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# "Grew Up in a Slaughterhouse"
# An Empirical Analysis of Homicides in Chicago 2000-2016

The University of Tampere
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Homicide rates have remained consistently high in Chicago in spite of a nationwide downward trend in the past decades. This thesis examines the effects of public housing policy on homicide rates in Chicago in order to see whether or not the city's decision to demolish high-rise public housing projects had the intended effect of lowering homicide rates.

This thesis applies game theory to build a model on expected actions of relocated gang members. Spatial and traditional analysis methods are used to analyze data to see if the game theoretic prediction holds true, and if the city's policy choices produced the desired effects. The data used in the thesis is compiled from crime statistics from the Chicago Police Department and population data from the U.S. Census Bureau.

Spatiotemporal analysis indicates that homicide rates decreased in areas where high-rise projects were demolished, but increased in other areas. A spatial lag model indicates that detrimental socioeconomic factors are correlated with homicide rates spatially. A regression model with fixed effects for community areas indicates that the presence of high-rise housing increases homicide rates.

The results emphasize the need to consider possibly unintended consequences in public housing policy. Based on the literature and data, preventive measures are vital, as bad policies and designs present the risk of a downward spiral that is almost impossible to break once it has begun. There are possibilities of conducting further research in the area in more detail and with more material under examination.

Keywords: Gangs, public housing, homicide, game theory, spatial data analysis

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# 1 Introduction

Even though crime rates have been trending downward in the United States over the past couple of decades, the number of homicides has continued to be high in Chicago and some other major cities, with 2016 proving to be a substantial upward spike in homicide rates. Estimates at the end of the year predict the rise in homicide rates in the 30 largest cities in the United States to be around 14 percent, with Chicago accounting for nearly 45% of that increase (Mark Berman, Chicago Tribune 2016).

Chicago's homicide rates have been high due to gang-related violence, but whereas gangs fought over territory and drug sales in the 1980s and 1990s, these days Chicago gangs have become highly fragmented into smaller units consisting of single or a few city blocks, with no overarching larger street gang to organize them into business in the illicit drug market (Wired 2013). Many acts of violence these days stem from petty disputes on social media which prompt violent responses in order to maintain one's reputation, or face, with no connection to competition in drug dealing (Wired 2013). Previously, committing homicides based on petty disputes was at least somewhat curbed by the presence of larger gangs as their business of selling drugs would suffer from increased police attention in an area with a surge in homicides.

There are two major reasons for the fragmented nature of Chicago gangs, which are outlined in a Wall Street Journal article (Belkin, 2012), namely the incarceration of major gang leaders and the subsequent severing of their communication ties to the outside world, as well as the demolition of the city's largest housing projects. Gang leaders, for example Larry Hoover of the Gangster Disciples, were issuing orders to their gangs from prison, but removing this line of communication did not remove the gang problem. Removing the head of a gang did not end gang activity, but instead resulted in former lieutenants of the leader competing to be the new leader, and this resulted in more violence.

Defining gangs is a difficult task in itself, as “there is a mercurial subculture of posses, cliques, crews, taggers, and other factions, all blending into the larger world of gangsta rap and hip-hop” and gangs themselves “have semipermeable boundaries, fluid membership, and fluctuating levels of affiliation" (Hayden 2004, 3). This problem of clear definition also extends to the justice system and their definitions of violence that is related to gangs and gang members.

Tom Hayden (2004, 9) points out differences between cities as it pertains to gang-related violence, where "Los Angeles uses a definition of gang-*related* homicide, which means a killing where one of the parties is defined by police as a gang member or associate" but in contrast, "Chicago counts those homicides that are gang-*motivated*, that is, which further a gang interest, like a drive-by shooting or the killing of a drug dealer in a feud over territory." Creatively using these definitions can help city administration portray the city's gang problem as being less serious than it truly is, but there is the limitation that a body cannot be made to disappear. Furthermore, ruling a death accidental or self-inflicted becomes nearly impossible if the deceased person is found in the street or dies in a hospital with multiple gunshot wounds in various locations on their body and head.

On an interesting side note, comparing the number of homicide victims in Chicago (Chicago Police Department data) to the number of combat casualties suffered by U.S. military forces in Afghanistan (iCasualties.org) for the years 2001 through 2016, the number of homicides in the city of Chicago is more than triple the number of military casualties that U.S. forces suffered in an actual war zone. By comparison, the number of homicides in Chicago is roughly equal to the number of casualties in the Iraq War between 2003 and 2011 (iCasualties.org), a grittier and more intense war than the conflict in Afghanistan.

The purpose of this thesis is to examine the effectiveness of the city's policy decision to demolish the high-rise housing projects with the aim of driving down crime and homicide in these hot spots and keeping it even at the worst in other areas. Thus, the main research question of the thesis is: did the city's policy of demolition have the desired effect on homicide rates?

The structure of the thesis is divided in the following manner: the chapter following the introduction provides background information on the city's housing projects and how their situation deteriorated as far as it did. Then, a chapter describing the theoretical and methodological approach used in the thesis. After that, there is a chapter that describes the game theoretic model which acts as the basis for a hypothesis on the consequences of the policy decision. Next, a chapter describing the data, and the data collection and preparation process. Following the data chapter, there is a chapter containing the findings and analysis of the tests run on the data. Finally, there is a chapter with concluding remarks, followed by the bibliography and appendices.

# 2 Background

This chapter provides a description of the history of public housing in Chicago as well as views on the causes for the problems within public housing projects that are presented in the literature on the subject. The chapter is divided into three parts, with the first describing the history of the public housing projects and their inherent problems, the second covering the advent of the gang problem within the housing projects, and the third part providing an overview of the response from the administration once the problems became too severe to ignore.

## 2.1 Problems with public housing policy

The idea of providing more of a safety net for citizens became more widespread during the Great Depression, which led to a “massive expansion of government in the economic and social life of the nation” (Heathcott 2012, 361) in the form of president Franklin Delano Roosevelt's set of programs known as the 'New Deal'. Public housing also moved forward in the 'New Deal' era, with Catherine Bauer summarizing “two decades of discourse and debate” (Heathcott 2012, 361) in her book *Modern Housing* where she “advanced two powerful arguments: Government must intervene where the market has failed to provide a basic human need; and the most desirable, rational, and humane mode of intervention should take the form of well-designed mass housing for the working class” (Heathcott 2012, 361).

The Great Depression was also a time where governmental involvement in the economy seemed justified to the public as well, as Smith (2009, 262) points out, “through public works projects, the federal government presented a physical justification of its new presence in the nation's economy” and that the “New Dealers compellingly demonstrated that public investment and state-sponsored economic development were essential to a modern society” in order to not only survive the Great Depression, but also laying the groundwork for the economic boom following the Second World War, even if the New Deal planners had no knowledge of the coming war.

The period following World War II was a time when the Chicago Housing Authority engaged in a concentrated effort of clearing slums and building public housing projects and over 20 years “built 23,400 apartments for low-income families, nearly all in African American neighborhoods” (Hunt 2009, 67). During the period, there was a trend of building massive housing projects where thousands of apartments were concentrated in small areas. Probably the most famous, or notorious, example of this trend was the Pruitt-Igoe housing project in St. Louis, Missouri, built in the 1950s and consisting of over 30 massive buildings. Hunt mentions a rise in criticism toward this public housing trend “after St. Louis imploded its 2,700-unit Pruitt-Igoe project in 1972 (after a mere seventeen years of operation)” with critics condemning “the minimalist, repetitive, concrete towers of Pruitt-Igoe and the Robert Taylor Homes [in Chicago] on aesthetic grounds as sterile and unfriendly environments” (2009, 121).

There are multiple factors that contributed to the problems in public housing in Chicago, and also in other places to a lesser degree. There were institutional pressures on the effort to build this new wave of public housing projects, and while there were some poor design choices, Hunt notes (2009, 122) that “blaming architects for public housing's failure exaggerates their importance” as they had to operate “within planning assumptions and policy restrictions that tightly constrained design possibilities.” Hunt further details (2009, 122) how an obsession with costs on behalf of Washington administrators forced the Chicago Housing Authority to opt for high-rise buildings to minimize land usage, and also to ensure that public housing projects were built for lower prices than privately-owned residences. Heathcott (2012, 363) mentions that during the drafting of the New Deal era bill that regulated public housing Senator “Harry Byrd introduced an amendment that imposed drastic cost ceilings on new projects that amounted to $5,000 per unit.”

Having budgetary deficiencies from the very beginning resulted in serious problems in the high-rise housing projects, with maintenance lagging behind immediately. Venkatesh (2009; 37, 51) mentions that residents were unable to use elevators due to them breaking down frequently with maintenance crews delayed sometimes for weeks, and in the worst cases elevators fell down shafts with unfortunate residents inside. With the immediate problems being so evident, it is no surprise that less than ten years from their inception, “the CHA's high-rise projects were seen by most observers as completely misguided. They produced imposing, institutional environments that were easily stigmatized and readily identifiable as second-class housing” (Hunt 2009, 141).

Hunt further notes the unfavorable atmosphere surrounding the effort to renew public housing in Chicago in the mid-20th century, where planners and administrators on the local and federal level knew the problems that would arise if the housing projects were built as planned, but no one had a creative way to work around the restrictions on designs, with the CHA finally acquiescing to high-rise projects to appease the federal PHA actors, “who, at times, behaved more like petty bureaucrats, less concerned with outcomes than with protecting their program from the perceived excesses of local authorities and potential wrath of congress” (2009, 141-142).

This strongly indicates that the subsequent failure was not a result of a single bad decision on behalf of any one party involved in the process, but rather a result of conflicting interests for various parties at different levels of governmental bureaucracy. Architects and designers had a hopeful vision of futuristic housing where residents would enjoy a new style of living arrangements, the local housing authority wanted a functioning method of housing provision that would help those in need and not produce additional problems in the process, and the higher level bureaucrats wanted to avoid sending signals of being frivolous with federal money and risk the whole program being shut down.

There is an issue that should not be overlooked when examining the downfall of public housing projects in Chicago. It appears that concentrated poverty in itself was not the cause for the problems that began escalating soon after the housing projects were finished and opened to the public. In fact, initially poverty was not highly concentrated in housing projects, but there was some variation in the incomes of the residents. Hunt mentions the issue in question by pointing out that “youth-adult ratios are an overlooked factor in collective efficacy and are essential to understanding the history of public housing’s decline” (2009, 146).

Having too many youths compared to adults produces problems on a community level, making communal adult supervision of young people an almost impossible task. Hunt mentions that “in project communities where youths far outnumber adults, those seeking to enforce order faced a daunting, and perhaps insurmountable, demographic burden” (2009, 146). This issue does not seem to appear in the usual public discourse on problems in housing projects, where the focus seems to be more on the poverty-related aspects of public housing residents.

However, the issue of youth-adult ratios is not a simple explanation for problems that arose in public housing projects. James Q. Wilson notes that there were analyses that "confirmed that the rise in crime rates in the 1960s was not wholly the simple result of an increase in the number of young persons in the population" (2013, 13). A further explanatory factor that may help explain the onset of problems in housing projects is the rate at which youth-adult ratios are changing, with faster changes being more likely to cause problems in the community. J. Wilson further notes that a "sudden increase in the number of persons at risk has an exponential effect on the rate of certain social problems" (2013, 14).

Expanding on this point, Wilson goes on to explain that there is possibly "a 'critical mass' of young persons such that, when that number is reached, or when an increase in that mass is sudden and large, a self-sustaining chain reaction is set off that creates an explosive increase in the amount of crime, addiction, and welfare dependency" (2013, 14). William J. Wilson is in agreement with this assessment, noting that the 'critical mass' "hypothesis seems to be especially relevant to inner-city neighborhoods and even more so to those with large public-housing projects" (1987, 38). Thus it appears that sudden shifts toward more youth-dominated demographics was one of the key contributing factors that caused large problems in the Chicago housing projects from the very beginning. While discussing some of the later problems that developed in the housing projects, Hunt mentions that "social disorder was present in high-rises with large numbers of children right from the start" (2009, 146).

As was mentioned earlier, having large amounts of young people in relation to adults, and having those young people causing trouble is detrimental to the state of the community in a given area. If the youth escalate their misbehavior to crimes that victimize others, the situation deteriorates even further. J. Wilson explains the situation, noting that "predatory crime does not merely victimize individuals, it impedes and, in the extreme case, prevents the formation and maintenance of community" (2013, 16). J. Wilson further elaborates on the mechanism of how crime deteriorates communities by stating that "by disrupting the delicate nexus of ties, formal and informal, by which we are linked with our neighbors, crime atomizes society and makes of its members mere individual calculators estimating their own advantage, especially their chances for survival amidst their fellows" (2013, 16).

This lack of a sense of community or the deterioration of an existing community is worse in areas with high populations, with people lacking connections with their fellow residents. Dennis Roncek explains that “the size of a block’s resident population and its area can affect contacts among residents and their ability to detect or distinguish potential offenders. Larger populations and areas may decrease contact and interaction among neighbors” (1981, 88). It is interesting to note how this relates to the concept of collective efficacy that was discussed earlier. Having large populations with diminished connections and interactions with their fellow residents in combination with large youth populations causing problems leads to the expectation of a weak community that cannot collectively stifle the delinquency of the youth population in that community. Furthermore, Roncek also points out that “on physically large blocks, events in one part may be of little concern to those using a different part” (1981, 88).

Keeping the description of large housing blocks in mind, it becomes apparent that housing projects such as the Robert Taylor Homes and Cabrini-Green are prime examples of what was discussed earlier in terms of large populations with limited connections and interactions amongst themselves. Also, in terms of the idea of collective efficacy, these massive housing projects can be seen as having large potentials for trouble with delinquent teenagers. W. Wilson points out that as the “description of the Robert Taylor Homes and Cabrini-Green in Chicago suggests, when large poor families were placed in high-density housing projects in the ghetto, both family and neighborhood life suffered” and allowed “high crime rates, family dissolution, and vandalism” to flourish in these areas (1987, 38). The issue of family dissolution also ties into the idea of crime breaking down communities as described by James Wilson (2013).

One fascinating aspect of the problems facing the Chicago housing projects is how quickly they began after the construction of the projects and when the first tenants had moved in. There was no slow deterioration of communities, but rather a quick descent into problems. As Hunt explains, “vandalism in the CHA’s large high-rise projects was endemic within months of occupancy, directly affecting tenant quality of life” (2009, 155). W. Wilson attributes much of this to the rapid shift in youth-adult ratios, noting that the “conditions of social disorganization are as acute as they are because of the unprecedented increase in the number of teenage and young adult minorities in these neighborhoods, many of whom are jobless, not enrolled in school, and a source of delinquency, crime, and unrest" (1987, 38). Furthermore, Hunt notes that "while quantifying vandalism is difficult, tenant complaints and managers' reports are filled with evidence that youths had the upper hand in the new projects" (2009, 155).

## 2.2 The rise of gangs

The situation in the new high-rise projects was troubled right from the beginning, but it deteriorated even further at a rapid pace. According to Hunt, an example of this could be seen in the Cabrini extension of the Cabrini-Green housing projects, where "destruction of tenant mailboxes made mail delivery insecure, damaged laundry machines compelled tenants to wash clothes in their apartments, and profanity-laced graffiti in stairwells demoralized residents" within a year of the opening of the extension (2009, 155). Noting the earlier mention of these high-rise projects having been criticized as being sterile and unfriendly environments, it is easy to imagine the exacerbating effect of vandalism and graffiti when it comes to the quality of life of the tenants. The deterioration of the community due to crime, combined with the deterioration of the surroundings due to vandalism undoubtedly worked to further facilitate the rise of more problems related to delinquency and crime.

The delinquency problem that manifested itself in the high-rise projects from the very beginning proved to be a fertile ground in which more serious gang-related problems were able to take root. Hunt notes that during the 1960s, organized gangs began infiltrating Chicago's housing projects where "they found high youth densities conducive to gang organizing" (2009, 157). A large population of youth not involved in work or education is highly vulnerable the onset of a gang problem, which did occur quite rapidly in the high-rise housing projects of Chicago. For gangs, it was unoccupied territory which they had every incentive to take hold of, and for the young residents the gangs provided an opportunity to earn some money, and gain a reputation as someone to be feared, if not respected.

Once the problems developed in the housing projects, the effort to regain collective efficacy and control the delinquent youth population proved to be a monumental task, with differing opinions on how to achieve it. As Hunt explains, whereas some people working for the CHA, some tenants and other agencies attempted to quell the disorder and regain collective efficacy, other residents and managers preferred the approach of expanding formal policing, whether by CHA security or by the Chicago Police Department (2009, 173). Considering how multi-faceted the problem is and how complex it is to tackle from the safe position of an analyst far removed from the situation, it is no wonder that there was no unified approach to be found among the residents and immediate officials involved in the process.

However, the proponents of increased formal policing faced another obstacle in addition to their disagreements with the contingent looking to increase collective efficacy. Hunt notes that "neither the Chicago Police Department nor the CHA's senior leadership were willing to spend resources beyond ordinary levels to increase formal policing" (2009, 173), meaning that they were willing to provide the same level of policing that other neighborhoods received, which proved to be insufficient to contain the problems that were developing in the housing projects.

Describing how the police operated, Hunt provides more details, mentioning that while CPD officers "patrolled in cars and responded to police calls, as they did in other neighborhoods," they were unwilling to exceed these basic levels of policing, which in turn meant that "foot patrols of public housing superblocks were rare, and 'vertical patrols' inside buildings were nonexistent" (2009, 173). Considering the physical composition of the housing blocks, this choice of strategy by the police was clearly inefficient as car patrols, or even foot patrols in the courtyards of the housing projects are unable to detect any illegal activities or disturbances within the vast array of stairwells, hallways, and galleries within the building blocks. However, the reluctance of the police to conduct these foot patrols within the buildings is completely understandable due to the security risks involved in sending units of two officers inside the massive building blocks.

The dilemma of patrolling inside these large housing blocks also relates to the economic formulations of Gary Becker on the costs caused by crime compared to the costs incurred by fighting and punishing crime, where the entirety of the costs adds up to the amount of social loss (1974, 43-44). To ensure the safety of any foot patrols entering into the largest housing blocks, there would need to be at least two units of two officers, if not more, patrolling the inner corridors and stairwells as a larger group. Increasing the number of officers from the regular two-person unit to a combination of two such units increases the number of officers to four, and also doubles the cost incurred by the patrol, as you now need to pay four officers instead of two. Also, in the case of the Robert Taylor Homes, the U-shaped positioning of the buildings presented a security risks for foot patrols operating in the courtyard, as the galleries facing the courtyard were convenient places from which to throw bottles, rocks, or other debris onto the patrolling officers, or in the worst case scenario, to act as a vantage point for sniper fire.

Chicago's housing projects were not the only areas facing problems during the decades following their opening, as there was an overall increase in crime rates all over the nation. As Hunt explains, "crime rates rose nationwide in the 1960s for numerous reasons, including rising numbers of baby-boom teenagers, increasing availability of handguns, and deteriorating relations between police and minority communities" (2009, 173). The growth of the teenage population in the housing projects is strongly connected to the concept of collective efficacy discussed earlier, and adding even more young people to the population could only work toward exacerbating the problem. This issue, as well as handguns being more easily available and relations with the police deteriorating all doubtlessly contributed to the downward spiral of life in the housing projects.

Hunt goes on to explain that while the change in crime rates in Chicago was generally along the lines of the whole country, "in public housing, crime rates were devastatingly high, especially as poverty grew more concentrated in the 1970s" (2009, 173). At this point, the crime problem in the housing projects had most likely reached a tipping point, from which there would be next to no chance to recover with conventional means. Once the gangs had become entrenched, they were the de facto administrators of the communities within the housing blocks, as described by Venkatesh (2009).

In fact, the situation did deteriorate even further, as countermeasures proved to be inadequate. Hunt explains the development in the situation at the end of the 1970s, stating that "crime at Cabrini-Green returned to epidemic levels after the initial and incomplete efforts of the 1970s" (2009, 176). Hunt further elaborates, maintaining that "by then, poverty was intensely concentrated and deferred maintenance had produced grim physical conditions, and neither vertical patrols nor attempts to create defensible space made much difference" (2009, 176). By the beginning of the 1980s, it appears that the housing projects were a lost cause to the authorities, with countermeasures proving ineffective or too costly to implement effectively.

The 1980s saw the rise of crack cocaine in poverty-stricken inner city areas, leading to a bustling underground market run largely by gangs, as the drug was fairly easy to make from powder cocaine, and the form it took in the process, little nuggets or “rocks”, also made it easy to distribute to users (Fryer et al. 2013, 1655). However, as this new underground market expanded into a major economic forum where substantial amounts of money began circulating, it also had an effect on the gangs themselves. As Sudhir Venkatesh and Steven D. Levitt note, “jealousies among members were rife as historic allies accused one another of cheating or price gouging; on occasion, members of a local faction – putatively ‘brothers’ – fought with one another (sometimes fatally) to secure their individual capacity to profit in underground markets” (2000, 427-428).

Having originally been functioning as neighborhood related groups that protected their members from outsiders, the explosion of the crack cocaine market also caused structural shifts in the gangs, as well as an overall change in the main purpose of the gangs. Smaller neighborhood groups or sets began to organize amongst themselves, forming larger conglomerations that organized themselves around the crack dealing business. As Venkatesh and Levitt explain, “the citywide gang federation had left behind the skein of a youth group involved primarily in social activities, minor crimes, and delinquency. They began to resemble and organized criminal network, interested more in consolidating their position in the city’s crack-cocaine market” (2000, 428). A new lucrative market provided financial incentives for these smaller groups to organize into larger units more capable of handling the competition and violence involved in such an underground market.

The need for a larger presence in an underground market stems from the very nature of that market. Being a market that deals in illegal substances necessitates some method of contract enforcement that is not overseen and administrated by the authorities (Sieberg 2005). When one party in a crack cocaine transaction deviates from the agreed-upon unwritten rules of “cash for product” whether the seller hands out pieces of soap or the buyer gives Monopoly money, neither one can go tell a police officer that they were cheated in the transaction, as they would be the one to immediately be in trouble with law enforcement (Sieberg 2005). Nor can sellers go to the police for help if a rival seller robs them of their money or product, and thus there is a need to enforce the rules without outside help, which requires the type of manpower and resources that gangs possess.

