American Economic Journal: Applied Economics 2016, 8(3): 217–246
http://dx.doi.org/10.1257/app.20140430

Race, Ethnicity, and Discriminatory Zoning†

By Allison Shertzer, Tate Twinam, and Randall P. Walsh*

Zoning policies can have marked impacts on the spatial distribution of people and land use, yet there is little systematic evidence on their origin. Investigating the causes of these regulations is complicated by the fact that land use and zoning have been co-evolving for nearly a century. We employ a novel approach to overcome this challenge, studying the factors underpinning the introduction of comprehensive zoning in Chicago. We find evidence consistent with a precursor to exclusionary zoning as well as support for the hypothesis that industrial use zoning was disproportionately allocated to neighborhoods populated by ethnic and racial minorities. (*JEL* J15, N32, N92, R23, R52)

Few policies are as profound in their impact on where people live and work as are locally determined land use regulations. However, little is systematically known about the origin and evolution of zoning and its relationship to neighborhood demographics, both in terms of consequences and causes. Critics argue that zoning is sometimes used as a tool to deter entry of poorer households into wealthier neighborhoods, for instance, through the use of minimum lot size requirements, thus contributing to segregation by race and income (Schlay and Rossi 1981; Rothwell and Massey 2009; and Sharkey 2013).[1] Further, some scholars and policymakers contend that mixed use zoning has been allocated disproportionately to low-income and minority communities, leading to disparities in environmental quality across neighborhoods and depressed land values.[2]

Identifying the link between local land use regulations and these disparities is difficult because land use and zoning have been co-evolving for almost a century in most American cities. Existing scholarship has struggled to disentangle potentially

* Shertzer: University of Pittsburgh, 4901 WW Posvar Hall, 230 South Bouquet Street, Pittsburgh, PA 15260, and NBER (e-mail: shertzer@pitt.edu); Twinam: University of Washington Bothell, 18115 Campus Way NE, Bothell, WA 98011 (e-mail: twinam@uw.edu); Walsh: University of Pittsburgh, 4901 WW Posvar Hall, 230 South Bouquet Street, Pittsburgh, PA 15260, and NBER (e-mail: walshr@pitt.edu). Antonio Diaz-Guy, Phil Wetzel, Justin Szilard, Jeremy Brown, and Andrew O'Rourke provided outstanding research assistance. Support for this research was provided by the NSF (SES-1459847). Additional support was provided by the Central Research Development Fund and the Center on Race and Social Problems at the University of Pittsburgh. We thank seminar participants at Yale, the Economics and Policy workshop at Booth, and the University Center for Social and Urban Research at the University of Pittsburgh. We are grateful to Gabriel Ahlfeldt and Daniel McMillen for providing the land price data and Christopher Winters at the University of Chicago Library for assistance with the land use maps. We also thank David Ash and the California Center for Population Research for providing support for the microdata collection, Carlos Villareal and the Early Indicators Project (uadata.org) for the Chicago street file, and Martin Brennan and Jean-Francois Richard for their support of the project.

† Go to http://dx.doi.org/10.1257/app.20140430 to visit the article page for additional materials and author disclosure statement(s) or to comment in the online discussion forum.

[1] For reviews of the exclusionary zoning literature, see Ihlanfeldt (2004) and Pogodzinski (1991).

[2] See for instance: Maantay (2001); Wilson, Hutson, and Mujahid (2008); and EPA Plan EJ 2014.

inequitable treatment in zoning ordinances and nuisance siting from residential mobility that is correlated with land use. For instance, the availability of affordable housing may cause low-income residents to cluster in areas with locally undesirable land uses (Been and Gupta 1997). Nonetheless, understanding the link between zoning and disparities in access to public goods and exposure to pollution is critical for effective policymaking.

In this paper we employ a novel approach to studying the link between land use regulation and demographics, focusing on the introduction of comprehensive zoning in the United States. The key innovation of our approach is that we observe detailed measures of existing land use at the city block level *prior* to the introduction of comprehensive zoning in Chicago in 1923. Our main empirical strategy asks what impact preexisting minority populations had on zoning outcomes, conditional on the extant land use and settlement patterns at the time of initial zoning adoption. The ability to control for ex ante density allows us to distinguish between minority neighborhoods receiving higher density zoning and the tendency of minorities to settle in neighborhoods with denser development. Similarly, the ability to observe and control for ex ante minority proximity to undesirable land uses enables us to disentangle unequal treatment in land use regulation from the observationally equivalent mechanism of poor minorities sorting into less expensive neighborhoods near polluting sites.[3]

We focus on the initial comprehensive zoning ordinance adopted by Chicago in 1923, one of the first and most influential policies of its kind, and ask how the racial and ethnic composition of neighborhoods influenced local zoning. An additional contribution of our study is the rich detail of the microdata assembled for the analysis. We observe place of birth and parents' place of birth for the universe of individuals living in Chicago in 1920, allowing us to precisely measure the size of both first- and second-generation immigrant populations. We are also able to distinguish Northern-born black populations from enclaves of Southern-born blacks who had migrated to Chicago, which enables us to ask whether these groups were treated differently in the zoning process.

We first study the density component of the zoning ordinance, finding evidence of an early form of "exclusionary" zoning that was applied to black neighborhoods.[4] On the margin between the two lowest levels of density zoning, where the greatest scope for unequal treatment in density restrictions would have existed, a 1 standard deviation increase in the black share of a neighborhood was associated with a 27 percentage point increase in the likelihood of the neighborhood being zoned for higher density. For European immigrants, the relationship is reversed. At the margin, the zoning board appears to have endeavored to increase the building density in

[3] Recent work by Depro, Timmins, and O'Neil (2015) takes a different approach to this question, estimating a structural model of mobility by race in the presence of polluting sites. They show that race-pollution correlations can be in part explained by whites having a higher marginal willingness than Hispanics to pay to avoid pollution exposure.

[4] The extant literature on exclusionary zoning emphasizes differences in zoning ordinances across various incorporated municipalities, not within a single city (for instance, *The Homevoter Hypothesis*, Fischel 2001). However, to the extent that cities faced pressure to concentrate minorities in particular neighborhoods, we may expect to see higher density zoning in black and immigrant neighborhoods in our context.

neighborhoods with high numbers of black residents, particularly when compared with neighborhoods with large numbers of European immigrants or natives.

Turning to the use component of the zoning ordinance, we find that neighborhoods with larger shares of Southern-born blacks or first-generation immigrants were more likely to be zoned for industrial uses than comparable neighborhoods with white natives. Specifically, a 1 standard deviation increase in Southern black share is associated with an 8 percentage point increase in the likelihood of an enumeration district being zoned to include manufacturing, and a 1 standard deviation increase in first-generation immigrant share is associated with a 7 percentage point increase in the likelihood of being zoned for manufacturing uses. These are quantitatively important effects given that only 26 percent of enumeration districts received any zoning for manufacturing uses.

To put these findings in context, we next explore the predictive power of demographics relative to other determinants of land use regulation. In general, we find that demographics are less important than geography, preexisting land uses, and transportation for predicting manufacturing and commercial zoning. However, when we focus our analysis on the areas of the city proximate to the predominantly black neighborhoods, we find the predictive power of demographics for manufacturing zoning to be much more pronounced.

Inequitable zoning had potential consequences in both the short and long run for blacks and immigrants. Minority communities that received industrial and high density zoning were excluded from the economic benefits of low density, purely residential zoning in the 1923 ordinance.[5] This unequal treatment in the zoning ordinances could translate directly into economic disparities since "… for the great majority of homeowners, the equity in their home is the most important savings they have" (Fischel 2001, 4).

In our final set of analyses we demonstrate that the 1923 density zoning had meaningful and persistent effects. Conditional on prezoning land use, neighborhoods that received higher density zoning in 1923 had both higher housing unit and population density by 1940. This finding is consistent with the claim that zoning ordinances may have been used to concentrate minorities in denser neighborhoods, potentially contributing to segregation and environmental disparities (Rothwell 2011). Furthermore, we demonstrate that this type of disparate policy treatment had emerged as early as the 1920s.

Our results cast doubt on the de jure racial blindness of comprehensive zoning ordinances, of which all but one (New York) were passed after the Supreme Court ruled explicitly racial zoning unconstitutional in the 1917 *Buchanan v. Warley* case.[6] Although our evidence is historical, the results demonstrate that unequal treatment can arise even with the most general and widely used forms of land use control.

[5] The price premium for strictly residential use zoning in the context of the Chicago ordinance is documented in McMillan and McDonald (2002). In order for blacks to be disadvantaged by the impact of the zoning ordinance on housing prices, it must be the case that some were homeowners and landlords. We cannot observe landlord status in the census, but nonetheless we see that 7 percent of blacks in our sample region were homeowners in 1920 and 10 percent in 1930.

[6] The Supreme Court found that a Louisville, Kentucky city ordinance prohibiting the sale of property in certain neighborhoods to blacks violated the Fourteenth Amendment; all subsequent zoning legislation in the Unites States thus made no explicit mention of race.

This finding is particularly important because zoning decisions made decades in the past can have far-reaching consequences: evidence from Los Angeles (Brooks and Lutz 2014) and Chicago (Shertzer, Twinam, and Walsh 2015) demonstrates that zoning appears to cause significant persistence in urban economic geography. Taken together, these papers suggest that observed racial inequities in contemporary cities could partially result from urban planning decisions made nearly a century ago.

I. Background on Zoning in Chicago

The origins of comprehensive land use regulation in Chicago were rooted in public demand for "orderly" urban development, in particular, the prevention of industrial and commercial encroachment on residential neighborhoods. Early twentieth century observers, including the influential Chicago Real Estate Board, expressed concern about the effect of unchecked expansion of commercial and industrial activity on property values (Schwieterman and Caspall 2006). Others objected to the "canyon effect" created by unbroken rows of skyscrapers and the potential negative effects of the associated reduction in sunlight exposure and air flow on public health (Hall 2002). Chicago's city government had made previous attempts to control undesirable land uses, including an 1837 municipal code that prohibited any landowner or tenant from maintaining nuisances, such as dead animals, dung, putrid meat, or fish entrails on their property. Such piecemeal approaches proved insufficient to meet public demand for controlled development, and in 1920 the newly created Chicago Zoning Commission began preparing a comprehensive zoning ordinance. The Commission, composed of 8 aldermen and 14 community representatives, spent 18 months surveying existing land use in Chicago before issuing the initial statute.

Chicago's comprehensive zoning ordinance regulated land through both use districts and volume districts. Four distinct use districts were included: residential (single-family housing), apartment, commercial, and manufacturing. These use districts were hierarchical, with apartment districts allowing residential uses, commercial districts allowing both apartments and single-family homes, and manufacturing districts allowing any use. Volume districts imposed restrictions on maximum lot coverage, aggregate volume, and height. The five volume districts were also hierarchical with district 5 allowing the tallest buildings.

