Land-Use Regulations As Exclusion: A GIS Analysis

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Abstract

Zoning regulations have been identified as a source of residential segregation in the United States. A common theme in the zoning literature is that municipalities adopt zoning regulations to exclude low-income and minority families. This study presents the first nationwide test for the presence of the exclusionary motive, using an existing dataset of land-use regulations in approximately 2,600 U.S. municipalities, and U.S. Census data on the demographics of the areas surrounding those municipalities. Geographic Information System (GIS) methods identify the demographics within a set radius of each municipality. This study uses a dataset of all school district desegregation court orders as indicators of municipalities' inclination and incentive to use land-use regulations to accomplish segregation. As a robustness check to address potential endogeneity of ethnic settlement patterns, this study employs a geographic instrumental variable. The results offer evidence of zoning to exclude low-income populations, but largely fail to provide empirical evidence of racially motivated land-use regulation.

1 Introduction

Residential areas in the United States are often segregated by race and wealth (Iceland and Weinberg, 2002). Zoning regulations have been identified as a cause of residential segregation in the United States. This has raised concerns about the motivations behind those regulations.

A common theme in the zoning literature is that municipalities adopt zoning regulations in order to exclude low-income and minority families (see, for example, Pendall (2000) , and Massey and Denton (1993). This "exclusionary motive" hypothesizes that homeowners vote to adopt stricter land-use regulations with the specific intent of preventing low-income or minority populations from moving into their municipality. Land-use regulations like minimum lot sizes and density restrictions can prevent the construction of lower-priced dwellings, thus effectively preventing low-income populations from being able to afford to live in the area.

In the early twentieth century, there were many instances of explicitly racially motivated restrictive zoning; Fogelson (2007) chronicles these, describing fear of outsiders as a motivation for restrictive covenants in the early twentieth century. After explicitly racial zoning was legally restricted in the civil rights era, Pendall (2000) states that local governments used minimum lot sizes and other land-use regulations to accomplish the same racial exclusion without explicitly targeting minorities. Clingermayer (2004) posits that smaller, more homogeneous municipalities adopt more zoning in order to exclude low-income and minority populations, even if local politicians use other rhetorical justifications for passing those regulations (see also Ellickson 1977).

The segregating causes and consequences of land-use regulations are empirically tied together. Land-use regulations may be adopted for one reason but have an unintended exclusionary effect. It is difficult to identify motivations, especially in a setting where the stated justification may not align with the true underlying motive. In 2015, the U.S. Supreme Court removed this difficulty in the legal realm, holding that even without an official record of exclusionary motivations, zoning regulations that have an exclusionary effect violate the Fair Housing Act, regardless of the stated intent of the regulations (Supreme Court of the

United States, 2015). The question of motivations behind land-use regulation remains of interest for social scientists and policymakers, however.

This paper seeks to clearly define an "exclusionary motive" and measure its impact on land-use regulations. I use a variety of identification methods to attempt to empirically separate the exclusionary motive from the exclusionary effects of zoning. The results are consistent with an intent to exclude low-income populations, but largely fail to provide empirical evidence of a racial motivation behind the adoption of land-use regulations.

To my knowledge, this is the first nationwide study to test for the exclusionary motive. For the purpose of this study, land-use regulations encompass any barriers to building development. This includes zoning by use, permitting processes, and requirements such as minimum lot sizes.[1] I employ Geographic Information System (GIS) methods to identify the demographics within set radii of each municipality. Since most household moves are within the same county (Ihrke and Faber, 2012), an exclusionary motive should be most sensitive to low-income and minority populations relatively nearby.

As a further robustness check, this study uses school district desegregation orders as indicators of a municipality's incentive to use land-use regulations to accomplish segregation. I also employ a geographic instrumental variable to address endogeneity of ethnic settlement patterns.

2 Literature Review

The exclusionary effects of zoning have been studied extensively. In a series of articles, Rothwell and Massey find that higher zoning regulations are associated with greater racial and income segregation in urban areas (Rothwell and Massey, 2009, 2010). Lens and Monkkonen (2016) concur that land-use regulations contribute to residential segregation between rich and poor in metropolitan areas.

Housing prices are a primary mechanism through which land-use regulations create observed segregation. Rules establishing minimum lot sizes or restricting density tend to limit the availability of lower-priced housing. The link between strict land-use regulations and housing prices has been explored by numerous researchers. Quigley and Rosenthal (2005) summarize previous findings on that relationship and called for renewed research with more precise methods. Ihlanfeldt et al. (2007) seeks to improve on previous methodologies and found for a Florida sample that land-use regulations increased housing prices and size of newly built homes, while decreasing land prices.

