A Thesis

entitled

Modeling Gentrification on Census Tract Level in Chicago from 1990 to 2000

By

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Gentrification refers to the changes that appear when wealthier people acquire property in low income and working class communities. My thesis uses decennial data sets from in the City of Chicago to examine some of these previously omitted or understudied aspects of this issue. Particular attention has been paid to each census tract’s gentrification situation and the socio-economic characteristics such as income level and other demographic characteristics.

The study begins with statistical analysis, identifying gentrified census tracts in Chicago in different time periods. Classification models and stepwise discriminant analysis are used to explain the interaction between the likelihood of gentrification and socio-economic characteristics.

The intent is to discover the socio-economic characteristics are closely related to gentrification patterns in the city. The variables used in the study falls into three categories: social and economic data, such as median household income for each census tract, population data; such as the percentage of population who has a professional job; and the housing data, such as the occupied housing units. The result shows how gentrification has spread in Chicago from 1990 to 2000, and distinguishes which
variables have the most significant influences on identifying gentrification. The model is evaluated by comparing the statistical results to the real world events. The most interesting part is to discover the evidence in real world that supports the results of the discriminate model.

This study not only contributes to the literature and methodology involved in indentifying gentrification, but also provides a better understanding of the relationship between socio-economic characteristics and gentrification, and will assist making more appropriate policies to deal with the problems of gentrification.
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# Table of Contents

An Abstract of .......................................................................................................................... iii
Acknowledgments .................................................................................................................. v
Contents .................................................................................................................................. vi
List of Tables ............................................................................................................................ viii
List of Figures ........................................................................................................................... ix
List of Abbreviations ................................................................................................................. x

1 Introduction .......................................................................................................................... 1
   1.1 Problem Statement ......................................................................................................... 1
   1.2 Objectives ...................................................................................................................... 2
   1.3 Study Area ..................................................................................................................... 3

2 Literature Review .................................................................................................................. 6
   2.1 Gentrification ................................................................................................................. 6
      2.1.1 Definition of Gentrification ................................................................................... 6
      2.1.2 Producing Gentrification ..................................................................................... 8
      2.1.3 New patterns of Gentrification ............................................................................. 11
      2.1.4 Future of Gentrification ....................................................................................... 14
   2.2 Inner City Change in Chicago City ............................................................................. 15
   2.3 Modeling Gentrification in United States ................................................................. 18

3 Methodology .......................................................................................................................... 25
3.1 Datasets ................................................................................................................................. 25
  3.1.1 Variable .......................................................................................................................... 26
3.2 Regression Part .................................................................................................................... 27
  3.2.1 OLS regression .............................................................................................................. 27
  3.2.2 Discriminant Analysis .................................................................................................. 28
  3.2.3 Stepwise Discriminant Analysis ................................................................................. 30
3.3 Data process ....................................................................................................................... 31

4 Results and Discussion ............................................................................................................ 34
  4.1 Result ................................................................................................................................. 34
  4.2 Evaluation of the model (internal statistics) ...................................................................... 41
  4.3 Evaluation of the model (comparison to the real world events) ........................................ 48
    4.3.1 Note General Pattern ............................................................................................... 48
    4.3.2 Identify Potential Errors .......................................................................................... 57

5 Conclusion ................................................................................................................................. 61
  5.1 Conclusion ......................................................................................................................... 61
  5.2 Future Study ...................................................................................................................... 63

References .................................................................................................................................... 66
List of Tables

3.1: Variables Table .......................................................................................................... 27

4.1: Classified Result Table .............................................................................................. 37

4.2: Median Social and Economic Data of the Four Categories ............................................. 39

4.3: Testing the equality of group means among the pre-defined classes ........................ 42

4.4: The nine final variables selected into model ............................................................. 44

4.5: F statistic values and correspondent p-values ............................................................ 45

4.6: Eigenvalue of stepwise discriminant analysis ............................................................. 46

4.7: Wilks’ Lambda for three discriminant functions ......................................................... 47

4.8: Standardized Discriminant Coefficients ................................................................. 47

4.9: Variables Table of Census Tract 7206 and Median of Census Tracts in Chicago City ........................................................................................................................................... 58
List of Figures

1-1: Census Tracts Map of Chicago ................................................................. 4

1-2: Population Change Map of Chicago on Census Tract Level ...................... 5

3-1: Poor and Rich Area Distribution Map Of Chicago ........................................ 33

4-1: Prior-Class Gentrification Map of Chicago .................................................. 35

4-2: Discriminant Result of Gentrification in Chicago .......................................... 36

4-3: Percentage of Change Pattern ...................................................................... 38

4-4: Scatter plot of data from four categories ...................................................... 48

4-5: The Neighborhood Map of Chicago ........................................................... 49

4-6: The Neighborhood Map of Chicago ........................................................... 50

4-7: Image of Cabrini-Green ............................................................................... 56
List of Abbreviations

CHA.................................................................Chicago Housing Authority
HMDA............................................................Mortgage Disclosure Act Datasets
HOPE VI..........................Home Ownership and Opportunity for People Everywhere
HUD.................................The Department of Housing and Urban Development
LDA.............................................................Linear Discriminant Analysis
OLS.............................................................Ordinary Least Square
TIGER.............. Topologically Integrated Geographic Encoding and Referencing system
Chapter 1

Introduction

1.1 Problem Statement

There are no available survey results of gentrification for Chicago, and we do not know which census tracts in Chicago have been gentrified from 1990 to 2000. Moreover, we also cannot conclude much about the impacts of the gentrification in each census tract and neighborhood during that decade. From the definition and purpose of gentrification, we can state the gentrified areas should have a larger increase in middle class population, household income and the number and percent of occupied housing units. I attempt to determine if these changes have actually occurred in Chicago, and to provide solid statistical data on the effects of gentrification during the 1990s. We have no evidence to convince people that gentrification can increase the quality of the neighborhood, such as increase of the income, breaking the racial segregation, and decreasing the crime rate. Nor do we even know precisely where gentrification has occurred. The study should reveal the relationship between gentrification and range of social and economic changes.

Gentrification refers to the changes resulted from wealthier people acquiring property in low income and working class communities. In Chicago area, during the
1990s, significant portion of the poor area of the city were housing projects managed by the Chicago Housing Authority (CHA). And since the 1990s, the HOPE VI has become a major force of gentrification in some cities in the United States, especially Chicago. From 1990 to 2000, the inner city of Chicago totally changed. The analysis of the CHA’s redevelopment plans funded through the HOPE VI program will be helpful for the evaluation of the gentrification in Chicago.

It is policy makers’ interest to develop a simple method of identifying gentrified areas using tract-level census data. By applying multivariate statistical models, government agencies can distinguish gentrified areas from other types of central-city neighborhood, and also begin to evaluate some of the effects of HOPE VI in Chicago to discover who has benefited the most. A better way to measure the long term impacts of reinvestment and social changes is within the context of the entire central-city housing market in Chicago.

This study will shed light on these questions: What are the spatial characteristics of the gentrification areas in Chicago? How can we distinguish gentrification at census tract level based on the secondary data such as Median household income, population, education and so on? Does the model works well for this problem? What are the leading variables which can distinguish the core gentrified area from other communities?

1.2 Objectives

My objectives in this research are to:

1. Review articles on related studies;
2. Identify the characteristics and processes of gentrification in Chicago from
1990 to 2000

3. Identify the spatial characteristics of the gentrification areas in Chicago
4. Construct a database of small-area estimates from other decennial census data
5. Use discriminant analysis to distinguish gentrified areas from other urban neighborhoods.
6. Evaluate the model from the statistical result and compare it to the real world gentrification events.
7. Discuss the potential errors in the model.

1.3 Study Area

The study area I selected is the City of Chicago in Cook County, Illinois. The City of Chicago seems to have undergone significant neighborhood changes from 1990 to 2000, which include gentrification and demolition and renovation of public housing. In the whole Cook County, there are approximate 1300 census tracts, compared with about 800 census tracts in the City of Chicago. (Figure 1-1) I am focusing on the City of Chicago and not the larger metropolitan area because previous studies on which I hope to build my research have focused on the city (Wyly and Hammel 1998, 2000, 2004). In addition gentrification is largely an urban event and does not have significant effects on the suburban portions of Cook County.
Considering the boundaries of each census tract may change between 1990 and 2000, I constructed a new map for the ten years in order to rectify the changing boundaries of the tracts. In 1990, there are 281 census tracts in Chicago with a median household income higher than the city-wide level. These census tracts are defined as the wealthier areas which cannot be the targets of the gentrification activity, because they never experienced decline. All the rest area could potentially be gentrified. The population of Chicago had decreased by more than 100,000 from 1990 to 2000. Comparably, the numbers of census tracts in the city decreased as well. Some census tracts in Chicago did experience an increase in population between 1990 and 2000. The map of the population
change on census tract level (Figure 1-2), shows the census tracts with increasing population from 1990 to 2000 are mostly locate in the southern part of city, and comparably, the census tracts which lost residents are most highly concentrated in the center of the city, especially the downtown area.

Figure 1-2: Population Change Map of Chicago on Census Tract Level
Chapter 2

Literature Review

2.1 Gentrification

2.1.1 Definition of Gentrification

The British sociologist Ruth Glass created the term — gentrification” about fifty years ago. She noted that is as a visible urban process that involves the transformation of a working class or vacant area of the central city into middle class residential and commercial use. Moreover, gentrification is a political and policy-relevant issue, and a challenge to the traditional theories of social structure. More recently, gentrification has been seen as an economic, culture, political, social and transformation, and the global leading edge of neoliberal urbanism. In the early years, Neil Smith defined the gentrification as —the process by which working class residential neighborhoods are rehabilitated middle class homebuyers, landlords and professional developers.” (Smith 1982, p.139) However, at the same time, some scholars believed that gentrification is the movement of middle class families into urban areas causing property values to increases and having the secondary effect of driving out poor families. (Oxford American Dictionary, 1980)
The US Department of Housing and Urban Development defines gentrification as “the process by lower-income households undergoes revitalization or reinvestment through the arrival of upper-income households” (US Department of Housing and Urban Development, 1979, P.4). Clay (1979) was the first person who focuses on a stage model of gentrification. His study was based on observations and data from a number of American cities, which have more than seventy years’ history. Clay’s model classified and predicted the four stages of gentrification from pioneer gentrification to maturing gentrification. How to study gentrification? We get various different answers to this question because the scale and scope of gentrification area presented are different. So my models here are just one of the approaches and scales that urban geographers used to measure and identify for gentrification. As the deindustrialization and urban water fronts, hotel, convention, retail and restaurants’ redeveloping, there were no liberate middle class spaces in the central city that can be used to construct.