Zoning statutes spread across the country in rapid order after Chicago's ordinance was passed, and by 1925 nearly 500 cities had adopted similar forms of comprehensive land use regulation (Mills 1979). By this time, the question of whether zoning could explicitly address race and block black residents from certain neighborhoods had been settled: the US Supreme Court had ruled a Louisville, Kentucky racial zoning ordinance unconstitutional in *Buchanan v. Warley* in 1917.[7] This case ended efforts by the Chicago Real Estate Board to pass such an ordinance. The realtors, led by agents from the Hyde Park, Kenwood, and Oakland neighborhoods, had argued that the dispersion of African Americans throughout the city could lead to a loss of

[7] Racial zoning ordinances were passed in a number of southern and border cities between 1910 and 1917. For an in depth discussion, see Troesken and Walsh (2015).

more than $250 million (in 1922 dollars) in property values (Chicago Commission on Race Relations 1922).

When the move for a racial zoning ordinance failed, demand for segregation and protection from black "encroachment" led to the proliferation of private alternatives such as restrictive covenants (Brooks 2011; Brooks and Rose 2013). White residents were concerned by the arrival of blacks from the South, seeing them as "ignorant and rough-mannered, entirely unfamiliar with the standards of conduct in northern cities" (Chicago Commission on Race Relations 1922). White immigrants were also concerned about competition for jobs from newly arrived African Americans and viewed the prospect of Negro neighbors as a "catastrophe equal to the loss of their homes" (Grossman 1989, 175). Even longtime black residents of Chicago were hostile to the new arrivals, worrying that they would lose what social privileges they had as a result of the influx of poor and uneducated Southern blacks into the city (Kennedy 1968, 222).

For their part, African Americans were suspicious of the movement for comprehensive zoning, particularly so soon after the racial zoning debate. Nonetheless, the 1923 zoning ordinance passed without notable opposition from Chicago's black community. Enthusiasm from black elites, many of whom welcomed the move for comprehensive zoning, may partly explain this outcome. For instance, a prominent African American developer on the zoning board, Charles S. Duke, championed land use regulation to the black community. He is credited by historians as having shielded the wealthiest black neighborhoods from mixed-use zoning (NAACP 1923). Secondary historical sources suggest City Council Chicago may have deliberated lowered zoning standards (e.g., permitted higher building density and mixed uses) in poorer black neighborhoods while maintaining strict zoning in white neighborhoods to prevent "encroachment" of blacks (Flint 1977). However, to our knowledge there is no empirical evidence regarding the disparate treatment of racial or ethnic minorities in either the 1923 ordinance or subsequent amendments over the 1930s and 1940s.[8]

II. Data

The dataset used in this paper has three components: 1920 census data at the enumeration district level, the comprehensive 1922 Chicago land use survey, and maps of the city's 1923 zoning ordinance. Summary statistics for key predictors and outcomes are provided in Table 1.

[8] Nonetheless, comprehensive land use regulation has been the subject of a large literature, and the case of Chicago has attracted particular interest. Previous work on Chicago's 1923 zoning ordinance used a sample of city blocks to determine the extent to which the ordinance followed existing uses, finding that zoning patterns were highly predictable given existing land uses, proximity to transportation networks, and distance to waterways (McMillen and McDonald 1999). The same authors also asked how the 1923 zoning ordinance impacted land values (McMillen and McDonald 2002). Using propensity score matching on the same sample of city blocks, they find that strictly residential zoning increased land values relative to mixed-use zoning.

Table 1—Descriptive Statistics

Percent manufacturing	0.097 (0.196)
Percent manufacturing if greater than 5 percent	0.371 (0.214)
Indicator for manufacturing zoning	0.262 (0.440)
Percent commercial zoning	0.218 (0.181)
Indicator for volume district 2 if within 500 feet of district 1 and 2	0.587 (0.493)
Total blacks	0.057 (0.181)
Southern blacks	0.039 (0.126)
Northern blacks	0.018 (0.057)
First-gen. immigrants	0.462 (0.221)
Second-gen. immigrants	0.208 (0.080)
1913 land values	103.368 (386.982)

Notes: Descriptive statistics for primary outcome and explanatory variables at the enumeration district (ED) level. Means are given with standard deviations in parentheses. Statistics are computed on the full sample unless otherwise indicated. Percentages of zoning variables are the fraction of the area of each ED covered by the specified type of zoning. Indicators equal one if and only if the ED includes any of the specified zoning. Demographic variables are the fraction of the total ED population attributed to each group. See Figure 1 for demographic group definitions.

A. *Census Enumeration District Data*

We obtained counts of the number of blacks and white ethnic group members at the census enumeration district level for a 100 percent sample of the population using a digitized version of the original 1920 census taken from the genealogy website Ancestry.com (Ancestry.com 2010). Enumeration districts were small administrative units used internally by the census to divide cities into small areas that could be surveyed by one person.[9] The spatial microdata compiled for this paper represents a significant improvement over existing sources, most of which are tabulations of the population at the ward level produced by the Census Bureau.[10] The average enumeration district in Chicago had 1,182 individuals in 1920, less than 2 percent of the population of the average ward.

In order to investigate the relationship between the composition of the population and zoning outcomes, we digitized the 1920 enumeration district map of Chicago. We first used written descriptions of the enumeration districts available on microfilm

[9] The Census Bureau did not switch to a mail-based survey system until 1960.

[10] The IPUMS sample for 1920 (Ruggles et al. 2004) covers 1 percent of the population of Chicago and contains enumeration district identifiers; however, this small sample is insufficient for studying neighborhoods.

from the National Archives. The information from these microfilms has been digitized and made available on the web due to the work of Stephen P. Morse.[11] Second, we took digital photographs of the physical map of the 1920 census enumeration districts of Chicago from the National Archives. Working primarily with a geocoded (GIS) historic base street map developed by the Early Indicators Project, we generated a GIS representation of the Chicago enumeration district map that is consistent with the historic street grid.[12]

In our empirical work we focus on four categories of racial and ethnic minorities. Given the emphasis in the historical record on the lack of cohesiveness between Northern and Southern blacks, we separate these two groups in much of our empirical work. We define as southern blacks those individuals who report their race as black or mulatto and their place of birth as in the South.[13] We also include in this category "second-generation" blacks, that is, individuals born in the North but with southern-born fathers in order to group all blacks of southern origin together.[14] Northern blacks are defined as black or mulatto individuals born outside the South to non-Southern fathers.

First-generation immigrants include all foreign-born individuals plus second-generation individuals under the age of 18. Second-generation immigrants are defined as individuals who were born in the United States and who are at least 18 years old with foreign-born fathers. Using these definitions, we avoid a standard problem in the segregation literature of immigrant populations being diluted by the presence of their native-born children.[15] Third-generation whites are defined as white individuals who were born in the United States to US-born fathers. As is shown in Table 1, in 1920 our study area's population is composed of 1.5 percent northern blacks, 2.9 percent southern blacks, 52.0 percent first-generation immigrants, and 17.9 percent second-generation immigrants.

There are important compositional and economic differences between the first- and second-generation immigrant groups. Adult second-generation immigrants primarily traced their ancestry to Ireland and Germany and tended to be wealthier than recent arrivals. First-generation immigrants were more likely to have arrived from Poland, Italy, Russia, Bohemia (now the Czech Republic), and other "new" sending countries of late nineteenth and early twentieth century European immigration. The German and Irish communities also held political clout and most aldermanic seats;

[11] Website: http://stevemorse.org/ed/ed.php.

[12] See "Historical health conditions in major US cities: The HUE dataset" (Villarreal et al. 2014) for details on the street file construction. See "Segregation and Neighborhood Change in Northern Cities: New Historical GIS Data from 1900 to 1930" (Shertzer, Walsh, and Logan 2015) for details on the enumeration district dataset construction.

[13] We use an 11 state definition of the South, defining the region to include Alabama, Arkansas, Florida, Georgia, Louisiana, Mississippi, North Carolina, South Carolina, Tennessee, Texas, and Virginia.

[14] Although we believe grouping all blacks of southern extraction together is the most consistent with the historical context, we also experimented with an alternate definition in which any black born in the North is classified as a northern black. Our results were qualitatively unchanged.

[15] In their 2008 study of immigrant segregation, Cutler, Glaeser, and Vigdor (2008) note that immigrants can "self-integrate" by having native-born children. Because our demographic data was constructed from individual-level records, we can sidestep this problem by simply counting minor second-generation children as first-generation immigrants. This approach provides a more accurate measure of the share of the total population composed of immigrant families.

the larger new immigrant groups had mobilized politically but counted few aldermen among their number.[16]

The spatial distribution of the minority groups we study is displayed in Figure 1.[17] Panel A shows the concentration of Southern-born blacks in the "Black Belt" south of downtown with a secondary population to the west. Northern-born blacks (panel B) are concentrated in the Black Belt as well, with larger numbers living to the north and south of the most densely African-American areas. Figure 2 illustrates this geographic variation in finer detail. Focusing on enumeration districts that were at least 5 percent black, the figure shows the percentage of each neighborhood's black population that we classify as Southern black. Southern black percentages range from a low near 20 percent to a high in excess of 80 percent. Thus, there is sufficient variation in where southern and northern blacks lived to examine their impact on zoning separately.

Turning to European immigrants, panels C and D of Figure 1, respectively, show the distribution of first- and second-generation immigrants. Numerically much larger than the black population, first-generation immigrants were most concentrated in inland neighborhoods in the periphery of the central business district. Second-generation immigrants occupy the next ring of enumeration districts further out from the downtown, particularly in the northwest.

B. *The 1922 Chicago Land Use Survey*

The comprehensive land use survey we draw upon was conducted by the Chicago Zoning Commission in 1922 for the purposes of informing the drafting process for the zoning ordinance. Four teams, each equipped with an automobile, recorded the use of every building and lot in the city (Zoning Chicago 1922 Pamphlet). From these survey maps we obtain the location of every commercial and manufacturing use in the city; we also obtain the location and number of stories for every building with four or more stories. We geocoded the largest sample to date of this pre-zoning survey for our study. While previous work by McMillen and McDonald used a sample of 1,000 blocks, we digitized nearly two-thirds of the city by land mass.[18] Our sample covers 79.4 percent of the 1920 population along with 97.8 percent of blacks and 80.8 percent of first-generation immigrants. Figure 3 shows the land area covered by our sample.

Figure 4 provides a map image of several survey blocks. Tilden Public School in the center of the image is surrounded by noxious facilities, indicated by "++N" on the map. The building heights of all structures over four stories can also be seen (surveyors occasionally indicated three-story buildings although not consistently). The letters on buildings correspond to specific uses, which we classified as residential, commercial, or manufacturing (further distinguished by subclass) using the same system as the Chicago Zoning Commission in 1922. Of particular interest to

[16] Centennial List of Mayors, City Clerks, City Attorneys, City Treasurers, and Aldermen, 1937.

[17] The two blank areas are the result of missing data. We had to omit 84 enumeration districts (out of 1,884) from our sample: 36 were missing from Ancestry.com's database and 48 had illegible or missing land use maps, leaving us with 1,800 observations.

[18] Our sample covers 64 percent of the 1920 area of Chicago.