Several authors have explored the public choice of land-use regulations. Fischel (2004) proposes a "homevoter" hypothesis, whereby homeowners vote for politicians and policies that will prop up their home values. Considering potential ways to prevent zoning that excludes, Clingermeyer's 1996 study of nine metropolitan areas suggested that greater state legislative oversight reduces zoning that has an exclusionary effect. Work by Cervero and Duncan (2004) and Lynch and Rasmussen (2004) offers a potential "homevoter" rationale behind exclusion-motivated zoning: They find that the presence of fewer low-income populations and minority populations correlates with higher home values.

Several prior analyses have used localized case studies to evaluate the motives behind adoption of zoning. Glaeser and Ward (2009) analyze land-use regulations across 187 municipalities in the Boston area. With unique panel data, they are able to identify trends over time in intensity and types of land-use regulation. They find some evidence of whites using land-use regulations to exclude minorities in the pre-World War II era.

Rolleston (1987) finds evidence of racial exclusion in part of New Jersey but does not find evidence of exclusion of low-income populations. In contrast, Bates and Santerre (1994) study communities in Connecticut and find support for exclusion of populations in poverty. Pogodzinski and Sass (1994) study Santa Clara County, California, and discover higher land-use regulations may exclude low-income populations; they note that this would be consistent with an exclusionary motive but do not attempt econometrically to separate the motive from the exclusionary effect.

Focusing on the origins of zoning, Shertzer et al. (2016) analyze block-level demographic data in Chicago

[1] The attributes of land-use are adopted from Gyourko et al. (2008), as I use their comprehensive index of land-use regulations in approximately 2,600 municipalities in the United States.

before and after the adoption of comprehensive zoning in 1923. They find that predominantly minority neighborhoods were more likely to be zoned for high densities and for industrial uses than neighborhoods with a higher native white population. Their study provides empirical evidence for an exclusionary motive in 1920s Chicago. The authors note the difficulty of separating the causes and consequences of zoning adopted in the present day, due to the continual interplay of regulations and subsequent settlement patterns over the past century.

3 Conceptual model and hypotheses

In order to test for evidence of an exclusionary motive at play in the adoption of land-use regulations, it is helpful to explicate the exclusionary motive hypothesis and its components in a simple mathematical model.

An assumption behind this research is that adoption of land-use regulation is responsive to local demand. This assumption is consistent with analysis by Fischel (2004); Ellickson (1977); and Been et al. (2014). The desire to exclude is a potential motivation for adopting land-use regulation. The exclusionary motive may be a function both of attitudes and surrounding demographics. The combination of these internal and external factors contributes to the exclusionary motive. Without attitudes opposing heterogeneity of incomes or race, a municipality's residents would not pursue exclusion through regulation, including through zoning. Without a perceived threat to the homogeneity of the municipality from surrounding populations, a municipality's residents would have no incentive to pursue exclusionary zoning. A simple mathematical model can help frame the complex and intertwined nature of this exclusionary motive, as well as clarify the empirical strategies in this paper.

Ihlanfeldt (2004) identifies four potential goals of land-use regulation: Reducing negative externalities, preserving certain land-use patterns,[2] establishing relatively homogeneous property values to ensure equitable contribution to public goods, and excluding low-income or minority populations. Adopting his breakdown, the demand for zoning can be represented as:

$$ZD = f(Ext, Pres, PG, EMZ) \tag{1}$$

Where ZD is the demand for zoning, Ext indicates the desire to reduce negative externalities, $Pres$ indicates desire to preserve land-use patterns, PG indicates desire to ensure equitable contribution to public goods, and EMZ indicates the desire to exclude low-income or minority populations. The desire to ensure that all members of a community contribute approximately equally to public goods provision may in practice overlap with a desire to exclude low-income populations. This paper's data and methods cannot disentangle the desire to exclude low-income populations in order to ensure equitable public goods contributions from a desire to exclude them arising from an intrinsic distaste for associating with low-income populations. This paper assumes that actual levels of zoning, Z, respond to local demand for zoning, such that:

$$Z = f(ZD) \tag{2}$$

The exclusionary motive, EMZ, is a function of several factors:

$$EMZ = f(I, X_I, X_R, Alt) \tag{3}$$

Where I represents the preferences of local decisionmakers or their constituents for segregation, X_I represents the presence of low-income populations nearby, X_R represents the presence of minority populations nearby, and Alt represents the availability of alternative methods of segregation.

