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HOUSING PRICE EQUALITY AND MIXED COMMUNITIES EXPLAINED BY THE  
PROCESS OF GENTRIFICATION: EVIDENCE FROM CHICAGO.

Laura Atuesta

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# Housing price equality and mixed communities explained by the process of gentrification: Evidence from Chicago.

Laura Atuesta<sup>a</sup> \*

<sup>a</sup> *Department of Agricultural and Consumer Economics  
University of Illinois at Urbana-Champaign*

## SUMMARY

During the decade of 1990s, cities in the US have undergone different gentrification processes. In Chicago, the process of gentrification cannot be studied as a unified phenomenon because the causes and consequences are different depending on the demographic characteristics and spatial location of the gentrified neighborhoods. When the gentrification process involves a mixture of ethnic and income groups, gentrified neighborhoods develop more housing price equality than non-gentrified neighborhoods. This is the case of gentrified tracts in the North and Northwest sides of the city, areas where most of the gentrified neighborhoods are located. While in the North and the Northwest, the gentrification was characterized by an influx of Hispanic population in white neighborhoods, in the South, it was driven by high-income blacks in predominantly black neighborhoods. Using a theoretical model originally developed by [Epple and Sieg \(1999\)](#), empirical evidence of heterogeneity of income and preferences in neighborhoods that have been gentrified will be presented, and housing price equality using quantile analysis will be conducted. The analysis will explore the effects of gentrification on different percentiles of the housing price distribution. Gentrification in the North and Northwest does not affect prices in the lower tail of the distribution allowing the lower-income Hispanic population to enjoy housing opportunities outside their ethnic enclaves, and increasing price equality in gentrified tracts.

**Keywords:** gentrification, housing price inequality, mixed-income neighborhoods, quantile regression.

## 1. INTRODUCTION

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Many large American cities have recently undergone a gentrification process generating mixed-income neighborhoods in central locations. Gentrification refers to the process of resettlement of the upper middle class in low income city neighborhoods (Clay, 1979). The process is dynamic and is characterized by an influx of investment and high income households into a central metropolitan area that initially suffered from disinvestment and one that was populated by low-income households (Freeman, 2005). Most of research in gentrification has been conducted at the national or metropolitan area (MSA) level without differentiating among regions. In the city of Chicago, gentrification processes are different in the South, West and North. For example, in the South, the process was driven by an influx of high-income blacks, in the Northwest was driven by an increment on the proportion of high-income Hispanics, and in the North, by an influx of low-income Hispanics. These different processes of gentrification generate different impacts on the local housing markets. While in the South, the housing price inequality increases in gentrified neighborhoods, in the North and Northwest, the price equality in gentrified neighborhoods is greater than in non-gentrified neighborhoods.

Given the possibility of different gentrification processes occurring in a city depending on the spatial location and the demographic composition of the gentrified neighborhoods, the theoretical model of Epple and Platt (1998), and Epple and Sieg (1999) is used to explain how people with different preferences and different income can live in the same neighborhood in equilibrium once the population is sorted not only by income but also by preferences. Because preferences are not observable, the population is divided by race and income groups to characterize different levels of income and preferences on the assumption that preferences vary by race. The results suggest that the low-income population is not displaced from gentrified neighborhoods because gentrification only affects the prices of the high-valued dwellings but not the ones located in the lower tail of the price distribution. When the lower tail of the price distribution is affected (in the case of the North side) it is because prices are driven down due to the gentrification process. With this new evidence, policies against or in favor of gentrification can be reevaluated.

This paper has two main contributions to the literature. The first one is an explanation of

the behavior of prices in gentrified and non-gentrified neighborhoods in different areas of the city by analyzing the tails of the housing distribution rather than the mean values. By using individual housing transactions within the neighborhood, albeit will be possible to analyze if the effects of the coefficients in the lower tail of the distribution are the same as in the mean of the distribution and in the upper tail, and therefore, provide an empirical explanation that supports the mixed neighborhood equilibrium suggested by the theoretical model once population is sorted by income and preferences.

The second contribution is to show that most of the gentrified neighborhoods in Chicago have higher housing price equality than non-gentrified neighborhoods, and this equality is achieved by an increasing proportion of the Hispanic population in gentrified neighborhoods. Improving price equality in the housing market has been an important political concern for housing authorities. In almost every state, local authorities have developed housing equality policies in order to diminish the unfair treatment received by low-income and minority groups. At the national level, the 1968 Fair Housing Act aimed to secure equal access to housing in order to mitigate discrimination by race, national origin, religion, disability, and family status (Sidney, 2004).

At the specific case of Chicago, the Chicago Housing Authority and the Department of Housing and Urban Development have been interested on diminishing the level of housing segregation in the city. The programs of mixed-income housing development are focused on mixing poor population with better-off households. Examples are the Gautreaux program (1966-1998) which offered housing opportunities in desegregated areas (mostly in predominantly white neighborhoods), the HOPE VI housing redevelopment program, and the Lake Parc Place program<sup>1</sup>. If the processes of gentrification in the city that involve an influx of Hispanic population create mixed communities, without the implementation of housing affordability programs, the results of this paper would be helpful for the development of new housing programs that take into account the relationship between public policy and local private market forces (Wyly and Hammel, 2000).

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<sup>1</sup>For details, see Wyly and Hammel (2000) and vonHoffman (1996).

The paper is divided as follows: Section 2 makes a review of the previous literature on gentrification and mixed-income neighborhoods. Section 3 introduces the theoretical model developed by Epple and Platt (1998), and Epple and Sieg (1999) that explains the equilibrium of communities sorted by income and preferences. Section 4 makes a description of the data set and the empirical model. Section 5 analyses the results and Section 6 provides some concluding comments.

## 2. LITERATURE REVIEW

Most of the gentrification studies in the literature are based on the monocentric city model first proposed by Alonso, Mills and Muth in 1960s (see Glaeser (2008) for a review). Brueckner and Rosenthal (2008) argue that the main cause of the gentrification near the center in U.S. is the redevelopment of the center and the creation of a “young” downtown. According to their work, high-income people prefer to live in new or renovated properties. Verifying the conclusions of the Alonso-Muth-Mills model, upper income classes were located in the suburbs because the suburbs were newer than the center. However, a second generation of neighborhoods is being built closer to the downtown, attracting high income people to live in the cities again, and linking the housing location decision to the gentrification process.

