered for a previous project which focuses on the Île-de-France region. These prior French research papers will be the inspiration for how I conduct my own research in the Chicagoland region.

The relationship between housing prices, crime rates, and public transportation can portray deep insights into the social tensions of Paris and Chicago. Just last year, Paris was gripped by protests from the *Mouvement des Gilets Juanes.* The "Yellow Vest Movement" was composed of middle-class workers who are, due to the high housing prices in Paris, forced to live in the suburbs. Due to the lack of public transportation from the suburbs to the capital, they must drive into the city for work. The "yellow vests" were protesting the recent gas tax from President Macron, which they claimed unfairly targeted the working class that lived in the Île-de-France region. Seeing no other options, they were forced to protest Macron and force him to revoke the gas tax. In comparison, Chicago is a city that has been highly segregated since the Great Migration in the 1920s. With the mass influx of African-Americans to Chicago, white citizens living on the South Side slowly made their way North towards the river. African-Americans were forced to replace the families that had left and the disparity in housing prices between the North and South Sides soon became outrageous. When the Chicago Transit Authority (CTA) was created in 1947, the train services did not serve or operate on the South Side, leaving African-Americans out from the boom of downtown Chicago.

While Paris and Chicago may seem different from one another, economists have done much research on the connection between commuting and resident location in both cities. The Paris School of Economics created a study in 2013 that identified the causal impact of urban rail transport on firm location and employment. Using hedonic pricing, we can understand that employment opportunities in a certain neighborhood will increase the value of land in its proximity and attract potential employees to the firm. Another study focuses on the Île-de-France region and incorporates a model that uses residential location choices with endogenous housing prices and traffic. The researchers are able to use the results from their model to coordinate land use policies with regards to transportation investments in order to address increased congestion and housing prices that come with rising populations. In Chicago, a study was conducted by Alex Anas and Liang Shyong Duann that created the *Chicago Area Transportation/Land-Use Analysis System* that synthesizes housing prices across the city with travel demands from transportation planning data. A similar article, titled "Analysis of Transit Quality of Service and Employment Accessibility for the Greater Chicago, Illinois, Region", from Inshu Minocha, P.S. Sriraj, Paul Metaxatos, and Piyushimita Thakuriah focused on the disparities of public transit quality and access to employment opportunities across the Chicagoland area.

In addition to the research that has already been conducted in this field, I seek to answer if a public transportation station impacts the economic and social makeup of the surrounding community in Chicago. Does the presence of public transportation stations impact the average housing price in Chicago? From my understanding of the makeup, history of the city's development, and research on the topic, it appears that public transportation stations can either bolster the economic value of the surrounding neighborhood or carry negative connotations with them. Stations can be a benefit to the community by providing residents with affordable means of commuting, but stations can also have negative externalities attached to them, like crime. This is an important Public Policy question to understand because it can provide insight into the functionality of a community and how public transportation can be used as a public asset. The second research question I will be addressing is: do higher crime rates near public transportation stations impact their usage? Further, is it possible to use crime data to bolster public transportation usage in both cities? Criminals on public transportation are provided an opportunity to strike with an enclosed environment without the immediate threat of law enforcement. An article published by Mahr and Wisniewski at the *Chicago Tribune* has shown that significant and violent crimes have statistically increased at a higher rate on CTA rail lines in the past few years than other forms of crime city-wide. With Chicago's public image as a high-crime city, understanding the role of crime and public transportation in relation to housing prices can help local government officials implement new policy to help fight crime.

Literature Review

Paris

In a span of thirty years of industrialization, Paris would integrate new public amenities that would greatly impact its future development: omnibus services in 1828 and the railway in 1837. With the introduction of new, industrialized transportation, people could now travel farther distances in less time with ease, but the rail system needed to be improved before it could impact the whole population. Access to transportation centers and railway stations was difficult due to congestion in the streets. Rapid industrialization further separated the working proletariats into a class of poverty and rich capitalist bourgeoise, which erupted in the revolutions of 1830 and 1848. When the Second Empire was created with the rise of Napoleon III, he knew that something needed to be done to ensure that the citizens of his capital could be controlled. He decided to appoint Baron Haussmann to carry out this task, whose work would go on to give us the city of Paris we know today. The ambition of his urban development was to be implemented across the city. He advocated for the creation of symmetrical grand boulevards that run straight across the city to reduce the vast congestion that had come to plague the streets of Paris. Also, as evidenced by the French Revolution, these boulevards were to ensure that further rebellions could be dealt with more easily as it was now harder to create barricades to stop the flow of troops in the city. Still in use today, Haussmann also constructed the city's modern sewer and water systems. After the fall of the Second Empire in 1871 and Haussmann removed from his position, many of his projects were still being implemented, such as the market of the Halles and new bridges along the Seine. With the emergence of Paris as a twentieth-century city, thanks to Haussmann, various international exhibitions took place. With these exhibitions, new landmarks were built, like the Trocadéro, Eiffel Tower and the Grand Palais. However, none would be as important to the functionality of the city as the inauguration of the metro in 1900.

As Paris had become a world-class city, it needed a world-class transportation system to move its people around. As the usage of trains continued to expand across the world, it was only natural for electric trains to alleviate the city's congestion by having rail lines belowground or elevated above the streets. French engineer Fulgence Bienvenüe drew up plans for this idea to become a reality. His design would eventually become one of the most used metro systems in Europe, second only to Moscow. On average, the Metro de Paris is used by around 4.5 million passengers per day. In its entirety, it includes 214 kilometers of track and contains 300 different metro stations across the city. Once Bienvenüe developed the design in 1896, he needed to find a company to manifest his vision into a reality. In July 1897, the construction bid was given to Compagnie de Chemin de Fer Métropolitan. Construction would begin the following November. The initial proposal included the construction of 10 metro lines, which would be completed by 1920. They would only need until July 19, 1900 for the first line, named Porte Maillot-Porte de Vincennes, to be inaugurated.

No matter how efficient the initial project seemed, it could not foresee the rapid increase of the city's population. It became necessary to expand and develop the system in order to accommodate this increasing population of Paris. Today, the metro system features 16 lines, a major expansion from the original 10. These 16 lines have created a spider-web over Paris that allows individuals to make their way into any arrondissement they wish. In the beginning of the twenty-first century, the Metro de Paris underwent a fairly massive extension. Lines 1 and 14 have recently become fully automated and driverless, while the other 14 still employ people to drive them. Lines 4, 8, 12, and 13 were recently extended to reach farther from the city center, allowing more citizens to have access. However, in order to deal with Paris' increasing population, further expansions were needed. Even with these recent expansions, the Paris Metro Authorities are currently planning on extending lines 14, 11, 10, and 1, in both directions. Additionally, a new station will be built on line 5, extending line 7 to the south, and adding two more stops on line 9. Yet even with the efficiency and capability that the Paris Metro has in transporting millions of people per day, it is not the only form of rail transportation that Parisians can use to travel across the city.