In this conceptual framework, the exclusionary motive will have the following characteristics:

1. $\frac{\partial Z}{\partial EMZ} > 0$: A higher motive to exclude will be reflected in stricter land-use regulations.

[2] Downzoning, a subset of zoning that restricts subdivision of undeveloped land, is largely used to preserve open space, often farm land. In a New Jersey case study, Adelaja and Gottlieb (2009) find that adoption of downzoning increases with declining farm population and rising non-farm populations.

2. $\frac{\partial EMZ}{\partial X_I} > 0$ if $I > 0$: As low-income populations nearby increase, the community's desire to use zoning to exclude increases, as long as the community has some desire to segregate.

3. $\frac{\partial EMZ}{\partial X_R} > 0$ if $I > 0$: As minority populations nearby increase, the community's desire to use zoning to exclude increases, as long as the community has some desire to segregate.

4. $\frac{\partial EMZ}{\partial Alt} < 0$ if $I > 0$: As alternative methods of segregation are foreclosed to the community, their desire to use zoning to exclude increases, as long as the community has a positive desire to segregate.

Empirically testing this model, I aim to isolate the exclusionary motive, EMZ. I assume that the desire to reduce negative externalities (Ext) is distributed among my observations independently from any exclusionary motivation. Housing density controls for the desire to preserve land-use patterns ($Pres$). As mentioned above, PG and EMZ with regard to low-income populations are indistinguishable with this identification strategy.

This model gives rise to three hypotheses: First, ceteris paribus, greater income heterogeneity between a municipality and nearby populations will lead to stricter regulations being adopted. Second, greater ethnic heterogeneity between a municipality and nearby populations will lead to stricter regulations being adopted. Third, when alternative methods of exclusion are removed, municipalities will substitute into land-use regulations as an alternative method of segregating by race.

Using the data on levels of land-use regulations, the empirical model tests the following hypotheses:

1. $\frac{\partial Z}{\partial X_I} = \frac{\partial Z}{\partial EMZ} \times \frac{\partial EMZ}{\partial X_I} > 0$

2. $\frac{\partial Z}{\partial X_R} = \frac{\partial Z}{\partial EMZ} \times \frac{\partial EMZ}{\partial X_R} > 0$

3. $\frac{\partial Z}{\partial Alt} = \frac{\partial Z}{\partial EMZ} \times \frac{\partial EMZ}{\partial Alt} < 0$

4 Data and methods

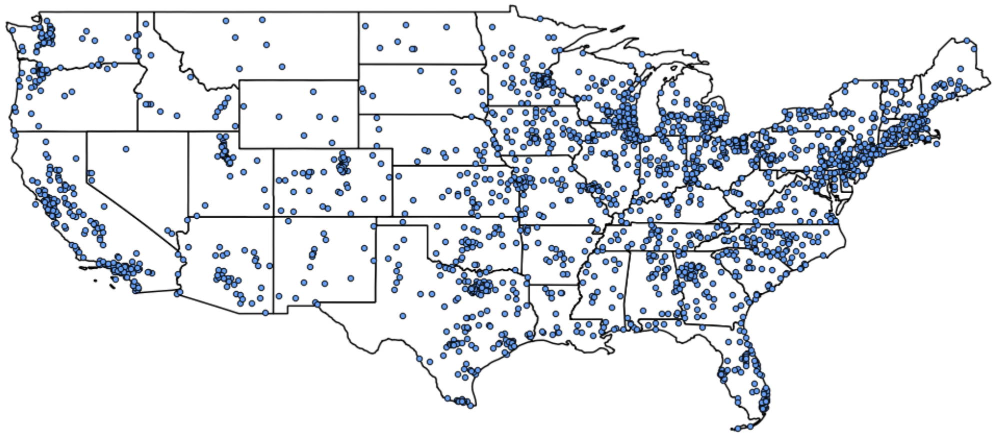
4.1 Data sources

The index of land-use regulations is from the Wharton Residential Land Use Regulation Index compiled by Gyourko et al. (2008). The index is comprised of 11 sub-indexes covering density restrictions, open-space restrictions, and time and cost of development approval, as well as the bureaucratic structure and judicial oversight. As with any analysis based on survey responses, selection bias may have been a factor. The index authors note that, compared to the average U.S. municipality, responding municipalities have larger populations, a greater share of the elderly and young, higher median levels of education, higher housing values, a lower share of non-Hispanic whites and less owner-occupied housing (Gyourko et al., 2008).[3] The index contains 2,611 observations, and is normalized to have a mean of 0 and standard deviation of 1. Values run from a minimum of -2.2 to a maximum of 4.8. Figure 1 shows a map of these municipalities.