McMillen (2008) conducted a quantile analysis of housing prices in Chicago using the same data set used in this paper for testing whether changes in the distribution are explained by changes in the distributions of the explanatory variables, or changes in the coefficients. Although he did not distinguish between gentrified and non-gentrified neighborhoods, and the purpose of his paper was different from this one, he concludes that over time, the appreciation of housing prices in Chicago is explained by the appreciation of prices located in the upper half of the price distribution rather than in the lower half which has remained stable through time.

Evidence about displacement of low-income population in gentrified neighborhoods is

mixed in the literature. Studies based on surveys of community leaders and active groups claim that gentrification produces displacement of low income population (Nyden et al., 2006, Palen and London, 1984). However empirical analyses have shown that the displacement evidence is not supported by the data. Freeman (2005) defines gentrified neighborhoods as those tracts that presented an increase in educational attainment, an increase in housing values and those where poor income population lived before the gentrification. Using census tract data combined with the Panel Study of Income Dynamics (PSID) survey, he is able to identify household heads who live in gentrified neighborhoods and to estimate their probability of moving once the neighborhood is gentrified. Regressions were estimated for households located in gentrified and non-gentrified neighborhoods. Freeman concludes that the probability of displacement from gentrified neighborhoods is slightly higher than from non-gentrified neighborhoods, suggesting that gentrification does not generate large displacement of the low-income population.

Immergluck and Smith (2003) conduct a study of income mixing and racial diversity in Chicago throughout the 1990s. Their findings show that the proportion of minority home buyers (mostly Hispanics) increased significantly from 1990 to 2000 and the neighborhoods with predominantly white home buyers decreased from 443 to 301. However, neighborhoods that are predominantly black remained constant, and predominantly Hispanic decreased, suggesting that Hispanic homeowners are more distributed than black home buyers. After dividing Chicago into five categories of income diversity, they conclude that there is high diversity in the housing markets of the North and Northwest sides of the city. However, the North is predominantly restrictive followed by the South, Southwest and West sides. The authors found that Hispanic tracts are more likely to face racial gentrification (with an influx of white home buyers higher than 20% ) than black tracts. Only 31.5% of white buyers are buying into neighborhoods that are at least 90% white. 43% of black buyers are buying into tracts that are predominantly black, while only 24% of Hispanics buy into neighborhoods that are predominantly Hispanics.

Martin (2007) defines the Hispanic immigration in the US using the spatial assimilation

model. This model was first developed in Chicago at the early 1900s to explain the immigration phenomenon from Southern, Eastern and Central Europe (Martin, 2007). According to this theory, the immigrant groups decide to segregate concentrating themselves in ethnic neighborhoods until they learn the language and achieve higher education attainment. Once they achieve these characteristics, they look for better housing and socioeconomic opportunities outside the enclaves. Using the index of dissimilarity (D)<sup>2</sup>, the author concludes that in 2000, for the specific case of Chicago, the Hispanic/white segregation measured by the dissimilarity index was 0.62, the Mexican/white segregation was 0.64 for a total number of Hispanics in the metropolitan area of 1,416,600 according to Census data.

### 3. THEORETICAL MODEL

Gentrification in Chicago was driven by different demographic groups depending on the spatial location of the neighborhood. In the North and Northeast, where most of the gentrified neighborhoods are located, a relevant influx of Hispanic population differentiates gentrified neighborhoods from non-gentrified neighborhoods. Most of these areas were European and white neighborhoods before the gentrification process. Nowadays, they are mixed-neighborhoods where people from different races and incomes coexist.

Once Hispanics decide to leave the ethnic enclaves, mixed-income neighborhoods are created and complete sorting of income is not longer valid. According to Schelling (1969) people sort based on their preferences for the attributes of their neighbors. On the other hand, Tiebout (1956) developed a theory in which people sorting is based on their preferences for locally provided public goods. The behavior of Hispanics follows Tiebout model: once they achieve a higher socioeconomic status, their preferences for public goods change, and they decide to leave the enclave for neighborhoods with a better public goods provision (lower

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<sup>2</sup>The dissimilarity index measures how evenly a group is spatially distributed by calculating what percentage of the group would have to relocate to achieve an even distribution. A value of zero means that the group is evenly distributed across all the area. A value of one means that every person in the group would have to relocate in order to achieve an even distribution.

crime rates, better school quality, etc), even if they have to pay higher property taxes which are reflected in higher gross housing prices.

Epple and Platt (1998), hereafter EP, and Epple and Sieg (1999), hereafter ES, describe the conditions necessary to achieve an equilibrium among communities when households differ in income and preferences (preferences for the public good locally provided). When households differ only in income, a complete stratification by income is achieved based on the monotonic variation of the marginal rate of substitution across households. However, when individuals differ not only in income, but also in preferences, this stratification is only partial and there will be mixed-income communities in equilibrium where high and low income groups are living together. Because preferences are unobservable, it will be assumed that preferences differ among race/ethnic groups (different preferences for whites, blacks and Hispanics).

The model explains the equilibrium of gentrified neighborhoods when they receive an influx of population from a different race and income. Following the notation of Henderson (1985), EP and ES, and including differences in preferences defined in ES, assume that there are only three goods in the economy: housing ( $h$ ), a public good ( $g$ ) and the numeraire ( $b$ ). Households are characterized by their level of income and their preferences towards the locally provided public good<sup>3</sup>. They choose the amount of housing and the numeraire in order to maximize their utility, subject to a budget constraint:

$$\text{Max}_{h,b} \quad U(h, g, b; \alpha) \tag{1}$$

$$\text{s.t.} \quad ph = y - b, \tag{2}$$

where  $y$  is income,  $p$  is the price per unit of housing that changes by neighborhood, and  $\alpha$  is the public good preference parameter. The price per unit of housing  $p$  is a gross-of-tax

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<sup>3</sup>The public good  $g$  is a vector of public goods, environmental amenities and other attributes of the neighborhood. It is irrelevant if the amenities were generated by the local government or not because this model does not require a collective choice mechanism.

price and include the ad valorem tax  $t$  on property values. Then, by choosing the level of housing given the price, the agents of the community indirectly choose the level of public goods provided (housing demand is affected by the preference parameter). Replacing the first order conditions in the utility function leads to the following indirect utility function:

$$V(g, p, y; \alpha) = U(g, h(p, y, g; \alpha), y - ph(p, y, g; \alpha); \alpha), \quad (3)$$

where  $h(\cdot)$  is the housing demand for households with income and preferences  $(y, \alpha)$  obtained from the maximization problem. From Roy's identity, the housing demand is defined as:

$$h(p, y; \alpha) = -\frac{(\partial V/\partial p)}{(\partial V/\partial y)}. \quad (4)$$