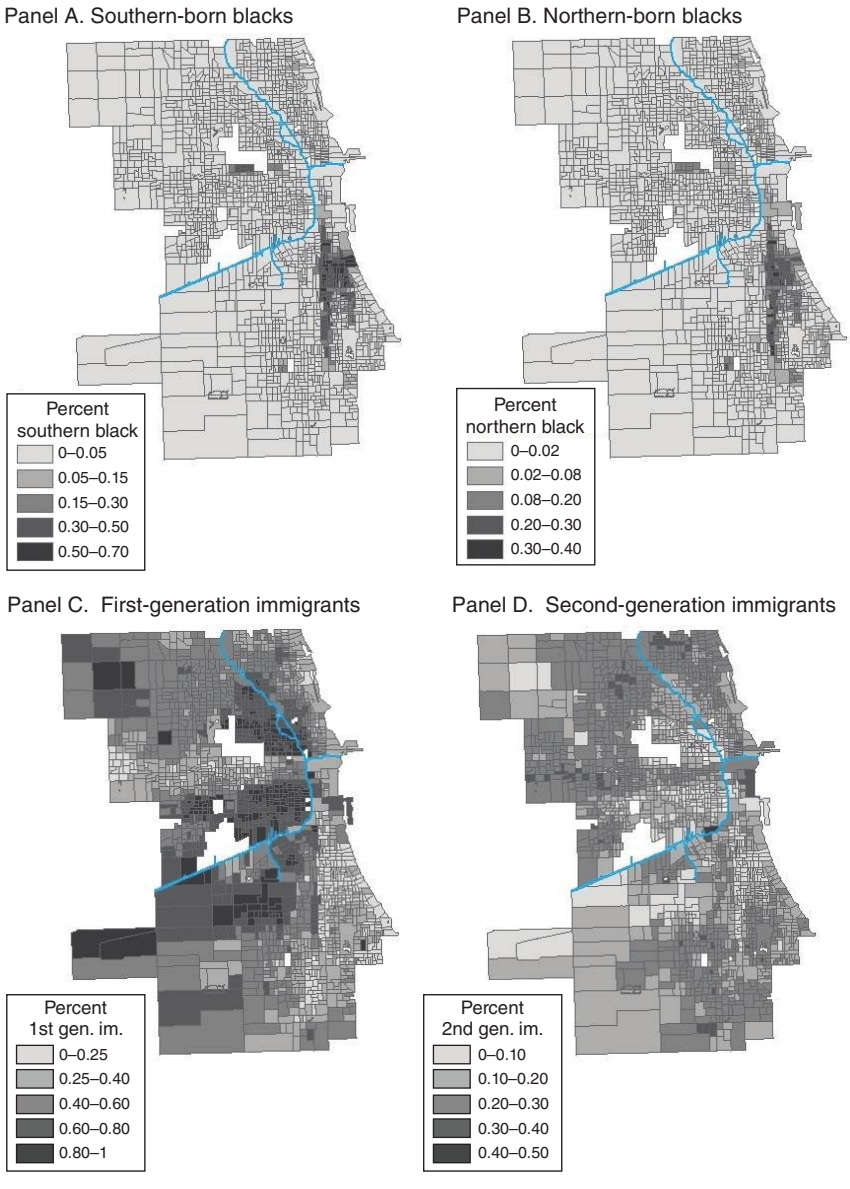

FIGURE 1. DISTRIBUTION OF BLACKS AND IMMIGRANTS ACROSS CHICAGO IN 1920

Notes: The sample covers the 1800 enumeration districts for which we have digitized land use data and census data. Southern blacks are black individuals born in the South or black individuals born in the North whose fathers were born in the South. Northern blacks are black individuals born in the North whose fathers were also born in the North. First-generation immigrants are individuals born abroad or minor second-generation immigrants (aged 18 or younger). Second-generation immigrants are individuals aged 18 and above who were born in the United States but whose fathers were born abroad.

our study are the various manufacturing classes: A and B include general manufacturing that does not cause a nuisance but may require yard storage, class S includes large-scale industrial facilities such as rail yards and granaries, class D covers storage of explosives and high pressure gases, and class C includes manufacturing facilities

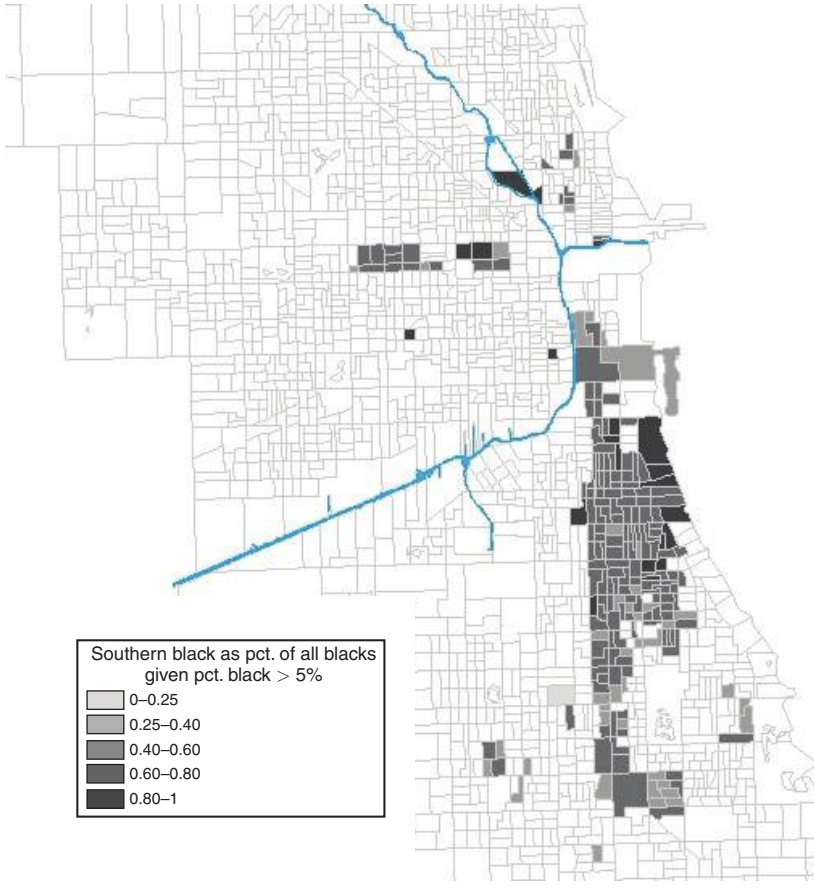

FIGURE 2. DISTRIBUTION OF SOUTHERN BLACKS AS PERCENTAGE OF ALL BLACKS

Notes: The figure shows the share of the percentage of each enumeration district's black population that we classify as being southern black among the sample of enumeration districts that are at least 5 percent black. Southern blacks are black individuals born in the South or black individuals born in the North whose fathers were born in the South.

that emit noise, smoke, odors, or pose a fire risk. We consider the noxious facilities in class C separately in much of our analysis (only one instance of class D manufacturing exists in our sample). Commercial use is indicated using only one category and covers retail establishments, offices, and entertainment venues such as theaters.[19]

C. *Comprehensive Zoning Ordinance of 1923*

We digitized the initial zoning ordinance for the same broad sample of Chicago as the land use survey, recording both volume zoning and use zoning. The volume districts in the zoning ordinance are essentially rough concentric rings radiating out from the central business district. Figure 5, panel A displays these districts with

[19] See the online Appendix for details on how the spatial and land use variables were constructed.

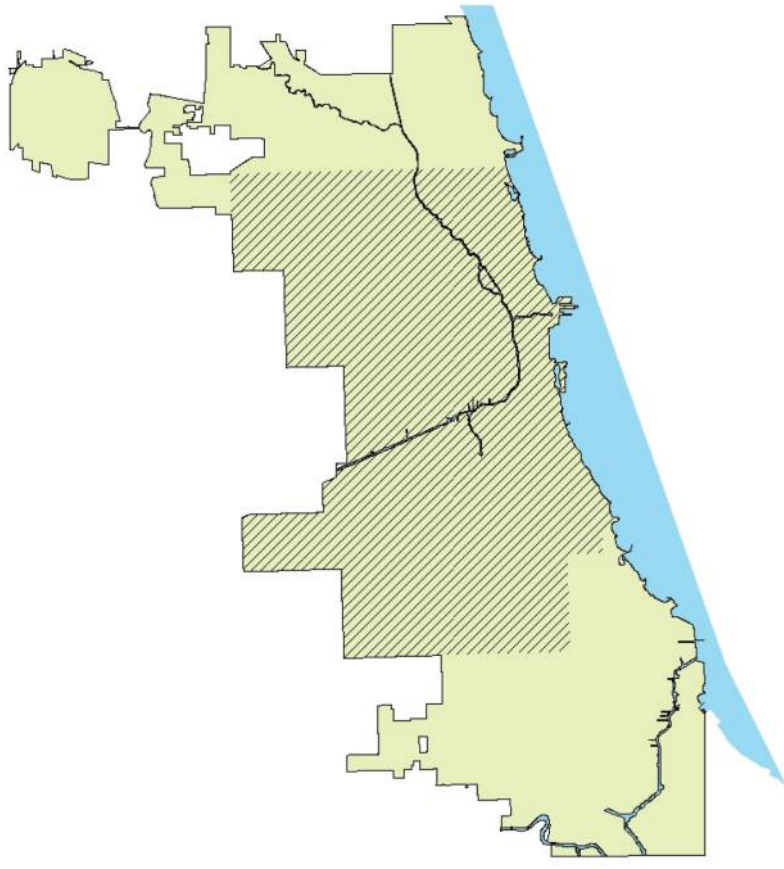

FIGURE 3. SAMPLE COVERAGE

Notes: The image shows the current (2013) borders of Chicago as well as Lake Michigan and the Chicago River. The hatched area is the section covered by our sample. Our sample covers 64 percent of the 1920 area of Chicago and 56 percent of the current city area.

each enumeration district assigned to the volume district most common within its borders. Our volume district analysis focuses on districts 1 and 2. Under zoning for volume district 1, buildings were capped at five to six stories and could cover only 50 percent of an interior lot. In volume district 2, buildings could reach 12 to 13 stories and cover 60 percent of the lot. The effective difference in height and density limitations between these two districts was actually much greater due to restrictions on overall building volume. The district 1 maximum building height was effectively 33 feet, corresponding to roughly three stories, while the district 2 maximum height was effectively 8 to 10 stories. The inner three volume districts allowed buildings with effective heights of 11, 16, and 22 stories, respectively, and were concentrated in the central business district (see Figure 5, panel A). There were no density "minimums," only restrictions on the maximum volume, height, and lot coverage.

