Do Gay Male and Lesbian Couples Induce Gentrification?

Mia Goodnature
Department of Economics, Finance, and Legal Studies
The University of Alabama
Box 870224
Tuscaloosa, AL 35487
Email: megoodnature@crimson.ua.edu

Daniel J. Henderson
Department of Economics, Finance, and Legal Studies
The University of Alabama
Box 870224
Tuscaloosa, AL 35487
Email: djhender@cba.ua.edu

Amanda Ross
Department of Economics, Finance, and Legal Studies
The University of Alabama
Box 870224
Tuscaloosa, AL 35487
Email: aross@cba.ua.edu

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Abstract
Gentrification occurs when run-down areas transition into higher income neighborhoods. While many things are discussed as possible causes of gentrification, there are empirical problems when highlighting a specific mechanism. In this paper, we examine one possible driver of gentrification – the influx of gay and lesbian couples into a community. Anecdotal evidence suggests that there is a relationship between gays and gentrification, but this could be because gays sort into neighborhoods that are more likely to gentrify. To address the endogeneity problem, we employ an instrumental variables strategy using voting results for the state-level equivalent of the Defense of Marriage Act (DOMA) as an instrument for the number of gay couples. We find that areas with more gay and lesbian couples are more likely to experience gentrification. In addition, using semi-parametric techniques we find there is a tipping point after which gentrification occurs. These findings are important for policy makers because understanding the drivers of gentrification is important to designing effective policy to revitalize decaying urban neighborhoods and address the possible problems of gentrification, like displacement, in urban areas.

I. Introduction

Gentrification occurs when run-down, undesirable neighborhoods transition into more desirable areas. Although a standard definition of gentrification does not exist, gentrification is associated with increases in household incomes, education levels, property values, and local tax revenues, as well as decreases in poverty rates in a neighborhood (Kennedy and Leonard, 2001). As gentrification occurs, richer, more educated residents move into an area and replace poorer, less educated, and often minority residents (Guerrieri et al., 2013; Meltzer and Ghorbani, 2017). The existing housing stock and local amenities tend to improve as well (Christafore and Leguizamon, 2017b). While gentrification may be viewed as a good thing for the area, many argue that it hurts the current residents because poor households are displaced when property values rise. Due to this, researchers and policy makers are interested in the consequences of gentrification, but understanding what causes areas to gentrify is equally important. While there are many theories about what causes neighborhood change, isolating a specific mechanism is problematic due to omitted variable bias.

In this paper, we examine one possible driver of gentrification – the presence of gay and lesbian couples – and draw upon an instrumental variables strategy to isolate this effect. Anecdotal evidence suggests gays may be inducing gentrification. For example, South Beach, Florida was renovated through housing purchases and real estate investments by gays (Dunlop, 1995). Castro in San Francisco had a large gay population and experienced rising property values and condominium conversions (Doan and Higgins, 2011). Midtown in Atlanta, Georgia used to be full of hippies and drug users before gay men renovated the run-down area by investing in the housing stock (Doan and Higgins, 2011).

While there are numerous case studies suggesting there is a relationship between gays and gentrification, it could be that a trait of gay couples is correlated with gentrification. For example, same-sex couples may be less likely to have children and are more likely to spend their income on adult-related activities, such as going out to eat, and less on child-related amenities, such as higher quality public schools (Black et al., 2002). If this is true, then the areas that gays self-select into might be more likely to gentrify if they chose areas that have certain amenities, or if their presence brings these amenities to the area. If unobservable neighborhood amenities are present and cannot be controlled for properly, then it could be misinterpreted that gays are causing gentrification. Therefore, it is possible that standard OLS methods produces biased estimates.

To isolate the relationship between gay couples and gentrification, we draw upon an instrumental variables (IV) strategy. We use precinct level voting data for the state-level equivalent of the Defense of Marriage Act (DOMA) in Ohio as an instrument for the number of gay couples in an area. This ballot initiative allowed Ohio residents to vote against the legalization of same-sex marriage in the state. We believe that voting outcomes on this initiative are likely to be correlated with the number of gay couples in an area because voting against this type of legislation indicates that an area is supportive of gay couples and their lifestyle. Given that gays are likely to be victims of discrimination (Collins, 2004; Herek, 2009), it is plausible that they choose to locate in areas that show they are more tolerant of their lifestyles. Our first stage regressions support using the percentage of a census tract that voted against having marriage legally defined as between a man and a woman as an instrument. In addition, we believe that voting on this gay marriage law will not be correlated with our dependent variable that measures gentrification, except through tolerance. After controlling for various socio-economic attributes of the area, including several tolerance measures, this allows us to address concern that there other variables that may be

correlated with the error term so that the exclusion restriction is satisfied and our instrumental variable is appropriate.

Using our instrumental variables approach, we find that areas with more gay couples are more likely to gentrify. The results are consistent across various definitions of gentrification, including the percent change in income and the probability that a tract gentrifies. These findings are robust across various specifications, such as restricting the sample to only urban areas and further restricting the sample to only areas with a positive amount of gay couples in 2000. In addition to using different definitions of gentrification, we look at different measures of gay male and lesbian couples, such as using a Gay Index, and our results are similar. Overall, we find consistent evidence that gays are contributing to increases in income and house prices for those neighborhoods that are in the lowest quartile of the income and house price distribution.