As there was a new purpose for the existence of gangs, one of financial profit from the underground crack cocaine market, as well as the associated incentives to form larger units in order to survive in that market, it is no surprise that the inner structures of gangs also underwent a significant change. Venkatesh and Levitt describe this structural shift, stating that a previously “disparate collection of neighborhood sets, with loose ties to one another and with little collaboration” within the Black Kings gang now became “part of an integrated hierarchy that had eerie resonance, structurally and in spirit, to a corporate franchise in which members held offices and specific roles” and in which each smaller “constituent set was tied to the overall organization through trademark and fiduciary responsibilities” (2000, 428). This is a notable change from the youth groups engaging in social activities and petty crimes that were described earlier.

## 2.3 Efforts to respond to the gang problem

The response on behalf of the authorities to this trend of consolidation among the gangs was one of harsher sentencing and large scale incarceration in an effort to quell the growing gang problems within cities and housing projects. Venkatesh and Levitt describe this shift in policy approach, stating that this “legal and law enforcement strategy, sometimes referred to as a ‘law and order’ campaign, involved a shift from liberal programming intent on reintegrating street gang members into mainstream institutions to ‘gang suppression’ tactics aimed at destabilizing gang networks and jailing members *en masse*” (2000, 433). The ‘law and order’ trend had been developing for over a decade, and according to Hayden “the idea of a ‘war on gangs’ emerged piecemeal, not as a conspiracy”, with the initial national step being the passing of the “1968 Crime Control and Safe Streets Act” which allocated “hundreds of millions of dollars for cities to toughen their law enforcement capacities” (2004, 16-17).

Following the Safe Streets Act, governmental expenditures on anti-gang programs grew at a rapid pace. Hayden mentions that Richard Nixon contributed to this growth after running a campaign focused on ‘law and order’, and that the “apparatus for fighting gangs was institutionalized steadily thereafter by the passage of six multibillion-dollar federal anticrime bills, the drug war’s draconian penalties for possession of crack cocaine, mandatory minimum sentencing laws, three-strike penalties, and the greatest splurge of prison construction in the nation’s history”

(2004, 16-17). The growth of the crack market appears to coincide with the expansion of the law enforcement and corrections systems, quite likely that one system was feeding the growth of the other, and vice versa.

The increased imprisonment rates of gang members undoubtedly affected the operations of gangs in Chicago's housing projects, as a sizable number of the leadership of various gangs were imprisoned during this period. In fact, Venkatesh and Levitt point out that this large-scale imprisonment "played a critical role in the infrastructural development of Chicago's largest gang federations and, to varying degrees, the organizations reinvented themselves when most of their leadership was incarcerated (2000, 435). This proved to be a problem for the authorities later on, as gang leaders were issuing directions for their gangs from within prison walls, which meant that the massive scale of incarceration did not prove to be as effective as the authorities would have hoped it to be.

Due to the continuing deterioration of the situation within the housing projects, and the ineffective nature of mass incarceration as a tool to correct the development, the administration had to devise a new approach in order to rectify the dire conditions in the housing projects. It appears that the administration deemed these large housing projects a lost cause during the 1990s, and toward the end of the decade, the U.S. Department of Housing and Urban Development drafted the legislation known as the Quality Housing and Work Responsibility Act (QHWRA) which was signed by President Bill Clinton in 1998 (hud.gov website). The purpose of this legislation was to reinvent how public housing is distributed to people in need, and to do away with the failed housing projects and the concentrated crime and poverty that were prevalent in those areas.

The legislation specifically targeted the large housing projects, as Jeff Crump notes in his article where he states that "specific policy objectives in the QHWRA include: the demolition of public housing projects and the provision of vouchers that will facilitate the movement of public housing residents into the private housing market; stipulations that demolished public housing be replaced only by mixed-income developments" (2003, 179). On the surface the change in policy seems warranted and perhaps even well-intentioned, but a number of issues are related to what the new policy's implications are and how the changes in public housing were brought forward. According to Edward Goetz, there were housing authorities that "allowed properties to decline by neglecting upkeep, failing to re-rent vacant units, and sometimes even refusing to spend HUD-allocated funds for modernization and improvement" (2012, 453). This type of procedure allowed the housing authorities to receive permission to demolish housing projects that were not originally designated for demolition, and acquire the land area for other developments. Even though these housing projects were not targeted for demolition, the willful neglect on behalf of the housing authorities allowed the buildings to deteriorate to a point where the administration permitted their demolition due to their poor condition.

Goetz further explains that this "revised policy has led to the dismantling of the New Deal social welfare model of publicly owned and operated housing for the poor" and this old model has been replaced by a system where "housing subsidies come in the form of vouchers for families to use in the private market or through the Low Income Housing Tax Credit program funded by private investors and operated by private developers" (2012, 453). This is an interesting development in that it appears to funnel public funding into the hands of private operators that provide the services for those in need. Whereas before, the New Deal model was based on public welfare provision to the most disadvantaged portion of the population with government-provided housing and funding, now there is a profit incentive involved on the side of those providing the housing services. This may lead to undesirable outcomes if the party providing the housing chooses to maximize their profit by cutting costs involved in housing provision, for which they have every incentive.

There do appear to be issues involved in this renewed policy of public housing provision. As Crump points out, the "rhetoric of residential mobility and self-sufficiency that characterizes US federal public housing policy masks a harsher reality for those displaced by the demolition of public housing: insecure shelter in privatized ghettos, low-wage working poverty, and the constant specter of homelessness and unemployment in deregulated urban labor markets" (2003, 279). This troubled sentiment is also echoed by Hayden, who mentions that the "decades of the eighties and nineties, when gang strife was at its worst, were a time of deindustrialization, privatization, and countless schemes to dismantle the New Deal tradition of government intervention" (2004, 53). This would further reinforce the indication of an apparent shift from government-provided help to a system where private operators provide the services in exchange for funding from the government.

According to Crump, there is an underlying reason for this shift in policy, where "moving the poor out and the middle- and upper-class into select center city locations, public and assisted housing policy, in concert with welfare reform, is intended to facilitate the spatial reorganization of urban labor markets" (2003, 180). This perspective on the housing policy reform casts a more cynical light on the whole process, where the driving force of the policy shift would not be an attempt to improve the living conditions of the poorest segment of the population, but rather an attempt to shift around populations in order to better cater to employers in urban areas.

Crump also makes a strong statement on the origins of problems in housing projects, claiming that "even though the root cause of 'concentrated poverty' was the desire of urban planners and politicians to maintain residential segregation and save on land costs by building at high densities, this fact is ignored in favor of theories that focus on the alleged 'contagion' effects of population density" (2003, 181). Even though residential segregation has not been explicitly mentioned in the literature here, multiple authors have noted how the housing authorities opted, or were forced to minimize the use of land area by building high-rise projects. The Chicago case appears to be such that the city's own housing authority wished to avoid high-rise buildings, but were coerced to build them through pressure from administrators in Washington and the PHA.

Considering the policy choice of demolition as a method to alleviate problems in what had developed to be hot spots for crime over the decades, there are some points that need to be addressed in relation to the expected and unexpected consequences of this policy choice. First, we must consider who is committing crimes in these areas, and second, why are they doing so. The literature suggests that the ones initially partaking in delinquency and committing petty crimes, and later becoming involved in gangs appear to be mostly young, perhaps minority, residents in these housing projects (W. Wilson 1987, J. Wilson 2013, Hunt 2009, Venkatesh 2009). The second question is a more difficult one, with no real consensus to be found in the literature. While there is agreement on the fact that high-rise housing project buildings were deemed cold and unfriendly environments, there is no real indication of the environment itself acting as a cause for people to commit crime (Crump 2003, Venkatesh 2009, Hunt 2009, Duke 2009, Baumont 2009).

Especially for those involved in gang activities, the environment ceases to be a major factor in why they commit crimes. As Andrew Papachristos explains, "gang members do not kill because they are poor, black, or young or live in a socially disadvantaged neighborhood. They kill because they live in a structured set of social relations in which violence works its way through a series of connected individuals" (2009, 75). This raises doubts in regard to the effectiveness of demolition and the dispersal of the population, as the environment itself does not appear to cause gang members to commit violent acts, but rather the social network within the gang and amongst its members.

However, gangs appear to be highly linked to their surroundings, with Papachristos et al. mentioning that "in many ways, gangs more strongly identify with their neighborhoods than does the typical neighborhood resident. Whereas the average resident may take pride in her neighborhood and participate in community life, gangs often view themselves as a symbolic manifestation of the neighborhood itself" (2013, 419). The integral question here is, would removing the gang members from this neighborhood they identify with cause them to stop their gang activities, or would they realign their identification toward their new surroundings or perhaps continue representing their old neighborhood in the new location?

There are positive aspects to the redevelopment of poor urban areas, but the focus seems to be more on what happens to those areas where troubled housing projects are torn down rather than what happens to the people that are displaced from those areas. As Catherine Baumont points out, "urban regeneration policies try to reverse the processes of economic, social and material decline in deprived areas", where new mixed-income developments are replacing the old housing projects, and "the benefits from 'social mixity' in the neighbourhoods and positive effects of social and economic spillovers toward other neighbourhoods are expected" (2009, 302). However, even this development of formerly poverty-stricken areas faces some problems. As Crump points out, "the very stigma that facilitated the demolition of public housing projects may threaten the viability of the new mixed-income developments. There is little doubt that it will take a great deal of effort to convince white, middle-class suburbanites that former 'no-go' zones of the inner city are now safe places to invest" (2003, 185).

What happens to those moving out of inner-city areas could be an even more vital issue in the redevelopment of former housing project sites. The people arriving in more wealthy areas are sure to face some problems, as they come from highly stigmatized areas and there is the potential for backlash from the residents of the areas receiving the relocated residents. Simply moving to a new area is unlikely to solve all their problems. Joanna Duke discusses this issue, stating that “public housing residents who gain access to low poverty environments must also be able to actively engage their surroundings in a way that is meaningful to them. Physical integration, often seen as panacea for public housing residents, might not be sufficient” (2009, 101). Based on this, moving residents to a more affluent area is a major contributor to an increase in their quality of life, but it cannot be the only one.

As Duke further explains, “after years of spatial disenfranchisement, public housing residents may need additional support to overcome the barriers faced in mixed income settings, including opposition by their more affluent neighbours” (2009, 102). The opposition from residents in the receiving area is entirely understandable, considering the highly negative stigma attached to those who have been living in the city’s worst areas in high-rise housing projects. In fact, Duke notes that “around the US, economic integration attempts have been met with resistance by individuals in the receiving communities of dispersal programmes” and that “this race and class based resistance was coming not just from the residents in the communities, but from political and administrative leaders as well” (2009, 105).

What the literature suggests is that the problems that developed within the massive housing projects were not caused by any single reason, but rather a combination of many contributing factors. These factors include demographic reasons, design flaws in the buildings themselves, as well as bureaucratic and funding issues that, through the lack of proper maintenance, caused deterioration in the functionality and safety of the buildings. All of these factors contributed to the rapid descent into poverty and squalor within the housing projects, a situation that proved to be so severe that rectifying it was impossible with policy measures that were less than drastic.

However, as the root causes for the disastrous situation could not be narrowed down to a single one, it seems unlikely that fixing the situation would be successful with only a single drastic measure. Through the decades people grew up in horrendous surroundings and situations, in proverbial “slaughterhouses”, where the community functioned in ways highly unfamiliar to middle-class social planners. One does not simply erase decades of such history by moving residents into more affluent surroundings and expect all problems to disappear. Rather one should expect issues from both the people being relocated and those living in the areas into which these relocated people arrive.

# 3 Methodology

This chapter of the thesis covers the methodology used in the formulation of a hypothesis, as well the literature providing support for that hypothesis. The chapter is divided into three parts. The first part provides the theoretical background used in the thesis, which is game theory, as well as literature on how gang members act as rational actors in the gang setting. The second part describes how the game theoretic framework applies to gang life in the modern age of social media. The final part of the chapter describes the main methodology used in the analysis, spatial data analysis.

## 3.1 Game theoretic approach

Viewing gang members from a law abiding citizen's perspective, their adherence to a lifestyle of crime and violence might be called, in the parlance of our time, 'irrational'. However, when their actions are viewed from a game theoretic perspective, their actions and choices within gang life are entirely rational. They have information on the mechanics of 'the game' of gang activity, meaning that they can figure out the consequences of potential choices of action or lack of action, and make their decisions in order to maximize their own utility based on that information. They make reasoned choices in order to get the best possible outcomes for themselves. This is a key difference between the colloquial 'rational' and the game theoretic 'rational', or as McCubbins and Thies (1996, 24) aptly summarize it, “rational choice is reasoned choice, not reasonable choice.” Shooting someone because of an insult will be deemed unreasonable by the public-at-large, but for gang members it is a rational course of action.

In addition to the assumption of rationality of the players in the game, there is the assumption is that the players are also self-interested and utility-maximizing. In accordance with this assumption, gang members make choices that they believe will give them the highest possible utility payoff while minimizing the risk of producing negative outcomes. Within the gang life this can be ultimately narrowed down to 'kill or be killed', as violence is an integral part of the game, and making the wrong strategy choices increases the likelihood of the player being on the receiving end of lethal violence. The status loss that results from not reacting to provocations brands the person as 'a punk' or 'a mark' which signals that they are an easy target

(Papachristos 2009, 79). Having members with this type of reputation is bad for the gang's reputation as well, so they will pressure members to retaliate to aggression with violence.

Interestingly enough, even if a gang member were to be incarcerated as a result of violent actions, it is an outcome that produces more utility for them and their gang than not reacting at all. For a regular citizen, this would be one of the worst possible outcomes, but for gang members there is an increase in status to be gained from incarceration, especially if it is because of a homicide they committed against a competing gang's member.

The gang members participating in gang activities know the structure and rules of the game, or as Tom Hayden calls it, the “code of the streets”, where the structure of life is not dependent on societal institutions but rather a system that is “a 'cultural adaptation' by those outside the formal system, is a prescriptive set of rules for navigating the inner-city streets and schools whether one is gang-affiliated or not” (2004, 3). This implies that the rules are known not only to those involved in the gang life, but they are universally known to everyone living in inner-city areas with or without gang affiliation or activity.

Sequential games “entail strategic situations in which there is a strict order of play. Players take turns making their moves, and they know what players who have gone before them have done.” (Dixit and Skeath 2004, 45). Gang violence can be viewed as a sequential game, as there is a back-and-forth mechanic at work in the sequence of violent acts. One party commits an act of violence, the other party assesses the damage, considers their strategy options and choose a strategy to follow, most likely a strategy of retaliation as reputation is an integral factor in the game and not retaliating results in a reduction in reputation. The first party then considers their strategy choices and possible outcomes and responds to this retaliation and the game progresses over time, one step at a time.

David Kreps and Robert Wilson discuss sequential rationality, stating that each player’s “every decision must be part of an optimal strategy for the remainder of the game” according to the player's beliefs about how the game has evolved prior to their decision and how it will develop after their move (1982, 863). Accordingly, should a gang come under attack, be it directed at them physically or toward their reputation through some slight or insult, they are obliged to retaliate and show that this aggression will not stand, as unchecked aggression sends a signal to other rival gangs that this particular gang is an easy target for future transgressions. Failing to react to provocations inevitably leads to a loss in status, which in turn increases the likelihood for future attacks and aggression from other rivals, and thus can be deemed the worst strategy option a gang under attack can choose.

The only viable option is to signal a willingness and capability to engage in violence, be it in retaliation to the attacker or an attack on some other rival gang. Papachristos (2009) likens gang violence to a pecking competition between chickens, where the loser suffers a loss in status, while the winner may reduce their chances of being challenged in the future based on winning this particular contest. The need to save face and retain status leads to gang violence being reciprocal much in the manner of a sequential game (Papachristos et al. 2013).

Gang leaders act as coordinators and devise larger scale strategies towards which they direct the actions of their lieutenants and their soldiers. It can be safely assumed that any established leader in a smoothly operating gang is also a strong leader, considering how important reputations are in the world of criminal gangs. Leaders showing weakness are likely to be deposed and replaced by someone with more perceived capabilities toward violent acts and an astute ability to run the gangs financial endeavors. Experimental research into coordination games shows the importance of credible leadership, as Wilson and Rhodes state: “The simple presence of a leader, however, is no guarantee that coordination problems will be solved. If followers are uncertain about their leader's incentives, then they can easily ignore leadership. Credibility is a central concern for followers, and when leaders lack it they are easily ignored” (1997, 789).

The incarceration and subsequent severing of the communication ties of top leaders in gangs created a nearly unsolvable dilemma for their lieutenants and their cliques of underlings. This is displayed in the research of Wilson and Rhodes, where they discovered that “subjects found decentralized coordination games to be extremely difficult” (1997, 788). Each lieutenant has an incentive to strive for the top leadership spot and not yield to their lieutenant peers, both for reputation and the utility benefits of being the leader of the entire gang. Allowing another lieutenant to take the leadership position would signal passivity and non-aggression, which leads to losses in reputation and the consequences of that reputation loss. For the overall functioning of the gang this is problematic as well, as there is no large scale strategy being implemented, and no lieutenant can agree with another lieutenant's suggestions even if they are prudent, due to the reputation loss connected to conceding to one's competitors.

Having a higher status or reputation is also a factor in decision-making in scenarios which are not gang-related. Experimental research has shown that a higher status helps in making successful coordinated efforts through signaling. As Eckel and Wilson (2007, 328) point out, “the play of a commonly observed agent does not merely make one equilibrium more salient or focal,” but instead that the “play is more effective in influencing others if the observed agent has high status.” An observed actor can signal a strategy in an effort to coordinate other players, but as Eckel and Wilson (2007, 328) state, while “signaling a strategy serves as a coordination device, but that signal is more powerful when it comes from an agent with higher status.”

The importance of reputations is further reinforced when looking into research on youth gangs in communities with lower populations, as those gangs are looking to project a threat level similar to larger gangs in large cities. Howell (2007, 46) points out that “youth gang problems are often difficult to assess, and gangs are often shrouded in myths,” and that many of these “myths are promulgated by the gangs themselves in order to enhance their status and aura of danger.” While the consequences of these small community youth gangs not having enough of a reputation are not severe, for gangs in larger cities lacking in reputation the consequences are dire as shown in Papachristos 2009, 2013.

## 3.2 The impact of social media

Whereas antagonistic or provocative signaling toward rival gangs had to be done physically in earlier decades, either by spraying graffiti on the rival's territory or by “face-to-face” interactions where the opponent sees the antagonist, now the effort of signaling is greatly diminished with the proliferation of social media and hand-held devices that allow easy access to these outlets.

Along with ease of access, sending antagonistic signals over social media allows relative safety, depending on the where the user is when the signal is sent. A gang member can send derogatory comments toward rival gangs while at home with friends, and the danger of retaliation only materializes once they are outdoors. Previously, having to venture into 'enemy territory' to spray graffiti, or flashing hand signals to rivals that can see you, presented an immediate danger of violent retribution.

The advent of smartphones is a fairly recent phenomenon, with the introduction of Apple’s first iPhone in 2007 being seen as the starting point of the smartphone revolution (The Guardian 2012). In the following ten years, the proliferation of smartphone technology has given mobile internet access to an ever-increasing percentage of the population in developed countries. Even the poorest segments of populations often possess some type of smartphone, as new and less costly alternatives have been introduced into the market.

However, as smartphones are hand-held and functional everywhere in the city, there is risk involved in posting provocations in the wrong place, the most prominent example being the death of 18-year-old Joseph Coleman in 2012. Coleman, going by the alias Lil Jojo in his rap career, had been involved in a back-and-forth feud with another Chicago rapper, Keith Cozart, whose stage name is Chief Keef. The two had been exchanging insults on social media and in songs, and the feud ended in Coleman being shot to death by an affiliate of Chief Keef after posting his location on Twitter, and in effect daring someone to do something (Wired 2013).

With the advent of Facebook Live, a direct video streaming service, there have been occasions of people streaming videos and being shot to death while doing so. There is a two-fold risk in streaming videos when involved in the gang life, as adversaries are able to find out your location by looking at the video and recognizing the area from what is seen of the surrounding area, and also that the person streaming the video has their attention focused on the device and the act of shooting a video, which allows the opponents to stealthily approach and perform a surprise attack.

As the costs of signaling have gone down with social media, there are naturally more provocations to be found on various platforms, which is conducive to an ongoing cycle of violence as retaliation to provocations is necessary in order to preserve one's reputation, and also their gang's reputation. The fragmentation of gangs, the lack of coordination among the small fragments and their members, and the constant flow of antagonism on social media all contribute to exacerbating the situation in Chicago.

## 3.3 Spatial Data Analysis

The starting point of spatial data analysis is Tobler's First Law of Geography, which postulates that "everything is related to everything else, but near things are more related than distant things" (Waldo R. Tobler 1970, 236). An intuitive example to help illustrate the concept could be if a house owner's neighbor gathers all the leaves in their yard and burns them, the smoke will be seriously detrimental to the house owner next door. However, if someone gathers leaves and burns them two blocks down the street, the house owner can probably smell the smoke, but it will not have much of an impact. If someone on the other side of town burns their pile of leaves, the house owner in our example most likely could not tell that the event has occurred, unless they possess some sensitive scientific equipment that measures a slight increase in airborne micro-particles as a result of the leaf-burning.

Of course, Tobler's First Law of Geography does not only apply to the burning of leaves. There is justification for considering the effect of spatial factors when examining statistical information that is divided into some type of spatial areas, for example counties or other administrative areas. Basile Chaix, Juan Merlo, and Pierre Chauvin argue that "people may be affected not only by the characteristics of their local administrative area of residence, but also by the context beyond these administrative boundaries, as their social activities may encompass a broader space" (2005, 517). People in community areas are not living in separate, isolated islands without any interaction with the surrounding community areas, with gated communities being the exception. Normal city administrative areas, however, are affected by and affect the surrounding areas in terms of various social and economic factors, and also in terms of criminal activities.

In their examination of health care use and outcomes in France, Chaix et al. "propose an approach for defining the social factors of the context that considers spatial neighbourhoods, defined as continuous spaces around individual places of residence, rather than territorial neighbourhoods arbitrarily defined by administrative boundaries" (2005, 517-518). Among many things, this approach is useful in analyzing health issues, for example the spread of contagious diseases, and it can also be utilized to model the occurrence and spread of various social issues, including that of crime.

In the concluding remarks of Chaix et al.'s article, they note that instead of a straight forward statistical approach that discretely separates observations into different administrative areas, "in many social epidemiological studies, investigating geographical variations across continuous space using spatial modeling techniques and place indicators that capture space as a continuous dimension may be more appropriate" to describe and explain spatial variations in health outcomes (2005, 524). Whereas traditional statistical approaches might not account for interactive effects between adjacent neighborhoods, a spatial approach can help extract factors that affect statistical outcomes and that statistical analyses could otherwise miss.

