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DISPLACEMENT IN D.C.: A CASE STUDY OF GENTRIFICATION AND GRANGER-CAUSALITY IN OUR NATION'S CAPITOL

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ABSTRACT

This study looks at the causal forces behind the social relocation phenomenon known as gentrification. Location theory posits that ever increasing commute times coupled with falling crime rates in the city-center incentivize the high-income population to move from the suburbs to the city, driving up housing prices and displacing the low-income, original residents who live in the city. This paper applies location theory to Washington, D.C. in an attempt to explain the ongoing gentrification process through the displacement of original residents. City-wide data at the neighborhood level for housing prices and crime rates are analyzed to explore the causal relationships each has with gentrification. I find that falling crime rates and rising housing prices each Granger-cause gentrification just as gentrification Granger-causes both a decrease in crime rates and an increase in housing prices.

I. INTRODUCTION

Driving through Washington, D.C. today is very different from thirty years ago. From personal experience, a twenty mile commute can average close to ninety minutes. In those last thirty years, commute time has risen by over 20% (See Appendix Graph 1). The landscape of the city-center has also drastically changed. In the last twenty years, the violent crime rate has been cut in half (See Appendix Graph 2). New housing developments are springing up in underdeveloped areas. From 1995 until 2010, the median housing price (in 2011 dollars) rose more than three-fold from $180,000 to $549,000 (Neighborhoodinfo DC, 2011). These astonishing changes are not mere coincidence.

Upper income suburbanites spending hours of their lives in traffic can certainly see the draw of living in the city: more time with their families, more time to relax, more time in general. The safe neighborhoods in the city, however, are often incredibly expensive. Moreover, communities with cheap housing prices are usually not the safest. When crime rates in those communities fall, suburbanites may find city life not just appealing, but a realistic goal. They no longer would have to sacrifice the safety of themselves and their families, as well as spending an unreasonable portion of their income on housing, just to live closer to their work. This study is about those individuals.

This paper looks at suburbanites' preferences for security, commute time, and housing prices and applies those preferences to the demographic shifts that are undergoing in Washington, D.C. Gentrification in a nutshell is the process of middle and upper class individuals moving into neglected neighborhoods and displacing the poor and working class residents. This study does not aim to explain the initial stages of gentrification. The first gentrifiers often have different reasons for venturing into neglected neighborhoods than the suburbanites studied here, whether it be culture, lighting (for artists), or value for money. They are important, however, because after the initial stages of gentrification, the crime rates tend to fall, paving the way for the suburbanites at issue in this study to enter the city. Rather, this study examines how one section of the population, the suburbanites, can perpetuate the gentrification process and result in the further displacement of the original residents.

First, I place the suburbanites and their preferences for security, housing and travel time within the context of the gentrification literature. Then, I look for causal relationships among these characteristics. This study argues that displacement is the best indicator for gentrification and it gives reason to believe that the preferences of suburbanites are important factors in explaining the gentrification process.

II. LITERATURE REVIEW

In order to understand the gentrification process, it pays to define it formally. Perez (2004) defines gentrification as:

> An economic and social process whereby private capital (real estate firms, developers) and individual homeowners and renters reinvest in fiscally neglected neighborhoods through housing rehabilitation, loft conversions, and the construction of new housing stock. Unlike urban renewal, gentrification is a gradual process, occurring one building or block at a time, slowly reconfiguring the neighborhood landscape of consumption and residence by displacing poor and working class residents unable to afford to live in the 'revitalized' neighborhoods with rising rents, property taxes, and new businesses catering to an upscale clientele.

There is still much disagreement in the gentrification literature which emphasizes the broad nature of the process. Some scholars (Smith, 1979 in particular) cite the importance of upgrading the housing stock while others (Glass, 1964; Zukin, 1991) point to the significance of culture. I instead focus on a theme that runs throughout the literature (Brown-Sparacino 2010, Glass 1964, Smith 1998, Zukin 1991), which is also captured in the above definition: the displacement of poor and working class original residents.