Use zoning delineated the city into four distinct districts: residential (single-family homes), apartment, commercial, and manufacturing. These use districts were hierarchical, with apartment districts allowing residential uses, commercial districts

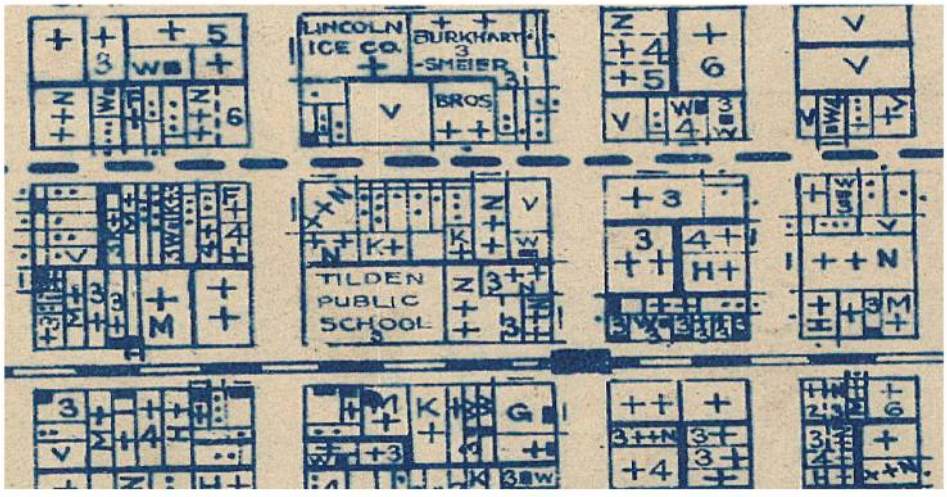

FIGURE 4. LAND USE MAP SAMPLE

Notes: The figure shows a portion of the 1922 land use survey map created by the Chicago Zoning Commission. These blocks are located just across the Chicago River to the west of the downtown. Numbers indicate building heights in stories. Black squares on parcel boundaries indicate commercial uses; letters sometimes accompany these to indicate a specific commercial activity. Black squares within parcel boundaries accompanied by the letter W indicate warehouses. V indicates a vacant lot/building. Letters followed or preceded by a single + indicate light industrial uses. Letters preceded by ++ indicate heavier industrial uses; in particular, ++N indicates uses which "by reason of excessive noise, odor, fumes, gases, etc., affect the adjacent territory." The Tilden Public School shares a block with six of these noxious industrial uses.

allowing both apartments and single-family homes, and manufacturing districts allowing any use.[20] The residential category was rarely used in the initial zoning ordinance; only 3 percent of the enumeration districts in our sample have any zoning of this type. Figure 5, panel B shows a section of a use zoning map from an area west of the downtown along the Chicago River. Zones for apartments, commercial activity, and manufacturing can all be seen.

III. Empirical Approach

Our empirical approach relies on the ability to observe the same land use data employed by the Chicago Zoning Commission when they drafted the ordinance. We pose two questions. First, how were minorities sorted across the city with respect to existing land use and urban geography prior to the zoning ordinance? Second, accounting for geography and extant land use, what was the impact of various minority populations on zoning outcomes? We are particularly interested in whether, all else equal, neighborhoods with minorities received more high density and mixed-use zoning relative to neighborhoods with native whites.

[20] There were additional gradations within the commercial and manufacturing districts, with certain objectionable commercial uses barred if they were within 125 feet of a residential or apartment district, while certain manufacturing uses were barred if they were within 100 to 2,000 feet of a residential, apartment, or commercial district. Some commercial uses within 125 feet of residential or apartment districts also saw restrictions on the hours during which trucking activities could occur.

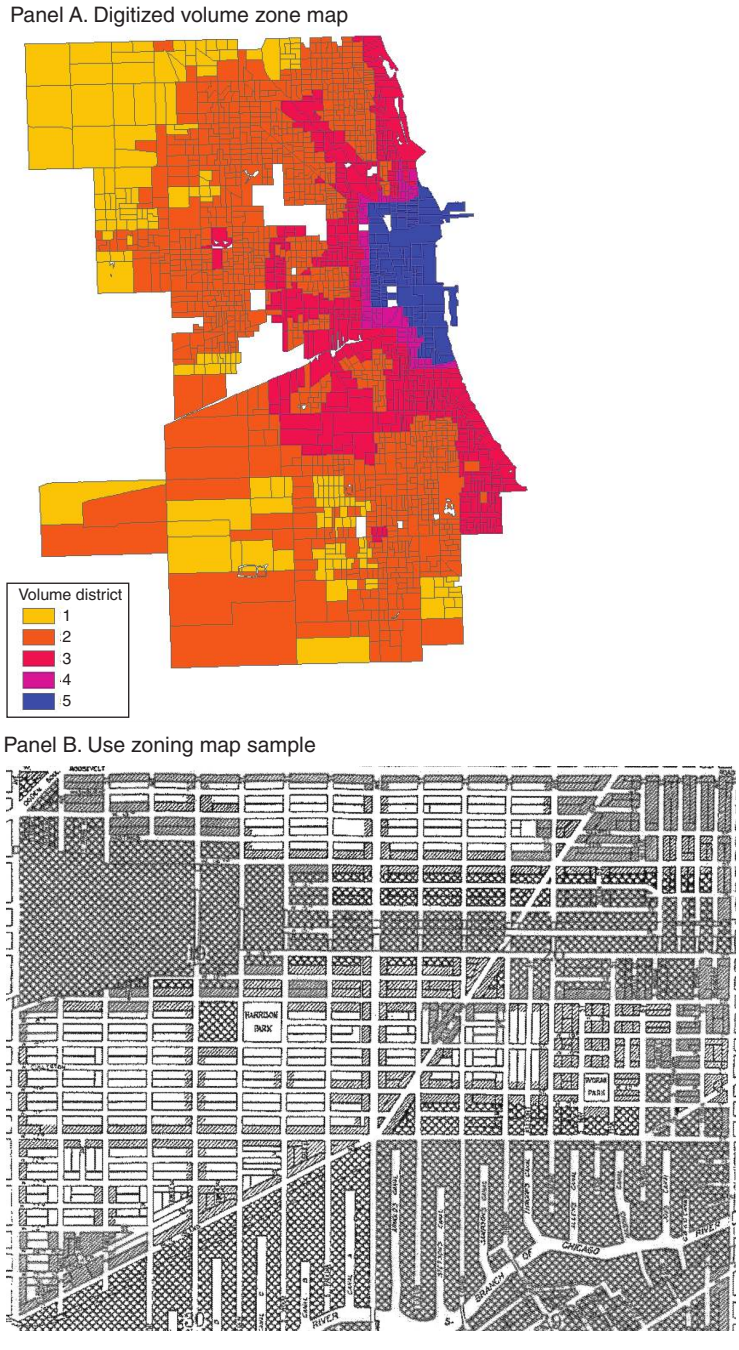

FIGURE 5. ZONING MAPS

Notes: Panel A: This map shows volume districts in the Chicago zoning ordinance with enumeration districts assigned to the volume district in which the majority of its area fell. District 5 permitted the tallest buildings, up to 22 stories. District 1 was the most restrictive, allowing only buildings with three or fewer stories. Panel B: This image shows the area of Chicago west of the downtown along the Chicago River. Unhatched areas are zoned for apartments, hatched areas are zoned for commercial uses, and cross-hatched areas are zoned for manufacturing.

Identifying the causal impact of neighborhood composition on zoning outcomes requires that we sufficiently account for other determinants of zoning that were correlated with these demographic factors. Our primary approach involves conditioning on an extensive array of economic, political, geographic, transportation, and land use variables constructed from the land use survey and digitized spatial data for the city of Chicago. We discuss these variables in detail below. Our empirical strategy attempts to block all "back-door" paths from our demographic variables to zoning outcomes (Pearl 2009). Of particular concern is the possibility that minorities sorted into neighborhoods that were unobservably well-suited for industry or dense development. Recognizing the limits of our ability to block all alternate mechanisms via controls, we further explore the robustness of our main results using a series of specification checks.[21]

Our baseline specification is

$$y_i = x_i'\beta + ward_i + \epsilon_i, \tag{1}$$

where y_i measures a zoning outcome in enumeration district i; $ward_i$ is a ward fixed effect; and x_i includes the extensive list of spatial and land use controls described below plus measures of the share of the enumeration district population composed of blacks, the share composed of first-generation immigrants, and the share composed of second-generation immigrants. We use robust standard errors (White 1980)[22] and decompose the black share into Southern- and Northern-born blacks in much of the analysis. We measure zoning outcomes using both continuous and discrete variables as appropriate. For example, we assess the probability that an ED contains any manufacturing zoning as well as the percentage of the enumeration district that is zoned for manufacturing. Because relatively few enumeration districts straddle the relevant density zone borders, we use only discrete outcomes for density zoning. Each enumeration district is assigned to the zoning district in which most of its area falls. For continuous outcomes, we report results from Tobit models, which assume the existence of a latent variable equal to $x'\beta$ plus a normal error term. The observed value of the latent variable equals zero if the latent variable is below zero; similarly, it equals one if the latent variable exceeds one. This model accounts for the fact that EDs receiving boundary values may differ substantially in their suitability for different types of zoning.[23]

[21] It is possible that blacks and immigrants varied in other ways which led their neighborhoods to be treated negatively in the zoning process. Further, our results could be driven by statistical discrimination rather than racial or ethnic animus. Our reading of the history suggests that blacks in particular were treated disadvantageously in real estate markets because they were black per se.

[22] Using the method of Conley (1999) to construct standard errors robust to spatial autocorrelation consistently resulted in smaller standard errors, which—in an effort to be conservative—we do not report here.

[23] In the Tobit model, β is the marginal effect of x on the underlying latent variable; the marginal effect over the uncensored range is obtained by multiplying this β by a shrinkage factor, which explains why it is generally larger than the estimates we obtain from the OLS specifications (McDonald and Moffit 1980). As an alternative, Papke and Wooldridge (1996) recommend the fractional logit estimation procedure in this context. In an out-of-sample prediction error test, the Tobit model outperformed the fractional logit model. As a robustness check, we also estimated all of the continuous dependent variable models reported here using the fractional logit specification. These results were qualitatively similar to those reported in the paper. For parsimony, we only report the Tobit results.

The primary identification challenge associated with interpreting equation (1) is that recent immigrants and black migrants may have located in cheaper areas of the city that were also suitable for manufacturing activity or dense urban development. We include a number of land value and wealth controls to address this concern. First, all specifications include a measure of land values transcribed by Gabriel Ahlfeldt and Daniel McMillen from the 1913 edition of Olcott's Blue Books.[24] Specifically, this variable is the average land value per front foot based on 125 foot tracts (see McMillen 2012). As a further control for household wealth, we use the head of household variable in the census to develop an income measure based on live-in hired help. For each enumeration district, we count the number of household heads as well as the number of individuals who report being a maid, cook, servant, or laborer in relation to the head of house.[25] We then compute the ratio of live-in hired help to heads of household and include this value in our regressions. We also include ward fixed effects to account for differential political influence exerted by alderman. There are approximately 51 enumeration districts per ward in our sample. Finally, to control for potential home neighborhood motivations by the zoning board members, we added an indicator for whether a zoning board member lived in the enumeration district.[26]

The models we estimate are all single index models, i.e., functions of a linear combination $x'\beta$ of our covariates. To permit nonlinearities in responses, we allow covariates to enter through indicators as well as polynomials. Specifically, spatial and transportation variables, such as distance to the central business district, distance to the nearest major street, distance to Lake Michigan, distance to the nearest river, distance to the nearest railroad, and distance to an ancillary railroad, all enter as quartic polynomials, and we include indicators that equal one whenever an enumeration district is proximate to any of these features. We also include quartic polynomials for population density and the area of the enumeration districts.

To control for existing land use, we include variables measuring the density of commercial uses, warehouses, and each of the five different manufacturing use classes; these enter as both indicators and quadratic polynomials in the density of each type of use. To account for large industrial sites, we add an indicator equal to one if the ED includes a contiguous area greater than 800,000 square feet (approximately four city blocks) populated by heavy industry. We include separate indicators for enumeration districts overlapping the Union Stockyards and those within 1,000 feet of the Stockyards. To capture the industrial character of the area surrounding an ED, we also include counts of different manufacturing

[24] Land prices may have influenced zoning directly; for example, the zoning board may have considered areas with cheaper land to be more suited for large-scale industrial uses. Land prices may also proxy for unobservable neighborhood characteristics. Since both racial and ethnic composition and unobservable neighborhood characteristics can be expected to have had a causal effect on land prices, conditioning on land prices may induce a correlation between these variables even if they are unconditionally independent. This "collider-stratification" could bias our estimates (Greenland 2003; Pearl 2009). Their inclusion has a small effect on our coefficient estimates.