As was mentioned earlier, modeling and estimating the spread of contagious diseases is something for which spatial data analysis is extremely useful. Interestingly enough, the historical roots of spatial data analysis can be traced back to such an endeavor in the 19th century. Michael D. Ward and Kristian Skrede Gleditsch describe John Snow's efforts to trace a cholera outbreak in London in 1854, where Snow discovered the outbreak to be "a result of Soho inhabitants (and others) drinking water from a pump on Broad Street, which had become infected from the burial site of many of the victims of the Cholera epidemic" (2008, 9). In fact, Snow's work is widely known today, and as Ward and Gleditsch note, "Snow's maps of London have become classics illustrating how spatial correlation can embody causal thinking" (2008, 9).

In today's world, spatial data analysis is applied in multiple fields, and it is becoming more prevalent in the social sciences as well. Luc Anselin, one of the prominent figures in the discipline's development, offers a concise description of the discipline, stating that "in general terms, spatial analysis can be considered to be the formal quantitative study of phenomena that manifest themselves in space. This implies a focus on location, area, distance and interaction" in the way described in Tobler's words mentioned earlier (1989, 2). The effects of the spatial distribution of variables and their interactions in space are taken into consideration in spatial data analyses. As an example, James P. LeSage and R. Kelley Pace describe such an interaction, where "*spatial dependence* reflects a situation where values observed at one location or region, say observation *i*, depend on the values of *neighboring* observations at nearby locations" (2009, 2).

As traditional regression analyses focus on the correlational relationships between variables without any emphasis on spatial effects, the discipline has similar statistics that account for those factors. As Arthur Getis explains, "whereas correlation statistics were designed to show relationships between variables, autocorrelation statistics are designed to show correlations within variables, and spatial autocorrelation shows the correlation within variables across space" (2007, 493). While non-spatial approaches have the assumption of observations being independent from each other, the measure of spatial autocorrelation can be used to indicate to what degree similar values of observations are clustered in spatial distributions. Getis further argues "that spatial autocorrelation should be and become a prominent subject for study in all the social sciences" (2007, 495).

There are multiple measures for spatial autocorrelation provided in the plethora of spatial data analysis software, slightly varying in their methods of measure and focus. However, as Getis points out, "among many measures of spatial association, Moran's I statistic is the most widely used measure of and test for spatial autocorrelation" (2008, 298). Ward and Gleditsch prove a more detailed explanation of the statistic, stating that "Moran's I compares the relationship between the deviations from the mean across all neighbors *i*, adjusted for the variation in *y* and the number of neighbors for each observation" (2008, 20). The value of Moran's I ranges from -1 to 1, which indicates the degree to which similar values are clustered in space.

When Moran's I values are positive, there is an indication of "stronger positive (geographical) clustering, i.e. that values of neighboring units are similar to one another" (Ward and Gleditsch 2008, 20). Paul R. Voss, David D. Long, Roger B. Hammer, and Samantha Friedman provide an even simpler explanation, stating that "positive values of Moran's I suggest spatial clustering of similar values," and they go on to explain that negative values in Moran's I "(infrequent in the social sciences) suggest that high values are frequently found in the vicinity of low values" (2006, 377). A simple visual representation of the lowest Moran's I value would be a map that looks like a chessboard, with opposite (black and white) values being perfectly evenly distributed to create the distinctive chessboard pattern.

In order to calculate Moran's I, the spatial units and their neighbors are assigned weights, which results in "an $n$ x $n$ spatial weights matrix, $\boldsymbol{W}$, defining the neighborhood structure within which spatial dependence is believed to operate. $\boldsymbol{W}$ often is row-standardized (each row summing to unity)" (Voss et al. 2006. 377). There are alternative methods of assigning weights to neighbors, some of which harken back to the chess analogy earlier. For example, a rook contiguity assigns weights to neighbors horizontally or vertically adjacent to the unit of observation, in the same way that a rook piece moves in chess. Another example is a queen contiguity, in which weights are assigned similarly to the queen piece's movement in the game, namely horizontally, vertically and diagonally. Also, weights can be assigned to apply only to the closest neighbors (first order), or the closest and second closest (second order) and so on, with neighbors further away receiving less weight than closer ones.

The analysis of the data will be performed with two software packages, GeoDa and GeoDaSpace. The GeoDa software is geared more towards representing spatial characteristics in data through the use of visual representations, i.e. maps, which will be applied in the spatiotemporal analysis of changes in variables over time in Chicago. On the other hand, the GeoDaSpace software "has been designed for the estimation and testing of spatial econometric models" without the use of maps and graphs (Coro Chasco 2013, 120). This software will be used in a supplementary analysis of socioeconomic data for the year 2012.

# 4 Model

This section of the thesis outlines the game in which the relocated gang member residents and the gang member or non-gang member residents of the receiving areas take part. The game is presented in two different forms, which are based on the primary assumptions about the situation and how the game proceeds. First, the game is considered as a sequential game where the relocated gang members arrive in the new area and have the first move. This version of the game is presented as an extended form game with the game tree displaying the choices and outcomes for all players (Figure 1).

Second, the game is considered as a simultaneous game, or a game of incomplete information. This version of the game is presented in matrix form. In this version, the players make their choices based on the knowledge they have of their opponents and of the game itself, but without actual knowledge of what their opponents' choices are. The players make their choices under uncertainty, trying to predict the opponents' responses to their own strategy choices and formulate a way to produce the best outcomes for themselves.

The preferences of the players differ somewhat between the different types of residents in the areas receiving the relocated gang members from the demolished housing projects. Whereas the relocated gang members and the resident gang members both participate in the “gang game”, the non-gang residents have the preferences of normal law-abiding citizens not looking to engage in violent conflict in order to gain illegal income and street reputation.

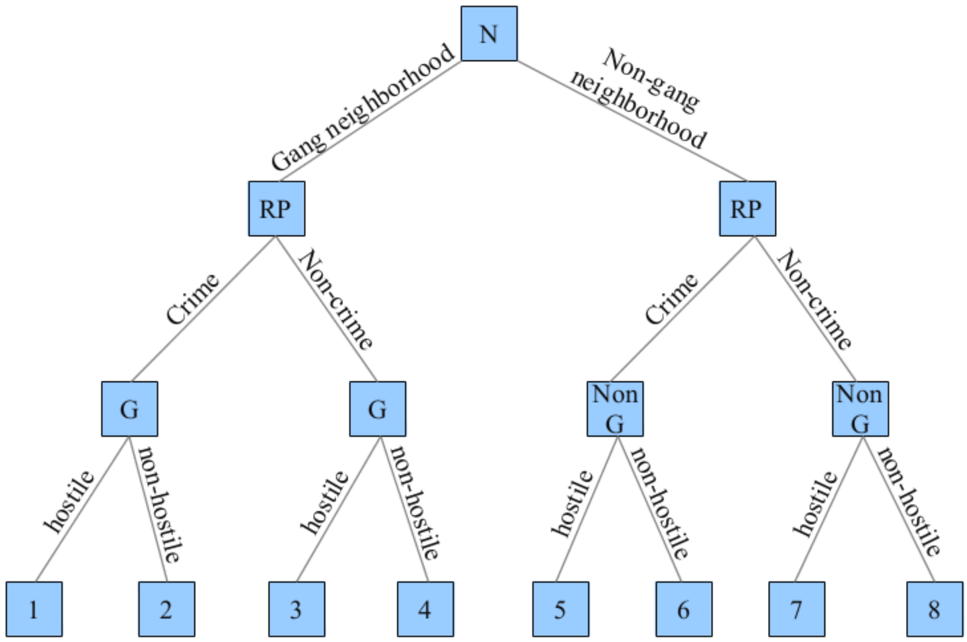


*Figure 1*

The variables considered in the model contribute to the players' final utility from choosing particular strategies. A key assumption for the model is that all players involved in the game are rational, self-interested individuals looking to maximize their utility. Another assumption is that the players know how the game is played and they know that the other players have this same information as well. Thus their strategies are formulated based on predictions of what the other players will do to maximize their utility. Based on these assumptions, the rest of this chapter will provide a clarification of the choices and payoffs of the players involved in each of the final nodes.

First, an explanation of the variables under consideration. Each player's payoff is calculated as utility (U), where the higher the utility is, the better the outcome is for that player. Each player looks to maximize their utility by their strategy choices and knowledge of what other players are likely to do. The first variable to consider is power (P) which means control of the area, for example having the ability to have a presence in the area with groups of gang members posted on street corners or parks and other outdoor locations. When conflict occurs, the players receive a share (f) of power (P) based on the results of the conflict, with the total of shares included in (f) adding up to 1.

The second variable contributing to a player's utility is status (St), which is perhaps the single most important variable for gang members to take into account. Having a high status (St) can help secure a share of power (P) even for smaller gangs as it signals a willingness to engage in violence which would result in costs for any aggressors. Having a high share of power (P) but a low status (St) sends a signal to rival gangs that taking over this territory would be beneficial and not likely to be very costly.

Closely related to the share of power (P) is the income from crime (I). Having control of an area allows gangs to, for example, post groups in various locations to sell illegal narcotics or to extort protection money from residents or businesses, or to commit robberies, all of which contribute to the final amount of income (I) the player receive. Again, having a high status (St) and a higher share of power (P) contribute to a player's ability to receive higher amounts of income from criminal activities (I).

With violence and conflict being integral parts of the game, there are variables addressing to results of these conflicts. When players choose aggressive actions, they incur the costs of fighting (F), which vary from higher with mutual aggression where both players commit and receive violence to lower where one player unilaterally inflicts violence and their costs are mainly the effort of committing the violent act. When one player unilaterally receives violence without fighting back, they incur the cost of victimization (V), which entails both the physical harm incurred in the attack as well as the mental anguish of humiliation.

Finally, there are two variables to account for the law-abiding segments of the population, or strategy choices that abide by legal restrictions. Those choosing to abide by the law receive some amount of income from work (W) and if they are not participating in any conflicts or being victimized by anyone else also receive the benefits of safety (S). They are able to conduct their daily business without fear of violence or a need to commit violence in order to maintain status (St).

The game begins with “nature” placing the relocated gang members in areas with residents who are either gang members or non-gang members. Because of this, there are a total of three players in the game, with two facing each other in each node. Relocated gang members are a participant in each node, but their opponent changes based on where “nature” places them, meaning that the opposing players will be either gang members or non-gang members.

## 4.1 Relocated gang members vs Gang members

When nature places the relocated gang members into a gang area, we end up in the left-hand side of the game tree, where the outcomes for the two players are found in nodes 1 through 4. In this subgame the relocated gang members play the game against established gang members who already live in and control the area. The payoffs for each node are as follows.

**Node 1 – Crime and Hostile**

RP – U = fP+St+dI-F
G – U = (1-f)P+St+(1-d)I-F

Starting with node 1, the first variable to consider for the players is power (P), mostly meaning the amount of control the gang has in the contested area. In node 1 where relocated gang members (RP) decide to become involved in criminal activity (crime) and the gang members (G) already established in the area decide to react with hostility (hostile), their power shares are determined by the fighting, meaning that the share (f) is somewhere between or equal to 0 and 1, with RP receiving the share fP and G the remainder (1-f)P. The same applies for income from criminal activities (I) where both players are fighting for some share (d) of the available income from crime, for example drug dealing, theft, robberies, and so on. Again, RP receives the share dI and G the remainder (1-d)I. Because both RP and G engage in hostilities, their street credibility or status (St) is maintained or increased, and both suffer the costs involved in engaging in fighting (F).

**Node 2 – Crime and Non-hostile**

RP – U = fP+St+dI-F (f=1, d=1)
G – U = (1-f)P+(1-d)I-V (1-f=0, 1-d=0)

The situation in node 2 is a result of relocated gang members (RP) deciding to be involved in criminal activities (crime) but the established gang members (G) choose not to react to this provocation (non-hostile). With this choice of non-hostility, RP is able to push out G and take control of the area and the income from crime in the area, which results in RP having all the power (P) and all the income from crime (I) and thus the shares become f=1 and 1-f=0, and d=1 and 1-d=0. As a result of not reacting to the provocation, G suffers a reputation loss and receives no status (St) while RP maintains a good street reputation (St). Additionally, G suffers the high costs of being victimized (V) by the aggressive newcomer RP as the area is taken over, and RP only suffers a lower cost of fighting (F) in being hostile toward their non-aggressive opponents.

**Node 3 – Non-crime and Hostile**

RP – U = fP+dI+W-V (f=0, d=0)
G – U = (1-f)P+St+(1-d)I-F (1-f=1, 1-d=1)

In node 3 the situation is reversed, with RP choosing a strategy of abiding by the law and seeking legal employment (non-crime) and G choosing to react with hostility (hostile) to the new people arriving in the area. As a result of RP's strategy choice, G receives the entirety of power (P) and income from crime (I) making the shares f=0 1-f=1, and d=0 and 1-d=1. By choosing a passive strategy, RP suffers a status loss, whereas G maintains a good reputation (St). The choice of being law-abiding citizens gives RP some amount of income from work (W), which may or may not be equal to the potential income from crime (I). Finally, RP suffers the high costs of being victimized (V) by the hostile actions of G who only suffer lower costs of fighting (F) from attacking non-resisting opponents.

**Node 4 – Non-crime and Non-hostile**

RP – U = fP+dI+S+W (f=0, d=0)
G – U = (1-f)P+(1-d)I+S (1-f=1, 1-d=1)

In node 4 both participants choose non-aggressive approaches, with RP deciding not to commit crimes (non-crime) and G choosing a passive approach to the new arrivals (non-hostile). The result of these strategy choices gives G the entirety of power (P) and income from crime (I), with the shares being f=0 and 1-f=1, and d=0 and 1-d=1. G effectively keeps their established control of the area and the income afforded by criminal activities in the area. In this two-player encounter both RP and G receive the benefit of safety (S), but as a result of a symmetrical approach of non-aggression, both participants suffer a loss of reputation (St). RP also receives some amount of income from work (W) from the law-abiding approach, which again may or may not be equal to the income from crime (I).

**Summary – Relocated gang members vs Gang members**

Due to the structure and rules of the game, an examination of the payoffs reveals that both players have a dominant strategy that they should choose for the best possible outcomes. For relocated gang members (RP) the dominant strategy is to become involved in criminal activities (crime) no matter what the opponent chooses, as their payoffs in node 1 are higher than those in node 3, and their payoffs in node 2 are higher than those in node 4. For the resident gang members (G), there is also a dominant strategy of choosing a hostile approach (hostile) to the newcomers, as their payoffs in node 1 are higher than in node 2, and their payoffs in node 3 are higher than in node 4.

The loss of status for non-aggression is highly influential for the players, as it affects their standings in games against other gangs in the area. Thus, safety in this this two-player game will have an adverse effect on the participant's chances when facing a different opponent. This is something that should be noted, as the games between two participants do not happen in a vacuum, but other potential players observe the interactions between the players and may adjust their future actions based on these observations. Non-aggressive players will be more likely to come under attack from other players in the area. For the purposes of this thesis, the model is simplified to focus only on the two-player interaction, but the effects of the choices in this game affect their payoffs in future games, which should be kept in mind, and which is partially modeled by the status variable (St).

In order to find the possible Nash equilibria in the subgame, backward induction can be applied to see what strategy choices each of the players will choose at various decision points in the subgame. Starting with the first decision point where RP has already chosen the "crime" strategy, G faces the choice between nodes 1 and 2, with the respective strategies being "hostile" and "non-hostile". Considering the payoffs between the two nodes, G will receive a better utility payoff if they choose "hostile" and end up in node 1. In the second decision point where RP has chosen a strategy of "non-crime", G has to choose between the strategies "hostile" and "non-hostile", and nodes 3 and 4 respectively. Again, choosing the "hostile" strategy produces the better outcome in node 3 and G is incentivized to choose it.

Working with this information provided by the initial stage of backward induction, it is possible to reduce the possible outcomes for RP in this subgame to nodes 1 and 3 based on what G will choose in their later decision points. Thus, RP will face the choice of the "crime" strategy and ending up in node 1 and the "non-crime" strategy and ending up in node 3. RP receives a notably higher payoff in node1 and is therefore incentivized to choose the strategy of "crime".

Backward induction solves this subgame into the Nash equilibrium (crime; hostile, hostile) which is in accordance with the earlier formulation that revealed that both players have a dominant strategy in this particular subgame. G has strong incentives to choose a strategy of hostility in every situation in the game, and RP also has strong incentives to choose a symmetrically opposite strategy of hostility as well. A further complication to the game is the fact that status losses incurred in this two-player game have dire effects on the players' situation in the area where other players may appear to participate in a new iteration of the same game.

## 4.2 Relocated gang members vs Gang members – simultaneous game

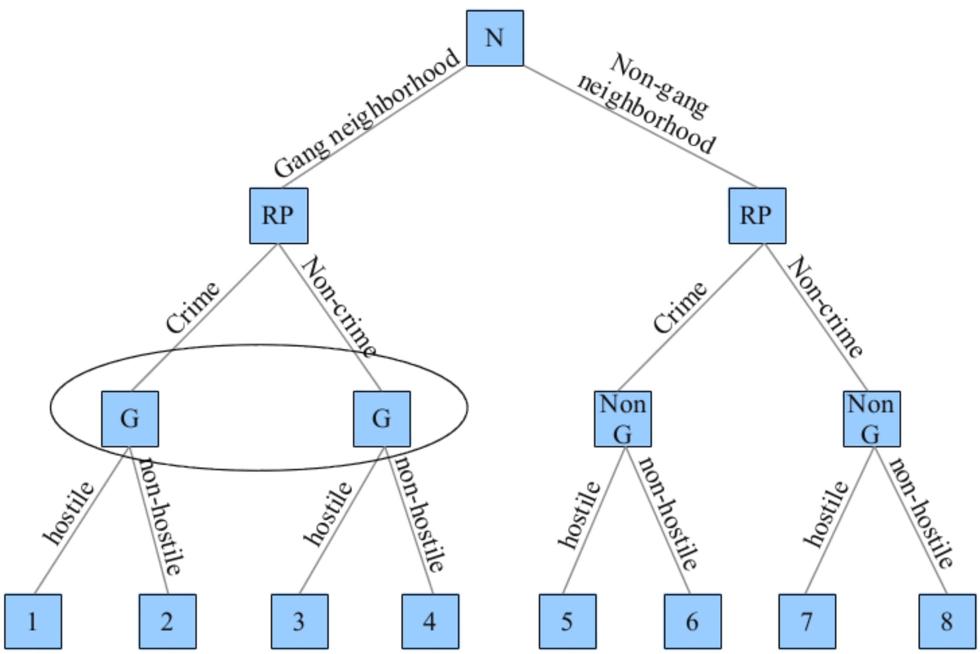


*Figure 2*

| | | Gang member resident | |
|---|---|---|---|
| | | Hostile | Non-hostile |
| RP | crime | 1* | 2 |
| | non-crime | 3 | 4 |

Considering this subgame as a simultaneous game with limited information about the opponent's strategy choices (Figure 2), the game can be represented as a 2x2 matrix game. Here the players simply choose their strategy without knowing what the opponent chooses, but rather by considering the possible outcomes that their strategy choices and the opponent's responses would produce. It is possible to solve the subgame for possible Nash equilibria by examining the payoffs in the matrix cells and see whether either of the players has an incentive to change their strategy in order to receive a better payoff.

Starting with the socially preferable non-violent outcome where the relocated gang members choose a strategy of “non-crime” and the resident gang members choose the “non-hostile” strategy, the payoffs for both players include safety (S), but both players suffer a significant loss to their status (St) which is a very detrimental outcome for both parties.

RP can be much better off by choosing the “crime” strategy and moving to node 2 where they receive better results with power (P), status (St), and income from crime (I). Also, G can improve their payoffs from node 4 by choosing the “hostile” strategy and moving from node 4 to node 3. Neither player has an incentive to stay in node 4, but both would prefer to change their strategy choice instead.

If RP has chosen “non-crime” as their strategy, and G has chosen “hostile”, then RP again has an inventive to change their strategy to “crime” and move to node 1. Also, if the roles are reversed and RP has chosen “crime” and G has chosen “non-hostile”, G can receive a much better payoff by changing their strategy choice to "hostile". Thus, both players will have a dominant strategy in the game as they receive better payoffs in any situation with the choice of a single strategy. For RP the dominant strategy is "crime", as they will be better off in node 2 compared to node 4, and in node 1 compared to node 3. On the other hand, the dominant strategy for G is "hostile", as they are better off in node 3 compared to node 4, and in node 1 compared to node 2.

## 4.3 Relocated gang members vs Non-gang members

When nature places the relocated gang members into an area without a gang presence, we will consider the right-hand side of the game tree, and the payoffs for the two players are located in nodes 5 through 8. In this subgame the relocated gang members are involved in playing the game against law-abiding citizens living in the area.

**Node 5 – Crime and hostile**

RP – U = P+St+I-F
NG – U = W-F

The first node in this subgame, node 5, results in the relocated gang members (RP) choosing to become involved in criminal activities (crime), and the non-criminal residents of the area (Non-G) responding with hostility to the new arrivals (hostile). As there is no competition for power (P) between two gangs, RP receives the entire benefits of the variable by default as they choose to continue the gang life. By acting aggressively, they also receive the benefits of status (St). Due to a lack of competition they also receive the entirety of the available income from crime (I). However, as the local population (Non-G) is hostile toward them, RP suffers the costs of fighting (F) in the conflict with the locals. This cost of fighting is lower than it is against other gang member opponents (G). The non-criminal residents of the area (Non-G) receive the usual amount of income from work (W), but suffer the costs of fighting (F) against the newly arrived gang members.

**Node 6 – Crime and Non-hostile**

RP – U = P+St+I-F
NG – U = W-V

In node 6 the relocated gang members (RP) have chosen a strategy of continuing criminal activities (crime) while the local residents (Non-G) choose a passive approach (non-hostile) toward them. As a result, RP receives all the power (P), as well as status (St) and all the income from crime (I). The local residents (Non-G) receive their income from work (W), but also suffer the high costs of victimization (V) while RP only incurs the lowered costs of fighting (F) a soft target.

**Node 7 – Non-crime and Hostile**

RP – U = W-V
NG – U = W+S-F

The situation in node 7 is the result of relocated gang members (RP) choosing a strategy of abiding by the law (non-crime) but the local residents still choosing a strategy of hostility (hostile). For RP, this strategy combination gives some amount of income from work (W) but also has them suffering the high costs of victimization (V), which in this context range from ostracism and humiliation to outright physical attacks. Due to their non-aggression, RP also suffers a loss of status (St). The non-criminal residents (Non-G) receive their normal income from work (W), and have the benefits of safety (S), but also suffer the low costs of fighting (F) non-aggressive opponents.