The displacement of original residents is an integral part of the gentrification process because it distinguishes gentrification from mere urban upgrading. This study explores that displacement through an economic model based on consumer preferences for security and travel times propounded by O'Sullivan (2005). O'Sullivan (2005) applies location theory to gentrification by weighing the suburbanites' preferences for security and travel costs. The model gets at the intuitions of the suburbanite sitting in traffic; once the commute has become too long and/or the crime rate has dropped enough from the initial gentrifiers, the suburbanite will move into the city, taking advantage of the close proximity to work. The suburbanites moving into the city has several effects. First, it continues to drive the crime rate down for the same reasons the crime rate fell for the initial gentrifiers: more political clout, more incentive for the police to deter crime, etc. It also continues to drive housing prices up because more gentrifiers will demand houses in those neglected neighborhoods. Finally, and this is why the process is gentrification, it continues to displace the original residents.

The method of examining consumer preferences to study gentrification does have its critics, but I argue studies of this nature have merit because they look at individual forces, especially in the context of location theory. While rising travel costs and falling crime rates are factors in gentrification, placing them in the context of consumer preferences allows us to make sense of their interrelationship. The angst of the driver sitting in traffic from the suburbs to the city center can be quantified and studied within an economic model.

As I mentioned previously, commute time and crime rates are not the only consumer preferences at play in gentrification. The initial gentry are usually part of a small subset of the population; stereotypically, artists take advantage of the cheap rent for more naturally lit lofts that would otherwise be out of their price range (Lloyd, 2005; Zukin, 1982). Butler (1997) and Glass (1964) emphasize the importance of culture in the gentries' desire to move into the city. In that same vein, Butler (1997) looks at other factors people take into account when deciding to move into the city, including the price of the houses. Butler (1997) studied two gentrifying neighborhoods in Central London and surveyed the new residents about various things including why they selected the home they moved into. 40% of the residents chose their new house because of the journey to work and 49% of the residents chose their house because of its price. Price, along with security, is a large barrier for most people to live in the city. If, however, the price of a house is low enough and the neighborhood is safe enough, as is the case in gentrifying neighborhoods, suburbanites have the opportunity to move into the middle of the city.

The preference for security is also a common theme in the literature. A major barrier to suburbanites moving into cheap housing in the middle of the city is because the city neighborhoods are not as safe as the suburbs. If the violent crime rates fall in the middle of the city, people are more willing to take advantage of cheaper housing in those neglected areas, perpetuating the gentrification process. That being said, there is conflicting literature referencing crime's relationship with gentrification. McDonald (1986) provides a literature review analyzing the different pressures for crime to increase or decrease from gentrification. Most of the literature is centered around the

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effects of gentrification, but since the variables are all interrelated with gentrification after the initial stages, it pays to examine those relationships as well. Some studies point towards gentrification leading to a decrease in crime, especially over the long term, through neighborhood watches, the gentry having more sway with the police, or the displacement of the poor and working class original residents (who traditionally have a higher crime rate than the upper class gentry) (McDonald, 1986). On the other hand, the initial stages of gentrification may lead to an increase in crime rates because of higher reporting rates and conflict between the gentry and original residents (McDonald, 1986).

The idea that the forces reducing violent crime are more long-term while those increasing crime are more short-term follows much of the literature. Pressures reducing crime rates drown out higher reporting rates in the aggregate. The conflict between gentry and initial residents will subside once the original residents have been displaced. These point to an overall decrease in crime which was shown in several case studies of individual neighborhoods (McDonald, 1986; O'Sullivan, 2005; Kreager et al, 2011). While this paper also looks at a reduction in crime, it is fundamentally different from the neighborhood case studies because it examines the city-wide effects of gentrification. Using data from every neighborhood in a city serves two purposes. First, it allows us to study the gentrification process as it permeates throughout the entire city. Second, gathering data from many, small geographic areas allows regression analyses to be performed and Granger-causality tests to be employed.