The classical gentrification is the process of working class housing turning into middle class housing, for instance, Park Slope in New York City. Park Slope was one of the first residential suburbs in New York City. And in 1880s, more and more middle class people such as merchants, lawyer and doctors, moved in this neighborhood. In the 1910, suburbanization began to affect Park Slope, and middle classes moved to the suburb of Flatbush. So in the following decades, the Black and Hispanic population significantly increased in this neighborhood. In 1965, pioneer gentrifiers began to move into Park Slope, but in fact a matrix of group. In 1966, a group called the Park Slope Betterment Committee bought houses and began to advertise them through brokers to white collar
workers, with the purpose of stabilizing the area. In the mid-late 1980s, the elite housing on Park Slope’s upper slope was pretty much thoroughly gentrified. (Squires 1992)

2.1.2 Producing Gentrification

Hackworth and Smith (2001) built a stage model of gentrification with four periods: sporadic gentrification, the anchoring of gentrification and gentrification returns. The reasons for the two transitions were gentrifiers buying property and gentrification slowing down. The first-wave period appeared in-between 1968 and 1973, and then, from 1978 to 1988, the second wave gentrification occurred. The last one began in 1994. Due to the government’s encouragement of gentrification, the fourth wave of gentrification has bloomed since 2001.

In 1970s, “back to the city” became the mainstream view of gentrification, and it was seen as reversal to the trend brought about by deindustrialization of the urban center and suburbanization. Then the dominant perspective in urban studies became a combination of social and spatial theories of the Chicago School of Sociology (Smith 1979). As the new sources of data and statistical method developed, the urban researchers got more detailed simulations and predictions basing on the neoclassical model. So gentrification can be predicted with the standard approach by the revised statistical model.

Because of the “highest and best use” theory, the cycle of depreciation and disinvestment brought about increasing destruction of inner city neighborhood. Moreover, disinvestment was difficult to be detected. Thus, the poorer residents can only choose to move to the neighborhood after disinvestment. In other words, the gap between capitalized land rent and potential land rent became the new topic and focus point of
gentrification. The rent gap is based on theories first published by Neil Smith in 1979. It is essentially a measure of the difference in a site's actual value and its potential value at 'best use.' The rent gap explains gentrification as the product of investment and disinvestment, so urban scholars concentrate on how to measuring the rent gap of several different cities by applying different methods. Obviously, the key point in gentrification of this period is the measuring method of the two types of rent. Eric Clark (1988) used long-term changes of observations to present the empirical results. Dan Hammel (1999) combined tax assessments to Eric Clark’s approach, and found that there is a linkage can be seen in the rent gap and gentrified area. So the rent gap theory was able to explain how the gentrification leads to the uneven urban development from local scale to the global. Above all, the summary of problems which associated with production of gentrification included the measurement and verification problems of the rent gap, the application of neoclassical model and theory on urban studies and the linkage between local cases of gentrification and global capitalism.

The rent gap has been the inextricably linked with for global uneven development and circuits of capital, and identified as the leading edge of uneven urban development has expanded dramatically inside gentrifying cities. Gentrification now receives more explicit governmental support, by subsiding large developers and attracting more and more individual residents. Urban policies become much more vicious in terms of any issue believed to enhance property values. Duany (2001) stated that gentrification rebalanced a concentration of poverty by providing the tax base, rub-off work ethic and the political effectiveness of a middle class. Unfortunately, the tax base benefits of gentrification invariably subsidize more the institutions that serve them. The production
explanation of gentrification in American cities includes the Neil Smith's rent gap thesis, theory of uneven development, methods of measuring the rent gap and predicting gentrification.

Through 1990s, the urban geographers interested in consumption-side theories tried to identify: who are the gentrifiers, where do they come from, and why they only chose to live in central city neighborhoods? David Ley and Chris Hamnett tried to explain the process of gentrification from the perspective of consumption. Ley (1980) began to understand gentrification from the perspective of postindustrial city. Ley argued that gentrification represented a new phase in urban development where consumption factors expanded. About twenty years later, Chris Hamnett put forward an advanced theory based on the postindustrial theory named “professionalization thesis”. Moreover, Hamnett’s prediction of further professionalization evidence from the 1991 UK Census was indeed accurate. From Hamnett’s view, gentrification is a product of transformation of cities from second industry centers to centers of business services. These two theories are tightly linked, and have been proven very important in consumption explanation during the process.

Then the scholars defined the new middle class from aspects of politics, education, and gender. Some of them applied the data from Canada cities to identify the educational situation of the gentrifiers. “Gentrifiers are usually well educated”, this is the conclusion from Butler's (2003) research, and they have shown how social relations gentrified neighborhoods are often governed by the performance of local schools. For the gender's part, Markusen (1981) recognized women were playing an active and important role in bringing about gentrification. The socialist-feminist urban geographer, Rose (1989),
played a significant role in identifying the linkage of gender and gentrification. She emphasized the growing importance of both single women professionals and dual-earner couples in gentrification. She also was one of the first scholars who noted the term of “gentrifiers” as a differentiated group. As the literature on gender and gentrification grew, urban geographers thought the explanation of who were the gentrifiers should focus on the gender and class division; what is more, the gender division may play a role of greater importance than the class division. Race and ethnicity also were treated as an important part to identify who the gentrifiers are. The existence of black gentrification can be as problematic as traditional white gentrification in term of displacement.

2.1.3 New patterns of Gentrification

Gentrification is a process that mutates frequently. An interesting result of this constant change is rural gentrification, which concentrated on the linkage between new middle class settlement and transformation of the rural landscape. Cloke and Little (1990) thought middle class population move into rural areas instead of lower class families’ migration. A more recent derivative is super-gentrification, which is a further level of gentrification and involves a higher financial investment in the neighborhood than previous waves of gentrification. Loretta Lees defined it as "By super-gentrification, I mean the transformation of already gentrified, prosperous and solidly upper-middle-class neighbourhoods into much more exclusive and expensive enclaves. This intensified regentrification is happening in a few select areas of global cities like London and New York that have become the focus of intense investment and conspicuous consumption by a new generation of super-rich ,financiers” fed by fortunes from the global finance and
"Studentification engenders the distinct social, cultural, economic and physical transformations within university towns, which are associated with the seasonal, immigration of HE students. At the conceptual level, processes of studentification connote urban changes which are tied to the recommodification of 'single-family' or the repackaging of existing private rented housing to produce and supply houses in multiple occupation for HE students" (Darren Smith, 2005, pp.73) With the gentrification theory's booming, the new terms such as Commercial gentrification and Tourism gentrification also became well-known to the urban geographers. On the other hand, gentrification became a global process because the progress of globalization was faster and faster. I emphasize the super-gentrification here because this derivative would have a high chance to appear in the gentrification process in Chicago. The famous examples of super-gentrification are London and New York City. The prefix –super” means that this is not only a higher leveled gentrification, but also projects on the already gentrified neighborhood. Super-gentrification is an interesting phenomenon in that it goes against the stage model of gentrification which used to predict the process of gentrification. (Lees, 2000, 2003; Butler and Lee 2006)

Neil Smith (2002) was the first gentrification scholar to focus on the relationship between globalization, neoliberalism and the contemporary gentrification. We preferred to believe that gentrification should be a positive result of a healthy real estate market, and
thanks to the intense economic competition, cities now must be sophisticated entrepreneurs. He also argued that gentrification has evolved from urban process in just few cities to a popular widespread global urban strategy. There is an obvious gap in the gentrification development between Global South and Global North. The neoliberalism appeals to a fundamentally universal rule of the individuals and market. However, in the Global South, the political movement always impacted the expanding of neoliberalism. So the contemporary geographers of gentrification need to consider the national context and the interaction of components of neoliberal policy. Some scholars thought the global gentrification presented a new form of urban colonialism, which was caused by the privileges‘ wealth and power. The similarity and diversity between gentrifying classes and transnational elite co-existed and both of them are highly educated and have a professional job. On the other hand, they have different served interests. Lee found three possible mechanisms in 2006 which may be the result of gentrification cascaded down on the urban hierarchy, including the economy, policy and culture.

The period of gentrification I focuses on in this research is 1990 to 2000, which belongs to the third-wave gentrification (K. Shaw, 2005). In this decade, the characteristics of gentrification are –“interventionist government working with the private sector to facilitate gentrification” (K. Shaw, 2005 p.183). The third wave of gentrification was described as recessional pause and subsequent expansion beginning in the mid-1990s. The wave focused on the reinvestment in disinvested inner city areas. The broad economic trends have driven gentrification deeper into the heart of disinvested city neighborhood. At the citywide scale, Lee noted that within a single city, gentrification in a similar time period has different geographic patterns on the same site.
2.1.4 Future of Gentrification

Gentrification has both positive and negative influence on the neighborhood. The positive aspects include stabilization of declining areas, reduced vacancy rates and suburban sprawl, increased local fiscal revenues and social mix, encouragement and increased viability of further development. On the other hand, gentrification possibly causes displacement through rent increase, community resentment, and loss of affordable housing, homelessness, increased cost and changes to local services, and housing demand pressures on surrounding poor areas. In the United States, HUD’s HOPE VI (Home Ownership and Opportunity for People Everywhere) program has been used to socially mix public housing in order to break the segregation between poor people and wealth people. Bryne (2003) stated “The success of HOPE VI in a gentrifying neighborhood actually represents the first successful government program to integrate residential neighborhoods by income.” (Bryne, 2003 p.429) Some Scholars were concerned about how the gentrification caused the displacement which means working-class and minority residents are steadily priced out of gentrified area.

Wyly listed some methods to predict future gentrification situation: “we can follow the empirical path of researchers who develop baseline measures and pursue subsequent follow-up analysis, more explicit theoretical consideration of future trends associated with gentrification”. (Lees, Wyly and Slater, 2007, p.240) Gentrification will continue along with uneven development, disinvestment, and persistent central-city poverty. Gentrification received more popular attention in recent years and statistics became news headlines. Since 1999, the number of headline about gentrification increased much faster than before. We have to admit there are difficulties for
contemporary movements in resisting gentrification, protecting against displacement, and encouraging a more socially form of neighborhood change not geared to the interests of those who benefit financially from such changes.

2.2 Inner City Change in the City of Chicago

Chicago’s first public housing projects were opened a year right after the Chicago Housing Authority and were enabled by the Federal Housing Act of 1937. The early story of public housing in Chicago was a success. The nation’s largest public housing project built at the highest density of the Chicago when the public housing always concentrated on the low density areas. The original aim of CHA was to provide housing for families.