**Node 8 – Non-crime and Non-hostile**

RP – U = W+S
NG – U = W+S

In the final node of the game, node 8, RP has chosen a strategy of not engaging in criminal activities (non-crime) and Non-G has chosen an approach of non-aggression (non-hostile). As a result, the payoffs for the players are identical. Both RP and Non-G receive income from work (W) and receive the benefits of living in a safe environment (S). However, due to their non-aggressive strategy choice, RP also suffers a loss of status (St).

## 4.4 Relocated gang members vs Non-gang members - simultaneous

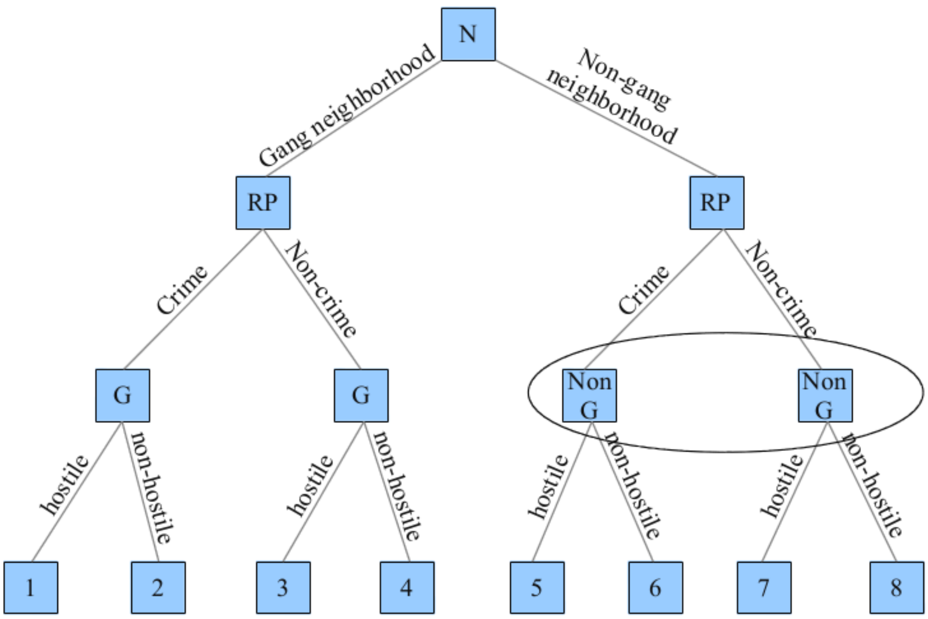


*Figure 3*

| | | Non-G resident | |
|---|---|---|---|
| | | Hostile | Non-hostile |
| RP | crime | 5* | 6 |
| | non-crime | 7 | 8 |

If the model is altered to a situation where the relocated gang members and the non-gang member residents of the new area do not know what their opponent's strategy choices are (Figure 3), the subgame can be represented as a 2x2 matrix. Here the two players have their two strategy choices, being "crime" and "non-crime" for the relocated gang members, and "hostile" and "non-hostile" for the non-gang member residents.

The socially optimal and preferred outcome would be node 8, where RP chooses a strategy of “non-crime” and Non-G chooses a strategy of “non-hostile”. In this situation everyone lives in peace with income for both players coming from legal employment. However, if RP considers their utility payoffs for their strategy choices when Non-G has chosen a strategy of “non-hostile”, they can improve their situation by choosing the strategy “crime” instead. Having power, status, and income from crime outweighs the utility of having safety and a legal income, and thus the players end up in node 6.

Conversely, when Non-G considers their options in node 6, they can improve their utility outcome by switching their strategy from “non-hostile” to “hostile” and moving over to node 5. They are better off by resisting the newcomers, be it through calling the police or shooing loitering gang members away from their storefronts than they would be by simply acquiescing to the new criminal activities.

Neither player has an incentive to move away from their strategy choices in node 5, making it the Nash equilibrium for this subgame. It is also the only Nash equilibrium present in the subgame, as RP would also prefer moving to node 5 if the game somehow ended up in node 7 where RP chooses “non-crime” and Non-G chooses “hostile”. Considering this, it becomes apparent that RP has a dominant strategy in this subgame, as they receive better payoffs in all situations by choosing the strategy of “crime”.

# 5 Data

The data used in the analysis is collected from two main sources: the annual reports of the Chicago Police Department (CPD), and the City of Chicago's own Data Portal (CCDP) website (https://data.cityofchicago.org/). The CPD annual reports include detailed information on index crimes divided disaggregated to a community area level, and the reports also include population data disaggregated to a community area level from the United States Census Bureau's census surveys in 2000 and 2010.

Unfortunately, the CPD annual reports are only available up to and including the year 2010, but the CCDP website provides a listing of all individual crimes starting from 2001, with detailed information on the time, location and type of crimes reported. The exact location of crimes is not revealed, with the last numbers of street addresses censored from the data sets. Every crime is coded with the community area number, which provided a method of constructing a data set for homicides for the period where the CPD reports are no longer available. For the years 2011-2016, the raw data was first filtered to exclude all crimes that were not homicide, and as each crime is coded with the community area number, the second step was to do a count of how many times homicides were recorded in each community area for any year in the period, which results in an output consistent with the data provided in the CPD annual reports.

The lower temporal cutoff for the data is effectively dictated to be the year 2000, as that is the first year when the CPD reports list data disaggregated into community areas as well as police districts, and not only police districts as was done prior to that point. Having data at the community area level is a requirement for the technical aspect of the analysis, as the spatial map information (shape file) divides the city into community areas. The CPD reports, the CCDP data, and the CCDP map shape file are all in congruence with the numbering of the community areas, which allows for convenient compilation of data sets for the purposes of spatial data analysis.

There are a number of indicators of population attributes that are extracted from data published by the United States Census Bureau, namely the 2000 Census and the 2010 Census, with supplemental data from the American Community Survey for the years 2008-2012, 2009-2013, and 2010-2014. As the Census tracts do not match the Chicago community areas with complete accuracy, the conversion process has been done by the Chicago Police Department and Rob Paral and associates (http://www.robparal.com/ChicagoCommunityAreaData.html).

Due to the data having gaps between the years 2000 and 2010, as well as between 2010 and 2012, and finally the years after 2014, it is necessary to apply some interpolation and extrapolation methods to estimate data for the missing years. The methods for these tasks are outlined in Swanson and Tayman (2012) and they are based on estimating populations with the help of growth rates, through the use of exponential approaches.

The population numbers for the years between 2000 and 2010 are estimated with the share-of-growth method described in Swanson and Tayman (2012, 130-131). The formula used in the interpolation is e^(ln(pop2000)+n/10*(ln(pop2010)-ln(pop2000))) where n is the number of temporal steps out of the total 10 steps between the years 2000 and 2010. For example for the year 2004, n would be 4, making the formula e^(ln(pop2000)+4/10*(ln(pop2010)-ln(pop2000))). This provides an estimate of populations in the years between that is based on an exponential growth rate instead of a simple linear interpolation, and the data more closely reflects the unknown reality of the population.

For the final years in the data, 2015 and 2016, population estimates are calculated by an exponential extrapolation method in Swanson and Tayman (2012, 118-119). The formula for extrapolating the missing data is pop2014*e^rz where r is (ln(pop2014/pop2010))/4 with 4 being the number of temporal steps between 2010 and 2014, and z being the number of temporal steps after the final known data point. With only two years to extrapolate, r is either 1 for the years 2015 or 2 for the year 2016. Again, this application of an exponential growth rate allows for estimations that are closer to the unknown reality than simple linear extrapolations would produce.

Naturally, the numbers produced by these methods are merely estimates, but they are the best method available for estimating missing data between two data points, or for the data points following the last year in the known data set. There is the possibility that unforeseen events have caused unexpectedly radical changes in populations, but these estimates based on growth-rates are the closest that are possible based on the known data (Swanson and Tedrow, 1984). For example, natural disasters could cause an unexpected and massive drop in an area's population, but it is possible to return to the data and adjust the numbers to reflect reality if such new information comes to light. For the time being, these estimates are the closest to real data with what is known at the moment.

All of the data are compiled into a GeoDa project file where each variable is encoded into the shapefile, assigning each data point to its corresponding spatial data point. As the shapefile and the data are all divided into space and data for each community area respectively, combining them provides a way to view the spatial distribution for each variable. There are a total of 77 community areas in the city of Chicago, all of which are assigned a number, and these numbers are the same across the various data sets and spatial data files provided by the City of Chicago and the Chicago Police Department.

The combination is done by linking the community area numbers that are present both in the shapefile as well as the data files. For example, one area of interest in the analysis of housing projects is the community area of Grand Boulevard, which is encoded with the number 38 both in the shapefile and all the corresponding data files on population and crime statistics.

The resulting project file contains data divided into spatial units as well as temporal units, which grants the possibility of observing spatial distributions of variables in space as well as over time. The GeoDa software allows for analysis that considers differential spatial autocorrelation in data on a temporal level, meaning the possibility of discovering spatial clustering of change in the data between two points in time.

There are some important variables taken into consideration in the analysis of Chicago's homicide rates, one of which is poverty. E. Britt Patterson explains that his findings in an analysis of data in 57 communities "lends support to the thesis that severe conditions of material disadvantage (absolute poverty) raise levels of community violence by eroding a community's capacity for social control and self-regulation" (1991, 769). This finding is in agreement with the literature discussed earlier in this thesis where the lack of collective efficacy was seen as one contributing factor to the problems in housing projects. Furthermore, Patterson notes that "the data show that violence is more prevalent in social areas characterized by greater levels of absolute poverty and that this association is independent of several other attributes of the areas" (1991, 769-770).

Another variable that is considered in the spatio-temporal analysis is the percentage of housing in an area that is owner occupied. This is used as a proxy indicator of the presence of public housing projects, as Chicago's housing projects were concentrated in particular community areas, where one would expect to see low percentages of housing owned by the people occupying them. If this expectation is true, it should be possible to notice some indication of changes in housing types in the community areas. If thousands of units of public housing residences are removed from an area, there should be a relative increase in the percentage of owner occupied housing.

From demographic and socioeconomic factors, the analysis considers some indicators of educational attainment as well as the ethnic breakdown of the community area populations. For the educational attainment, the data includes percentages of people without high school diplomas, people with only a high school diploma, as well as people with some college education, and finally people with a bachelor's degree or higher. The ethnic breakdown divides people into percentages of people of Asian, black, Hispanic, white, or other ethnicities.

In addition to the statistical data, the Encyclopedia of Chicago and various newspaper sources have been used to ascertain the locations of the city's largest housing projects as well as the years during which they were ultimately demolished. Two such community areas present in the data are Douglas and Grand Boulevard, which were concentrations of some of the largest housing projects in the city, including the Robert Taylor Homes. Unfortunately, due to the limitations of the data, the effects of the demolition of the Cabrini-Green Homes in Near North Side cannot be captured, as the data begins in the year 2000, and the demolition of Cabrini-Green had begun already in 1995.

# 6 Findings and Analysis

This section of the thesis will cover the results produced in the analyses, and there will be additional discussion on the interpretation of the results. However, this will not be done in separate subsections, but rather with the findings and analysis discussion flowing from one to the other. The first topic of discussion will be the findings of the spatiotemporal tests and their accompanying analysis. The second topic discussed will be the findings from a linear regression model with fixed effects and the results are also analyzed. Finally, the last part of this section presents results from a complementary spatial data analysis that examines the connections between a number of detrimental socioeconomic factors and homicide rates, and the subsection contains both the findings and analysis.

## 6.1 Spatiotemporal

In order to help the reader follow the results and analysis of the spatiotemporal analysis, below is a map of all of Chicago's 77 community areas, numbered and named (Figure 4). As the results images produced by the GeoDa software are unlabeled, utilizing this map will allow the reader to orient themselves on the map. When discussing the results as they pertain to specific community areas, the reference number of the community area will be added to each mention of that area for easier map checking, in the following manner: Hyde Park [41], Norwood Park [10], Garfield Ridge [56], and so on.

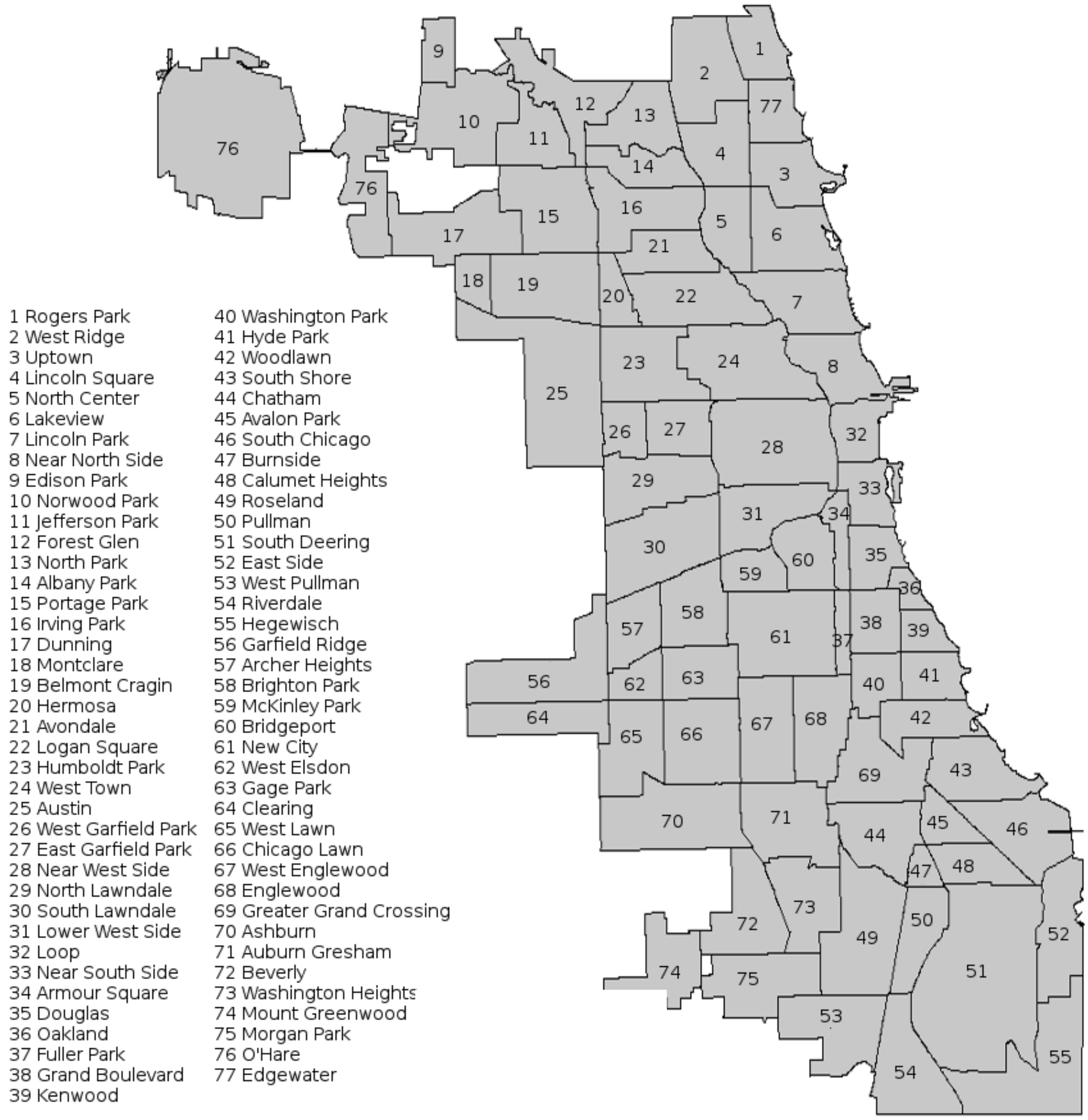


*Figure 4*

The following maps present the findings of a differential local Moran's I analysis where the starting point was defined as the year 2000 and the ending point as the year 2008. The policy of demolition of high-rise public housing was already in full effect in the year 2000, with the community areas of Douglas [35] and Grand Boulevard [38] being the locations where the majority of the demolition was occurring, with a miles long stretch along State Street comprising of large housing projects. This concentration of public housing was known as the State Street Corridor. One of the city's largest housing projects, the Robert Taylor Homes, was in the community area of Grand Boulevard [38] and its demolition was finished during

2007. Along with Cabrini-Green Homes, the Robert Taylor Homes were possibly the most notorious housing projects in terms of gang presence and violence, as described by Venkatesh (2009).

In order to capture the possible lagged effects of residents moving away from the community area of Grand Boulevard, I have chosen the year 2008 as the end point for a differential local Moran's I analysis. The demolition was still ongoing in 2007, so it is preferable to choose 2008 as that is the first complete year following the finished process of demolition, and it should capture any immediate effects of the demolition as the displaced residents would find new housing units during the year of 2007, or 2008 at the latest. Interestingly enough, the findings indicate that there were indeed changes in a number of variables following the completion of the Robert Taylor Homes demolition.

### 6.1.1 Homicide rates

This subsection focuses on the changes in homicide rates in the city of Chicago, with descriptions of what findings were produced by the tests and discussion on how to interpret these results. The first image displays the clustering of change in homicide rates between the years 2000 and 2008 (Figure 5). There are five different colors indicated in the map image, with the legend provided by the GeoDa software in the upper left corner.

The majority of the map is colored light gray, which means there is no statistically significant clustering of any kind when compared to an artificial null hypothesis produced by running Monte Carlo permutations on the data. In these images the number of permutations has been set to 999. The weights matrix used in the analysis is a queen contiguity, meaning that all contiguous neighbors on all sides of an area are weighted in the local Moran's I analysis.

The four other colors in the map indicate that some type of clustering is present in the area. Areas colored red indicate places where high values of homicide rates are surrounded by similar high values. Areas colored blue are areas where there is clustering of low values surrounded by similar low values. The remaining cases contain clustering of dissimilar values, where light purple areas are low values of homicide rates surrounded by high values, and light red areas are high values of homicide rates surrounded by low values.

In the differential local Moran's I, the values are interpreted somewhat differently. Whereas in a local Moran's I statistic low and high values are interpreted in a straight forward manner, where a high value corresponds to a high value in the data, in a differential local Moran's I the values are determined by examining the changes between the starting point and the ending point. A low value in this analysis means a decrease in the values between the starting point and the ending point, namely that the starting point value is higher than the ending point value. Conversely, a high value means an increase in the value between the two points in time, with the ending point value being larger than the starting point value.

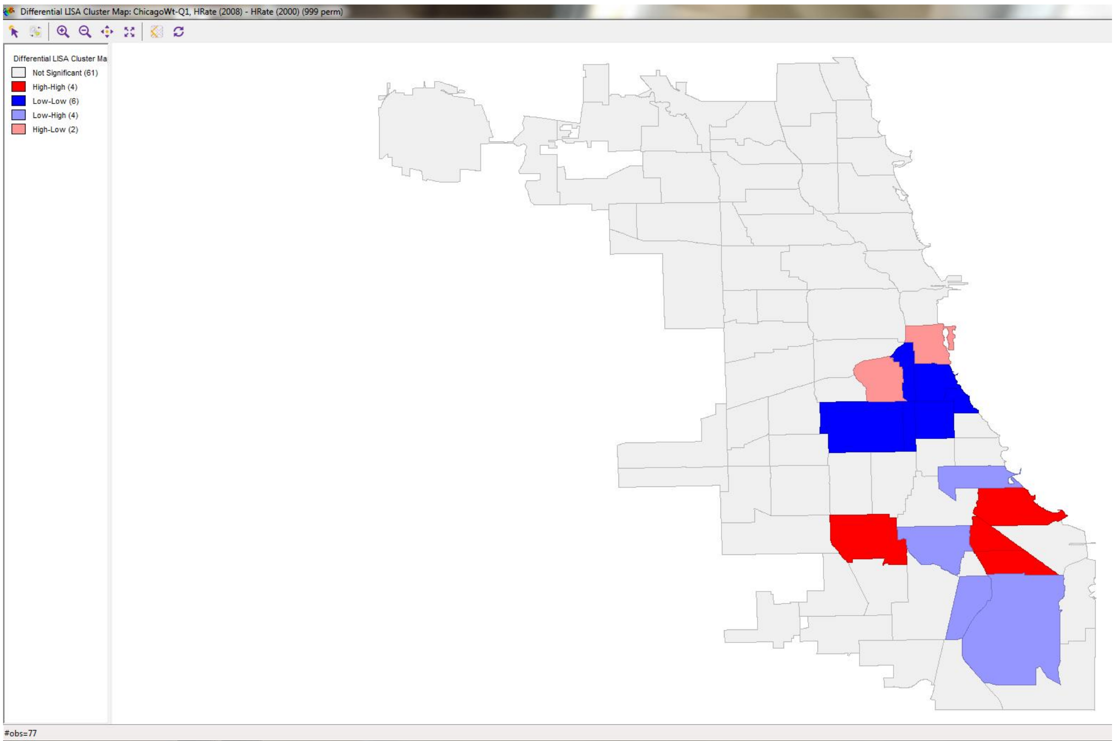


*Figure 5*

As the map shows, there are four areas where there is clustering of high values surrounded by high values, six areas where there is clustering of low values surrounded by low values, four areas of lows surrounded by highs, and two of highs surrounded by lows.

What is interesting to note is where the clustering of values occurs. The clustering of decrease in homicide rates is located in and around the area where the Robert Taylor Homes and a large number of other housing projects were demolished during that time period, namely the community areas of Grand Boulevard [38] and

Douglas [35]. The immediate surrounding community areas of Armour Square [34], Oakland [36], and Fuller Park [37] also show clustering of decreases in homicide rates following the demolition of public housing.

However, there are also areas where homicide rates have gone up between the years 2000 and 2008. This is of particular interest as there was an overall trend of decreasing homicide rates in the city following the dwindling crack cocaine boom, starting around the year 2000, with the actual numbers of homicides decreasing from 582 in 2000 (CPD annual report 1999/2000) to 510 in 2008 (CPD annual report 2008). In spite of this 12% decrease in homicide, there are areas where homicide rates have gone up from 2000 to 2008. Of course, it is impossible to claim direct causality based on the indications displayed in the results of the analysis, but they are interesting anomalies nonetheless.

There are two community areas on the edges of the concentration of decreasing homicide rates where homicide rates have increased, namely Near South Side [33] and Bridgeport [60]. These are immediately adjacent to the areas where massive demolitions of public housing occurred, which is interesting to note even if concrete verification of causality or connection cannot be made with the data that is available. There are also some areas in the southern parts of the city where homicide rates have gone up.