For this study, I restrict this sample to the contiguous United States, that is, omitting Hawaii and Alaska. The omitted states contain a total of 8 survey respondents. Further, I restrict my sample to the 1,439 municipalities for which all explanatory variables are available. Summary statistics for the land-use regulation measure for this restricted sample are listed in .

Demographic data is from the U.S. Census Bureau's American Community Survey. For most data, 5-year averages from 2005-2009 are used. Density data is from 2010. All Census data used is at the level of incorporated municipalities, that is, Census-designated places. There are approximately 26,000 of these municipalities in each Census dataset. Geocoded maps are from the U.S. Census Bureau's Topologically Integrated Geographic Encoding and Referencing (TIGER) database, using U.S. Census 2000 boundary definitions.

[3] This widely used index of zoning regulations has provided the data for many studies of land-use regulations, including influential papers in the *Journal of Political Economy* (Stroebel and Vavra, 2019) and *Journal of Urban Economics* (Glaeser and Kahn, 2010).



Note: Data from Gyourko et al. (2008). Alaska and Hawaii are omitted from this map as they are from this paper.

Figure 1: A map showing the municipalities in the Wharton Residential Land Use Regulation Index

Data on court-ordered desegregation in U.S. school districts comes from Reardon et al. (2012). The authors used a variety of sources to construct a comprehensive list of school districts ever under a federal court order to desegregate.

4.2 Reduced-form empirical model

Using this data to test the hypotheses, the basic specification is:

$$Regulations_{ij} = \alpha + \beta_1 DemographicDelta_{ij} + \beta_2 Income_i + \beta_3 Controls_i + \gamma F_i + \epsilon_{ij} \tag{4}$$

Regulations for municipality i are measured by the Wharton Index. Income for municipality i is the median household income for that Census-designated place. Controls included are housing density and municipality population.[4] F_i indicates state fixed effects. To control for potential state-level variation in land-use regulations,[5] I use state fixed effects specifications for all regressions, and standard errors are clustered at the state level. I assume negative externalities are randomly distributed within a state. There may be state-level variation in state or federal contributions to public goods, and certain state-level land-use regulations may be in effect in some states. Employing state fixed effects removes all state-level variation on these and other margins, so the remaining variation in zoning should be explained by the exclusionary motive, although, as mentioned above, the public goods motive is inextricable from the desire to exclude low-income populations.

DemographicDelta indicates the income or ethnic difference between municipality i and the municipalities within a buffer zone j. In other words, this is the measure of X_I or X_R from the conceptual model. The buffer zone is a geographic zone of a fixed radius around each survey-responding municipality i; in this study, I report specifications with a 10-mile radius and provide footnotes with results from a robustness check using a 20-mile radius.[6] The income disparity is measured by the population-weighted Gini coefficient among the municipalities within buffer j.[7]

Ethnic difference is captured in two ways. First, ethnic difference between each municipality and the surrounding municipalities in the specified buffer zone is measured as:

[4]In a Chicago-area case study, McDonald and McMillen (2004) find that larger suburbs are more likely to utilize growth controls.

[5]Clingermayer (1996) analyzes the presence of state-level legislation curbing local governments' ability to adopt ad-hoc zoning.

[6]These radii were selected because the majority of household moves are within the same county Ihrke and Faber (2012), and median county size for the contiguous United States is 651 square miles (author's calculations using U.S. Census 2010), which would correspond to a 14.5-mile radius if counties were perfectly circular.

[7]The Gini is calculated using the Ginidesc module for Stata (Aliaga-Diaz and Montoya, 1999).

$$Ethnic_{ij} = \frac{1}{n} \sum (s_{gi} - s_{gj})^2 \tag{5}$$

where n is the number of ethnic groups g, and s is the share of ethnic group g in municipality i or buffer zone j. The second measure of ethnic dissimilarity is

$$WhiteDelta_{ij} = max[pctwhite_i - pctwhite_j, 0] \tag{6}$$

Where *pctwhite* is the percentage of non-Hispanic white residents in municipality i or buffer zone j. $WhiteDelta$ measures the difference in percentage white between a municipality and its neighboring municipalities. This variable is equal to that difference for municipalities that have a higher percentage of white residents than their neighbors, and is zero otherwise. If the exclusionary motive primarily affects largely white populations, this measure will capture the exclusionary motive more precisely than the Ethnic measure. The summary statistics for these variables, as well as the control variables, are shown in Table 1.