During the Great Migration, African American population of Chicago increased dramatically to comprise over 12 percent of whole city by the 1940s. The extreme segregation enforced in the city created a substantial housing shortage for African American (Hammel 2006). The housing situation worsened because of the increasing African American population and buying power in a context of general housing scarcity. Moreover, the prevalence of race and class segregation ran throughout from the 1920 period of gentrification to the 1960s in Chicago. So the gentrification in that period brought a paradox that the new projects made the residents whose houses were gentrified more isolated from the middle class people than ever before. And at that time, significant entities at federal level and a broad range of private organizations pushed forward higher levels of integration in federal housing projects. Based on this situation, the CHA developed the now famous map of selected sites on an open land throughout the city though the sites should be built on the low density housing areas in order to synthesize house poor individuals and families of all races. Chicago was a good example for other
American cities for how to use public housing to promote segregation. During the 1950s, the housing shortage in the African American community was dire and led to rapidly declining housing conditions, and the 1960s were a period of decent funding for massive new construction. Resistance to problematic housing policies on the part of the poor was limited by the overwhelming need to escape horrendous housing conditions, this pattern happened in Chicago twice, in 1950s and early 1990s.

“The early 1970s were a crucial time for public housing and the incompetence and corruption in the CHA during this period was easily as large a factor in the failings of public housing as poor architecture and design.” (Hammel, 2006, p.176) Despite the displacement, the segregation and other negative influences of public housing. At that time, the new projects were greeted with enthusiasm and optimism. By the 1980s, public housing in the United States was widely viewed as a failure. The difficulties faced by the poorest Americans were well known in the early 1990s. Then the policy of poverty de-concentration had the concentration of destroying the poor.

Housing Opportunities for People Everywhere (HOPE VI) was intended to fundamentally change public housing. HOPE VI was the most highly funded public housing program in over two decades. After the HOPE VI was enacted in 1992, income mixing became a feature of the program. In the mid 1990s, neighborhoods were transformed during three decades of gentrification and the neighborhoods surrounding a number of public housing projects in Chicago were being gentrified. By 1999, the CHA had received nearly $160 million from six HOPE VI grants to revitalize parts of Cabrini Homes Extension, ABLA Homes, Henry Horner Homes, Rockwell Gardens, and Robert Taylor Homes. Plans for ABLA and Henry Horner Homes on the city’s gentrifying near
west side called for a mix of moderate income units. Cabrini Green, located west of the North Michigan Avenue corridor had the highest gentrification pressures. Thus, there were some negative aspects of the HOPE VI, such as using the capital to subsidize the construction of market rate housing in the hottest housing market.

Through 2003, there were $395 million had been spent on demolition, only 15 percent of the whole funding of HOPE VI. The CHA secured $83.4 million to demolish 12,449 units and nearly $358 million in revitalization throughout 2003. (Popkin, 2004) Some residents moved out of public houses and entered the rental market with Housing Choice Vouchers, and both failure and success existed. Chicago is experiencing a massive displacement of former public housing residents. And because of the residents who remained in the public housing, the revitalization and new construction was significantly delayed with creating relocation problems, such as the Cabrini Green redevelopment project. Only 244 new apartments were constructed through early 2005, and Cabrini residents filed a lawsuit to force the CHA to stop the destruction of buildings it planned to demolish in 2005. (Grossman, 2005a)

The CHA was unable to deal with the exceedingly tight housing market, and, because of the high cost of living in Chicago, the segregation situation became a deeper problem than during the early period of public housing projects (Lawrence, 2004). After all, the public housing residents were not only the ones to benefit from the CHA, but the local real estate investor and the middle class residents were also benefited because of being surrounded by the new areas and projects. Gentrification changed the inner city of Chicago totally, no matter from the physical aspect or the mental aspect of the neighborhood. In Chicago and a handful of other major American metropolitan areas, the
entire context of the inner city is changing. Three decades of gentrification, often fueled by direct public subsidies, have created a place where there is little space and less tolerance for the poor. The massive relocation of residents, even if temporary, has made the process of the gentrification of Chicago’s inner city more brutally efficient.

Chicago witnessed an increase of population and housing values during the 1990s. Chicago grew by roughly 4 percent in the 1990s reaching 2.9 million people in 2000. The price of homes increased one-quarter during the late 1990s, while the number of homes bought increased by 30 percent. The accelerated housing market did not happen uniformly across neighborhoods throughout the city, however. Neighborhoods bordering Lake Michigan north of the central business district and neighborhoods immediately south and west of the downtown area appeared to drive the city’s overall housing market gain. Neighborhoods located on the far south and west sides—historically African American and poor—continued to experience neglect during the 1990s (Levy, Comey, Padilla 2006).

2.3 Modeling Gentrification in United States

Hammel and Wyly (1996) tried to apply a combination of field work and modeling census data to find the gentrification frontier, as Smith (1996, p.189) defined “a very sharp economic line in the landscape. Behind the line, civilization and profit-making are taking their toll; in front of line, savagery, promise and opportunity still stalk the landscape.”

Smith (1996) maintained that the frontier of gentrification was more political than economic; however, scholars are still discussing the methods of defining the frontier of gentrification. In the case of Chicago, gentrification began at the Near North Side near
downtown, instead of the South Side, poorest area of the city (Hammel, 1999). However, in the past few years, the CHA used the federal funds to expand gentrification around all the sides of the downtown core.

For more urban scholars, gentrification is more than an economic and demographic change. Some state it as a reconstruction of the inner city (Wyly and Hammel, 2005), and others insist this process as a re-urbanization (Buzar, 2007). When people focus on the relationship between gentrification and racial diversity, they may ascribe the racial diversity as the result of gentrification.

Scholars also focused on the fortunes of poor neighborhoods in United States. They analyzed all the poor census tracts from 1980 to 1990 and found in that period concentrated poverty rose quickly (Galster and Quercia, 2003).

The early stage models of gentrification developed in the 1970s and 1980s in order to predict and stimulate the tracking of gentrification in the U.S. Clay (1979) produced one of the first major studies in the gentrification field and developed the first model for gentrification, dividing the process into 4 stages.

Gentrification is a social and economic phenomenon, so Hammel and Wyly (1996) wanted to find a simple method to classify the situation of each structure. Based on the 24 criteria, they classify for each building in gentrifying areas of Minneapolis-St. Paul in 1996. They put each building into one of three categories: improved, unimproved, and new. They then use 13 variables from the tract level reports of the U.S. Census of Population and Housing in a discriminant analysis. The variables include median household income, change in median household income and so on. Moreover, they employ different variables for the three different decades of their analysis. Finally, they
figure out that it is difficult to distinguish gentrification from urban housing redevelopment. After this research, they continued to focus on the modeling of gentrification from 1960 through 1990 in Chicago city, Milwaukee and Washington D.C in 1998 (Wyly and Hammel 1998). They listed three factors that establish the parameters for gentrification such as metropolitan employment structures, public sector actors‘ influence on the supply of new commercial and housing market condition. Metropolitan employment structure and downtown development trends influence the demand for gentrified residential settings by high-wage white-collar workers. The varied roles of private and public sector actors influence the supply of new commercial, retail, and residential development. Housing market conditions at the scale of the city and metropolitan area mediate the interaction of supply and demand side processes of gentrification.

Wyly and Hammel (1998) developed four categories of census tracts: poor, non-gentrified, fringe gentry and core gentry through field surveys. The non-gentrifiable areas were areas that had never declined; the poor areas were those that had dropped below the citywide median income and could be gentrified; the fringe areas were partially gentrified and the core areas were highly gentrified. Employing stepwise discriminant analysis with some social-economic data, they classify the non-gentrified tracts regions and poor tracts failing to attract reinvestment parts.

The quantitative gentrification measures have relied mostly on census data. Even if the results may have several limitations, this method still is the major way to evaluate gentrification quantitatively (Hammel and Wyly 1996). Freeman (2005) also developed a model to classify gentrified and non-gentrified neighborhoods. He preferred to induce a
census tract that was located in the central city or had median household income below the 40 percentile of the metropolitan area as the example of definition gentrification.

Some urban scholars chose the city of Portland, Maine as their study area for defining the frontier of gentrification. (Heidkamp and Lucas, 2006) They selected field survey as their first step of analysis, similar with Hammel and Wyly (1996). They also have 4 categories for blocks: not gentrified with high status, non gentrified-poor, gentrification frontier and gentrified. The non gentrified-poor blocks refers to the blocks could be gentrified but show no sign of reinvestment now. The frontier category includes block groups where the dwelling displays at least some indicators of physical upgrading. They have three study periods, 1980-1990, 1990-2000 and 1980-2000. And for each period, they use different variables which include change in the percentage of the population living in owner-occupied housing, change in household median income, and so on. After the priori classification of block groups, they employ stepwise discriminant analysis to evaluate census data’s ability which can distinguish the four categories of block groups. The examination of the percentage of the block groups correctly classifying each neighborhood type should be conducted to identify the frontier of gentrification. By reanalyzing the misclassified block groups, they can define and identify the frontier of gentrification more clearly. From their results, I think it is possible of using available US Census Block Group Level data and a field survey to identify a fragmented gentrification; therefore, we can classify gentrification statuses of neighborhoods more precisely.

By modeling the demand and supply side of housing stock, Wyly and Hammel (2000) found that the three decades of national and local changes in housing markets have significant influence to the demand near Chicago’s Loop. They also figure out the
changes of housing finance and federal regulations have proceeded in the context of a resurgence of middle-class demand in the inner-city in Chicago.

Some scholars want to find the relationship between gentrification, social mix, and social polarization in Canada’s three largest cities (Walks and Maaranen 2008). They attempt to apply the Wolfson index to measure the polarization in the cities, and the index includes the exponential measure and Gini concentration ratio. They also concerned about the levels of ethnic mix and immigrant concentration in the process of gentrification. Moreover, they employ the Simpson index of ethnic diversity as a variable in the calculation. The result shows the income inequality and polarization increases the overall in gentrifying areas. Many gentrified neighborhood in Toronto and Vancouver lose their immigrant people, however, in Montreal, the result is totally different. In their conclusion, they fail to find the evidence to prove that the gentrification is leading to greater levels of social mix, but they convince us the gentrification actually deepens the polarization. Clearly, the relationships between these three phenomena are complicated and highly contingent on policies in the neighborhoods.