The following image is a significance map for the differential local Moran's I statistic between the years 2000 and 2008 in terms of changes in homicide rates (Figure 6). As was described earlier, the statistical significance is calculated based on a pseudo null hypothesis that is constructed by running Monte Carlo permutations on the existing data, and for the purposes of these analyses the number of permutations has been set at 999. Naturally, the significance map corresponds to the earlier cluster map, where only statistically significant clustering is displayed.

In the same way as the cluster map for the differential local Moran's I, the significance levels are encoded on the map with the use of colors. In this particular map, the majority of the community areas are colored gray, which translates to no statistical significance at the set levels. The areas with the standard p-level of 0.05 are colored a light green. Areas with a p-level of 0.01 are indicated by a medium green color, and highly significant areas with a p-level of 0.001 are colored a dark green.

As the map shows, there are 8 areas that are statistically significant at p-level 0.05, 4 areas that are significant at p-level 0.01, and also 4 areas that are significant at p-level 0.001. The areas with the lowest p-level of 0.001, or the highest statistical significance are, from top left to bottom right, Bridgeport [60], Armour Square [34], Chatham [44], and Avalon Park [45]. Of these, Bridgeport [60], Chatham [44], and Avalon Park [45] saw increases in homicide rates between 2000 and 2008, and Armour Square [34] experienced a decrease during this period.

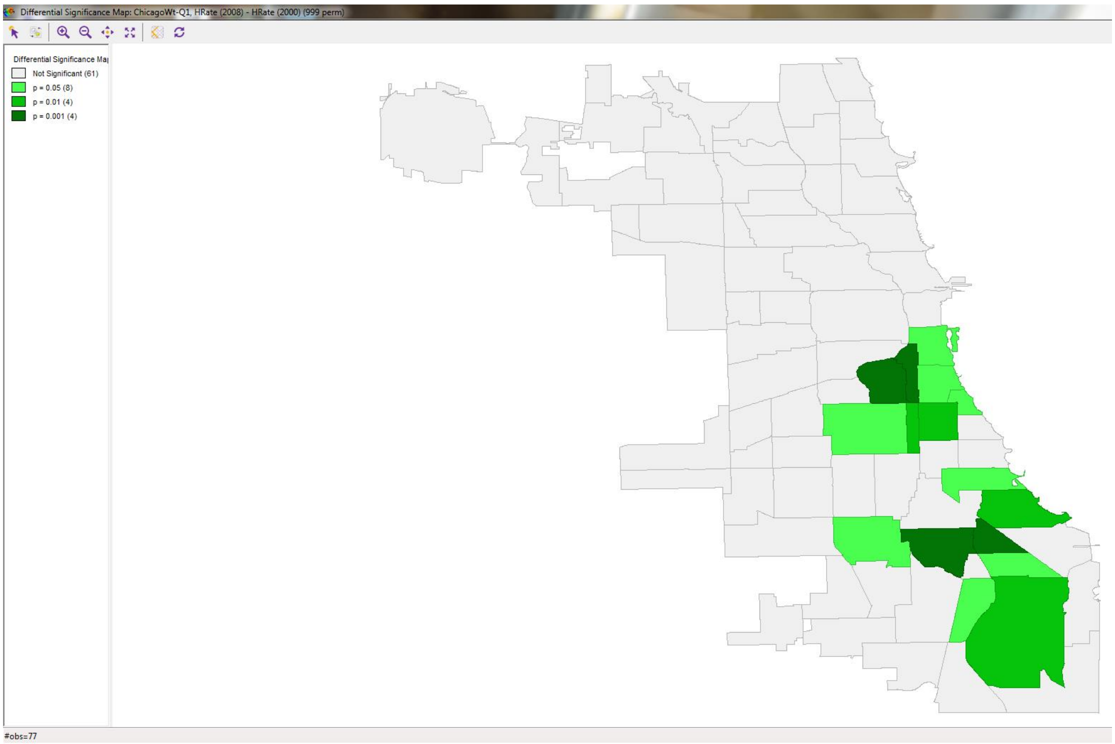


*Figure 6*

The community areas of most interest in terms of public housing, Douglas (35) and Grand Boulevard [38] were statistically significant at p-levels 0.05 and 0.01 respectively. The strength of the significance is especially noteworthy for Grand Boulevard [38], where the notorious Robert Taylor Homes high-rise housing projects had been demolished during this period. In the surrounding community areas with decreases in homicide rates, there were two highly significant ones. Armour Square [34] had a decrease in homicides that was significant at p-level 0.001 and Fuller Park had a decrease significant at p-level 0.01.

Again, making definitive claims of causality with the available data is not possible, but it is worth noting the strongest statistical significances in and around the area where the concentration of high-rise housing projects was. Of these, Fuller Park [37] and Grand Boulevard [38] were significant at a p-level of 0.01 and both areas experienced decreases in homicide rates between 2000 and 2008. Another two areas, Armour Square [34] and Bridgeport [60], had extremely high statistical significance at p-level 0.001, with the first one experiencing a decrease and the latter one experiencing an increase in homicide rates.

### 6.1.2 Owner Occupied

This subsection focuses on changes in the percent of owner occupied housing in Chicago. The justification for the notability of this variable was outlined earlier, but as a short reiteration, the percentage of owner occupied housing has the potential to reveal areas where there are concentrations of public housing residents, as they would not be the owners of their residences. In terms of change, this variable can act as a proxy indicator of where public housing residents move to after the demolition of the largest high-rise housing projects.

The first map illustrates the results of a differential local Moran's I analysis on the variable of percentage of owner occupied housing between the years 2000 and 2008 (Figure 7). Here, there are more clusters of change to be found than in the previous maps on homicide rates. Only slightly more than half of the map, 42 community areas out of 77, do not contain statistically significant clustering of change.

There are 15 areas where clusters of high values surrounded by high values, or in this differential context clustering of increases in values, occur and those areas are again marked on the map with red. Conversely, there are 18 clustered areas where decreasing values are surrounded by decreasing values and these areas are marked on the map with blue. Finally, there are two areas where decreasing values are surrounded by increasing values and these areas are marked on the map with a light purple color.

It is possible to discern four major concentrations where the changes in the percentage of owner occupied housing occurs. There are two sections of the city where the clustering of decreasing percentages in owner occupied housing are present. One is on the western edge of the city and consists of Montclare [18], Belmont Cragin [19], and Austin [25], the last of which is one of the largest majority black community areas in the city. Most of the city's southern portion has also gone through decreases in the percentage of owner occupied housing, with Washington Heights [73] being an island of no statistically significant clustering in the middle.

Again, the area of most interest lies in the area where the public housing projects have been demolished. There is a concentration of clustering of owner occupied percentage increases around the area where the Robert Taylor Homes and other large housing projects were demolished. Armour Square [34], Douglas [35], Oakland [36], Grand Boulevard [38], Kenwood [39], and Hyde Park [41] all have clustering of increased percentages in owner occupied housing, and all are either the sites of the housing project demolition or in their immediate vicinity.

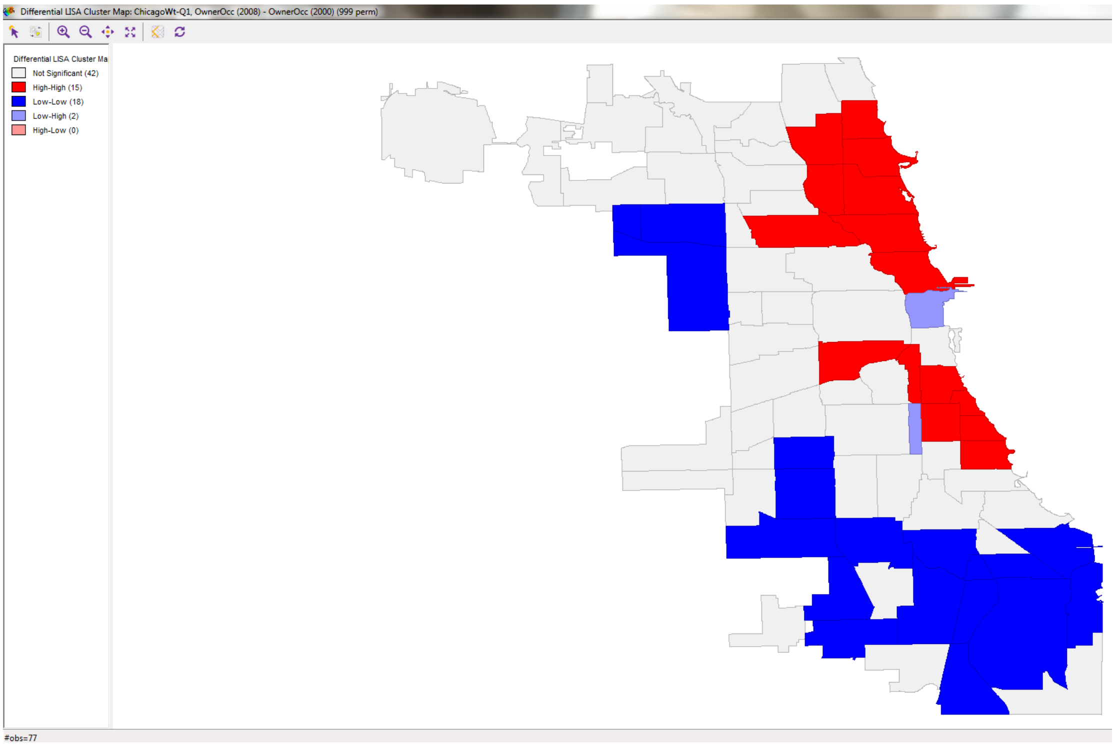


*Figure 7*

Only Fuller Park [37] right next to the area where the Robert Taylor Homes stood has experienced a decrease in the percentage of owner occupied housing during this period. Some distance to the north, the community area of Near North Side [8] has also experienced an increase in the percentage of owner occupied housing. This is noteworthy due to the fact that this particular community area was the location of the Cabrini-Green housing projects, which were demolished between the years 1995 and 2011. It is feasible that the process is captured in this analysis, as the number of rented residences was decreasing during the period.

Without access to data on the movement of individuals, it is difficult to claim anything concrete, but the results indicate a large-scale shift in the ownership patterns in housing that has occurred in different parts of the city. It is possible that this variable has captured, at least partially, the movement of the population displaced from the demolished housing projects. If this is the case, it would indicate populations moving down to the southern areas of the city, or toward Austin [25] and the surrounding neighborhoods.

The concentration of percentage increase clustering in the northeastern part of the city may be an indicator of something unrelated to the subject of this thesis, but it is interesting nonetheless. These community areas are more of the affluent type than those in the south, or those around the State Street Corridor. There was a housing bubble in the US that reached its peak during the period under examination here, and it is possible, if not likely, that the data has captured some part of the housing bubble's effects. This also presents another possibility of explaining the decreases in ownership in other areas of the city, where people may have been losing ownership of their houses through foreclosures, but this trend only became prevalent after the financial crisis of 2007-2008.

The following image is a significance map for the differential local Moran's I statistic between the years 2000 and 2008 in terms of changes the percentage of owner occupied housing (Figure 8). As before, the different degrees of statistical significance and the accompanying p-levels are displayed on the map with different shades of green. Light green areas have a p-level of 0.05, medium green areas have a p-level of 0.01, and the dark green areas have a p-level of 0.001. Also as before, the significances are based on the pseudo null constructed by 999 Monte Carlo permutations. In correspondence with the previous cluster map of the same variable, areas that are light gray in color are areas where no statistically significant clustering occurs.

There are two community areas with the highest statistical significance and a p-level of 0.001, and both are in clusters of increases surrounded by increases. The two community areas are those of Lincoln Park [7] in the northeast and Douglas [35] in the area of the State Street Corridor. The high statistical significance is no surprise, knowing the number of public housing units that had been removed during the period under consideration.

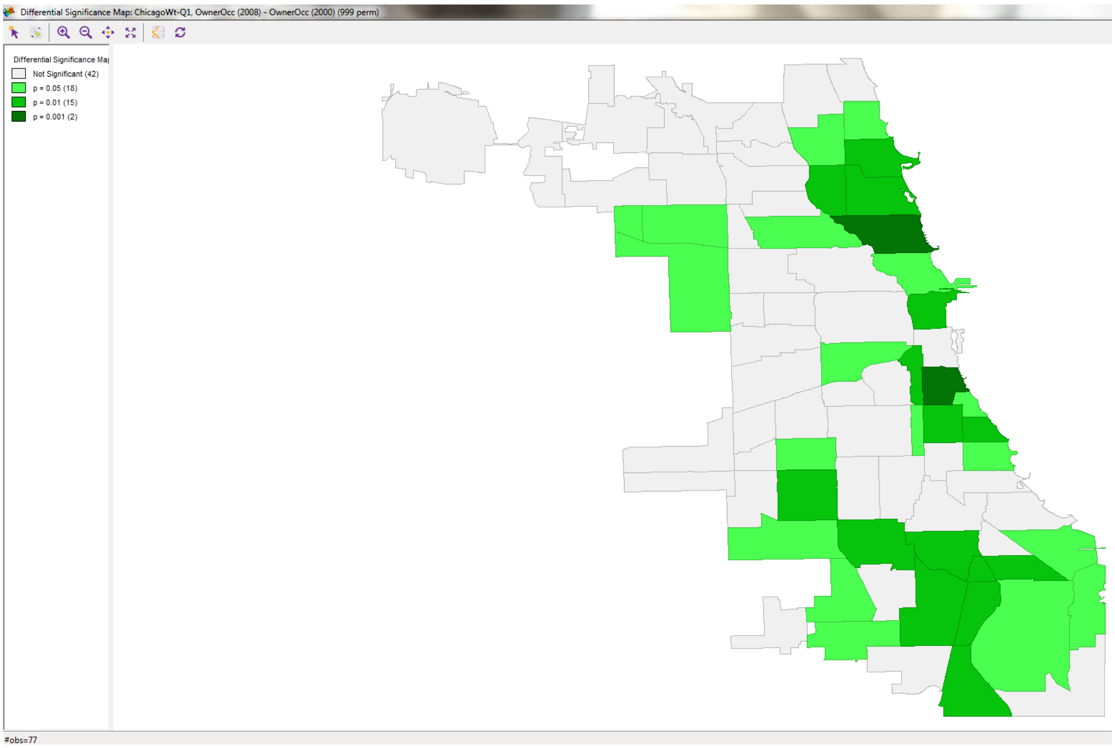


*Figure 8*

Also in and around the State Street Corridor area there are three community areas that are highly significant at a p-level of 0.01, namely Armour Square [34], Grand Boulevard [38], and Kenwood [39]. All saw increases in the percentage of owner occupied housing during the period. Around the area are also three other community areas with statistical significance at a p-level of 0.05, those being Fuller Park [37], Oakland [36], and Hyde Park [41]. The latter two experienced increases in the percentage of owner occupied housing. The interesting outlier, and a somewhat unexpected result is Fuller Park [37] experiencing a decrease in the percentage of owner occupied housing, as it goes against the overall trend in this concentration of community areas formerly containing or being adjacent to massive public housing projects.

### 6.1.3 Poverty

This subsection focuses on changes in the percent of people living below the poverty line in Chicago. The connection between violent crime and poverty was discussed earlier, where the literature showed that the two are highly correlated. The first image shows the results of a differential local Moran's I analysis on the percentage of people living in poverty between 2000 and 2008 (Figure 9). There are not as many areas with significant clustering as there were in the map of the percentage of owner occupied housing, but there are apparent similarities to where the concentrations of clustering are when comparing this map to the map on owner occupied housing and the one on homicide rates.

A majority of the map is colored gray which denotes no statistically significant clustering, in this case 53 community areas fall under this category. There are 10 areas where increases in the value of the variable are surrounded by similar increases, and these areas are marked red in the cluster map. There are 8 community areas where decreases in the value are surrounded by similar decreases, with these areas being marked blue on the cluster map. Three areas of decreases surrounded by increases are marked on the map with a light purple color. Finally, there are three areas where increases are surrounded by decreases, and these are marked light red on the cluster map.

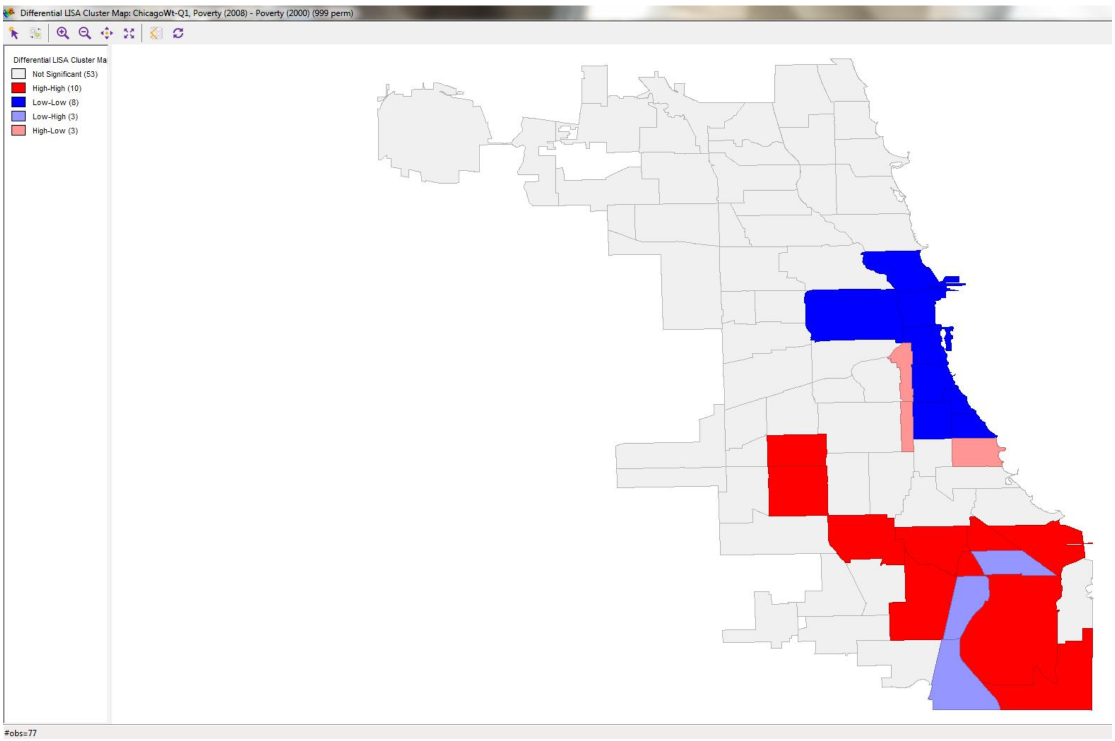


*Figure 9*

Once more, there is a concentrated area where decreasing percentages of people in poverty are discovered in the analysis for the time period from 2000 to 2008, and again it is centered in the area where large public housing projects have been demolished, and the areas surrounding it. Starting from the southeastern point, the community areas of Kenwood [39], Grand Boulevard [38], Oakland [36], Douglas [35], and Near South Side [33] all show clustered decreasing percentages of poverty during the period. At the northernmost point of the concentration of decreasing values, the community area of Near North Side [8] may again be displaying the effects of the demolition of the Cabrini-Green Homes.

Conversely, on the western side and to the southeast of the State Street Corridor, some community areas in the immediate vicinity show changes toward the other direction. Armour Square [34], Fuller Park [37], and Hyde Park [41] all show clustering of increasing values of poverty even though most of the adjacent areas are showing decreasing values. Considering how the poorest section of the population most likely does not have many resources to spend in moving to a new location, it is probable that they would instead choose areas closest to ones where they previously resided.

The southern areas of the city show a large mass of clustering of increasing values in the poverty percentage. Gage Park [63] and Chicago Lawn [66] are somewhat of an island to the northwest of the main concentration, and in the mass of increases in poverty, two notable examples are the community areas of Auburn Gresham [71] and Avalon Park [45]. The presence of Hegewisch [55] in the very farthest southeastern point on the map is interesting in that the community area has not been present in the analyses done on other variables.

Also of interest are the areas in the middle of the concentration of poverty increase clusters that have experienced decreases in poverty in spite of all the surrounding areas becoming more affected by poverty. These community areas are Calumet Heights [48], Pullman [50], and Riverdale [54].

The final map image is the significance map accompanying the cluster map for the differential local Moran's I statistic between the years 2000 and 2008 in terms of changes the percentage of people living below the poverty line (Figure 10). Once more, the different p-levels are represented by different shades of green on the map, with p-level 0.05 being light green, p-level 0.01 a medium green, and p-level 0.001 a dark green. The community areas with a gray color do not have any statistically significant clustering in them.

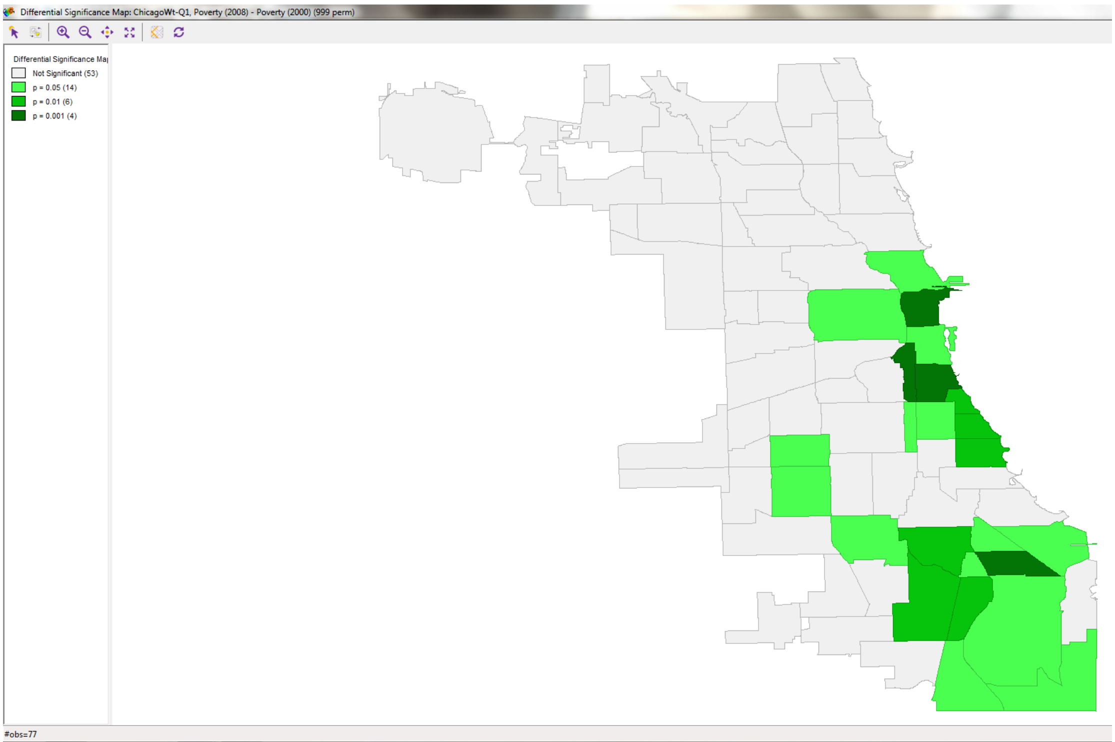


*Figure 10*

There are four community areas with the highest statistical significance of p-level 0.001, namely Loop [32], Armour Square [34], Douglas [35], and Calumet Heights [48]. Apart from Armour Square [34], which saw an increase in poverty, all of the other three areas showed clustering of decreasing poverty percentage values.