We then use semi-parametric techniques to look for possible non-linear relationships regarding how gay couples may affect neighborhood change. Specifically, it is plausible that one or two additional gay couples may not be sufficient to induce gentrification, but having a larger increase in gay couples could cause an area to gentrify. A parametric model would not allow us to fully capture this relationship. Using a semi-parametric instrumental variables approach, we find that there is a tipping point of about 30 additional gay couples, after which a neighborhood begins to gentrify.

We make several contributions to the literature. First, we add to a growing literature that is working to understand the mechanisms driving gentrification (Schuetz, 2014; Guerrieri et al., 2013). Since policy makers are interested in gentrification, as there are concerns about displacement of low-income families when this occurs and interests in revitalizing declining urban neighborhoods, understanding what is causing gentrification is important to designing effective

policy. Second, we propose an instrumental variables strategy to help isolate the effect of same-sex couples on gentrification. Prior research examining this relationship has been more successful at establishing correlations, while we add an instrumental variables approach that allows us to better isolate the effect. Finally, we utilize semi-parametric methods to examine non-linearities in the relationship between gay couples and gentrification. The use of a semi-parametric model sheds light on how gay couples may be driving gentrification, specifically because we find there is a tipping point, or minimum number of gay couples needed, before an area gentrifies.

The rest of the paper will proceed as follows. The next section discusses the theories and literature regarding how gays may cause gentrification. Section III describes our methodology and the data is discussed in Section IV. Results are presented in Section V, while our semi-parametric model and results are presented in Section VI. Section VII concludes and discusses the policy implications of our research.

II. Conceptual Model

All levels of government and the media have become more and more interested in gentrification. These concerns have grown since the 1980s, when gentrification received media attention in predominately black neighborhoods like Harlem in New York City (Schaffer and Smith, 1986). Interest in gentrification has only increased over time, as more and more neighborhoods across the world have gentrified, such as Soho in London, Columbia City in Seattle, Middletown in Atlanta, and South Beach in Miami. The public is concerned with this issue, as there are questions about what happens to the lower-income residents that are forced out of their homes as the higher-income individuals move into the area. As more neighborhoods gentrify, the issue of displacement has received increased attention from researchers.

Existing research has examined various issues related to gentrification – many examining the consequences and some examining the possible causes.[1] Much of the initial literature on the causes of gentrification assumes that proximity to the Central Business District (CBD) is causing higher income families to move back into the downtown to reduce their commute to work (Helms, 2003; Rosenthal, 2007). Kolko (2007) and Guerrero et al. (2013) look at the importance of location with regards to the possibility of endogenous gentrification, arguing that tracts directly adjacent to higher income tracts are more likely to gentrify.

In research that is more closely related to ours, Florida and Mellander (2010) proposed that gays and bohemians, specifically artists, contribute to gentrification.[2] Schuetz (2014) examined if art galleries affect the likelihood that a neighborhood gentrifies using precise microdata and an instrumental variables strategy to deal with the possibility that art galleries locate in areas that will gentrify regardless of their presence. The argument is similar to those suggested by Florida and Mellander (2010) regarding how increases in bohemian activities and lifestyles increases the likelihood an area gentrifies. While Schuetz (2014) examines gentrification from the point of view that artists are driving gentrification, we examine the relationship between gay and lesbian couples and gentrification. Christafore and Leguizamon (2017a) examined the relationship between gays and gentrification. While they utilize an extensive number of controls in their analysis, there are still likely to be other characteristics of neighborhoods not controlled for that affect gentrification. We add to their analysis by including additional control variables and use an instrumental variables

[1] Examples of research on the consequences of gentrification include Doan and Higgins (2011), Freeman (2005), Freeman and Braconi (2004), and Newman and Wyly (2006).

[2] Several papers have considered gays as a proxy for tolerance, which is another way to argue that gays are driving gentrification (Fan, 2007; Florida and Mellander, 2010; Berggren and Elinder, 2012; Leguizamon and Leguizamon, 2017).

approach, which helps us to better control for the possibility that gays self-select into areas that are more likely to gentrify.

As gays experience discrimination in the housing market, the workplace environment, and everyday life (Herek, 2009), it is possible that gays choose to form communities together. By doing so, gays can create safe environments where they do not have to worry about experiencing harassment due to their sexual preference. This could be one of the reasons why gays might cluster together. In terms of how gay couples could specifically induce gentrification in an area, Collins (2004) proposed a mechanism through which gay couples could drive gentrification.[3] First, a neighborhood within an urban area is in decline. As is typical in many areas that gentrify, houses are decaying, commercial lots are vacant, and property values are low. However, in his model there is at least one gay licensed bar. Then, a few gay male or lesbian run establishments begin to emerge in the neighborhood. Next, there is an increase in gay males and lesbians in the area, both living there and frequenting the area for various amenities. Finally, the area is sufficiently built up and invested in that the quality of housing and amenities in the neighborhood are such that the area assimilates into the mainstream.

III. Methodology

We use the following initial equation to examine the relationship between gay couples and gentrification:

$$y_i = \alpha + \beta_1(\text{same-sex couples}_i) + \beta_2 X_i + \varepsilon_i$$

where i indexes individual tracts in seven Metropolitan Statistical Areas (MSA) in Ohio in 2000 and includes MSA fixed effects.

[3] The model developed by Collins (2004) is based on the rise of the gay community in Soho in London. However, Knopp (1998) analyzed the transformation of gay districts in the US, UK, Australia, and Canada and found a similar model. Therefore, we believe that the model developed by Collins (2004) could be applied to analysis such as ours.