Wyly and Hammel want to map the new inner city in 2004 by using the census reports from 1960 to 1970. The consulting results, calculating outcomes of discriminant analysis model based on 1970, 1980, 1990 census tract data and finalizing the neighborhood taxonomy on the basis of fieldwork. In the modeling of segregation and discrimination, they employ the Ordinary Linear Estimates to evaluate these arguments from dynamics of the demand and supply sides of the residential mortgage credit market. In the end, they announce the significant link between gentrification and worsened
processes of racial and ethnic discrimination to be the gentrification articulated in the
"whitening" of the neighborhood.

Papachristos and Smith (2001) attested to examine the relationship between
gentrification and neighborhood crime rates in Chicago from 1991 to 2005. Some
scholars maintained the gentrification frequently invokes crime rates. They focused on
using the number of coffee shops in a neighborhood as an indicator of gentrification
instead of the census data in order to support their decision. They listed some evidence
that related to the appearance of coffee shops as a meaningful representation as
neighborhood change. For dependent variables, they selected the annuals counts of
homicides and street robberies. They employed Principal Component Factor Analysis to
convince us the Coffee Shop Variable can represent the changes of neighborhood
structure. The results of modeling suggest that those neighborhoods experiencing
gentrification also experienced a greater decline than expected in homicide and robbery.
In conclusion, they answered the question that experienced neighborhoods brought more
coffee shops, and moreover, more coffee shops meant a decline of homicide in the
neighborhood. Therefore, gentrification did not increase the crime rate.

Galster and Quercia (2003) use the Underclass Database and employed logistic
regression to classify neighborhoods into one of the three categories. They present five
sets of factors such as using percent change in total population to present the strength of
economy in the analysis. They conclude that the racial composition is unrelated to the
poverty of a neighborhood. Continued poverty is not the only or even most likely fate for
poor neighborhoods, but it also depends on both local and regional context.
Freeman (2008) attempted to compare socioeconomic diversity in gentrifying neighborhoods with some neighborhoods without gentrification. He used the work of Wyly and Hammel (2005) to measure a neighborhood as gentrified and non-gentrified by calculation based on the census data, and then he tried to link the neighborhood characteristics to gentrification status. He maintained the statement that there was no significant evidence to support the relationship existing between gentrification and segregation. About the conclusion, he insisted gentrification had not invoked the racial diversity on the neighborhood level. However, on the city level, he found some evidences that could prove the relationship between them.
Chapter 3

Methodology

3.1 Datasets

To identify the characteristics and process of gentrification in Chicago from 1990 to 2010, I downloaded the Census data and US Census Tract Level data from the website of US Census Department. Then I analyzed them by using the works of Freeman (2005), Hammel and Wyly (1996), and Headlamp and Lucas (2006) to figure out what census data could be used in measuring the gentrification. The closet measurable unit to an urban neighborhood is the census tract, which the Bureau of Census defines as "a relatively homogenous area with respect to population characteristics, economic status, and living conditions with an average population of 4000."

Simple descriptive analysis is conducted after data cleaning to describe the distribution of gentrification in Chicago from 1990 to 2000. The first step is calculating the gentrification values of the neighborhood blocks, and then completing the classification based on the values. Moreover, all the cases are then aggregated at the census tract levels, and then standardized into the gentrification rates. Gentrification rates during this period are classified into 4 categories (core gentrified area, fringe gentrified, poor, non-gentrified, Hammel and Wyly 1996) and visualized in a thematic map.
To identify the spatial characteristics of the gentrification areas in Chicago, I need to do the classification of the census tracts in Chicago. When I get the map of the gentrification neighborhoods, I can conduct some spatial analysis to find the characteristics of them. I will construct a database of small-area estimates from other decennial census and use discriminant analysis to distinguish gentrified areas from other urban neighborhoods to identify who have benefited most from 1990 to 2000.

The variables we will use in the discriminant analysis include Median household income, change in median household income, employ persons, percentage of population with bachelor degrees, median rent, change in median rent, percentage of workers in professional occupations, the change of it and so on.

The data I used is the decennial database from US census Bureau. This data type is secondary data. In this part, I decided the 16 variables which were treated as two parts should be concluded in the discriminant model.

3.1.1 Variable
Table 3.1 Variables Table

<table>
<thead>
<tr>
<th>First Part</th>
<th>Second Part</th>
</tr>
</thead>
<tbody>
<tr>
<td>Persons</td>
<td>Change of Persons</td>
</tr>
<tr>
<td>Percentage of the person who has a Bachelor degree or over (/over 25+ population)</td>
<td>Change of Percentage of the person who has a Bachelor degree or over (/over 25+ population)</td>
</tr>
<tr>
<td>Employed Persons</td>
<td>Change of Employed Persons</td>
</tr>
<tr>
<td>Percentage of Professional Job (/Employed 16+)</td>
<td>Change of Percentage of Professional Job(/ Employed 16+)</td>
</tr>
<tr>
<td>Occupied House Unit</td>
<td>Change of Occupied House Unit</td>
</tr>
<tr>
<td>Median House Value</td>
<td>Change of Median House Value</td>
</tr>
<tr>
<td>Median Contract Rent</td>
<td>Change of Median Rent</td>
</tr>
<tr>
<td>Median Household Income</td>
<td>Median Household Income</td>
</tr>
</tbody>
</table>

3.2 Regression Analysis

3.2.1 OLS regression

A general OLS model is expressed as:

\[ Y = X\beta + \varepsilon \]

where \( Y \) is the matrix of the dependent variable, \( X \) is the matrix of the independent variables, and \( \varepsilon \) is the error term matrix.

When we get the result of OLS regression, we need to test the heteroscedasticity results for verifying the BLUE (best, efficient, unbiased and linear) characterizes of the
OLS estimators. Although there are several tests to determine whether heteroscedasticity is present or not in a model, it's difficult to tell the cause of the problem from these tests. If heteroscedasticity is significant, OLS does not provide the estimate with the smallest variance. Therefore, significance tests can be either too high or too low, and the direction of the bias depends on the nature of the heteroscedasticity.

3.2.2 Discriminant Analysis

Discriminant analysis can be used only for classification (i.e., with a categorical target variable), not for regression. The target variable may have two or more categories).

The variables which I want to use in the discriminant analysis include income, income change, occupation, occupation change, education, education change, rent, rent change, value change, and population and so on. We can employ SPSS or STATA software to do this discriminant analysis.

Discriminant analysis, under the known of classification, once we need to expand to the new samples, the method has been applied to select a criterion to determine how the new sample is placed in that population. The model is different from cluster analysis, for example, if we know there are two groups of people, a group of Chinese and a group of American. We need to analysis a person who is new coming, and answering this question can be regarded as Discriminant analysis.

Linear discriminant analysis (LDA) was developed by R. A. Fisher in 1936. This model tried to transfer the multivariate data to unvaried data by linear combination at first, then using a linear combination of values into a single variable to distinguish the difference between things.
Balakrishnama and Ganapathiraju described LDA as one of the numerous data classification techniques. This technique maximizes the class separability by maximizing the ratio of the between-class variance to the within-class variance or the ratio of the overall variance to the within-class variance. Choosing the former or the latter case rests on the type of transformation used. There are two types of transformation: class dependent transformation and class-independent transformation. The class-dependent transformation maximizes the separability of the classes by maximizing the ratio of the variance between the classes to the variance within the classes while the class independent transformation maximizes the class separability by maximizing the ratio of the overall variance to the variance within the classes (Balakrishnama and Ganapathiraju 1998).

LDA is closely related to regression analysis, in which dependent variable is described as a linear combination of other measurements. However, there still exist differences between these methods concerning the dependant variables whether numerical data or categorical date. Other regression model such logistic regression model is more similar to LDA, to explain categorical variable. These other methods are preferable in applications where it is not reasonable to assume that the independent variables are normally distributed, which is a fundamental assumption of the LDA method.

\[
\Sigma_b = \frac{1}{C} \sum_{i=1}^{C} (\mu_i - \mu)(\mu_i - \mu)^T
\]

In the case where there are more than two classes, the analysis used in the derivation of the Fisher discriminant can be extended to find a subspace which appears to
contain all of the class variability. Suppose that each of $C$ classes has a mean $\mu_i$ and the same covariance $\Sigma$. Then the between class variability may be defined by the sample covariance of the class means:

$$\Sigma_b = \frac{1}{C} \sum_{i=1}^{C} (\mu_i - \mu)(\mu_i - \mu)^T$$

Where $\mu$ is the mean of the class means, the class separation in a direction $\vec{w}$ in this case will be given by

$$S = \frac{\vec{w}^T \Sigma_b \vec{w}}{\vec{w}^T \Sigma \vec{w}}$$

This means that when $\vec{w}$ is an eigenvector of $\Sigma^{-1} \Sigma_b$ the separation will equal the corresponding eigenvalue. Since $\Sigma_b$ is of most rank $C-1$, then these non-zero eigenvectors identify a vector subspace containing the variability between features. These vectors are primarily used in feature reduction, as in PCA.

3.2.3 Stepwise Discriminant Analysis

In stepwise discriminant function analysis, a model of discrimination is built step-by-step. Specifically, at each step, all variables need to be reviewed and evaluated to determine which one will contribute most to the discrimination between groups. That variable will then be included in the model, and the process starts again. We also can base on the prediction result to find the variable which contributes least to the prediction. Therefore, if we want to evaluate the result as a successful discriminant analysis, we just need to keep the "important" variables in the model, it means, those variables that contribute the most to the discrimination between groups. We evaluate the contribution of every variable by the respective $F$ value. The $F$ value for a variable indicates its statistical
significance in the discrimination between groups, that is, it is a measure of the extent to which a variable makes a unique contribution to the prediction of group membership. A common misinterpretation of the results of stepwise discriminant analysis is to take statistical significance levels at face value. By nature, the stepwise procedures will capitalize on chance because they "pick and choose" the variables to be included in the model so as to yield maximum discrimination. Thus, when using the stepwise approach the researcher should be aware that the significance levels do not reflect the true *alpha* error rate, that is, the probability of erroneously rejecting *H₀* (the null hypothesis that there is no discrimination between groups).

3.3 Data process

Income, income change, education are used as the variables for discriminant analyze for Chicago by Hammel and Wyly (1996). Moreover, they focused on the three kinds of models. Among them, one is including the all central-city tracts, the second one excludes non-gentrified tracts and model three excludes tracts with median household income below city median in 1960. In their analysis for different cities, different variables and models are applied. In general, the variables they have chosen in the analysis part mainly are income, income change, and education.