Six areas also have high statistical significance at p-level 0.01. These community areas are those of Oakland [36], Kenwood [39], Hyde Park [41], Chatham [44], Roseland [49], and Pullman [50]. Of these six, three areas experienced decreases in the percentage of poverty and conversely, three experienced increases. The community areas with decreases in poverty were Oakland [36], Kenwood [39], and Pullman [50], and the ones with increases in poverty were Hyde Park [41], Chatham [44], and Roseland [49]. All of the remaining statistically significant community areas were significant at a p-level of 0.05.

### 6.1.4 Summary of spatiotemporal analysis

There are some patterns to be found when looking at a combination of all the analyses that were discussed previously. While the variable of most interest is homicide rates, combining the effects on the homicide rate variable with effects on the other two variables produces indications of effects on the quality of life in a number of community areas following the demolition of the city's largest high-rise housing projects.

| Area No | Community Area | Homicide Rate | Owner Occupied | Poverty |
|---|---|---|---|---|
| **8** | Near North Side | | High-High * | Low-Low * |
| **35** | Douglas | Low-Low * | High-High *** | Low-Low *** |
| **36** | Oakland | Low-Low * | High-High * | Low-Low ** |
| **38** | Grand Boulevard | Low-Low ** | High-High ** | Low-Low * |
| **50** | Pullman | Low-High * | Low-Low ** | Low-High ** |
| | | | | |
| **33** | Near South Side | High-Low * | | Low-Low * |
| **43** | South Shore | High-High ** | | |
| **45** | Avalon Park | High-High *** | | High-High * |
| **48** | Calumet Heights | High-High *** | Low-Low ** | Low-High *** |
| **60** | Bridgeport | High-Low *** | | |
| **71** | Auburn Gresham | High-High * | Low-Low ** | High-High * |
| | | | | |
| **Sig.** | * 0.05 \| ** 0.01 \| *** 0.001 | | | |

The table displays a collection of the most prominent examples of the patterns of change, with the positive examples displayed on the top five rows and the negative examples on the remaining bottom rows. The variables are noted by the differential local Moran's I statistic results for them between the years 2000 and 2008, with the notation reporting the type of clustering for the variable in a given community area, for example "low-low" means a cluster of low values surrounded by low values, or in the differential case decreases surrounded by decreases, and "low-high" means lows or decreases surrounded by highs or increases, and so on.

Most of the positive cases include decreases in homicide rates accompanied by increases in the percentage of owner occupied housing and decreases in the percentage of people living below the poverty line. The negative cases included were chosen mainly due to the highly significant increases in homicide rates, which is the variable of main interest. In some cases increases in homicide rates were accompanied by decreases in the percentage of owner occupied housing and increases in the percentage of people in poverty.

The overall effects following the demolition of the massive high-rise housing projects appear to be such that the situation was improved in and around the immediate area where those projects stood, but a number of community areas in the southern parts of the city took a turn for the worse, especially in terms of homicide rates. As was mentioned earlier, there was an overall decrease in homicides in the city during the period, and for that reason increases in homicide rates in some community areas is even more troubling.

## 6.2 Linear regression with fixed effects

For the purposes of this analysis, the data was compiled into panel form, which separated all the variables under consideration by community areas and by year. Furthermore, the status of a community area's high-rise housing projects were converted into a categorical dummy variable, where 0 indicates no presence of high-rise public housing, 1 indicates high-rise public housing that is currently lived in, 2 indicates high-rise public housing that is currently condemned or in the process of demolition, and 3 indicates areas where the demolition of high-rise public housing has been completed. The inclusion of the value of 2 is warranted, as the demolition process takes a substantial length of time, the longest example being the Cabrini-Green Homes where the demolition process began in 1995 and ended in 2011.

With panel data covering the years from 2000 to 2016 for variables that vary over time, and which can be divided into observations on individual community areas as well as dummy variables dividing observation into different categories, a linear regression model that controls for fixed effects is a proper approach to observe variations within and between the various categories (Paul D. Allison, 2009). The variables used in the regressions are as follows:

| **Dependent variable:** |
|---|
| Homicide rate (homiciderate) |
| **Independent variables:** |
| Log of population (logpop) |
| % of population – Asian (pctasian) |
| % of population – black (pctblack) |
| % of population – Hispanic (pcthispanic) |
| % of population – other (pctother) |
| % of population below poverty level (pctpoverty) |
| % of housing occupied by owner (pctownerocc) |
| % of population without high school diploma (pctnohsd) |

| |
|---|
| % of population with only high school diploma (pcthsd) |
| % of population with some college studies (pctcollege) |

### 6.2.1 No fixed effects

The first regression was run without controlling for any fixed effects, with the public housing categorical dummy included among the independent variables. Presented here is a truncated version of the regression results, the complete Stata outputs can be found in the appendices. The same applies for all variations when different fixed effects are controlled for on the following pages, where truncated results are presented in the text and the complete tables are located in the appendices.

| homiciderate | Coef. | Std. Err. | t | P>\|t\| |
|---|---|---|---|---|
| | | | | |
| **pubhousing** | -1,067406 | 0,8076334 | -1,32 | 0,187 |
| **logpop** | 1,927535 | 1,585337 | 1,22 | 0,224 |
| **pctasian** | -0,3869041 | 0,0640607 | -6,04 | 0,000 |
| **pctblack** | 0,3009993 | 0,034576 | 8,71 | 0,000 |
| **pcthispanic** | -0,1682697 | 0,0414527 | -4,06 | 0,000 |
| **pctother** | -0,0239857 | 0,6895816 | -0,03 | 0,972 |
| **pctpoverty** | 0,505394 | 0,0968547 | 5,22 | 0,000 |
| **pctownerocc** | 0,0017847 | 0,0482926 | 0,04 | 0,971 |
| **pctnohsd** | 0,0737428 | 0,0820822 | 0,90 | 0,369 |
| **pcthsd** | 0,8207175 | 0,0986925 | 8,32 | 0,000 |
| **pctcollege** | -0,9115294 | 0,1377842 | -6,62 | 0,000 |
| **_cons** | -3,993771 | 9,260696 | -0,43 | 0,666 |

The results of the regression show indications that some demographic factors have a statistically significant effect on the homicide rate, with Asian and Hispanic having a negative coefficient while black has a positive one. Also, the percentage of people in poverty has a notable effect on the homicide rate, and it is also highly statistically significant. Educational factors also have a statistically significant effect on the homicide rate, with no high school diploma and only a high school diploma have a positive coefficient, while college has a negative coefficient. The adjusted R-squared for this test is 0.5866. However, as these results go through notable changes as various fixed effects are controlled for, they will not be discussed in more detail at this point.

### 6.2.2 Fixed effects – public housing

The first step in controlling for fixed effects is the addition of the categorical dummy variable of public housing. To reiterate, the categories in the variable are: 0 for no high-rise housing, 1 for high-rise housing in use, 2 for high-rise housing in the process of demolition, and 3 for high-rise housing where demolition has been finished.

| homiciderate | Coef. | Std. Err. | t | P>\|t\| |
|---|---|---|---|---|
| | | | | |
| **pubhousing** | | | | |
| **1** | 3,439348 | 5,167882 | 0,67 | 0,506 |
| **2** | -2,633058 | 2,731618 | -0,96 | 0,335 |
| **3** | -3,124514 | 2,819188 | -1,11 | 0,268 |
| | | | | |
| **logpop** | 2,091819 | 1,59738 | 1,31 | 0,191 |
| **pctasian** | -0,3857288 | 0,0642359 | -6,00 | 0,000 |
| **pctblack** | 0,3006231 | 0,0347369 | 8,65 | 0,000 |
| **pcthispanic** | -0,1680579 | 0,0418194 | -4,02 | 0,000 |
| **pctother** | -0,0440973 | 0,6923825 | -0,06 | 0,949 |
| **pctpoverty** | 0,502293 | 0,0971115 | 5,17 | 0,000 |
| **pctownerocc** | -0,0009386 | 0,0484225 | -0,02 | 0,985 |
| **pctnohsd** | 0,0718783 | 0,0824829 | 0,87 | 0,384 |
| **pcthsd** | 0,8289907 | 0,0997891 | 8,31 | 0,000 |
| **pctcollege** | -0,9067786 | 0,1379481 | -6,57 | 0,000 |
| **_cons** | -4,797133 | 9,307663 | -0,52 | 0,606 |

With this addition, there are not many notable changes in the results. Some of the coefficients change slightly both up and down, but no major alterations become apparent when the public housing variable is controlled for, except for the no high school diploma losing statistical significance. At this point, the different categories in the public housing variable are all not statistically significant. The adjusted R-squared for this version of the test is 0.5862, marginally worse than the simple regression performed at the beginning.

### 6.2.3 Fixed effects – public housing, year

Adding a control for the year in addition to the variable on public housing produces the following results. The year-by-year coefficients and p-values can be found in the appendices, as the table would become too lengthy to include in the text.

| homiciderate | Coef. | Std. Err. | t | P>\|t\| |
|---|---|---|---|---|
| | | | | |
| **pubhousing** | | | | |
| **1** | 5,361189 | 5,073736 | 1,06 | 0,291 |
| **2** | -0,3784674 | 2,727847 | -0,14 | 0,890 |
| **3** | -4,155314 | 2,761962 | -1,50 | 0,133 |
| | | | | |
| **logpop** | 1,482291 | 1,569415 | 0,94 | 0,345 |
| **pctasian** | -0,4769785 | 0,0679379 | -7,02 | 0,000 |
| **pctblack** | 0,2824532 | 0,0340957 | 8,28 | 0,000 |
| **pcthispanic** | -0,2983607 | 0,0528628 | -5,64 | 0,000 |
| **pctother** | 0,2849758 | 0,6975592 | 0,41 | 0,683 |
| **pctpoverty** | 0,2939613 | 0,1092771 | 2,69 | 0,007 |
| **pctowneroccc** | -0,0270927 | 0,0477337 | -0,57 | 0,570 |
| **pctnohsd** | 0,4338896 | 0,1219022 | 3,56 | 0,000 |
| **pcthsd** | 0,7274708 | 0,0989587 | 7,35 | 0,000 |
| **pctcollege** | -0,8598039 | 0,1348108 | -6,38 | 0,000 |
| **_cons** | -3,735569 | 9,235028 | -0,40 | 0,686 |

Again, there are no major shifts in the results when controlling for year in the regression. The p-values for the public housing variable shift closer to statistical significance, except for the "in process" value of 2, which leaps far away from it. The population characteristics remain highly significant in this iteration, as well as the variable on poverty and the ones for educational attainment. The "no high school diploma" variable regains its statistical significance. The adjusted R-squared for this regression is 0.6063, which is higher than the previous two regressions.

### 6.2.4 Fixed effects – public housing, community area

In this iteration of the regression, the fixed effects variables that are controlled for are public housing and community area. Again, the bulk of the table and the accompanying outputs are located in the appendices, as including all 77 community areas in the table would produce an unwieldy inclusion within the text proper.

| homiciderate | Coef. | Std. Err. | t | P>\|t\| |
|---|---|---|---|---|
| | | | | |
| **pubhousing** | | | | |
| **1** | 33,1871 | 17,64672 | 1,88 | 0,060 |
| **2** | 29,26884 | 14,02624 | 2,09 | 0,037 |
| **3** | 24,74888 | 13,02659 | 1,90 | 0,058 |
| | | | | |
| **logpop** | -29,06 | 17,41719 | -1,67 | 0,095 |
| **pctasian** | 0,0308025 | 0,4479231 | 0,07 | 0,945 |
| **pctblack** | -0,1539104 | 0,2980601 | -0,52 | 0,606 |
| **pcthispanic** | -0,014614 | 0,1336585 | -0,11 | 0,913 |
| **pctother** | 0,5010452 | 0,9787869 | 0,51 | 0,609 |

| | | | | |
|---|---|---|---|---|
| **pctpoverty** | -0,1980966 | 0,1859895 | -1,07 | 0,287 |
| **pctownerocc** | -0,901327 | 0,2215887 | -4,07 | 0,000 |
| **pctnohsd** | 0,0330712 | 0,172537 | 0,19 | 0,848 |
| **pcthsd** | 0,7186223 | 0,2527457 | 2,84 | 0,005 |
| **pctcollege** | 0,2171052 | 0,3269153 | 0,66 | 0,507 |
| **_cons** | 158,7321 | 80,25033 | 1,98 | 0,048 |

Controlling for the community area produces massive changes in the results of the regression. The demographic factors containing the percentages of various population types all completely lose their statistical significance, and their coefficients have gone through changes as well. Having only a high school diploma retains its statistical significance with a positive coefficient, whereas having no high school diploma or some college education both lose their statistical significance. The percentage of people in poverty also loses its statistical significance in the regression, and its positive coefficient has become a negative one.

Perhaps the most interesting changes in the results brought forth by the control for community areas pertain to housing types and ownership. The percentage of owner occupied housing has become highly significant with a negative coefficient. According to this regression, the higher the percentage of people living in housing that they own, the lower the homicide rate is generally. Also, with this added control variable, the presence of high-rise housing becomes very close to statistical significance, or passes the threshold in the case of its ‘2’ value. All of the values for the high-rise project variable have high coefficients in terms of homicide rates. The adjusted R-squared value for this regression is 0.6641, notably higher than all the previous regressions.

### 6.2.5 Fixed effects – public housing, community area, year

The final regression includes all the fixed effects controls, meaning public housing, community area, and year. Once again the inclusion of year and community area makes the results tables quite lengthy, and thus a truncated version without the community area and year portions are presented here, with the complete versions in the appendices.

| homiciderate | Coef. | Std. Err. | t | P>\|t\| |
|---|---|---|---|---|
| | | | | |
| **pubhousing** | | | | |
| **1** | 47,56625 | 17,79019 | 2,67 | 0,008 |
| **2** | 45,27854 | 14,4159 | 3,14 | 0,002 |
| **3** | 38,8968 | 13,45388 | 2,89 | 0,004 |
| | | | | |
| **logpop** | -32,81856 | 17,73013 | -1,85 | 0,064 |
| **pctasian** | -0,1838188 | 0,45175 | -0,41 | 0,684 |
| **pctblack** | -0,2045532 | 0,2908936 | -0,70 | 0,482 |
| **pcthispanic** | -0,0849017 | 0,1462269 | -0,58 | 0,562 |
| **pctother** | -0,0590287 | 0,9645166 | -0,06 | 0,951 |
| **pctpoverty** | -0,3759569 | 0,2066277 | -1,82 | 0,069 |
| **pctownerocc** | -0,4696189 | 0,2309043 | -2,03 | 0,042 |
| **pctnohsd** | 0,6335945 | 0,3015511 | 2,10 | 0,036 |
| **pcthsd** | 0,9053425 | 0,2806724 | 3,23 | 0,001 |
| **pctcollege** | 0,6777234 | 0,350016 | 1,94 | 0,053 |
| **_cons** | 136,2558 | 84,93435 | 1,60 | 0,109 |

With the inclusion of all the fixed effects controls, the results become altered in quite an interesting fashion. Whereas the simple linear regression estimated that all the major population characteristics were statistically significant, including all the fixed effects controls removes all statistical significance from the population characteristics. The percentage of people in poverty has also lost its significance, but not by much, and interestingly its coefficient is now negative whereas it was positive in the regressions that did not account for the community area effects.

The variables pertaining to educational attainment are once again statistically significant, with some college education being just above the p-level threshold. The coefficients for all three educational variables are positive, which is somewhat perplexing in terms of the one on college education. It is also interesting to note that the log of the populations in the community areas is also close to statistical significance.

Controlling for the year in addition to the community areas has caused the p-value for owner occupied housing to rise somewhat, but the variable is still statistically significant. While the magnitude of the coefficient is somewhat diminished, a higher percentage of owner occupied housing is still negatively correlated with homicide rates. As was discussed earlier, this variable may be a somewhat noisy proxy variable for the presence of public housing.

The most noteworthy changes in the results are in terms of the variable pertaining to the presence of high-rise public housing projects. While the variable started without significance in the original linear regression, including the control for community areas brought it close to statistical significance, and now including a control for both the year and the community areas has resulted in all three categories of the variable having very strong statistical significance.

What is also very apparent is the magnitude of the coefficients for the presence of high-rise public housing. The presence of high-rise housing projects or demolished high-rise housing projects has a notable increasing effect on homicide rates. It is interesting to note the differences in the coefficient values for the categories. With 1, where the high-rise projects are in full use, the coefficient is higher than with 2, where the high-rise projects are in the process of demolition, and this is in turn higher than with the value 3, where the demolition is completed. This would indicate that areas going through the process of demolition and finishing it leads to a reduction in homicide rates. The adjusted R-squared for this regression was 0.6826, the highest value produced in any of the regressions. On a final note, the fixed effects control for the year indicated that the years 2015 and 2016 had higher homicide rates, and the coefficients for both years were statistically significant.

### 6.2.6 Fixed effects summary

Overall, controlling for the various fixed effects helped tease out the significance of variables that would have been ignored in a straight forward linear regression. Especially the inclusion of the community area control helped estimate the coefficients of the chosen independent variables with more accuracy, as there are notable differences in homicide rates between the different community areas.

Below is a table presenting the results produced by the different regressions run on the data set, with comparisons of the coefficients, their significances and the R-squared and adjusted R-squared values for each of the regressions:

| Variable | OLS | OLS + pubhous | OLS + pubhous + year | OLS + pubhous + commarea | OLS + pubhous + commarea + year |
|---|---|---|---|---|---|
| **logpop** | 1,927535 | 2,091819 | 1,482291 | -29,06 | -32,81856 |
| **pctasian** | -0,3869041 *** | -0,3857288 *** | -0,4769785 *** | 0,0308025 | -0,1838188 |
| **pctblack** | 0,3009993 *** | 0,3006231 *** | 0,2824532 *** | -0,1539104 | -0,2045532 |
| **pcthispanic** | -0,1682697 *** | -0,1680579 *** | -0,2983607 *** | -0,014614 | -0,0849017 |
| **pctother** | -0,0239857 | -0,0440973 | 0,2849758 | 0,5010452 | -0,0590287 |
| **pctpoverty** | 0,505394 *** | 0,502293 *** | 0,2939613 ** | -0,1980966 | -0,3759569 |

| | | | | | |
|---|---|---|---|---|---|
| **pctownerocc** | 0,0017847 | -0,0009386 | -0,0270927 | -0,901327 *** | -0,4696189 * |
| **pctnohsd** | 0,0737428 | 0,0718783 | 0,4338896 *** | 0,0330712 | 0,6335945 * |
| **pcthsd** | 0,8207175 *** | 0,8289907 *** | 0,7274708 *** | 0,7186223 ** | 0,9053425 ** |
| **pctcollege** | -0,9115294 *** | -0,9067786 *** | -0,8598039 *** | 0,2171052 | 0,6777234 |
| **pubhous1** | | 3,439348 | 5,361189 | 33,1871 | 47,56625 ** |
| **pubhous2** | | -2,633058 | -0,3784674 | 29,26884 * | 45,27854 ** |
| **pubhous3** | | -3,124514 | -4,155314 | 24,74888 | 38,8968 ** |
| | | | | | |
| **R-squared** | 0.5901 | 0.5904 | 0.615 | 0.6867 | 0.7078 |
| **Adj. R-squared** | 0.5866 | 0.5862 | 0.6063 | 0.6641 | 0.6826 |
| | | | | | |
| **Sig. * 0.05 \| ** 0.01 \| *** 0.001** | | | | | |

## 6.3 Spatial Data Analysis

As a supplementary analysis, this subchapter considers some detrimental health factors and other adverse socioeconomic and health indicators and how they are related to the homicide rate, and also whether or not there is some spatial dependence between the variables that may be missed by OLS regression models.

The variables in the analysis are compiled from datasets available at the Chicago Data Portal, and from those the following were selected for use: CrwdHous – the percentage of crowded housing units, DiabRel – diabetes related deaths per 100,000, LoBirthWt – percentage of low birth weight live births, LungCanc – lung cancer deaths per 100,000, Tuberc – tuberculosis cases per 100,000, Unempl – percentage of people over 16 years old in the work force unemployed. OOcc2012 and Pov2012 are variables also examined in the spatiotemporal analysis chapter, being the percentage of owner occupied housing in 2012 and percentage of people living below the poverty line in 2012 respectively.

| Variable | Coefficient | Std.Error | t-Statistic | Probability |
|---|---|---|---|---|
| | | | | |
| **CONSTANT** | -29.5146060 | 12.4608699 | -2.3685831 | 0.0207042 |
| **CrwdHous** | 0.9031612 | 0.6838020 | 1.3207933 | 0.1909981 |
| **DiabRel** | -0.1645418 | 0.1278704 | -1.2867857 | 0.2025324 |
| **LoBirthWt** | 1.9601490 | 0.7233107 | 2.7099681 | 0.0085088 |
| **LungCanc** | 0.4999914 | 0.1900838 | 2.6303732 | 0.0105405 |
| **OOcc2012** | -0.0248421 | 0.1530815 | -0.1622800 | 0.8715666 |
| **Pov2012** | 0.6755164 | 0.3632114 | 1.8598435 | 0.0672335 |
| **Tuberc** | -0.1204474 | 0.4792192 | -0.2513409 | 0.8023085 |
| **Unempl** | -0.0374834 | 0.4752213 | -0.0788757 | 0.9373632 |

The OLS regression results show that there is statistically significant correlation between the homicide rate and the independent variables of low birth weight and lung cancer deaths, with poverty being close to statistical significance. The R-squared value for the regression is 0.6370, and the adjusted R-squared is 0.5943. However, the diagnostics for spatial dependence suggest that the OLS regression is missing something in the data.