Given the indirect utility function (equation 3), the indifference curves can be drawn in a  $(g, p)$  plane by obtaining the slope of the equation 3:

$$M(g, p, y; \alpha) = \frac{dp}{dg}_{V=\hat{V}} = \frac{\partial V(g, p, y; \alpha)/\partial g}{\partial V(g, p, y; \alpha)/\partial p} = \frac{1}{h(p, y, g; \alpha)} > 0. \quad (5)$$

For the existence of the equilibrium, equation 5 must be monotonic in income for each preference parameter  $\alpha$ , and monotonic in  $\alpha$  for each level of income. Then, the "single crossing" property condition is satisfied in income  $y$  and preferences  $\alpha$ . Three conditions are necessary for the existence of equilibrium:

1. *Boundary Indifference:*

Define two communities,  $j$  and  $j + 1$  with public goods  $g^j < g^{j+1}$  and prices  $p^j < p^{j+1}$ . By continuity of income groups, there will be an income group  $\hat{y}(p^j, p^{j+1}, g^j, g^{j+1}; \alpha)$  such that:

$$V(g^j, p^j, \hat{y}(p^j, p^{j+1}, g^j, g^{j+1}; \alpha); \alpha) = V(g^{j+1}, p^{j+1}, \hat{y}(p^j, p^{j+1}, g^j, g^{j+1}; \alpha); \alpha). \quad (6)$$

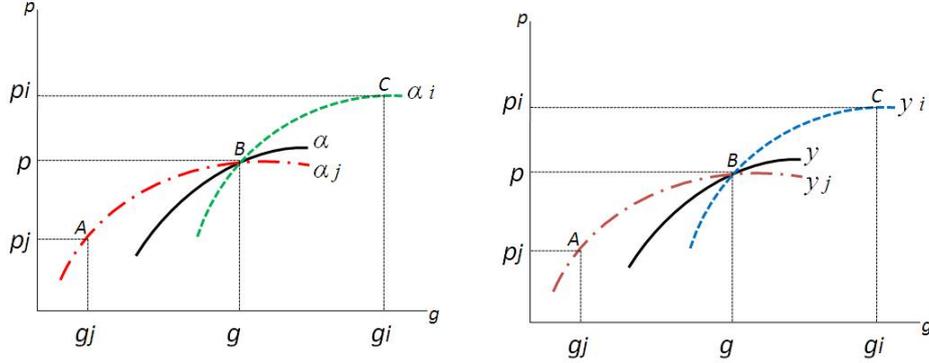


Figure 1: Equilibrium conditions and single-crossing property in preferences  $\alpha$  (left) and income  $y$  (right) (see Appendix A, ES p. 676).

## 2. Stratification of income:

By continuity of income groups,

$$y^j(\alpha) < \hat{y}(p^j, p^{j+1}, g^j, g^{j+1}; \alpha) < y^{j+1}(\alpha). \quad (7)$$

## 3. Increasing bundles:

Define two neighborhoods,  $i$  and  $j$ . Prices and public goods are higher in neighborhood  $i$  than in neighborhood  $j$ . That is,  $p_i > p_j$  and  $g_i > g_j$ . The “single-crossing” property in income requires the high-income population to be located in neighborhood  $i$  and the low-income population in neighborhood  $j$ . In a similar way, the “single-crossing” property in preferences require the population with higher preferences to be located in neighborhood  $i$  and the population with lower preferences in neighborhood  $j$ . The “single-crossing” property requires that the the indifference curves of the two income (preference) groups cross only once, and the one of the group with lower income (preference) with a greater slope than the one with higher income (preference) (Mas-Colell et al., 1995, p.453).

Figure 1 is an illustrative example of the conditions imposed. “Low” groups (in income and preferences), called  $y_j$  and  $\alpha_j$ , will live in neighborhood  $j$ . “High” groups will live in neighborhood  $i$  and will be called  $y_i$  and  $\alpha_i$ . Groups  $y_j$  (and  $\alpha_j$ ) will be indifferent between points A and B while groups  $y_i$  (and  $\alpha_i$ ) will be indifferent between points B and C. By

the continuity of income groups, there exists an indifferent group,  $y$  and  $\alpha$ , which will prefer point B rather than A or C. The indifference curves of the three groups in the  $p, g$  map have positive slope and the single-crossing property will be satisfied with respect to income and preferences: as income (preferences) increases, the slope of the indifference curves decreases. In this case, the neighborhoods are stratified not only by income, but also by preferences for the provision of public goods. Then, in equilibrium, there will be neighborhoods with high and low-income groups, the same as neighborhoods with people with high and low preferences for public goods.

This framework can be used to explain the development of gentrification. Neighborhoods in the Northwest of Chicago closer to Milwaukee Avenue have been gentrified by Hispanics in the 1990s. One example, Logan Square at the Northwest of the Loop, was a community where mainly European immigrants lived after the World War I. The proportion of whites living there was 99.2% in 1960, but in 2000, 65.1% of the population was Hispanic. However, the neighborhood is not considered a Hispanic enclave, because of the existence of Americans and Polish that coexist next to the Hispanics ([Patterson, 2005](#)). According to the assimilation theory explained above, Hispanics decided to migrate to this neighborhood looking for better opportunities and a higher provision of public goods. There are still some other groups (Polish and Americans) who lived there based on their income stratification (if sorted with respect to other white groups) making Logan Square a mixed-income and race neighborhood.

Following this theoretical framework, three questions will be answered by the empirical model:

1. Are gentrified neighborhoods mixed communities due to the fact that low income population is not displaced from the neighborhood?
2. Is equality in housing prices a consequence of mixed communities? How this equality is achieved if low-income population is not displaced?
3. What is the role played by the Hispanic population in the gentrification process? What are the differences between the processes of gentrification in different areas of the city?