The dependent variable is a measure of gentrification. Since there is no official definition of gentrification, we use different measures based on the previous literature (Kolko, 2007; Florida and Mellander, 2010; Guerrieri et al., 2013; Meltzer and Ghorbani, 2017; Christafore and Leguizamon, 2017a; Christafore and Leguizamon, 2017b). Initially, we look at the percent change in income for tracts in the bottom income quartile. In addition, we use a dummy variable for if the tract gentrified, saying that a tract has gentrified if it starts in the bottom income quartile in 2000 and moves to the top two quartiles in 2014. We focus on tracts in the bottom quartile because growth in income for the tracts at the top of the distribution is not considered gentrification. When we use the percentage change as the dependent variable, we use an OLS model and when we use the probability a tract has gentrified, we use a linear probability model (LPM). We also consider the same measures using house prices instead of income as our measure of gentrification.[4]

Our measure of same-sex couples is the change in the number of same-sex unmarried partnered households per 1000 households between 2000 and 2010.[5] Our control variables are included in X_i and MSA fixed effects for Akron, Cincinnati, Cleveland, Columbus, Dayton, Toledo, and Youngstown MSAs. All control variables take on their 2000 value and their summary statistics can be seen in Table 1.

We include a variety of control variables in X_i to reduce the possibility that characteristics associated with gay couples are the actual driver of gentrification. For example, if gays self-select into high amenity areas (Black et al., 2002), then controlling for amenities will reduce the

[4] We also considered other measures of gentrification. As additional measures of gentrification, we looked at the percent change in income for all tracts, the percent change in income for tracts in the bottom two income quartiles, the probability of moving out of the bottom income quartile, and the probability of moving out of the bottom two income quartiles. These measures are repeated using house price. In addition, we explored the percent change in the percent with a bachelor's degree or higher, the percent change for tracts in the bottom education quartile, and the percent change for tracts in the bottom two education quartiles. Our results are consistent when we use these other measures. These additional results are available from the authors upon request.

[5] We use other measures of same-sex couples to confirm the robustness of our results, which we will describe in more detail later.

possibility that it is these amenities, not gay couples, that are inducing neighborhood change. To control for amenities, we include measures that capture how good the local schools are, the crime rate, the air pollution, temperature, precipitation, the median house value, and the distance to the CBD. If these amenities are the true driver of gentrification, then different-sex couples with similar characteristics to gay couples will also self-select into areas with adult-related amenities. For that reason, we control for demographics associated with gay couples by controlling for the family size, the amount of different-sex unmarried couples, the amount of married couples, the age of people in the area, and the amount of children living in the area. In addition, gay couples might choose to live in areas that are more tolerant to their lifestyle, so gay couples might serve as a proxy for the tolerance level of the area (Florida and Mellander, 2010) For that reason, we include measures of tolerance such as the education level, the income, measures that capture diversity,[6] and the amount of Bohemians[7] living in the area.

However, despite including all of these control variables, there may still be something we have not been able to properly control for in an OLS specification. If unobservable amenities have not been capitalized into housing prices yet, then failing to control for amenities could cause OLS to have biased results. For example, gays are less likely to have children then heterosexual couples (Black et al., 2002; Christafore and Leguizamon, 2017a). As a result, they will demand more amenities that singles enjoy, like restaurants and stores, and less amenities that families value, like quality schools and other goods and services associated with children. Therefore, the direction of the bias would be ambiguous, as some of the local amenities are positively correlated with gays,

[6] The measure of ethnic heterogeneity is from Brasington (2007) and is based on the Leik (1966) index of racial heterogeneity in Census block groups. A value of zero represents that the area is racially homogeneous and a value of one is racially heterogeneous.

[7] The Bohemian Index is an over- or under- representation of the number of Bohemians in the tract. Bohemians are considered to be artists, designers, actors, producers, directors, dancers, choreographers, musicians, singers, writers, authors, and photographers. This index is similar to the Gay Index described below and is calculated as the fraction of Bohemians who live in the tract divided by the fraction of the total population that live in the tract.

like adult bars, while others are negatively correlated with gays, like parks that attract children. If amenities are positively correlated with gentrification, then the amenities that gays are positively correlated with will cause OLS to have a positive bias. However, if there are amenities that gays are negatively correlated with, then will cause OLS to have a negative bias.

In addition, gays may be the case that gays demand amenities that have variation in quality and therefore variation in what the effect will be, such as bars. While people may consider bars to be an amenity, the type of bar is extremely relevant. Higher class bars are likely to be positively correlated with neighborhood improvement. However, lower quality bars, which may be louder and associated with more bar fights and noise on the streets, are likely to be negatively associated with neighborhood improvement. Failing to control for classier bars would cause OLS to have a positive bias, but failing to control for lower quality bars will result in OLS having a negative bias. Since we cannot properly obtain data on these differences in the type and quality of amenities that may come to the area, the direction of the bias is ambiguous.

To address the concerns regarding endogeneity and to isolate a mechanism driving this relationship, we adopt an instrumental variables approach. Specifically, as an instrument for the change in the number of gay couples, we use the percentage of a tract that voted against a law that would only allow marriage to be between a man and a woman. Voting for or against a gay-unfriendly law can serve as information about the preferences of a neighborhood that repels or brings gays to certain areas, respectively.