**DIAGNOSTICS FOR SPATIAL DEPENDENCE**

| TEST | MI/DF | VALUE | PROB |
|---|---|---|---|
| **Lagrange Multiplier (lag)** | 1 | 4.051 | 0.0441 |
| **Robust LM (lag)** | 1 | 5.541 | 0.0186 |
| **Lagrange Multiplier(error)** | 1 | 0.336 | 0.5619 |
| **Robust LM (error)** | 1 | 1.826 | 0.1766 |
| **Lagrange Multiplier (SARMA)** | 2 | 5.877 | 0.0529 |

The diagnostics indicate that there is some spatial dependence present in the dataset, and further steps should be taken. Based on the diagnostics, the appropriate model to run is a spatial lag model, with a p-value of 0.0441. The results from the spatial lag model are below. The analysis was run with the same spatial weights file as before, where the neighbors were weighted with a queen contiguity and only for the first-order, or immediately adjacent neighbors.

| Variable | Coefficient | Std.Error | z-Statistic | Probability |
|---|---|---|---|---|
| **CONSTANT** | -24.7166047 | 11.4747948 | -2.1539910 | 0.0312409 |
| **CrwdHous** | 1.1197585 | 0.6277571 | 1.7837448 | 0.0744651 |
| **DiabRel** | -0.1262862 | 0.1173082 | -1.0765334 | 0.2816888 |
| **LoBirthWt** | 1.6729943 | 0.6664706 | 2.5102296 | 0.0120653 |
| **LungCanc** | 0.4578695 | 0.1739282 | 2.6325209 | 0.0084754 |
| **OOcc2012** | -0.0924245 | 0.1413875 | -0.6536966 | 0.5133073 |
| **Pov2012** | 0.2517075 | 0.3594870 | 0.7001855 | 0.4838115 |
| **Tuberc** | 0.0647909 | 0.4413294 | 0.1468086 | 0.8832831 |
| **Unempl** | -0.2539525 | 0.4392699 | -0.5781241 | 0.5631804 |
| **W_HR2012** | 0.5050583 | 0.1663404 | 3.0362947 | 0.0023951 |

In the spatial lag model, crowded housing moves quite close to significance, and its coefficient increases. Low birth weights and lung cancer deaths are still statistically significant, but their coefficients are reduced. Interestingly, the p-value for poverty moves far away from significance. Finally the weighted homicide rate variable confirms the presence of spatial dependence, with a substantially large coefficient, and it is highly statistically significant.

This supplementary spatial data analysis confirms what was discovered in the previous analyses, in that there are indeed clusters of high homicide rates in different sections of the city, largely in the southern parts. Community areas around these parts of the city are notably higher in the homicide statistics than the safer areas in the more affluent northern and northwestern parts of the city.

# 7. Conclusion

The aim of this thesis was to analyze the temporal development of homicide rates and other adverse socioeconomic factors in the city of Chicago in order to discover the effects of the city's public housing policy decisions. The analysis shows that homicide rates of the crime hot spots in the largest concentration of high-rise public housing did go down, but conversely there were other areas in the city where new clusters of homicide rate hot spots came into being. The effect was also mirrored by changes in poverty rates, with the area of the demolition showing reduced poverty, but the southern parts of the city showing increases in poverty.

The additional analyses further reinforced the differences between homicide rates in community areas, and the effects of high-rise public housing projects on homicide rates. A linear regression with fixed effects confirmed what the spatial analyses suggested, the presence of high-rise public housing increases homicide rates, and the demolition of those housing projects does not completely mitigate this increase. Furthermore, a spatial lag model also indicated the presence of spatial dependence in homicide rates, as well as showing that some adverse health indicators are correlated with homicide rates.

The focus of this thesis was on a subject that is not widely covered in research literature, and the methodology of choice, spatial data analysis, was also something now widely applied in the research literature. High homicide rates in inner cities of the largest U.S. cities is an important area of study, and this thesis provides new knowledge on the subject in the form of an empirical analysis. Previous studies have applied ethnographic methods, some game theoretic concepts, and for example some social network analysis, but this thesis provides a new perspective on the topic.

Seeing increases in crime rates is in line with the predictions of the game theoretic model, where gang members are expected to continue criminal activities after their relocation based on the structure of and assumptions inherent in the gang lifestyle. The major limitation of the study is confirming the fact that gang members moved into areas where rising homicide rates were clustered. This is due to ethical limitations, as there is a severe privacy issue inherent in attempting to track movement of individuals from one form of housing to another, as well as confirming their gang affiliations. Combining the information of those two factors would make individuals likely to be identifiable, making the preservation of anonymity problematic. Also, due to the limited scope of a master's thesis, the amount of data that could be handled and included in the analysis was limited, and many interesting Census data points were excluded.

However, for future research on this subject, some type of proxy indicator of people's movement pattern could be devised. One possible option would be to track the use of Section 8 vouchers in community areas following the demolition, as that was the new method of providing public housing after the large public housing projects were discarded. Also, a more comprehensive spatial data analysis that includes more variables from Census data, which are examined in closer detail, would be a worthwhile pursuit.

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# Appendices

Linear regression - Stata

| Source | SS | df | MS | Number of obs = | 1309 |
|---|---|---|---|---|---|
| | | | | F(11, 1297) = | 169,74 |
| Model | 469049,395 | 11 | 42640,8541 | Prob > F = | 0,0000 |
| Residual | 325818,371 | 1297 | 251,20923 | R-squared = | 0,5901 |
| | | | | Adj R-squared = | 0,5866 |
| Total | 794867,766 | 1308 | 607,697068 | Root MSE = | 15,85 |

| homiciderate | Coef. | Std. Err. | t | P>\|t\| | 95% Conf. Interval | |
|---|---|---|---|---|---|---|
| pubhousing | -1,067406 | 0,8076334 | -1,32 | 0,187 | -2,651817 | 0,5170049 |
| logpop | 1,927535 | 1,585337 | 1,22 | 0,224 | -1,18257 | 5,03764 |
| pctasian | -0,3869041 | 0,0640607 | -6,04 | 0,000 | -0,5125781 | -0,2612302 |
| pctblack | 0,3009993 | 0,034576 | 8,71 | 0,000 | 0,2331682 | 0,3688304 |
| pcthispanic | -0,1682697 | 0,0414527 | -4,06 | 0,000 | -0,2495913 | -0,086948 |
| pctother | -0,0239857 | 0,6895816 | -0,03 | 0,972 | -1,376803 | 1,328832 |
| pctpoverty | 0,505394 | 0,0968547 | 5,22 | 0,000 | 0,315385 | 0,6954029 |
| pctownerocc | 0,0017847 | 0,0482926 | 0,04 | 0,971 | -0,0929555 | 0,0965249 |
| pctnohsd | 0,0737428 | 0,0820822 | 0,90 | 0,369 | -0,0872856 | 0,2347712 |
| pcthsd | 0,8207175 | 0,0986925 | 8,32 | 0,000 | 0,627103 | 1,014332 |
| pctcollege | -0,9115294 | 0,1377842 | -6,62 | 0,000 | -1,181834 | -0,6412251 |
| _cons | -3,993771 | 9,260696 | -0,43 | 0,666 | -22,16136 | 14,17381 |

Linear regression with fixed effect for public housing - Stata

| Source | SS | df | MS | Number of obs = | 1309 |
|---|---|---|---|---|---|
| | | | | F(13,1295) = | 143,56 |
| Model | 469255,028 | 13 | 36096,5406 | Prob > F = | 0,0000 |
| Residual | 325612,737 | 1295 | 251,438407 | R-squared = | 0,5904 |
| | | | | Adj R-squared = | 0,5862 |
| Total | 794867,766 | 1308 | 607,697068 | Root MSE = | 15,857 |

| homiciderate | Coef. | Std. Err. | t | P>\|t\| | 95% Conf. Interval | |
|---|---|---|---|---|---|---|
| pubhousing | | | | | | |
| 1 | 3,439348 | 5,167882 | 0,67 | 0,506 | -6,69899 | 13,57769 |
| 2 | -2,633058 | 2,731618 | -0,96 | 0,335 | -7,991939 | 2,725823 |
| 3 | -3,124514 | 2,819188 | -1,11 | 0,268 | -8,65519 | 2,406162 |
| logpop | 2,091819 | 1,59738 | 1,31 | 0,191 | -1,041918 | 5,225556 |
| pctasian | -0,3857288 | 0,0642359 | -6,00 | 0,000 | -0,5117466 | -0,259711 |
| pctblack | 0,3006231 | 0,0347369 | 8,65 | 0,000 | 0,2324764 | 0,3687699 |
| pcthispanic | -0,1680579 | 0,0418194 | -4,02 | 0,000 | -0,2500991 | -0,0860167 |
| pctother | -0,0440973 | 0,6923825 | -0,06 | 0,949 | -1,402412 | 1,314217 |
| pctpoverty | 0,502293 | 0,0971115 | 5,17 | 0,000 | 0,3117799 | 0,6928062 |
| pctownerocc | -0,0009386 | 0,0484225 | -0,02 | 0,985 | -0,0959338 | 0,0940566 |
| pctnohsd | 0,0718783 | 0,0824829 | 0,87 | 0,384 | -0,0899364 | 0,2336931 |
| pcthsd | 0,8289907 | 0,0997891 | 8,31 | 0,000 | 0,6332247 | 1,024757 |
| pctcollege | -0,9067786 | 0,1379481 | -6,57 | 0,000 | -1,177405 | -0,6361524 |
| _cons | -4,797133 | 9,307663 | -0,52 | 0,606 | -23,05688 | 13,46262 |

Linear regression with fixed effects for public housing, year - Stata

| Source | SS | df | MS | | Number of obs = | 1309 |
|---|---|---|---|---|---|---|
| | | | | | F(29,1279) = | 70,45 |
| Model | 488849,613 | 29 | 16856,8832 | | Prob > F = | 0,0000 |
| Residual | 306018,153 | 1279 | 239,263606 | | R-squared = | 0,615 |
| | | | | | Adj R-squared = | 0,6063 |
| Total | 794867,766 | 1308 | 607,697068 | | Root MSE = | 15,468 |

| homiciderate | Coef. | Std. Err. | t | P>\|t\| | 95% Conf. Interval | |
|---|---|---|---|---|---|---|
| **pubhousing** | | | | | | |
| 1 | 5,361189 | 5,073736 | 1,06 | 0,291 | -4,59257 | 15,31495 |
| 2 | -0,3784674 | 2,727847 | -0,14 | 0,890 | -5,730014 | 4,973079 |
| 3 | -4,155314 | 2,761962 | -1,50 | 0,133 | -9,573788 | 1,263161 |
| | | | | | | |
| **logpop** | 1,482291 | 1,569415 | 0,94 | 0,345 | -1,596619 | 4,561201 |
| **pctasian** | -0,4769785 | 0,0679379 | -7,02 | 0,000 | -0,6102605 | -0,3436965 |
| **pctblack** | 0,2824532 | 0,0340957 | 8,28 | 0,000 | 0,2155637 | 0,3493428 |
| **pcthispanic** | -0,2983607 | 0,0528628 | -5,64 | 0,000 | -0,402068 | -0,1946533 |
| **pctother** | 0,2849758 | 0,6975592 | 0,41 | 0,683 | -1,08351 | 1,653462 |
| **pctpoverty** | 0,2939613 | 0,1092771 | 2,69 | 0,007 | 0,0795792 | 0,5083434 |
| **pctownerocc** | -0,0270927 | 0,0477337 | -0,57 | 0,570 | -0,1207376 | 0,0665522 |
| **pctnohsd** | 0,4338896 | 0,1219022 | 3,56 | 0,000 | 0,1947393 | 0,67304 |
| **pcthsd** | 0,7274708 | 0,0989587 | 7,35 | 0,000 | 0,5333315 | 0,92161 |
| **pctcollege** | -0,8598039 | 0,1348108 | -6,38 | 0,000 | -1,124278 | -0,5953293 |
| | | | | | | |
| **year** | | | | | | |
| 2001 | 2,545591 | 2,497762 | 1,02 | 0,308 | -2,35457 | 7,445752 |
| 2002 | 3,885367 | 2,508911 | 1,55 | 0,122 | -1,036666 | 8,8074 |
| 2003 | 4,05589 | 2,526734 | 1,61 | 0,109 | -0,901108 | 9,012888 |
| 2004 | -1,63057 | 2,550624 | -0,64 | 0,523 | -6,634436 | 3,373296 |
| 2005 | -0,2116245 | 2,580108 | -0,08 | 0,935 | -5,273333 | 4,850084 |
| 2006 | 2,381026 | 2,614718 | 0,91 | 0,363 | -2,748581 | 7,510633 |
| 2007 | 1,311736 | 2,654096 | 0,49 | 0,621 | -3,895124 | 6,518596 |
| 2008 | 4,597543 | 2,702894 | 1,70 | 0,089 | -0,7050493 | 9,900135 |
| 2009 | 5,245283 | 2,75622 | 1,90 | 0,057 | -0,1619268 | 10,65249 |
| 2010 | 4,457474 | 2,808978 | 1,59 | 0,113 | -1,053236 | 9,968184 |
| 2011 | 4,522208 | 2,865425 | 1,58 | 0,115 | -1,099242 | 10,14366 |
| 2012 | 6,911856 | 2,926681 | 2,36 | 0,018 | 1,170233 | 12,65348 |
| 2013 | 2,814812 | 2,97378 | 0,95 | 0,344 | -3,01921 | 8,648834 |
| 2014 | 3,985764 | 3,004393 | 1,33 | 0,185 | -1,908316 | 9,879845 |
| 2015 | 8,331204 | 3,047052 | 2,73 | 0,006 | 2,353435 | 14,30897 |
| 2016 | 19,26638 | 3,090805 | 6,23 | 0,000 | 13,20278 | 25,32998 |
| | | | | | | |
| **_cons** | -3,735569 | 9,235028 | -0,40 | 0,686 | -21,85304 | 14,3819 |

Linear regression with fixed effects for public housing, community area - Stata

| Source | SS | df | MS | | Number of obs = | 1309 |
|---|---|---|---|---|---|---|
| | | | | | F(88, 1220) = | 30,39 |
| Model | 545830,822 | 88 | 6202,62298 | | Prob > F = | 0,0000 |
| Residual | 249036,944 | 1220 | 204,128642 | | R-squared = | 0,6867 |
| | | | | | Adj R-squared = | 0,6641 |
| Total | 794867,766 | 1308 | 607,697068 | | Root MSE = | 14,287 |
| | | | | | | |
| | | | | | | |
| homiciderate | Coef. | Std. Err. | t | P>\|t\| | 95% Conf. Interval | |
| | | | | | | |
| pubhousing | | | | | | |
| 1 | 33,1871 | 17,64672 | 1,88 | 0,060 | -1,434187 | 67,80839 |
| 2 | 29,26884 | 14,02624 | 2,09 | 0,037 | 1,750615 | 56,78706 |
| 3 | 24,74888 | 13,02659 | 1,90 | 0,058 | -0,8081234 | 50,30589 |
| | | | | | | |
| logpop | -29,06 | 17,41719 | -1,67 | 0,095 | -63,23095 | 5,110959 |
| pctasian | 0,0308025 | 0,4479231 | 0,07 | 0,945 | -0,8479825 | 0,9095875 |
| pctblack | -0,1539104 | 0,2980601 | -0,52 | 0,606 | -0,7386776 | 0,4308569 |
| pcthispanic | -0,014614 | 0,1336585 | -0,11 | 0,913 | -0,2768401 | 0,2476121 |
| pctother | 0,5010452 | 0,9787869 | 0,51 | 0,609 | -1,419247 | 2,421337 |
| pctpoverty | -0,1980966 | 0,1859895 | -1,07 | 0,287 | -0,5629914 | 0,1667982 |
| pctownerocc | -0,901327 | 0,2215887 | -4,07 | 0,000 | -1,336064 | -0,4665898 |
| pctnohsd | 0,0330712 | 0,172537 | 0,19 | 0,848 | -0,3054309 | 0,3715733 |
| pcthsd | 0,7186223 | 0,2527457 | 2,84 | 0,005 | 0,2227579 | 1,214487 |
| pctcollege | 0,2171052 | 0,3269153 | 0,66 | 0,507 | -0,4242733 | 0,8584838 |
| | | | | | | |
| commarea | | | | | | |
| Archer Heights | -1,505556 | 13,89583 | -0,11 | 0,914 | -28,76793 | 25,75681 |
| Armour Square | -19,67079 | 29,61851 | -0,66 | 0,507 | -77,77964 | 38,43807 |
| Ashburn | 44,50051 | 18,4889 | 2,41 | 0,016 | 8,226952 | 80,77407 |
| Auburn Gresham | 42,63798 | 28,54581 | 1,49 | 0,136 | -13,36633 | 98,6423 |
| Austin | 51,58239 | 27,006 | 1,91 | 0,056 | -1,400967 | 104,5657 |
| Avalon Park | 38,54421 | 28,38374 | 1,36 | 0,175 | -17,14215 | 94,23057 |
| Avondale | -3,145183 | 7,619479 | -0,41 | 0,680 | -18,09392 | 11,80355 |
| Belmont Cragin | 14,79128 | 10,20185 | 1,45 | 0,147 | -5,223837 | 34,80639 |
| Beverly | 32,29782 | 15,22027 | 2,12 | 0,034 | 2,437014 | 62,15863 |
| Bridgeport | -4,892846 | 10,70172 | -0,46 | 0,648 | -25,88865 | 16,10296 |
| Brighton Park | 14,42206 | 9,703654 | 1,49 | 0,137 | -4,61564 | 33,45976 |
| Burnside | 37,22394 | 30,52497 | 1,22 | 0,223 | -22,66331 | 97,1112 |
| Calumet Heights | 42,55856 | 27,85576 | 1,53 | 0,127 | -12,09195 | 97,20906 |
| Chatham | 44,10572 | 27,65153 | 1,60 | 0,111 | -10,1441 | 98,35554 |
| Chicago Lawn | 31,43527 | 15,81228 | 1,99 | 0,047 | 0,412988 | 62,45755 |
| Clearing | 6,810443 | 12,50583 | 0,54 | 0,586 | -17,72487 | 31,34575 |
| Douglas | -27,52415 | 12,68749 | -2,17 | 0,030 | -52,41586 | -2,632439 |
| Dunning | 17,91513 | 12,09636 | 1,48 | 0,139 | -5,816842 | 41,64711 |
| East Garfield Park | 44,00674 | 25,30541 | 1,74 | 0,082 | -5,640209 | 93,65368 |
| East Side | 11,69296 | 13,62704 | 0,86 | 0,391 | -15,04207 | 38,42799 |
| Edgewater | 5,158987 | 9,217529 | 0,56 | 0,576 | -12,92498 | 23,24295 |
| Edison Park | 8,61178 | 14,21732 | 0,61 | 0,545 | -19,28134 | 36,50489 |
| Englewood | 65,49531 | 26,549 | 2,47 | 0,014 | 13,40856 | 117,5821 |
| Forest Glen | 28,40455 | 12,60304 | 2,25 | 0,024 | 3,678502 | 53,13059 |
| Fuller Park | 32,40192 | 28,55645 | 1,13 | 0,257 | -23,62327 | 88,42711 |
| Gage Park | 26,78157 | 11,95053 | 2,24 | 0,025 | 3,335705 | 50,22744 |

| | | | | | | |
|---|---|---|---|---|---|---|
| **Garfield Ridge** | 26,96891 | 13,09654 | 2,06 | 0,040 | 1,274671 | 52,66315 |
| **Grand Boulevard** | -3,586465 | 16,52616 | -0,22 | 0,828 | -36,00932 | 28,83639 |
| **Greater Grand Crossing** | 51,65851 | 27,24913 | 1,90 | 0,058 | -1,801833 | 105,1189 |
| **Hegewisch** | 7,550602 | 15,6741 | 0,48 | 0,630 | -23,20057 | 38,30178 |
| **Hermosa** | -2,555136 | 10,91127 | -0,23 | 0,815 | -23,96207 | 18,8518 |
| **Humboldt park** | 39,01143 | 13,24074 | 2,95 | 0,003 | 13,03428 | 64,98857 |
| **Hyde Park** | 2,104339 | 13,84164 | 0,15 | 0,879 | -25,05171 | 29,26039 |
| **Irving Park** | 3,94307 | 6,694751 | 0,59 | 0,556 | -9,191431 | 17,07757 |
| **Jefferson Park** | 4,627253 | 9,54733 | 0,48 | 0,628 | -14,10375 | 23,35826 |
| **Kenwood** | 0,8935943 | 21,34813 | 0,04 | 0,967 | -40,98952 | 42,77671 |
| **Lake View** | 12,77276 | 14,48842 | 0,88 | 0,378 | -15,65222 | 41,19775 |
| **Lincoln Park** | 17,03855 | 13,43607 | 1,27 | 0,205 | -9,321808 | 43,39892 |
| **Lincoln Square** | -4,322187 | 7,458718 | -0,58 | 0,562 | -18,95552 | 10,31115 |
| **Logan Square** | 10,12589 | 9,568236 | 1,06 | 0,290 | -8,646127 | 28,89792 |
| **Loop** | 6,468319 | 11,27574 | 0,57 | 0,566 | -15,65368 | 28,59032 |
| **Lower West Side** | 1,251225 | 9,245782 | 0,14 | 0,892 | -16,88817 | 19,39062 |
| **McKinley Park** | -1,809648 | 12,46048 | -0,15 | 0,885 | -26,25598 | 22,63669 |
| **Montclare** | -7,98703 | 12,28728 | -0,65 | 0,516 | -32,09357 | 16,11952 |
| **Morgan Park** | 42,54579 | 21,00062 | 2,03 | 0,043 | 1,344453 | 83,74713 |
| **Mount Greenwood** | 16,98807 | 14,56663 | 1,17 | 0,244 | -11,59036 | 45,56649 |
| **Near North Side** | -3,60089 | 9,741265 | -0,37 | 0,712 | -22,71238 | 15,5106 |
| **Near South Side** | -17,00346 | 10,51236 | -1,62 | 0,106 | -37,62777 | 3,620847 |
| **Near West Side** | 0 | (omitted) | | | | |
| **New City** | 38,77388 | 10,47932 | 3,70 | 0,000 | 18,2144 | 59,33337 |
| **North Center** | 5,613078 | 9,605493 | 0,58 | 0,559 | -13,23204 | 24,45819 |
| **North Lawndale** | 43,21313 | 25,37588 | 1,70 | 0,089 | -6,572063 | 92,99833 |
| **North Park** | -2,084171 | 11,28579 | -0,18 | 0,854 | -24,22589 | 20,05755 |
| **Norwood Park** | 20,70999 | 12,25763 | 1,69 | 0,091 | -3,338376 | 44,75836 |
| **Oakland** | -17,65404 | 26,84265 | -0,66 | 0,511 | -70,31691 | 35,00882 |
| **Ohare** | -25,02417 | 10,31243 | -2,43 | 0,015 | -45,25622 | -4,79211 |
| **Portage Park** | 7,397372 | 9,886741 | 0,75 | 0,454 | -11,99953 | 26,79427 |
| **Pullman** | 9,187001 | 23,94756 | 0,38 | 0,701 | -37,79597 | 56,16997 |
| **Riverdale** | 7,007511 | 26,56039 | 0,26 | 0,792 | -45,10159 | 59,11661 |
| **Rogers Park** | -0,6847207 | 11,08241 | -0,06 | 0,951 | -22,42742 | 21,05798 |
| **Roseland** | 58,49149 | 28,66593 | 2,04 | 0,042 | 2,251497 | 114,7315 |
| **South Chicago** | 41,39025 | 19,7497 | 2,10 | 0,036 | 2,643095 | 80,1374 |
| **South Deering** | 29,36304 | 19,00972 | 1,54 | 0,123 | -7,932335 | 66,65841 |
| **South Lawndale** | 23,51768 | 10,25552 | 2,29 | 0,022 | 3,397283 | 43,63809 |
| **South Shore** | 31,11005 | 27,95172 | 1,11 | 0,266 | -23,72871 | 85,94881 |
| **Uptown** | 3,717332 | 10,18138 | 0,37 | 0,715 | -16,25762 | 23,69228 |
| **Washington Heights** | 51,0773 | 28,70027 | 1,78 | 0,075 | -5,230059 | 107,3847 |
| **Washington Park** | 32,7143 | 26,2959 | 1,24 | 0,214 | -18,87589 | 84,30449 |
| **West Elsdon** | 12,39796 | 14,83211 | 0,84 | 0,403 | -16,70131 | 41,49723 |
| **West Englewood** | 70,28241 | 27,23795 | 2,58 | 0,010 | 16,844 | 123,7208 |
| **West Garfield Park** | 58,93571 | 26,29419 | 2,24 | 0,025 | 7,348876 | 110,5225 |
| **West Lawn** | 23,2102 | 13,75999 | 1,69 | 0,092 | -3,785665 | 50,20607 |
| **West Pullman** | 63,90821 | 27,01583 | 2,37 | 0,018 | 10,90557 | 116,9109 |
| **West Ridge** | 11,53403 | 8,002719 | 1,44 | 0,150 | -4,166587 | 27,23465 |
| **West Town** | 16,51885 | 11,04282 | 1,50 | 0,135 | -5,146175 | 38,18387 |
| **Woodlawn** | 17,8553 | 24,57561 | 0,73 | 0,468 | -30,35983 | 66,07044 |
| | | | | | | |
| **_cons** | 158,7321 | 80,25033 | 1,98 | 0,048 | 1,288131 | 316,176 |