In the decades following World War II, Paris underwent a rapid population growth. From 1945 to 1975, the entire Île-de-France region, the population grew from 6.6 million to 8.5 million. The rise in population created a lack of housing in the city-center, spilling citizens into the surrounding suburbs. However, at that time, the suburbs were not large enough to accompany all of the new citizens, causing overcrowding, too. Once the suburbs had been filled, urban development began to spread, forcing people further away from the downtown region. To accommodate, new suburbs had been developed in order to house the rising population. To do their rushed development, these developments "were underequipped: old transportation infrastructures, few public services, no jobs at proximity" (Mayer 4). It was apparent something needed to be done in order to alleviate the strain that had been placed on the metro and bus systems. This would eventually become the job of the Central Government as local authorities did not have the ambition or resources to complete this major, large-scale task. The Central Government began to pass laws that created "redistribution of administrative boundaries, construction of an airport, highway and railways, and decentralization of jobs and population, especially in 'new towns'" (Mayer 5). These policies were implemented to disperse the rising population into the planned sub-cities that are located 30 kilometers from Paris. However, a commuter rail network was needed to connect the sub-cities with Paris and in 1965 the proposed Schéma Directeur d'Aménagement et d'Urbanisme de la Région Parisienne (SDAURP) meant to increase suburbanization.

Part of Haussmann's urban development programs during the Second Empire focused on expanding France's rail network with Paris as the central hub. This meant that numerous rail lines, operated by private companies, connected every region of France to the capital. None had been built to connect the different parts of Paris together. This meant that it was impossible to cross the city by train because the current railways only ran from outside the city and terminated in Paris. Additionally, the current metro lines did not frequently service the suburbs and made it impossible for people to commute into the city center. With the introduction of SDAURP, implementation of the Regional Express Rail (RER) had begun. The goal of the RER was

> "to upgrade the commuter rail system by increasing frequency and commissioning new trains. But the major, and most costly, improvement planned by the SDAURP was the construction of hundreds of kilometers of new lines crossing the historical core of Paris toward the major subcenters of the Paris metropolitan area: the new towns, the two airports, and the business district of La Défense" (Mayer 5).

The end result of this ambitious urban planning project ended up being more modest than originally thought. The main factor that limited the scope of SDAURP was the price. However, President Pompidou and his administration believed that they could achieve similar results and cut costs by integrating the existing rail lines into the RER system. Also, it was decided to reduce the number of new towns, from 8 to 5, that were built to house the rising population. Even with all of the reductions in SDAURP, the progress that was made achieved great results. The existing rail lines implemented into the RER system were upgraded and connected together by tunnels that ran below the city. New lines were constructed to reach the two airports and five new sub-cities that had been built. With a more expansive commuter rail system, it was now possible to commission new trains to run at a higher frequency than before. All of this infrastructure made commuting much easier to the Île-de-France region. The implementation of the RER decreased the average travel time by roughly five and a half minutes in regions that it connected.

To understand the connection between housing price, a major factor in residential location choice, and accessibility to the public transportation system in Paris, we must apply the notion of hedonic pricing. In economics, “hedonic prices are defined as the implicit prices of attributes and are revealed to economic agents from observed prices of differentiated products and the specific amounts of characteristics associated with them” (Rosen 34). In essence, hedonic pricing models are used to quantify how much a certain attribute of a good should be valued. This is an important tool in the overall housing market, as economists can ascertain how much a certain aspect of a home, like neighborhood safety or distance to public transportation, should be worth to consumers. To estimate the implicit price, economists must use a first-step regression analysis to determine the correlation between the variables that are being tested. Models that use hedonic pricing also play an important role in estimating how an entire market will behave to achieve equilibrium.

In order for the estimation to be applicable, some assumptions about the average buyer and seller in the market must be applied in the model. First and foremost, the home developers and buyers are human. Due to this, we can assume that the buyer side of the market is trying to maximize the personal utility they gain from their home location choice and the sellers want to maximize the profits they receive from each transaction. In addition, home developers should be aware that individual preferences do not change when shopping for housing, but overall home buyer preferences can change overtime. Therefore, home developers must be aware of the preferences of their potential buyers, otherwise the housing projects they produce will not be bought. Obviously, in every market, there is only a finite number of goods available for purchase which creates competition between buyers. As no two homes are identical, there are various sub-markets that have distinct characteristics attractive to buyers with the same preferences that the goods provide. In particular, the price of the home available for purchase “guides both consumer and producer locational choices regarding packages of characteristics bought and sold” (Rosen 35). In order for equilibrium to be reached in the housing market, the amount of homes for sale must be equal to the demand for houses from the buyers. This core principle is applicable to all locations in the housing market, although not always followed and equilibrium not attained. If equilibrium is not attained, then this can have serious repercussions on city, even state-wide, housing markets. This is why it is important to use hedonic pricing models in order to quantify them and to estimate the attributes of goods. When applied to the housing market in Paris or Chicago, this can show us the impact that accessibility to the public transportation system has on home price and how big of a role it plays when individuals are looking to purchase a home.

With global trends demonstrating that roughly 50% of the world’s population will live in urban areas within the next thirty years, it has becoming increasingly important to coordinate future land use policies with transportation developments. However, it is difficult to do so because typically land use decisions are made by local governments and transportation is coordinated at the metropolitan level. Additionally, a lack of models that incorporate housing location patterns and changes in transportation adds to the difficulty of coordination. To help solve the technical side of coordination, André de Palma of the University of Cergy-Pontoise and Ecole Nationale de Ponts et Chaussées, Kiarash Motamedi and Nathalie Picard of the University of Cergy-Pontoise, and Paul Waddell of the University of Washington formulated a model that incorporated land use and traffic flows in Paris. Even though a few models had been created before, they were never able to fully capture the link between land use and transportation because they did not factor in time. The Palma, Motamedi, Picard, and Waddell model was unique because of their "approach, by contrast, avoids this assumption by representing the partial adjustment of households, firms and developers in annual steps of time, allowing the effects of a major shock such as a change in infrastructure to be spread over multiple years" (Palma 68). By incorporating annual increments of time into the model, they were able to achieve more behavioral realism. Additional realism allows the model to be more responsive to contemporary land use issues which requires behavioral data to represent both long and short-term trends regarding transportation development.

In their model, Palma, Motamedi, Picard, and Waddell linked together two existing models that dealt with land use and transportation. The first model, known as UrbanSim,

> "is a simulation model developed since the late 1990's to simulate the spatial and temporal evolution of household location, job location, and real estate supply and prices using microsimulation to allow complete disaggregation in agents, locations, and the representations of time" (Palma 68).

The second model, referred to as METROPOLIS, "is a dynamic traffic assignment model that simulates evolving traffic conditions on large-scale networks over the course of a day, representing individual travelers" (Palma 68). In essence, UrbanSim estimates how the changes and location in real estate developments and jobs for each commune in Paris will change each year. On the other hand, METROPOLIS uses a macroscopic formulation to compute travel time with the flow condition of each link. The QUATOR model, the application of METROPOLIS in the Paris region, models the mode, departure time, and route choices of individual passengers. In order for the METROPOLIS and UrbanSim models to feed data to one another, a data preparation module was needed to convert log sums and travel times for UrbanSim. In order to create Macro-economic and Demographic data for UrbanSim, an additional module was needed. Once UrbanSim received this data, then it assigned locations to jobs and homes in each commune. The key data transferred between the two models was the Travelers' Surplus Matrix or Origin-Destination (O-D) matrix. However, UrbanSim does not create the O-D matrix, instead another module was created to do so. To create the O-D matrix, the module uses trip emissions and attractions, trip distribution, and the mode of transportation. The O-D matrix produced represents the number of trips taken by the population and where they are going. Once a revised O-D matrix is given to the METROPOLIS model, then a complete loop is made with the traffic model based on geographical distribution of population and firm location across Paris. The process is then continually produced each year, whereas previous models could only do so every five years.