Table 1: Descriptive statistics for variables used in this paper's subsample of municipalities

	Obs.	Mean	Std. Dev.	Min.	Max.
Land-use regulations	1,439	-0.33	0.84	-2.15	3.46
Gini (10-mile buffer)	1,439	0.09	0.06	0.00	0.32
Ethnic delta (10-mile buffer)	1,439	0.01	0.01	0	0.16
White delta (10-mile buffer)	1,439	0.07	0.11	0	0.55
Log income	1,439	10.70	0.36	9.67	12.31
Log population	1,439	9.52	1.21	6.44	15.93
Log housing density	1,439	6.54	0.74	3.04	9.32

Due to the cross-sectional nature of the regulatory index, causal claims are difficult to make.[8] For this reason, I use a variety of robustness checks.

4.3 Court-ordered desegregation

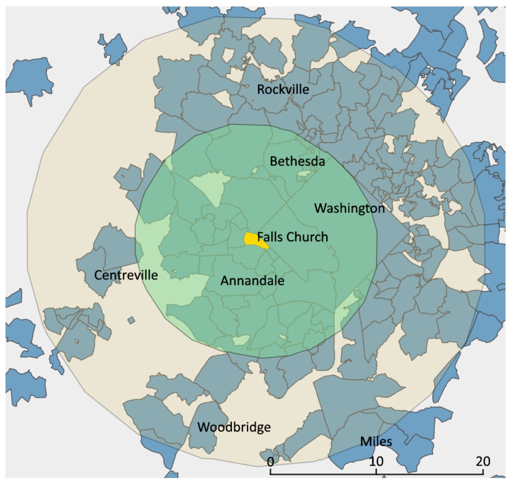
In the decades following *Brown v. Board of Education* in 1954, many school districts were given federal court orders to desegregate (Reardon et al., 2012). These desegregation orders provide an opportunity to identify a motive to exclude minorities. If the exclusionary motive is a determinant of land-use regulations, we would expect higher land-use regulations in municipalities whose school districts received court desegregation orders. This would occur for two reasons. First, segregated districts may indicate local attitudes in favor of segregation, or $I > 0$ in the conceptual model. Attitudes are difficult to capture in the data, especially considering the correlation among a variety of neighborhood attributes (see, for example, Bayer et al. (2007)). Court-ordered desegregation identifies some of the most segregated schools and offers a proxy measure of these attitudes. Given local control over school districts, the makeup and policies of a school district likely reflect the majority preferences of the locality's citizens. Attitudes in favor of school segregation would reasonably be positively correlated with an exclusionary motive behind zoning regulations.

There is a second mechanism by which court desegregation orders identify a motive to use land-use regulations to exclude. These court orders removed a potential method of limiting contact with minorities. Municipalities with exclusionary motives that were barred from segregating their schools may have substituted into land-use regulations in order to achieve exclusion. In terms of the conceptual model, this would correspond to *Alt*. As noted in the model section, the removal of alternative methods of segregation may increase demand for exclusionary zoning. This study uses the dataset compiled by Reardon et al. (2012) of all districts that had court orders to desegregate. For this study, a municipality is coded with a dummy variable equal to 1 if any of the school districts overlapping its boundaries were ever under a desegregation order, and 0 otherwise.

[8]While some authors have analyzed determinants broad zoning shifts, e.g., from residential to commercial (see Cho et al. 2012 and Munneke 2005), nationwide data on the tightening or loosening of residential requirements such as minimum lot size does not appear to be available.

4.4 Geographic instrumental variable

I use a geographic instrumental variable, following a process similar to that used by Johnson and Koyama (2017). The location of certain populations may be endogenous to welcoming attitudes, which would also be correlated with lower exclusionary regulations. In terms of the conceptual model, $\frac{\partial X}{\partial I} < 0$. That is, low-income or minority populations may settle in places relatively non-hostile toward them, and further influxes of those groups may tend to locate near existing populations. To attempt to remove the effect of a municipality's openness to heterogeneous groups on the presence of those groups nearby, I use the demographics of the ring of municipalities outside of the buffer zone to instrument for the demographics of the municipalities within the buffer around the municipality of interest. For the 10-mile buffer, this study uses the municipalities between 10 miles and 20 miles from the municipality of interest; for the 20-mile buffer, the demographics of the 20- to 40-mile ring are used as an instrument. The outer ring is set to be sufficiently far from the core municipality to avoid the neighborhood effects of specific racial groups locating in and close to towns more open to diversity.



Note: Falls Church, VA is just one example of a municipality that responded to the Wharton land-use survey.