III.   THEORY

O'Sullivan (2005) took location theory and applied it to gentrification in a consumer preferences model. While I have already generally described the forces at play in location theory, the following is a more formal treatment. Theoretically, it plays out as follows: at T_0, the high-income individuals live outside of the city with lower crime but longer commute times while the low-income individuals live inside the city where there is high crime and shorter commute times. As travel costs increase and crime in the city decreases, high-income individuals move into the city to take advantage of lower housing prices and shorter commute times without having to sacrifice too much safety.

In practice, this model is an oversimplification of gentrification. It is not diverse enough to account for all of the factors at play throughout the gentrification process. It does, however, provide an intuitive account of the perpetuating process of gentrification, especially when suburbanites are the incoming gentry. While the first gentrifiers are often part of a small subset of the population who have different preferences than the suburbanites at study here, location theory is more suited to capture the ongoing process of gentrification through those preferences of suburbanites. To relate it back to McDonald (1986), the high-income individuals from the suburbs are attracted to already gentrifying neighborhoods that have experienced some reduction in crime. They are likely not, as the first gentrifiers may have been, subjected to the tensions McDonald (1986) describes as possibly leading to an increase in crime because this reduction in crime is such an important factor for the suburbanites to move into the city.

This study is an extension of O'Sullivan's location theory in that it also includes the suburbanite's preference for housing. Affordable housing in the middle of the city is difficult to find, but gentrifying neighborhoods provide an avenue for suburbanites to take advantage of previously overlooked neighborhoods that are safer than they were in years past. This paper looks at gentrification in Washington, D.C. by looking at those housing prices along with commute times and crime rates. Displacement is a good measure of gentrification because regardless of the study of

gentrification, the displacement of poor and working class original residents is virtually always present.

Figure 1 shows the interrelationship among the variables.

Figure 1
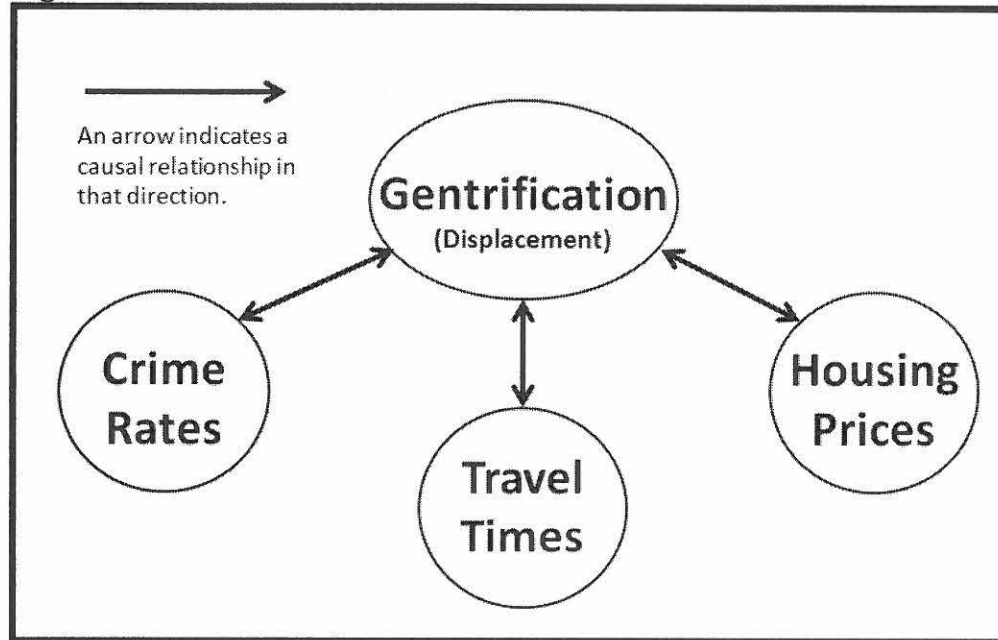
The main component labeled "Gentrification" accounts for the suburbanites' choice to move into the city as well as the concurrent displacement of the original residents. Reduced crime, low (though increasing) housing prices and longer travel times should all cause the gentry to move into the city. When the crime is low enough, the houses are cheap enough, and the commute is long enough, the gentry should move into the city. Because this paper examines the ongoing gentrification process, the relationship each variable has with gentrification should be causal in both directions. For example, once the gentrification process has started, crime should go down due to the various reasons McDonald (1986) cited. That low level of crime prompts suburbanites to make the move into the city according to location theory. Once those suburbanites have moved into the gentrifying neighborhood, the crime rates should drop even more, perpetuating the process. The same feedback loop can explain the relationship gentrification has with traffic and housing.