## 4. DATA SELECTION AND EMPIRICAL MODEL

### 4.1 Definition of gentrification

There are different definitions of gentrification based on housing prices changes or on changes in household status (household size, structure, income or education). Because the process of gentrification is complex, it is not possible to include all the neighborhood changes in one single definition. In this paper, housing prices in poor neighborhoods are used to identify gentrified neighborhoods. The reason why this definition of gentrification was chosen is because one of the objectives of this paper is to measure the effect of Hispanic migration in Chicago local housing markets. Although the monotonicity between income and housing prices is assumed, a definition of gentrification based on income changes may not show this effect because not always the process of gentrification was driven by high-income Hispanics <sup>4</sup>.

For the definition of gentrification, two periods of time were chosen: period zero and period one. Tracts that were located in the three lowest quintiles of the income distribution in period zero were selected. For those tracts, the median housing price in period one was calculated and was compared with the median housing price of the central city. Gentrified neighborhoods are those tracts that, in period one, have a median price higher than or equal to the median price of the city and were located in the three lowest quintiles of the income distribution in period zero. Gentrification dummy ( $g_i$ ) is equal to one if:

$$(a) Y_{it=0} \in \tau \leq 3, \text{ and}$$

$$(b) P_{it=1} \geq \bar{P},$$

where  $g_i$  is the gentrification dummy for neighborhood  $i$ ,  $Y_{it}$  is the income mean of neighbor-

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<sup>4</sup>A sensitivity analysis was realized in which gentrification was defined by income changes in poor neighborhoods instead of housing prices. Results show that most of the income-gentrified neighborhoods are located in the North and West, instead of the Northwest, and the main demographic change in these locations was an increase of white population. Tables and results are available upon request.

hood  $i$  in period  $t$ ,  $\tau$  are the income quintiles in  $t = 0$ ,  $P_{it}$  is the median price of neighborhood  $i$  in period  $t$ , and  $\bar{P}$  is the median price for the city. For this analysis, period zero is 1990 and period one is 2000. Although there have been several processes of gentrification in Chicago since 1980, only in the decade of the 1990s, did Hispanics play an important role in the process. The gentrification definition was created by comparing the median price for the tract with the median price for the city, but it does not include more information about the housing price distribution of the neighborhood. Therefore, when estimating the quantile regressions for analyzing the price distribution, problems of correlation (circularity) between the dependent and independent variables are not expected.

## 4.2 Inequality measures

To understand housing price equality in gentrified neighborhoods, three measurements of inequality were taken into consideration: the Gini coefficient, the log of the ratio between the 95th percentile and 5th percentile and the coefficient of variation<sup>5</sup>. The Gini coefficient for a uniform population of tract  $j$  is defined as:

$$G_j = \frac{2 \sum_{i=1}^n iy_i}{n \sum_{i=1}^n y_i} - \frac{n+1}{n}, \quad (8)$$

where  $y_i$  are housing prices,  $i$  is the order of each of the prices, and  $n$  is the number of observations for each of the neighborhoods. The lower the Gini coefficient the more equal the neighborhood. The Gini coefficient is more sensitive to changes around the mean of the distribution than changes in the tails of the distribution because it is measuring the area between the 45 degrees line (total equality) and the Lorentz curve (graphical representation of the cumulative distribution function of the distribution) (Murray et al., 1998).

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<sup>5</sup>The kurtosis of the distribution which measures how concentrated the observations are in the tails (how thick are the tails) or in the peak (how rounded is the peak) was also included as an inequality measure. However, the results were not significant. Results are available upon request.

The log of the ratio between 95th and 5th percentiles of the housing price distribution per tract is calculated also as an inequality measure that is less sensitive to large or small values. The coefficient of variation (standard deviation over the mean) measures the dispersion around the mean of housing prices. It is more sensitive to high and low variables because all changes in prices are treated equally, no matter whether they are located in the extremes of the distribution. With both measures, the lower the value, the more price equal the neighborhood. Only neighborhoods that have more than five transactions were included in the analysis<sup>6</sup>.

### 4.3 Data sets and summary of statistics

Although the Chicago metropolitan area consists of six counties, the central city is located fully in Cook County. Then, only Cook County is taken into consideration for the econometric analysis. The demographic and income variables used in the model are obtained from the Neighborhood Change Database (NCDB) provided by Geolytics in which Census information of years 1970, 1980, 1990 and 2000 is standardized to year 2000 geographic specifications. The data set contains social, demographic, economic and housing data by census tract, county and state levels for the U.S. Individual housing transactions, including their characteristics, price, and month and year of sale were provided by the Illinois Department of Revenue. The housing information available is from January 1983 until December 2006.

There are two units of analysis in the econometric models: the first one, used for the quantile regression analysis are individual housing prices. Using “individual” observations instead of “aggregate” variables by neighborhood, makes it possible to analyze the behavior of the price distribution. The second one is neighborhoods measured by census tracts. Census tracts are the smallest unit of analysis provided by the Census and are the best proxy for measuring neighborhoods effects ([Tatian, 2003](#)).

Figure 2 shows the tracts that were taken into the analysis for 2000 characterized by their

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<sup>6</sup>I realized a sensitivity analysis to determine which the minimum of observations in each tract was without producing large changes in the distribution of the measures for all tracts and decided to delete tracts with less than five observations.

Gini coefficient and their gentrified status. It can be seen that most of the gentrified tracts are located in the Northwest and the North of the city, and most of them are more equal than non-gentrified tracts in terms of housing prices. Dark gray tracts are city neighborhoods without or with less than five housing transactions in 2000 and are not included in the econometric analysis. Of the 1,343 census tracts in Cook County, 863 are considered “city tracts” for being part of the City of Chicago. In 2000, there were 29,463 housing transactions of which 9,463 of those transactions occurred in city tracts. In 2000, only 443 city tracts from the 863 have more than five housing transactions<sup>7</sup>. Most if the tracts with zero or low number of observations are located in the downtown or closer to the downtown. This is because most of the housing market in that area is a renting market instead of a sales market. A similar analysis should be done to identify the effect of renters in gentrified neighborhoods, but it goes beyond the scope of this paper.

To understand the dynamics of the gentrification process, demographic groups are defined by level of income for each of the tracts. After controlling by the total population for each group, nine variables that measure the change in the proportion of each income-population group for each tract were generated: the change in the proportion of low-income whites (blacks, Hispanics), mid-income whites (blacks, Hispanics), and high-income whites (blacks, Hispanics).

The summary of statistics by location for 2000 are shown in table 1. Chicago was divided into nine geographical areas and the statistics are presented for those areas that have evidence of gentrification (excluded Central, Far Southeast side, Far Southwest side, and Southwest side). Figure 3 shows the nine geographical areas of the city: Central, Far North, Far Southeast, Far Southwest, North, Northwest, South, Southwest and West.