[25] We do not observe occupation in the Ancestry.com data, so relation to head of house is our only opportunity to measure household employment status.

[26] Only one enumeration district with a board member received any industrial zoning. We explored a variety of political representation indicators in our analysis, including whether a ward's alderman served on the zoning board. We found small and insignificant results on manufacturing zoning for all variables relating to local representation on the board.

uses in 500 and 1,000-foot rings around each enumeration district. To account for the existing distribution of building heights, we include the densities of four, five, six, seven, eight, nine, and ten story buildings. We also include the density of 11 through 25 story buildings; disaggregating this category has little impact on the analysis due to the concentration of these buildings in the central business district. Online Appendix Table II provides a complete listing of our control variables by category.

To evaluate the relative importance of different factors affecting zoning outcomes, we partition our covariates into four distinct groups and compare the predictive power of models based solely on each group of variables. The groups included are: geography (ED area and the distance to the CBD, Lake Michigan, and the nearest river), transportation (distance to a railroad and major street), preexisting uses (density of different commercial/manufacturing uses and 4+ story buildings), and demographics (percent southern/northern black, first/second generation immigrant, maids per head of household). For both commercial and manufacturing zoning, we compare the reduction in prediction error resulting from adding each subset of variables to an otherwise uninformative model.

Predictive power is measured using out-of-sample mean absolute prediction error. To estimate this statistic, we use five-fold cross-validation. The sample is randomly divided into five subsets, and each model is estimated on four of the subsets. Then, out-of-sample prediction error is calculated using the excluded subset, with the exercise repeated using a different holdout sample each time. The five prediction errors are then averaged. Finally, because blacks were concentrated in a small subset of Chicago neighborhoods, we replicate this exercise on a subset of neighborhoods that we expect to more effectively capture the margin at which race may have played a role in zoning decisions. In particular, we focus on the set of enumeration districts that were either at least 5 percent black or were located within 1,000 feet of such a neighborhood.

IV. Existing Patterns of Minority Residential Location

We begin by documenting the distribution of minority location across the city and within neighborhoods with respect to measures of urban density, proximity to commercial and manufacturing activity, and proximity to other demographic groups. Table 2 reports the exposure to various land uses experienced by the average member of each demographic group.[27] The first two columns of panel A report the average number of four story and four to ten story buildings per acre experienced by members of each demographic group. Southern-born blacks had the highest exposure to both categories of tall structures, followed by Northern blacks, and then first-generation immigrants. However, first-generation immigrants experienced the highest population density (column 3). The ordering is similar for commercial enterprises per acre, noxious facilities per acre (defined as the number of Manufacturing

[27] Additional analysis of the relationship between demographics and preexisting land uses can be found in the online Appendix, where Table I provides results from regressing a variety of land use variables on demographic composition and basic spatial controls.

Table 2—Exposure to Urban Features and other Demographic Groups

Group	Number 4+ story buildings (1)	Number 4–10 story buildings (2)	Population density (3)	Commercial enterprises per acre (4)	Noxious facilities per acre (5)	Industrial facilities per acre (6)
Panel A						
Southern blacks	0.19	0.22	64.91	0.91	0.0072	0.02
Northern blacks	0.17	0.21	64.21	0.89	0.0060	0.02
First-gen. immigrants	0.12	0.15	70.09	1.01	0.0070	0.02
Second-gen. immigrants	0.08	0.11	58.01	0.72	0.0046	0.01
Third-gen. whites	0.10	0.14	55.00	0.64	0.0040	0.01
Sample average	0.11	0.15	58.03	0.79	0.0071	0.02

Group	Share southern black (1)	Share northern black (2)	Share first-gen. immigrant (3)	Share sec.-gen. immigrant (4)	Share white third-gen. (5)	1913 avg. land prices (6)
Panel B						
Southern blacks	0.45	0.19	0.16	0.08	0.14	90.66
Northern blacks	0.42	0.19	0.17	0.09	0.15	96.69
First-gen. immigrants	0.01	0.01	0.60	0.19	0.20	93.11
Second-gen. immigrants	0.01	0.01	0.45	0.23	0.29	92.15
Third-gen. whites	0.02	0.01	0.38	0.23	0.36	125.67
Sample average	0.04	0.02	0.46	0.21	0.27	103.37
Sample SD	0.13	0.06	0.22	0.08	0.16	386.98

Notes: The numbers in panel A reflect the average value of the variable specified for the column experienced by the average member of the group specified for the row. For example, the first two columns of panel A report the average number of four-story and four-to-ten story buildings per acre experienced by the average member of each demographic group we study. Panel B documents minority exposure to other demographic groups as well as the typical 1913 average land value experienced by the typical member of each group. See Figure 1 for demographic group definitions.

Source: The demographic data come from Ancestry.com and the land use counts were computed using the 1922 Land Use Survey created by the Chicago Zoning Commission.

class C uses), and general manufacturing facilities per acre (defined as Manufacturing classes B, C, and S uses), with both black groups and first-generation immigrants having the highest exposure (columns 4–6). Although industrial facility exposure was essentially equal across groups, Southern blacks and first-generation immigrants were exposed to the most noxious industrial uses (0.007 uses per acre compared with 0.006 for Northern blacks and 0.0046 for second-generation immigrants).

Minority exposure to other demographic groups is shown in panel B. As we would expect, both northern and southern blacks live in enumeration districts with larger shares of other blacks. However, the sum of share Northern and share Southern black faced by the average Southern black is only 0.64. We interpret this result as evidence that blacks were not completely segregated by race; we also note that many black individuals served as live-in maids in white neighborhoods and would have been enumerated in their employers' houses. Immigrants and native whites had very low exposure to blacks (average share 0.02 and 0.03, respectively). Finally, we observe that Southern blacks lived on the cheapest land relative to other groups, with first-generation immigrants just behind them. The difference in land values faced by the average black and average third-generation white is a striking $35 ($90.66

versus $125.67 in 1913 dollars) and underscores the potential importance of controlling for land values in our regressions.

These relationships illustrate the need to control for existing sorting according to land use when asking how the spatial distribution of minorities shaped the zoning ordinance. We note, however, that the land use and demographic composition relationships identified in panel B are in many instances at odds with the zoning findings we report in the next section, suggesting that our main results cannot be driven solely by preexisting relationships between land use and demography that later influenced the zoning ordinance.

V. The Impact of Minority Share on Zoning Outcomes

A. *Density Zoning*

We begin by exploring whether density zoning was used to concentrate blacks in higher density neighborhoods, a potential precursor to modern day arguments regarding exclusionary zoning.[28] Because the volume districts were essentially concentric rings radiating out from the central business district, the opportunity for adjustment existed along the border of adjacent volume districts. We focus on the two outermost rings, which were volume districts 1 and 2 (see Figure 5, panel A). Under zoning for volume district 1, buildings were effectively capped at three stories. In volume district 2, apartment buildings could reach as high as eight to ten stories. As a result, volume districts 1 and 2 effectively delineated the boundary between high-density and low-density housing making this boundary the relevant margin for the proto-exclusionary zoning behavior we seek to analyze.

To focus our analysis on this region of potential adjustment and increase the comparability of our sample we focus our analysis on the border between volume districts 1 and 2, identifying the sample of enumeration districts that are within 1,000 feet of both types of zoning, to obtain a sample of neighborhoods that were similar prior to the adoption of the zoning ordinance.[29] To test for a potential exclusionary zoning motive in the location of these boundaries, in Table 3 we report the results from an OLS analysis with the outcome variable equal to one if the enumeration district received a majority of zoning for volume district 2. To make the results readily comparable across groups, we report both coefficient estimates and standard errors in units of standard deviations for the relevant demographic variable (for instance, the coefficient on the variable "Southern black" is reported in units of the standard deviation of Southern black share). The standard deviations for each variable are reported in Table 1. The omitted demographic category is native-born whites (of the third generation or greater).

[28] A second potential vehicle through which the zoning ordinance could have been used to advance exclusionary motives would have been through the location of residential versus apartment use zoning. However, in practice, residential zoning was restricted to outlying portions of the city in neighborhoods that were not proximate to significant numbers of black residents. Thus, there is little scope for an empirical analysis of trade-offs along this margin.

[29] We also experimented with the full sample of enumeration districts in volume districts 1 and 2; however, there are very few blacks living in outlying parts of the city, and comparing these all-white neighborhoods to areas closer to the downtown yielded estimates that were sensitive to specification. We thus focus our attention on the border sample which, while limited in scope, allows us to control for unobserved neighborhood characteristics.

Table 3—Effect of Minority Share on Volume Zoning

	Indicator for receiving a majority zoning for higher density			
	(1)	(2)	(3)	(4)
Total black percent share	0.0350		0.268	
	(0.0994)		(0.0964)	
Southern black share		0.208		0.294
		(0.261)		(0.198)
Northern black share		−0.126		0.00344
		(0.217)		(0.166)
First-gen. immigrant share	−0.0716	−0.0720	−0.0585	−0.0592
	(0.0456)	(0.0457)	(0.0898)	(0.0900)
Second-gen. immigrant share	−0.0190	−0.0192	0.0826	0.0817
	(0.0443)	(0.0443)	(0.0586)	(0.0588)
1913 land values			5.046	5.035
			(0.757)	(0.758)
Diff. between black and first-gen. effect (p-value)	0.264		0.001	
Diff. between south. black and first-gen. effect (p-value)		0.289		0.093
R^2	0.007	0.008	0.525	0.525
Controls	No	No	Yes	Yes
Observations	395	395	395	395

Notes: Sample is restricted to EDs within 1,000 feet of the border between volume districts 1 and 2 and excluding EDs containing any other type of volume zoning. Volume district 1 restricted buildings to roughly three stories in height; volume district 2 permitted apartment buildings with eight to ten stories (depending on overall building volume, see Section IIIC for details). The outcome indicator is equal to one if the enumeration district received a majority of volume district 2 zoning, the higher density type. Demographic variables are standardized. The specifications in columns 3–4 include the full set of controls listed in online Appendix Table II. See Figure 1 for demographic group definitions.

We begin with a simple specification omitting any controls (columns 1 and 2) and then add the full set of controls for geography, land use, political boundaries, and economic values (see online Appendix Table II for list) in columns 3 and 4. Here we are particularly interested in the relative treatment of blacks and European immigrants. Given the historical narrative regarding perceptions of southern blacks we also decompose the effects of Southern and Northern blacks. The no-controls specifications are relatively uninformative. Point estimates are positive for black and Southern black percentages and negative for first generation immigrant percentages, but standard errors are large (p-values for the tests of unequal coefficients are 0.26 and 0.29).