IV. EMPIRICAL MODEL

In order to look at the security and housing side of the location theory scale, this paper employs Granger-causality tests to examine the relationship between gentrification and the preferences of the suburbanites. A Granger test attempts to show causality between two variables, although it is closer to an inference than a conclusive finding. Granger-causality looks at whether a first variable is a better descriptor of a second variable than just the lags of the second variable. It operates from the intuition that the future cannot cause the past. The logic behind the Granger test is that if an independent variable 'X_t' and its lags 'X_{t-1}' combined with lags for a dependent variable 'Y_{t-1}' can give a better estimate of the dependant variable 'Y_t' than just 'Y_{t-1},' 'X_t' is said to have 'Granger-caused' 'Y_t.'

In the context of this study, it is possible for one variable to Granger-cause a second variable just as that second variable Granger-causes the first. If this occurs, the two variables are working simultaneously and both variables have some causal relationship with the other. This indicates a feedback effect, which is demonstrated in the ongoing process of gentrification. For example, increased housing prices could cause gentrification because they price out the original residents. As gentrification increases, housing prices increase even more due to the gentry's increased demand for those residences. This continues to accelerate the gentrification cycle. If neither variable Granger-causes the other, then the two variables still can be related, we just cannot make any causal inferences about them

The empirical model in this paper follows the Granger-causality test[1]. Six separate Granger-causality tests will be run: one in each direction between housing prices and gentrification, one in each direction between gentrification and crime, and one in each direction between housing prices and crime. As an example, I use the Granger-causality test between housing prices and crime. The Granger test takes the following form:

$$CRIME_t = \beta_0 + \beta_1 HOUSE_t + \beta_2 HOUSE_{t-1} + \beta_3 CRIME_{t-1} \qquad (1)$$

This is the unrestricted model. Next, the variables $HOUSE_t$ and $HOUSE_{t-1}$ are removed in the restricted model yielding the following equation:

$$CRIME_t = \beta_0 + \beta_1 CRIME_{t-1} \qquad (2)$$

An F-test is then run to determine if removing $HOUSE_t$ and $HOUSE_{t-1}$ has a statistically significant effect on the prediction of CRIME. The F-statistic calculated is as follows:

$$F_c = \frac{(ESS_R - ESS_U)/(DF_R - DF_U)}{ESS_U/DF_U} \qquad (3)$$

ESS is the Error Sum of Squares for the respective restricted and unrestricted models and DF is the Degrees of Freedom for the respective restricted and unrestricted models. If the F-test is significant, then it can be said that HOUSE 'Granger-causes' CRIME.

A second test then needs to be run to determine if CRIME 'Granger-causes' HOUSE. It looks exactly the same as the first Granger-causality test except the initial setup is as follows:

$$HOUSE_t = \beta_0 + \beta_1 CRIME_t + \beta_2 CRIME_{t-1} + \beta_3 HOUSE_{t-1} \qquad (4)$$

$$HOUSE_t = \beta_0 + \beta_1 HOUSE_{t-1} \qquad (5)$$

The F-test is then run to determine if CRIME 'Granger-causes' HOUSE. Two more Granger tests are then run with the variable TANF in place of the variable HOUSE. Equations 1-5 are followed and the methodology is exactly the same. Finally, two Granger tests are run between TANF and HOUSE to see if there is Granger-causality in either direction between those variables.

V.   DATA

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[1] I follow Ramanathan's methodology for Granger-causality in his textbook, *Introductory Econometrics with Applications* (2002).