Figure 2: An example of a 10-mile buffer and 10-mile to 20-mile outer ring constructed around Falls Church, Virginia

As an example, Figure 2 shows the 10-mile and 20-mile radii around Falls Church, Virginia, a suburb of Washington, D.C. Falls Church, highlighted in yellow, answered the Wharton survey, and is municipality i for this example. The 10-mile buffer zone is denoted in green, and includes such nearby municipalities as Bethesda, Maryland; Annandale, Virginia; and Washington, D.C. The beige ring includes all municipalities between 10 and 20 miles from Falls Church.[9] It includes such municipalities as Rockville, Maryland; Woodbridge, Virginia; and Centreville, Virginia. The average demographics of the outer, beige ring is used to instrument for the average demographics of the inner, green buffer zone.[10]

5 Results

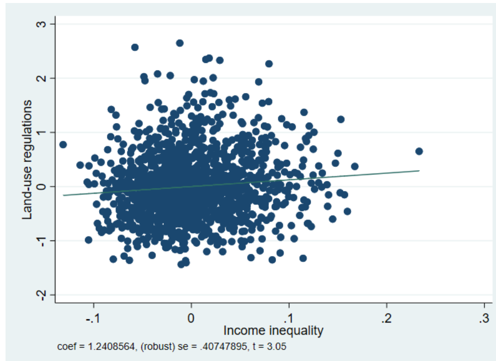
5.1 Neighboring income demographics and zoning

The first hypothesis stated in Section 3 was that higher levels of income heterogeneity between the municipality and the surrounding area prompt a community to use exclusionary zoning. Figure 3 shows the correlation

[9] Municipalities partially intersecting the buffer zone or outer ring are included; in Figure 2, for example, Washington, D.C. is included in both the buffer zone and the outer ring for calculation purposes.

[10] Demographics of the orange buffer zone and purple outer ring are gathered by averaging the demographics within all the municipalities that at least partially intersect the relevant radius.

between the Gini coefficient between each municipality and the surrounding area within a 10-mile radius, with basic controls included. The positive relationship between the Gini coefficient and levels of land-use regulation is statistically significant at the 1 percent level.



Note: Includes controls for log income, housing density, log population, and state.

Figure 3: A plot of land-use regulations and the Gini coefficient between each municipality and those within a 10-mile radius

Table 2 reports the relationship between the Gini coefficient among municipalities within 10 miles of each municipality tested.[11] With and without controls, these estimates are positive and statistically significant at the one percent level. The r-squared values indicate that alone, the Gini coefficient explains 3.5 percent of variation in land-use regulations among municipalities.

Table 2: Land-use regulations and Gini coefficient among 10-mile buffer

Variables	(1)	(2)	(3)
Gini (10-mile buffer)	2.426***	1.175***	1.241***
	(0.535)	(0.407)	(0.401)
Log income		0.693***	0.671***
		(0.0852)	(0.0865)
Housing density			-0.148***
			(0.0438)
Log population			0.0615***
			(0.0200)
R-squared	0.035	0.139	0.157

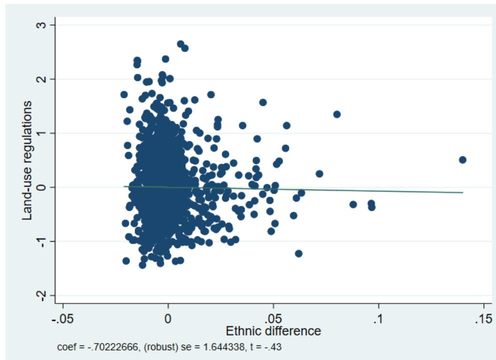
Note: Standard errors in parentheses and clustered by state. State fixed effects included. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. Constant not reported. Observations = 1,439 and number of states = 48.

Including income of the municipalities tested explains another 10 percent. Controlling for income also halves the coefficient estimate for the effect of income inequality on land-use regulations. Land-use regulations appear to be a normal good, with higher-income municipalities demanding and providing higher levels of regulation. Lower housing density is associated with higher land-use regulations, providing some support for the conceptual idea that regulations are adopted partly out of a desire to preserve low-density land-use patterns. Municipalities with higher populations tend to have higher levels of zoning.

[11] Using a 20-mile radius, the estimated coefficients for the Gini coefficient are slightly larger, but follow the same pattern and are also statistically significant at the one-percent level.

5.2 Neighboring ethnic demographics and zoning

The second hypothesis was that greater ethnic differences between a municipality and its surrounding area will prompt the municipality to adopt higher land-use regulations. As noted in the Data section, this paper uses two measures of ethnic difference: an ethnic fractionalization measure, and a measure of the difference in percentage of non-Hispanic white residents.