As our instrumental variable, we use the state-level version for Ohio of the Defense of Marriage Act (DOMA), a federal law passed on September 21, 1996 which defined marriage as the union between a man and a woman and allowed states to pass a law refusing to recognize same-sex marriages. Although DOMA was ruled unconstitutional in 2013, following its passage in 1996

many states passed laws that banned same-sex marriages or clarified the language used in DOMA (McVeigh and Diaz, 2009).[8] In 2004, Ohio voted on State Issue 1 which would "preserve in Ohio law the universal, historical institution of marriage as the union of one man and one woman, and to protect marriage against those who would alter and undermine it" (Ohio Secretary of State[9]). Therefore, as an instrumental variable, we use the percent that voted "no" on 2004's State Issue 1. The voting outcome for each precinct serves as a change that either attracts or repels gays from the area. The law was voted on in 2004 and we measure gay couples by looking at the change in the number of same-sex unmarried partnered households per 1000 households between 2000 and 2010. Precincts with a high percent that voted no to allowing marriage to be between a man and a woman are areas that can be perceived as being more gay friendly, which could attract gays to these precincts so that the change in gay couples between 2000 and 2010 will be positive.

The first stage regression is as follows:

$$\text{same-sex couples}_i = \delta_1 + \theta_1(\text{vote no}_i) + \delta_2 X_i + u_i$$

where vote no_i is the percent of tract i that voted no on Ohio State Issue 1 in 2004.

For voting on a gay-related law to be an appropriate instrumental variable for the number of gay men and lesbians in the area, the voting outcome has to satisfy two conditions. First, the precinct voting outcome must be correlated with the number of gays in the area. Klawitter and Flatt (1998) found that same-sex couples are more likely to live in areas that have adopted an anti-discrimination policy of gays in the workplace, so this condition is likely satisfied and our first

[8] The following thirty states passed laws banning same-sex marriages between 1998 and 2008: Alabama, Alaska, Arizona, Arkansas, California, Colorado, Florida, Georgia, Hawaii, Idaho, Kansas, Kentucky, Louisiana, Michigan, Mississippi, Missouri, Montana, Nebraska, Nevada, North Dakota, Ohio, Oklahoma, Oregon, South Carolina, South Dakota, Tennessee, Texas, Utah, Virginia, and Wisconsin. Arizona failed to pass legislation that banned same-sex marriage in 2006 but succeeded in 2008. Therefore, all of these states succeeded at passing laws banning same-sex marriage (McVeigh and Diaz, 2009).

[9] See https://www.sos.state.oh.us/elections/election-results-and-data/2004-elections-results/state-issue-1-november-2-2004/state-issue-1-argument-in-support-of/.

stage results support this argument. The second condition is that the voting outcome is not correlated with the error term. The dependent variables we use are either the change in income or house price. We do not believe that the voting outcome on a gay-marriage law will affect these dependent variables except through the number of gays and, perhaps, the tolerance level of the area. Since Bohemians act as a proxy for tolerance (Florida and Mellander, 2010) and education and diversity are highly correlated with tolerance (Jenkins et al., 2009; Qian, 2013; Clark, 2015), we control for the Bohemian Index; the percent of the population 25 years and older with a bachelor's degree or higher; the percent of the population that is only white, only black, and Hispanic; a measure of ethnic heterogeneity; and the income of the tract. If these variables appropriately control for tolerance, the exclusion restriction will be satisfied and our estimates will be unbiased.

IV. Data

Data for 2000 and 2014 median income and median house price come from the 2000 Decennial Census[10] and the 2012-2016 five-year American Community Survey,[11] respectively.

Measuring the number of same-sex couples is problematic given the nature of the questions in the Decennial Census. Starting in the 1990 Census, the "Relationship to Householder" question had "unmarried partner" as a response option, allowing people to identify themselves as living as an unmarried cohabitating couple. Therefore, cohabitating, unmarried partnered gays are identified when Person 1 is the same sex as Person 2 and chooses that Person 2 is their "unmarried partner."

[10] This data is in 2000 nominal dollars and is converted to 2012 real dollars.
[11] The 2016 data on income and house price is broken down by 2010 tracts. This is converted to 2000 tracts by using a conversion file from the Census. The 2010 data is in 2016 nominal dollars and is converted to 2012 real dollars.

This change in the form allowed the Census to gather data on gay males and lesbians that lived with their partner.[12]

We use the change in the number of gay male and lesbian unmarried partners in each Census tract per 1000 households between 2000 and 2010. As one of our alternative measures of gay couples, we use the Gay Index in 2000, similar to Florida and Gates (2015), where the Gay Index is a measure of the over- or under-representation of gays in the tract and is equal to

$$\frac{same\ sex\ unmarried\ partners\ in\ tract/total\ same\ sex\ unmarried\ partners\ in\ Ohio}{population\ in\ tract/total\ population\ in\ Ohio}$$

This alternative measure of gay couples helps test the robustness of our results.[13] We also explore results when using the number of same-sex unmarried partners per 1000 households in 2000 and the change in the number of gay male unmarried partners per 1000 households between 2000 and 2010. All measures of same-sex unmarried partnered households come from the 2000 and 2010 Census, but additional information is needed to correct these counts due to different-sex couples miscoding their gender and being recorded as same-sex couples. This additional information comes from 2000 5% Integrated Public Use Microdata Series, the 2010 state-level count of the sex-corrected number of same-sex unmarried partnered households, and the 2010 Census mail-in participation rates.