Once the models had been run, the produced results highlighted the connections between land use and transportation. Regarding, housing prices, the correlation is clear. The model found that a decrease in the average travel time will significantly increase the price of a home. Specifically,

> "10 minutes less travel time to work imply a 2.8% increase in housing price. The price is very sensitive to socio-economic structure of the commune: a 10% increase in the proportion of one-member households causes a 50% increase of the price. A similar 10% increase for the proportion of two-member households results in a 19% increase of the price. Similarly, the fraction of households with no or only one working member has a positive effect on the price. Strangely enough, the fraction of foreign households has a positive effect on the price. Finally, we notice the negative and highly significant effect of the proportion of low- and intermediate-income families on the price" (Palma 79).

Note here the severity that a decrease in travel time has on price depends on the structure of the housing market. This demonstrates that developers know people will be willing to pay a higher price to decrease their travel time, so the closer a home is to the public transit system the higher the price will be. This means that housing prices have a negative effect on locational choice for individuals in a commune. The specific effect that public transit has on price and locational choice is interesting to note. The model found that an increase in the average travel time for public transit trips decreases the personal utility of households. Additionally, "the number of metro stations in a commune increases the probability of location but the number of railway stations decreases it" (Palma 81). This effect can be explained by the perceived externalities that come with both forms of public transit such as the clustering of the metro closer to shopping and employment and the RER having a higher chance of petty crime. The results that Palma, Motamedi, Picard, and Waddell created have discovered the endogeneity of residential location and employment with public transportation traffic. Their work has contributed to the further urban development of the Île-de-France region.

Even though the metro system in Paris has played an important role in the city's development, it is not the only transit system to do so. The expansion of the RER rail lines since 1970 has given urban researches, like Thierry Mayer and Corentin Trevien, the opportunity to determine how it has impacted firm, employment, and population location in the Île-de-France region. Specifically, they decided to focus on the effect of a station opening on a municipal level in Paris. Besides the effect on employment, the introduction or improvement of public rail systems has reduced air pollution and decreased the necessity for owning private automobiles. In many European cities, especially Paris, public transportation has been a major part of urban development. These transportation systems were utilized well before the United States. In European cities, a larger percentage of people use the rail system to commute to work. In America roughly only 5% of workers use public transit to commute to work, while in France specifically it is 13.3% of the working population.

To ensure their model would account for every variable, Mayer and Trevien had to provide enough data to make their findings accurate. Regarding firms, they accessed the Sirene database which provides information on the industry, location, operating years of municipal level firms, and foreign shareholder information. Then, they applied census data to confirm the population level, employment, and social makeup of each municipality in Paris. Next, they had to find data that reflects the quality of the RER service and how it improved upon the previous rail system. To do this, Mayer and Trevien accounted for the number of train stations within each municipality and tried to construct the frequency of the trains. Then, they tried to measure the decrease in average travel time from 1969-2009. This data would give them an informed understanding of how effective the RER system has been since its implementation. Once they had gathered all the data, they fed it into their model to determine the results.

The results that Mayer and Trevien produced clearly highlight the connection between RER locations and employment opportunities across Paris. They found that the opening or improvement of an RER station increases the employment levels in a municipality by 7% to 11%. By connecting individuals from the surrounding neighborhoods to the city center, the RER contributes to decentralizing the job market in the Île-de-France region. However, they found that the effect the RER has on employment only reaches about 20 kilometers from the city center, while areas beyond this boundary seek employment in new towns that are much closer. Also, to note, the further you are from the city center the more likely you are to commute by car to work. Mayer and Trevien found that “64% of commuters use public transportation in the municipality of Paris, 44.8% in the inner ring, and 29% in the outer ring” (Mayer 16-17). The results they produced found that the homes within 100 meters of an RER station have the highest percentage of employment. Therefore, employment of people living in proximity to an RER station additionally increases by 2.4% when the average travel time to Paris decreases by a single minute. However, as proximity to RER stations becomes desirable to homeowners, developers can charge a higher price. Only employed individuals that can afford to pay the higher prices will live in direct proximity to the stations. This creates a gentrification effect for the poor. This is true across Paris, as the number of executives living in proximity to the RER is positive in the inner rings and negative in the outer. On top of employment, RER locations have positively impacted how firms select locations in Paris. The RER does not affect the distribution of industries which is positive because it has kept municipal economies diverse.

The development of Paris, over the thousands of years that it has existed, has contributed to the efficiency of the public transportation system. For a majority of its history, until the industrial revolution, the main forms of transportation were walking and horseback. The original layout of the city was meant to ensure people could get around. In essence, it fulfilled this mission, but it would take a long time for one to do so. During the Second Empire and Haussmann's urban development projects, Paris transformed into a twentieth-century capital that was meant to be the idealized form for other cities to view as a pristine model. Haussmann knew that transportation was to be the future of urban planning, thus he made Paris the central rail hub of France. It would not be for another thirty years that the introduction of rail and metro lines meant a large percentage of the population could now quickly and efficiently navigate throughout the dense city. With a modern transportation network now available for the public, the location preference of individuals began to change. No longer were people forced to live in the city-center to feel connected to Paris but could now live in the surrounding neighborhoods and still be a short trip away. During the population boom in Paris following the Second World War, it had become apparent that the rail and metro lines were incapable of handling the increase. The introduction of the RER system was meant to connect the new suburbs that were popping up outside Paris with the city center in order to incentivize people to move out there. The RER and metro lines have contributed to the urban development of Paris by increasing employment and desirability of land near their stations. As the world's population continues to become more and more urbanized, it will be interesting to monitor how Paris will handle the increased strain on its public transportation system in the future.

Chicago

In 1848, the history of Chicago as a central railway hub began with the arrival of the first locomotive. This aspect of its history is important to note as the railways helped to make Chicago the largest growing city in the Midwestern United States, at the time, which attracted people to find work. Once the rails were set, the Galena, Chicago Union Railroad, Chicago, Burlington, Quincy, Rock Island, Illinois Central, and Milwaukee lines connected the city to other major Midwest towns. As a central railway hub, vast amounts of raw materials, passengers, and finished goods had to transfer between lines in the city, which contributed to the development of hotels, restaurants, taxicabs, warehouses, rail yards, trucking companies, and the Chicago stockyards. In 1850, Chicago reached a population of 30,000, which would triple over the next decade. The Chicago Fire of 1871 destroyed the original city, but created the opportunity for contemporary architects to rebuild Chicago as a modern metropolis. After the destruction caused by the Great Chicago Fire, the city reached a population of 500,000 and was becoming the crown jewel of the Midwest. The next step to transition Chicago into a twentieth-century city was the adoption of railways to help citizens traverse to the neighborhoods as quickly as possible. The public railways transitioned from horsepower, then to underground cables, until they were hooked up to electrical lines. Even though public transit is designed to reduce street congestion, Chicago’s adaptation only added more traffic to the already busy streets.