However, in the Heidkamp and Lucas‘ (2006) study for of Portland, Maine, they used a similar method to identify the gentrification status of census block groups in Portland with a combination of survey field and discriminant analysis. They advocated the concept of gentrified frontier instead of the fringe gentrified group which is used in the Hammel and Wyly‘s article. In the stepwise discriminant analysis, they prefer employing the variables such as the change in the percentage of the population living
below the poverty line, the change in household median income, the change in the percentage of population with four-plus years of college, the change in the percentage of population living in owner occupied housing, the change in the percentage of the population in managerial technical and professional occupations, the change in the number of persons, and also the change in the percentage of person aging 25 years. They also selected different variables for two periods.

In my study, I would prefer applying some of the models into the analysis, and different variables for different models and periods. For each period, there are three models employed. As the study area of mine is the City of Chicago, I simply need to do the analysis six times for two different periods and with three models. The variables I would select include: household income, household income change, education, and education change, number of population, number of the labor population, and number of the labor population change, the change of population living below the poverty line, change in population living in owner occupied housing, and change of the population in managerial technical and professional occupation.

In modeling, I will do the normalization at the very beginning with the function of

$$\frac{X - \bar{X}}{S}$$

so as to eliminate the influence of the data dimension.

First, we distinguished the poor and rich areas of Chicago, (Figure 3-1) because the gentrification can only occur in the poor areas. The wealthy areas cannot experience gentrification. The standard for this process is the median household income for the whole city wide level. The median household income of Chicago in 1990 was $35,224, so each census tract with lower median household income than $35,224 will be classified as the poor areas, will be the potential area for gentrification.
In modeling, I will do the normalization at the very beginning so as to eliminate the influence of data dimension. In my study, I will consider applying some models into the analysis, and utilizing different variables for different models and periods. For each period, there are three models employed. As my study area is the City of Chicago, I just need to do the analysis six times for two different periods and with three models. They are: Model 1: all the groups; Model 2: exclude the No-gentrified part; Model 3: exclude the poor part and No-gentrified part.
Chapter 4

Results and Discussion

4.1 Result

The first step in the modeling process was to create a map of gentrification in Chicago based on Wyly and Hammel's (2000) map. Second, I create a map of poor areas in Chicago based on the median household income from the census tract. There are four categories in the map: Core Gentrified, Fringe Gentrified, Poor and the rest area of city (higher median household income compared with city wide level). (Figure 4-1)
Then based on the classes I previously determined, I conducted the discriminant analysis on each variable in census tract. Finally, I got the discriminant results which reflect gentrification situation in Chicago from 1990 to 2000. (Figure 4-2)
Based on the two maps, we can find most of the pattern changing areas concentrates in the east center of Chicago. Compared with the gentrification result of 1990, the gentrification area and fringe gentrified area expand a lot. It implies the CHA has begun more gentrification or public housing projects during the ten years from 1990
to 2000. Gentrification has also retained some of the population in the city. Though Chicago lost nearly 110,000 people it has maintained its population better than other old industrial metropolises in United States. This is classified result from the discriminant analysis. (Table 4.1)

### Table 4.1: Classified Result Table

<table>
<thead>
<tr>
<th>Prior-class</th>
<th>Predicted</th>
<th></th>
<th></th>
<th></th>
<th>total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Poor area</td>
<td>Rich area</td>
<td>Fringe Gentrified</td>
<td>Core Gentrified</td>
<td></td>
</tr>
<tr>
<td>initial number</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Poor area</td>
<td>322</td>
<td>17</td>
<td>14</td>
<td>6</td>
<td>359</td>
</tr>
<tr>
<td>Stable area</td>
<td>8</td>
<td>258</td>
<td>22</td>
<td>22</td>
<td>310</td>
</tr>
<tr>
<td>Fringe Gentrified</td>
<td>5</td>
<td>0</td>
<td>9</td>
<td>7</td>
<td>21</td>
</tr>
<tr>
<td>Core Gentrified</td>
<td>1</td>
<td>2</td>
<td>10</td>
<td>17</td>
<td>30</td>
</tr>
<tr>
<td>Unclassified</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>%</td>
<td>Poor area</td>
<td>89.7</td>
<td>4.7</td>
<td>3.9</td>
<td>1.7</td>
</tr>
<tr>
<td></td>
<td>Stable area</td>
<td>2.6</td>
<td>83.2</td>
<td>7.1</td>
<td>7.1</td>
</tr>
<tr>
<td></td>
<td>Fringe Gentrified</td>
<td>23.8</td>
<td>.0</td>
<td>42.9</td>
<td>33.3</td>
</tr>
<tr>
<td></td>
<td>Core Gentrified</td>
<td>3.3</td>
<td>6.7</td>
<td>33.3</td>
<td>56.7</td>
</tr>
<tr>
<td></td>
<td>Unclassified</td>
<td>.0</td>
<td>.0</td>
<td>.0</td>
<td>100.0</td>
</tr>
</tbody>
</table>

a. Accuracy assessment result: 84.2%.

Based on the table, we can find that there are 17 poor census tracts transformed to the Stable area, along with 14 census tracts to Fringe Gentrified census tract and 6 poor census tracts to the Core Gentrified census tract in this decade. The most interesting part is how the Fringe Gentrified census tract transfers to the Core Gentrified census tracts.

There are seven census tracts in fringe gentrified census tracts transferring to core gentrified. Totally 117 census tracts have changed situation in this decade. Stable area transfers to other areas compose nearly 50 percent of change. In the prior classification, we define 21 census tracts belonging to the fringe gentrified category and 66 percent of them changed type in this decade. Moreover, there is no fringe gentrified census tract
changing to the stable area. From these finding, we can judge that the model is effective since we know that the fringe gentrified area are unlikely to transfer to stable area.

Obviously, the category which has the peak change is the fringe gentrified, and this result fits the definition of the fringe gentrified area. These census tracts should be unsteady and fickle from 1990 to 2000.

For the Core gentrified area, we can find there are two census tracts transferring to stable area in this decade, and this process is the original purpose for gentrification to increase people's living standard of the neighborhood. However, there are 27 of them still being the core gentrified area and the fringe gentrified area, which do not show process of gentrification. (Figure 4-3)

![Percentage of Every Category](image)

**Figure 4-3: Percentage of Change Pattern**
<table>
<thead>
<tr>
<th>Characteristics of Chicago</th>
<th>Population</th>
<th>Percentage over college</th>
<th>Employed persons</th>
<th>Percentage of Professional Job</th>
</tr>
</thead>
<tbody>
<tr>
<td>Year</td>
<td>2,000</td>
<td>2000</td>
<td>2000</td>
<td>2000</td>
</tr>
<tr>
<td>Poor Area</td>
<td>2,961</td>
<td>4.38</td>
<td>886</td>
<td>17.53</td>
</tr>
<tr>
<td>Rest of City</td>
<td>4,111</td>
<td>10.69</td>
<td>1791</td>
<td>18.01</td>
</tr>
<tr>
<td>Fringe Gentrified</td>
<td>2,346</td>
<td>48.65</td>
<td>1509</td>
<td>39.25</td>
</tr>
<tr>
<td>Core Gentrified</td>
<td>3,534</td>
<td>43.80</td>
<td>2001</td>
<td>28.04</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Characteristics of Chicago</th>
<th>Occupied housing units</th>
<th>Median contract rent</th>
<th>Median value of house</th>
<th>Median household income</th>
</tr>
</thead>
<tbody>
<tr>
<td>Poor Area</td>
<td>968</td>
<td>458.5</td>
<td>116,200</td>
<td>26,664</td>
</tr>
<tr>
<td>Rest of City</td>
<td>1,402</td>
<td>561</td>
<td>140,300</td>
<td>43,930</td>
</tr>
<tr>
<td>Fringe Gentrified</td>
<td>1,160</td>
<td>799</td>
<td>313,400</td>
<td>59,375</td>
</tr>
<tr>
<td>Core Gentrified</td>
<td>1,624</td>
<td>733</td>
<td>199,450</td>
<td>45,002</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Characteristics of Chicago</th>
<th>Change of Population</th>
<th>Change of Percentage over college</th>
<th>Change of Employed persons</th>
<th>Change of Percentage of Professional Job</th>
</tr>
</thead>
<tbody>
<tr>
<td>Poor Area</td>
<td>-104</td>
<td>0.85</td>
<td>-30</td>
<td>3.18</td>
</tr>
<tr>
<td>Rest of City</td>
<td>232</td>
<td>2.12</td>
<td>13</td>
<td>-2.99</td>
</tr>
<tr>
<td>Fringe Gentrified</td>
<td>107</td>
<td>8.60</td>
<td>252</td>
<td>2.38</td>
</tr>
<tr>
<td>Core Gentrified</td>
<td>148</td>
<td>10.93</td>
<td>11</td>
<td>13.96</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Characteristics of Chicago</th>
<th>Change of Occupied Housing Units</th>
<th>Change of Median House Value</th>
<th>Change of Median Contract Rent</th>
<th>Change of Median House Income</th>
</tr>
</thead>
<tbody>
<tr>
<td>Poor Area</td>
<td>-1</td>
<td>40,224</td>
<td>35.05</td>
<td>2,836</td>
</tr>
<tr>
<td>Rest of City</td>
<td>48</td>
<td>26,366</td>
<td>21.53</td>
<td>775</td>
</tr>
<tr>
<td>Fringe Gentrified</td>
<td>132</td>
<td>74,534</td>
<td>140.14</td>
<td>18,877</td>
</tr>
<tr>
<td>Core Gentrified</td>
<td>72</td>
<td>110,035</td>
<td>31.70</td>
<td>3,211</td>
</tr>
</tbody>
</table>
From this table (Table 4.2), we can conclude that the some variables increase in the core gentrified category during the ten years such as change of professional job, change of median house value, change of percentage of population over college education and the change of percentage of professional jobs. From these changes, we can understand how gentrification impacts the neighborhood characteristics, such as the house value. What is more, in the 2000 data, the percentage of professional jobs and occupied housing units of core gentrified area is the highest among the four categories. We find the variables of core gentrified area are quite different from the others categories. The house value has a great increase in the other areas through 1990 to 2000 in Chicago. The interesting thing is the median household income of core gentrified area is much higher in the poor area which also is the purpose of gentrification. The highest increase of income happens in the fringe gentrification area and the lowest one is the rest of city category. The occupied housing units increase in this decade in the core gentrified area in general and the gentrification play a positive effect to the development of neighborhood in Chicago. The core gentrification area loses the population with professional job and a high education experience.

This table is in consistence with the result of Wyly and Hammel (2000). Their result show that the gentrification will bring an increase in some social and economic indexes of the census tract, such as median household income, college graduates, professional job owners and the house value.