This study uses crime[2] data (CRIME) directly from the Metropolitan Police Department's (MPD) Research and Analysis Branch as well as the FBI's Uniform Crime Reporting Database. Police Service Areas (PSAs) are used to approximate neighborhoods. PSAs are areas within each of the 7 police districts in Washington, D.C. and there are 56 PSAs. Ideally, this study would examine data going back to 1995 when crime was at a relative peak (See Appendix Graph 2). Unfortunately, MPD was not comfortable releasing data prior to 2004 due to reporting and geographic inconsistencies. Because of this, the study will only span from 2004 to 2010. Going back to only 2004 will yield a large enough sample size to conduct a regression analysis, but it is unlikely to show as strong of a correlation between the factors at hand. Because gentrification is a process, only six years might not be enough time to examine the process in its entirety.

In 2004, Washington, D.C. redrew the lines for the Police Service Areas. Unfortunately, the data from the Metropolitan Police Department coded for the post-2004 PSAs while the data from NeighborhoodInfoDC.com coded for the pre-2004 PSAs. While this certainly detracts from the credibility of the data, it does not completely undermine the study. The biggest issue is that in the redistricting, two new PSAs were created. Because this study cannot accurately redistribute the crime data from the new PSAs to the old ones, those data points have been omitted. That being said, the geographic area of a PSA is very small, one fifty-sixth of the entire city. The Police Districts have also not changed, so while the PSAs are slightly different, the neighborhoods still have a lot of overlap. Therefore, the omission of two PSAs is not a serious detriment to the study.

In order to approximate gentrification, I used Temporary Assistance for Needy Families[3] (TANF) which is a government subsidy given to indigent families. A decrease in TANF accounts for the displacement of the poor in certain neighborhoods, but it also can be used to approximate the increase in the gentry. That is useful because this paper looks at the preferences of the incoming suburbanites, not the displaced original residents. Using displacement as a proxy for gentrification gives us a relevant avenue to examine those preferences.

This study obtained TANF data from a website called NeighborhoodInfoDC.com which is a source that pulls together data from a variety of sources including the D.C. Department of Human Services and the D.C. Office of Tax and Revenue's Real Property Tax Administration's real property database. From this website, the number of individuals receiving TANF for each individual PSA is used. I use median housing data (HOUSE) for each PSA that were also obtained through the NeighborhoodInfoDC.com. All of the housing prices are in 2010 dollars. Median housing price not only accounts for increased demand of housing in the neighborhoods but investment in the housing stock as well.

I unfortunately do not have the commute data that allow me to perform Granger-causality tests. The only commute data are condensed in Appendix Graph 1. Because of this, we cannot make any Granger-causal statements about commute time and cannot evaluate the travel side of location theory. That being said, the data we do have support, to some extent, the location theory picture.

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[2] The 'crime' used in this study is violent crime rates. These may not reflect an actual decrease in the number of illegal acts committed, especially when the police do not practice uniform enforcement for various reasons. Regardless, crime rates are the best indicator for the amount of crime in a given area so that is why they are used in this study.

[3] TANF has a potential problem as an indicator for the displacement of original residents. If the residents are being "pulled up" as opposed to being "pushed out," then the TANF levels will fall but there will not be a population shift. However, it does not appear to be the case in Washington, D.C. As stated in the introduction, housing prices have tripled in 15 years. When an individual comes off of public aid, it is hardly likely that gentrification would pull them up enough to afford housing that is that much more expensive.

VI. RESULTS

My hypotheses are that HOUSE and CRIME each Granger-cause TANF, just as TANF Granger-causes both HOUSE and CRIME. Location theory holds that falling crime rates cause gentrification and the suburbanites' preferences for housing prices do the same. Because this study looks at the ongoing process of gentrification, gentrification should also cause housing prices and crime rates because of the feedback nature of the process. If the Granger tests show that my hypotheses are correct, this would be evidence for location theory and the gentry's preferences as an explanation for gentrification. This suggests that the gentry are moving in from the suburbs after the gentrification process has already started. Following from McDonald (1986), the crime rates have already started to fall as a result of gentrification, spurring on the process and incentivizing suburbanites to make the jump to the city. The theme of this study, that an integral aspect of gentrification is the displacement of original residents, fits the literature, but it is merely one force among many at play in the gentrification process.