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<sup>7</sup>This number changes for every year. Number of tracts in 1990 were 405. Tracts with less than five transactions were not included in the analysis because the inequality measurements would be affected by the small number of observations per tract.



Table 1: Summary of statistics: changes in the proportion of population divided by income and race group

North	All Tracts (54)	Gentrified (24)	Non-gentrified (30)
proportion of whites	75.53%		
low white	4.30%	4.65%	4.02%
mid white	-2.91%	-3.73%	-2.25%
high white	15.10%	12.49%	12.96%
proportion of Hispanics	25.58%		
low Hispanics	5.55%	7.16%	4.20%
mid Hispanics	-0.05%	-1.59%	1.18%
high Hispanics	5.66%	4.50%	6.58%
proportion of blacks	5.27%		
low blacks	5.15%	2.09%	7.59%
mid blacks	-0.50%	-2.14%	0.81%
high blacks	6.93%	3.54%	9.65%
Northwest	All Tracts (55)	Gentrified (16)	Non-gentrified (39)
proportion of whites	72.75%		
low white	2.00%	3.51%	6.03%
mid white	-9.38%	-9.38%	-9.37%
high white	2.44%	2.23%	2.60%
proportion of Hispanics	41.95%		
low Hispanics	2.92%	3.03%	2.88%
mid Hispanics	-9.15%	-8.07%	-8.19%
high Hispanics	2.50%	2.83%	2.37%
proportion of blacks	2.69%		
low blacks	5.30%	3.51%	6.04%
mid blacks	3.65%	3.13%	3.87%
high blacks	5.54%	5.43%	5.59%
Far North	All Tracts (55)	Gentrified (15)	Non-gentrified (40)
proportion of whites	73.20%		
low white	4.87%	7.69%	3.81%
mid white	-5.63%	-1.33%	-7.24%
high white	4.64%	6.71%	3.65%
proportion of Hispanics	18.94%		
low Hispanics	4.44%	6.67%	3.61%
mid Hispanics	-6.47%	-2.05%	-8.14%
high Hispanics	2.88%	3.31%	2.72%
proportion of blacks	6.35%		
low blacks	3.01%	5.09%	2.24%
mid blacks	-1.10%	24.59%	-2.44%
high blacks	6.88%	4.10%	7.93%
West	All Tracts (47)	Gentrified (8)	Non-gentrified (39)
proportion of whites	25.55%		
low white	7.67%	13.70%	6.43%
mid white	-3.44%	9.20%	-6.03%
high white	6.54%	18.05%	4.18%
proportion of Hispanics	31.90%		
low Hispanics	6.66%	13.96%	5.17%
mid Hispanics	-0.29%	7.65%	-1.92%
high Hispanics	2.44%	4.44%	2.03%
proportion of blacks	52.51%		
low blacks	9.08%	19.59%	6.92%
mid blacks	-0.21%	3.93%	-1.06%
high blacks	2.60%	3.80%	2.35%
South	All Tracts (29)	Gentrified (4)	Non-gentrified (25)
proportion of whites	13.93%		
low white	2.47%	12.76%	21.19%
mid white	-4.29%	3.36%	-5.52%
high white	7.53%	7.65%	7.51%
proportion of Hispanics	5.49%		
low Hispanics	-2.41%	9.14%	-4.26%
mid Hispanics	-1.81%	-9.82%	-3.67%
high Hispanics	2.24%	0.00%	2.60%
proportion of blacks	74.65%		

low blacks	13.92%	21.19%	12.75%
mid blacks	-3.65%	7.76%	-5.48%
high blacks	3.84%	8.91%	3.02%

Table 1 shows how different the processes of gentrification are in different areas of the city. Most of the gentrified tracts are located in the North, Northwest and Far North sides of Chicago. Most of the population in the North is white, in gentrified and non-gentrified neighborhoods. White population was also the ethnic group that presented the greatest changes in the area, suggesting that gentrification in the North side was driven by white population. However, the increment of low income Hispanics was also significant in gentrified tracts, change that is not related with the existence of ethnic enclaves, but by the influx of this population in gentrified neighborhoods.

The Northwest side had sixteen gentrified neighborhoods in 2000. The area is predominantly white with an average white proportion per tract of 72.75% . The only ethnic group that presented an increase of high-income population greater in gentrified than non-gentrified tracts is the Hispanic population. Low-income Hispanics also increased more rapidly in gentrified tracts suggesting that the process of gentrification was driven mainly by the Hispanic population.

In the Far North side, fifteen gentrified tracts were found. Although most of the population is white (73.20% on average per tract), the increment of high-income Hispanics and mid-income blacks was greater in gentrified than non-gentrified tracts suggesting that Hispanics also played a role in the gentrification process in the area. The West is the most diverse area of the city. The average proportions of whites, Hispanics and blacks per tract are 25.55% 31.90% and 52.51% respectively. It is also interesting to observe that the increment of low-income population for all ethnic groups increased higher in gentrified than in non-gentrified neighborhoods. Just observing this data, it is not possible to provide an explanation of gentrification in this area. There were only four gentrified tracts in the South side of the city.

The proportion of blacks in the South is 74.65% on average per tract and the increment of low-, mid- and high-income black population were higher in gentrified tracts than in non-gentrified tracts suggesting that the gentrification process was mainly driven by black population in predominantly black neighborhoods.

Table 2 provides the averages of each of the measures of housing price inequality for gentrified and non-gentrified tracts in each of the regions where the gentrification was observed. In the North and the Northwest, the gentrified neighborhoods are more price equal than the non-gentrified neighborhoods. In the South and the Far North, non-gentrified neighborhoods are more price equal than gentrified neighborhoods, and in the West, the differences are not significant having almost the same values for all the inequality measures. Because most of the gentrification in the North and Northwest was characterized by an increment of the Hispanic population, the data suggests that the presence of Hispanics in the neighborhood increase housing price equality.

According to the theory proposed before, the influx of Hispanic population in the North and Northwest sides allow the mixed neighborhoods to be more equal than non-mixed neighborhoods. Although the data used does not reveal information about interaction of ethnic groups living in the same neighborhood, it seems that this housing price equality is achieved by the assimilation process undergone by the Hispanic population in mixed neighborhoods. Mixed-ethnic neighborhoods are not found in the South, where most of the gentrification resulted from an increment in the proportion of high-income blacks in neighborhoods that were already predominantly black. Because those neighborhoods are not ethnically mixed, there is no evidence of more price equality due to the process of gentrification.