For our instrumental variable, we use the percent that voted no on 2004's State Issue 1 in Ohio which stated that marriage could only be between a man and a woman, which we will refer

[12] Given that sexual preference is not asked by the Census, there is no way to determine how many single gays or non-cohabitating gay couples live in an area. For that reason, we are only able to consider same-sex cohabitating couples. See Klawitter and Flatt (1998), Carpenter (2008), and Carpenter and Gates (2008) for a discussion of the implications of this data limitation. There are some miscoding issues with this data from the Census as there is a concern that different-sex couples miscode one of their genders so that the Census counts them as a same-sex couple. We follow the previous literature to address these issues. See Black et al. (2007), Christafore and Leguizamon (2012), Christafore et al. (2013), and Gates and Cooke (2012) for how to deal with these issues.

[13] The Gay Index has been used in the previous literature. See Madden and Ruther (2015), Poston and Change (2016), and Walther and Poston (2004), and Florida and Mellander (2012) for examples.

to as DOMA from this point forward for simplicity. The 2004 voting results on this issue are available from the Ohio Secretary of State and are available at the precinct level.

The measure of ethnic heterogeneity; the percent of 12th grade students who passed all five sections of the Ohio proficiency test in 2000-2001; total expenditure per pupil for the 2000-2001 school year; the crime rate; and the total air pollution comes from Brasington (2007). The average maximum temperature and total precipitation come from the US Department of Agriculture. The count of Bohemians is from the 2000 5% Integrated Public Use Microdata Series. The dummy variable equal to 1 if the Census tract is within one mile of another tract that was created using median income from the 2000 Decennial Census and distances available from the National Bureau of Economic Research. All remaining variables come from the 2000 Decennial Census. Table 1 presents summary statistics for all of the variables.

All of our control variables take on their 2000 value. These variables are used to control for common attributes that could affect gentrification. Since we measure gentrification occurring over fourteen years from 2000 to 2014, these variables are included to see how they affect gentrification fourteen years later. The voting on DOMA, which is used as an IV, occurs in 2004. The variable of interest, the change in gay couples, is measured between 2000 and 2010. Therefore, we see how many additional gay couples are in a tract six years after voting has occurred. Then we investigate how these additional gay couples in 2010 affected gentrification between 2000 and 2014.

V. Results

The results from the OLS regressions, where gentrification is defined as the change in income or house prices for tracts in the bottom quartile, are presented in Table 2. The first three columns correspond to a change in income when focusing on tracts that are in the bottom income

quartile, while the last three columns correspond to a change in house price when focusing on tracts that are in the bottom house price quartile. In columns (1) and (4), all tracts in the bottom income and house price quartile, respectively, are used. In columns (2) and (5), the sample is further restricted to tracts that are considered to be 100% urban. Finally, columns (3) and (6) further restrict the sample to only include tracts that are 100% urban, have a positive number of gay couples in 2000, and are in the bottom income and house price quartile, respectively. This last restriction does not include tracts that had zero gay couples in 2000 but a positive number of gays in 2010. Although these excluded tracts could help induce neighborhood change, we want to focus on tracts that have ample time to change and only having gay couples in 2010 may not be enough time to affect gentrification four years later in 2014.

The rows represent the different independent variables used to measure the number of gay couples. The first row uses the change in gay unmarried partnered households per 1000 households between 2000 and 2010 as the independent variable. The second row uses the change in gay male unmarried partners per 1000 households between 2000 and 2010. The third row uses the number of gay unmarried partnered households per 1000 households in 2000 and the fourth row uses the Gay Index, which is an over- or under-representation of gay couples in 2000.

Table 3 is similar to Table 2, but uses the probability that a tract gentrifies as the dependent variable. The first three columns consider a tract as gentrified if it goes from the bottom quartile of income in 2000 to the top two quartiles of income in 2014. The last three columns use house price instead of income to measure the probability of going from the bottom house price quartile in 2000 to the top two house price quartiles in 2014. The rest of the rows and columns follow the same set-up as Table 3.

The results from Table 2 and Table 3 suggest that additional gays have a positive effect on gentrification, but the effect is not always statistically significant. When gentrification is measured by income, gays tend to have a positive and statistically significant effect which signifies that areas with a higher influx in the number of same-sex unmarried partners are more likely to gentrify. Specifically looking at urban tracts that are in the bottom income quartile and have a positive number of gays in 2000, when there is an additional gay couple per 1000 households in between 2000 and 2010, the percent change in income is expected to increase by 1.5 percentage points.[14] This corresponds to an average increase in income of about $474.22. Looking at these same tracts, when there is an additional gay couple per 1000 households, the tract is 0.5 percentage points more likely to gentrify when using income to measure gentrification.

Areas with higher changes in the number of gay male couples are more likely to experience gentrification. We looked into the effect of lesbian couples as well, but the first stage results did not indicate the instrument was valid. In addition, the OLS results signified that the effect of lesbians on gentrification was not as statistically significant. For these reasons, we believe that lesbians do not have much of an effect on gentrification and the results are not reported here.[15] The literature has documented differences in behavior between lesbians and gay males, which may explain why lesbians do not affect gentrification as much as gay males. The previous literature suggests that lesbian couples tend to behave similar to straight couples as they are more likely to have children (Black et al., 2002). Lesbians are also less likely to cluster together (Fu, 2007), implying that the Collins (2004) model might not apply to lesbian couples. Therefore, it is not

[14] In all of the tracts considered in this analysis, there are an average of 1169 households in each tract in 2000. In urban tracts that are in the bottom income quartile in 2000 with a positive number of gay couples in 2000, the average number of households is 1156.

[15] Results using lesbian couples as the independent variable are available from the authors upon request.

unsurprising that gay male couples, who tend to behave differently than straight couples and tend to cluster together, are driving different results.