As Chicago continued to transform into the city it is today, it was important for local researches to understand the relationship between travel choice demand, residential location, and land development projects. They already knew that any improvement in transportation or infrastructure will raise local real estate prices due to the increase in accessibility, quality of services, and shorter commuting times. At the time, however, it was unknown how to accurately estimate public investments impact on real estate price increases. Economists had created models of long-term equilibrium between land and real estate markets, but these models only provide data for travel-related issues and travel demand. However, in order for practical decisions to be made by urban transportation planners, empirical models that account for transportation, land use, and property values need to be created. Once urban transportation planners had strong empirical estimates, they could accurately forecast and predict how real estate markets would react with the fluctuations in property values due to transportation improvements. In 1985, two professors, Alex Anas and Liang Shyong Duann, from Northwestern University and National Cheng Kung University, set out to create this model. They created the *Chicago Area Transportation/Land Use Analysis System* or CATLAS. This model

> “synthesizes our knowledge of ‘location rent analysis’ from urban economics with our knowledge of ‘travel demand analyses’ from transportation planning. It is a dynamic model which simulates the market in recursive periods of one year in length, and for a geographic grid system of 1690 zones covering the Chicago metropolitan area” (Anas and Duann 37).

CATLAS will provide data on resident’s preferences of travel method and their choice of residential location.

The model found that public transportation projects raise the attractiveness and utility of downtown city zones because they reduce commuting times and cost. Extending services to places they were not previously available attracts potential new households to move into the city zones from the suburbs. This raises rents in the city while lowering suburban rents. However, average rents across the city are reduced since the movement of households is from the more expensive suburbs to the cheaper city. Southwest Chicago sees slightly different results from CATLAS. Aggregate rents actually increase in the city and suburban areas, but the impact is very slight. Rent changes of only a few dollars per household have no effect on taxation as well. The largest monthly increase in rent is only $20, while the average is much closer to $2 per month. The authors can assume then that if the average homeowner is only slightly impacted by an increase in monthly rent, there would not be any political opposition to improvements in transportation or infrastructure.

Another issue that plagues public transportation usage in Chicago is the relationship between the availability of transit and employment opportunities that are commutable. The downtown Loop district is the heart of business in Chicago, which makes it necessary to connect it with every form of public transportation. However, as more and more companies are established outside of the Loop, public transportation needs to connect these new companies with their employees. Otherwise, in the future, public transit ridership will continue to decline. That’s why Minocha et all set out to study the variations of local transit service quality and regional employment accessibility. In order to accomplish this feat, the authors needed to develop the supply and demand-side data for their model. The supply-side analysis involves a transit availability index (TAI) that includes number of residents, number of jobs within walking distance of public transportation, frequency, hours of service, and service coverage. On the demand-side, the study uses a transit employment accessibility index (TEAI), which has a spatial interaction model to estimate the data at the census track geographic level. Having information from the two different indexes allowed the authors of the study to highlight regions in the Chicago metropolitan area that have a mismatch between the availability and demand for public transit to access employment opportunities.

The results from the study found that residents living in areas with low scores on both the TAI and TEAI indexes rely more on private automobiles and have fairly longer distances to commute. Areas that scored low on the TAI and high on the TEAI are in desperate need of new public transit investments, which the authors hope their study will alert local policymakers. On the other hand, regions with low TEAI and high TAI need to research new spatial policies to increase residents' access to employment opportunities. A possible solution for policymakers to implement would be economic development policies that bring jobs closer to these neighborhoods. Another solution could be building affordable housing closer to employment-dense areas.

Methodology

Background

To fully understand the connection between public transportation and housing migration and price patterns, I must apply several assumptions and prior research to answer my research questions. Public transportation offers citizens low-cost means of commuting and train systems help decongest busy streets clogged with automobile traffic. However, riding public transportation does not allow for the same privacy that one can experience behind the wheel of their own car or ridesharing. Also, in both cities, public transportation creates an enclosed environment that criminals can take advantage. Even though both transit systems have their differences, the basic theoretical factors are the same for all public transit systems.

To understand the direct relationship between housing prices, migration patterns, and public transportation, I used the notion of hedonic pricing. In essence, hedonic pricing models are used to quantity how much a certain attribute of a good should be valued. This tool is important to understand the overall housing market. In particular, economists can use hedonic pricing models to determine how much a certain aspect of a home, like neighborhood safety or distance to public transportation, should be worth to consumers. To estimate the implicit price, economists must use a first-step regression analysis to determine the correlation between tested variables. Models that use hedonic pricing can estimate how an entire market will behave to achieve equilibrium. In order for the estimation to be applicable, some assumptions about the average buyer and seller must be applied in the model. First and foremost, as the parties are human, we can assume that the buyer side of the market is trying to maximize the personal utility they gain from their home location choice and the sellers want to maximize profits they receive from each transaction. In addition, home developers should be aware that individual preferences won't change when shopping for housing, but over time overall home buyer preferences can change. Therefore, the home developers must be aware of the preferences of the buyers otherwise the housing projects that they produce will not be bought. Finally, we can assume that these models will apply to the different zip codes across the city of Chicago.

An article, "The Effects of Expected Transport Improvements on Housing Prices", from 2004 takes into consideration hedonic pricing models and applies them to transportation and housing prices. The article, written by C.Y. Yiu and S.K. Wong, understood that improvements in any form of transportation were found to have a positive value effect on housing prices. They know that these infrastructure projects take several years to complete, which allowed them to assume that investors will consider the improvement in infrastructure when pricing and trading these properties. Yiu and Wong studied the premiums that were paid by investors before a tunnel project was completed. Instead of simply using a hedonic pricing model, the authors decided to include a price index and price gradient analysis.

To determine if public transportation impacts the social and economic makeup of the surrounding zip codes in Chicago, I analyzed the role of crime. A study, "Impact of Crime Statistics on Travel Mode Choice: Case Study of the City of Chicago, Illinois", conducted by Halat et all examined the impact that crime has on choice of travel for residents in Chicago. First, I assume that the role crime plays in determining mode of travel will apply equally to all zip codes in Chicago. The Halat et all paper assumed that there is a correlation to ten bus stations with the highest crime rates in Los Angeles and Chicago CTA train stations. The ten bus stations were in parts of Los Angeles that were dimly lit, had poor police presence, and lacked public phones. Using the correlation between the physical environment and crime, the Halat et all study used the Chicago Police Department's crime data to perform a spatial analysis of crime density in different proximities to CTA train stations. On top of using the Loukatou-Sideris findings to explain this inverse relationship, Halat et all assumed that crime also requires a criminal and a target. To determine the probability that any random person will choose a certain mode of travel, Halat et all created a usual discrete-choice model. The model is a function of a trip interchange vector, a vector of sociodemographic characteristics, a vector of built environment characteristics, and a vector of crime indexes.

Data Collection and Processing

The best way to determine the differences in housing prices is to use Census data. This public, open access information features the average price of homes in every zip code across Chicago. Once I arranged the average housing price by zip code, I cross-referenced these results with the locations of every CTA train station. These results gave me an idea of the relationship between accessibility to public transportation and housing prices in Chicago. Next, I analyzed ridership trends in Chicago. Using QGIS, I determined ridership trends in Chicago based on CTA station location. This information is important as it allows city leaders to make informed decisions regarding public transit usage and land-use decisions. My data analysis step is dissecting crime trends. Using prior research conducted on crime's impact on rider mode of choice, I hypothesized the future impact crime on public transportation will have on housing prices. Finally, I formed a regression with these variables to determine the overall relationship between public transportation, housing prices, and crime trends in Chicago. After building my regression, I provide policy recommendations for municipal leaders in Chicago to help curb potential gentrification effects due to public transportation and to lower the potential danger riders face due to criminal activity.