Figure 2 is similar to Figure 1 in that it shows the interrelationships of the variables. The major difference is that "Traffic" is omitted. This is because I do not have enough commute data to run a Granger-causality test. "Gentrification (Displacement)," "Crime Rates," and "Housing Prices" have all been replaced with their respective variables, "TANF," "CRIME," and "HOUSE."

Figure 2
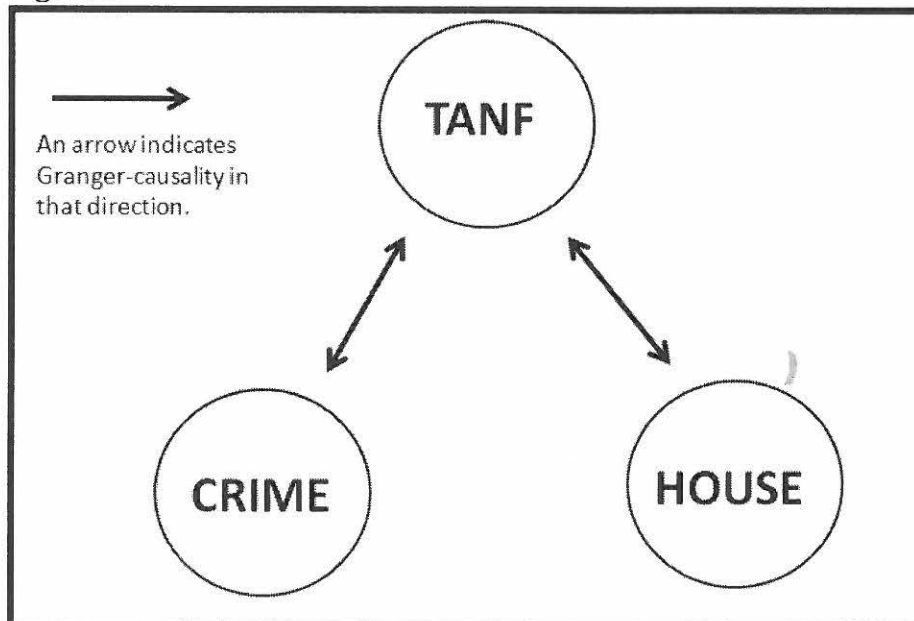
Each arrow indicates a Granger-causal relationship between the two variables. There are double arrows between HOUSE and TANF as well as between CRIME and TANF. This indicates that HOUSE Granger-causes TANF just as TANF Granger-causes HOUSE. HOUSE Granger-causing TANF is significant at the .1 level while TANF Granger-causing HOUSE is significant at the .05 level. CRIME Granger-causing TANF and TANF Granger-causing CRIME are both significant at the .01 level. The calculations can be found in Tables 1 & 2 in the appendix. This supports the idea that TANF, as an indicator for the displacement of original residents, is a good proxy for gentrification.

There is not a Granger-causal connection between CRIME and HOUSE. The calculations for Granger-causality can be found in Table 3 of the appendix. The Granger-causality tests for CRIME and HOUSE were insignificant, which shows that the one variable does not Granger-cause the other. This does not mean that CRIME and HOUSE are unrelated. Rather, it implies that they are better understood through the displacement of the original residents, or, in other words, through gentrification.

VII. CONCLUSIONS

While it may seem at first that the lack of a causal relationship between housing prices and crime is problematic, these results tell a lot about the gentrification process. As mentioned earlier, the characteristic that is pervasive throughout the literature is the displacement of original residents. It is not just about an upgrade in the housing stock. These results show how TANF, a proxy for the displacement of the original residents, is a good approximation for gentrification while crime and housing prices are actually causes and effects of the process. A drop in crime can cause gentrification, according to location theory, just as gentrification can cause that same drop in crime according to McDonald (1986). A rise in housing prices can cause gentrification by pricing out the original residents just as gentrification can cause an increase in housing prices because the demand for houses from the gentry increases. Since crime and housing prices were not shown to be Granger-causally linked, this does not mean the two variables are not related. Rather, according to the results, they are indirectly linked through TANF, suggesting that gentrification is best understood through the displacement of original residents.