Adding controls increases the precision of our estimates. Results from column 3 indicate that a standard deviation increase in black share increased the likelihood that a neighborhood received higher density zoning by 22 percentage points relative to the omitted category of native-born whites (p-value < 0.01). When we decompose this effect by separating Northern and Southern blacks in column 4, while we lose some precision (p-value $= 0.14$), the results suggest that the presence of southern blacks drive this density zoning result.[30] In contrast, first-generation

[30] The low precision of these estimates may arise from the fact that there are relatively few black neighborhoods in the border sample. For example, the main area of the "black belt" shown in Figure 2 received none of the lowest density zoning category.

immigrant populations are insignificantly negatively associated with higher density zoning in all specifications in Table 3. Further, in the models of both columns 3 and 4, we reject the hypothesis that blacks and southern blacks were treated the same as first-generation immigrants in terms of density zoning. In interpreting these results we highlight that, prior to zoning, first-generation immigrants generally lived in *more* densely populated neighborhoods (see Table 2) than did blacks. Thus, disparate outcomes for blacks and immigrants are unlikely to be driven by ex ante sorting. This fact also helps explain why the inclusion of spatial controls makes a difference for the estimated coefficients.

In some ways, these findings are unexpected because our reading of the history indicates the overarching concern of the zoning board relating to density was to keep skyscrapers in the downtown area. However, our results suggest that a precursor to modern-day exclusionary zoning may be found in the implementation of Chicago's initial zoning law. At the time, both European immigrants and black migrants faced housing shortages. The Chicago Zoning Board adopted a strategy that had the effect of keeping blacks in place through high-density housing. In contrast, lower density zoning in European immigrant neighborhoods suggests an expectation or intention that these immigrants would spread out across the city. Given the existence at the time of public animus toward both recent European immigrants and blacks, one possibility is that this differential treatment reflected the 1921 passage of federal immigration restrictions. With the border closing, the tide of European immigration was abating, while the inflow of Southern blacks was likely to continue unabated.

Nonetheless, our findings suggest an early form of exclusionary zoning that was applied only to blacks and likely altered the trajectory of neighborhood density faced by minority groups. Previous work has suggested that legal barriers and collective action were the driving forces behind segregation in the prewar period; this evidence mainly takes the form of higher housing prices in black neighborhoods (Cutler, Glaeser, and Vigdor 1999). Higher density zoning could have been one mechanism through which black-white segregation was perpetuated. Alternately, higher density zoning could also have improved welfare for blacks who were trapped in particular neighborhoods by allowing the construction of more housing units within the existing ghetto.

B. *Manufacturing Zoning*

We next examine the relationship between the size of various minority groups and the likelihood of being zoned for manufacturing uses, again scaling coefficients by the standard deviation of the respective minority group. Turning first to the presence of any manufacturing zoning in the neighborhood, columns 1 through 3 of Table 4 report coefficient estimates from versions of equation (1) where the dependent variable is an indicator for the presence of manufacturing zoning in the neighborhood. We begin with a simple OLS model omitting all controls; this specification can be thought of as the standard environmental justice regression that does not control for sorting into areas suited for manufacturing. The results show a significant positive relationship between both black and first-generation immigrant share and the likelihood of receiving at least some zoning for manufacturing. In column 2 we include

Table 4—Effect of Minority Share on Manufacturing Zoning

	Ind. for industrial zoning in ED OLS			Percent of ED zoned industrial Tobit		Percent of ED zoned industrial OLS (percent industrial > 0)	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Total black share	0.040	0.054		0.0420		−0.006	
	(0.0162)	(0.0156)		(0.0158)		(0.0175)	
Southern blacks share			0.077		0.112		0.064
			(0.0233)		(0.0208)		(0.0225)
Northern black share			−0.022		−0.0655		−0.063
			(0.0219)		(0.0174)		(0.0197)
First-gen. immigrant share	0.080	0.068	0.067	0.0669	0.0682	0.001	0.006
	(0.0137)	(0.0200)	(0.0201)	(0.0198)	(0.0196)	(0.0192)	(0.0191)
Second-gen. immigrant share	−0.027	0.017	0.016	−0.0175	−0.0179	−0.037	−0.035
	(0.0147)	(0.0162)	(0.0163)	(0.0162)	(0.0160)	(0.0180)	(0.0177)
1913 land values		0.009	0.011	0.000608	0.00557	−0.017	−0.013
		(0.0103)	(0.0104)	(0.00995)	(0.0108)	(0.0099)	(0.0097)
Controls	No	Yes	Yes	Yes	Yes	Yes	Yes
R^2/Pseudo R^2	0.044	0.632	0.635	0.916	0.923	0.689	0.697
Observations	1,800	1,800	1,800	1,800	1,800	471	471

Notes: Columns 2–7 include the full set of controls listed in online Appendix Table II. Demographic variables are standardized. See Figure 1 for demographic group definitions.

the full vector of controls described in Section III. We find that a standard deviation increase in black (first-generation immigrant) share increases the likelihood that a neighborhood received any manufacturing zoning by 5.4 (6.8) percentage points relative to native whites. The R^2 rises from 0.044 to 0.632 with the addition of controls.

In column 3 we replicate column 2 with Northern and Southern blacks included separately. It is immediately clear from these results that the positive relationship between black share and the presence of manufacturing zoning is being driven by Southern blacks. The results in column 3 imply that a 1 standard deviation increase (roughly 13 percentage points) in Southern black share is associated with a 7.7 percentage point increase in the likelihood of an ED being zoned to include manufacturing uses. These estimates are particularly large given that only 26 percent of enumeration districts in our sample received any manufacturing zoning. In contrast, Northern blacks were less likely to get manufacturing zoning in their neighborhoods. This finding is consistent with the anecdotal evidence regarding the status of Northern blacks in the zoning process. Neighborhoods with larger populations of Northern blacks were likely wealthier, more exclusive, and better represented by the Zoning Commission. In particular, contemporary reports suggest that Charles S. Duke, an African-American on the Zoning Commission, actively worked to protect Northern black interests during the zoning process (Schwieterman and Caspall 2006).

So far, we have argued that manufacturing use zoning was unambiguously "bad" in the sense that minority communities thus zoned would face disproportionate environmental hazards and decreased future home values. However, it is also possible

that poor minority groups benefited economically from living in close proximity to their places of employment due to lower transportation costs. One response to this possibility is to focus instead on the share of a neighborhood that is zoned for manufacturing uses. The motivation here is that a positive relationship between minority share and the *percentage* of manufacturing zoning may be more consistent with the notion of encroachment of industry into black and immigrant neighborhoods and a finding that minorities were disadvantageously zoned.

Thus, we replicate our basic model using the continuous outcome measure, the percent of the enumeration district zoned for manufacturing. Tobit results are presented in columns 4 and 5 of Table 4. The dichotomy between the experience of Northern and Southern blacks is highlighted in these specifications. Overall, a 1 standard deviation increase in total black share is associated with a roughly 4 percent increase in the area of an ED being zoned for manufacturing uses. This effect is again driven by southern blacks, with a standard deviation increase in Southern black share associated with an 11 percentage point increase in manufacturing zoning. As with the extensive margin, Northern blacks were protected from manufacturing zoning at the intensive margin. In standard deviation terms, the southern black effect is nearly twice as large as the effect on first-generation immigrant share (0.112 versus 0.068). For completeness, in columns 6 and 7 we further report OLS results, dropping from the sample EDs that received no manufacturing zoning. The decomposed results presented in column 7 highlight the differential treatment of Southern and Northern blacks. Thus, our primary finding on manufacturing zoning is that Southern black and first-generation immigrant neighborhoods were more likely to be zoned for manufacturing uses and tended to receive a larger amount of such zoning.[31]

To investigate the robustness of our approach, we reran the specifications from Table 4 restricting our sample to enumeration districts with limited exposure to manufacturing uses. These results, presented in online Appendix Table III, are quantitatively similar to the baseline results presented in Table 4.

C. *Commercial Zoning*

We next turn our attention to commercial zoning. While zoning for this use was undesirable for the wealthiest of neighborhoods that were exclusively residential, poor black and immigrant populations would likely have viewed close proximity to food stores, shops, and entertainment venues as a benefit and would have viewed proximity to commercial uses as preferable to manufacturing uses.[32] Over

[31] One potential area of interest is the fact that the first-generation immigrant group is itself composed of immigrants from many countries. In online Appendix Table IV, we present the results from the indicator and continuous measures of industrial zoning with the first-generation immigrants further divided by sending country; these results are also presented in standard deviation terms. We observe that no group was as disadvantageously zoned for industrial uses as were southern blacks; furthermore, the coefficients on the share of the enumeration district population composed of the main ethnic groups (Polish, Russian, Italian, Irish, and German) are all quantitatively similar. Thus, it does not appear that any particular immigrant group was singled out for industrial zoning in the same way as southern blacks.

[32] An African American member of the Zoning Commission, Charles S. Duke, succeeded in removing two objectionable parts of the zoning ordinance covering the Black Belt, one of which would have extended a commercial

Table 5—Effect of Minority Share on Commercial Zoning

	Percent of ED zoned commercial OLS		
	(1)	(2)	(3)
Total black percent share	0.009	−0.017	
	(0.0080)	(0.0081)	
Southern black share			−0.049
			(0.0152)
Northern black share			0.032
			(0.0130)
First-gen. immigrant share	−0.009	−0.041	−0.040
	(0.0067)	(0.0082)	(0.0082)
Second-gen. immigrant share	−0.048	−0.018	−0.017
	(0.0067)	(0.0067)	(0.0067)
1913 land values		−0.009	−0.010
		(0.0052)	(0.0053)
Controls	No	Yes	Yes
R^2	0.081	0.582	0.585
Observations	1,800	1,800	1,800

Notes: Columns 2–3 include the full set of controls listed in online Appendix Table II. Demographic variables are standardized. See Figure 1 for demographic group definitions.

92 percent of neighborhoods in our sample experienced at least some commercial zoning. As a result, we focus solely on the intensive margin. This lack of "corner" observations also leads OLS and Tobit models to yield essentially identical results.

In Table 5 we report OLS estimates of the relationship between demographics and the percentage of the enumeration district zoned for commercial uses.[33] We begin with the standard specification without controls in column 1 (continuing to list outcomes in terms of standard deviations). There is no effect of either black or first-generation immigrant share on commercial zoning, while second-generation immigrant share is associated with less commercial zoning. However, adding controls addresses the prezoning sorting shown in Table 2 and online Appendix Table I, and these results are shown in column 2 (black share entered separately) and column 3 (Northern and Southern black share entered separately). Column 3 shows that the small negative effect on total black share is driven by the presence of Southern blacks with Northern blacks receiving more commercial zoning. Similarly to the manufacturing results, we find that first-generation immigrant neighborhoods also received less commercial zoning. Given that commercial zoning was more than twice as prevalent as manufacturing zoning, these estimates for commercial zoning are effectively much smaller in magnitude than are those for manufacturing.

district through Grand Boulevard, where most of the "better colored homes" were situated (Schwieterman and Caspall 2006, 29).

[33] Commercial zoning was much more prevalent than manufacturing zoning: 92 percent of enumeration districts received at least some commercial zoning, while only 28 percent received any manufacturing zoning. Thus, there is little reason to model commercial zoning outcomes using an indicator variable.