Linear regression with fixed effects for public housing, community area, year - Stata

| Source | SS | df | MS | | Number of obs = | 1309 |
|---|---|---|---|---|---|---|
| | | | | | F(104, 1204) = | 28,04 |
| Model | 562604,76 | 104 | 5409,66116 | | Prob > F = | 0,0000 |
| Residual | 232263,005 | 1204 | 192,909473 | | R-squared = | 0,7078 |
| | | | | | Adj R-squared = | 0,6826 |
| Total | 794867,766 | 1308 | 607,697068 | | Root MSE = | 13,889 |
| | | | | | | |
| | | | | | | |
| homiciderate | Coef. | Std. Err. | t | P>\|t\| | 95% Conf. Interval | |
| | | | | | | |
| pubhousing | | | | | | |
| 1 | 47,56625 | 17,79019 | 2,67 | 0,008 | 12,66303 | 82,46947 |
| 2 | 45,27854 | 14,4159 | 3,14 | 0,002 | 16,99547 | 73,56161 |
| 3 | 38,8968 | 13,45388 | 2,89 | 0,004 | 12,50114 | 65,29246 |
| | | | | | | |
| logpop | -32,81856 | 17,73013 | -1,85 | 0,064 | -67,60395 | 1,966835 |
| pctasian | -0,1838188 | 0,45175 | -0,41 | 0,684 | -1,070123 | 0,7024859 |
| pctblack | -0,2045532 | 0,2908936 | -0,70 | 0,482 | -0,7752679 | 0,3661616 |
| pcthispanic | -0,0849017 | 0,1462269 | -0,58 | 0,562 | -0,3717895 | 0,2019861 |
| pctother | -0,0590287 | 0,9645166 | -0,06 | 0,951 | -1,951349 | 1,833291 |
| pctpoverty | -0,3759569 | 0,2066277 | -1,82 | 0,069 | -0,7813473 | 0,0294334 |
| pctownerocc | -0,4696189 | 0,2309043 | -2,03 | 0,042 | -0,9226384 | -0,0165993 |
| pctnohsd | 0,6335945 | 0,3015511 | 2,10 | 0,036 | 0,0419704 | 1,225219 |
| pcthsd | 0,9053425 | 0,2806724 | 3,23 | 0,001 | 0,3546812 | 1,456004 |
| pctcollege | 0,6777234 | 0,350016 | 1,94 | 0,053 | -0,0089855 | 1,364432 |
| | | | | | | |
| commarea | | | | | | |
| Archer Heights | -23,64628 | 14,13398 | -1,67 | 0,095 | -51,37626 | 4,083695 |
| Armour Square | -10,86993 | 29,56241 | -0,37 | 0,713 | -68,8695 | 47,12964 |
| Ashburn | 18,74082 | 19,10464 | 0,98 | 0,327 | -18,74128 | 56,22291 |
| Auburn Gresham | 34,44636 | 28,51775 | 1,21 | 0,227 | -21,50364 | 90,39636 |
| Austin | 46,50656 | 27,3259 | 1,70 | 0,089 | -7,105112 | 100,1182 |
| Avalon Park | 19,5778 | 28,11826 | 0,70 | 0,486 | -35,58844 | 74,74404 |
| Avondale | -6,990966 | 7,450706 | -0,94 | 0,348 | -21,60878 | 7,626843 |
| Belmont Cragin | 1,24273 | 10,75416 | 0,12 | 0,908 | -19,85625 | 22,34171 |
| Beverly | 18,00693 | 15,2058 | 1,18 | 0,237 | -11,82588 | 47,83974 |
| Bridgeport | -6,235135 | 10,57863 | -0,59 | 0,556 | -26,98974 | 14,51947 |
| Brighton Park | 0,4407452 | 9,938007 | 0,04 | 0,965 | -19,05699 | 19,93848 |
| Burnside | 20,07474 | 30,14191 | 0,67 | 0,506 | -39,06178 | 79,21125 |
| Calumet Heights | 22,3369 | 27,64993 | 0,81 | 0,419 | -31,9105 | 76,58431 |
| Chatham | 42,43806 | 27,18236 | 1,56 | 0,119 | -10,892 | 95,76811 |
| Chicago Lawn | 21,785 | 16,0954 | 1,35 | 0,176 | -9,793149 | 53,36315 |
| Clearing | -16,30608 | 12,97093 | -1,26 | 0,209 | -41,75421 | 9,142063 |
| Douglas | -28,42925 | 12,4369 | -2,29 | 0,022 | -52,82965 | -4,028853 |
| Dunning | -4,077688 | 12,80102 | -0,32 | 0,750 | -29,19248 | 21,0371 |
| East Garfield Park | 44,72698 | 24,82785 | 1,80 | 0,072 | -3,983682 | 93,43764 |
| East Side | -9,68433 | 13,82572 | -0,70 | 0,484 | -36,80951 | 17,44085 |
| Edgewater | 15,86492 | 9,540946 | 1,66 | 0,097 | -2,853813 | 34,58364 |
| Edison Park | -13,52048 | 14,37394 | -0,94 | 0,347 | -41,72124 | 14,68028 |
| Englewood | 63,32147 | 26,31795 | 2,41 | 0,016 | 11,68732 | 114,9556 |

| | | | | | | |
|---|---|---|---|---|---|---|
| **Forest Glen** | 11,99068 | 12,9056 | 0,93 | 0,353 | -13,32928 | 37,31064 |
| **Fuller Park** | 25,89422 | 27,984 | 0,93 | 0,355 | -29,00859 | 80,79704 |
| **Gage Park** | 6,174958 | 12,49073 | 0,49 | 0,621 | -18,33107 | 30,68098 |
| **Garfield Ridge** | 1,052309 | 13,95592 | 0,08 | 0,940 | -26,32832 | 28,43294 |
| **Grand Boulevard** | -12,41176 | 16,98016 | -0,73 | 0,465 | -45,72575 | 20,90224 |
| **Greater Grand Crossing** | 50,60797 | 26,82744 | 1,89 | 0,059 | -2,025749 | 103,2417 |
| **Hegewisch** | -17,12834 | 15,91606 | -1,08 | 0,282 | -48,35464 | 14,09795 |
| **Hermosa** | -15,78105 | 10,90264 | -1,45 | 0,148 | -37,17135 | 5,609238 |
| **Humboldt park** | 33,74731 | 13,38561 | 2,52 | 0,012 | 7,485593 | 60,00903 |
| **Hyde Park** | 20,22214 | 15,20256 | 1,33 | 0,184 | -9,604313 | 50,04859 |
| **Irving Park** | 1,025098 | 6,541452 | 0,16 | 0,876 | -11,80881 | 13,85901 |
| **Jefferson Park** | -10,44693 | 9,679538 | -1,08 | 0,281 | -29,43757 | 8,543705 |
| **Kenwood** | 12,49222 | 21,13612 | 0,59 | 0,555 | -28,97551 | 53,95994 |
| **Lake View** | 31,10708 | 15,08516 | 2,06 | 0,039 | 1,510963 | 60,7032 |
| **Lincoln Park** | 32,468 | 14,30085 | 2,27 | 0,023 | 4,410646 | 60,52536 |
| **Lincoln Square** | 3,559034 | 7,889229 | 0,45 | 0,652 | -11,91913 | 19,0372 |
| **Logan Square** | 15,80942 | 9,46028 | 1,67 | 0,095 | -2,751051 | 34,36988 |
| **Loop** | 20,70515 | 13,38315 | 1,55 | 0,122 | -5,551735 | 46,96203 |
| **Lower West Side** | -0,6618566 | 9,002786 | -0,07 | 0,941 | -18,32475 | 17,00104 |
| **McKinley Park** | -15,51182 | 12,47167 | -1,24 | 0,214 | -39,98044 | 8,956806 |
| **Montclare** | -25,79328 | 12,39744 | -2,08 | 0,038 | -50,11626 | -1,470303 |
| **Morgan Park** | 24,46292 | 20,97643 | 1,17 | 0,244 | -16,6915 | 65,61733 |
| **Mount Greenwood** | -9,226052 | 14,95679 | -0,62 | 0,537 | -38,57032 | 20,11822 |
| **Near North Side** | -3,9608 | 9,530812 | -0,42 | 0,678 | -22,65964 | 14,73805 |
| **Near South Side** | -23,36093 | 10,47795 | -2,23 | 0,026 | -43,918 | -2,803869 |
| **Near West Side** | 0 | (omitted) | | | | |
| **New City** | 30,06729 | 10,81933 | 2,78 | 0,006 | 8,84046 | 51,29412 |
| **North Center** | 10,75555 | 10,05051 | 1,07 | 0,285 | -8,962904 | 30,474 |
| **North Lawndale** | 45,01507 | 25,07651 | 1,80 | 0,073 | -4,183448 | 94,21359 |
| **North Park** | -3,293066 | 11,84358 | -0,28 | 0,781 | -26,52941 | 19,94327 |
| **Norwood Park** | -0,7364676 | 12,69217 | -0,06 | 0,954 | -25,6377 | 24,16476 |
| **Oakland** | -11,53868 | 26,29524 | -0,44 | 0,661 | -63,12826 | 40,0509 |
| **Ohare** | -27,43785 | 10,23977 | -2,68 | 0,007 | -47,52763 | -7,348067 |
| **Portage Park** | -3,557044 | 10,17769 | -0,35 | 0,727 | -23,52503 | 16,41094 |
| **Pullman** | -1,889191 | 23,5665 | -0,08 | 0,936 | -48,12517 | 44,34679 |
| **Riverdale** | 11,98573 | 25,9521 | 0,46 | 0,644 | -38,93064 | 62,9021 |
| **Rogers Park** | 10,7539 | 10,99642 | 0,98 | 0,328 | -10,82038 | 32,32818 |
| **Roseland** | 45,80211 | 28,65008 | 1,60 | 0,110 | -10,40751 | 102,0117 |
| **South Chicago** | 35,19359 | 19,56284 | 1,80 | 0,072 | -3,187456 | 73,57464 |
| **South Deering** | 12,48298 | 19,00548 | 0,66 | 0,511 | -24,80457 | 49,77052 |
| **South Lawndale** | 12,90604 | 10,87513 | 1,19 | 0,236 | -8,430269 | 34,24235 |
| **South Shore** | 37,56051 | 27,46598 | 1,37 | 0,172 | -16,326 | 91,44702 |
| **Uptown** | 17,43525 | 10,49754 | 1,66 | 0,097 | -3,160251 | 38,03074 |
| **Washington Heights** | 33,15339 | 28,6738 | 1,16 | 0,248 | -23,10278 | 89,40955 |
| **Washington Park** | 38,7659 | 25,67291 | 1,51 | 0,131 | -11,60272 | 89,13452 |
| **West Elsdon** | -14,44351 | 15,27057 | -0,95 | 0,344 | -44,4034 | 15,51638 |
| **West Englewood** | 59,62011 | 27,32729 | 2,18 | 0,029 | 6,005714 | 113,2345 |
| **West Garfield Park** | 57,93981 | 25,9102 | 2,24 | 0,026 | 7,10566 | 108,774 |
| **West Lawn** | -3,548594 | 14,38553 | -0,25 | 0,805 | -31,7721 | 24,67491 |
| **West Pullman** | 47,17659 | 27,06097 | 1,74 | 0,082 | -5,915314 | 100,2685 |
| **West Ridge** | 13,98276 | 7,846188 | 1,78 | 0,075 | -1,41096 | 29,37648 |
| **West Town** | 26,14246 | 11,04235 | 2,37 | 0,018 | 4,478065 | 47,80686 |
| **Woodlawn** | 24,34841 | 24,02368 | 1,01 | 0,311 | -22,78452 | 71,48134 |
| | | | | | | |
| **year** | | | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| **2001** | 2,335331 | 2,25886 | 1,03 | 0,301 | -2,096409 | 6,767071 |
| **2002** | 3,508939 | 2,311354 | 1,52 | 0,129 | -1,025789 | 8,043668 |
| **2003** | 3,511159 | 2,392498 | 1,47 | 0,142 | -1,182769 | 8,205088 |
| **2004** | -2,341146 | 2,496863 | -0,94 | 0,349 | -7,239833 | 2,55754 |
| **2005** | -1,088391 | 2,619556 | -0,42 | 0,678 | -6,227793 | 4,051011 |
| **2006** | 1,336656 | 2,756569 | 0,48 | 0,628 | -4,071558 | 6,744869 |
| **2007** | 0,1016447 | 2,904722 | 0,03 | 0,972 | -5,597234 | 5,800523 |
| **2008** | 3,287026 | 3,055122 | 1,08 | 0,282 | -2,706928 | 9,28098 |
| **2009** | 3,760081 | 3,218439 | 1,17 | 0,243 | -2,554291 | 10,07445 |
| **2010** | 2,807943 | 3,388399 | 0,83 | 0,407 | -3,83988 | 9,455767 |
| **2011** | 3,072926 | 3,499282 | 0,88 | 0,380 | -3,792442 | 9,938294 |
| **2012** | 5,775714 | 3,611761 | 1,60 | 0,110 | -1,310331 | 12,86176 |
| **2013** | 1,505216 | 3,781449 | 0,40 | 0,691 | -5,913746 | 8,924179 |
| **2014** | 2,608489 | 3,931203 | 0,66 | 0,507 | -5,10428 | 10,32126 |
| **2015** | 6,977585 | 4,077349 | 1,71 | 0,087 | -1,021914 | 14,97708 |
| **2016** | 17,93996 | 4,218443 | 4,25 | 0,000 | 9,663649 | 26,21628 |
| | | | | | | |
| **_cons** | 136,2558 | 84,93435 | 1,60 | 0,109 | -30,37998 | 302,8916 |

## OLS and Spatial 2SLS – GeodaSpace

**SUMMARY OF OUTPUT: ORDINARY LEAST SQUARES**

| | | | |
|---|---|---|---|
| **Data set:** | geo_export_e426f717-8227-4798-8332-af2ec8482f22.dbf | | |
| **Weights matrix:** | File: ChicagoWt-Q1.gal | | |
| **Dependent Variable :** | HR2012 | Number of Observations: | 77 |
| **Mean dependent var:** | 20.8849 | Number of Variables: | 9 |
| **S.D. dependent var :** | 23.0781 | Degrees of Freedom: | 68 |
| **R-squared:** | 0.6370 | | |
| **Adjusted R-squared:** | 0.5943 | | |
| **Sum squared residual:** | 14693.905 | F-statistic: | 14.9150 |
| **Sigma-square:** | 216.087 | Prob(F-statistic): | 2.299e-12 |
| **S.E. of regression:** | 14.700 | Log likelihood: | -311.436 |
| **Sigma-square ML:** | 190.830 | Akaike info criterion: | 640.873 |
| **S.E of regression ML:** | 13.8141 | Schwarz criterion: | 661.967 |

| Variable | Coefficient | Std.Error | t-Statistic | Probability |
|---|---|---|---|---|
| CONSTANT | -29.5146060 | 12.4608699 | -2.3685831 | 0.0207042 |
| CrwdHous | 0.9031612 | 0.6838020 | 1.3207933 | 0.1909981 |
| DiabRel | -0.1645418 | 0.1278704 | -1.2867857 | 0.2025324 |
| LoBirthWt | 1.9601490 | 0.7233107 | 2.7099681 | 0.0085088 |
| LungCanc | 0.4999914 | 0.1900838 | 2.6303732 | 0.0105405 |
| OOcc2012 | -0.0248421 | 0.1530815 | -0.1622800 | 0.8715666 |
| Pov2012 | 0.6755164 | 0.3632114 | 1.8598435 | 0.0672335 |
| Tuberc | -0.1204474 | 0.4792192 | -0.2513409 | 0.8023085 |
| Unempl | -0.0374834 | 0.4752213 | -0.0788757 | 0.9373632 |

| | |
|---|---|
| **REGRESSION DIAGNOSTICS** | |
| **MULTICOLLINEARITY CONDITION NUMBER** | 25.616 |

| | | | |
|---|---|---|---|
| **TEST ON NORMALITY OF ERRORS** | | | |
| **TEST** | DF | VALUE | PROB |
| **Jarque-Bera** | 2 | 39.150 | 0.0000 |
| | | | |
| **DIAGNOSTICS FOR HETEROSKEDASTICITY** | | | |
| **RANDOM COEFFICIENTS** | | | |
| **TEST** | DF | VALUE | PROB |
| **Breusch-Pagan test** | 8 | 54.705 | 0.0000 |
| **Koenker-Bassett test** | 8 | 21.341 | 0.0063 |
| | | | |
| **DIAGNOSTICS FOR SPATIAL DEPENDENCE** | | | |
| **TEST** | MI/DF | VALUE | PROB |
| **Lagrange Multiplier (lag)** | 1 | 4.051 | 0.0441 |
| **Robust LM (lag)** | 1 | 5.541 | 0.0186 |
| **Lagrange Multiplier(error)** | 1 | 0.336 | 0.5619 |
| **Robust LM (error)** | 1 | 1.826 | 0.1766 |
| **Lagrange Multiplier (SARMA)** | 2 | 5.877 | 0.0529 |
| | | | |
| **END OF REPORT** | | | |

**SUMMARY OF OUTPUT: SPATIAL TWO STAGE LEAST SQUARES**

| | | | |
|---|---|---|---|
| **Data set:** | geo_export_e426f717-8227-4798-8332-af2ec8482f22.dbf | | |
| **Weights matrix:** | File: ChicagoWt-Q1.gal | | |
| **Dependent Variable:** | HR2012 | Number of Observations: | 77 |
| **Mean dependent var:** | 20.8849 | Number of Variables: | 10 |
| **S.D. dependent var:** | 23.0781 | Degrees of Freedom: | 67 |
| **Pseudo R-squared:** | 0.6584 | | |
| **Spatial Pseudo R-squared:** | 0.6485 | | |

| | Variable | Coefficient | Std.Error | z-Statistic | Probability |
|---|---|---|---|---|---|
| | CONSTANT | -24.7166047 | 11.4747948 | -2.1539910 | 0.0312409 |
| | CrwdHous | 1.1197585 | 0.6277571 | 1.7837448 | 0.0744651 |
| | DiabRel | -0.1262862 | 0.1173082 | -1.0765334 | 0.2816888 |
| | LoBirthWt | 1.6729943 | 0.6664706 | 2.5102296 | 0.0120653 |
| | LungCanc | 0.4578695 | 0.1739282 | 2.6325209 | 0.0084754 |
| | OOcc2012 | -0.0924245 | 0.1413875 | -0.6536966 | 0.5133073 |
| | Pov2012 | 0.2517075 | 0.3594870 | 0.7001855 | 0.4838115 |
| | Tuberc | 0.0647909 | 0.4413294 | 0.1468086 | 0.8832831 |
| | Unempl | -0.2539525 | 0.4392699 | -0.5781241 | 0.5631804 |
| | W_HR2012 | 0.5050583 | 0.1663404 | 3.0362947 | 0.0023951 |

| | |
|---|---|
| **Instrumented:** | W_HR2012 |
| **Instruments:** | W_CrwdHous, W_DiabRel, W_LoBirthWt, W_LungCanc, W_OOcc2012, W_Pov2012, W_Tuberc, W_Unempl |

| | | | |
|---|---|---|---|
| **DIAGNOSTICS FOR SPATIAL DEPENDENCE** | | | |
| **TEST** | MI/DF | VALUE | PROB |

| | | | |
|---|---|---|---|
| **Anselin-Kelejian Test** | 1 | 1.424 | 0.2327 |

**END OF REPORT**