Due to data restrictions, this is a limited study. That being said, it still draws some important conclusions. It takes a look at the city-wide process of gentrification and how it is affected by housing prices and crime rates, just as gentrification also affects those same variables. A logical extension of this paper requires a larger dataset to draw from, not simply regarding commute times but also in terms of number of years. This study only looks at data from 2004 through 2010. The gentrification process first began in Washington, D.C. in the early to mid 1990s. In order to get the prior data, a Freedom of Information Act (FOIA) request would be necessary.

Were we to have data on commute times, we could then run Granger-causality tests to see the relationship between those commute times and gentrification. Even with limitations concerning the travel data, Appendix Graph 1 still suggests that O'Sullivan's location theory has merit. The average commute time increased over 20% from 1980 until 2010. While no regressions were run and no causal inferences can be made, the trend does not give any reason to abandon location theory.

With a more complete data set, the complete gentrification process could be examined and location theory could receive a more thorough treatment. More characteristics of the gentrification process, including the movements of businesses (the Starbucks effect) and subcultures (often the impetus behind the initial stages of gentrification) could be examined.

Policy implications from this study, however, can still be made. The desirability of gentrification has received plenty of scholarship in its own right (Levy & Cybriwksy, 1980; Smith, 1998; Freeman, 2006) and the debate is still ongoing as to whether or not it is seen as a social good. The interrelationship between housing prices, crime rates, the number of poor, and, to some extent, commute times found in this study can be used by lawmakers to either promote or inhibit the gentrification process. The link between crime and gentrification suggests that crime reduction policies could make certain neighborhoods desirable to suburbanites, prompting those with long commute times to move into the city. On the other hand, combating rising housing prices with subsidies could help original residents maintain their homes.

In sum, this paper provides a method for analyzing city-wide gentrification which can be applied to other cities. Ideally, a city that has already experienced complete gentrification[4] could be studied using the same techniques and a better understanding of the interrelationship between the variables could be gleaned. Then, stronger conclusions could be reached and more definite policy implications could be realized.

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[4] By complete, I mean that the poor, original residents have all been displaced. This does not account for the "super-gentrification" examined by Less (2003) where high-income gentrifiers displace the middle income residents who once were gentrifiers themselves.