Note: Includes controls for log income, housing density, log population, and state.

Figure 4: A plot of land-use regulations and the ethnic difference between each municipality and those within a 10-mile radius

Figure 4 plots the relationship between land-use regulations and the ethnic fractionalization between each municipality and the surrounding 10-mile radius. As the figure indicates, there is minimal relationship between ethnic difference and land-use regulations, and the relationship is not statistically significant.

Table 3: Land-use regulations and Ethnic delta among 10-mile buffer

Variables	(1)	(2)	(3)
Ethnic difference	2.148	-1.077	-0.702
	(1.633)	(1.729)	(1.617)
Log income		0.753***	0.729***
		(0.0930)	(0.0944)
Housing density			-0.134***
			(0.0454)
Log population			0.0682***
			(0.0206)
R-squared	0.002	0.132	0.149

Note: Standard errors in parentheses and clustered by state. State fixed effects included. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. Constant not reported. Observations = 1,439 and number of states = 48.

Table 3 reports the coefficients for the relationship between land-use regulations and the ethnic difference between each municipality and the surrounding 10-mile radius. In no specification is the measure of ethnic difference between a municipality and those in the surrounding 10 miles statistically significant. As controls are added, the magnitude of the estimated coefficient falls from 2.148 to -0.702.[12]

Income and population are positively correlated with higher land-use regulations, and these estimates

[12] Using a 20-mile radius, the estimated coefficient for the Ethnic delta is slightly larger and statistically significant at the 10-percent level. With controls, the estimated coefficients for Ethnic delta are statistically insignificant.

are statistically significant at the 1 percent level. Housing density is statistically significantly and negatively correlated with land-use regulations.

Table 4: Land-use regulations and White delta among 10-mile buffer

Variables	(1)	(2)	(3)
White delta (10-mile buffer)	1.262***	-0.170	0.0270
	(0.247)	(0.237)	(0.240)
Log income		0.778***	0.719***
		(0.105)	(0.112)
Housing density			-0.136***
			(0.0451)
Log population			0.0687***
			(0.0207)
R-squared	0.038	0.132	0.149

Standard errors in parentheses and clustered by state. State fixed effects included in (2) but not (1). * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. Constant not reported. Observations = 1,439 and number of states = 48.

The difference in percentage white provides an alternative measure of X_R. Table 4 shows the estimated impact of the difference, or delta, between the percentage white of the municipality and the percentage white in municipalities within 10 miles. Without controls, that difference has a positive and statistically significant impact on land-use regulations. Controlling for income, however, the estimated impact of difference in percentage white is close to zero and is statistically insignificant. Again, income and population are positively correlated with higher land-use regulations, with these estimates statistically significant at the one percent level. Housing density is also negatively and statistically significantly correlated with land-use regulations.[13]

5.3 Desegregation orders and zoning

To test the third hypothesis implied by the exclusionary motive, I analyze the impact of school desegregation on land-use regulations. Court-ordered desegregation identifies areas that revealed a preference for segregation through school district policies; in terms of the conceptual model, municipalities in these districts would seem to exhibit $I > 0$. These orders also remove one mechanism of achieving segregation, increasing the incentive to use land-use regulations as a substitute policy to exclude.

Table 5: Land-use regulations and school desegregation orders

Variable	(1)	(2)
Court orders	-0.0702	-0.0619
	(0.0751)	(0.0517)
Log income		0.722***
		(0.0914)
Housing density		-0.133***
		(0.0454)
Log population		0.0706***
		(0.0213)
R-squared	0.001	0.150

Note: Standard errors in parentheses and clustered by state. State fixed effects included in (2) but not (1). * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. Constant not reported. Observations = 1,439 and number of states = 48.

[13] Using a 20-mile radius yields similar estimated coefficients and statistical significance for the White delta specifications.

Table 5 shows the relationship between land-use regulations and court-ordered desegregation of schools. "Court orders" is defined as 1 if any school district in the municipality was ever under a court desegregation order, 0 otherwise. The results show that regulations tend to be lower in municipalities located in school districts that were ever under court orders to desegregate. With and without controls, the coefficients on the dummy variable for a court order are negative and statistically insignificant. The estimated effects of income, housing density, and population are similar to the previous specifications.

5.4 Geographic instrumental variable

It is possible that low-income or minority populations move to locations that are particularly friendly toward them. In this case, the lack of exclusionary attitudes in a community would lead to increases in income and ethnic heterogeneity. To address the potential endogeneity of I, the preference for segregation, and X_I and X_R, the presence of adjacent low-income or minority populations, I implement a geographic instrumental variable (IV), using two-stage least squares (2SLS). I use the demographics in the 10-mile to 20-mile ring around each municipality to instrument for the demographics in the 10-mile buffer zone around the municipality. As a further robustness check, I also use the demographics in the 20-mile to 40-mile ring to instrument for the demographics in the 20-mile buffer.