Table 6—Main Result by Commercial and Manufacturing Activity Quartiles

	1st quarter	2nd quarter	3rd quarter	4th quarter
Panel A. Commercial density				
Pct. zoned manufacturing				
Avg. pct. zoned manufacturing	15.97%	12.16%	6.78%	4.05%
Percent southern black share	0.0467	0.0131	0.0315	0.0236
	(0.0158)	(0.0193)	(0.0187)	(0.0182)
Percent foreign born share	0.0563	0.00398	0.0184	−0.00531
	(0.0187)	(0.0150)	(0.0146)	(0.00997)
Pct. zoned commercial				
Avg. pct. zoned commercial	9.25%	16.52%	25.23%	36.11%
Percent southern black share	0.00618	−0.000764	−0.0966	−0.0406
	(0.0393)	(0.0269)	(0.0321)	(0.0260)
Percent foreign born share	0.00604	−0.0243	−0.0465	−0.0712
	(0.0110)	(0.0177)	(0.0197)	(0.0203)
Observations	450	450	450	450
Observations w/s. black > 10%	22	40	54	45
Observations w/for. born > 40%	164	233	256	325
Panel B. Manufacturing density				
Pct. zoned manufacturing				
Avg. pct. zoned manufacturing	1.76%	12.15%	12.97%	15.00%
Percent southern black share	0.0188	0.00256	0.0328	0.0117
	(0.0109)	(0.0525)	(0.0188)	(0.0187)
Percent foreign born share	0.0134	0.0613	−0.00725	−0.0107
	(0.00645)	(0.0215)	(0.0155)	(0.0174)
Pct. zoned commercial				
Avg. pct. zoned commercial	13.88%	17.21%	23.37%	33.59%
Percent southern black share	0.0237	−0.161	−0.0625	−0.0283
	(0.0258)	(0.0628)	(0.0290)	(0.0272)
Percent foreign born share	−0.0116	−0.000510	−0.0172	−0.0561
	(0.0124)	(0.0201)	(0.0177)	(0.0239)
Observations	577	323	450	450
Observations w/s. black > 10%	38	11	61	51
Observations w/for. born > 40%	233	206	239	300

Notes: This table conducts an analysis of the determinants of zoning on different subsets of the sample. Panel A divides the sample into four quartiles based on the density of pre-zoning commercial and light manufacturing (mfg A) uses. The first row of panel A lists the average percentage of a block zoned for manufacturing use across each quartile of commercial use density. The next two rows report regression coefficients from models with percent manufacturing zoning as the outcome variable, each estimated on the particular subset of the data. The fourth row of panel A lists the average percentage of a block zoned for commercial uses across the four quartiles of commercial use density. The next two rows report regression coefficients with percent commercial zoning as the outcome variable. Panel B divides the sample into four quartiles based on the density of pre-zoning heavy manufacturing (mfg B, C, D, and S) uses and replicates the exercise from panel A. All specifications include the full set of controls listed in online Appendix Table II. Demographic variables are standardized. See Figure 1 for demographic group definitions. All models are estimated using OLS.

D. *Decomposing the Commercial versus Manufacturing Zoning Trade-off*

To better understand the mechanisms through which minority neighborhoods received more manufacturing and less commercial zoning, in Table 6 we split

the sample by preexisting levels of manufacturing and commercial activity and reproduce our baseline specifications. Panel A presents results by quartile of preexisting commercial use density, and panel B by quartile of preexisting manufacturing use density.[34] To give a sense of scale and overall zoning patterns, we also present the average percentage of the neighborhoods in each quartile that were zoned for commercial or manufacturing uses. We also report by quartile the number of neighborhoods whose population is at least 10 percent Southern black and greater than 40 percent first-generation immigrant.[35]

Turning to the regression results in panel A, the largest concentration of neighborhoods comprised of at least 10 percent Southern blacks occurs in the third quartile of the commercial density distribution. On average, these neighborhoods received a high level of commercial zoning and relatively low levels of manufacturing zoning. A 1 standard deviation increase in Southern black share in these neighborhoods is associated with a 9.7 percentage point decrease in commercial zoning and a 3.2 percentage point increase in manufacturing zoning. Similarly, a 1 standard deviation increase in first generation immigrant shares is associated with a 4.7 and 7.1 percentage point decrease in commercial zoning in the third and fourth quartile neighborhoods (where this group was concentrated).

Panel B presents decompositions based on preexisting manufacturing density.[36] While very little manufacturing zoning was applied in the first quartile neighborhoods, here a 1 standard deviation increase in Southern black or first-generation immigrant share is associated with roughly doubling the level of manufacturing zoning—the second quartile reveals a similar result for immigrants, but not for Southern blacks. Southern blacks and first-generation immigrants were concentrated in the top two quartiles of manufacturing density where commercial zoning was prevalent. However, the presence of both groups was associated with decreased levels of commercial zoning in the neighborhoods where they were most concentrated.

E. *The Relative Importance of Zoning Determinants*

The results presented thus far have focused on the racial and ethnic predictors of zoning. To place our findings in the larger context of land use regulation, we next consider the importance of the demographic predictors compared with three other major categories of zoning determinants: geography (ED area and the distance to the CBD, Lake Michigan, and the nearest river), transportation (distance to a railroad and major street), and preexisting uses (density of different uses and tall buildings). Figure 6 presents prediction error reductions from adding each subset of variables to an uninformative model as described in Section IV. We focus on manufacturing and commercial zoning as outcomes. Panel A shows preexisting land

[34] For parsimony, we only present the coefficient estimates for the enumeration district's percent southern black and percent foreign born, again scaled so that the coefficients reflect the estimated effect of a 1 standard deviation increase in the given demographic group. The underlying regressions include the entire set of control and demographic variables that were incorporated in the baseline specification (listed in online Appendix Table II).

[35] We use a 10 percent cutoff for southern blacks and a 40 percent cutoff for foreign immigrants to characterize the presence of "enclaves" because of the difference in their relative size in the overall population.

[36] Here, there are 577 enumeration districts with no preexisting manufacturing uses. As a result, the first and second quartiles differ in their number of observations.

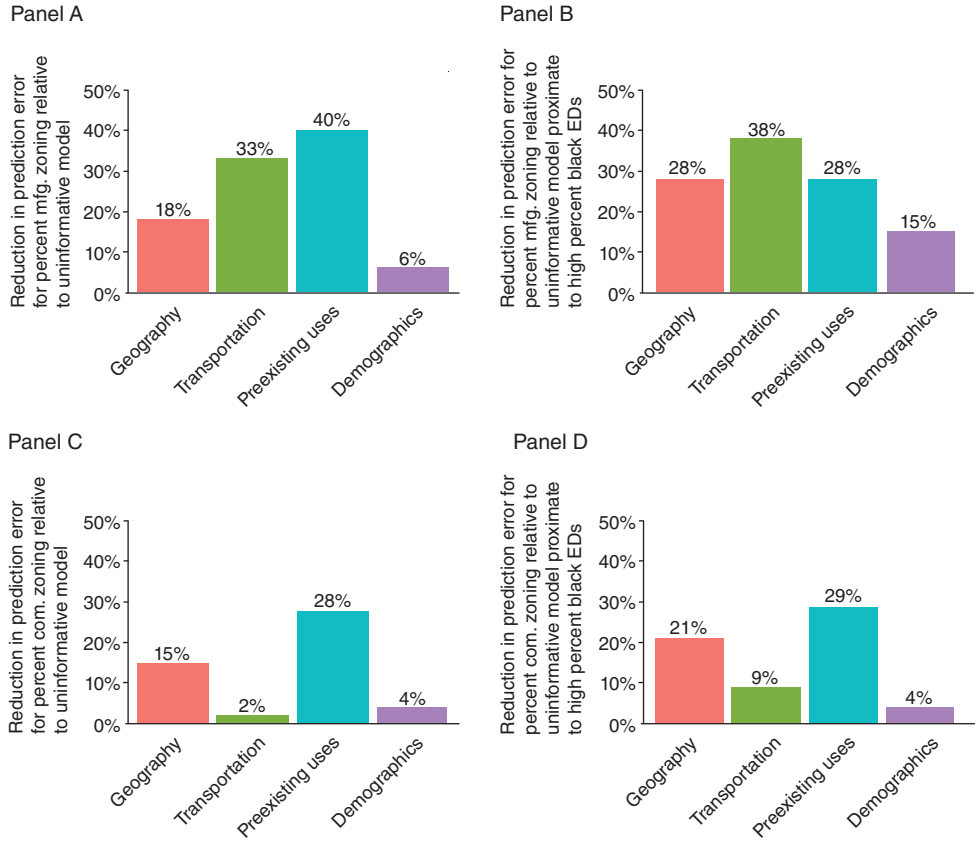

FIGURE 6. DETERMINANTS OF ZONING

Notes: Panel A (top left) shows the reduction in out-of-sample prediction error when different subsets of pre-zoning variables are added to an uninformative model of the percent of an ED receiving manufacturing zoning in 1923. Panel B (top right) repeats this exercise on the subsample of EDs that are at least 5 percent black or within 1,000 feet of such an ED. Panels C and D (bottom left and right) replicate panels A and B, respectively, with the outcome variable now the percent of an ED receiving commercial zoning. Out-of-sample prediction error is calculated using five-fold cross validation.

uses have the most predictive power for manufacturing zoning, reducing prediction error by 40 percent. Transportation factors follow closely, reducing error by 33 percent. Given that manufacturing zoning was placed primarily in industrial areas and near railroads, these findings are unsurprising. Geography was also important since industry was concentrated near water (18 percent reduction). Demographics played a relatively small role overall, reducing prediction error by only 6 percent relative to an uninformative model.

The low level of explanatory power demonstrated by demographics in panel A is perhaps not surprising. As is clear from Figure 1, black residents were concentrated in a relatively small subset of city neighborhoods. Thus, the relevant margin at which demographics would be likely to have much explanatory power is those neighborhoods in and around areas of concentrated black populations. In order to focus on this margin, in panel B we replicate the analysis of panel A, limiting the

Table 7—Impact of 1923 Zoning Ordinance on 1940 Outcomes

	Housing unit density (1)	Population density (2)	Percent zoned industrial (3)	Indicator for industrial zoning (4)	Percent zoned commercial (5)
Percent 1923 lowest density zoning	−1.484	−3.638	0.0521	0.201	0.0195
	(0.548)	(1.909)	(0.0941)	(0.1232)	(0.0446)
Percent 1923 industrial zoning	−4.747	−13.82	0.952	1.540	0.0643
	(2.285)	(8.146)	(0.0421)	(0.1014)	(0.0269)
Percent 1923 commercial zoning	0.167	1.093	0.225	0.204	0.668
	(2.171)	(7.453)	(0.0551)	(0.0633)	(0.0289)
Model	OLS	OLS	Tobit	OLS	Tobit
Observations	395	395	1,800	1,800	1,800

Notes: The sample in columns 1 and 2 is restricted to EDs within 1,000 feet of the border between density districts 1 and 2. The housing density is defined as the number of housing units per acre in the 1940 census. Population density is defined as individuals per acre from the 1940 census. The zoning outcomes in columns 3–5 are from the revision to the Chicago zoning ordinance issued in 1942. The unit of observation for all specifications is the 1920 enumeration district. Zoning and density measures from the 1940 decade are assigned to these geographic areas using areal interpolation. All specifications include the full vector of controls listed in online Appendix Table II.

sample to enumeration districts that were either 5 percent black or were located within 1,000 feet of such enumeration districts. While still not as important as geography, transportation, and preexisting uses, demographics play a much bigger role in predicting manufacturing in these areas, reducing prediction errors by roughly half as much as these other three categories. Turning to commercial zoning, panel C shows that geography and preexisting uses are the primary drivers for commercial zoning. In panel D we show that, even when focusing on the relevant marginal neighborhoods, demographics remain relatively unimportant for predicting the presence of commercial zoning.