In Chicago, gentrification surrounds the Loop from the north and south side, and also has expanded to the far north side and far southwest side area. South side gentrification is dominated by the developments in the Woodlawn, Kenwood and Hyde..
Park neighborhood and other conversion of industrial land along the Chicago River. On the west side, gentrification expand to the Lower west side area, comparing to the prior classification result from 1980-1990. On the north side and far north side, reinvestments began initially in Lincoln Park and then expand to the Rogers Park, almost crossing through the north area of Chicago. The most concentrated gentrification area in Chicago should be the south side area. More interesting thing is that gentrification around University of Chicago has not disappeared, but expanded to more census tracts. It means rehabilitation and new construction had been still spreading in this area throughout the twenty years.

4.2 Evaluation of the model (internal statistics)

This part should be evaluated by the F-test result and the Wilk’s lambda.
Table 4.3: Testing the equality of group means among the pre-defined classes

<table>
<thead>
<tr>
<th></th>
<th>Wilks’ Lambda</th>
<th>F</th>
<th>df1</th>
<th>df2</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Population</td>
<td>.966</td>
<td>8.217</td>
<td>3</td>
<td>711</td>
<td>.000</td>
</tr>
<tr>
<td>Percentage over college</td>
<td>.712</td>
<td>95.757</td>
<td>3</td>
<td>711</td>
<td>.000</td>
</tr>
<tr>
<td>Employed persons</td>
<td>.892</td>
<td>28.659</td>
<td>3</td>
<td>711</td>
<td>.000</td>
</tr>
<tr>
<td>Percentage of Professional job</td>
<td>.827</td>
<td>49.438</td>
<td>3</td>
<td>711</td>
<td>.000</td>
</tr>
<tr>
<td>Occupied housing units</td>
<td>.951</td>
<td>12.184</td>
<td>3</td>
<td>711</td>
<td>.000</td>
</tr>
<tr>
<td>Median contract rent</td>
<td>.718</td>
<td>93.263</td>
<td>3</td>
<td>711</td>
<td>.000</td>
</tr>
<tr>
<td>Median value of house</td>
<td>.896</td>
<td>27.495</td>
<td>3</td>
<td>711</td>
<td>.000</td>
</tr>
<tr>
<td>Median household income</td>
<td>.628</td>
<td>140.327</td>
<td>3</td>
<td>711</td>
<td>.000</td>
</tr>
<tr>
<td>Change of Population</td>
<td>.935</td>
<td>16.451</td>
<td>3</td>
<td>711</td>
<td>.000</td>
</tr>
<tr>
<td>Change of Percentage over college</td>
<td>.950</td>
<td>12.437</td>
<td>3</td>
<td>711</td>
<td>.000</td>
</tr>
<tr>
<td>Change of Employed persons</td>
<td>.958</td>
<td>10.330</td>
<td>3</td>
<td>711</td>
<td>.000</td>
</tr>
<tr>
<td>Change of Occupied Housing Units</td>
<td>.929</td>
<td>18.138</td>
<td>3</td>
<td>711</td>
<td>.000</td>
</tr>
<tr>
<td>Change of Median House Value</td>
<td>.919</td>
<td>20.967</td>
<td>3</td>
<td>711</td>
<td>.000</td>
</tr>
<tr>
<td>Change of Median Contract Rent</td>
<td>.975</td>
<td>6.129</td>
<td>3</td>
<td>711</td>
<td>.000</td>
</tr>
<tr>
<td>Change of Median House Income</td>
<td>.962</td>
<td>9.285</td>
<td>3</td>
<td>711</td>
<td>.000</td>
</tr>
<tr>
<td>Change of Percentage of Professional Job</td>
<td>.832</td>
<td>47.870</td>
<td>3</td>
<td>711</td>
<td>.000</td>
</tr>
</tbody>
</table>

From table 4.3, we gain information about the equality among the four categories for the total 16 variables by examining the p-value coming with each variable. The p-values of all the 16 variables are extremely small, obviously less than 0.05. We have no evidence to support the null hypothesis that all the means of four classifications are equal.
So all the 16 variable is suitable for the discriminant analysis model. Those sixteen variables are sufficient and good enough for us to enter the model and further to distinguish the differences between the four categories we defined. What we can find here the variable which has the lowest Wilks' Lambda is Median household income also is the most significant variable which was selected by the stepwise discriminant analysis model.

Since no single indicator can be justified a priori to identify gentrified areas, a multivariate approach is required to analyze alternative combinations. My goal was to determine the degree to which census variables can distinguish between the types of neighborhoods we identified. To develop a model for this purpose, I employed discriminant analysis, a multivariate statistical procedure commonly used to evaluate the validity of a priori classifications and the relative ability of each census variable to distinguish between the four predefined categories.

At each step of this iterative procedure, each the iteration first adds the variable contributing most to the discriminatory power of the model and then evaluates the statistical significance of indicators added in previous steps. Variables are added and removed from the model on the basis of Wilks' Lambda. The iterations stopped when no variables met a specified criterion of statistical significance for inclusion or exclusion; given the exploratory nature of our analysis, we set $\alpha = 0.15$. Wilks' lambda, the ratio of within-group to between-group variation, measures the discriminatory power of the model. Lambda values range from 0 to 1, with lower values indicative of superior classifications. Lower lambda values indicative of superior classifications. A comparatively low lambda of 0.2, for example, would be interpreted to mean that within-
group differences account for only one-fifth of the total variation in respective indicators selected by the stepwise analysis; yet, this figure does not distinguish each category’s contribution to total variance.

Applying this model to the census data we have for year 1990-2000, nine independent variables differentiate among the priori categories, with Population, Change in median house value, Change in percent of professional job, Change in population and occupied housing units contributing the most to the model with the lowest five lambda values. Output is as follows: (Table 4.4)

Table 4.3: The nine final variables selected into model

<table>
<thead>
<tr>
<th>Steps</th>
<th>Input/Deleted variable</th>
<th>Wilk’s Lambda</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Inputed</td>
</tr>
<tr>
<td>1</td>
<td>Median household income</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Change of Median House Income</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Percentage over college</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Change of Percentage over college</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Occupied housing units</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Change of Population</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Change of Percentage of Professional Job</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Change of Median House Value</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Population</td>
<td></td>
</tr>
</tbody>
</table>

In each iteration, we carefully study the Wilks’ lambda value of each variable. By comparing their values in each step, we pick out the variable with the lowest lambda (equally to find the largest F statistic value) and then this variable will be added into the next round of iteration. Following this principle, we are able to find nine suitable variables that best discriminates between the categories and other variables contributing least are removed. The following table shows the F statistic values and correspondent p-
values. The table lists the nine variables that should be selected to the linear discriminant analysis model. There are five more variables included in the model than the census tract data in 2000. This outcome really reflected the gentrification as a process which impacts the neighborhood slowly and progressively. (Table 4.5)

**Table 4.4: F statistic values and correspondent p-values**

<table>
<thead>
<tr>
<th>Input/Deleted variable</th>
<th>Wilks' Lambda</th>
<th>Accurate F</th>
<th>Approximate F</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Statistic</td>
<td>df1</td>
</tr>
<tr>
<td>1</td>
<td></td>
<td>140.327</td>
<td>3</td>
</tr>
<tr>
<td>2</td>
<td></td>
<td>129.297</td>
<td>6</td>
</tr>
<tr>
<td>3</td>
<td></td>
<td>108.297</td>
<td>9</td>
</tr>
<tr>
<td>4</td>
<td></td>
<td>88.828</td>
<td>12</td>
</tr>
<tr>
<td>5</td>
<td></td>
<td>71.938</td>
<td>15</td>
</tr>
<tr>
<td>6</td>
<td></td>
<td>61.171</td>
<td>18</td>
</tr>
<tr>
<td>7</td>
<td></td>
<td>53.238</td>
<td>21</td>
</tr>
</tbody>
</table>

A p-value less than 0.05 show the statistical significance of a variable in the model. All the nine variables have small p-values and relatively large F values compared to others in the process of stepwise discriminate analysis.

Discriminate analysis involves the determination of a linear equation like regression that will predict which group the case belongs to. The form of the equation or function is:

\[ D = v_i \times X_i + \alpha, \text{ for } i = 1, 2, \ldots, 9 \]

Where \( D \) = discriminate function

\( v \) = the discriminant coefficient or weight for that variable
\( X_i = \) respondent's score for that variable

\( \alpha = \) a constant

\( i = \) the number of predictor variables

This function is similar to a regression equation. The \( \nu \)'s are unstandardized discriminant coefficients and maximize the distance between the means of the dependent variable. Good predictor tends to have large weights. What we expect this function to do is to maximize the distance between the four categories we defined and come up with an equation with strong discriminatory power. The number of discriminant functions is one less the number of groups. In our case, there will be three functions for the basic four categories discriminant analysis.

**Table 4.5: Eigenvalue of stepwise discriminant analysis**

<table>
<thead>
<tr>
<th>Function</th>
<th>Eigenvalue</th>
<th>Variance %</th>
<th>cumulative %</th>
<th>Canonical correlation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1.375 (^a)</td>
<td>72.1</td>
<td>72.1</td>
<td>.761</td>
</tr>
<tr>
<td>2</td>
<td>.503 (^b)</td>
<td>26.4</td>
<td>98.4</td>
<td>.578</td>
</tr>
<tr>
<td>3</td>
<td>.030 (^a)</td>
<td>1.6</td>
<td>100.0</td>
<td>.171</td>
</tr>
</tbody>
</table>

\(^a\) 3 Canonical discriminant functions were used in the analysis

Table: Eigenvalues for three discriminant functions

From the table above (Table 4.6), we see larger eigenvalues and canonical correlation coefficients for the first two discriminant functions. Large eigenvalues indicates high judging power of the discriminant function and canonical correlation tells the extent of correlation between two categories. Table of Wilks' lambda (Table 4.7) also provides us with the power of the three discriminant functions to distinguish categories where lower Lambda indicates higher capability to tell the difference.
Table 4.6: Wilks’ Lambda for three discriminant functions

<table>
<thead>
<tr>
<th>Testing function</th>
<th>Wilks’ Lambda</th>
<th>Chi-square</th>
<th>Df</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 to 3</td>
<td>.272</td>
<td>921.091</td>
<td>27</td>
<td>.000</td>
</tr>
<tr>
<td>2 to 3</td>
<td>.646</td>
<td>309.246</td>
<td>16</td>
<td>.000</td>
</tr>
<tr>
<td>3</td>
<td>.971</td>
<td>21.115</td>
<td>7</td>
<td>.004</td>
</tr>
</tbody>
</table>