For the Gini coefficient, instrumenting with the 10-mile to 20-mile ring yields an effective F statistic of 10.585 corresponding to a Montiel Olea and Pflueger measure of "worst-case" bias (τ) greater than 30%. For the ethnic delta, the effective F statistic is 12.285 ($\tau < 30\%$). For the white gap, the 10- to 20-mile ring is a strong instrument for the 10-mile radius, with an effective F statistic of 79.149 ($\tau < 5\%$). For the 20- to 40-mile ring, the effective F statistics are smaller for the Gini and the ethnic delta measure (2.511 and 2.298, respectively), while the white gap measure has an effective F statistic of 89.952 ($\tau < 5\%$).

Table 6: Land-use regulations and instrumented diversity variables among 10-mile buffer

Variables	(1)	(2)	(3)	(4)	(5)	(6)
Gini (instrumented)	6.492***	5.882**				
	(2.090)	(2.594)				
Log income		0.470***		0.676***		0.641***
		(0.125)		(0.0919)		(0.102)
Housing density		-0.197***		-0.151***		-0.140***
		(0.0418)		(0.0390)		(0.0305)
Log population		0.0366*		0.0678***		0.0767***
		(0.0216)		(0.0159)		(0.0181)
Ethnic delta			11.34	7.446		
(instrumented)			(11.83)	(11.59)		
White gap					1.415***	0.433
(instrumented)					(0.310)	(0.458)

Standard errors in parentheses and clustered by state. State fixed effects included. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. Constant not reported. Observations = 1,439 and number of states = 48.

The results are shown in Table 6. The results are very similar to estimates in the tables above. The Gini coefficient is positively and statistically significantly correlated with higher land-use regulations. The ethnic delta and white gap are not statistically significantly correlated with higher land-use regulations once including controls. Income of the municipality of interest is a strong predictor of levels of land-use regulations.

6 Discussion and conclusion

The results in this paper are consistent with wealthy communities seeking to exclude low-income populations. A higher Gini coefficient between a municipality and its surrounding populations is statistically significantly correlated with higher land-use regulations in that municipality. The "homevoter" hypothesis that homeowners are concerned with preserving their housing values offers one potential explanation for this motivation to exclude (Fischel, 2004).

Regarding exclusion of minorities, however, the data fail to show evidence that greater ethnic dissimilarity between a municipality and its surrounding area prompts adoption of higher land-use regulations. This null result could stem from a variety of reasons. It is possible that a desire to exclude minorities is not at play in most municipalities' land-use decisions. There are documented examples of explicitly racially motivated exclusionary zoning (see Fogelson 2007 and Shertzer et al. 2016). These null results could occur despite those instances, since this paper looks at the whole available population of nearly 1,500 municipalities, and does not find evidence that, on average, municipalities are motivated to use land-use regulations to exclude minorities. However, these results could also occur if legal restrictions on using zoning to exclude minorities prevents municipalities from acting on an exclusionary motive, especially in areas already under judicial scrutiny for school district segregation. Another possibility is that exclusionary zoning may not be responsive to nearby minority populations, in which case this study would fail to identify a motive to exclude minorities.

This paper's findings are consistent with Bates and Santerre's results from their 1994 study of Connecticut municipalities, in which they found evidence of a motive to exclude low-income populations. These findings discover the opposite pattern from Rolleston (1987), who in New Jersey found evidence of racial but not low-income exclusion.

Across specifications, a municipality's median household income is a robust predictor of its levels of land-use regulations. Wealthier municipalities tend to adopt stricter regulations. This relationship is consistent with non-exclusionary motivations for land-use regulations, such as public goods provision and preservation of lower density (Ihlanfeldt, 2004).

Municipalities with higher populations appear to have higher land-use regulations. The robustly positive estimates for the impact of total population on land-use regulations go against the hypothesis in much of the exclusionary zoning literature that smaller municipalities are more prone to adopt more extensive land-use regulations (see, e.g., Clingermayer 2004).

The estimated negative correlation between housing density and land-use regulations is consistent across specifications. A low level of housing density could reasonably be a cause of land-use regulations, as in areas motivated by the desire to preserve low density (see Ihlanfeldt 2004), or an effect of these regulations, as many land-use regulations limit density directly or indirectly.

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