The zip codes included in my first regression depended on a certain set of characteristics. For average housing price, all zip codes are included in my regression that have median home values available on Social Explorer, which analyzes Census data. However, zip codes that do not have median home values are discarded from my first regression. If a median home value based on zip code is not available on Social Explorer this means that it has zero homes. The zip codes I have had to remove from the regression are located in the downtown region of Chicago. Knowing the layout of the city, this would make logical sense as there is no room for individual homes between the high-rise apartment buildings and offices packed into these areas. In order to determine if crime plays a role for public transportation and housing prices, I used the average crime rate across the city and analyzed the specific zip code in relation. The crime data is from the Chicago Data Portal, drawn from the Chicago Police Department website. This allowed me to see the parts of Chicago affected least and most by criminals and if the average housing price or CTA presence is a factor

The datasets I analyzed for my research project are all available online from reputable academic sources. I collected the median home value across every zip code in Chicago from Social Explorer. From the Chicago Data Portal, I collected zip code locations, crime reports for January 2018 through June 2019, CTA station locations, CTA station usage statistics from January 2018 through June 2019. With this publicly available data, I built two different regression models to answer my research questions. My first regression equation (below) includes variables per zip code for median home value in USD, CTA station presence, cumulative crime rates, a high crime indicator, and finally an interaction variable between station presence and high crime.

$$\boldsymbol{Fiscal\ Impact\ of\ Public\ Transportation\ Access\ on\ Median\ Home\ Value} = \beta_0 + \beta_1 \boldsymbol{Median\ Home\ Value\ in\ USD\ per\ Zip\ Code} + \beta_2 \boldsymbol{CTA\ Station\ Present\ Yes\ or\ No} + \beta_3 \boldsymbol{Cumulative\ Crime} + \beta_4 \boldsymbol{High\ Crime\ Dummy\ Variable} + \beta_5 \boldsymbol{Station}\ \&\ \boldsymbol{High\ Crime\ Interaction}.$$

To answer my second research question (below), I created another regression that includes variables per CTA rail station for the total number of riders, the crime rate within a ¼ mile radius of that station, the population density, and median household income.

$$\boldsymbol{Relationship\ between\ Ridership\ at\ each\ CTA\ Rail\ Station\ and\ Crime\ Rates} = \beta_0 + \beta_1 \boldsymbol{Cumulative\ Ridership\ Total} + \beta_2\ \boldsymbol{Cumulative\ Crime\ Rate} + \beta_3 \boldsymbol{Cumulative\ Ridership\ Total\ Divided\ by\ Population\ Density\ within} \frac{1}{4} \boldsymbol{Mile} + \beta_4 \boldsymbol{Median\ Household\ Income}.$$

From the CTA report it is clear that over the past several years ridership has been decreasing at a significant rate and I investigated to see if this is true for all of Chicago. This played an important role in future public transportation and housing investments. If an insignificant percentage of either population are still using transit, then municipalities will no longer want to spend money operating these transit systems. Once I had outputs from both of my regressions, I was able to see the correlation between public transportation and average housing prices across Chicago and whether crime rates near public transportation stations impact their usage by local residents.

Applied Methodology

In order to analyze the data for Chicago, I needed to use QGIS to map my datasets. QGIS is a spatial software that combines different geographical datasets together into one map. This was an effective tool for my research because combined Chicago city zip codes, CTA rail lines, locations of each station, and crime from January 2018 to June 2019 into one project and extract information for my regression variables. Once the datasets were uploaded, I was able to visually see the geographical layout of Chicago. This layout included all of the CTA rail stations and their respective crime rates. With this map, I determined whether a zip code or CTA station had a high crime rate and that percentage compared to the citywide average. However, in order to isolate the correct data from these datasets in QGIS, there are a few steps I needed to take. First, I needed to create “buffer zones” around each zip code and CTA rail station. Buffer zones are an area within a certain distance from a feature on my QGIS map. In this case, my buffer zones are my zip codes and CTA rail stations. They can be used to overlay features from another dataset, like crime, into that buffer zone. In my QGIS map, I created buffer zones of 0.10 and 0.25 miles around each CTA station and buffer zones of 0.00005 degrees around Chicago zip codes. I decided on these specific distances for CTA stations because I wanted to capture crime that is roughly within a city block of the station to determine if that specific station is a hotbed for various criminal activities. I choose 0.00005 degrees because I wanted the buffer zone to be as close as possible to the exact layout of each zip code. This would help me accurately count the true number of crimes for this period. Once I had my buffer zones, the next step was to perform a "spatial join" for these datasets. A spatial join is a way to combine the attributes from one data layer to another based on their spatial relationship. In my QGIS map, this will be used to combine the buffered zones with the original CTA locations and zip codes with the crime data. Once the spatial joins were in place, the new map layer was able to count the number of crimes within each zip code and the buffer radius around the stations. With this data, I was then able to isolate high crime zip codes and CTA stations, the final input for my regressions.

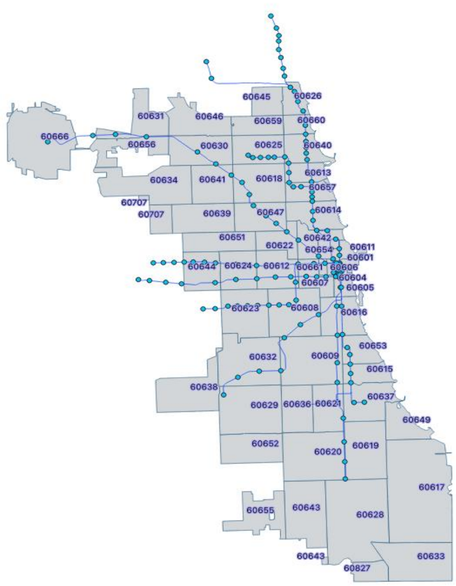
Data Analysis

When I began my thesis project, I set out to answer two different questions, each regarding the socioeconomic makeup of Chicago. The first question determined if there was a relationship between the presence of CTA rail stations and the average housing price across various Chicago zip codes. The second research question focused on crime rates affecting average usage of CTA rail stations. In order to answer my research questions, I collected datasets from the Chicago Data Portal and Social Explorer, which analyzes Census data to provide users with a variety of outputs. With this data, I was able to build geospatial maps on QGIS. This software allowed me to combine different data layers, like CTA rail station location and crime rates, into one. With this final data layer, I gathered outputs for crime in each zip code and at each CTA rail station to be used in my final regressions.

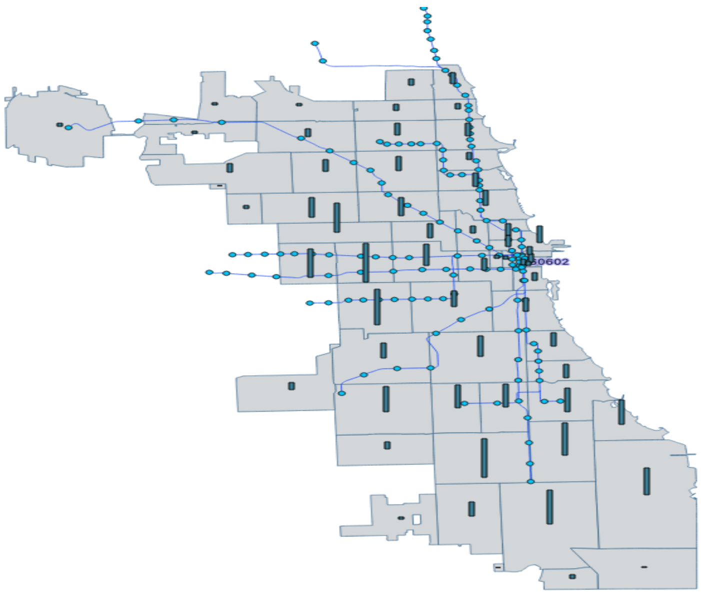
Research Question 1

From my personal usage and knowledge of public transportation as a Chicagoland resident, I have noticed that every CTA rail station has different design styles, upkeep levels, ease of accessibility, and criminal activity. Applying the principle of hedonic pricing, I was curious how each of these stations would affect housing prices in their respective communities. Therefore, I questioned whether the presence of public transportation stations impacted the average housing price in Chicago. Before attempting any data collection and analysis, I hypothesized that a CTA station, whether in a high or low crime area, could either have a positive or negative fiscal value in a given community. However, after running the regression for this question, it appears that a CTA station will always have a positive fiscal impact on the community. In order to understand the true repercussions of this finding, I had to analyze the inputs and outputs of the regression.