#### 4.4 Empirical model

The first two questions that follow the theoretical framework can be explained by conducting a quantile analysis. According to the theoretical model, and the monotonicity of preferences

Table 2: Average of inequality measures for gentrified and non-gentrified neighborhoods

Area	Gentrified tracts			Non-gentrified tracts		
	Gini	ln ratio	CV	Gini	ln ratio	CV
Far North	0.147	0.958	0.289	0.123	0.755	0.232
North	0.126	0.741	0.249	0.179	1.061	0.370
Northwest	0.085	0.546	0.161	0.102	1.648	0.192
South	0.215	1.781	0.469	0.219	1.534	0.446
West	0.158	0.873	0.343	0.153	1.181	0.300

of public goods and housing prices for income and preferences, a mixed-income neighborhood is a community where high and low income people and people with high and low preferences for public goods live together. Hence, one would expect to find evidence of no displacement of low-income population from gentrified neighborhoods in order to satisfy the stability of the equilibrium of mixed neighborhoods. A semi-hedonic quantile regression is used with the log of housing prices as dependent variable, and the gentrification dummy and housing characteristics as independent variables. The hedonic function is an equilibrium function in which forces of housing supply and demand are implicitly included in the shadow prices of the characteristics estimated by the model. The hedonic price function has the following form:

$$\ln P_{ij}^\tau = D_j \alpha^\tau + X_i \beta^\tau + \mu_j^\tau + \epsilon_i, \quad (9)$$

where  $\ln P_{ij}^\tau$  is the log of price of house  $i$  which belongs to the  $\tau$ th percentile of the distribution and is located in area  $j$ .  $D_j$  is the gentrification dummy for each of the five geographical areas in the city where gentrification occurred (Far North, North, Northwest, South and West). It is important to make these geographical distinctions because mixed and more equal gentrified neighborhoods are expected to be found in the North and Northwest, where an influx of Hispanic population was present.  $X_i$  represents the structural characteristics of house  $i$ .  $\mu$  are location-fixed effects. The reason why tract-fixed effects are not included is because quantile analysis does not support controlling for fixed-effects as in OLS estimations (Koenker, 2005). Each coefficient  $\alpha, \beta, \mu$  is estimated to a specific  $\tau$ th percentile of the housing price distribution conditional on the values of the explanatory variables.

With the quantile model, albeit will be possible to test whether the variable coefficients are the same in different percentiles of the housing price distribution. Differences between the gentrification processes in different locations are expected. Inasmuch as the North and Northeast are more equal and more mixed than the South, West and Far North, the changes in prices are expected to be located in the middle and upper tail of the distribution rather than in the lower tail. In the South, where the gentrification process involved high-income blacks moving into already black neighborhoods, the stratification of income should be more complete than in mixed-neighborhoods, because the preference sorting is very small (following the idea of having changes in preferences characterized by ethnic/race groups). Therefore, the displacement of the low-income population will result from increase in prices of low-value properties. Changes in characteristics are included only to control for endogeneity of housing prices. Although they are reported in the results, no explanation of those coefficients will be provided.

The third conclusion of the theoretical model, which assumes a relationship between gentrification, housing price equality and existence of Hispanics, is tested using the analysis drew on [Murray et al. \(1998\)](#) whose attempted to measure how the education-finance reform affected the within-state spending inequality of school districts. The inequality on housing prices is explained using the changes in the proportion of the population divided by income and race groups described in table 1. As the data suggest, the influx of Hispanics will be expected to decrease the housing price inequality in the North and Northwest gentrified neighborhoods. On the other hand, because gentrification in the South was driven by high-income blacks, the influx of high-income blacks will be expected to increase the housing inequality in the South neighborhoods. While the quantile analysis uses housing prices, this regression uses neighborhoods (census tracts) as unit of analysis. Inequality measures are used as dependent variables, and gentrification by geographical areas and demographic/income groups as explanatory variables:

$$Y_i = D_i\alpha + High_j\beta_{1j} + Mid_j\beta_{2j} + Low_j\beta_{3j} + \epsilon_i, \quad (10)$$

where  $Y_i$  is the measurement of inequality,  $D_i$  is a dummy variable that identifies gentrified neighborhoods in each location  $i$ ,  $High_j$  are the changes in the proportion of high-income population of demographic group  $j$  ( $j$ = white, black and Hispanic),  $Mid_j$  are the changes in the proportion of mid-income population of demographic group  $j$ , and  $Low_j$  are the changes in the proportion of low-income population of demographic group  $j$ . Each of these demographic variables is an interaction term between location dummies and demographic/income variables, and only the variables that had a significant change in gentrified neighborhoods were included. A negative relationship between gentrification and inequality measures is expected in the North and Northwest with an important role played by Hispanics in the process.

## 5. ANALYSIS OF THE RESULTS

Table 3 shows the results of the regression proposed by equation 9. The results provide information about the composition of the neighborhood (if it is a mixed-neighborhood or not) by analyzing the price distribution. The quantile analysis allows the understanding of how the price equality is achieved: either as a result of an increase of the price of low-value properties, or generated by the decrease of the price of high-value properties.

Two results are expected from the quantile regression: first, evidence of the existence of mixed-communities in gentrified tracts by the no displacement of the low-income population, and secondly, evidence that gentrified neighborhoods have higher price equality than non-gentrified neighborhoods, achieved by the concentration of high-value property prices around the mean of the distribution.

However the results are mixed, depending on the different gentrification processes that have occurred in the city. In the case of the Far North Side, the results show no significant changes in the lower tail of the distribution suggesting no displacement of low-income population, but a significant increment on prices in the upper tail of the distribution suggests that gentrified tracts are more price unequal than non-gentrified neighborhoods. In the North,

the gentrified tracts have lower prices in the lower and upper tails, as well as in the middle of the distribution than the non-gentrified tracts. Since the reduction in the upper half is greater (33.3% ) than the one in the lower half (25.9% ), not only is there no evidence of displacement, but also that gentrified tracts are more price equal than non-gentrified tracts.