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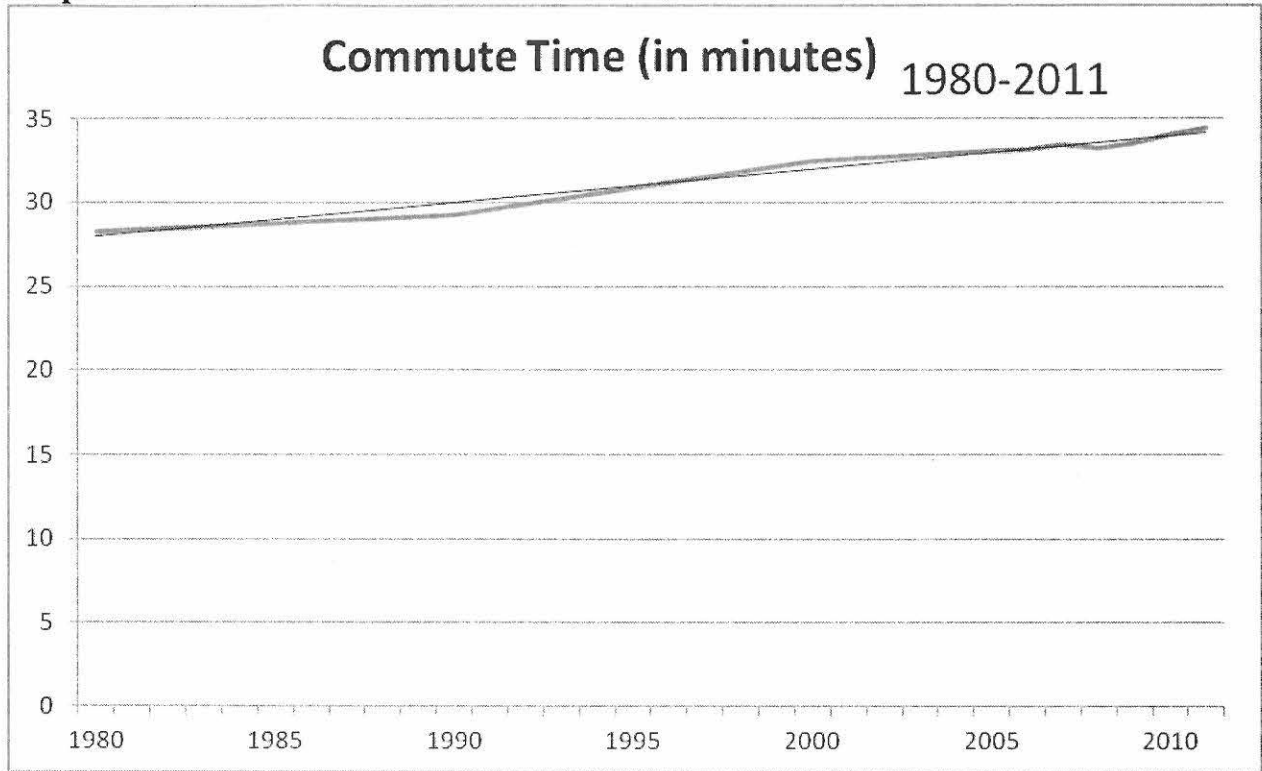
IX. APPENDIX

Table 1:		
A: Does HOUSE Granger-cause TANF?		
Variable	**Unrestricted**	**Restricted**
HOUSE	-.230 (-2.07)**	
$HOUSE_{t-1}$	.166 (1.52)	
$TANF_{t-1}$	.984 (102.81)***	.994 (146.46)***
Error Sum of Squares	1928613	1984167
Sample Size	191	191
F-Statistic	2.708*	
B: Does TANF Granger-cause HOUSE?		
TANF	-.097 (-2.07)**	
$TANF_{t-1}$	.085 (1.84)*	
$HOUSE_{t-1}$	.911 (33.75)***	.947 (49.07)***
Error Sum of Squares	811909	841927
Sample Size	191	191
F-Statistic	3.475**	

Table 2:

A: Does TANF Granger-cause CRIME?

Variable	Unrestricted	Restricted
TANF	-.200 (-3.15)***	
$TANF_{t-1}$	.216 (3.40)***	
$CRIME_{t-1}$	.954 (57.93)***	.976 (61.68)***
Error Sum of Squares	1435675	1569432
Sample Size	185	185
F-Statistic	8.48***	

B: Does CRIME Granger-cause TANF?

Variable	Unrestricted	Restricted
CRIME	-.259 (-3.15)***	
$CRIME_{t-1}$	.222 (2.74)***	
$TANF_{t-1}$	1.00 (133.98)***	.994 (142.01)***
Error Sum of Squares	1861376	1982638
Sample Size	185	185
F-Statistic	5.9***	

Table 3:

A: Does HOUSE Granger-cause CRIME?

Variable	Unrestricted	Restricted
HOUSE	.042 (.33)	
$HOUSE_{t-1}$	-.061 (-.49)	
$CRIME_{t-1}$	.975 (60.76)***	.976 (61.68)***
Error Sum of Squares	1564447	1569432
Sample Size	185	185
F-Statistic	.29	

B: Does CRIME Granger-cause HOUSE?

Variable	Unrestricted	Restricted
CRIME	.014 (.33)	
$CRIME_{t-1}$	-.026 (-.59)	
$HOUSE_{t-1}$	.957 (53.93)***	.960 (54.50)***
Error Sum of Squares	537240	542220
Sample Size	185	185
F-Statistic	.84	

Graph 1:

Commute Time (in minutes) 1980-2011

Graph 2:

Number of Violent Crimes in Washington, D.C.

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