The output variable in my regression, Median Home Value by Zip Code, was easily accessible from Social Explorer. Once these values were in place, I manipulated data in QGIS in order to create inputs for the regression.



With the map shown above, I investigated which zip codes have or are missing a CTA rail line. Using this information as a dummy variable in a regression allows me to determine the impact that accessibility has on Median Home Values. Initially, I saw how public transportation is highly present in the Loop and Downtown Chicago, while the South and West Sides of the city have much lower accessibility. This can be an early indication of the impact that CTA rail stations have on median home values because the trend is similar for both variables: The Loop, Downtown Chicago, and the North Side have higher median home values than the South and West parts of the city. The next step is to add the crime variable onto the map.



Combining the various crime datasets from January 2018 to June 2019 into a single layer on QGIS created a map with 190,725 reported crimes. This large amount of crime data creates an unrecognizable blob on the software, so I created a histogram that makes the information more digestible for the reader. The vertical bar in each zip code can be used to compare the total number of crimes to each other. Visually, it appears that the South and West Side also have higher crime per zip code than the Loop and Downtown. Using the “Zip Code” and “Crime” layers, I found that the average number of crimes per zip code during this time was 3,407. With the average as my benchmark, I compared the cumulative total of crimes per zip code to determine whether that specific zip code was considered “high crime.” Once I had the appropriate inputs, I could run my regression.

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.636708843
R Square	0.405398151
Adjusted R Square	0.36052254
Standard Error	107732.6747
Observations	58

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	4	4.19398E+11	1.04849E+11	9.033819027	1.22117E-05
Residual	53	6.15135E+11	11606329193		
Total	57	1.03453E+12			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	266489.1266	36226.44788	7.356203606	1.20506E-09	193828.0738	339150.1793
CTA Station Present Y/N	168954.3398	41804.29528	4.04155455	0.000172649	85105.54198	252803.1377
Cumulative Crime	-28.82581186	10.13625172	-2.843833464	0.006319415	-49.15655816	-8.495065552
High Crime Dummy Var	65582.86682	73033.31017	0.897985682	0.373254566	-80903.40257	212069.1362
Station&High Crime	-104198.8813	67980.96752	-1.532765494	0.131281658	-240551.4346	32153.6721

The results of the final regression provided me with some surprising results. The initial intercept in this situation, Median Home Values, has an average value of 266,489.1266 with standard error 36,226.44788. In terms of the regression, this means that if every variable has a value of zero, then the average home value ranges from $230,262.68 to $302,715.58. With a p-value of 1.20506E-09, we can say with certainty that this result is statistically significant. The next variable, CTA Station Present Y/N, has a coefficient of 168,954.3398 with a standard error of 41,804.29528. This means that zip codes without a CTA station presence have an average value between $127,150.04 to $210,758.64. We can say this result is statistically significant with a p-value of 0.000172649. The result for Cumulative Crime, with a coefficient value of -28.82581186, makes sense logically. For every crime reported in a given zip code, the median home value lowers by a range of -$38.962006358 to -$18.68956014. With a p-value of

0.006319415, we can determine that this result is statistically significant. Sadly, the final two variables, High Crime Dummy Var and Station & High Crime interaction variable, provided me with statistically insignificant findings. Therefore, their coefficients cannot provide us with any reliable insight into the affect that high crime and the presence of a CTA rail station in a high crime zip code have on Median Home Values.

Research Question 2

After determining the effect that CTA rail stations have on the surrounding community, I set out to uncover the impact that crime has on ridership. If a CTA rail station always has a positive fiscal impact on the community, would it be possible that crime could deter people from using these valuable assets? Once again, I recognized the fact that not every station in Chicago has the same crime rates and ridership statistics. By applying the notion of hedonic pricing, it was possible to determine the relationship between crime rates immediately around CTA rail stations and the stations ridership usage. I initially hypothesized that crime would lower CTA ridership, but, after running my regressions, it actually appears that ridership drives crime rates. In order to understand the true repercussions of this finding, I had to analyze the inputs and outputs of the regression.

The output variable for this regression, Cumulative Ridership Total, was easily accessible on the Chicago Data Portal. Once I had this data, I needed to use QGIS in order to isolate the crime rate around each CTA rail station.

The map above is a layout of the CTA rail stations with the 0.25-mile buffer zone around each station. The green circles around each station will count the number of crimes within that radius. I decided on a 0.25-mile buffer zone because I wanted to limit the crimes to immediately around the station itself. This is to ensure that stations in higher crime zip codes will not be over weighted with crimes and I could see the true affect that crime has on ridership. Once the crime and 0.25-mile buffer zone layers were spatially joined, I had the data I needed for my Cumulative Crime variable.

To account for the differences in population density, I added a variable for the usage rate divided by the population density around that individual station. With this variable included in my regression, it made stations in higher populated areas have similar usage per person to those in lower populated areas of Chicago. The population density per square mile data was easily available from Social Explorer. I divided that number for each zip code by four, so the population density was the same distance as the buffer zone around each rail station. The final variable I included in my second regression was Median Household Income. Prior research from Lindblad et al has shown that areas with lower median household incomes have higher crime rates. By including a variable that accounts for the connection between Cumulative Crime and Median Household Income, it made my findings more precise.

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.743474282
R Square	0.552754009
Adjusted R Square	0.5414789
Standard Error	1170045.432
Observations	123

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	3	2.01344E+14	6.71145E+13	49.02427171	1.05704E-20
Residual	119	1.62912E+14	1.36901E+12		
Total	122	3.64255E+14			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	455800.7792	238622.94	1.91012976	0.058523192	-16696.47486	928298.0332	-16696.47486	928298.0332
Cumulative Crime	1089.288932	182.0437807	5.983664632	2.36008E-08	728.8240645	1449.7538	728.8240645	1449.7538
Usage/Pop Density by 1/4 Mile	6286.786379	1489.082771	4.221918688	4.76157E-05	3338.253768	9235.318991	3338.253768	9235.318991
Median Household Income	11.05988402	3.88575999	2.846260203	0.005211131	3.365691144	18.7540769	3.365691144	18.7540769

The results from the second regression are even more surprising than the first. Starting with the output variable, Cumulative Usage, a coefficient of 455,800.7792 with standard error 238,622.94 tells me that the average CTA rail station had 216,577.8392 to 694,423.7192 riders over this eighteen-month period. However, this result is slightly statistically insignificant with a p-value of 0.058523192, but it is close enough to our threshold of 0.05 to not be completely discarded. The second variable, Cumulative Crime, had a p-value of 2.36008 E-08, which is an extremely statistically significant result. The coefficient for my crime variable was 1,089.288932 with a standard error of 182.0437807. This shows me that for every unit of change in crime, ridership increased by 907.2451513 to 1,271.3327127. This finding goes against my initial hypothesis of crime lowering ridership, when it appears that higher crime actually causes higher ridership. This could be due to the fact that regressions do not explain the causal mechanisms behind correlations. One potential explanation for this bizarre finding could be that higher ridership actually leads to higher crime rates just because there is a greater opportunity for crime to be committed when there are more people around a given CTA rail station.