More equal gentrified tracts are also found in the Northwest side of the city. Prices located in the middle and in the 95th percentile of the distribution are lower in gentrified than in non-gentrified tracts achieving higher levels of price equality than non-gentrified neighborhoods. On the other hand, prices in the lower tail remain unchanged when the neighborhood is gentrified suggesting mixed-income neighborhoods with no displacement of low-income population.

Recall that most of the gentrified neighborhoods are located in the North and Northwest sides of the city. As these gentrified tracts are more price equal and low-income population is not displaced, one would expect a negative relationship between the inequality measures and the gentrification dummy. However, this relationship is not valid in the case of the gentrified neighborhoods located in the South, Far North and West of the city. There are no differences in the tails of the distribution between gentrified and non-gentrified neighborhoods in the South side. Most of the changes are presented in the middle of the distribution, with the gentrified tracts revealing higher prices than non-gentrified tracts. Although there is no evidence of displacement of the low-income population, higher prices in the middle of the distribution could suggest the displacement of mid-income population from gentrified tracts.

In the West, gentrified tracts have higher prices in all percentiles of the distribution. Because the increase in prices is higher in the upper tail (145% ) than in the lower tail (126% ), there is no evidence of more housing price equality when a neighborhood is gentrified. The increase in prices in all the percentiles of the distribution suggests that a gentrified tract is not a mixed-neighborhood and the low-income population is displaced.

The conclusion from the analysis is that in the Far North, South and West, gentrification process was characterized by an increase of housing prices in the middle or/and higher tails

Table 3: Quantile regression 2000. Dependent Variable: log of price. Independent variables: gentrification dummies (by location), housing characteristics and location-fixed effects. Percentiles analyzed: 5th, 50th and 95th.

	$\tau = 0.05$	$\tau = 0.50$	$\tau = 0.95$
gent-farnorth	.046 (.068)	.126 (.023)***	.202 (.041)***
gent-north	-.259 (.072)***	-.353 (.024)***	-.333 (.040)***
gent-northwest	.013 (.046)	-.079 (.016)***	-.169 (.029)***
gent-south	.086 (.175)	.324 (.060)***	-.137 (.105)
gent-west	1.267 (.108)***	1.105 (.039)***	1.451 (.065)***
dcbd	-.114 (.012)***	-.039 (.004)***	-.034 (.007)***
dnorth	.178 (.021)***	.080 (.008)***	.053 (.012)***
deast	.324 (.053)***	.140 (.020)***	.120 (.033)***
delstop	.177 (.011)***	.082 (.004)***	.062 (.006)***
dlake	.399 (.061)***	.172 (.023)***	.131 (.038)***
rr	-.008 (.018)	.017 (.006)***	.009 (.011)
el	.046 (.036)	.071 (.013)***	.146 (.022)***
age	-.008 (.0005)***	-.003 (.0002)***	-.0002 (.0003)
bedsno	.0009 (.016)	.017 (.005)***	.029 (.010)***
story2	.008 (.022)	-.044 (.008)***	-.015 (.012)
multilev	.007 (.060)	.040 (.020)**	.103 (.033)***
centair	-.0001 (.025)	.011 (.008)	.002 (.014)
garage1	.039 (.022)*	.032 (.008)***	-.023 (.014)*
garage2	.066 (.022)***	.058 (.008)***	.025 (.013)*
fireplace	.119 (.033)***	.123 (.011)***	.204 (.019)***
brick	-.014 (.023)	-.011 (.008)	-.021 (.012)*
basement	.141 (.028)***	.012 (.009)	-.007 (.014)
attic	.061 (.020)***	.002 (.007)	-.017 (.011)
lnland	.235 (.033)***	.280 (.011)***	.337 (.024)***
lnbldg	.300 (.048)***	.352 (.015)***	.436 (.031)***
e(N)	8435	8435	8435

Bootstrapped standard errors in parenthesis.  $p > 0.05$  \*,  $p > 0.01$  \*\*,  $p > 0.001$  \*\*\*

of the distribution, while in the North and Northwest side, the process was characterized by lower prices in the 50th and 95th percentiles (in the case of the Northwest side), or in all percentiles of the distribution (in the case of the North side). When the 95th and 50th percentile prices cease being concentrated around the mean, the neighborhoods are more price equal. On the other hand, if there are no significant changes in the lower tail of the distribution with gentrification, the neighborhood is more mixed because low-income population is not displaced.

Table 4 shows the results of the regression proposed by equation 10. The dependent variable for the first regression (first column) is the Gini coefficient, for the second regression (second column) is the log of the 95th/5th ratio and for the third one (third column) is the coefficient of variation. The independent variables are the gentrification dummy by location, and interaction terms between location and different demographic variables. According to table 1, the most significant changes in demographic variables by income and by location were included in the model in order to understand which groups decrease the level of housing inequality in the neighborhood. The interaction terms are the following:

- For the Far North side: high-income whites, low-income whites, low-income Hispanics and mid-income blacks.
- For the North side: high-income whites and low-income Hispanics.
- For the Northwest side: high-income Hispanics and low-income Hispanics.
- For the South side: high-income blacks, low-income Hispanics, low-income blacks, and mid-income blacks.
- For the West side: low-income whites, low-income Hispanics, low-income Blacks, high-income Blacks and mid-income blacks.

Gentrified neighborhoods located in the North and Northwest are more price equal than non-gentrified neighborhoods. However, no evidence of price equality is found in gentrified tracts located in the Far North and West. Surprisingly, gentrification in the South side has a negative relationship with inequality when the Gini coefficient and the coefficient of variation

Table 4: Dependent variables: Inequality measures. Independent variables include gentrification dummies by locations and demographics by income.