F. *Impact of 1923 Zoning on 1940 Housing Density and Zoning Revisions*

In Table 7 we explore whether inequitable treatment in the initial zoning ordinance had persistent effects. We begin with the density component of the ordinance, linking the volume zoning outcome in 1923 to housing and population density from the 1940 census. We are also interested in the impact of the use zoning ordinance on the location of industrial and commercial activity over time; however, the limited availability of land use data in the early twentieth century makes it difficult to undertake a similar analysis for this part of the ordinance. Instead, we digitized the first major revision to the Chicago zoning ordinance, which occurred in 1942, to examine the persistence of use zoning. We show in a companion paper (Shertzer, Twinam, and Walsh 2015) that the 1923 zoning ordinance had robust effects on the location of commercial and industrial activity in 2005. Assessing the persistence in zoning over the 1923 to 1942 period sheds light on the channels through which the initial zoning ordinance affected minority exposure to industry and commerce over the ensuing decades.

For the density persistence analysis, we begin with the sample of 1920 census enumeration districts that were located 1,000 feet from the border between the two

most restrictive volume zoning categories from the 1923 ordinance and proceed in a similar manner to our exclusionary zoning analysis in part *a*. The population and housing unit density of these geographic units in 1940 is interpolated using the 1940 census tracts. Our specifications include the full set of controls for 1922 land use, building characteristics, population density, geography, and land values employed in the main analysis (see online Appendix Table II for the full list), plus the 1923 zoning shares. Column 1 shows that moving to the lowest density category from the second lowest (from volume category 2 to 1) is associated with 1.6 fewer housing units per acre in 1940. The average housing unit density in this sample is 10.9, so this effect represents a 15 percent decrease with respect to the mean. These results suggest that zoning had a causal effect on the subsequent development of the housing stock. Taken together with our results from part *a*, these findings suggest that black neighborhoods became more densely developed relative to immigrant neighborhoods within two decades of the zoning ordinance. The effect of lower density zoning on population density is negative and significant at the 10 percent level (column 2).

Turning to use zoning, we find strong evidence of persistence. Column 3 indicates that a standard deviation increase in 1923 industrial zoning share is associated with an 18.6 percent increase in industrial zoning share in 1942 ($0.196 \times 0.952 = 0.186$) off a base of 9 percent. The effect is similarly large if we use an indicator for any industrial zoning (column 4), with the presence of industrial zoning in 1923 associated with a 65 percentage point increase in the likelihood of industrial zoning in 1942. Finally, we find that commercial zoning is persistent to a similar degree (column 5). Taken together with our main findings, these results suggest that the inequitable treatment of minorities in the use zoning ordinance had meaningful impacts and persisted for decades.

VI. Conclusion

This paper examines the introduction of zoning in Chicago and asks whether ostensibly race blind comprehensive zoning ordinances discriminated against minorities. We find evidence that neighborhoods with more black residents were more likely to be zoned for higher density buildings, suggesting that volume restrictions may have been used as an early form of exclusionary zoning. We also find robust and quantitatively important evidence that otherwise comparable neighborhoods with larger populations of blacks or recent immigrants were zoned disproportionately for manufacturing. Our results are robust to the inclusion of an extensive set of controls for geography, existing land use, land prices, and political factors, so it is unlikely that sorting of minorities into neighborhoods suitable for industry can explain our results.

These findings suggest that zoning reshaped the urban landscape faced by black and immigrant residents of the city of Chicago. Immigrants had selected into more densely populated neighborhoods in the early twentieth century, but one result of the zoning ordinance was to reduce the density of immigrant neighborhoods in the future via constraints on building height. Meanwhile, black neighborhoods were zoned for higher building density along the same margin. Zoning for higher density

and mixed uses meant that minorities were excluded from the economic benefit of low density, purely residential zoning in the 1923 ordinance in terms of increased property values. Moreover, greater exposure to industrial uses may have adversely affected the health of blacks and immigrants relative to native whites. The findings of this paper indicate that zoning may have played a causal role in the adverse experience of minorities as highlighted by the environmental justice and exclusionary zoning literature. Further research is needed to better understand the long-term impacts of land use regulation.

REFERENCES

Ancestry.com. 2010. *1920 United States Federal Census*. Records of the Bureau of the Census, Record Group 29. Provo, Utah: National Archives.

Been, Vicki, and Francis Gupta. 1997. "Coming to the Nuisance or Going to the Barrios? A Longitudinal Analysis of Environmental Justice Claims." *Ecological Law Quarterly* 24 (1): 1–56.

Brooks, Leah, and Bryon Lutz. 2014. "Vestiges of Transit: Urban Persistence at Micro Scale." Unpublished.

Brooks, Richard R. W. 2011. "Covenants without Courts: Enforcing Residential Segregation with Legally Unenforceable Agreements." *American Economic Review* 101 (3): 360–65.

Brooks, Richard R. W., and Carol M. Rose. 2013. *Saving the Neighborhood: Racially Restrictive Covenants, Law, and Social Norms*. Cambridge: Harvard University Press.

Chicago Commission on Race Relations. 1922. *The Negro in Chicago: A Study of Race Relations and a Race Riot*. Chicago: University of Chicago Press.

Chicago Zoning Commission. 1922. *Zoning Chicago*. Chicago, April.

Conley, T. G. 1999. "GMM Estimation with Cross Sectional Dependence." *Journal of Econometrics* 92 (1): 1–45.

Cutler, David M., Edward L. Glaeser, and Jacob L. Vigdor. 2008. "Is the Melting Pot Still Hot? Explaining the Resurgence of Immigrant Segregation." *Review of Economics and Statistics* 90 (3): 478–97.

Depro, Brooks, Christopher Timmins, and Maggie O'Neal. 2015. "White Flight and Coming to the Nuisance: Can Residential Mobility Explain Environmental Justice?" *Journal of the Association of Environmental and Resource Economists* 2 (3): 439–68.

Fischel, William A. 2001. *The Homevoter Hypothesis: How Home Values Influence Local Government Taxation, School Finance, and Land-Use Policies*. Cambridge: Harvard University Press.

Flint, Barbara J. 1977. "Zoning and Residential Segregation: A Social and Physical History, 1910–1940." Ph.D. diss. University of Chicago.

Gossman, James R. 1989. *Land of Hope: Chicago, Black Southerners, and the Great Migration*. Chicago: University of Chicago Press.

Greenland, Sander. 2003. "Quantifying Biases in Causal Models: Classical Confounding vs. Collider-Stratification Bias." *Epidemiology* 14 (3): 300–306.

Hall, Peter. 2002. *An Intellectual History of Urban Planning and Design in the Twentieth Century.* Malden, MA: Wiley-Blackwell Publishing.

Ihlanfeldt, Keith R. 2004. "Exclusionary Land-use Regulations within Suburban Communities: A Review of the Evidence and Policy Prescriptions." *Urban Studies* 41 (2): 261–83.

Kennedy, Louise Venable. 1968. *The Negro Peasant Turns Cityward: The Effects of Recent Migrations to Northern Centers.* New York: AMS Press.

Maantay, Juliana. 2001. "Zoning, Equity, and Public Health." *American Journal of Public Health* 91 (7): 1033–41.

McDonald, John F., and Robert A. Moffit. 1980. "The Uses of Tobit Analysis." *Review of Economics and Statistics* 62 (2): 318–21.

McMillen, Daniel. 2015. "Conditionally parametric quantile regressions for spatial data: An analysis of land values in early nineteenth century Chicago." *Regional Science and Urban Economics* 55: 28–38.

McMillen, Daniel P., and John F. McDonald. 1999. "Land Use before Zoning: The Case of 1920s Chicago." *Regional Science and Urban Economics* 29 (4): 473–89.

McMillen, Daniel P., and John F. McDonald. 2002. "Land Values in a Newly Zoned City." *Review of Economics and Statistics* 84 (1): 62–72 .

Mills, Edwin S. 1979. "Economic Analysis of Urban Land-Use Control." In *Current Issues in Urban Economics*, edited by Peter Mieszkowski and Mahlon Straszheim. Baltimore: Johns Hopkins University Press.

Papke, Leslie E., and Jeffrey M. Wooldridge. 1996. "Econometric Methods for Fractional Response Variables with an Application to 401(k) Plan Participation Rates." *Journal of Applied Econometrics* 11 (6): 619–32.

Pearl, Judea. 2009. *Causality: Models, Reasoning, and Inference*. 2nd ed. Cambridge: Cambridge University Press.

Pogodzinski, J. M. 1991. "The Effects of Fiscal and Exclusionary Zoning on Household Location: A Critical Review." *Journal of Housing Research* 2 (2): 145–60.

Rothwell, Jonathan T. 2011. "Racial Enclaves and Density Zoning: The Institutionalized Segregation of Racial Minorities in the United States." *American Law and Economics Review* 13 (1): 290–358.

Rothwell, Jonathan, and Douglas S. Massey. 2009. "The Effect of Density Zoning on Racial Segregation in U.S. Urban Areas." *Urban Affairs Review* 44 (6): 779–806.

Ruggles, Stephen, et al. 2004. "Integrated Public Use Microdata Series: Version 4.0 (Machine-readable database)." Minneapolis, MN: Minnesota Population Center.

Schwieterman, Joseph P., and Dana M. Caspall. 2006. *The Politics of Place: A History of Zoning in Chicago.* Chicago: Lake Claremont Press.

Sharkey, Patrick. 2013. *Stuck in Place: Urban Neighborhoods and the End of Progress Toward Racial Equality*. Chicago: University of Chicago Press.

Shertzer, Allison, Tate Twinam, and Randall P. Walsh. 2016. "Race, Ethnicity, and Discriminatory Zoning: Dataset." *American Economic Journal: Applied Economics*. http://dx.doi.org/10.1257/app.20140430.

Shertzer, Allison, Tate Twinam, and Randall P. Walsh. 2015. "Zoning and the Economic Geography of Cities." Unpublished.

Shertzer, Allison, Randall P. Walsh, and John R. Logan. 2015. "Segregation and Neighborhood Change in Northern Cities: New Historical GIS Data from 1900 to 1930." http://www.allisonshertzer.com/files/Shertzer%20et%20al%20Hist%20Methods%20November%202015.pdf.

Shlay, Anne B., and Peter H. Rossi. 1981. "Keeping up the Neighborhood: Estimating the Net Effects of Zoning." *American Sociological Review* 46 (6): 703–19.

Troesken, Werner, and Randall P. Walsh. 2015. "Jim Crow on the Block: The Political Economy of Municipal Segregation Ordinances." Unpublished.

Villarreal, Carlos, Brian Bettenhausen, Eric Hanss, and Jonathan Hersh. 2014. "Historical Health Conditions in Major U.S. Cities: The HUE Data Set." *Historical Methods* 47 (2): 67–80.

Wilson, Sacoby, Malo Hutson, and Mahasin S. Mujahid. 2008. "How Planning and Zoning Contribute to Inequitable Development, Neighborhood Health, and Environmental (In)Justice." *Environmental Justice* 1 (4): 211–16.