Estimated standardized discriminant coefficients of the three functions are given as follows: (Table 4.8)

Table 4.7: Standardized Discriminant Coefficients

<table>
<thead>
<tr>
<th>standardized discriminant coefficients</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Population</td>
<td>-.300</td>
</tr>
<tr>
<td>Percentage over college</td>
<td>-.332</td>
</tr>
<tr>
<td>Occupied housing units</td>
<td>.303</td>
</tr>
<tr>
<td>Median household income</td>
<td>1.529</td>
</tr>
<tr>
<td>Change of Population</td>
<td>-.097</td>
</tr>
<tr>
<td>Change of Percentage over college</td>
<td>-.128</td>
</tr>
<tr>
<td>Change of Median House Value</td>
<td>.053</td>
</tr>
<tr>
<td>Change of Median House Income</td>
<td>1.054</td>
</tr>
<tr>
<td>Change of Percentage of Professional Job</td>
<td>.152</td>
</tr>
</tbody>
</table>

By checking the scatter plot from SPSS, we can clearly see category 1 and 2 are much closer compared to other categories and this definitely implies a relatively high correlation. Category 4 is the furthest from the other three and this indicates a much lower correlation. (Figure 4-4)
4.3 Evaluation of the model (comparison to the real world events)

4.3.1 Note General Pattern

I also built a neighborhood level map of gentrification in Chicago. (Figure 4-5)

The data I applied here is the UIC gentrification influence table. Based on the neighborhood level map, there is a lot of census with the core gentrified area of the discriminant results. However, the census tract map will be more accurate than the neighborhood level map. And there are more areas with gentrification process in the neighborhood map. Also, in this map, the gentrification mostly concentrates on the southwest side and the west side area. The reason for this false result is the higher scale of neighborhood map and the area and pattern in this map is much bigger than the census.
tract level map. Based on this map, we can do the analysis about accuracy of my modeling results. In other words, there still are some neighborhoods with a gentrification process in the result of University of Illinois, Chicago. However, my model has trouble to distinguishing them. From this perspective, we can say the gentrification in these neighborhoods may not play a positive stimulation to the development of the neighborhood. It means these neighborhoods are failed to attract more persons who has higher education and professional jobs.

Figure 4-5: The Neighborhood Map of Chicago

I used the LexisNexis database to figure out how the census tract gentrification situation changes when matching to the real world event. The analysis will include
several census tracts which have changed but not all the changed census tract can be evaluated in this way. (Figure 4-6)

Figure 4-6: The Neighborhood Map of Chicago

Here I listed some successful examples to support my discriminant analysis results. In most of them, the gentrification does happen to the type changing area from 1990 to 2000.

South Side Area, Chicago

Example 1: census tract 4110 in Chicago, which belongs to the Woodlawn neighborhood, is defined in the model as the transfer from poor area and fringe gentrified area to the core gentrified area. This census tract is bounded by Lake Michigan to its east.
In the census data of 1990, Woodlawn had approximately 27,000 individuals, living in 10,000 households. Over 98 percent of the population is African American and over half of them are with some forms of public aid, and the median household income is over $13,000. This neighborhood rapidly turns famous for its abandoned buildings, the high crime rate and preserving an estimated 5000 units of housing in Woodlawn since established. Many of its programs - Abandoned Property Program, Vintage Homes for Chicago, Step-Up Housing - have become citywide models. In this area, gentrification process occurred during period 1980 to 1990 in the Woodlawn neighborhood. Sufficient evidences convince us the existence of gentrification in this area. There is another explanation for Woodlawn, because the model is very sensitive to slum clearance, the destruction of very low value housing. And it sometimes confuses this with gentrification.

Example 2: census tract 4106, which belongs to the Washington Park neighborhood, has been defined in the model as the transfer from fringe gentrified area to the core gentrified area. As Wikipedia described, “neighborhood rehabilitation (and, in some cases, gentrification) can also be seen in parts of Washington Park, Woodlawn.” In this area, African Americans constitute 99 percent of the population and this area has a poverty rate of 51 percent. This should be the golden bullet of gentrification in 2009 when the International Olympic Committee rejects Chicago's bid to host the 2016 games.

Example 3, census tract 3139, included in the Fuller Park and The Robert Taylor Homes neighborhood, has been defined in the model as the transfer from fringe gentrified area to the core gentrified area. From the UIC gentrification table, we can find these areas are belonged to gentrification project. The Robert Taylor Homes is a public housing development completed in 1962 and named after Robert Taylor. He was an African
American activist and board member of Chicago Housing Authority (CHA). In 1993, the CHA decided to replace all Robert Taylor Homes with a mixed-income community in low-rise buildings as part of a federal block grant received from the HOPE VI federal program. In 1996, HOPE VI federal funds were granted specifically for off-site Taylor replacement housing. The project was active between 1996 and 2007, and cost a total of estimated $583 million. As of 2007, a total of 2,300 low-rise residential homes and apartments, seven new and renovated community facilities, and a number of retail and commercial spaces are to be built in place of the old high-rise buildings. However, in this area, the model just does the classification based on the data of 2000, which cannot show the whole process of this redevelopment project. We are glad to find that the model can identify this partially developed project.

Example 4: census tract 3506, belonged to Bridgeport neighborhood, is defined in the model as the transfer from fringe gentrified area to the core gentrified area. From the UIC gentrification table, we discover that these areas are influenced by gentrification pressure. Bridgeport is a neighborhood located on the city's South Side. The New York Time stated—"In the last few years, many more Asian and Hispanic people have moved into the blue-collar neighborhood, accounting for about 40 percent of the population. But almost no blacks live in Bridgeport, even though many shop in the stores during the day.” (Terry, 1997, Mar 27) In 2008, the Chicago Sun-Times listed Bridgeport as one of the four most ethnically diverse neighborhoods in Chicago alongside Albany Park, West Ridge, and Rogers Park. Chinese and Mexican fares are well represented, particularly along 31st Street as well as Archer Avenue. Though it may potentially be a sign of gentrification, Bridgeport in the early 21st century has also begun to experience an
upswing in new restaurants. There is no direct evidence to support the specific
gentrification process has happened in this neighborhood. However, the potential chance
of gentrification is very high.

Example 5: census tract 3510, belonged to the Bronzeville neighborhood, has
been defined in the model as the transfer from fringe gentrified area to the core gentrified
area. From the UIC gentrification table, we cannot determine if these areas experienced
any gentrification pressure. This neighborhood is famous for being an African American
neighborhood in Chicago. Throughout the 1980s and 1990s, African American have
moved increasingly rapidly into poor areas, while urban neighborhoods like
Douglas/Grand Boulevard and initiated processes of residential and commercial
investment and upgrading. In 1990, most of Douglas/Grand Boulevard residents moved
into public housing. The median family income of these communities is much lower than
the average level of the city. Moreover, more than half of Douglas/Grand Boulevard
families survived on the incomes below the poverty line. In addition, the community had
a large non-working population with 26 percent of unemployed residents. Thirty-eight
percent of its inhabitants are 19 or younger and residents aged 65 years or older
constituted 14.5 percent of the community.

Boyd stated the gentrification in this area: Here, gentrification is being used by
African American middle class elites for adopting the master's tool to keep ownership of
their own instead of dismantling his house but. (Boyd 2008)

Above all, this neighborhood is representative of the African American’s
gentrification in United States. The gentrification process in this neighborhood between
1990 and 2000 is confirmed.
Far North Side

Example 6: Rogers Park, census tracts 104, has been defined in the model as the transfer from poor area to the core gentrified area. We also can find the evidence from the gentrification table from University of Illinois, Chicago website.

In this area, a total population of 5,325 represented a decline by 345 between 1990 and 2000. During this decade, the white population has declined more 1,000, meanwhile the population of Asians, others, Hispanics and Blacks has increased. Median household income has declined to $29,884 by 11 percent. The percentage of households with incomes below the poverty level has increased from 16 percent to 20 percent. Owner-occupied units increased from 17 percent to 413, and make up 18 percent of occupied units now (Giangreco, Williams, Rohrbeck, 2002). It seems clear that there is gentrification process in census tract 104. Moreover, gentrification plays a positive role in the development of the neighborhood from 1990 to 2000.

Example 7: census tract 314, the Uptown neighborhood, has been defined in the model as the transfer from stable area to a core gentrified area. We also can find evidence from the gentrification table from University of Illinois, Chicago website.

The neighborhood has experienced an accelerated housing market during the 1990s, along with an influx of new upscale retail and restaurant establishments. Residential development has been prevalent in Uptown during the 10 years. With the developing of the housing market and some resident communities, this neighborhood has transfer from a wealthy neighborhood to a normal one in the whole city. Uptown also has a rich pool of human service providers and nonprofit organizations, such as ethnic and immigrant organizations, homeless service providers, job training programs. Commercial
and retail activities are concentrated on the main streets running north-south and east-west in the neighborhood and consist of small businesses such as beauty and nail salons, convenience stores, and fast food restaurants. Another characteristic of this neighborhood is: Uptown has the greatest concentration of single-room occupancies hotels in the city. (Haas 2002)

Uptown has not yet completely gentrified. Therefore, there still are affordable housing units available to current residents. As a result, the pool of housing for families and the lowest income population in Uptown is at risk as gentrification proceeds. Subsidized rental units are crucial to the low income and very low income residents, and there are steep challenges to ensure affordable rental units as land prices skyrocket and financial incentives exist for landlords to opt out of federal subsidy programs. (Levy, Comey, Padilla 2006)

Above all, the gentrification progress in this neighborhood from 1990 to 2000 can be confirmed.

Example 8: Cabrini Green in Chicago belonged to the census tract 810 is classified as the Core gentrification area. This project is famous for its gentrification, marked by the new lower-density mixed-income communities. Despite its location next to some of the most expensive real estates in Chicago, Cabrini-Green presents the worst case of public housing in the United States under HUD. $ Fifty million dollars have been put into the redevelopment of this community. One of the first HOPE VI grants received by Chicago was used to redevelop Cabrini–Green as a mixed-income neighborhood in 1994, and the Demolition began in 1995. Chicago Housing Authority announced Plan for Transformation, which was estimated to cost $1.5 billion over ten years to demolish
18,000 apartments and build and/or rehabilitate 25,000 apartments. Earlier redevelopment plans for Cabrini–Green are included in the Plan for Transformation.