The next regression variable is Usage divided by Population Density by 0.25-miles. With a coefficient of 6286.786379 and standard error 1,489.082771, the result makes logical sense. This is saying that for every unit change in ridership, usage per 0.25-mile population density increases by 4,797.703608 to 7,775.86915. In terms of CTA rail ridership, I expected that areas that have higher ridership are within highly populated areas of Chicago, like the Loop or Downtown. Having a p-value of 4.76157 E-05, we can conclude that this result is statistically significant. The final variable in my regression, Median Household Income, had a coefficient of 11.05988402 with a standard error of 3.88575999. This result tells me that for every unit change in ridership, Median Household Income increased by $7.17412403 to $14.94564401. An increase in Median Household Income with an increase in ridership makes sense because the stations with the highest ridership are located in areas of Chicago with higher incomes. I believe this result is statistically significant with a p-value of 0.005211131.

Policy Recommendations

Current Policy Space

Chicago Transit Authority

The Chicago Transit is the main party involved is the Regional Transit Authority (RTA). The RTA oversees the operation of the Chicago Transit Authority (CTA), Metra rail system, and the Pace bus system. The CTA is actually an independent government agency created by the *Metropolitan Transit Authority Act (70-ILCS-3605).* CTA began operating in October 1947, after it purchased the Chicago Rapid Transit Company and Chicago Surface Lines. Five years later, CTA bought the Chicago Motor Coach system and officially became the sole Chicago transit agency. The CTA is governed by the Chicago Transit Board, currently headed by Terry Peterson. The Chicago Transit Board is made up of seven members, three of them are appointed by the Governor of Illinois while the Mayor of Chicago appoints the other four. Each party involved in the appointment process has approval powers over current appointees. The appointees of the Mayor of Chicago have to be approved by the Governor and the Chicago City Council, while the Governor's appointees must be approved by the Mayor and the Illinois State Senate. CTA's current president, Dorval R. Carter, Jr., oversees the day-to-day operations of the agency. The goal of the CTA, besides transporting Chicagoans around the city, is to generate revenue from farebox collections and non-farebox revenue sources. In addition to the revenue CTA brings in, the RTA provides funding for the operational expenses. Illinois state law does require that the service boards of the RTA, CTA, Metra, and Pace, collectively recover at least 50% of operating costs from their farebox and non-farebox revenues.

Median Home Values

Most major metropolitans have some form of rent control or stabilization efforts to protect buyers or renters from astronomically high prices for the place they live. However, Chicago is not like most major cities and the State General Assembly is responsible for that fact. In 1997, the *Illinois Rent Control Preemption Act* was passed. The name of the bill does a good job of describing what it accomplishes: “A unit of local government, as defined in Section 1 of Article VII of the Illinois Constitution, shall not enact, maintain, or enforce an ordinance or resolution that would have the effect of controlling the amount of rent charged for leasing private residential or commercial property” (Illinois General Assembly). However, this Act has a home rule preemption, which states: “A home rule unit may not regulate or control the amount of rent charged for leasing private residential or commercial property” (Illinois General Assembly). The Rent Control Preemption Act was a major victory for real estate developers and landlords because it gave them the unregulated freedom to change rent payments. This Act has contributed to the gentrification effects we see in Chicago today.

Current Policy Changes

Chicago Transit Authority

In 2019, Representative Thaddeus Jones of the 101st General Assembly of the State of Illinois, introduced bill *70 ILCS 3605/27*. This bill amended the original Metropolitan Transit Authority Act and required the Chicago Transit Board to appoint and fund a minimum of one police officer or other security personal on every bus and train operated by the CTA. If this policy were to pass, crime committed on or in immediate proximity of CTA operations would decline. The Illinois General Assembly website does not provide information on potential support or opposition of each policy, but I would have to assume that General Assembly Members and CTA riders would heavily be in favor of increased protection against crime while commuting on the CTA.

Median Home Values

The city of Chicago has made attempts to protect home owners from gentrification. On July 24, 2019, the Chicago Committee on Housing and Real Estate passed *Ordinance O2019-5568*. This ordinance amended *Municipal Code Section 4-6-050* to prohibit predatory tactics by residential real estate developers. The Ordinance established what acts would be prohibited:

> "use predatory tactics to persuade, convince, cajole, pressure, force, harass or otherwise coerce any homeowner to sell their property. For purposes of this subsection (e)(7), the term 'predatory tactics' means: (1) repeated and unsolicited attempts, within any 180-day period, to contact a homeowner via email, telephone calls, house visits, written material or similar means, under circumstances when the homeowner has affirmatively requested the license or the licensee's agent to refrain from such activity: or (2) threats, whether express or implied" (City Council of the City of Chicago).

In my opinion, this amendment is a step in the right direction to protect homeowners from gentrification effects, but more needs to be done for Chicagoans.

From Findings to Policy

Research Question 1

After uncovering that every CTA rail station has a positive fiscal impact on the zip code it is in, I needed to understand how this relates to Public Policy in Chicago. In Illinois, it is currently illegal for Chicago's government to enact any forms of rent control. This has created gentrification in certain parts of the city. Since the presence of any CTA rail station, whether it be in a high or low crime area, helps to raise property values, we can safely assume that these stations have contributed to gentrification. In order to curb the gentrification effects that CTA rail stations impose on its users, I propose a two-course plan. The first step is to require that the Illinois General Assembly amends the Illinois Rent Control Preemption Act. With this Act amended, the people of Chicago will have more protection from unfair rent prices and cannot be forced out of their current homes by real estate developers. Besides having protection from the Illinois General Assembly, the people of Chicago will have the unrestricted power of the city's government to combat gentrification. The second step is for the City Council of the City of Chicago to enact rent control. That way, if the City Council ever proposes future additions to the CTA rail system, then lower income residents will not be forced out of their homes by an increase in properties value along the new routes.

Research Question 2

The results from my second regression indicated that higher ridership at CTA rail stations actually drives higher crime at these stations. This went against my initial hypothesis of crime lowering ridership. In terms of Public Policy in Chicago, the Illinois General Assembly has already attempted to lower crime at CTA rail and bus stations by proposing a bill to fund the placement of one security personnel at every station. My policy recommendation would be to pass this bill and take it a step further by placing more than one security guard at stations with higher usage. This necessitates it will have higher crime rates than stations with lower ridership figures. Using the data, I would recommend that more than one security personnel be placed at the Jackson-Dearborn, 69th, E 63rd-Cottage Grove, 47th-Dan Ryan, Armitage, Wilson, Kostner, Damen-Cermak, 95th-Dan Ryan, Austin-Lake, Berwyn, Laramie, Addison-Brown, and Damen-

Brown stations due to the fact that they have more than one thousand crimes committed during this eighteen-month period. If more than one security personnel is placed at each of these stations, then their crime rates should decrease.