As discussed above, there are reasons to believe that the OLS regressions could be biased since there may still be unobservable variables in the error term that affect our outcome of interest. Some of this potential bias could be due to the inability to control for unobservable amenities that might help spur gentrification. Moreover, the sign of this possible bias is ambiguous.

To address this concern, an instrumental variable approach is used. Specifically, the percentage of the tract that voted against DOMA is used as an instrument for the change in the number of gay couples. The results from the first stage regression are presented in Table 4, which shows the coefficient of the voting outcome on the number of gay couples. The layout of Table 4 is identical to Tables 2 and 3. The first stage is the same regardless of which dependent variable is used since they both focus on tracts in the bottom income and house price quartile. Therefore, the first stage results are presented in one table.

Voting on DOMA is statistically significant in all different specifications and the F-statistic on all regressions is well above the standard threshold of 10, suggesting that we have an appropriate IV. Areas that had a higher percent of the tract vote no on DOMA are areas that are more likely to be accepting of gay couples' lifestyles. These areas attract gays as the coefficient on the voting variable is positive and statistically significant.

Results when using the instrumental variables approach are presented in Tables 5 and 6. These tables are identical to Table 2 and Table 3, respectively, but uses the percent of the tract that voted no on DOMA as an IV for the change in the number of gay couples. Table 5 uses the percent change as a measure of gentrification and Table 6 uses the probability that a tract gentrifies. In all specifications, additional gays have a positive and statistically significant effect on gentrification.

Specifically looking at urban tracts that are in the bottom income quartile and have a positive number of gays in 2000, when there is an additional gay couple per 1000 households in between 2000 and 2010, the percent change in income is expected to increase by 4.6 percentage points. This corresponds to an average increase in income of about $1454.28. Looking at these same tracts, when there is an additional gay couple per 1000 households, the tract is 2.0 percentage points more likely to gentrify when using income to measure gentrification. Overall, the results from the 2SLS regressions support the argument that tracts with more gay couples are more likely to experience gentrification.

VI. Semi-Parametric Results

In addition to the parametric regressions discussed above, we also explored results using semi-parametric regressions. If gentrification is occurring due to gays clustering, then there might be some tipping point in the number of gays after which gentrification occurs. A semi-parametric model allows us to capture this type of relationship. The semi-parametric model is as follows

$$y_i = g(\text{same-sex couples}_i) + \beta_2 X_i + \varepsilon_i$$

$$\text{same-sex couples}_i = m(\text{vote no}_i) + \delta_2 X_i + u_i$$

where all of the variables are defined as before and $g(\cdot)$ and $m(\cdot)$ are unknown smooth functions. Here, the percent that voted no on DOMA enters in non-parametrically in the first stage while all other variables enter in parametrically and the change in same-sex couples enter in non-parametrically in the second stage while all other variables enter in parametrically. The method employed by Ozabaci et al. (2014) is used here to estimate the parametric and unknown functions, which uses B-splines and kernel smoothing.[16]

[16] The method used here is detailed in Ozabaci et al. (2014) and Chu et al. (2017). First the same-sex couples is regressed semi-parametrically on the percent that voted no using B-splines. The residual from this first stage regression is used as an additional control variable in the second stage semi-parametric regression that involves B-splines, which identifies g(·). The third stage uses kernel methods to produce a more efficient estimation of g(·) and its gradient.

We formally test for correct parametric specification by using the goodness-of-fit test from Ullah (1985).[17] From the results from the Ullah (1985) test, we fail to reject the null that the parametric model is correctly specified. Even though the Ullah (1985) test says that the parametric model is likely to be correctly specified, the results from the semi-parametric model could shed some light on the mechanism in which gays affect gentrification.

The marginal effect from the semi-parametric regressions can be seen in Figure 1, which displays the semi-parametric gradients in red and the parametric coefficient in blue. When measuring gentrification by the percent change in income or house price, the semi-parametric gradients are within the 95% confidence intervals of the parametric coefficient. This indicates that the results from the semi-parametric model are statistically similar to the results of the parametric model, implying that the parametric model is correctly specified.

The second row in Figure 1 shows the marginal effect when using the probability that a tract gentrifies. Defining gentrification by income or house price generates similar results: when the change in gay couples between 2000 and 2010 is under 30 or 40, the semi-parametric and parametric specifications have similar results. However, when the change in gay couples is over 30 or 40, the semi-parametric results diverge from the parametric results. When the change in gays is high, the semi-parametric results estimate a higher marginal effect than the marginal effect estimated from the parametric results.

These semi-parametric results suggest that as the change in gays gets larger, the chances of gentrifying increases. It appears that there is a tipping point in the number of gays that are needed to induce gentrification. In the model developed by Collins (2004), decaying areas become gentrified as the numbers of gays increase and they demand more amenities and services in the

[17] The null hypothesis is that the parametric model is correctly specified while the alternative hypothesis is that the semi-parametric model is correctly specified. A wild bootstrap is used and the steps are outlined in Chu et al. (2017).

area. Therefore, the semi-parametric results show that it is th e clustering of gays that induces gentrification. However, prior to this threshold additional gay couples may not be sufficient to drive neighborhood change.

VII. Conclusion

Gentrification is becoming an increasingly important issue for policy makers and researchers. We examine one of the possible causes of gentrification – the influx of gay and lesbian couples into an area. However, there are likely to be endogeneity issues present in an OLS regression. To address these concerns, we focus on Ohio where there was a state-wide vote on a law similar to the federal Defense of Marriage Act (DOMA) and use an instrumental variables approach. Our first stage results support using the percentage of a tract that voted against this law as an instrument. The results from our instrumental variables regression suggests that more gay couples induce gentrification.