There is no doubt that gentrification process happened in this neighborhood from 1995 to 2000. However, the gentrification also brought some displacement problems to government. (Figure 4-7)

In 1996, the federal government mandated the destruction of 18,000 units of public housing in Chicago (along with tens of thousands of other units nationwide). In response, some Cabrini–Green tenant activists were organized to prevent themselves from becoming homeless and to protect what they and their supporters see as a right to public housing for the city's poorest residents. The activists succeeded in obtaining a consent decree guaranteeing that some buildings will remain standing while the new structures are built so that tenants can remain in their homes until new ones are available.

*Figure 4-7: Image of Cabrini-Green*
(Source: http://en.wikipedia.org/wiki/Cabrini - Green)
Based on the eight examples which I listed above, and the statistical analysis results, the evaluation of the model is almost done. And most results of the census tracts which have transferred from fringe gentrified to core gentrified are correct and in accordance with the social and economic characteristics changing in gentrification progress.

4.3.2 Identify Potential Errors

Example 1: census tract 7206, in the Beverly neighborhood. I had trouble finding the direct evidence to prove the gentrification process exist in this area, so I have tried to analyze this situation by comparing the census tract data to the citywide data. Beverly is located on the South Side on the southwestern edge of the city. Beverly Hills is located on the highest elevation in the City of Chicago. Beverly is one of the most racially and ethnically diverse neighborhoods in Chicago. Certain neighborhoods of Chicago are more Irish than others, namely the south side areas of Bridgeport and Beverly. Traditionally, these locales are the places where working class Irish immigrants would settle when they arrive in Chicago. All of them still retain a bit of that blue collar flavor although Bridgeport in particular is becoming more gentrified.
Table 4.9: Variables Table of Census Tract 7206 and Median of Census Tracts in Chicago City

<table>
<thead>
<tr>
<th></th>
<th>2000</th>
<th>Change</th>
<th>2000</th>
<th>Change</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Beverly</td>
<td>City</td>
<td>Beverly</td>
<td>City</td>
</tr>
<tr>
<td>Population</td>
<td>1,801</td>
<td>3,278</td>
<td>-75</td>
<td>69</td>
</tr>
<tr>
<td>Percentage over college</td>
<td>35.70</td>
<td>9.20</td>
<td>-18.39</td>
<td>-1.39</td>
</tr>
<tr>
<td>Employed persons</td>
<td>875</td>
<td>1407</td>
<td>21</td>
<td>7.5</td>
</tr>
<tr>
<td>Percentage of Professional Job</td>
<td>18.4</td>
<td>18.45876</td>
<td>-34.05</td>
<td>0.068</td>
</tr>
<tr>
<td>Occupied housing units</td>
<td>638</td>
<td>-1207</td>
<td>19</td>
<td>37</td>
</tr>
<tr>
<td>Median contract rent</td>
<td>811</td>
<td>520.25</td>
<td>132.28</td>
<td>32.42</td>
</tr>
<tr>
<td>Median value of house</td>
<td>227,900</td>
<td>139,850</td>
<td>40,815</td>
<td>29,526</td>
</tr>
<tr>
<td>Median household income</td>
<td>78,263</td>
<td>37,538</td>
<td>70,603</td>
<td>2,421</td>
</tr>
</tbody>
</table>

Based on the table above (Table 4.9), we can find the census tract has a great increase in the median household income and the house value, but the percentage of professional job and high education has a huge decrease. These changes may imply that the residents, who live in the census tract, may simply want to stay in the city of Chicago, and had chosen not to move out of the city. The value of houses in this area had a great increase, compared with the most core gentrified area. This result is reasonable because the most gentrified area has a great increase of median house value. Even if I can find evidence from gentrification table from University of Illinois, Chicago’s website, I still can not prove the gentrification has happened in this census tract. So this area is a potential error for the model.

In the period analyzed, 1990-2000, the model correctly classified more than 80 percent of all the census tracts which have a transformed from fringe gentrification to core gentrification. This creates difficulty in adjusting the accuracy of the fringe area results. If based on the discriminant result of pattern change progress, the model has a
very high accuracy rate. When the stepwise discriminant model picked up nine variables from the sixteen variables, we can found the variables are different from what Wyly and Hammel used in 2000. The leading variables in their study include income, education, income change, education change, rent, occupation, white-collar workforce. (Wyly and Hammel, 2000) The variables in their model for Chicago from 1960 to 1990 are most from the 1970, 1980 and 1990’s data. In my model, the change variables play a more important role in the analysis. Rent is not very significant in the analysis, the population and the value of house became the leading variables in my model. These changes can be explained by the characteristics changes of gentrification in the 40 years. Among those changes, the population is different from what I expected. Population in 2000 is a leading variable which may tell us that the gentrification can attract more people back to the community and increase the population density of gentrified area.

Data collection errors, the correlation between the variables, the relatively long time span between different data sets, omitted variables, and spatial effects might somehow, make the estimated results difficult to interpret. Another challenge of this study is lacking field survey and the information of how and where gentrification happens in Chicago. Although we can find some evidence which can support the statement gentrification exists in the neighborhood, however, the area of neighborhood is larger than the area census tract contains. We only can know the neighborhood has gentrification pressures. But in detail which census tract it is on, the result may in error or is unable to identify. Lacking the precise gentrification pressure location and period is the potential error existed in my model. In the discriminant result, there are some census
tracts which were stable area before defined as gentrified area, and there will be some potential error in this part.
Chapter 5

Conclusion

5.1 Conclusion

As mentioned before, there is no survey result for gentrification for Chicago. We do not know which census tract in Chicago has been gentrified from 1990 to 2000. Moreover, we also cannot conclude how the gentrification impacted each census tract and neighborhood in that decade. From the gentrification definition and purpose, we can state the gentrification area should have a high increase of middle class population, household income and the occupied housing units.

The pattern of gentrification changed significantly in the ten years from 1990 to 2000. The pattern of redevelopment in this decade is different from the years between 1980 and 1990. So does the gentrification inscribe remarkably similar social and economic changes in the city in different periods? The goal of this study was to identify the gentrification area in Chicago from 1990 to 2000. The model I used is discriminant analysis model which already has been tested by the Hammel and Wyly (1996), Heidkamp and Lucas (2006). Using readily available U.S. Census tract level data and the newspaper database, it was possible to identify a fragmented gentrification area in Chicago. In my model, there are nine variables that have more significant influence to the
analysis result, such as percentage of the population who has a degree over bachelor, population, and median household income, percentage of the population who has a professional job and the change pattern of these data.

In the period analyzed, 1990-2000, the model correctly classified more than 80 percent of all the census tracts which has a transformation progress from fringe gentrification to core gentrification. Comparing the difficulty of adjusting the accuracy of the fringe gentrification area result, the model has a very high access accuracy rate on core gentrified area classification. When the stepwise discriminant model picked up nine variables from the sixteen variables, we found the variables are different from those used by Wyly and Hammel in 2000. The leading variables in their study included income, education, income change, education change, rent, occupation, white-collar workforce. (Wyly and Hammel, 2000) The variables in their model which used for Chicago from 1960 to 1990 are most concentrated on the 1970, 1980 and 1990 data. And in my model, the change pattern variables played more important role in the analysis. Rent became not very significant in the analysis, the population and the value of house became the leading variables in my model. These changes can be explained by the characteristics changes of gentrification in the 40 years. Among those changes the population is different from what I expected. Population in 2000 became a leading variable maybe told us that the gentrification can attract more people back to the community and increased the population density of the gentrified area.

Gentrification areas are sufficiently similar to one another, and different from other urban neighborhoods that they from a distinctive neighborhood type. Gentrification is also used as an urban policy to improve people’s living conditions. Indeed,
gentrification still attracts the attention of policy makers interested in de-concentrating poverty in urban neighborhood. Our results may help explain whether gentrification improves poor people’s living condition.

Challenges of time and data are a major limitation of this study. Although we can download the census tract data from the decennial database of the U.S. Census Bureau, the boundaries changes of the census tracts had some change pattern data which has a little error. At the first, we would like to analyze the data from 1990 to 2010. However, till Feb 2012 the housing data for 2010 was not available on the website. Hence, we had to focus on the period from 1990 to 2000. Data collection errors, the correlation between the variables, the relatively long time span between different data sets, omitted variables, and spatial effects might somehow, make the estimated results difficult to interpret. Another challenge of this study is without field survey and the lacking the information of how and where gentrification happened in Chicago. Although we can find some evidence which can support the statement gentrification existed in the neighborhood, however, the area of neighborhood is larger than the census tract. We only can know the neighborhood has gentrification project, but on the detail on which census tract, the result maybe has some error which is unable to be identified. Lacking the precise gentrification project location and period is the potential error existed in my model.

5.2 Future Study

Many of the study results are really interesting, though further investigation is needed. For instance, How to define the fringe gentrification area and what is the relationship between fringe gentrification area and gentrification frontier. These questions
can be concluded in next step analysis. For example, we can conclude the social and economic characteristics of the fringe gentrification, by comparing the redevelopment history and do some field survey in these areas. Hence, how to find the characteristics of fringe gentrification area in the real world will be the next step for this study.

In addition, it is interesting to find out why some socio-economic characteristics affect gentrification pattern and others do not. We can apply more variables to classify the more than 800 census tracts and also can do the discriminant analysis to the categories which already has been classified. For example, we can use model to classify the fringe gentrification area and core gentrified area, the observation just includes these two categories, the leading variables which gave by the model can tell us the most difference between this two categories. The different leading variables of different categories classification will be another aspect to study how gentrification impacts the social and economic characteristics of community.

Another interesting area for future study is how to predict the gentrification spread in the future period. We already have classified result and spatial distribution for the 40 years, 4 periods, from 1960 to 2000. We can do the prediction for the period between 2000 and 2010, and then when the census tract data for 2010 is available, does the normal discriminant analysis for 2000 to 2010, then comparing the result of prediction to the discriminant result. The step needs to use some spatial analysis model to development a quantitative predict method of gentrification.

Further research also is needed to gauge the extent and character of the phenomenon and its spread during the considerable urban transformations of the 1990s. It means that the continued transformation of urban industrial and occupational structures,
along with the current devolution of federal housing policy and the state and city levels, mean that contextual differences in how gentrification occurs will be of increasing importance for both urban theory and urban policy. Hence, we also need to identify whether my classification result can fit the redevelopment progress and purpose of CHA. And we can add the poverty population data in the model in order to find the relationship between gentrification and de-concentrate poverty, which has the perfect example as HOPE VI. So applying the quantitative methodology on the urban policy such as the gentrification should be the mainstream in urban geography.
References