	gini	lnratio	cv
	(1)	(2)	(3)
gent-farnorth	.014 (.018)	.072 (.122)	.032 (.037)
gent-north	-.025 (.014)*	-.222 (.079)***	-.052 (.031)*
gent-northwest	-.042 (.010)***	-.278 (.067)***	-.086 (.021)***
gent-south	-.125 (.057)**	-.241 (.849)	-.260 (.140)*
gent-west	.004 (.042)	-.170 (.303)	.041 (.090)
highwhite-farnorth	.057 (.154)	.992 (1.220)	.132 (.302)
lowwhite-farnorth	-.401 (.238)*	-3.460 (1.819)*	-.798 (.462)*
lowhisp-farnorth	.185 (.130)	1.022 (.925)	.367 (.260)
midblack-farnorth	.055 (.046)	.665 (.359)*	.103 (.101)
highwhite-north	-.001 (.077)	-.202 (.440)	.099 (.183)
lowhisp-north	.126 (.165)	.542 (.766)	.244 (.365)
highhisp-northwest	-.019 (.180)	.021 (1.319)	-.043 (.372)
lowhisp-northwest	-.521 (.217)**	-4.192 (1.551)***	-1.062 (.455)**
highblack-south	1.821 (.387)***	10.968 (4.140)***	3.850 (1.030)***
lowhisp-south	-.036 (.044)	-.621 (.402)	-.045 (.090)
lowblack-south	.165 (.072)**	.817 (.563)	.465 (.189)**
midblack-south	.034 (.083)	.058 (.574)	.101 (.219)
lowwhite-west	-.013 (.076)	-.518 (.787)	-.122 (.187)
lowhisp-west	-.068 (.196)	-.774 (1.472)	-.042 (.390)
lowblack-west	.097 (.124)	1.270 (1.139)	.175 (.258)
highblack-west	.159 (.319)	2.813 (2.521)	.513 (.702)
mmidblack-west	-.028 (.176)	-1.440 (1.321)	.022 (.387)
e(N)	240	240	240
e(r2)	.25	.241	.243

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Robust standard errors in parenthesis.  $p > 0.05$  \*,  $p > 0.01$  \*\*,  $p > 0.001$  \*\*\*

are used. This equality in the South can be explained by the increase of prices in the middle of the distribution and the increase of mid-income blacks in gentrified neighborhoods (this group increased 7.76% in gentrified neighborhoods and decreased in 5.48% in non-gentrified tracts). In the North and Northwest, the Gini coefficient decreased by 0.025 and 0.042 points respectively in gentrified neighborhoods. The log of the 95th/5th ratio decreases in 0.222 and 0.278, and the coefficient of variation in 0.052 and 0.086 respectively.

Analyzing demographic variables, note that the low-income whites increase price equality in the Far North but the mid-income blacks decrease price equality. Because in gentrified neighborhoods the change in mid-income blacks was greater than the change of low-income whites (24.59% vs. 7.69% ), these neighborhoods in the Far North are more price unequal than non-gentrified neighborhoods. On the North side, demographic groups by income provide little explanation as to why gentrified neighborhoods are more price equal than non-gentrified neighborhoods. Although the increase of low-income Hispanics was higher in gentrified neighborhoods, the coefficient of this variable is not statistically significant. In the Northwest, price equality of housing prices is explained by the presence of low-income Hispanics. Although the high-income Hispanics increased more in gentrified than non-gentrified neighborhoods, it is the presence of low-income Hispanics that makes the neighborhoods more price equal. This result is according to the theoretical model. When more Hispanics decide to become homeowners by leaving their ethnic enclaves, they generate more mixed-income neighborhoods and more equality in the housing prices.

In the South, the increment of low-income and high-income blacks increases price inequality. Even if the gentrification dummy suggests more price equality in gentrified neighborhoods, this area is still the part of the city with the highest coefficients of price inequality and this is explained because there are no ethnically-mixed neighborhoods. Under the assumption that people's preferences depend on their ethnic group and observing that there is only one predominantly ethnic group in the South, a complete stratification of income is generated and neighborhoods become more price unequal. There are only eight gentrified neighborhoods in the West side of the city and no evidence that these tracts are more equal than non-gentrified

neighborhoods. Therefore, price inequality cannot be explained by income and demographic groups. None of the demographic variables included in the regression are significant in explaining inequality of housing prices in the West side.

## 6. CONCLUSIONS

In this paper empirical evidence is provided for the existence of heterogeneity of income and preferences in neighborhoods when they have been gentrified. Following [Epple and Sieg \(1999\)](#) tests for changes in prices in different quantiles of the housing price distribution are conducted in order to understand the dynamics of the gentrification process. In the North and Northwest sides of the city of Chicago, where most of the gentrified neighborhoods are located, the prices in the lower tail of the distribution are not affected by the process of gentrification suggesting that the low-income population is not displaced. If low-income groups are not displaced and the neighborhood is receiving an influx of high-income population, a mixed-income community is created.

Thereafter, once the existence of mixed-income neighborhoods is revealed, tests for housing equality in these neighborhoods are made. The results show that not only the prices of the low-value properties remain unchanged, but the increment on prices in the upper tail of the distribution are concentrated around the mean generating more housing price equality in gentrified than non-gentrified neighborhoods. Analyzing the changes in the proportion of ethnic groups in these neighborhoods and characterizing them by level of income, it was found that the Hispanic population plays an important role in gentrification and housing price equality. Not only does the Hispanic population remain in gentrified neighborhoods, but they also become homeowners and increase the level of housing equality. This is the case of gentrified neighborhoods located in the Northwest and North of the city. In the case of the South side, where gentrified neighborhoods are gentrified by high-income black population, the level of equality does not increase because a mixed-ethnic neighborhood is

not created. Since these neighborhoods were predominantly black before the gentrification process, population is sorted only by income but not by preferences (given the assumption that preferences change by race), and the stratification of income is almost complete.

The results of this paper are significant because they change the notion of the effects of gentrification on housing segregation. At least at the neighborhood level, housing segregation decreases with gentrification. But results may be different if more aggregated locations are analyzed. Chicago is still suffering of high levels of segregation at the inter-neighborhood level and the fact that gentrified neighborhoods are more price equal than non-gentrified neighborhoods does not mean that the city is less segregated than before. Racial and socioeconomic segregation is still observed when analyzing the North and Northwest sides of the city with the South and Southwest. A further analysis may investigate this issue deeper.

Further research needs to be conducted. First, because of data constraints, the assumption of monotonicity between income and housing prices had to be employed. Higher-value houses are bought by high-income population and vice versa. However, if information of ethnicity and income is provided for each housing sale transaction, this exercise can be replicated without using monotonicity assumptions and test if in effect low income population is not displaced from gentrified neighborhoods reassuring the existence of mixed-income communities.

Secondly, gentrification processes in the West and the Far North of the city are different than gentrification in the North and Northwest. The conclusions of this paper only apply for the North and Northwest where an influx of Hispanics was observed. Low-income groups increased significantly in the Far North and West gentrified neighborhoods. Additionally high-income groups increase also in the West, but none of these increments was able to explain gentrification or to provide evidence of no displacement or price equality in gentrified neighborhoods.

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