In addition, we consider that there is a non-linear effect of gay couples. Specifically, we use a semi-parametric model to look at possible non-linear relationship between the number of gay couples and the likelihood of gentrification. These semi-parametric results suggest that there is a tipping point in the number of gays required for an area to gentrify. Once gays are sufficiently clustered, they begin to demand amenities and invest in the housing, which may be what ultimately drives gentrification (Collins, 2004). However, given we only have one state and one law change, we are limited in terms of a sample size to examine this effect. More data from other areas will help shed addition light on how many gay couples need to cluster in an area to induce gentrification.

The results presented in this paper are specific to cohabitating gay couples due to data limitations. Couples that do not live together are not included in this analysis, nor are single gay

men and lesbians, due to the data available. Since clustering of gays is not specific to cohabitating gay couples, excluding single or non-cohabitating gays may cause the 2SLS regressions to underestimate the number of gays necessary to induce neighborhood change. Future research should work to find appropriate data and measures of gay singles and non-cohabiting gay couples.

These results have important implications for policy makers as they have important insights to neighborhood change. Moss (1997) emphasizes the need for public officials to incorporate pro-gay actions in the steps towards urban redevelopment. Creating a welcoming and more tolerant environment for individuals with this type of lifestyle increases neighborhood incomes and house prices. Therefore, local policy makers that are looking to encourage neighborhood redevelopment should pursue policies that remove discriminatory practices against same-sex couples.

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Table 1: Summary Statistics for Tracts in the Bottom Income or House Price Quartile

Variable	N	Mean	St. Deviation	Min	Max
% Δ in income	673	-21.76	31.29	-81.40	287.86
% Δ in house price	673	-17.31	40.79	-98.55	397.70
ℙ(gentrify – income, Q1 to Q3-Q4)	673	0.02	0.13	0	1
ℙ(gentrify – house price, Q1 to Q3-Q4)	673	0.02	0.15	0	1
change in same-sex couples	673	4.54	5.66	-10.58	44.85
same-sex couples	673	3.36	3.86	0	36.76
Gay Index	673	1.92	2.60	0	26.96
change in gay male couples	673	1.89	3.81	-5.82	33.49
education in 2000	673	11.22	10.71	0.74	78.96
% white	673	50.55	34.21	0.26	99.37
% black	673	43.23	35.78	0	98.72
% Hispanic	673	4.36	7.65	0	57.42
ethnic heterogeneity	673	0.13	0.05	0.01	0.34
Bohemian Index	673	0.92	0.55	0.19	2.35
% passed all 5 exams	673	42.47	5.79	33.70	59.82
total school expenditure	673	8400	866	5913	9472
crime rate	673	73.43	18.66	9.43	106.41
total air pollution	673	3166	4850	0	39501
precipitation in Dec, Jan, Feb	673	196.66	15.74	158.86	231.65
precipitation in June, July, Aug	673	296.01	14.80	258.18	324.97
temperature in Dec, Jan, Feb	673	2.98	1.11	1.38	5.00
temperature in June, July, Aug	673	27.85	0.99	26.34	29.31
house value in 2000	673	88513	42120	18266	599984
distance to CBD	673	7.62	10.29	0	63.32
average family size	673	3.12	0.26	2.19	4.26
income in 2000	673	34691	10014	9126	60877
different-sex unmarried partners	673	66.05	21.38	1.99	147.32
age	673	32.71	5.94	15.60	68.60
number of children in households	673	767.98	273.53	21.93	1994.44
married households	673	290.24	117.31	21.63	854.43
one mile from top quartile	673	0.13	0.33	0	1
% house age over 20	673	92.02	10.99	14.55	100
% vacant	673	12.08	6.69	0	44.28
% owner-occupied	673	46.65	19.67	0.81	92.95
% labor force	673	58.28	9.79	10.20	84.30
population density	673	5773	3871	21.79	21323
Akron	673	0.08	0.27	0	1
Cincinnati	673	0.17	0.38	0	1
Cleveland	673	0.32	0.47	0	1
Columbus	673	0.18	0.38	0	1
Dayton	673	0.11	0.31	0	1
Toledo	673	0.09	0.28	0	1
Youngstown	673	0.06	0.23	0	1
vote no	673	45.50	8.80	7.82	85.96

Table 2: OLS Coefficients Estimating the Impact of Gay Couples on the Percent Change in Income and House Price

	Income			House Price		
	(1)	(2)	(3)	(4)	(5)	(6)
	Tracts in Q1	Urban Tracts in Q1	Urban Tracts in Q1 with Gays > 0	Tracts in Q1	Urban Tracts in Q1	Urban Tracts in Q1 with Gays > 0
Change in Gay Couples as Independent Variable	1.479***	1.468***	1.540***	1.758***	1.676***	1.605***
	(0.234)	(0.240)	(0.245)	(0.327)	(0.329)	(0.315)
Change in Gay Male Couples as Independent Variable	2.498***	2.471***	2.547***	2.743***	2.586***	2.476***
	(0.331)	(0.340)	(0.349)	(0.501)	(0.503)	(0.478)
Number of Gay Couples as Independent Variable	1.497***	1.414***	1.375***	0.579	0.224	0.751
	(0.385)	(0.401)	(0.422)	(0.713)	(0.717)	(0.703)
Gay Index as Independent Variable	2.709***	2.620***	2.585***	0.614	-0.066	0.979
	(0.577)	(0.602)	(0.630)	(1.359)	(1.364)	(1.340)