Conclusion

With the continued urbanization of mankind, I set out to determine how various aspects of cities impacted each other. In particular, I wanted to focus on the relationship between housing, public transportation usage, and crime rates. Using Paris as my example city, I wanted to uncover these relationships with Chicago. To do so, I needed to collect data from the Chicago Data Portal on CTA usage by individual stations, crime rates across Chicago, and precise zip code layouts. On top of this data, I collected the average housing price and median income in each Chicago zip code from Social Explorer. Using this geospatial data, I have been able to create maps on QGIS that combine these datasets together and isolate crime by individual CTA rail station based on zip code. With this data, I ran regressions to determine the relationships they share with one another. The first regressions found that a CTA rail station will always have a positive fiscal impact on the respective zip code, whether it be a high or low crime area. The second regression was able to discover that crime does not lower CTA usage, but that higher CTA usage actually creates higher crime rates at individual stations. Using this information, I recommend that the Illinois General Assembly should overturn *the Illinois Rent Control Preemption Act* in order for rent control measures to combat gentrification in Chicago. For the second research question, I recommended that the Illinois General Assembly pass bill *70 ILCS 3605/27*, which would place a security personnel on every bus and train operated by CTA. On top of this measure, the bill should be amended to add additional security personnel at the CTA rail stations with the highest crime rates. With these policy recommendations, the Chicago Transit Authority can become an even greater asset to the city of Chicago.

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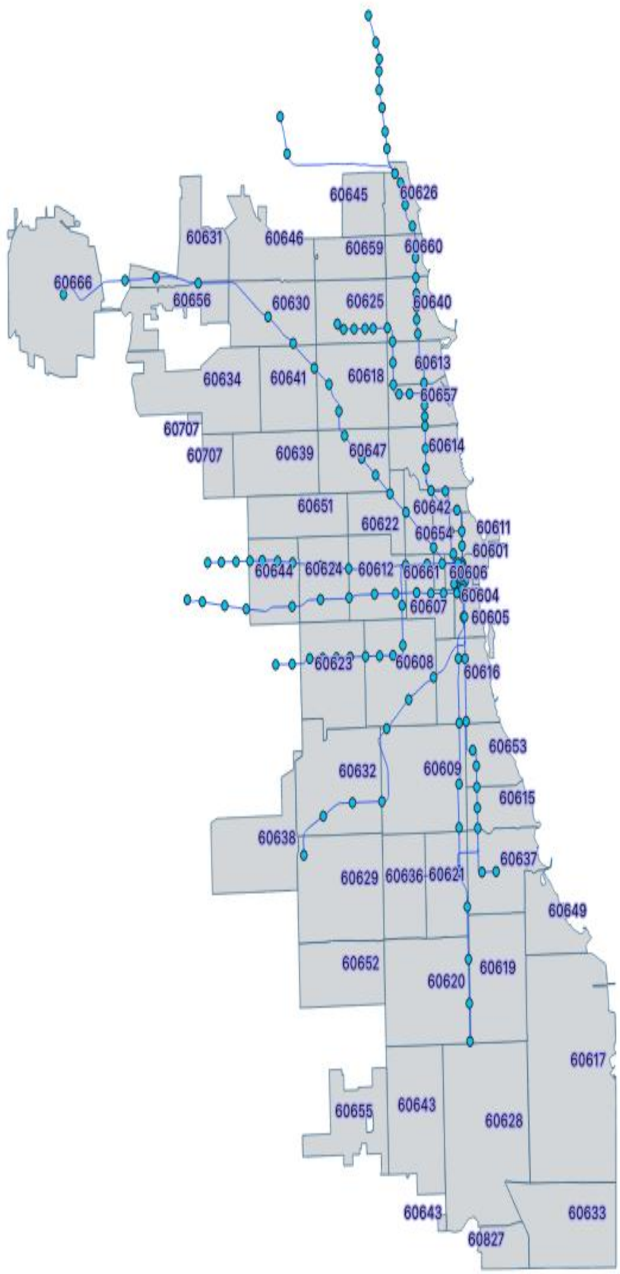
Appendix: QGIS Maps

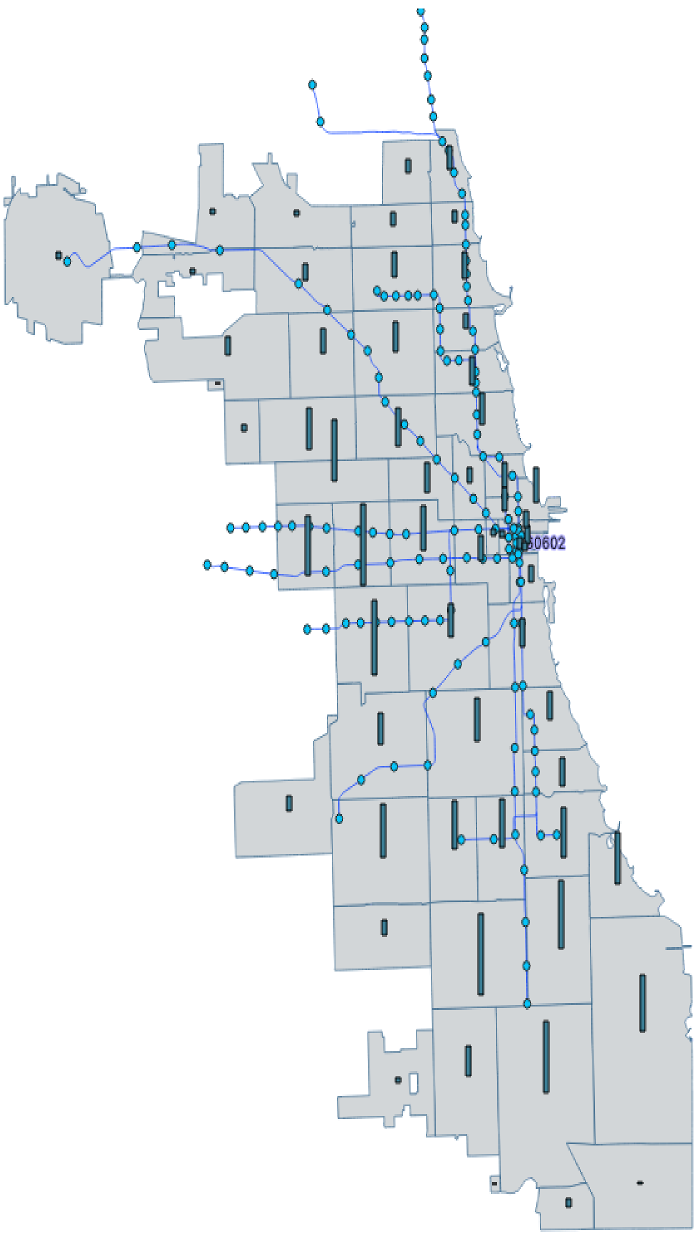
Map 1

Layout of Chicago's precise zip code layout with labels. The blue line is a depiction of the Chicago Transit Authority's complete rail system and the blue nodes are rail stations.



Map 2

Depiction of crime rates across Chicago's zip codes. The Chicago Transit Authority's rail system is still shown. The vertical bars in each zip code are a histogram of the cumulative number of crimes per zip code.



Map 3

Depiction of crime rates within a ¼ mile radius of each Chicago Transit Authority rail station. The green circles count the number of crimes within the ¼ mile radius and the orange dots are the rail stations.