Notes: Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table 3: LPM Coefficients Estimating the Impact of Gay Couples on the Probability a Tract Gentrifies

	Income			House Price		
	(1)	(2)	(3)	(4)	(5)	(6)
	Tracts in Q1	Urban Tracts in Q1	Urban Tracts in Q1 with Gays > 0	Tracts in Q1	Urban Tracts in Q1	Urban Tracts in Q1 with Gays > 0
Change in Gay Couples as Independent Variable	0.005***	0.005***	0.005***	0.005***	0.005***	0.006***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Change in Gay Male Couples as Independent Variable	0.007***	0.006***	0.007***	0.010***	0.010***	0.009***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Number of Gay Couples as Independent Variable	0.009***	0.008***	0.009***	0.006**	0.006**	0.006**
	(0.002)	(0.002)	(0.002)	(0.003)	(0.003)	(0.003)
Gay Index as Independent Variable	0.017***	0.015***	0.017***	0.010*	0.009*	0.008
	(0.003)	(0.003)	(0.003)	(0.006)	(0.005)	(0.006)

Notes: Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table 4: First Stage Regression Coefficients Estimating the Impact of the Percent that Voted No on DOMA on the Amount of Gay Couples

	Income			House Price		
	(1)	(2)	(3)	(4)	(5)	(6)
	Tracts in Q1	Urban Tracts in Q1	Urban Tracts in Q1 with Gays > 0	Tracts in Q1	Urban Tracts in Q1	Urban Tracts in Q1 with Gays > 0
Change in Gay Couples as Dependent Variable	0.270***	0.272***	0.268***	0.310***	0.310***	0.316***
	(0.051)	(0.053)	(0.055)	(0.055)	(0.059)	(0.061)
	28.48	26.21	23.36	31.84	27.45	27.08
Change in Gay Male Couples as Dependent Variable	0.188***	0.190***	0.184***	0.187***	0.184***	0.185***
	(0.035)	(0.037)	(0.038)	(0.036)	(0.039)	(0.040)
	28.57	26.45	22.88	27.02	22.30	21.10
Number of Gay Couples as Dependent Variable	0.215***	0.230***	0.225***	0.141***	0.151***	0.146***
	(0.031)	(0.032)	(0.032)	(0.026)	(0.028)	(0.028)
	48.50	51.91	48.39	29.65	29.58	27.45
Gay Index as Dependent Variable	0.145***	0.153***	0.151***	0.077***	0.081***	0.078***
	(0.020)	(0.021)	(0.022)	(0.014)	(0.015)	(0.015)
	49.87	52.77	49.25	31.74	30.91	28.14

Notes: Standard errors in parentheses and F-statistics below. *** p<0.01, ** p<0.05, * p<0.1

Table 5: 2SLS Coefficients Estimating the Impact of Gay Couples on the Percent Change in Income and House Price

	Income			House Price		
	(1)	(2)	(3)	(4)	(5)	(6)
	Tracts in Q1	Urban Tracts in Q1	Urban Tracts in Q1 with Gays > 0	Tracts in Q1	Urban Tracts in Q1	Urban Tracts in Q1 with Gays > 0
Change in Gay Couples as Independent Variable	4.244***	4.629***	4.634***	5.175***	4.621***	4.937***
	(1.146)	(1.235)	(1.289)	(1.484)	(1.516)	(1.473)
Change in Gay Male Couples as Independent Variable	6.102***	6.626***	6.749***	8.576***	7.806***	8.455***
	(1.595)	(1.710)	(1.830)	(2.510)	(2.623)	(2.618)
Number of Gay Couples as Independent Variable	5.324***	5.494***	5.517***	11.362***	9.480***	10.668***
	(1.424)	(1.420)	(1.498)	(3.658)	(3.435)	(3.515)
Gay Index as Independent Variable	7.935***	8.246***	8.215***	20.970***	17.664***	20.092***
	(2.078)	(2.088)	(2.183)	(6.733)	(6.413)	(6.646)

Notes: Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table 6: 2SLS Coefficients Estimating the Impact of Gay Couples on the Probability a Tract Gentrifies

	Income			House Price		
	(1)	(2)	(3)	(4)	(5)	(6)
	Tracts in Q1	Urban Tracts in Q1	Urban Tracts in Q1 with Gays > 0	Tracts in Q1	Urban Tracts in Q1	Urban Tracts in Q1 with Gays > 0
Change in Gay Couples as Independent Variable	0.020***	0.019***	0.020***	0.026***	0.024***	0.021***
	(0.006)	(0.005)	(0.006)	(0.007)	(0.007)	(0.006)
Change in Gay Male Couples as Independent Variable	0.029***	0.027***	0.029***	0.043***	0.040***	0.035***
	(0.008)	(0.008)	(0.008)	(0.011)	(0.011)	(0.011)
Number of Gay Couples as Independent Variable	0.026***	0.023***	0.023***	0.057***	0.048***	0.045***
	(0.006)	(0.006)	(0.006)	(0.016)	(0.014)	(0.014)
Gay Index as Independent Variable	0.038***	0.034***	0.035***	0.106***	0.090***	0.084***
	(0.009)	(0.009)	(0.009)	(0.029)	(0.026)	(0.027)

Notes: Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Figure 1: Gradients and Marginal Effect from the Semi-parametric and Parametric Models Estimating the Effect of the Change in Gay Couples on Gentrification